Gas Network Development Plan 2022–2032

Consultation

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Date: 21 December 2022

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DIE FERNLEITUNGSNETZBETREIBER

Consultation

Gas Network Development Plan 2022–2032

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Realisation:
CBE DIGIDEN AG

Translation:
A.C.T. GmbH

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bayernets GmbH
Munich

Customers: 47 downstream network operators (of which 12 are directly downstream) as well as national and international gas traders

Employees	142
Gas transmission network	1,659 km
Compressor stations	2
Compressor units	5
Total capacity of the compressor units	50 MW
Cross-border interconnection points	5
Exit points in the high-pressure network	1896
Concurrent annual peak load	28,452 MWh/h
Annual exit quantity to final consumers and distributors	74 TWh

Source: www.bayernets.de/infrastruktur/unser-netz/netzstrukturdaten

Ferngas Netzgesellschaft mbH
Schwaig b. Nürnberg

Customers: Gas distribution system operators, municipal utilities as well as industrial customers, traders and shippers

Employees	37 (group)
Gas transmission network	approx. 214 km
Compressor stations	0
Compressor units	0
Total capacity of the compressor units	0 MW
Cross-border interconnection points	0
Exit points in the high-pressure network	19
Concurrent annual peak load	5,252 MWh/h
Annual exit quantity to final consumers and distributors	16 TWh

Source: www.ferngas.de/314.html

Fluxys Deutschland GmbH
Düsseldorf

Customers: Gas traders

Employees	6
Gas transmission network	approx. 920 km
Compressor stations	0
Compressor units	0
Total capacity of the compressor units	0 MW
Cross-border interconnection points	1
Exit points in the high-pressure network	2
Concurrent annual peak load	4,720 MWh/h
Annual exit quantity to final consumers and distributors	32.74 TWh

Source: www.fluxys.com/de/company/fluxys-deutschland/nel-eugal

Fluxys TENP GmbH
Düsseldorf

Customers: 32

Employees	15
Gas transmission network	approx. 1,010 km
Compressor stations	4
Compressor units	17
Total capacity of the compressor units	150 MW
Cross-border interconnection points	3
Exit points in the high-pressure network	22
Concurrent annual peak load	14,989 MWh/h
Annual exit quantity to final consumers and distributors	46.52 TWh

Source: www.fluxys.com/de/company/fluxys-tenp/tenp-pipeline

Information on company name, headquarters, customers, and employees: reporting date 31.12.2021
Other information: reporting date 31.12.2020

GASCADE Gastransport GmbH
Kassel (Hessen)

Customers: Regional companies, municipal utilities, industrial customers and gas traders

Employees	approx. 480
Gas transmission network	2,908 km
Compressor stations	10
Compressor units	32
Total capacity of the compressor units	approx. 552 MW
Cross-border interconnection points	10
Exit points in the high-pressure network	83
Concurrent annual peak load	102,718 MWh/h
Annual exit quantity to final consumers and distributors	136.2 TWh

Source: www.gascade.de/netzinformationen/unser-leitungsnetz

Gastransport Nord GmbH
Oldenburg

Customers: Approximately 50 national and international shippers, regional companies and industrial customers

Employees	43
Gas transmission network	322 km
Compressor stations	0
Compressor units	0
Total capacity of the compressor units	0 MW
Cross-border interconnection points	1
Exit points in the high-pressure network	71
Concurrent annual peak load	6,812 MWh/h
Annual exit quantity to final consumers and distributors	29 TWh

Source: gtg-nord.de/de/netzinformationen/strukturdaten.php

Gasunie
Deutschland Transport Services GmbH
Hanover

Customers: 140 regional companies, municipal utilities, industrial customers and gas traders

Employees	242
Gas transmission network	3,795 km
Compressor stations	10
Compressor units	32
Total capacity of the compressor units	206 MW
Cross border interconnection points	6
Exit points in the high-pressure network	181
Concurrent annual peak load	38,534 MWh/h
Annual exit quantity to final consumers and distributors	146 TWh

GRTgaz Deutschland GmbH
Berlin

Customers: 26 shippers

Employees	39
Gas transmission network	1,161* km
Compressor stations	6*
Compressor units	23*
Total capacity of the compressor units	348* MW
Cross border interconnection points	3*
Exit points in the high-pressure network	15*
Concurrent annual peak load	60,425 MWh/h
Annual exit quantity to final consumers and distributors	220* TWh

* MEGAL value

Information on company name, headquarters, customers, and employees: reporting date 31.12.2021
Other information: reporting date 31.12.2020

Lubmin-Brandov Gastransport GmbH
Essen

Lubmin-Brandov Gastransport

Customers: Gas traders

Employees	3
Gas transmission network	472 km
Compressor stations	1
Compressor units	3
Total capacity of the compressor units	96 MW
Cross-border interconnection points	2
Exit points in the high-pressure network	1
Concurrent annual peak load	no details MWh/h
Annual exit quantity to final consumers and distributors	0 TWh

NEL Gastransport GmbH
Kassel (Hessen)

Customers: Municipal utilities, industrial customers and gas traders

Employees	6
Gas transmission network	441 km
Compressor stations	0
Compressor units	0
Total capacity of the compressor units	0 MW
Cross-border interconnection points	1
Exit points in the high-pressure network	1
Concurrent annual peak load	62,949 MWh/h
Annual exit quantity to final consumers and distributors	0,6 TWh

Quelle: www.nel-gastransport.de/netzinformationen/die-nordeuropaeische-erdgasleitung

Nowega GmbH
Münster

Customers: Regional companies, municipal utilities, industrial customers and gas traders

Employees	116
Gas transmission network	1,541 km
Compressor stations	1
Compressor units	2
Total capacity of the compressor units	1 MW
Cross-border interconnection points	0
Exit points in the high-pressure network	104
Concurrent annual peak load	8,701 MWh/h
Annual exit quantity to final consumers and distributors	25 TWh

Quelle: www.nowega.de/wp-content/uploads/2019/08/strukturmerkmale-des-gasversorgungsnetzes_2018.pdf

ONTRAS Gastransport GmbH
Leipzig

Customers: 83 national and international shippers

Employees	379
Gas transmission network	7,414 km
Compressor stations	2
Compressor units	5
Total capacity of the compressor units	38 MW
Cross-border interconnection points	4
Exit points in the high-pressure network	442
Concurrent annual peak load	41,645 MWh/h
Annual exit quantity to final consumers and distributors	155 TWh

Quelle: www.ontras.com/de/netztransparenz/netzdaten

Information on company name, headquarters, customers, and employees: reporting date 31.12.2021
Other information: reporting date 31.12.2020

OPAL Gastransport GmbH & Co. KG
Kassel (Hessen)

Customers: Gas traders

Employees	8
Gas transmission network	473 km
Compressor stations	1
Compressor units	3
Total capacity of the compressor units	99 MW
Cross-border interconnection points	2
Exit points in the high-pressure network	1
Concurrent annual peak load	45,036 MWh/h
Annual exit quantity to final consumers and distributors	0 TWh

Source: www.opal-gastransport.de/netzinformationen/ostsee-pipeline-anbindungsleitung

Open Grid Europe GmbH
Essen

Customers: more than 450 national and international wholesale transmission companies, municipal utilities, industrial customers and gas traders

Employees	approx. 1,450
Gas transmission network	approx. 12,000 km
Compressor stations	27
Compressor units	100
Total capacity of the compressor units	approx. 1,150 MW
Cross-border interconnection points	17
Exit points in the high-pressure network	1,009
Concurrent annual peak load	111,622 MWh/h
Annual exit quantity to final consumers and distributors	approx. 298 TWh

Source: https://oge.net/de/fuer-kunden/gastransport/marktinformationen/gesetzliche-veroeffentlichungen/strukturdaten

terranets bw GmbH
Stuttgart

Customers: more than 170 national and international customers – gas network operators, municipal utilities, industrial customers and traders

Employees	290
Gas transmission network	2,730 km
Compressor stations	2
Compressor units	7
Total capacity of the compressor units	approx. 34 MW
Cross-border interconnection points	3
Exit points in the high-pressure network	310
Concurrent annual peak load	28,662 MWh/h
Annual exit quantity to final consumers and distributors	106 TWh

Quelle: www.terranets-bw.de/en/gas-transmission/gas-grid-information/#_datafacts

Thyssengas GmbH
Dortmund

Customers: 48 network interconnection partners 150 network connection customers with 185 NCPs

Employees	392
Gas transmission network	4,399 km
Compressor stations	6
Compressor units	17
Total capacity of the compressor units	149 MW
Cross-border interconnection points	5
Exit points in the high-pressure network	1,063
Concurrent annual peak load	17,507 MWh/h
Annual exit quantity to final consumers and distributors	61.2 TWh

Quelle: thyssengas.com/de/netzauskunft/transparenzinformation/strukturdaten.html

Information on company name, headquarters, customers, and employees: reporting date 31.12.2021
Other information: reporting date 31.12.2020

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Foreword | Executive Summary

Foreword

Dear reader,

The Russian war of aggression in Ukraine is profoundly changing the energy situation in Germany and Europe. There is talk of a new era, not only in terms of security policy, but also in terms of energy policy. The changed situation makes it necessary to diversify our energy sources to a much greater extent and to further accelerate the transition from natural gas to green and carbon-neutral gases such as hydrogen. Consequently, new supply sources such as liquefied natural gas (LNG) will have to be integrated into the transmission network. Furthermore, load flows will be partially or even completely reversed, while the use of conventional natural gas will be reduced and gradually replaced by green gases such as hydrogen. These changes will have a significant impact on gas network development planning. In consultation with the Bundesnetzagentur (BNetzA – Federal Network Agency), the transmission system operators have considered these new challenges in the present Gas Network Development Plan (NDP) 2022–2032 by incorporating the LNG and LNGplus security of supply variants and the hydrogen variant.

In July 2022, the transmission system operators had already published an Interim Status on the Gas Network Development Plan 2022–2032. It included the basic variant based on the Scenario Framework confirmed in January 2022 as well as the LNG security of supply variants for partial replacement of Russian natural gas volumes. The hydrogen variant was also already part of the NDP interim status.

In September 2022, the transmission system operators supplemented their scenario framework to reflect a current gas demand development and the complete replacement of Russian natural gas volumes with LNG and hydrogen in their network modelling. After consulting, parts of the scenario framework were revised by the BNetzA.

Due to the special circumstances, the current Gas Network Development Plan 2022–2032 is not a normal network development plan in scope and nature. Generally, the planning process is not designed to provide short-term answers to current events. Instead, it usually represents a medium- to long-term perspective of network development planning. Due to the particular challenges of the time, the transmission system operators are striving to provide initial answers to the current crisis with this Gas Network Development Plan.

The transmission system operators are working intensely to adapt the transmission network as quickly as possible to the changed geopolitical and energy sector conditions. Their goal is to continue to ensure secure and, in the future, carbon-neutral gas transport. The development of the hydrogen infrastructure is particularly important in this regard. The transmission system operators are ready to further advance the development of the hydrogen infrastructure. A lack of regulatory framework conditions, especially in connection with financing of the infrastructure, and the avoidance of introducing integrated hydrogen and gas network planning are increasingly proving to be impede the development of the urgently needed infrastructure.

Without networks, the ramp-up of the hydrogen economy and thus the carbon-neutral supply of our industries cannot succeed. Other sectors, such as the heating market and the transport sector, are also affected by it. The existing gas infrastructure at the transmission level and at the distribution network level lays the foundation for development of this hydrogen infrastructure. It functions as the backbone for the rapid and socially acceptable achievement of our ambitious climate targets. The objective of gas network development planning is to pave the way for this transition from natural gas to hydrogen and other green gases. In this regard, the transmission system operators propose a concept in Chapter 10 on how the climate policy goals can be reflected even better in the future within the gas network development planning. In this sense, the transmission system operators will also be actively involved in the process of developing the German government's system development strategy. One of our expectations of the process is the introduction of an upstream energy scenario process. It should provide a common scenario basis in the form of uniform assumptions and thus consistent input parameters, e. g. for demand forecasts and targets as well as for electricity and gas (hydrogen and methane) network planning. The respective scenario frameworks for the electricity network development plan and gas network development plan (hydrogen and methane) could then be based on these energy scenarios in the future. The transmission system operators have presented additional concept proposals for future integrated hydrogen network planning in their Hydrogen Report published on 1 September 2022.

Lastly, the transmission system operators would like to thank the other potential hydrogen network operators for their active participation and Prognos AG for its support.

Best regards,

Your transmission system operators

Executive Summary

In this consultation document on the Gas Network Development Plan 2022–2032, the transmission system operators present the results of the Network Development Plan and thus fulfil the requirements of the Energiewirtschaftsgesetz (EnWG – Energy Industry Act) and the Gasnetzzugangsverordnung (GasNZV – Gas Network Access Ordinance). This Gas Network Development Plan is based on the scenario framework prepared by the transmission system operators and confirmed by the BNetzA on 20 January 2022. It is also based on the scenario framework supplemented by the transmission system operators with three modelling variants, which was also publicly conferred and confirmed by the BNetzA in a decision on 11 November 2022.

By expanding the already confirmed scenario framework with a supplemented scenario framework, the transmission system operators decided to adjust the gas demand development for additional modelling variants against the backdrop of geopolitical developments and the ongoing decarbonisation of energy supply. Overall, a 20 % decrease in natural gas consumption was assumed over the period under consideration until 2032.

Due to the significant changes in physical load flows in the German and European transmission network compared to the previous Gas Network Development Plan, the focus of the Gas Network Development Plan 2022–2032 is on ensuring security of supply and diversification of import sources, in particular the short-term and accelerated connection of LNG terminals.

Therefore, three LNGplus security of supply variants, three LNG security of supply variants, one hydrogen variant and the base variant were considered in the Gas Network Development Plan 2022–2032.

In the previous network development planning, the required network expansion measures were determined for the fifth and tenth year in the respective Network Development Plan. Deviating from this procedure, the transmission system operators have determined the required network expansion measures of the LNGplus security of supply variants for the year 2032 in accordance with the new partial decision for the confirmation of the Scenario Framework 2022 and, on the basis of the existing regulatory framework, assumed the fastest possible commissioning for them. Network expansion measures can be completed much faster if the conditions for accelerated project progress are met, e. g., by inclusion in the Gesetz zur Beschleunigung des Einsatzes verflüssigten Erdgases (LNGG – Act to Accelerate Use of Liquefied Natural Gas). However, this has not yet been the case for all LNGplus measures.

In the new partial decision of the Scenario Framework 2022, the BNetzA instructed the transmission system operators to determine the solution with the lowest possible network expansion while simultaneously implementing the necessary network expansion measures as quickly as possible.

Security of supply variant LNGplus A has significantly higher network expansion costs compared to security of supply variants LNGplus B and C. Moreover, implementation of parts of the necessary network expansion measures can only take place later. Furthermore, the performance and volume balances show that the requested 182 GWh/h for LNG terminals are not required for the supply of Germany and the neighbouring European countries. Therefore, security of supply variant LNGplus A cannot be considered as a network expansion proposal.

Security of supply variants LNGplus B and C differ with regard to Germany's supply routes. In the LNGplus B security of supply variant, Germany is increasingly supplied via direct LNG imports from the North Sea and Baltic Sea coasts. Conversely, in the LNGplus C security of supply variant, Germany is increasingly supplied via LNG capacities from neighbouring European countries.

The goal of the security of supply variants LNGplus is to quickly increase the available entry capacity and simultaneously identify an efficient and sustainable network expansion. The transmission system operators meet this objective with a view to the current status of LNG terminal planning. The network expansion measures for the provision of LNG capacities are to be largely realised by 2026. Full implementation of all network expansion measures is planned by 2028. The prerequisite for an accelerated project development are significantly shorter approval procedures. This can be achieved, for example, by including the measures in the LNGG. However, this has not yet been the case for all LNGplus measures.

The LNGplus security of supply variants LNGplus B and C describe network expansion measures in which the capacity of new LNG terminals as well as existing capacities via western cross-border interconnection points can be used. The transmission system operators point out that, depending on the actually implemented LNG systems and their planned entry capacities, the required network expansion may change due to the framework conditions, which have not been conclusively clarified, as well as due to future political decisions. In addition to future political decisions, this dynamic is particularly attributable to the fact that only some of the implementation schedules for the capacity expansion requirement under section 39 GasNZV have been completed to date. From today's perspective, the completion of the outstanding implementation schedules is still subject to uncertainties and strongly influences the respective LNG locations and the associated network expansion measures.

The results of the LNGplus security of supply variants are broken down as follows:

Tabelle 1: Results of the LNGplus security of supply variants until the end of 2032

Summary of the results of the LNGplus variants	LNGplus variant A	LNGplus variant B	LNGplus variant C
Pipeline [km]	1,062	805	805
Compressor stations (additional capacity and necessary reversals) [MW]	249	165	175
Investments [in EUR billion]*	5.4	4.1	4.2
– Network expansion measures from the Gas Network Development Plan 2020–2030 (without LNG)	1.8	1.8	1.8
– LNG measures	3.2	1.9	1.9
– Further new network expansion measures from the Gas Network Development Plan 2022–2032	0.4	0.4	0.4
* rounded values			

Source: Transmission system operators

Since security of supply variants LNGplus B and C require similar investment costs in the transmission network, the transmission system operators are initially refraining from formulating a specific network expansion proposal. For the time being, they would also like to put the network expansion measures of security of supply variants LNGplus B and C out for consultation.

The transmission system operators plan to formulate a network expansion proposal, taking into account the consultation results and other comments on the draft document of the Network Development Plan Gas 2022–2032.

The L-to-H-gas conversion planning is well advanced and has already been finalised to a large extent. The development of the L-gas supply was also assessed against the background of a security of supply scenario. The transmission system operators are still in close contact with the respective distribution system operators, the BNetzA and the Bundesministerium für Wirtschaft und Klimaschutz (BMWK – German Federal Ministry of Economics and Climate Protection).

Furthermore, the hydrogen variant in the Gas Network Development Plan 2022–2032 was created and modelled jointly by the transmission system operators and other potential hydrogen network operators in an open and transparent process. Based on the demand reports from the survey 'Wasserstoffabfrage Erzeugung und Bedarf und Grüne Gase ('Hydrogen Generation and Demand and Green Gases Market Survey; WEB Market Survey) carried out in spring 2021, a demand-oriented Germany-wide hydrogen network was determined. An annual transport demand of 165 TWh can be met by the modelled network. This is accomplished by including more than 250 projects with whose project sponsors the transmission system operators or other potential hydrogen network operators have concluded Memoranda of Understanding (MoU). The results of the hydrogen modelling are presented in the table below:

Tabelle 2: Results of hydrogen modelling

	Until end of 2027	Until end of 2032
Mainline compressor	0–25 MW	0–245 MW
Lead compressor	0 MW	0–100 MW
Pipelines	2,900–3,000 km	7,600–8,500 km
Investments	**EUR 2.3–2.8 billion**	**EUR 8.1–10.2 billion**

Source: Transmission system operators and other potential H2 network operators

Taking into consideration that there is a tenfold increase in hydrogen transport demand compared to the last Gas Network Development Plan, the hydrogen network 2032 presents a significant advancement. This requires investments of up to EUR 2.8 billion by 2027 and up to EUR 10.2 billion by 2032.

These plans are a specific proposal for a domestic and, in the long term, European hydrogen network. However, realisation of this hydrogen network is still subject to a change in the existing legal and regulatory framework. Nevertheless, the transmission system operators consider the development of a hydrogen infrastructure to be more urgent than ever.

Introduction 1

1 Introduction

1.1 Legal basis and task definition

Pursuant to section 15a of the Energiewirtschaftsgesetz (EnWG – Energy Industry Act), the German transmission system operators (TSO) are mandated to prepare a joint Network Development Plan (NDP) in every even calendar year and to submit it to the Bundesnetzagentur (BNetzA – Federal Network Agency) as the competent national regulatory authority.

Gas network development plan

The Germany-wide Gas Network Development Plan pursuant to section 15a EnWG must consider all effective measures for optimising, reinforcing and expanding the network in line with demand as well as for ensuring security of supply. These measures must meet the required network technology for secure and reliable network operation over the next ten years. In particular, measures to be implemented in the next three years must be specified. Preparation of the Gas Network Development Plan is based on the Scenario Framework. The Scenario Framework contains reasonable assumptions about the development of the most important exogenous contributing factors with regard to the dimensioning of a transmission network. This also includes production, supply and consumption of methane, the gas exchange with other countries, planned investments in infrastructure and the effects of any supply disruptions. The network development plan must consider the community-wide network development plan referred to in article 8(3b) of Regulation (EC) No 715/2009.

Prior to submission to the BNetzA, transmission system operators must give the public and downstream system operators the opportunity to comment. The BNetzA must again consult all actual and potential network users on the draft Network Development Plan submitted by the transmission system operators and publish the result. It may subsequently demand amendments to the Network Development Plan.

Network expansion measures in Germany with PCI status

No gas transport project from Germany is included in the European Commission's 5th list of 'Projects of Common Interest' (PCI) dated 19 November 2021 [EC 2021].

1.2 Timing and structure of the Gas Network Development Plan

The Gas Network Development Plan 2022–2032 is based on the Scenario Framework 2022, which was publicly conferred and confirmed by the BNetzA on 20 January 2022.

The significant changes in the German and European energy supply, in particular the supply of natural gas, which have occurred due to the geopolitical situation, made it necessary to supplement the Scenario Framework with significant new aspects in order to adapt the network development planning accordingly. The transmission system operators therefore initially presented an Interim Status of the Gas Network Development Plan on 06 July 2022. Among other things, they published LNG security of supply variants, which already reflected a replacement of around 50 % of the natural gas previously imported from Russia.

Following the momentum of events since then, the transmission system operators publicly consulted in the period from 26 September 2022 to 16 October 2022 to discuss a supplement to the Scenario Framework 2022 with LNGplus security of supply variants considering a full substitution of Russian natural gas. On 11 November 2022, the BNetzA redetermined parts of the Scenario Framework 2022 based on this update.

With the publication of this consultation document on the Gas Network Development Plan 2022–2032, the transmission system operators have laid the foundation for a network development without taking Russian gas imports into account. The public has the opportunity to comment until 31 January 2023.

The transmission system operators plan to submit the draft document of the Gas Network Development Plan 2022–2032 to the regulatory authority and publish it by the end of the first quarter of 2023 in accordance with section 15a (2) EnWG.

The following list describes the structure of the document.

- **Chapter 2** summarises the requirements of the BNetzA from the **confirmation of the Scenario Framework 2022** dated 20 January 2022 and the new partial decision dated 11 November 2022.

- **Chapter 3** presents the basic procedure for **modelling of the transmission networks** and the necessary input parameters for the modelling variants as well as the quantity balances for the LNGplus security of supply variants.

- **Chapter 4** shows the **implementation status of the network expansion measures**. In addition to the measures for the transmission network expansion that is already under construction or currently in decision or planning status, it describes the implementation status of the network expansion measures from the Gas Network Development Plan 2020–2030. Furthermore, this Chapter presents measures with a planned change in commissioning, with a delay that has occurred or with a foreseeable delay. Moreover, it describes further measures without a final investment decision (FID).

- **Chapter 5** deals with the **development of L-gas supply**, the security of supply scenario and the market area transformation from low-caloric natural gas (L-gas) to high-caloric natural gas (H-gas). It contains an L-gas volume and capacity balance up to the year 2030 as well as descriptions of the planned conversion areas of the respective transmission system operators.

- The **development of H-gas supply** is presented in **Chapter 6**. It contains the H-gas capacity balances up to 2032 as well as the distribution of the determined additional demand to the cross-border interconnection points in the modelling variants.

- The results of the modelling of **LNGplus** and **LNG supply variants** as well as for the **base variant** are presented in **Chapter 7** . Calculations in the modelling of the base variant were based on the confirmed Scenario Framework 2022 and network expansion measures were subsequently determined. Furthermore, additional LNG security of supply variants were modelled for the interim status for the Gas Network Development Plan 2022–2032, which are also presented in Chapter 7. In accordance with the new partial decision on the Scenario Framework 2022, LNGplus security of supply variants were examined, and the corresponding respective network expansion were determined.

- **Chapter 8** describes the procedure for the **hydrogen variant,** including the joint hydrogen modelling of transmission system operators and other potential hydrogen network operators. It also presents the possible measures for the development of a Germany-wide hydrogen infrastructure resulting from the modelling. Furthermore, the results of the Hydrogen Review, which deals with the reported hydrogen demands of the distribution system operators (DSO) from the survey 'Wasserstoffabfrage Erzeugung und Bedarf und Grüne Gase ('Hydrogen Generation and Demand and Green Gases Market Survey; WEB Market Survey), are described by the transmission system operators.

- **Chapter 9 deals with** the **network expansion proposal** of the transmission system operators.

- **Chapter 10** provides an **outlook** on future network development planning.

1.3 Database for the Gas Network Development Plan

The transmission system operators provide the public with a database containing input data for modelling, expansion measures and further details on the Gas Network Development Plan at www.nep-gas-datenbank.de.

Abbildung 1: Homepage of the NDP gas database

Source: www.nep-gas-datenbank.de

In the following chapters, reference is made in each case to the corresponding categories of the database cycle ‘2022 – NDP Consultation’. All available data can also be downloaded as Excel files. To do this, the user must select the ‘Download data’ field in the lower left corner of the homepage display (see Figure 1).

The network expansion measures for the replacement of Russian natural gas imports of the LNGplus security of supply variants are presented in the NDP gas database in the current database cycle ‘2022 – NDP Consultation’ with a reporting date of 1 October 2022. The other network expansion measures have a reporting date of 1 January 2022.

Please feel free to contact FNB Gas if you have any questions about the NDP gas database.

Confirmed Scenario Framework 2

2 Basis for the Gas Network Development Plan 2022–2032

With its results and provisions, the Scenario Framework forms the essential foundation for the modelling. Chapter 2.1 shows the provisions of the BNetzA from the confirmed Scenario Framework 2022 dated 20 January 2022. Subsequently, Chapter 2.2 presents the provisions of the BNetzA from the new partial decision on the confirmed Scenario Framework 2022 dated 11 November 2022.

2.1 Confirmed Scenario Framework 2022 by the BNetzA

The BNetzA confirmed the draft Scenario Framework [FNB Gas, SR 2021a] revised by the transmission system operators following consultation, with amendments and conditions on 20 January 2022 [BNetzA 2022].

The requirements of the BNetzA from the confirmation of the Scenario Framework were considered as far as possible by the transmission system operators in various chapters of the Gas Network Development Plan 2022–2032:

- **Operative provision 1** of the confirmed Scenario Framework obliges the transmission system operators to allocate each resulting network expansion measure to the respective consumer. In the presentation of the individual network expansion measures, the specific consumer on which the individual measure is based must be stated. If a one-to-one allocation is not possible and the measure is attributable to several consumers, the relevant consumer must be specified.

This requirement has been implemented in the NDP gas database in the 'network expansion measures' tile.

- In **operative provision 2**, the transmission system operators are obligated to examine the use of market-based instruments (MBI) as an alternative to network expansion, which was determined in the base variant, in an additional modelling variant called 'MBI base variant'. The following aspects must be considered:

  2a. The assessment must be carried out for all network expansion measures resulting from the base variant. Only network expansion measures that are part of the initial network and whose commissioning is planned for 2024 or earlier are excluded from the review.

  2b. In particular, VIP-wheeling, third-party network use and the exchange-based spread product should be considered as market-based instruments in the review.

  2c. Congestion zones must be formed with MBI to solve the congestion resulting from the base variant. The congestion zones must be selected by the transmission system operators within the context of the 'MBI base variant' modelling variant with the goal of ensuring that the congestion resulting from the base variant can be resolved through the use of MBI. At the same time, it must be ensured that each congestion zone contains sufficient entry and exit points to ensure sufficient liquidity and prevent possible abuse of market power. The selection of congestion zones must be presented transparently by the transmission system operators in the Gas Network Development Plan 2022–2032 so that it is comprehensible for other potential hydrogen (H2) network operators and allows an evaluatioin of the possible use of MBI.

  2d. The model used by the transmission system operators for the modelling variant 'MBI base variant', the load situations considered therein and the underlying assumptions must be described in detail in the Gas Network Development Plan 2022–2032.

  2e. For the bottlenecks arising from the base variant, the 'MBI base variant' modelling variant must comprehensibly determine and justify whether and why the use of MBI is preferable to the expansion of the network in order to eliminate them. If the use of MBI is more efficient and cheaper in terms of network technology in order to solve the transport task under consideration, the probable expenses must be indicated for information purposes in the Gas Network Development Plan 2022–2032. They must include a transparent and comprehensible justification for the amount. They must also be presented so that they can be understood by other potential H2 network operators without requiring further information.

2f. Where the use of MBI is preferable to the expansion of the network, the transmission system operator must roughly examine and transparently present whether there is any impacts on the natural gas pipelines identified for conversion in the hydrogen variant. If the examination shows that there are effects on convertible natural gas pipelines that could not be converted as a result of these effects, the potentially required expansion costs for new hydrogen pipelines must be presented for information purposes.

As explained in more detail in Chapter 3.3, the transmission system operators refrain from forecasting MBI using NewCap.

- Pursuant to **operative provision 3**, the transmission system operators are mandated to develop a concept on how the requirements of the Federal Climate Protection Act, in particular the net greenhouse gas neutrality prescribed for 2045, can be considered within the network development planning in the future. The concept must be presented in the consultation document of the Gas Network Development Plan 2022–2032 and consulted with the public. The aspects mentioned in section II B 1.3 of this decision should be considered and evaluated in the concept development.

The requirement was implemented in Chapter 10.4.

- **Operative provision 4** mandates that the transmission system operators use the capacities for production in the modelling in accordance with the plausibility-tested forecast of the Bundesverband Erdgas, Erdöl und Geoenergie e. V. (BEVG – Federal Association for Natural Gas, Petroleum and Geoenergy).

The transmission system operators implemented this requirement in the modelling.

- **Operative provision 5** mandates that the transmission system operators provide the BNetzA with detailed information on the peak load case considered in the network development plan within the context of the capacity balances of the base variant. This must be done no later than by the submission date of the draft Gas Network Development Plan 2022–2032. For this purpose, information must be provided on the respective assumed capacities for each individual cross-border interconnection point, market area exchange point, distribution system operator network interconnection point, underground gas storage connection point, power plant connection point, industrial connection point, LNG connection point, production entry point, biogas entry point and hydrogen entry point.

The transmission system operators will comply with this requirement.

- Pursuant to **operative provision 6**, the transmission system operators are obliged to identify the network-optimised locations of electrolysers throughout Germany from the point of view of the gas and electricity transmission system operators in a study that is separate from the Gas Network Development Plan 2022–2032. The separate study requires consultation with the market by the transmission system operators. The study must be made available to the BNetzA by 1 September 2022 at the latest, taking into account the results of the consultation. The network-optimised locations are supposed to be determined with regard to a joint or integrated consideration of the electricity and gas networks, in which the potential must be shown in the infrastructure planning with regard to the network expansion costs. The criteria to be developed for determining the network-optimised electrolyser locations must be presented transparently and comprehensibly in the study.

In the meantime, the BNetzA has confirmed that the study for the designation of network-optimised electrolyser locations (so-called electrolyser study) no longer needs to be prepared and does not have to be submitted to the BNetzA.

- **Operative provision 7** mandates that the transmission system operators implement the following requirements with regard to the modelling of systemically important power plants in the Gas Network Development Plan 2022–2032:

7a. The transmission system operators must use firm dynamically allocable capacities for the systemically relevant power plant Burghausen – O1 (BNA0172) in the modelling.

7b. The transmission system operators must include the new system-relevant gas power plants Cuno Heizkraftwerk Herdecke (BNA0442), Knapsack I (BNA0548a) and Gersteinwerk (BNA1046b and BNA1042) with firm dynamically allocable capacities (DZK) in the modelling. In addition, the following capacity values must be applied: Cuno combined heat and power plant Herdecke with 1,025.8 MWh/h, Knapsack I with 1,761 MWh/h and Gersteinwerk with 791 MWh/h.

The transmission system operators have implemented these specifications in the modelling.

- Pursuant to **operative provision 8**, the transmission system operators are obliged to implement the following requirements in the Gas Network Development Plan 2022–2032 with regard to the consideration of the requests for potential LNG terminals contained in the Scenario Framework for the Gas Network Development Plan 2022–2032:

  8a. The transmission system operators are obligated to include the requests for capacity expansion pursuant to section 39 of the Verordnung über den Zugang zu Gasversorgungsnetzen (GasNZV – Gas Network Access Regulation) in the amount of 6,950 MWh/h and 5,450 MWh/h for the LNG terminal at the Stade site in the Network Development Plan 2022–2032 as newly submitted expansion requests pursuant to section 39 GasNZV in the modelling.

  8b. The transmission system operators must include the LNG terminal requests contained in the Scenario Framework for the Gas Network Development Plan 2022–2032 as competing for planning purposes in the modelling. In doing so, they must exploit the relocation potential, identify the competing zones and the included cross-border and storage interconnection points that are in competition with the respective LNG entry points and present them transparently in the Gas Network Development Plan 2022–2032.

The transmission system operators have fulfilled this obligation within the scope of the modelling of the base variant.

- In operative provision 9, the transmission system operators are obligated, within the framework of the modeling of the hydrogen variant, to apply the capacities planned for each year from 2029 for the electrolysis capacity as well as the connected hydrogen entry capacity and hydrogen entry quantity per year only in the respective subsequent year for all projects from Appendix 2 'Results of the WEB and Green Gases Market Survey', which involve hydrogen injection by means of electrolysis.

The transmission system operators have implemented these requirements in the modelling and presented the results in Chapter 8.

- **Operative provision 10** mandates that the transmission system operators specify the distribution system operators for which an additional demand of more than 3 % has been determined for 2027 compared to the internal orders for 2022 according to their plausibility-tested long-term forecasts. For these distribution system operators, the specific additional demand must be shown in total and as the share attributable to the connection of new network areas with household customers.

The requirement was implemented in Appendix 1.

- Pursuant to **operative provision 11**, the transmission system operators are exempted from modelling the design variant for Baden-Württemberg in the Gas Network Development Plan 2022–2032. If they jointly model the optional design variant, the transmission system operators must justify in detail the necessity of this modelling variant and the resulting network expansion.

The extensive consideration of the design variant in the Gas Network Development Plan 2020–2030 forms a valid basis for network planning for Baden-Württemberg. Due to the increased complexity of the design variant and the new tasks arising from the confirmation of the Scenario Framework, the transmission system operators refrain from presenting the Baden-Württemberg design variant again in the Gas Network Development Plan 2022–2032.

2.2 New partial decision of the confirmed Scenario Framework 2022 by the BNetzA

On 11 November 2022, the BNetzA issued a new partial decision on the confirmed Scenario Framework 2022.

The transmission system operators have considered the BNetzA's requirements from the new partial decision of the confirmed Scenario Framework 2022 in various chapters of the Gas Network Development Plan 2022–2032 as follows:

- In addition to the modelling variants that were previously assigned with the confirmation of the Scenario Framework on 20 January 2022, **operative provision 1** of the new partial decision mandates that the transmission system operators calculate three further modelling variants with the following specifications (LNGplus variants):

The three LNGplus variants are based on the input parameters of the base variant of the confirmed Scenario Framework for the Gas Network Development Plan 2022–2032, but with the following adjustments:

(1) The modelling year 2032 must be considered, though the fastest possible commissioning dates must be specified for the network expansion measures determined from this variant, even if they already occured before 2032.

(2) An injection of Russian gas quantities is not to be assumed. This applies to the capacities planned for the supply of Germany as well as the capacities planned for transits from Russia. A sufficient supply of transport capacities to neighbouring countries, especially in the direction of South Eastern Europe, must be ensured. To compensate for the Russian gas volumes, additional possible entry capacities from German LNG terminals as well as at Western European cross-border interconnection points are to be assumed.

(3) On the consumption side, a 9.4 % decrease in output from distribution system operators and industrial customers is assumed for 2032 compared to 2021. For new and existing power plants, no adjustments should be made compared to the base variant.

Moreover, a further reduction in consumption can be assumed through the substitution of methane with hydrogen in the natural gas-reducing projects submitted in the context of the 'Hydrogen Query for Generation and Demand', for which a corresponding Memorandum of Understanding (MoU) has been concluded. In this respect, the project-specific substitution potentials at the respective network interconnection point should be applied in a power-reducing manner.

(4) The resulting network expansion measures must be presented in such a way that they can be allocated to the individual LNG terminals and cross-border interconnection points. Furthermore, the necessary expansion measures for the connection of the LNG terminals to the TSO network should be listed for information purposes.

(5) Specifically, the following three variants must be calculated:

a) 'LNGplus variant A': Within the scope of the calculations in variant A, all requests regarding capacity reservations or capacity expansion claims for LNG terminals pursuant to sections 38, 39 GasNZV that were received by the transmission system operators by 30 September 2022 must be taken into account. Consideration must also be given if the entry capacities contained in the requests are not required in full to ensure security of supply.

b) 'LNGplus variant B': Within the scope of variant B, entry capacities from German LNG terminals and Western European cross-border interconnection points that are required to ensure security of supply must be determined and included in the modelling. With regard to the locations and capacities of the German LNG terminals as well as the cross-border capacities, the most efficient solution from a network perspective should be selected. A solution that results in the least possible network expansion while simultaneously realising the necessary network expansion measures as quickly as possible should be regarded as efficient. Priority must be given to entry capacities of German LNG terminals. The capacities required beyond that should be applied at Western European cross-border interconnection points.

c) 'LNGplus variant C': Within the scope of variant C, entry capacities from German LNG terminals and Western European cross-border interconnection points that are required to ensure security of supply must be determined and included in the modelling. With regard to the selection of the locations and capacities of the German LNG terminals as well as the cross-border capacities, the most efficient solution from the network point of view must be chosen. A solution that results in the least possible network expansion while simultaneously realising the necessary network expansion measures as quickly as possible should be regarded as efficient. Priority must be given to entry capacities of Western European cross-border interconnection points. The additional required capacities are supposed to be applied to German LNG terminals.

The specifications were implemented by the transmission system operators in the modelling of the LNGplus security of supply variants.

- Pursuant to **operative provision 2**, the transmission system operators are required to determine based on one of the LNGplus variants which natural gas pipelines can be removed from the natural gas network and used for the hydrogen network published in the interim report of 6 July 2022 and for an ad-hoc test as defined in section 28p EnWG.

The transmission system operators will address this topic in the draft of the Gas Network Development Plan 2022–2032.

- **Operative provision 3** mandates that the transmission system operators carry out an H-gas quantity balance for each LNGplus variant. The quantity balance should focus on the consideration of the Germany-wide balance, taking into account the potential LNG terminals and their required utilisation.

The requirement was implemented in Chapter 3.5.

3 Modelling of the transmission networks

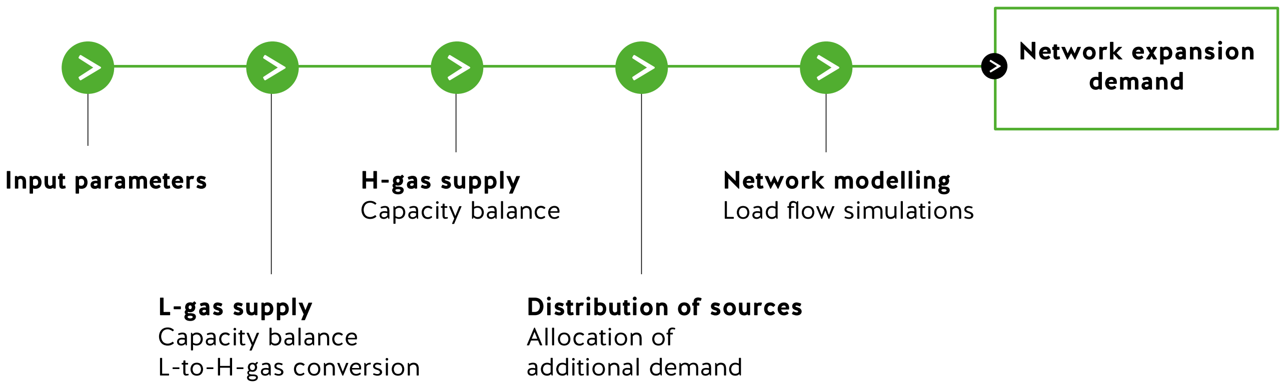
3 Modelling of the gas transmission networks

The Germany-wide modelling of the transmission networks in the Gas Network Development Plan 2022–2032 is based on an established and continuously refined methodology. The basis for the modelling is the Scenario Framework confirmed by the BNetzA on 20 January 2022 and the new partial decision dated 11 November 2022.

3.1 Basic procedure and input parameters for network modelling

The basic procedure for network modelling is shown in Figure 2. The starting point is the determination of the relevant input parameters for the network modelling. The conversion areas are subsequently identified and the L-gas capacity and quantity balance is drawn up in the course of the analysis of the L-gas supply. The next step involves drawing up the H-gas capacity balance and, as a result, determining the additional H-gas capacity demand. Based on the results of the distribution of H-gas sources, the required additional H-gas demand is subsequently allocated with the appropriate potential to the regions and, using certain criteria, to the cross-border interconnection points. The network modelling of the transmission system operators is then carried out on the basis of these values. After several iteration steps, results are subsequently generated that then lead to the definition of the network expansion demand in the individual modelling variants.

Figure 2: Basic procedure of network modelling

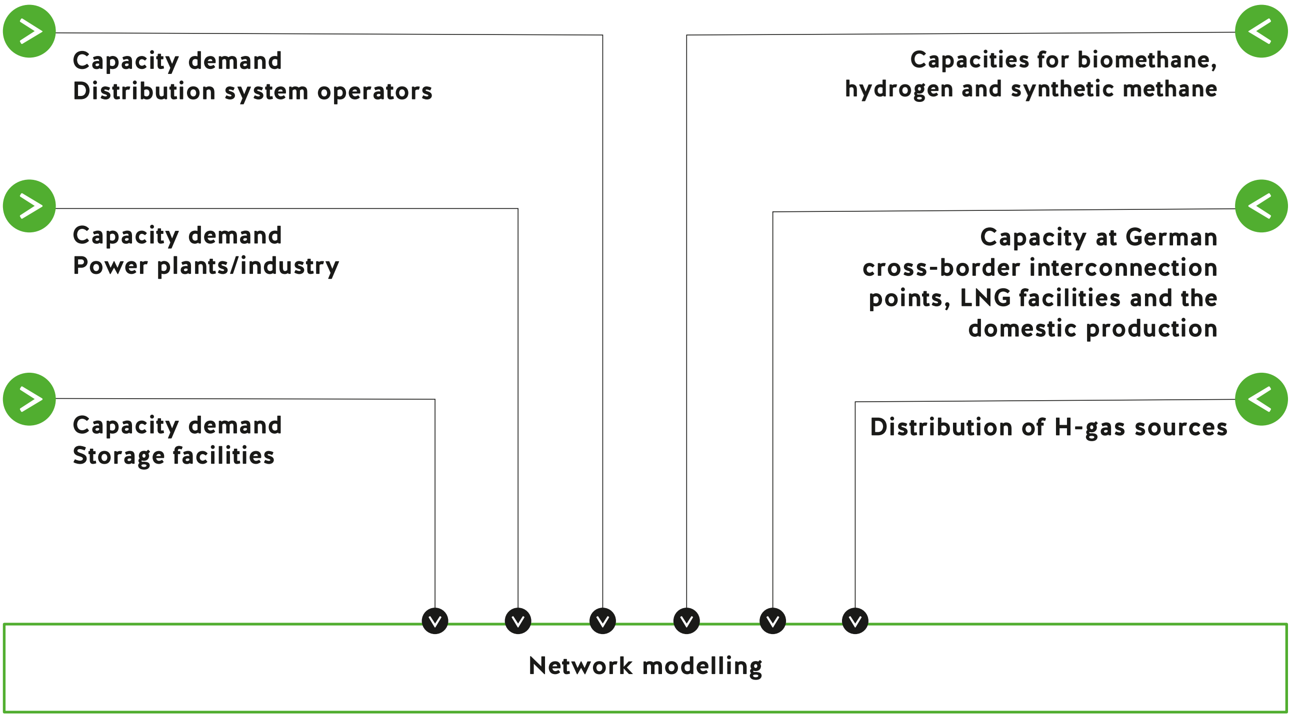


Source: Transmission system operators

The capacity demand as of 31 December 2027 are used to determine the network expansion measures of the base variant, which are supposed to be completed by the end of 2027. Similarly, the capacity demand of 31 December 2032 are used to determine the network expansion measures that are supposed to be completed by the end of 2032 at the latest. These periods are presented in this document as gas years 2027/2028 and 2032/2033 respectively. The earliest possible commissioning dates are determined for the network expansion measures of the LNG and LNGplus security of supply variants.

The input paramters for the network modelling are basic data that originate from various data sources and were subjected to any potentially necessary adjustments or updates. Figure 3 shows all important input parameters for network modelling.

Figure 3: Input parameters for network modelling



Source: Transmission system operators

All capacities of the input paramters for network modelling can be found in the NDP gas database in the cycle '2022 – NDP Consultation'.

3.2 Important input paramters for the modelling

The key input paramters based on the confirmation of the Scenario Framework 2022 are described are below.

3.2.1 Distribution system operator

The following modelling approach is used to model the capacity demand of the distribution system operators (DSO) in the **LNGplus security of supply variants**:

- Starting value: Requested internal order of the year 2022.
- Development from 2023 to 2032: Assumption of a power reduction of 9.4 % related to the starting value of the internal order of the year 2022 based on a volume decrease of gas demand by 15 % until the target year 2032.
- The substitution of methane by hydrogen indicated in the concluded MoU is reflected accordingly in the LNGplus security of supply variants.

The following modelling approach is used to model the capacity demand of the distribution system operators in the **base variant** and the **LNG security of supply variants**:

- Starting value: Requested internal order of the year 2022.
- Development from 2023 to 2027: The plausibility-tested 10-year forecast of the distribution system operators according to section 16 of the cooperation agreement up to and including 2027.
- Development from 2028 to 2032: Constant update of the values of the plausibility-tested long-term forecast from 2027.

In deviation from the base variant, the modelling of the capacity demand of the distribution system operators in the **hydrogen variant** takes the following into account:

- Development from 2028 to 2032: Plausible decreases, e.g. due to the substitution of methane by hydrogen, are taken into account.

3.2.2 Gas power plants

For modelling of gas power plants, a distinction must be made in all modelling variants between gas power plants that are directly connected to the transmission system operator's network and gas power plants that are connected to downstream networks.

Power plant capacities that are not connected to the transmission system operators' network but to downstream networks must be taken into account by the distribution system operators in the internal order.

Gas power plants that are directly connected to the transmission system operators' network can be subdivided as follows:

- non-system-relevant existing gas power plants,
- system-relevant existing gas power plants, and
- new build gas power plants.

For the modelling of the capacity demand of the gas power plants in the **LNGplus security of supply variants**, the transmission system operators do not make any capacity adjustments compared to the confirmed Scenario Framework 2022. The reason for this is to ensure security of supply in the area of electricity supply; appropriate changes should only be made here in consultation with the electricity transmission system operators and the BNetzA.

For any power plants that have already reported a substitution potential of methane by hydrogen to the transmission system operators in the hydrogen variant, the decreases in consumption of natural gas are reflected accordingly.

Non-system-relevant existing gas power plants

Non-system-relevant existing gas power plants connected to the transmission network are taken into account in the modelling with the existing capacity according to the NDP gas database.

System-relevant existing gas power plants

The explanations in this document on systemically important gas power plants refer to gas power plants directly connected to the transmission network.

The systemically relevant gas power plants were defined by the electricity transmission system operators in consultation with the BNetzA. The prerequisite for the designation was that the availability of these gas power plants is considered potentially necessary for maintaining the security and stability of the transmission network and that they are thus necessary for ensuring safe electricity network operations. The gas power plants classified as system-relevant are presented in Table 3 and Figure 4.

In accordance with the confirmation of the Scenario Framework 2022, the transmission system operators have modelled gas power plants classified as systemically relevant in all modelling variants for the years 2027 and 2032. The capacity product used in each case can be seen in the following table. None of the power plants shown in Table 3 are included in the BNetzA power plant retirement list published on 15 November 2021.

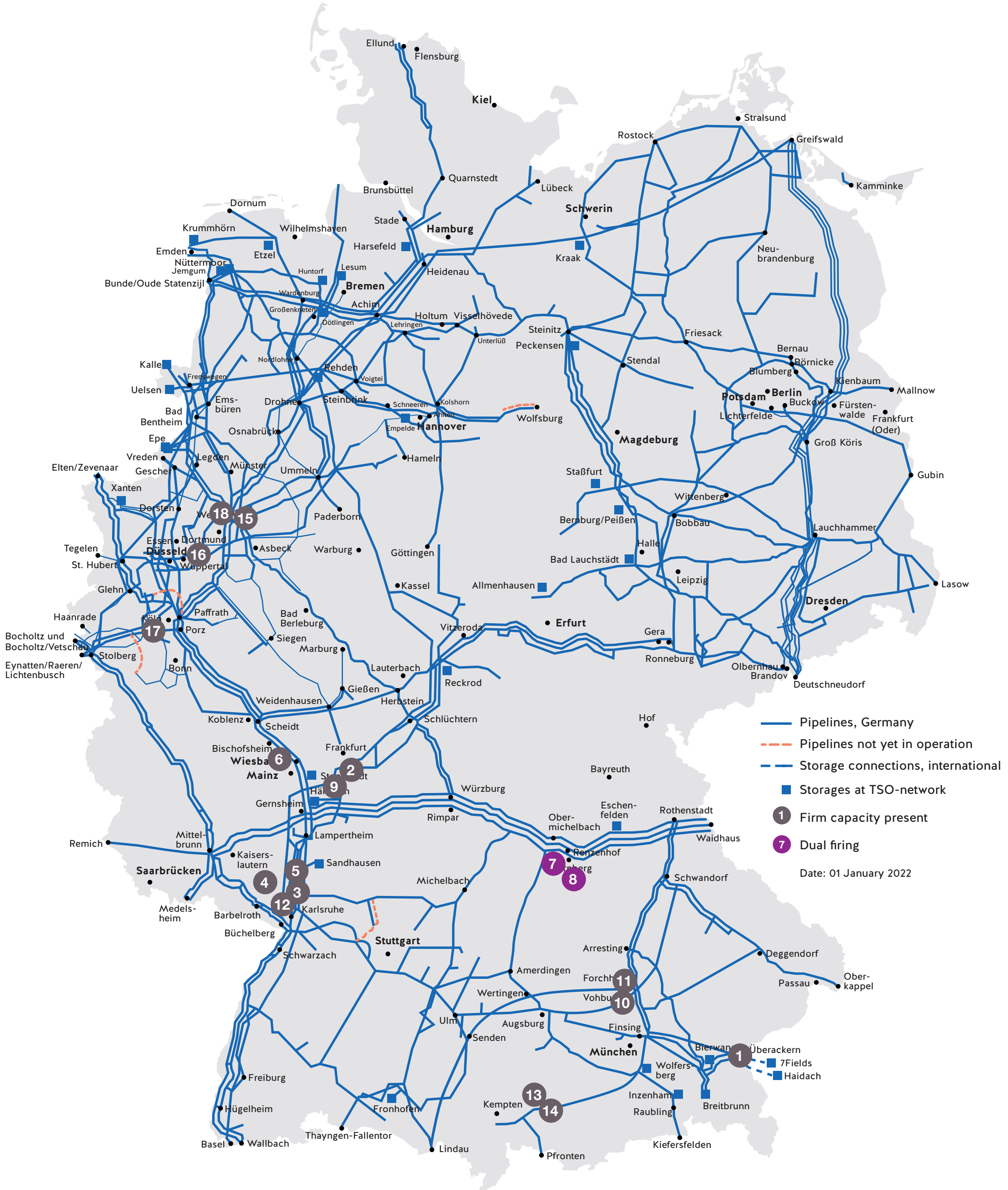
Table 3: System-relevant gas power plants with connection to the transmission network

No.	Power plant number	Power plant name	Scheduled exit capacity [MWh/h]	Transmission system operator	Allocation point	2027	2032
1	BNA0172	Dampfkraftwerk BGH – O1	710	bayernets	USP Haidach, Überackern 2	fDZK	fDZK
2	BNA0374	Staudinger 4	1,914	OGE	–	FZK	FZK
3	BNA0514	Rheinhafen-Dampfkraftwerk, Karlsruhe	740	OGE	VIP Germany-CH	fDZK	fDZK
4	BNA0614b	Kraftwerk Mitte, Ludwigshafen	–*	GASCADE	–	FZK	FZK
5	BNA0615	Kraftwerk Süd, Ludwigshafen	–*	GASCADE	–	FZK	FZK
6	BNA0626	Kraftwerk Mainz	1,500	OGE	–	FZK	FZK
7	BNA0744	Franken 1 Block 1, Nürnberg	0**	OGE	–	–	–
8	BNA0745	Franken 1 Block 2, Nürnberg	0**	OGE	–	–	–
9	BNA0857	GuD-Anlage Rüsselsheim	445	OGE	–	FZK	FZK
10	BNA0994	Gemeinschaftskraftwerk Irsching 5	1,700	OGE	–	FZK	FZK
11	BNA0995	Ulrich Hartmann (Irsching)	1,100	OGE	Haiming 2 7F, Speicher Bierwang, Speicher Breitbrunn	fDZK	fDZK
12	BNA1078	HKW Wörth	–*	GASCADE	–	FZK	FZK
13	BNA1248a	UPM Schongau	75	bayernets	–	FZK	FZK
			180	bayernets	Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn, Wolfersberg/USP, Inzenham-West USP	fDZK	fDZK
14	BNA1248b	HKW 3 UPM Schongau	150	bayernets	–	FZK	FZK
			70	bayernets	Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn, Wolfersberg/USP, Inzen-ham-West USP	fDZK	fDZK
15	BNA0411/ BNA0410	Trianel Gaskraftwerk Hamm	1,700	OGE	–	FZK	FZK
16	BNA0442	Cuno Heizkraftwerk Herdecke	1,026	GASCADE	Eynatten	fDZK	fDZK
17	BNA0548a	Knappsack I	1,761	GASCADE	Eynatten	fDZK	fDZK
18	BNA1046b/ BNA1042	Gersteinwerk	791	OGE	VIP Belgium-THE-Süd	fDZK	fDZK

* No publication due to trade secrets of third parties
** bivalent firing system

Source: Transmission system operator based on the BNetzA's power plant list and assessment notices on systemically important gas power plants, [BNetzA 2021a], [BNetzA 2021b]

Figure 4: System-relevant gas power plants with connection to the transmission network



Source: Transmission system operators, schematic diagram

New build gas power plants

The transmission system operators have considered the new gas power plants shown in Table 4 and Figure 5 in all modelling variants in accordance with the confirmation of the Scenario Framework 2022.

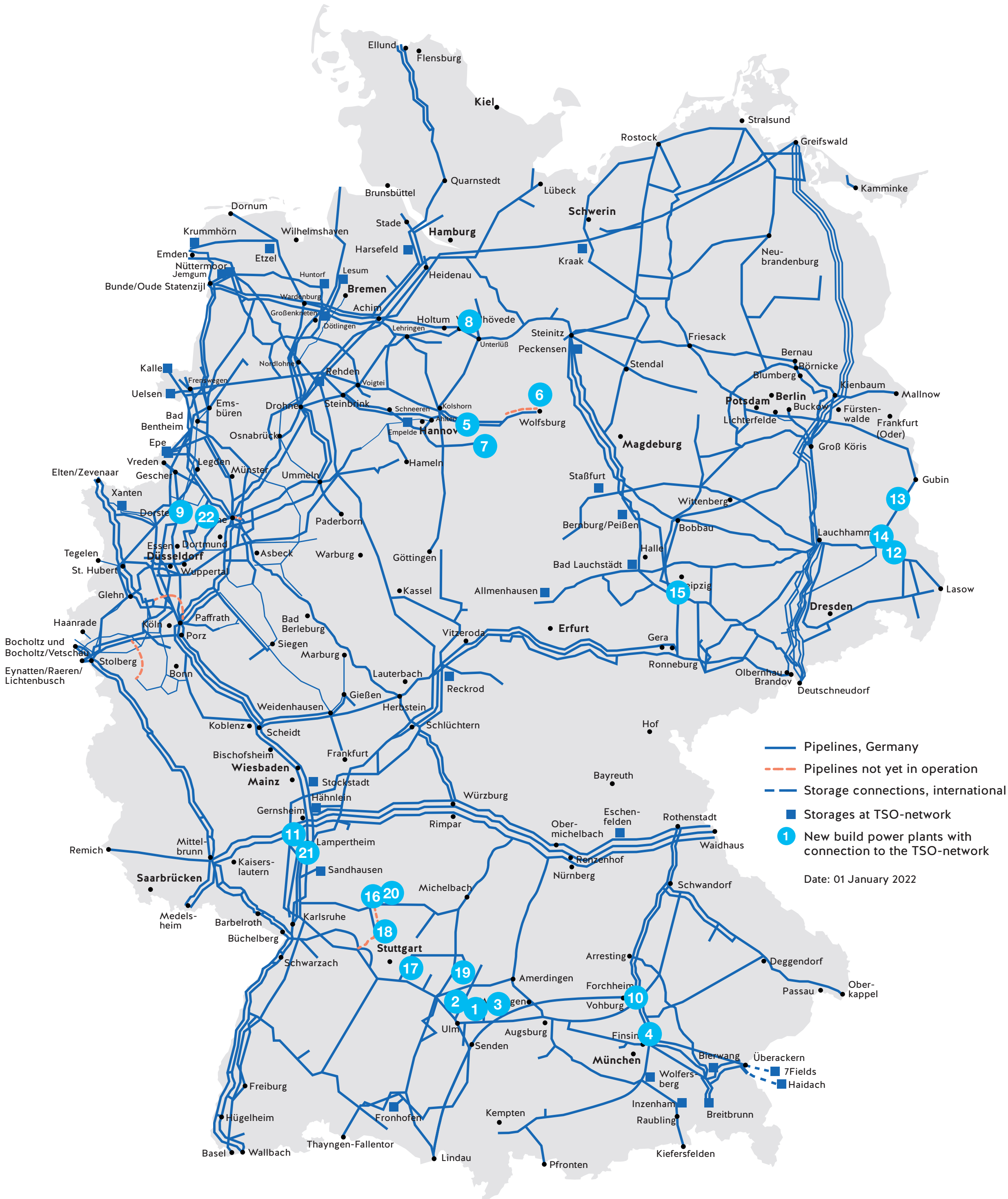
The allocation points required for new gas power plants were checked or determined as part of the modelling and can also be found in the following table. New power plant capacities are taken into account with firm dynamically allocable capacity (fester dynamisch zuordenbarer Kapazität - fDZK).

Table 4: New build gas power plants with connection to the transmission network

No.	Transmission system operator	Project name	Gas type	Gas connection capacity [MWh/h]	Status	Allocation point	Modelling years 2027	Modelling years 2032
1	bayernets	GK Leipheim (Block 1)	H-gas	950	Section 39 GasNZV	Überackern 2, Überackern, Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn	x	x
2	bayernets	GK Leipheim (Block 2)	H-gas	950	Section 39 GasNZV	Überackern 2, Überackern, Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn	x	x
3	bayernets	Kraftwerk Gundremmingen	H-gas	1,500	Section 39 GasNZV	Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn	x	x
4	bayernets	Kraftwerk Zolling	H-gas	1,300	Section 38 GasNZV	Haiming 2-7F/bn, Haiming 2-RAGES/bn, USP Haidach, Inzenham-West USP, Wolfersberg/USP	x	x
5	GUD	Kraftwerk Mehrum	H-gas	1,450	Section 39 GasNZV	Dornum, Greifswald, UGS Harsefeld, UGS Uelsen, UGS Etzel, UGS Jemgum EWE	x	x
6	GUD	GHKW VW 2	H-gas	920	Section 39 GasNZV	Ellund, Greifswald, UGS Harsefeld, UGS Uelsen, UGS Etzel, UGS Jemgum EWE	x	x
7	GUD	Werk Salzgitter	H-gas	1,125	Section 38 GasNZV	Dornum, Greifswald, UGS Harsefeld, UGS Uelsen, UGS Etzel, UGS Jemgum EWE	x	x
8	GUD	Werk Uelzen	H-gas	190	Section 38 GasNZV	Dornum, Greifswald, UGS Harsefeld, UGS Uelsen, UGS Etzel, UGS Jemgum EWE	x	x
9	OGE	Kraftwerk Scholven	H-gas	40	Section 38 GasNZV	Storage facility Epe H	x	x
10	OGE	Kraftwerk Irsching	H-gas	1,000	Section 38 GasNZV	Storage facility Bierwang, Storage facility Breitbrunn, Haiming 2 7F	x	x
11	OGE	Kraftwerk Biblis	H-gas	973	Section 38 GasNZV	Eynatten	x	x
12	ONTRAS	Innovatives Hybrid-Kraftwerk Boxberg	H-gas	1,665	Section 39 GasNZV	VIP Brandov-THE-Nord	x	x
13	ONTRAS	Innovatives Hybrid-Kraftwerk Jänschwalde	H-gas	1,665	Section 39 GasNZV	VIP Brandov-THE-Nord	x	x
14	ONTRAS	GuD Schwarze Pumpe	H-gas	1,665	Section 39 GasNZV	VIP Brandov-THE-Nord	x	x
15	ONTRAS	Innovatives Hybrid-Kraftwerk Lippendorf	H-gas	1,665	Section 38 GasNZV	VGS Storage Hub	x	x
16	terranets	Gasturbine Heilbronn	H-gas	1,200	Section 39 GasNZV	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	x	x
17	terranets	GuD-Anlage Altbach	H-gas	1,200	Section 39 GasNZV	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	x	x
18	terranets	GuD-Anlage Marbach	H-gas	800	Section 39 GasNZV	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	x	x
19	terranets	GuD-Anlage Aalen	H-gas	316	Section 39 GasNZV	Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn	x	x
20	terranets	KWK-Anlage AUDI AG WerkNeckarsulm	H-gas	120	Section 39 GasNZV	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	x	x
21	terranets	GuD-Anlage Mannheim	H-gas	1,025	Section 39 GasNZV	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	x	x
22	Thyssengas	GuD-Anlage Herne	H-gas	1,191	Section 39 GasNZV	Epe/Xanten I (UGS-E; Innogy)	x	x

Source: Transmission system operators

Figure 5: New build gas power plants connected to the transmission network



Source: Transmission system operators, schematic diagram

3.2.3 Industry

With regard to industrial customers, the transmission system operators also distinguish between customers directly connected to the transmission network and those connected to the distribution system.

The following modelling approach is used to model the capacity demand of industrial customers in the **LNGplus security of supply variants**:

- A capacity reduction was assumed for the existing capacities and requested capacity increases of the industrial customers directly connected to the transmission network as well as for the capacity of the distribution system operators. Based on the starting value of the year 2022, a capacity reduction of 9.4 % is taken into account based on the gas volume reduction of 15 % until the target year 2032.
- The substitution of methane by hydrogen indicated in the concluded MoU is reflected accordingly in the LNGplus modelling variants.

The following modelling approach is used for the capacity demand modelling of industrial customers in the **base variant** and the **LNG security of supply variants**:

For the industrial customers directly connected to the transmission network, the existing capacities in the base variant and the LNG security of supply variants were constantly updated until 2032, provided that no deviating capacity reports are received from the industrial customers.

In the modelling, additional capacities are always assumed to be freely allocable capacities (frei zuordenbaren Kapazitäten – FZK).

The additional demand of industrial customers is subjected to a network planning review by the transmission system operator requested in each case, provided that the demand notification has been submitted to the transmission system operator by 15 July 2021. The transmission system operators will apply a procedure based on section 39 GasNZV for the implementation of allocable network expansion measures for industrial demand.

The substitutions of methane by hydrogen specified in the concluded MoU are applied in a reducing manner in the hydrogen variant.

Industrial customers connected to downstream networks must be considered in the internal orders and forecasts by the distribution system operators.

3.2.4 Underground gas storage

The capacity reservations and capacity expansion claims contained in the Scenario Framework 2022 pursuant to sections 38 and 39 GasNZV are taken into account as another input variable in the modelling.

For the modelling of the transport capacities, the capacities presented in the NDP gas database (cf. NDP gas database cycle '2022 – NDP Consultation') were used in all modelling variants. New storage facilities or expansions (cf. Table 5) were reflected with 100 % firm, temperature-dependent capacity.

Table 5: Additional capacity demand for storage facilities on the transmission network

TSO	Storage facility	Gas type	Gas connection capacity [MWh/h]	Status
bayernets	Speicher Nussdorf/Zagling (7F)	H-gas	648 Entry/432 Exit	Section 39 GasNZV
bayernets	Speicher Nussdorf/Zagling (7F)	H-gas	346 Entry/230 Exit	Section 39 GasNZV

Source: Transmission system operators

3.2.5 Biomethane, hydrogen and synthetic gas

Biomethane, hydrogen and synthetic gas are taken into account in the modelling as described in Chapter 6 and 8.

3.2.6 LNG terminals in the LNGplus security of supply variants

Requests for LNG terminals according to sections 38/39 GasNZV and their clustering

Due to the large number of modelling variants with LNG reference and the capacity reservations or capacity expansion claims pursuant to sections 38/39 GasNZV taken into account therein, a distinction is made below between the LNGplus security of supply variants as well as the LNG security of supply variants and the base variant.

As of the reporting date on 30 September 2022, the following capacity reservations or capacity expansion claims pursuant to sections 38/39 GasNZV existed with the transmission system operators. For the Hamburg location mentioned in the LNG Acceleration Act, there is no capacity reservation pursuant to section 38 GasNZV or no capacity expansion entitlement pursuant to section 39 GasNZV. As of the reporting date on 30 September 2022, there were capacity requests amounting to 182 GWh/h.

Table 6: Requests for LNG terminals on the transmission system operators' network (reporting date: 30 September 2022)

No.	TSO	Cluster	LNG project locations	Gas connection capacity [MWh/h]	Status	FSRU	onshore LNG terminals
1	OGE	Wilhelms-haven	Wilhelmshaven	26,000	Section 39 GasNZV	yes*	yes
				10,600		yes	no
				5,500		yes	no
				6,000	Section 38 GasNZV	no	yes
Total cluster Wilhelmshaven				**48,100**			
2	GUD	Lower Elbe	Brunsbüttel	8,700	Section 39 GasNZV	no	yes
				1,975		no	yes
				3,125		no	yes
				15,469		yes	no
3			Stade	9,300	Section 39 GasNZV	no	yes
				6,950		no	yes
				5,450		no	yes
				10,150	Section 38 GasNZV	yes	no
4	–		Hamburg	–	–	–	–
Total cluster Lower Elbe				**61,119**			
5	ONTRAS	Baltic Sea	Rostock	6,250	Section 38 GasNZV	yes	no
6	Fluxys D, GUD LBTG, NGT, OGT		Lubmin	6,000	Section 38 GasNZV	yes	no
	GASCADE			11,100	Section 38 GasNZV	yes	no
				49,400	Section 38 GasNZV	yes	no**
Total cluster Baltic Sea				**72,750**			
Total of all clusters (LNG terminals)				**181,969**			

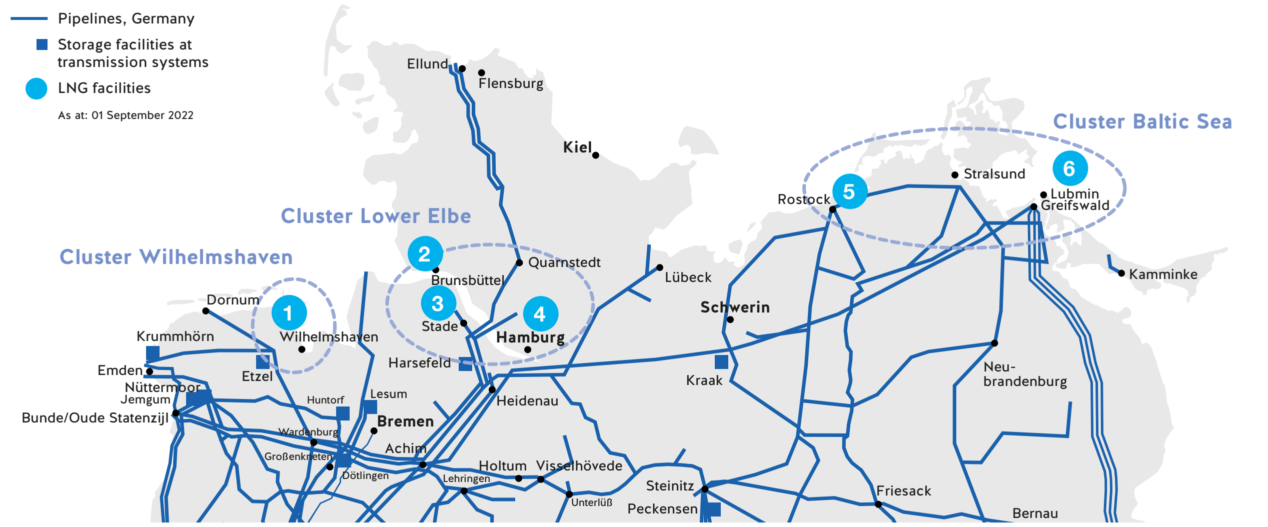
* until completion of the onshore LNG terminal, part of the capacity will be provided via an FSRU
** Offshore platform in phase 2

Source: Transmission system operators

In security of supply variant LNGplus A, all received LNG requests were taken into account as outlined in Table 6. For security of supply variants LNGplus B and C, the transmission system operators have divided the LNG requests into clusters. This was welcomed by the BNetzA in the new partial decision of the Scenario Framework 2022 dated 11 November 2022. The requested capacities of LNG terminals that affect a network area are combined in this 'clustering'. Very high requested capacities in a cluster would result in large network expansions within the respective network area and beyond. Therefore, the transmission system operators consider a limitation of the LNG terminal capacity within the clusters to be appropriate to ensure an efficient network expansion and the fastest possible realisation.

The formed clusters are Wilhelmshaven, Lower Elbe (Brunsbüttel, Stade, Hamburg) and the Baltic Sea (Rostock, Lubmin). They are shown in the following figure.

Figure 6: Possible LNG sites and their clustering



Source: Transmission system operators

Cluster Wilhelmshaven

For the consultation by the transmission system operators and the confirmation of the Scenario Framework 2022 by the BNetzA, the only project sponsor of the Wilhelmshaven LNG terminals at that time had withdrawn its request for capacity reservation pursuant to section 38 GasNZV. Accordingly, no capacities for LNG terminals at the Wilhelmshaven site were to be considered in the Scenario Framework 2022.

At the start of planning for the interim status for the Gas Network Development Plan 2022–2032, Open Grid Europe GmbH (OGE) had capacity reservation requests in accordance with section 38 of the GasNZV amounting to 26 GWh/h for LNG terminals in Wilhelmshaven; the injection of synthetic methane in the amount of 10 GWh/h, which was already included in the base variant, was included in the requests.

For the consultation of the supplemented Scenario Framework 2022, OGE received network expansion requests amounting to 42.1 GWh/h for LNG terminals at the Wilhelmshaven site from three project sponsors pursuant to section 39 GasNZV. In two cases these were LNG Floating Storage and Regasification Units (FSRU) and in one case an FSRU that is supposed to be expanded by an onshore LNG terminal starting 2025.

As part of the consultation, another capacity reservation request pursuant to section 38 GasNZV in the amount of 6 GWh/h was received on time for the Wilhelmshaven site.

Through the construction of a new pipeline from Wilhelmshaven to Drohne, additional capacities amounting to 26 GWh/h can be made available by the end of 2025. Additional capacities beyond this would require further network expansion measures (loop lines), which means that the additional capacities would not be available promptly. Therefore, the cluster is limited to 26 GWh/h in the LNGplus B and C security of supply variants. In security of supply variant A, the full capacity is considered in the modelling for 2032 in the amount of 48.1 GWh/h.

Cluster Lower Elbe (Brunsbüttel, Stade, Hamburg)

The **Brunsbüttel LNG terminal** project was included in the Gas Network Development Plan 2018–2028 via a capacity expansion claim in accordance with section 39 GasNZV. The expansion measures required to provide the entry capacity of 8.7 GW and the connection infrastructure (ID 502-02a and ID 502-03b) were confirmed by the BNetzA. The system operator has submitted two further capacity expansion claims in accordance with section 39 of the GasNZV in August 2019 and May 2021. The transmission system operators will take the LNG terminal in Brunsbüttel into account accordingly in the Gas Network Development Plan 2022–2032.

A capacity expansion claim under section 39 GasNZV was made for the Brunsbüttel site (FSRU) in August 2022 in order to be able to feed regasified LNG into the transmission network in the winter of 2022/2023. In order to accelerate the provision of LNG quantities, the partial use of the distribution system operator pipeline Brunsbüttel – Klein Offenseth (VNB-Leitung Brunsbüttel – Klein Offenseth ID 874-01) was introduced in the Interim Status for the Gas Network Development Plan 2022–2032.

For the planned **LNG terminal** in **Stade** (onshore), an application for capacity reservation pursuant to section 38 of the GasNZV was submitted for the first time in June 2019. As the requested capacity could not be made available, the project sponsor asserted its capacity expansion claim under section 39 of the GasNZV. The resulting expansion measures and connection infrastructure (ID 640-02 and ID 641-02) were confirmed by the BNetzA in the Gas Network Development Plan 2020–2030. The updated planning of the project sponsor provides for a significant increase to the originally planned capacity. As a result, further capacity expansion claims were made in November 2020 and March 2021 in accordance with section 39 GasNZV.

For the Stade site (FSRU), a capacity reservation request pursuant to section 38 GasNZV was submitted as part of the interim status for the Gas Network Development Plan 2022–2032 in order to be able to feed regasified LNG into the transmission network before the end of winter 2023. To accelerate the provision of LNG quantities, the connecting pipeline LNG Stade (Anbindungsleitung LNG Stade – ID 872-01) and the gas pressure control and measuring (GPCM) station LNG Stade (GDRM-Anlage LNG Stade – ID 873-01) were introduced in the interim status for the Gas Network Development Plan 2022–2032.

The **Hamburg site** is explicitly named as a project site in the LNG Acceleration Act and was examined as a site for an FSRU procured by the federal government. There are currently no capacity reservations/capacity expansion claims for the Hamburg site pursuant to sections 38/39 GasNZV.

In total, there are capacity reservation requests and capacity expansion claims of around 61 GWh/h for the Lower Elbe cluster in accordance with sections 38/39 GasNZV. The relevant LNG terminal projects are at different stages of project development. The FSRU projects in Brunsbüttel with around 15.5 GWh/h and Stade with around 10 GWh/h are regarded as secured. It is very likely that the technical capacity of the Brunsbüttel – Hetlingen connecting pipeline of 1.125 million m^3/h (up to 15 GWh/h), which will be available in Q4 2023, will be fully utilised by the construction of corresponding plant capacities in Brunsbüttel. The LNG terminal locations in Brunsbüttel and Stade are explicitly mentioned in the LNG Acceleration Act for FSRUs procured by the federal government. Onshore LNG terminals at these locations have already been reflected in the Gas Network Development Plan 2020–2030 with a capacity of about 20 GWh/h.

The expansion measures for capacity provision in the amount of 20 GWh/h identified and confirmed in the Gas Network Development Plan 2020–2030 as well as the necessary connection infrastructure for the plants are well advanced in the planning phase or are already under construction due to the urgency.

Taking into account the changed gas flows, additional measures were identified that can be implemented in the short term or are already being implemented. With these measures, the LNG capacity fed into the GUD network can be gradually increased to 27.5 GWh/h by 2026. Entry capacities at LNG terminals exceeding this capacity would require further network expansion measures (loop lines and extension of the compressors). Since there is no privileged status for these additional network expansion measures under the LNG Acceleration Act and since there aren't any preliminary technical plans, they are not expected to be available until five years after the Gas Network Development Plan 2022–2032 comes into effect at the earliest.

Therefore, the Lower Elbe cluster is limited to 27.5 GWh/h in security of supply variants B and C. In security of supply variant A, the full capacity is considered in the modelling for the year 2032 in the amount of around 61 GWh/h.

Cluster Baltic Sea (Rostock, Lubmin)

For the **Rostock site**, no capacity reservations/capacity expansion claims pursuant to sections 38/39 GasNZV were available by the start of consultation of the supplemented Scenario Framework 2022.

As part of this consultation, a capacity reservation request pursuant to section 38 GasNZV in the amount of 6.25 GWh/h was received on time for the Rostock site.

For the **Lubmin site**, there were capacity reservation requests pursuant to section 38 of the GasNZV for Phase I with 6 GWh/h and for Phase II with another 11.1 GWh/h by the start of consultation of the supplemented Scenario Framework 2022. For Phase I, regasified LNG is initially supposed to be fed into the German pipeline transmission network via an FSRU in the industrial port of Lubmin. For Phase II, the injection has been requested for the end of 2023.

As part of this consultation, a capacity reservation request pursuant to section 38 GasNZV in the amount of 49.4 GWh/h was received on time for the Lubmin site.

A prompt capacity provision of 1.5 GWh/h is possible for the Rostock site. Additional capacities beyond this would require further network expansion measures (line construction and compressors), which means that the additional capacities would not be available promptly. Therefore, the capacity for the Rostock site in security of supply variants B and C is set at 1.5 GWh/h. In security of supply variant A, the full capacity is considered in the modelling for 2032 in the amount of 6.25 GWh/h.

At the Lubmin site, the balance shortfalls in capacity to cover the demand quantities are considered in security of supply variants B (28.2 GWh/h) and C (10.1 GWh/h). In security of supply variant A, the full capacity is considered in the modelling for 2032 in the amount of 66.5 GWh/h.

Explanation of the LNGplus security of supply variants

In the following, the transmission system operators explain why the capacities between LNG terminals and cross-border interconnection points should be varied in the LNGplus security of supply variants.

In the LNG security of supply variants published in the interim report, the partial replacement of Russian supply volumes destined for the German market with additional injections from German LNG terminals was examined.

The LNGplus security of supply variants examine the complete replacement of the Russian supply volumes destined for the German market. In this context, the transmission system operators assume that the complete replacement of Russian volumes exclusively by German LNG terminals is not efficient and that cross-border interconnecting points with access to Western European LNG terminals should also be used to provide the capacities quickly. This is especially true in light of the fact that neighbouring network operators from Belgium, France and the Netherlands have signalled that additional capacities could be made available at cross-border interconnecting points bordering Germany.

From the point of view of the transmission system operators, it is therefore appropriate to consider two variants with the different focuses cross-border interconnecting points (IP) and LNG, especially as it is not yet clear which LNG sites and capacities will actually be realised.

Therefore, in security of supply variant LNGplus B, the focus is on replacing Russian supply volumes with German LNG terminals, while in security of supply variant LNGplus C, the focus is on providing additional capacities via Western European cross-border interconnecting points.

Furthermore, in security of supply variant LNGplus A, the full capacity of all capacity reservations/capacity expansion claims according to sections 38/39 GasNZV for LNG terminals is taken into account.

In accordance with the specifications of the BNetzA, the task in the LNGplus security of supply variants is to investigate the extent to which potential German LNG terminals could substitute Russian natural gas imports and what network expansion measures this would entail, taking into account the following criteria. The basis is formed by the input parameters of the base variant of the confirmed Gas Scenario Framework 2022, but with the following adjustments for all LNGplus security of supply variants:

1. Complete replacement of Russian natural gas injections affecting Germany amounting to 92 GWh/h
2. No consideration of Russian transit volumes to neighbouring European countries
3. Consideration of natural gas supply from South Eastern Europe in the modelling with corresponding exit capacities to the Czech Republic amounting to 30 GWh/h (7 GWh/h of existing capacities and 23 GWh/h of additional capacities)
4. The exit capacities in the direction of Switzerland, Austria and Luxembourg remain unchanged and can be viewed in the NDP gas database
5. The exit capacities in the direction of Poland are reduced to the bundled capacities
6. LNG and IP capacities must be reflected as firm capacities
7. Determination of the resulting network expansion for the year under consideration 2032

LNGplus security of supply variant A

- Consideration of all requests pursuant to sections 38, 39 GasNZV that were submitted to the transmission system operators by the reporting date on 30 September 2022 (cf. Table 6).
- On this reporting date, capacity requests amounting to around 182 GWh/h were received.
- Based on the requested LNG capacity, the amount of the required entry capacities at the cross-border interconnecting points will be reviewed within the modelling framework of the Gas Network Development Plan 2022–2032 and set accordingly.
- The exit capacity in the direction of Belgium, Denmark, France and the Netherlands remains unchanged.

LNGplus security of supply variant B

In security of supply variant LNGplus B, the replacement of Russian natural gas by priority consideration of LNG capacity in the amount of 83 GWh/h is assumed. The distribution among the LNG site clusters is shown in Table 7:

Table 7: Considered LNG terminals in security of supply variant LNGplus B

No.	TSO	Cluster	LNG project locations	Gas connection capacity [MWh/h]
1	OGE	Wilhelmshaven	Wilhelmshaven	26,000
2	GUD	Lower Elbe	Brunsbüttel, Stade, Hamburg	27,500
3	ONTRAS Fluxys D, GUD LBTG, NGT, OGT GASCADE	Baltic Sea	Rostock, Lubmin	29,700
Sum of all clusters (security of supply variant LNGplus B)				**83,200**

Source: Transmission system operators

A withdrawal in the direction of Belgium, Denmark, France and the Netherlands is not assumed in the peak load case; the exit capacities remain unchanged. The additional import demand resulting from the LNG terminals is covered via Western European cross-border interconnecting points to Belgium (Eynatten), Denmark (Ellund), France (Medelsheim) and the Netherlands (Bunde). The exact distribution is presented in Chapter 6.1.2.

LNGplus security of supply variant C

In the LNGplus C security of supply variant, Russian natural gas is replaced by giving priority to IP capacity. The resulting import demand is covered via Western European cross-border interconnecting points to Belgium (Eynatten), Denmark (Ellund), France (Medelsheim) and the Netherlands (Bunde). The exact distribution is presented in Chapter 6.1.3.

A withdrawal in the direction of Belgium, Denmark, France and the Netherlands is not assumed in the peak load case; the exit capacities remain unchanged.

In security of supply variant LNGplus C, an LNG capacity of 65 GWh/h is taken into account. The distribution among the LNG site clusters is shown in Table 8:

Table 8: Considered LNG terminals in security of supply variant LNGplus C

No.	TSO	Cluster	LNG project locations	Gas connection capacity [MWh/h]
1	OGE	Wilhelmshaven	Wilhelmshaven	26,000
2	GUD	Lower Elbe	Brunsbüttel, Stade, Hamburg	27,500
3	ONTRAS Fluxys D, GUD, LBTG, NGT, OGT GASCADE	Baltic Sea	Rostock, Lubmin	11,600
Total of all clusters (security of supply variant LNGplus C)				**65,100**

Source: Transmission system operators

Connection infrastructure for the LNG terminals

Figure 7 shows that the LNG terminals are not planned in the immediate vicinity of the existing transport infrastructure. Consequently, connection infrastructure is needed to connect the plants to the transmission network.

Wilhelmshaven

For quick connection of the first planned LNG terminal, which is expected to be commissioned as early as the end of 2022, OGE has started the construction of a pipeline (WAL Teil 1) and the associated GPCM station between the existing transmission network near Etzel and Wilhelmshaven. The WAL Teil 1 pipeline was already the result of the modelling of the base variant (ID 818-01) and the LNG security of supply variants (ID 851-01). Therefore, no connecting pipeline is identified.

Brunsbüttel (onshore)

For the connection of the Brunsbüttel LNG terminal, the connection infrastructure (ID 502-02a and ID 502-03b) already included since the Gas Network Development Plan 2018–2028 is still required.

Brunsbüttel FSRU

In order to accelerate the provision of LNG quantities at the Brunsbüttel site, the partial use of the distribution system operator pipeline Brunsbüttel – Klein Offenseth (‘VNB-Leitung Brunsbüttel – Klein Offenseth’ – ID 874-01) was introduced in the interim status for the Gas Network Development Plan 2022–2032.

Stade (onshore)

For connection of the Stade LNG terminal, the connection infrastructure (ID 640-02 and ID 641-02) already included in the Gas Network Development Plan 2020–2030 is still required.

Stade FSRU

To accelerate the provision of LNG volumes at the Stade site, the connecting pipeline LNG Stade (‘Anbindungsleitung LNG Stade’ – ID 872-01) and the GPCM station LNG Stade (‘GDRM-Anlage LNG Stade’ – ID 873-01) were introduced in the interim status for the Gas Network Development Plan 2022–2032.

Hamburg

The Port of Hamburg is explicitly named as a project site in the LNG Acceleration Act and was examined as a site for a FSRU procured by the federal government. There are currently no capacity reservations/capacity expansion claims for the Hamburg site pursuant to sections 38/39 of the GasNZV. Therefore, no connecting pipeline is shown.

Rostock

In order to be able to inject gas volumes into the ONTRAS Gastransport GmbH (ONTRAS) network, a connecting pipeline with a length of approx. 3.5 km (ID 885-01) will be built and a GPCM station (ID 886-01) will be installed. In order to be able to utilise the full output of the LNG terminal all year round, a connection to the NEL pipeline is necessary. This requires the LNG terminal – Groß Tessin (NEL) pipeline (‘Leitung LNG-Terminal – Groß Tessin (NEL)’ – ID 889-01), the compressor station (CS) Groß Tessin (‘Verdichterstation Groß Tessin’ – ID 930-01) and the GPCM station Groß Tessin (‘GDRM-Anlage Groß Tessin’ – ID 929-01).

Lubmin

For the connection of the Lubmin LNG terminal, the Lubmin industrial port connecting pipeline (‘Anbindungsleitung Industriehafen Lubmin – ID 915-01) and the BEG connecting pipeline (‘Anbindungsleitung BEG’ – ID 916-01) are required.

3.2.7 LNG terminals in the base variant and in the LNG security of supply variants

Apart from editorial changes, this Chapter corresponds to Chapter 3.2.6 from the interim status of the Gas Network Development Plan 2022–2032.

Requests for LNG terminals pursuant to sections 38/39 GasNZV

For the interim report of the Gas Network Development Plan 2022–2032, the transmission system operators had capacity expansion requests according to section 39 GasNZV for the planned LNG terminals in Brunsbüttel and Stade. They were considered in the modelling of the base variant in accordance with the confirmed Scenario Framework 2022.

Table 9: LNG terminals considered in the modelling of the base variant

No.	TSO	Location	Gas type	Gas connection capacity [MWh/h]	Status	Base variant
1	GUD	Brunsbüttel	H-gas	8,700	Section 39 GasNZV	x
				1,975		x
				3,125		x
			Total	**13,800**		
2	GUD	Stade	H-gas	9,300	Section 39 GasNZV	x
				6,950		x
				5,450		x
			Total	**21,700**		

Source: Transmission system operators

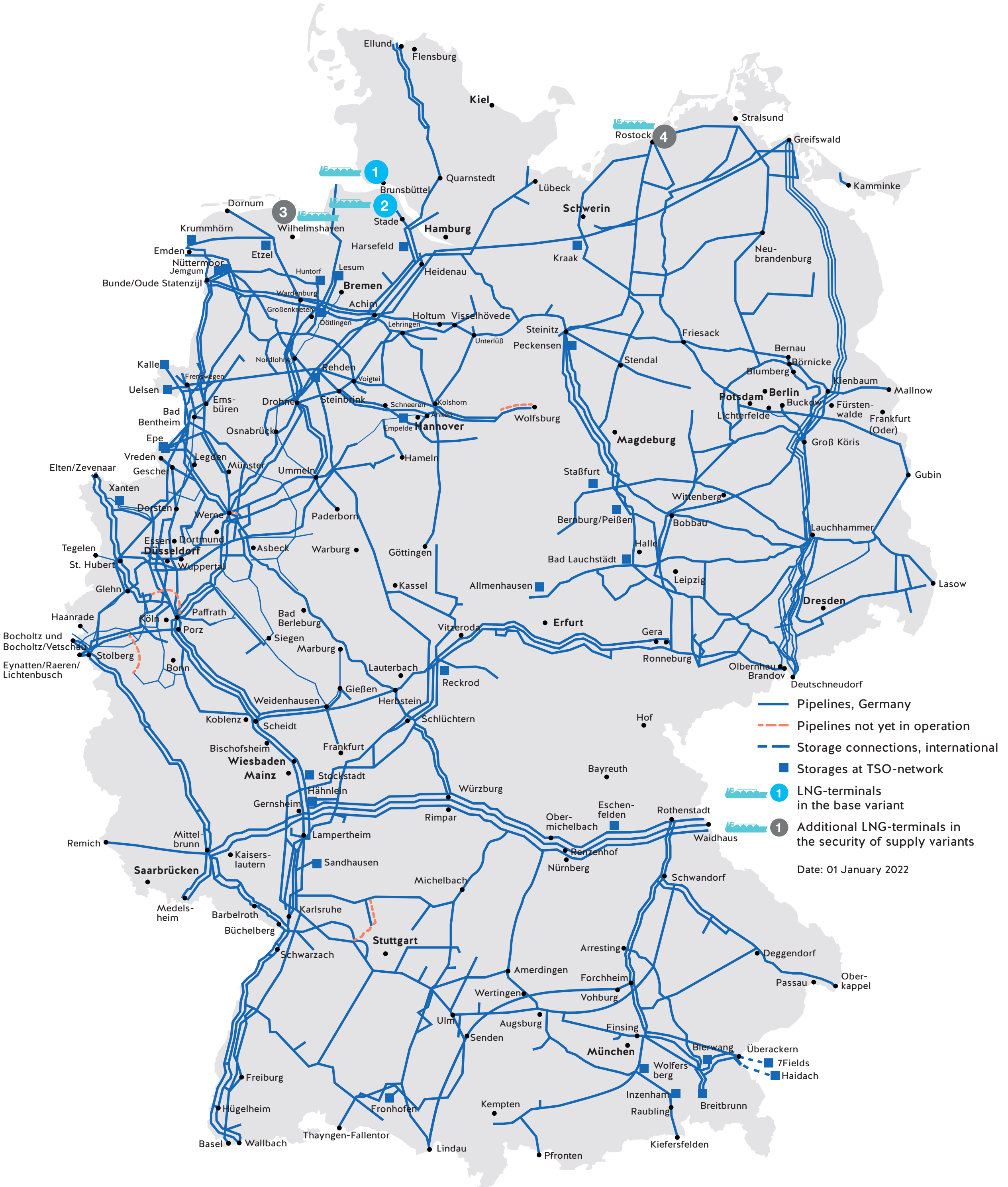
As described in Chapter 2.2, due to the current geopolitical situation, the transmission system operators have decided to include additional LNG security of supply variants in the Gas Network Development Plan 2022–2032. Moreover, the BNetzA has requested the transmission system operators to model the LNG security of supply variants described below. Within the framework of these modelling variants, the potential LNG sites Wilhelmshaven and Rostock are also taken into account. Further assumptions of the LNG security of supply variants are described in Chapter 6.2. The LNG terminals reflected in the modelling of the LNG security of supply variants are presented in the table below.

Table 10: LNG terminals considered in the modelling of the LNG security of supply variants

No.	TSO	Location	Gas type	Gas connection capacity [MWh/h]	LNG variant 1	LNG variant 2	LNG variant 2.1
1	GUD	Brunsbüttel	H-gas	13,800	x	x	x
2	GUD	Stade	H-gas	21,700	x		
3	OGE	Wilhelmshaven	H-gas	26,000	x	x	x
4	GASCADE/ ONTRAS	Rostock	H-gas	10,000		x	
	GASCADE/ ONTRAS	Rostock	H-gas	21,700			x

Source: Transmission system operators

Figure 7: Planned LNG terminals on the transmission system operators' network



Source: Transmission system operators, schematic diagram

Consideration of the LNG terminals in the base variant

The capacity demand of the planned LNG terminals are considered as FZK in the modelling in the same way as in the Gas Network Development Plan 2020–2030. In the view of the transmission system operators, this procedure contributes to security of supply and serves to increase the liquidity of the markets by diversifying the supply sources.

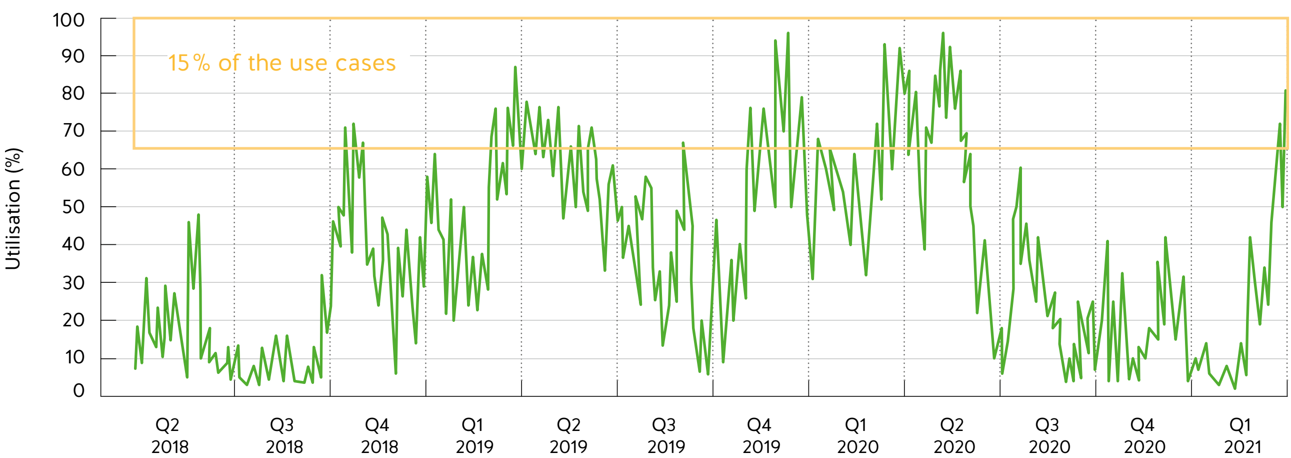
The capacity reservation requests according to section 38 GasNZV could not be confirmed, so that capacity expansion claims according to section 39 GasNZV were filed. These capacity expansion claims result in measures for the representation of entry capacities in the network of Gasunie Deutschland GmbH. Furthermore, the necessary exchange potential between the congestion zones Trading Hub Europe (THE)-South and THE-North is modelled, allowing for swapping potential from other cross-border interconnecting points and storage facilities, and expansion measures are determined.

The transfer of capacities to the LNG locations takes place in the GUD system from the points Emden, storage facility Jemgum and Oude Statenzijl (H-gas).

The engagement of the existing north-western European LNG terminals in the Netherlands and Belgium was used to determine the required exchange potential. This engagement profile was also assumed for the German LNG terminals to be built. The period under consideration runs from 1 April 2018 to 31 March 2021. In order to avoid unnecessary network expansion, the German transmission system operators opted for an 85 % quantile, which excludes the top 15 % of all utilisation cases (cf. Figure 8). These high-load cases are supposed to be covered with the help of market-based instruments.

In order to be able to cover 85 % of the use cases, it is necessary to provide an exchange capacity of 66 % of the total capacity of the LNG terminals. Based on the total capacity of the planned LNG terminals of 35.5 GWh/h, this results in an exchange capacity of 23.4 GWh/h. In addition to the transfer of capacities in the GUD network amounting to 9.2 GWh/h, an additional exchange capacity between the former German market areas of 14.2 GWh/h is taken into account.

Figure 8: Utilisation rate of LNG terminals in NL and BE



Source: Transmission system operators based on GLE, Aggregated Storage Inventory Database

As shown in Figure 8, the LNG terminals are not planned in close proximity to the existing transport infrastructure. Consequently, connecting pipelines are needed to connect the plants to the transmission network. They are supposed to be built by the transmission system operator following the amendment of sections 38 and 39 of the GasNZV as part of the 'Ordinance to improve the framework conditions for the development of the LNG infrastructure in Germany'. The connection points of the respective connecting pipelines were therefore used as input parameters for the modelling. The connecting pipelines and the associated GPCM stations are not the results of the modelling; therefore, they are not a proposal for expansion by the transmission system operators, but are presented as measures in the NDP gas database for the purposes of complete mapping and monitoring. They are listed below:

Connection infrastructure for the LNG terminals of the base variant

Brunsbüttel

In order to fulfil the capacity expansion requirement according to section 39 GasNZV of the planned LNG terminal in Brunsbüttel, the construction of a pipeline from Brunsbüttel to Hetlingen (ID 502-02a) and a GPCM station in Hetlingen (ID 502-03b) is necessary.

Stade

In order to fulfil the capacity expansion requirement according to section 39 GasNZV of the planned LNG terminal in Stade, the construction of a pipeline from Stade to the existing GUD system (ID 640-02) and a GPCM station (ID 641-02) is necessary.

Consideration of LNG terminals in the LNG security of supply variants

In accordance with the specifications of the BNetzA, the task in the LNG security of supply variants is to investigate the extent to which potential German LNG terminals could substitute Russian natural gas imports and what network expansion measures this would entail, taking into account the following criteria. The basis is formed by the input parameters of the base variant of the confirmed Gas Scenario Framework 2022, but with the following adjustments:

- Consideration of the modelling year 2032.
- Modelling of two variants, each with 3 LNG terminals, which are supposed to be set as FZK:
  - Variant 1: Stade: 21.7 GWh/h, Brunsbüttel: 13.8 GWh/h, Wilhelmshaven: 12.5 GWh/h
  - Variant 2: Rostock: 10.0 GWh/h, Brunsbüttel: 13.8 GWh/h, Wilhelmshaven: 12.5 GWh/h
- An injection via Nord Stream 2 is not to be assumed. The capacities planned from Nord Stream 2 for the supply of Germany are supposed to be substituted by the LNG entry capacities. The capacities earmarked for transits should be assumed not to be employed.
- The remaining LNG entry capacities (minus the substituted capacities of Nord Stream 2) of the three LNG terminals should be considered as competing in planning terms with the other entry points that feed Russian natural gas into Germany.
- Capacities intended to supply Germany are to be relocated, but not capacities intended for transits. A competing planning approach to entry points from the west (such as Dornum, Emden, Oude Statenzijl or Jemgum) is therefore not applicable.
- To compensate for possible missing entry capacities, a maximum utilisation of Western European LNG terminals and resulting higher entry capacities at the corresponding cross-border interconnecting points to Germany should be assumed.
- It must be possible to allocate the resulting network expansion measures to the individual LNG terminals. The fastest possible commissioning dates must be specified for the determined network expansion measures, even if they already occur before 2032.

Additions by the transmission system operators

After consultation with the BNetzA, the transmission system operators have made the following additions and adjustments to the terms of reference:

Rostock LNG terminal

Consideration of an additional LNG security of supply variant with a capacity of the Rostock LNG terminal of 21.7 GWh/h (in the same way as in the capacity of the Stade LNG terminal), as the expansion measures are only insignificantly higher than in the variant specified by the BNetzA with a capacity of 10.0 GWh/h.

Wilhelmshaven LNG terminal

At the start of planning, OGE had capacity reservation requests in accordance with section 38 GasNZV amounting to 26 GWh/h for the LNG terminal in Wilhelmshaven; the supply of synthetic methane in the amount of 10 GWh/h, which was already included in the base variant, was included in the requests. Therefore, the transmission system operators have modelled the LNG terminal in Wilhelmshaven with a capacity of 26 GWh/h, of which 12.5 GWh/h were assumed to compete with entry capacities from Russia.

This results in the following LNG security of supply variants:

LNG variant 1: LNG entry capacity: 61.5 GWh/h
Stade: 21.7 GWh/h, Brunsbüttel: 13.8 GWh/h, Wilhelmshaven: 26 GWh/h

LNG variant 2: LNG entry capacity 49.8 GWh/h
Rostock: 10.0 GWh/h, Brunsbüttel: 13.8 GWh/h, Wilhelmshaven: 26 GWh/h

LNG variant 2.1: LNG entry capacity 61.5 GWh/h
Rostock: 21.7 GWh/h, Brunsbüttel: 13.8 GWh/h, Wilhelmshaven: 26 GWh/h

The capacity demand of the planned LNG terminals is modelled as FZK, in the same way as in the Gas Network Development Plan 2020–2030 and in accordance with the BNetzA specifications. Unlike in the base variant, no planning competition with existing cross-border interconnecting points and storage connection points in the network area of Gasunie Deutschland GmbH is taken into account. The capacity reduced by 9.2 GWh/h within the context of the Gas Network Development Plan 2020–2030 is reapplied to increase the available entry capacity at the corresponding points Emden, Jemgum storage and Oude Statenzijl (H-gas).

In the LNG security of supply variants, the capacities of the LNG terminals up to a level of 48 GWh/h are designated as competing with Russian entry capacities in planning terms in order to create the option for market participants to replace Russian gas volumes with LNG.

Unlike in the base variant, frequent simultaneous engagement of the LNG terminals is assumed. This expectation is supported by the fact that the LNG terminals are intended to ensure the substitution of cross-border interconnection points for Russian natural gas, which have been heavily utilised in the past. Therefore, the plants in the LNG security of supply variant are considered to be almost fully utilised, and simultaneity effects between the LNG terminals and the existing entry points are not taken into account.

The capacity demand of the LNG terminals results in measures for connecting and representing the entry capacities in the network of the respective transmission system operator. Furthermore, the necessary exchange potential between transmission system operators, to whose network LNG terminals are connected, and other transmission system operators is modelled under consideration of the changed framework conditions, and necessary expansion measures are determined.

An increase in the exchange capacities between THE-North and THE-South is not necessary due to the balanced LNG entries and reduction of Russian injections in the respective congestion zone, in contrast to the base variant. Detailed information can be found in Chapter 6.2.

Connection infrastructure for the LNG terminals of the LNG security of supply variants

Figure 7 shows that the LNG terminals are not planned in the immediate vicinity of the existing transport infrastructure. Consequently, connecting pipelines are needed to connect the plants to the transmission network. The additional measures compared to the base variant are listed below:

Brunsbüttel

In order to already connect the LNG terminal in Brunsbüttel in 2022, it is necessary to make the infrastructure of the distribution system operator between Brunsbüttel and Klein Offenseth usable for LNG transport (ID 874-01). Taking over the full capacity of the planned LNG terminal in Brunsbüttel in the long term requires the previously mentioned measures 'Leitung Brunsbüttel-Hetlingen' (ID 502-02a) and 'GDRM-Anlage Hetlingen' (ID 502-03b).

Rostock

The connection is from the LNG terminal at the Rostock overseas port to the NEL pipeline. This connection can be made by GASCADE or ONTRAS.

Connection of the LNG infrastructure at the port of Rostock to the NEL requires the construction of a new connecting pipeline from Rostock to the NEL pipeline. Currently, GASCADE assumes a required length of the connecting pipeline 'Tie-In LNG Rostock' of approx. 50 km with a maximum operating pressure (MOP) of 100 bar for LNG security of supply variants 2 and 2.1. For LNG security of supply variant 2, a pipeline with a diameter of DN 700 (ID 878-01) and a GPCM station (ID 879-01) are required. For LNG security of supply variant 2.1, a pipeline with a diameter of DN 1000 (ID 876-01) and a GPCM station (ID 877-01) are required.

GASCADE plans to apply for Important Projects of Common European Interest (IPCEI) funding for the construction of a new hydrogen pipeline from the port of Rostock to Glasewitz. As part of the so-called ripple process for pre-notification by the EU Commission, the project portfolio document was submitted to the project sponsor Jülich in March 2022. The document includes detailed project descriptions as well as an elaborated business case. This pipeline is an integral part of the 'IPCEI doing hydrogen' and the so-called RHATL wave. Preparations for implementation of this project are already well advanced.

The northern section of the 'Tie-In LNG Rostock' connecting pipeline will run parallel to the Rostock–Glasewitz hydrogen pipeline, which is at an advanced stage of planning by GASCADE. Due to the parallel positioning, considerable synergies for the approval procedure and construction are to be expected. Exploratory talks have already been held with pipe manufacturers with regard to the possible time frame for pipe deliveries and the prospect of short production and delivery times. A timely implementation of the measure 'Tie-In LNG Rostock' is thus possible with a short-term decision on project implementation and necessary shortened approval processes by Q4 2023. Allowing for further measures in the flow-mechanical downstream gas transmission network, this measure makes it possible to add approx. 7 GWh/h to the German gas transmission network in Q4 2023, followed by approx. 19 GWh/h in the first quarter of 2024 and up to 21.7 GWh/h in the fourth quarter. This would effectively replace larger Russian import volumes.

In order to be able to feed the first quantities from the Rostock LNG terminal into the ONTRAS network as early as 2022, a connecting pipeline with a length of approx. 3.5 km (ID 885-01) will be built and a mobile GPCM station (ID 886-01) will be installed. Besides that, other small adjustments are necessary. In order to be able to utilise the full output of the LNG terminal all year round, a connection to the NEL pipeline is necessary. For this purpose, a pipeline with a total length of approx. 65 km is supposed to be laid from the overseas port of Rostock to Groß Tessin. The route of the pipeline is largely based on existing transport routes in order to speed up the planning and approval of the pipeline. Synergy effects are also expected with regard to the development of future hydrogen infrastructure. To enable a transport of up to 10 GWh/h (LNG security of supply variant 2) at the required injection pressure into the NEL, a pipeline in DN 900 (ID 889-01) would need to be laid. For the transport of up to 21.7 GWh/h (LNG security of supply variant 2.1) at the required injection pressure into the NEL, a pipeline in DN 1,200 (ID 891-01) would be required. The presented dimensions are calculated conservatively and may still change depending on the pressure conditions of the NEL at Groß Tessin (Ticino). In addition to the connecting pipeline, a GPCM station is required in the Groß Tessin (Ticino) location to transfer 1 million m^3/h (ID 890-01) (LNG security of supply variant 2) or 2 million m^3/h (ID 892-01) (LNG security of supply variant 2.1) to the NEL.

Stade

To connect the Stade LNG terminal as early as mid-2023, the construction of a 2.5 km pipeline from Stade to the GUD existing system (ID 872-01) and a GPCM station (ID 873-01) is necessary. Taking over the full capacity of the planned LNG terminal in Stade in the long term requires the previously mentioned 'Anbindungsleitung LNG Stade' (ID 640-02) and 'GDRM-Anlage LNG Stade' (ID 641-02).

Wilhelmshaven

The 'WAL Teil 1 pipeline' (ID 818-01) is the result of the modelling of the base variant. Therefore, no additional connecting pipeline is identified.

3.2.8 Cross-border interconnection points and VIP

According to Article 19 (9) Regulation (EU) 2017/459 (NC CAM), transmission system operators must establish virtual interconnection points at the market area borders where transport customers can book capacities. Available capacities at the physical cross-border interconnection points of the participating transmission system operators are marketed at the VIP. However, not all VIPs could be set up yet, as there is still a need for clarification of individual requirements from the regulation for implementation in accordance with the NC CAM.

3.2.9 H-gas source distribution

As described in the Scenario Framework, the decline in L-gas imports from the Netherlands and Germany's own production, as well as increased demand (e. g. for gas power plants and distribution system operators), leads to an increased H-gas import requirement for Germany.

For the LNG and LNGplus security of supply variants, an adjusted H-gas source distribution is shown in Chapters 6.1 and 6.2. The additional demand of the base variant is determined in Chapter 6.3 and distributed to the cross-border interconnection points according to the criteria presented there.

3.3 Market area consolidation

NewCap

In the Gas Network Development Plan 2020–2030, the NewCap model was used for the first time within the scope of the network development planning (cf. Chapter 3.4 from the Gas Network Development Plan 2020–2030) in order to estimate the need for market-based instruments arising from the market area merger. In line with the Scenario Framework 2022, this was also planned for the Gas Network Development Plan 2022–2032. This procedure is no longer applicable for the following reasons.

The use of NewCap assumes high liquidity in the market and price-driven engagement of the entry groups LNG in Western Europe, Norway and Russia. Currently, this market behaviour cannot be assumed with certainty – and very probably not in the future either.

Historical data is used as the basis for the statistical analysis by NewCap. Neither specific locations and capacities nor historical data are conclusively available for the new LNG terminals in Germany. In the current market environment, short- and long-term political decisions that are difficult to assess, in addition to price-driven indications, play a major role in the engagement of the entry groups. Moreover, the historical data of the Russia entry group are no longer meaningful, since they should be seen as competing with the new LNG locations for Germany. Additionally, transit flows to our European neighbouring countries are very likely to change, since other sources are also more in focus there.

For the reasons mentioned above, the transmission system operators refrain from forecasting the MBI using NewCap, as the result largely depends on assumptions and would therefore not be valid right now.

Long-term capacity demand

Analysing long-term capacity demand requires high liquidity in the market and price-driven engagement of the entry groups LNG in Western Europe, Norway and Russia. Currently, this market behaviour cannot currently be assumed with certainty and very probably not in the next few years either.

Historical data is typically used as a basis for statistical analyses. Neither specific locations and capacities nor historical data are available for the new LNG terminals. Experiences of how the LNG terminals could be used cannot be transferred from other European LNG terminals either, as no typical usage patterns can be derived from the current situation. This is mainly attributable to the fact that in the current market environment – in addition to price-driven indications – political decisions that are much more difficult to assess in the short and long term will play a major role in the engagement of the entry groups.

Moreover, the historical data of the Russia entry group are also no longer meaningful, since they should be seen as competing with the new LNG terminals for Germany. Additionally, transit flows to our European neighbouring countries are very likely to change, since other sources are also more in focus there.

Furthermore, an increase in exchange capacities between the THE-North and THE-South congestion zones has not been identified as necessary in the modelling due to the balanced LNG entries to the reduction of existing Russian injections in the respective congestion zone.

Furthermore, the transmission system operators cannot seriously forecast the exit side right now due to the efforts on all sides to accelerate the withdrawal from natural gas supply or to significantly reduce demand in the short term by increasing efficiency and swapping energy sources, mainly towards hydrogen.

For the reasons mentioned above, the transmission system operators refrain from an analysis of the long-term capacity demand in this Network Development Plan, as the result largely depends on the assumptions regarding utilisation and would therefore not be valid.

3.4 Modelling variants

The following table provides an overview of the LNGplus and LNG security of supply variants, the hydrogen variant and the base variant of the Gas Network Development Plan 2022–2032.

Table 11: Overview of the modelling variants

Modelling variant	LNGplus variant A	LNGplus variant B	LNGplus variant C
Calculation	complete 2032		
Reference date (capacity provision)	31 December 2032		
Distribution system operator (internal orders)	Start value of internal orders 2022; capacity reduction until 2032 related to the start value of internal orders according to Chapter 3.2.1		
H-gas sources	LNG and western cross-border interconnection points completely replace Russian injections, approach according to Chapter 6.1		
IP/VIP	no Russian natural gas transits; supply of South Eastern Europe via IP to the Czech Republic, approach according to chapter 6.1	No exit capacity at IP to Belgium, France, Denmark and the Netherlands; no Russian natural gas transits; supply of South Eastern Europe via IP to the Czech Republic, approach according to chapter 6.1	
MBI deployment	No calculation		
L-to-H-gas conversion	Modelling of the conversion areas including conversions until 2033 to determine the required network expansion measures until 31 December 2032		
Underground gas storage	Existing capacity according to database cycle ‘2022 – NDP Consultation’, new storage facilities according to Chapter 3.2.4: 100 % bFZKtemp		
Power plants	Existing capacity according to database cycle ‘2022 – NDP Consultation’, interruptible Directly connected system-relevant power plants and new power plants according to Chapter 3.2.2, 100 % fDZK		
LNG	Full consideration of all requests pursuant to sections 38/39 of the GasNZV as of 30 September 2022	Prioritised, needs-based consideration of German LNG capacities in accordance with Chapter 3.2.6	Prioritised, needs-based consideration of additional capacities at western cross-border interconnection points according to Chapter 3.2.6
Production	Inventory according to database cycle ‘2022 – NDP Consultation’, taking the BVEG forecast according to Chapters 2 and 5 into consideration		
Industry	Capacity reduction according to Chapter 3.2.3		
Biomethane and synthetic methane	Inventory according to database cycle ‘2022 – NDP Consultation’, new construction according to Chapters 6 and 8		
Hydrogen	Inventory according to database cycle ‘2022 – NDP Consultation’		

Modelling variant	LNG variant 1	LNG variant 2	LNG variant 2.1	Hydrogen variant 2027	Hydrogen variant 2032
Calculation	complete 2032			complete 2027	complete 2032
Reference date (capacity provision)	31 December 2032			31 December 2027	31 December 2032
Distribution system operators (internal orders)	Starting value: Internal orders 2022, Development from 2023–2027: Distribution system operators' plausibility-tested 10-year forecast Development from 2028 to 2032: Constant extrapolation			Starting value: Internal orders 2022, development from 2023–2027: The plausibility-tested 10-year forecast of the distribution system operators; reduction in methane demand with planned replacement by hydrogen	Development from 2028 to 2032: Constant projection; reduction in methane demand with planned replacement by hydrogen
H-gas sources	Approach according to Chapter 6.2			Additional demand according to H-gas source distribution as per Chapter 6.3.8	
IP/VIP	Approach according to Chapter 6.2			Existing capacity according to database cycle '2022 – NDP Consultation'	
L-to-H-gas conversion	Modelling of the conversion areas, including conversions until 2033 to determine the required network expansion measures until 31 December 2032			Modelling of the conversion areas, including conversions until 2033 to determine the required network expansion measures until 31 December 2032	
Underground gas storage	Existing capacity according to database cycle '2022 – NDP Consultation', new storage facilities according to Chapter 3.2.4: 100 % bFZKtemp			Existing capacity according to database cycle '2022 – NDP Consultation', new storage facilities according to Chapter 3.2.4: 100 % bFZKtemp	
Power plants	Existing capacity according to database cycle '2022 –NDP Consultation', interruptible today Directly connected system-relevant power plants and new build power plants according to Chapter 3.2.2, 100 % fDZK			Existing capacity according to database cycle '2022 – NDP consultation', interruptible today Directly connected system-relevant power plants and new build power plants according to Chapter 3.2.2, 100 % fDZK	
LNG	Consideration according to Chapter 3.2.7			Consideration according to Chapter 3.2.7	
Production	Existing capacity according to database cycle '2022 – NDP Consultation', taking into account the current BVEG forecast according to Chapters 2 and 5			Existing capacity according to database cycle '2022 – NDP Consultation', taking into account the current BVEG forecast according to Chapters 2 and 5	
Industry	Existing capacities are constantly updated until 2032, taking into account the additional demand according to Chapter 3.2.3, approach basically from FZK			Existing capacities are constantly updated until 2032, taking into account the additional demand according to Chapter 3.2.3, approach always based on FZK; the substitutions of methane by hydrogen identified in the MoU discussions are applied in a reducing manner in the methane modelling of the hydrogen variant.	
Biomethane and synthetic methane	Existing capacity according to database cycle '2022 – NDP Consultation', new construction according to Chapters 6 and 8			Existing capacity according to database cycle '2022 – NDP Consultation', new construction according to Chapters 6 and 8	
Hydrogen	Existing capacity according to database cycle '2022 – NDP Consultation'			Existing capacity according to database cycle '2022 – NDP Consultation', under consideration of specific projects of the WEB Market Survey, provided that an MoU (according to Chapter 8.1.1) is concluded by 1 October 2021; modelling according to Chapter 8.2	

Modelling variant	Base variant 2027	Base variant 2032	L-gas balance 2032	H-gas balance 2032
Calculation	complete 2027	complete 2032	Balance analysis	Balance analysis
Reference date (capacity provision)	31 December 2027	31 December 2032	31 December 2032	31 December 2032
Distribution system operator (internal orders)	Starting value: Internal orders 2022, development 2023–2027: The plausibility-tested 10-year forecast of the distribution system operators	Development from 2028 to 2032: Constant extrapolation	Security of supply scenario L-gas 2032, analysis of long-term L-gas balances up to the year 2032	Security of supply scenario H-gas 2032, analysis of long-term H-gas balances up to the year 2032
H-gas sources	Additional demand by H-gas source distribution according to Chapter 6.3.8			
IP/VIP	Existing capacity according to database cycle ‘2022 – NDP Consultation’			
L-to-H-gas conversion	Modelling of the conversion areas including conversions until 2033 to determine the required network expansion measures until 31 December 2032			
Underground gas storage	Existing capacity according to database cycle ‘2022 – NDP Consultation’, new storage facilities according to Chapter 3.2.4: 100 % bFZKtemp			
Power plants	Existing capacity according to database cycle ‘2022 – NDP Consultation’, interruptible directly connected system-relevant power plants and new build power plants according to Chapter 3.2.2, 100 % fDZK			
LNG	Consideration according to Chapter 3.2.7			
Production	Existing capacity according to database cycle ‘2022 – NDP Consultation’, taking into consideration the BVEG forecast according to Chapters 2 and 5			
Industry	Existing capacities are constantly updated until 2032; additional demand is considered in accordance with Chapter 3.2.3; approach always based on FZK			
Biomethane and synthetic methane	Existing capacity according to database cycle ‘2022 – NDP Consultation’, new construction according to Chapters 6 and 8			
Hydrogen	Existing capacity according to database cycle ‘2022 – NDP Consultation’			

Source: Transmission system operators

3.5 Quantity balance for the LNGplus security of supply variants

As the current geopolitical situation shines the spotlight on the availability of LNG as the solution to meeting demand, the transmission system operators and the BNetzA have decided to draw up an all-German quantity balance based on the LNGplus security of supply variants in addition to the L-gas quantity balance in the Gas Network Development Plan 2022–2032.

No differentiation is made between L-gas and H-gas. This is particularly important for consideration of the required import quantities via cross-border interconnection points. If they are no longer required in accordance with the quantity balances presented below, this essentially applies to H-gas imports. L-gas imports will continue to be required until the market area conversion is completed. This must be considered in particular for the LNGplus A security of supply variant (cf. Chapter 3.2.6).

3.5.1 General approach

In the future, German natural gas demand will have to be covered to a large extent by LNG imports. Depending on the development of demand and the utilisation rate of the LNG terminals, additional imports via cross-border interconnection points will be necessary to meet demand.

Since the utilisation rates of the LNG terminals not only depend on the price development but also on a large number of factors that are difficult to forecast, the transmission system operators have used different utilisation rates of the LNG terminals as a basis for determining the quantity balance. They have also presented the effects on the quantity balance in the respective LNGplus security of supply variants.

The following assumptions were made:

Gas demand

The basis for determining the quantity balance is the development of German natural gas consumption up to 2032 presented in Chapter 3.2.6, which serves as the basis for modelling the LNGplus security of supply variants. Accordingly, it is assumed that German gas demand will slow down by around 20 % by 2032. This means a decrease of around 200 TWh compared to 2021.

German production

The approach is based on the forecast published in the Bundesverband Erdgas, Erdöl und Geoenergie e. V. (BVEG – German Federal Association for Natural Gas, Petroleum and Geoenergy) Annual Report for 2021/2022.

Biogas

The approach is based on the BNetzA monitoring report and the development assumed in the Scenario Framework 2022.

LNG

The basis for determining the LNG volumes is the development of the LNG entry capacities assumed in the LNGplus security of supply variants. They are converted into a volume development via assumed full utilisation hours (utilisation rates). In order to illustrate the range of possible LNG imports, the full utilisation hours are varied to create different LNG volume developments. The lower limit for the utilisation of the LNG terminals is assumed to be 3,000 full utilisation hours per year. This corresponds to the average utilisation of LNG terminals in Europe before the start of the Russian war of aggression.

An almost maximum utilisation of 8,000 full utilisation hours per year is assumed as the upper limit. This high utilisation is necessary at the beginning, as the existing IP capacities via Norway, the Netherlands and Belgium as well as the IP capacities offered on a daily basis from France are initially not sufficient to cover demand.

From gas year 2026/2027 onwards, this value is reduced to 6,000 full utilisation hours per year, as it is assumed that from this point on all German LNG terminals will be available at full capacity and the power balance will no longer be under-utilised. This also reflects the current utilisation of the north-western European LNG terminals.

Cross-border interconnection points

For the quantity balance, it is assumed that the remaining volume demand required to meet demand in the balance after the application of production, biogas and LNG, if available, is covered by cross-border interconnection points. The results of the gas quantity balances of security of supply variants LNGplus A, B and C are presented below.

3.5.2 LNGplus security of supply variant A

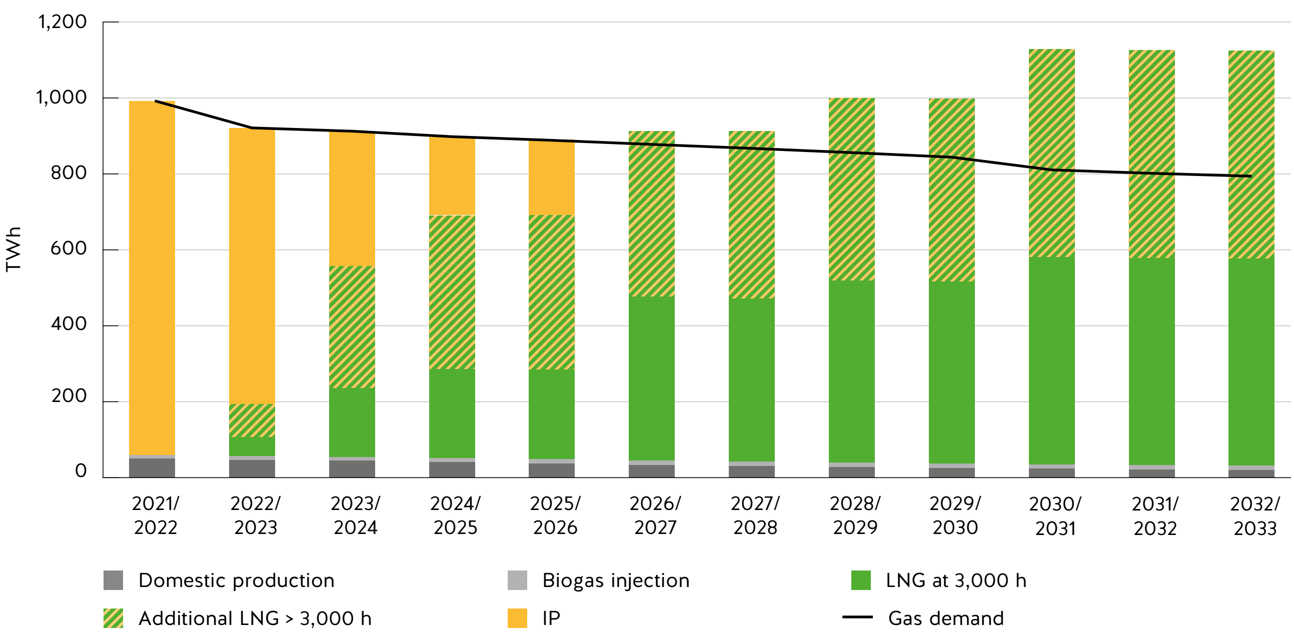
By considering all capacity reservations/capacity expansion claims according to sections 38/39 GasNZV for LNG, the highest LNG entry capacities of 182 GWh/h are assumed in the long term in this variant.

In the event of high utilisation of the LNG terminals, according to the total capacity reservations/capacity expansion claims requested pursuant to sections 38/39 GasNZV, gas imports via the cross-border interconnection points would no longer be necessary as early as gas year 2024/2025. As explained in the description of the general procedure, this is a balance-based treatment of the gas quantities. The import of L-gas via the cross-border interconnection points beyond 2024 will continue to be necessary until the market area conversion is completed.

In terms of balancing, the permanently high utilisation of the LNG terminals means that the gas demand could not only be completely covered by LNG imports. Instead, due to the increasing overcapacity, up to one third of the LNG imports would not be used domestically and could serve to supply neighbouring countries.

With a low utilisation of the LNG terminals, imports via cross-border interconnection points would still be necessary to cover demand until gas year 2032/2033.

Figure 9: Gas quantity balance of security of supply variant LNGplus A



Source: Transmission system operators

Table 12: Data on the gas quantity balance of the LNGplus A security of supply variant

Gas year LNGplus A	2021/ 2022	2022/ 2023	2023/ 2024	2024/ 2025	2025/ 2026	2026/ 2027	2027/ 2028	2028/ 2029	2029/ 2030	2030/ 2031	2031/ 2032	2032/ 2033
	TWh											
Gas demand (exit)	991	920	911	897	887	876	866	854	843	815	800	793
Domestic production (entry)	50	47	45	42	38	34	31	29	26	24	22	20
Biogas injection (entry)	10	10	10	11	11	11	11	11	11	11	11	11
LNG at 3,000 h (entry)	0	51	190	239	241	434	434	480	480	546	546	546
Additional LNG > 3,000 h (entry)	0	85	316	399	401	434	434	480	480	546	546	546
IP (entry)	931	727	350	207	197	0	0	0	0	0	0	0

Source: Transmission system operators

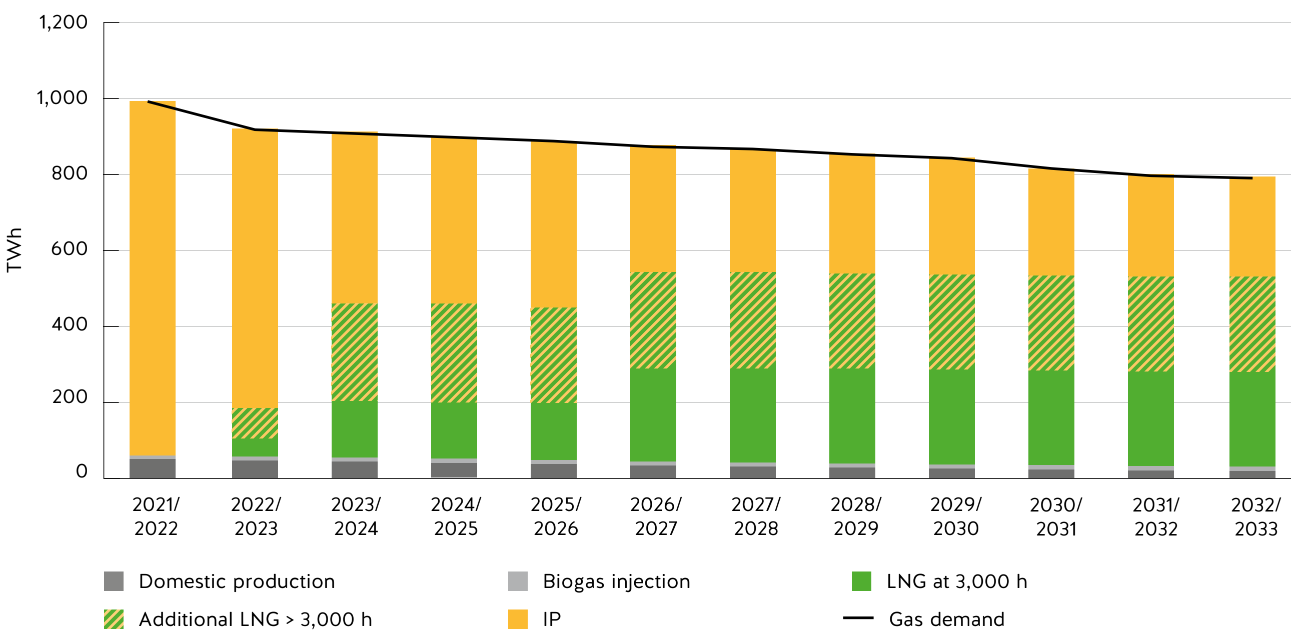
3.5.3 LNGplus security of supply variant B

In this variant, at 83 GWh/h in gas year 2032/2033, significantly lower LNG entry capacities are assumed than in the LNGplus A security of supply variant.

Depending on the utilisation of the LNG terminals, one to two thirds of the gas demand in Germany could be covered by LNG.

Furthermore, it becomes clear that significant import volumes via cross-border interconnection points will also be necessary in the long term to cover demand.

Figure 10: Gas quantity balance of security of supply variant LNGplus B



Source: Transmission system operators

Table 13: Data on the gas quantity balance of the LNGplus B security of supply variant

Gas year LNGplus B	2021/ 2022	2022/ 2023	2023/ 2024	2024/ 2025	2025/ 2026	2026/ 2027	2027/ 2028	2028/ 2029	2029/ 2030	2030/ 2031	2031/ 2032	2032/ 2033
	TWh											
Gas demand (exit)	991	920	911	897	887	876	866	854	843	815	800	793
Domestic production (entry)	50	47	45	42	38	34	31	29	26	24	22	20
Biogas injection (entry)	10	10	10	11	11	11	11	11	11	11	11	11
LNG at 3,000 h (entry)	0	48	154	154	154	250	250	250	250	250	250	250
Additional LNG > 3,000 h (entry)	0	80	257	257	257	250	250	250	250	250	250	250
IP (entry)	931	735	446	434	428	332	324	315	306	281	269	263

Source: Transmission system operators

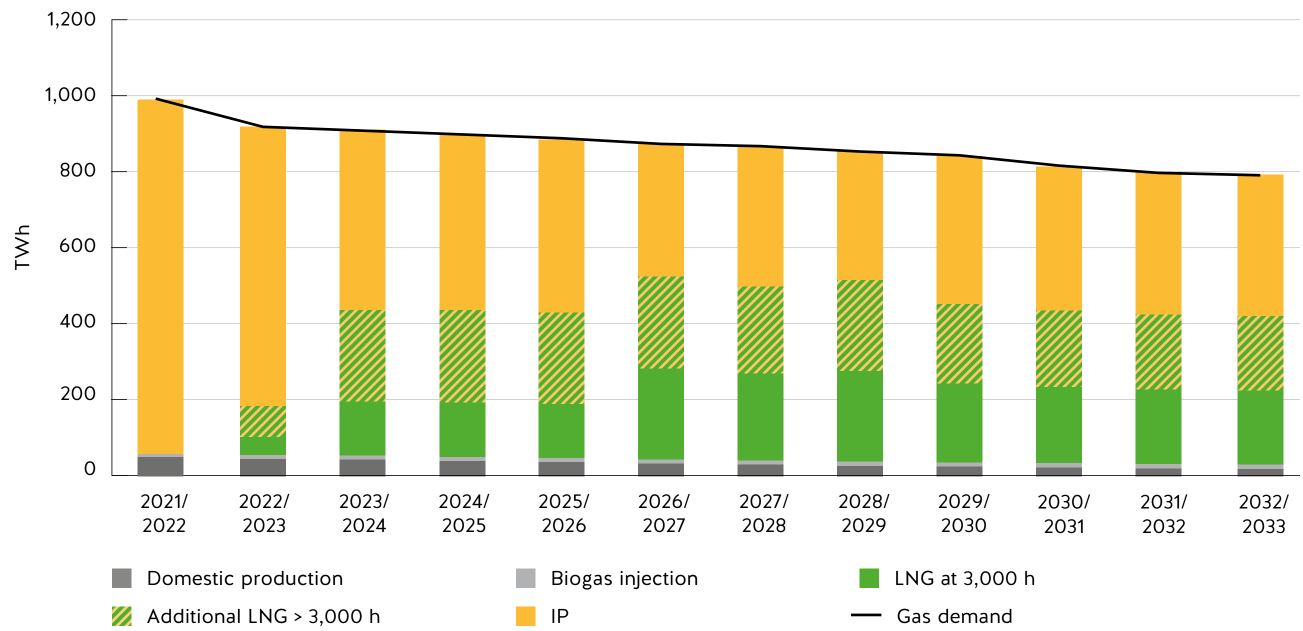
3.5.4 LNGplus security of supply variant C

In this variant, the lowest LNG entry capacities of the LNGplus security of supply variants are assumed with 65 GWh/h in gas year 2032/2033.

Accordingly, the share of LNG terminals to cover demand is lower than in the LNGplus B security of supply variant. Depending on the utilisation rate, around a quarter to half of the gas demand in Germany can be covered by LNG in gas year 2032/2033.

Consequently, significant import volumes via cross-border interconnection points are necessary in the long term to cover demand. The amount of imported gas to meet demand is greater than in the LNGplus B security of supply variant.

Figure 11: Gas quantity balance of security of supply variant LNGplus C



Source: Transmission system operators

Table 14: Data on the gas quantity balance of the LNGplus C security of supply variant

Gas year LNGplus C	2021/ 2022	2022/ 2023	2023/ 2024	2024/ 2025	2025/ 2026	2026/ 2027	2027/ 2028	2028/ 2029	2029/ 2030	2030/ 2031	2031/ 2032	2032/ 2033
	TWh											
Gas demand (exit)	991	920	911	897	887	876	866	854	843	815	800	793
Domestic production (entry)	50	47	45	42	38	34	31	29	26	24	22	20
Biogas injection (entry)	10	10	10	11	11	11	11	11	11	11	11	11
LNG at 3,000 h (entry)	0	48	144	144	144	240	229	239	209	201	197	195
Additional LNG > 3,000 h (entry)	0	80	241	241	241	240	229	239	209	201	197	195
IP (entry)	931	735	471	460	453	351	366	337	388	378	374	371

Source: Transmission system operators

3.5.5 Development of German gas imports via cross-border interconnection points

German LNG terminals are indispensable for the goal to replace the current imports from Russia. However, the results of the gas quantity balances for security of supply variants LNGplus B and C make it particularly clear that Germany will continue to be dependent on gas imports via cross-border interconnection points in the long term.

As illustrated in Table 15, there have been significant changes in the gas volumes imported or exported at the cross-border interconnection points in gas year 2021/2022.

The decline in Russian gas imports was mainly offset by an increase in imports from Norway, the Netherlands and, to a large extent, Belgium. The existing transport infrastructure was utilised at maximum capacity by using technical redundancies.

Table 15: Gas imports to Germany until September 2022

Gas imports to Germany	01.10.2020–30.09.2021	01.10.2021–30.09.2022
	TWh	
Russia	621	476
Poland	286	18
Czech Republic*	279	166
Austria	14	4
Switzerland	0	7
France	0	0
Luxembourg	0	0
Belgium	6	202
Netherlands	183	232
Norway	291	448
Denmark	0	0

* These values include imports from Russia that were subsequently exported to the Czech Republic

Source: Transmission system operators based on the ENTSOG Transparency Platform

Currently, it is uncertain how German gas imports at individual cross-border interconnection points will develop in the long term. The swap of previous imports via cross-border interconnection points in the past two years presented in this chapter can provide an initial indication. An expansion of LNG imports to Europe and especially to Germany (e.g. via the cross-border interconnection points of Belgium, France and the Netherlands) may further change this development in the future. Since the future development of LNG imports to Europe and Germany depends on price developments as well as on a large number of factors that are difficult to forecast, it is currently not expedient to allocate the imports required to meet demand to individual cross-border interconnection points. Therefore, the import quantities via cross-border interconnection points are only shown in total in the quantity balance.

Implementation status of network expansion measures 4

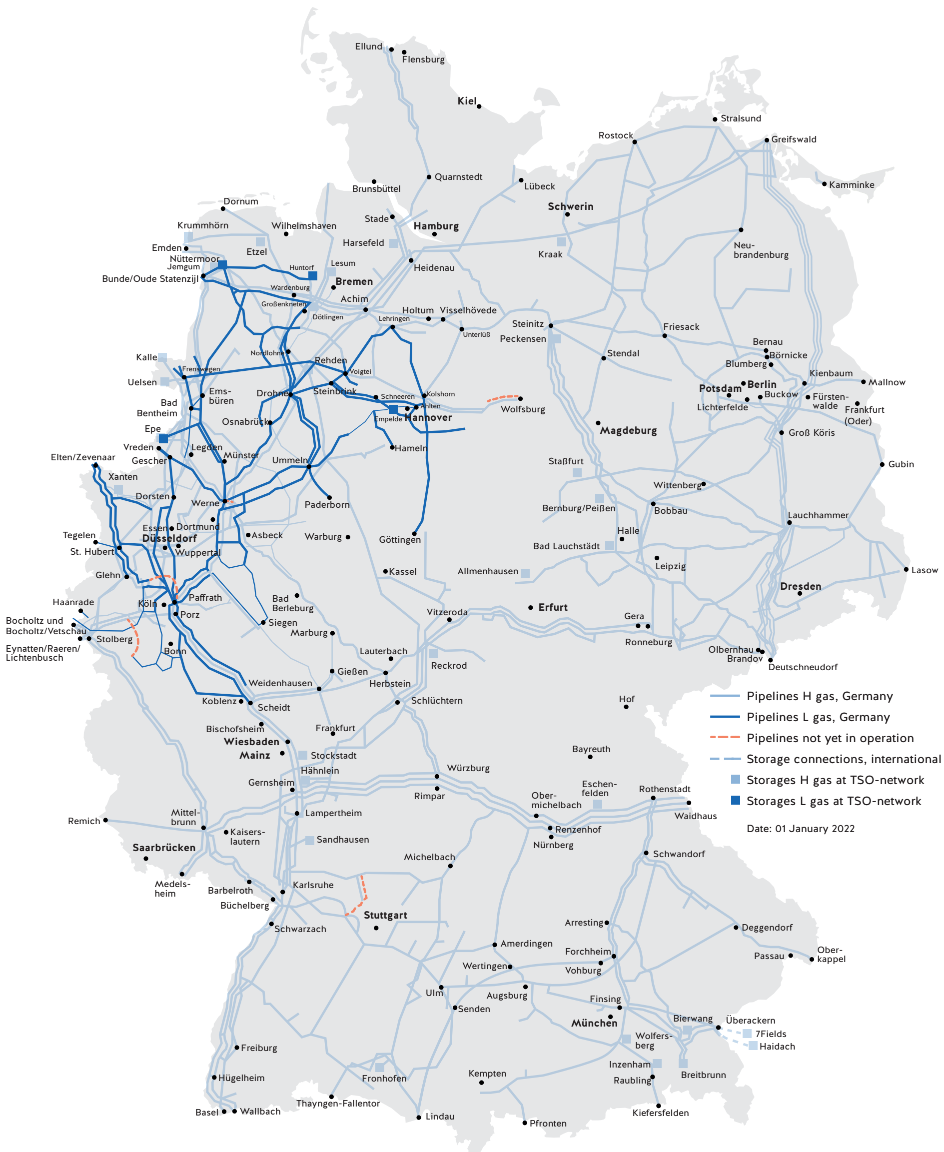
4 Implementation status of network expansion measures

Chapter 4.1 presents the current transmission network. The initial network for modelling of the Gas Network Development Plan 2022–2032 is then shown in Chapter 4.2. The implementation status of the Network Development Plan measures is covered in Chapter 4.3. Then the measures with a planned change of commissioning dates (Chapter 4.4) and the measures with a delay (Chapter 4.5) are presented. Other measures without a final investment decision are described in Chapter 4.6. Chapter 4.7 provides a brief summary. With the exception of editorial adjustments, the chapter corresponds to the status from the Interim Status of the Gas Network Development Plan 2022–2032.

4.1 Current transmission network

The German gas transmission network is divided into an H-gas and an L-gas transport network. These two transmission networks are presented in Figure 12. Chapter 4.1 shows the initial network on which the modelling is based (reporting date: 1 January 2022) and the implementation status of the Gas Network Development Plan 2020–2030.

Figure 12: H-gas and L-gas transmission network



Source: Transmission system operators, schematic diagram

4.2 Initial network for modelling of the Gas Network Development Plan 2022–2032

In accordance with the confirmed Scenario Framework, the initial network used in the network modelling comprises the currently available transmission network, measures commissioned since the previous Network Development Plans, measures under construction as well as further measures selected based on the following criteria from the Gas Network Development Plan 2020–2030 as of 1 January 2022:

- The FID by the transmission system operators has been made and
- the approvals under public law required for the measure have been obtained.

In the initial network simulation, the measures included in the initial network are treated in the same way as existing pipelines and facilities in the existing network. Measures included in the initial network can therefore no longer become the result of the modelling. In fact, they are now given the status of the existing network. The funding requirements necessary to implement these measures are reflected in the total costs for the network expansion proposal.

Measures no longer considered in the Gas Network Development Plan 2022–2032

Measures that were recognised as being in operation in the Implementation Report (IR) 2021 are no longer listed in the Gas Network Development Plan 2022–2032 or in the NDP gas database. This applies to the measures in Table 16.

Table 16: Measures no longer considered in the Gas Network Development Plan 2022–2032, as they were already recognised in the 2021 Implementation Report with the 'commissioned' status

Seq. no	ID number in IR 2021	Network expansion measure	Transmission system operators
1	203-02	VDS Würselen	OGE (75 %)/Thyssengas (25 %)
2	208-02	GDRM-Anlage Rimpar	OGE (44.96 %)/GRTD (55.04 %)
3	221-01	Umstellung auf H-Gas (Bereich: Luttum bis Wolfsburg)	GUD
4	223-01	Umstellung auf H-Gas (Bereich: Bremen Nord, Bremerhaven bis Cuxhaven und östlicher Teil des Netzes der EWE Netz)	GUD
5	308-02b	GDRM-Anlage Gernsheim (OGE)	OGE
6	309-01	VDS MEGAL Rimpar	OGE (44.96 %)/GRTD (55.04 %)
7	310-02	GDRM-Anlage Reichertsheim und Verbindungsleitung	OGE
8	311-02	Leitung Schlüchtern – Rimpar	OGE
9	323-02	Umstellung Netzgebiet Aggertal	Thyssengas
10	325-01	Armaturenstation Neukirchen und Verbindungsleitung	OGE (68.4 %)/Thyssengas (31.6 %)
11	326-02	Armaturenstation Horrem und Verbindungsleitung	OGE (69.4 %)/Thyssengas (30.6 %)
12	327-03	GDRM-Anlage Niederschelden und Verbindungsleitung	OGE
13	328-03	GDRM-Anlage Langenscheid und Verbindungsleitung	OGE
14	329-03	GDRM-Anlage Siegwiesen und Verbindungsleitung	OGE
15	330-02	GDRM-Anlage Elsdorf und Verbindungsleitung	OGE
16	334-02	Armaturenstation Rauschendorf und Verbindungsleitung	OGE
17	336-02	Armaturenstation Oberaden und Verbindungsleitung	OGE
18	410-02a	GDRM-Anlage Rehden	GASCADE
19	410-02b	GDRM-Anlage Drohne	GASCADE
20	415-01	VDS Krummhörn	OGE
21	419-02	GDRM-Anlage Hamborn Erweiterung	Thyssengas
22	420-01	VDS Emsbüren	OGE
23	432-02b	GDRM-Anlage Bunde-Landschaftspolder und H-L-Gas-Mischanlage	GTG Nord
24	445-01a	Armaturenstationen St. Hubert-Voigtslach und Verbindungsleitung (NETG)	OGE (50 %)/Thyssengas (50 %)
25	445-01b	Armaturenstationen St. Hubert-Voigtslach und Verbindungsleitung (OGE)	OGE

Seq. no	ID number in IR 2021	Network expansion measure	Transmission system operators
26	505-01	Erweiterung Konvertierung Rehden	Nowega
27	507-01e	GDRM-Anlage Radeland II	Fluxys D (16.5 %)/GASCADE (50.5 %)/ GUD (16.5 %)/ONTRAS (16.5 %)
28	520-01	Armaturenstation Visbek Astrup	GTG Nord
29	521-01	Armaturenstation Twistringen Ehrenburg	GTG Nord
30	523-01	Systemanpassung GDRM-Anlage Bergedorf	GTG Nord

Source: Transmission system operators

Measures put into operation compared to the Implementation Report 2021

The following measures, which were still in the planning or construction phase in the Implementation Report 2021, have since been put into operation:

Table 17: Measures put into operation compared to the Implementation Report 2021 (reporting date: 1 January 2022)

No.	ID number	Network expansion measure	Transmission system operators
1	116-02	GDRM-Anlage Wiernsheim (Raum Heilbronn)	terranets
2	119-03	GDRM-Anlage Achim	GUD
3	204-02a	ZEELINK 1	OGE (75 %)/Thyssengas (25 %)
4	204-02b	ZEELINK 1 GDRM-Anlage Glehn und Verbindungsleitung	OGE (75 %)/Thyssengas (25 %)
5	204-02c	ZEELINK 1 GDRM-Anlage St. Hubert und Verbindungsleitung	OGE (75 %)/Thyssengas (25 %)
6	204-03d	ZEELINK 1 GDRM-Anlage Stolberg und Verbindungsleitung	OGE (75 %)/Thyssengas (25 %)
7	205-02a	ZEELINK 2	OGE (75 %)/Thyssengas (25 %)
8	205-03b	ZEELINK 2 GDRM-Anlage Legden und Verbindungsleitung	OGE (75 %)/Thyssengas (25 %)
9	206-02	GDRM-Anlage Mittelbrunn	OGE (44.96 %)/GRTD (55.04 %)
10	302-01	Leitung Datteln-Herne	Thyssengas
11	305-02	Reversierung TENP	Fluxys (64.25 %)/OGE (35.75 %)
12	307-01	GDRM-Anlage Mittelbrunn	OGE (44.96 %)/GRTD (55.04 %)
13	320-01	Umstellung des Netzgebietes Bergheim 1 auf H-Gas	Thyssengas
14	331-01	GDRM-Anlage Scheidt	OGE
15	418-02	Erweiterung VDS Scharenstetten	terranets
16	444-01a	GDRM-Anlage Werne/Stockum und Verbindungsleitung	OGE
17	501-03e	Erweiterung GDRM-Anlage Unterlüß	GUD
18	507-01a	Ferngasleitung EUGAL	Fluxys D (16.5 %)/GASCADE (50.5 %)/ GUD (16.5 %)/ONTRAS (16.5 %)
19	507-02d	VDS Radeland II	Fluxys D (16.5 %)/GASCADE (50.5 %)/ GUD (16.5 %)/ONTRAS (16.5 %)
20	507-01h	GDRM-Anlage Börnicke (DÜG)	ONTRAS
21	508-01	Erweiterung GDRM-Anlage Leonberg-West	terranets
22	524-01	Systemanpassung GDRM-Anlage Steinfeld-Düpe	GTG Nord
23	526-01	Leitung Hamm-Bergkamen	OGE
24	528-01	Leitung Merschhoven-Daberg	OGE
25	555-03	Querverbindungen TENP I zu TENP II	Fluxys (64.25 %)/OGE (35.75 %)
26	601-01	Leitung GDRM-Anlage Lauchhammer	ONTRAS
27	645-01	Leitung Neuenkirchen-Rheine	Thyssengas

Source: Transmission system operators

Measures under construction

The following measures are currently under construction:

Table 18: Measures currently under construction (reporting date: 1 January 2022)

No.	ID number	Network expansion measure	Transmission system operators
1	067-02a	Leitung Voigtslach-Paffrath	OGE (50 %)/Thyssengas (50 %)
2	067-03b	GDRM-Anlage Paffrath und Verbindungsleitung	OGE (50 %)/Thyssengas (50 %)
3	312-02	VDS MEGAL Rimpar	OGE (44.96 %)/GRTD (55.04 %)
4	333-02	GDRM-Anlage Asbeck und Verbindungsleitung	OGE
5	335-02b	Leitungen Wipperfürth-Niederschelden	OGE
6	338-02	GDRM-Anlage Paffrath	OGE
7	402-02c	GDRM-Anlage Kötz	bayernets
8	416-02	VDS Legden	OGE (75 %)/Thyssengas (25 %)
9	417-02	VDS Mörsch (Nordschwarzwaldleitung)	terranets
10	431-02	GDRM-Anlage Emstek	GTG Nord
11	435-03	GDRM-Anlage Altena und Verbindungsleitung	OGE
12	440-02	Leitung Erftstadt-Euskirchen	OGE
13	448-01	GDRM-Anlage Euskirchen und Verbindungsleitung	OGE
14	501-02a	Leitung Walle – Wolfsburg	GUD
15	504-02b	Erweiterung GDRM-Anlage Folmhusen	GUD
16	507-01l	Reversierung VDS Holtum	GUD (44.06 %)/OGE (55.94 %)
17	527-01	Leitung Stockum-Bockum Hövel	OGE

Source: Transmission system operators

Further initial network measures of the Gas Network Development Plan 2022–2032

The following measures fulfill the aforementioned criteria for further measures to be included in the initial network:

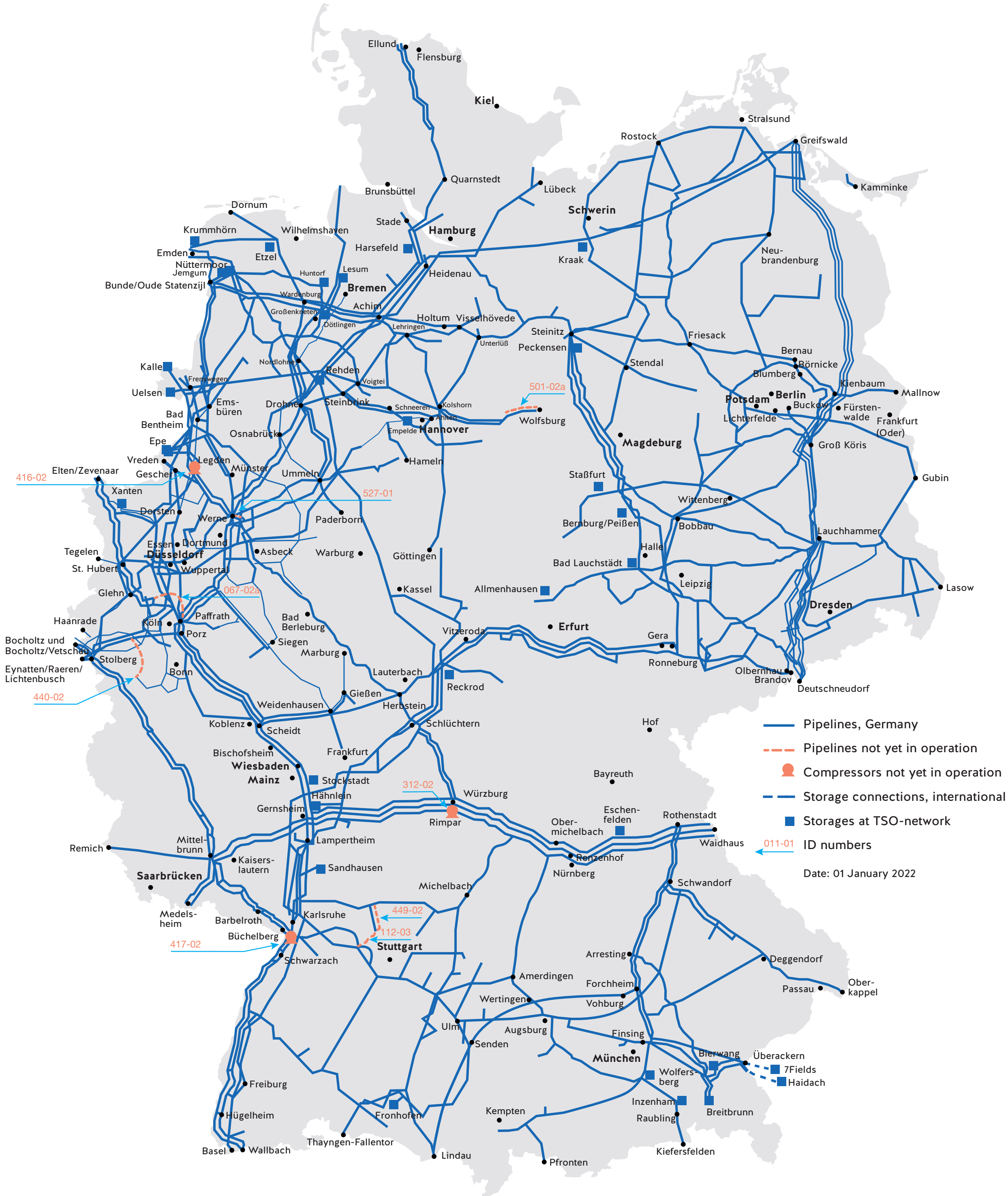
Table 19: Further initial network measures of the Gas Network Development Plan 2022–2032 (reporting date: 1 January 2022)

No.	ID number	Network expansion measure	Transmission system operators
1	112-03	Anbindung Heilbronn	terranets
2	335-02a	GDRM-Anlage Kempershöhe und Verbindungsleitung	OGE
3	439-01	GDRM-Anlage Pattscheid und Verbindungsleitung	OGE
4	446-01	Umstellung Wipperfürth-Niederschelden	Thyssengas
5	449-02	Verlängerung Anbindung Heilbronn (SEL 1)	terranets

Source: Transmission system operators

Figure 13 shows the current transmission network with the measures reflected in the modelling as well as the storage facilities as of 1 January 2022. For greater clarity, the large number of compressor plants in the existing network as well as the commissioned compressor plants and smaller measures (e. g. GPCM stations and valve stations) are generally not shown in the maps of the Gas Network Development Plan 2022–2032. Commissioned pipelines are treated as initial network measures in the same way as the existing network and are therefore presented in the same way.

Figure 13: The initial network for modelling of the Gas Network Development Plan 2022–2032 (reporting date: 1 January 2022)



Source: Transmission system operators, schematic diagram

4.3 Implementation status of the Gas Network Development Plan 2020–2030

In accordance with section 15a(2) EnWG, the current Gas Network Development Plan must contain the implementation status of the previous Gas Network Development Plan. In the Implementation Report 2021 [FNB Gas, USB 2021], the implementation status of the measures of the Gas Network Development Plan 2020–2030 was presented as of 1 January 2021. The transmission system operators have updated the implementation status of the measures of the Gas Network Development Plan 2020–2030 in Table 20 as of 1 January 2022. Measures that were presented in the Implementation Report 2021 with the 'commissioned' status are no longer listed (cf. Table 17). Furthermore, the measures 'Leitung MIDAL Mitte Nord' (ID 627-01), 'Leitung MIDAL Mitte Süd' (ID 628-01), 'Leitung NEL West' (ID 634-01) and 'GDRM-Anlage Herringhausen' (ID 650-01) were dropped in the course of the modelling of the Gas Network Development Plan 2022–2032.

Table 20 shows 'implemented km' for the measures in one column. The term 'implemented km' refers to the pipeline sections laid in the pipe trench as part of a measure. They are not necessarily fully interconnected sections ready for operation. In particular, construction measures involving longer pipelines cannot be built chronologically from a starting point to an end point, for example, due to permit conditions such as construction time restrictions or for technical reasons. Therefore, the indication of the operational length would not do justice to the respective project progress.

Table 20: Implementation status of the Network Development Plan measures (reporting date: 1 January 2022)

No.	ID no. IR 2021	ID no. Gas NDP 2022–2032	Network expansion measure	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	km planned	km realised	Commissioning IR 2021	Commissioning Gas NDP 2022–2032
1	067-02a	067-02a	Leitung Voigtslach-Paffrath	▨	▨	▨	▨	▨	▨	▨	▨	▨	⬛									23.2	17.0	12/2022	12/2022
2	067-03b	067-03b	GDRM-Anlage Paffrath und Verbindungsleitung	▨	▨	▨	▨	▨	▨	▨	▨	▨	⬛									0.2	0.1	12/2022	12/2022
3	112-03	112-03	Anbindung Heilbronn		▨	▨	▨	▨	▨	▨	▨	▨	●									28.0	0.0	12/2021	12/2021
4	116-02	116-02	GDRM-Anlage Wiernsheim (Raum Heilbronn)		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩										0.1	0.1	12/2021	12/2021
5	119-03	119-03	GDRM-Anlage Achim		🟩	🟩	🟩	🟩	🟩	🟩	🟩	🟩										0.1	0.1	10/2021	10/2021
6	204-02a	204-02a	ZEELINK 1			🟩	🟩	🟩	🟩	🟩	🟩	🟩										112.0	112.0	03/2021	03/2021
7	204-02b	204-02b	ZEELINK 1 GDRM-Anlage Glehn und Verbindungsleitung			🟩	🟩	🟩	🟩	🟩	🟩	🟩										0.1	0.1	03/2021	03/2021
8	204-02c	204-02c	ZEELINK 1 GDRM-Anlage St. Hubert und Verbindungsleitung			🟩	🟩	🟩	🟩	🟩	🟩	🟩	▒									0.1	0.1	12/2021	03/2022
9	204-02d	204-03d	ZEELINK 1 GDRM-Anlage Stolberg und Verbindungsleitung			🟩	🟩	🟩	🟩	🟩	🟩	🟩	▒									0.1	0.1	12/2021	03/2022
10	205-02a	205-02a	ZEELINK 2			🟩	🟩	🟩	🟩	🟩	🟩	🟩										115.0	115.0	03/2021	03/2021
11	205-02b	205-03b	ZEELINK 2 GDRM-Anlage Legden und Verbindungsleitung			🟩	🟩	🟩	🟩	🟩	🟩	🟩										0.1	0.1	03/2021	03/2021
12	206-02	206-02	GDRM-Anlage Mittelbrunn			🟩	🟩	🟩	🟩	🟩												0.1	0.1	12/2019	12/2019
13	300-02	300-02	Einbindung der VDS Folmhusen im H-Gas				🟫	🟫	🟫	🟫	🟫	🟫	⬛	⬛	⬛	⬛	⬛					0.0	0.0	07/2026	07/2026
14	301-01	301-01	Überspeisung Embsen				🟨	🟨	🟨	🟨	🟨	🟨	⬛	⬛	⬛	▒						0.0	0.0	07/2024	11/2025
15	302-01	302-01	Leitung Datteln-Herne				🟩	🟩	🟩	🟩	🟩	🟩										23.0	23.0	12/2021	12/2021
16	305-02	305-02	Reversierung TENP				🟩	🟩	🟩	🟩	🟩											0.0	0.0	12/2020	12/2020
17	307-01	307-01	GDRM-Anlage Mittelbrunn				🟩	🟩	🟩	🟩	🟩											0.1	0.1	12/2020	12/2020
18	312-02	312-02	VDS MEGAL Rimpar				▨	▨	▨	▨	▨	▨	⬛	⬛								0.0	0.0	12/2023	12/2023
19	320-01	320-01	Umstellung des Netzgebietes Bergheim 1 auf H-Gas				🟩	🟩	🟩	🟩	🟩	🟩										1.0	1.0	09/2021	09/2021
20	331-01	331-01	GDRM-Anlage Scheidt				🟩	🟩	🟩	🟩	🟩											0.2	0.2	12/2020	12/2020
21	333-02	333-02	GDRM-Anlage Asbeck und Verbindungsleitung				▨	▨	▨	▨	▨	▨	▒									0.2	0.2	12/2021	08/2022
22	335-02a	335-02a	GDRM-Anlage Kempershöhe und Verbindungsleitung				▨	▨	▨	▨	▨	▨	●									0.2	0.0	12/2021	12/2021
23	335-02b	335-02b	Leitungen Wipperfürth-Niederschelden				▨	▨	▨	▨	▨	▨	●									7.0	5.5	12/2021	12/2021
24	337-02	337-02	GDRM-Anlage Porz				🟥	🟥	🟥	🟥	🟥	🟥	⬛	⬛	⬛							0.1	0.0	12/2024	12/2024
25	338-02	338-02	GDRM-Anlage Paffrath				▨	▨	▨	▨	▨	▨	⬛									0.2	0.1	12/2022	12/2022
26	402-02a	402-02a	AUGUSTA (Leitung Wertingen-Kötz)					🟨	🟨	🟨	🟨	🟨	⬛	⬛	⬛							41.0	0.0	12/2024	12/2024
27	402-02b	402-02b	GDRM-Anlage Wertingen 2					🟧	🟧	🟧	🟧	🟧	⬛	⬛	⬛							0.3	0.0	12/2024	12/2024
28	402-02c	402-02c	GDRM-Anlage Kötz					▨	▨	▨	▨	▨	⬛	⬛	⬛							0.4	0.0	12/2024	12/2024

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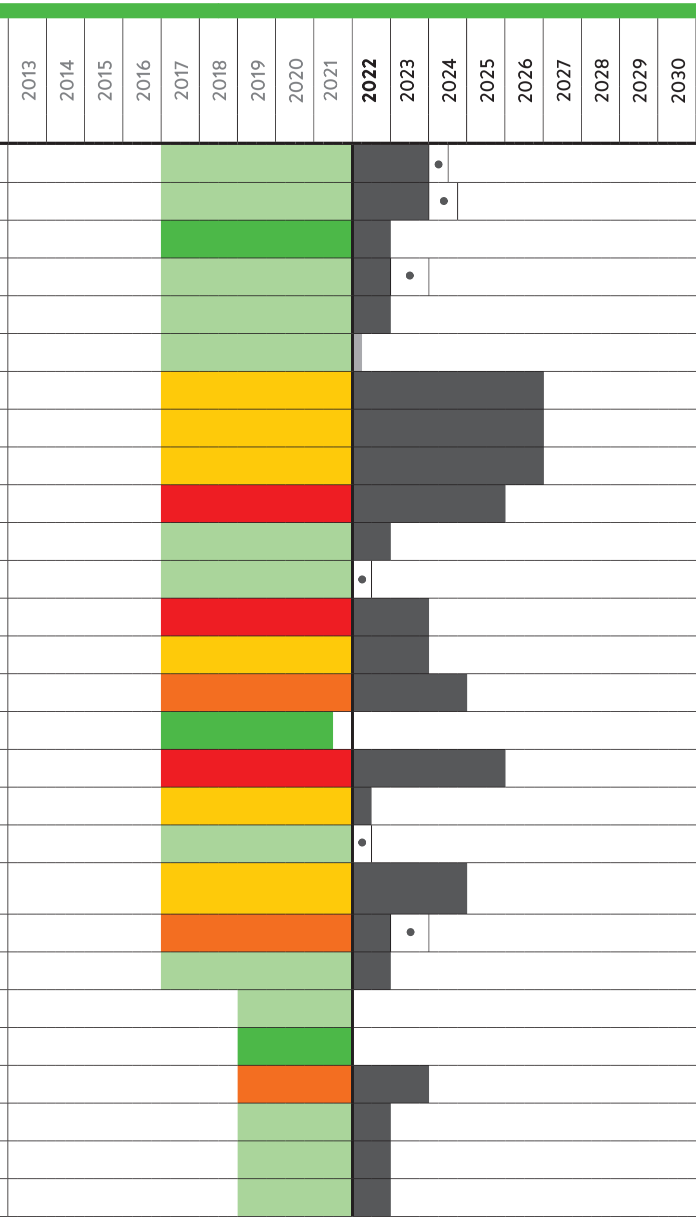
⬛ Future project steps
● (Foreseeable) delay if procedural progress is not optimal
▒ Planned change

Source: Transmission system operators

No.	ID no. IR 2021	ID no. Gas NDP 2022–2032	Network expansion measure	km planned	km realised	Commissioning IR 2021	Commissioning Gas NDP 2022–2032
29	416-02	416-02	VDS Legden	0.0	0.0	12/2023	12/2023
30	417-02	417-02	VDS Mörsch (Nordschwarzwaldleitung)	0.0	0.0	12/2023	12/2023
31	418-02	418-02	Erweiterung VDS Scharenstetten	0.0	0.0	12/2022	12/2022
32	422-01	422-01	VDS Elten	0.0	0.0	12/2022	12/2022
33	431-02	431-02	GDRM-Anlage Emstek	0.3	0.0	10/2022	10/2022
34	435-03	435-03	GDRM-Anlage Altena und Verbindungsleitung	0.1	0.1	12/2021	03/2022
35	436-02a	436-02a	Leitung Marbeck-Heiden	1.5	0.0	12/2026	12/2026
36	436-02b	436-02b	Leitung Heiden-Dorsten	17.0	0.0	12/2026	12/2026
37	437-01	437-01	GDRM-Anlage Heiden-Borken u. Verbindungsleitung	0.1	0.0	12/2026	12/2026
38	438-01	438-01	Umbindung Speicheranbindungsleitungen Epe	0.1	0.0	12/2025	12/2025
39	439-01	439-01	GDRM-Anlage Pattscheid und Verbindungsleitung	0.5	0.0	12/2022	12/2022
40	440-02	440-02	Leitung Erftstadt-Euskirchen	18.4	0.0	12/2021	12/2021
41	441-02	441-02	Armaturenstation Vinnhorst und Verbindungsleitung	0.1	0.0	12/2023	12/2023
42	442-02	442-02	GDRM-Anlage Ahlten und Verbindungsleitung	0.1	0.0	12/2023	12/2023
43	443-02	443-02	GDRM-Anlage Drohne und Verbindungsleitung	0.3	0.0	12/2024	12/2024
44	444-01a	444-01a	GDRM-Anlage Werne/Stockum u. Verbindungsleitung	0.2	0.2	05/2021	05/2021
45	444-01b	444-02b	GDRM-Anlage Werne und Verbindungsleitung	0.1	0.0	12/2025	12/2025
46	446-01	446-01	Umstellung Wipperfürth-Niederschelden	0.1	0.0	05/2022	05/2022
47	448-01	448-01	GDRM-Anlage Euskirchen und Verbindungsleitung	0.1	0.0	12/2021	12/2021
48	449-02	449-02	Verlängerung Anbindung Heilbronn (SEL 1)	25.0	0.0	10/2024	10/2024
49	450-01	450-01	GDRM-Anlage Pfuhl (Steinhäule)	0.1	0.0	12/2022	12/2022
50	451-02	451-02	Erweiterung GDRM-Anlage Au am Rhein	0.1	0.0	12/2022	12/2022
51	501-02a	501-02a	Leitung Walle – Wolfsburg	33.0	33.0	10/2021	10/2021
52	501-03e	501-03e	Erweiterung GDRM-Anlage Unterlüß	0.1	0.1	10/2021	10/2021
53	503-02b	503-03b	Erweiterung VDS Embsen	0.0	0.0	10/2025	12/2023
54	504-01a	504-01a	Leitungsverbindung EPT-Rysum – Rysum-Folmhusen	0.4	0.0	10/2023	10/2022
55	504-02b	504-02b	Erweiterung GDRM-Anlage Folmhusen	0.1	0.1	10/2022	10/2022
56	504-02c	504-02c	GDRM-Anlage Emden	0.1	0.0	10/2022	10/2022



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Planned change

Source: Transmission system operators

No.	ID no. IR 2021	ID no. Gas NDP 2022–2032	Network expansion measure	2013	2014	2015	2016	2017	2018	2019	2020	2021	**2022**	2023	2024	2025	2026	2027	2028	2029	2030	km planned	km realised	Commissioning IR 2021	Commissioning Gas NDP 2022–2032
57	507-01a	507-01a	Ferngasleitung EUGAL																			480.0	480.0	12/2019	12/2019
58	507-01h	507-01h	GDRM-Anlage Börnicke (DÜG)																			0.1	0.1	12/2019	12/2019
59	507-01l	507-01l	Reversierung VDS Holtum																			0.0	0.0	10/2022	10/2022
60	507-01m	507-01m	VDS Sayda												•							0.0	0.0	12/2023	12/2023
61	507-02d	507-02d	VDS Radeland II																			0.0	0.0	12/2020	12/2020
62	508-01	508-01	Erweiterung GDRM-Anlage Leonberg-West																			0.1	0.1	12/2022	12/2022
63	524-01	524-01	Systemanpassung GDRM-Anlage Steinfeld-Düpe																			0.1	0.1	12/2021	12/2021
64	525-02	525-02	GDRM-Anlage Meerbusch Osterrath u. Verbindungsleitung																			0.2	0.0	12/2024	12/2024
65	526-01	526-01	Leitung Hamm-Bergkamen																			5.5	5.5	05/2021	05/2021
66	527-01	527-01	Leitung Stockum-Bockum Hövel																			4.0	3.1	12/2022	12/2022
67	528-01	528-01	Leitung Merschhoven-Daberg																			2.0	2.0	05/2021	05/2021
68	529-01	529-01	Armaturenstationen Elten – St. Hubert																			0.1	0.0	12/2025	12/2025
69	530-01	530-01	Umstellung Köln – Dormagen																			0.3	0.0	12/2024	12/2024
70	531-01a	531-01a	GDRM-Anlage Appeldorn																			0.1	0.0	12/2025	12/2025
71	531-01b	531-01b	Armaturenstation Xanten																			0.1	0.0	12/2025	12/2025
72	532-01	532-01	GDRM-Anlage Leer und Verbindungsleitung																			0.1	0.0	12/2023	12/2023
73	552-01	552-01	Leitung Mittelbrunn-Schwanheim																			38.0	0.0	12/2024	12/2024
74	554-01	554-01	Leitung Hügelheim-Tannenkirch																			16.0	0.0	12/2024	12/2024
75	555-03	555-03	Querverbindungen TENP I zu TENP II																			0.1	0.1	12/2021	12/2021
76	601-01	601-01	Leitung GDRM-Anlage Lauchhammer																			0.1	0.1	12/2021	12/2021
77	602-02	602-02	Leitung Schwanheim-Au am Rhein																			13.0	0.0	12/2025	12/2025
78	603-01	603-01	Leitung Schwarzach-Eckartsweier																			28.5	0.0	12/2025	12/2025
79	604-01	604-01	Leitung Tannenkirch-Hüsingen																			16.0	0.0	12/2025	12/2025
80	609-01	609-01	Leitung Wirtheim-Lampertheim																			115.0	0.0	10/2027	10/2027
81	610-01	610-01	GDRM-Anlage Wirtheim																			0.1	0.0	10/2027	10/2027
82	611-01	611-01	GDRM-Anlage Lampertheim																			0.1	0.0	10/2027	10/2027
83	612-01	612-01	Leitung Löchgau-Altbach (SEL 2)																			44.0	0.0	12/2025	12/2025
84	613-01	613-01	GDRM-Anlage Bietigheim																			0.1	0.0	10/2024	10/2024

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Future project steps
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Planned change

Date: 16 December 2022

Source: Transmission system operators

No.	ID no. IR 2021	ID no. Gas NDP 2022–2032	Network expansion measure	km planned	km realised	Commissioning IR 2021	Commissioning Gas NDP 2022–2032
85	614-01	614-01	Leitung Heidelberg-Heilbronn (SEL 3)	60.0	0.0	12/2026	12/2026
86	616-01	616-01	GDRM-Anlage Heidelberg	0.1	0.0	12/2026	12/2026
87	618-01	618-01	GDRM-Anlage Heilbronn	0.1	0.0	12/2026	12/2026
88	620-01	620-01	GDRM-Anlage Kirchheim unter Teck	0.1	0.0	12/2025	12/2025
89	621-01	621-01	GDRM-Anlage Hittistetten	0.1	0.0	12/2025	12/2025
90	622-01	622-01	GDRM-Anlage Eichstegen	0.1	0.0	12/2025	12/2025
91	624-01	624-01	GDRM-Anlage Weißensberg 2	0.1	0.0	12/2025	12/2025
92	625-01	625-01	GDRM-Anlage Scharenstetten	0.3	0.0	12/2025	12/2025
93	626-01	626-01	Leitung Aalen-Essingen	2.0	0.0	12/2026	12/2026
94	629-01	629-02	VDS Reckrod	0.0	0.0	10/2027	10/2027
95	630-01	630-01	GDRM-Anlage Lampertheim 5	0.1	0.0	10/2027	10/2027
96	631-01	631-01	GDRM-Anlage Lubmin II	0.1	0.0	12/2025	12/2025
97	632-01	632-01	GDRM-Anlage Anlandestation Greifswald – Anlagenerweiterung 3	0.1	0.0	12/2025	12/2025
98	633-01	633-02	VDS Wittenburg	0.0	0.0	12/2025	12/2025
99	635-01	635-01	GDRM-Anlage Embsen	0.1	0.0	10/2022	12/2025
100	636-01	636-02	Leitung Elbe Süd-Achim	100.0	0.0	12/2025	12/2026
101	637-01	637-02	Anpassung Verdichter Achim	0.0	0.0	11/2025	11/2025
102	638-01	638-01	Vorwärmung Embsen	0.0	0.0	11/2025	11/2025
103	639-01	639-01	GDRM-Anlage Achim	0.1	0.0	10/2022	12/2025
104	642-01	642-01	GDRM-Anlage Ludwigshafen	0.1	0.0	10/2027	10/2027
105	–	645-01	Leitung Neuenkirchen – Rheine	8.4	8.4	–	12/2021
106	651-01	651-01	GDRM-Anlage Neuss Rheinpark und Verbindungsleitung	0.1	0.0	12/2024	12/2024
107	652-01	652-01	GDRM-Anlage Engelbostel und Verbindungsleitung	0.1	0.0	12/2022	12/2022
108	653-01	653-01	GDRM-Anlage Kleinenhammer und Verbindungsleitung	0.1	0.0	12/2028	12/2028
109	654-01	654-02	Armaturenstation Iserlohn Hennen	0.1	0.0	12/2021	12/2021
110	655-01	655-01	Armaturenstation Essen Dellwig und Verbindungsleitung	0.2	0.0	12/2026	12/2026

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Source: Transmission system operators

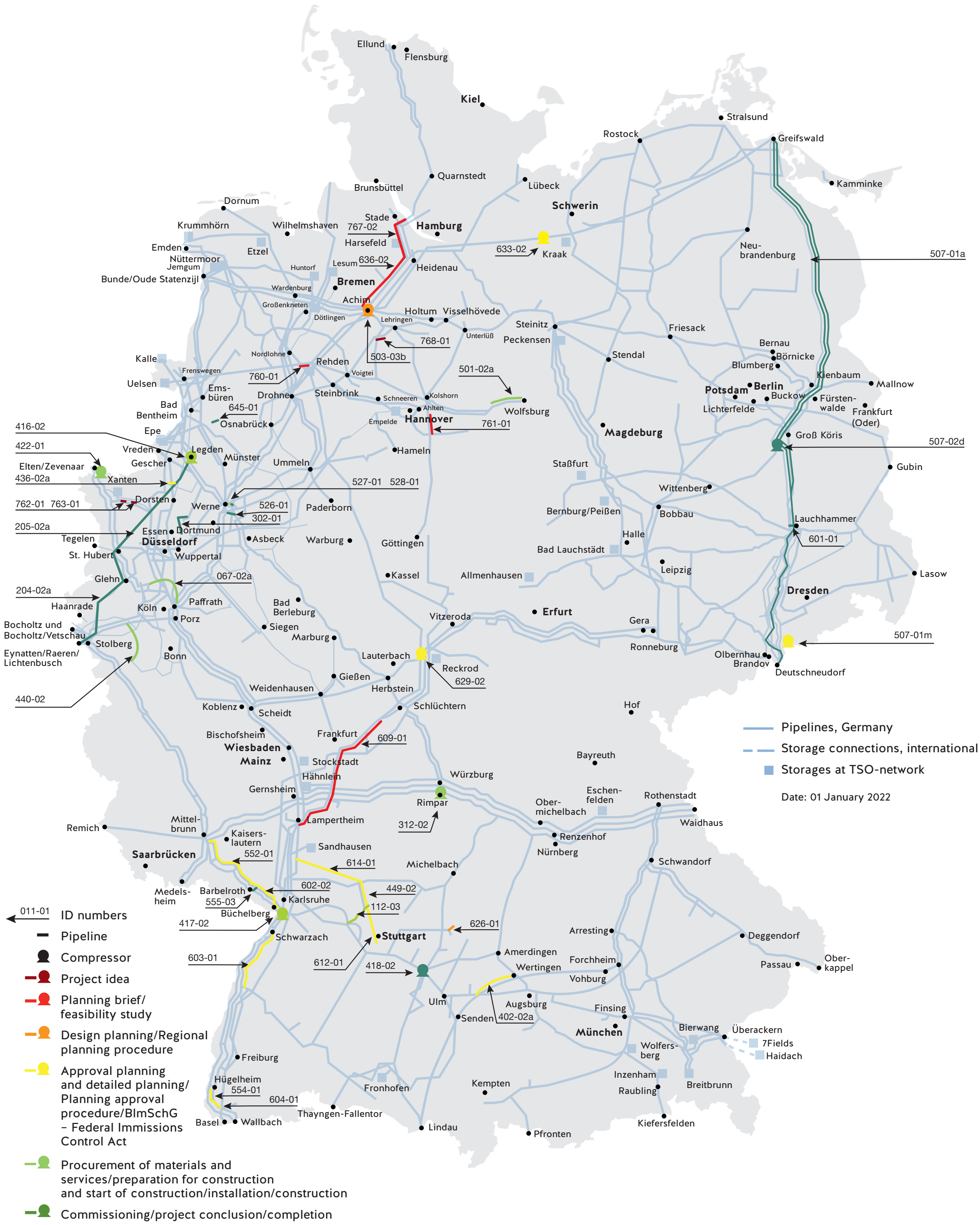
No.	ID no. IR 2021	ID no. Gas NDP 2022–2032	Network expansion measure	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	km planned	km realised	Commissioning IR 2021	Commissioning Gas NDP 2022–2032
111	656-01	656-01	Armaturenstation Duisburg Mündelheim und Verbindungsleitung																			0.1	0.0	12/2026	12/2026
112	657-01	657-01	Umstellung auf H-Gas (Bereich Rehden-Bassum)																			0.0	0.0	01/2024	01/2024
113	658-01	658-01	Umstellung auf H-Gas (Bereich Emsland II)																			0.0	0.0	01/2028	01/2028
114	659-01	659-01	Umstellung auf H-Gas (Kolshorn-Ahlten-Speicher Empelde)																			0.0	0.0	01/2024	01/2024
115	760-01	760-01	Leitung Rehden-Diepholz																			9.0	0.0	12/2030	12/2030
116	761-01	761-01	Leitung Egenstedt-Clauen																			17.0	0.0	12/2030	12/2030
117	762-01	762-01	Leitung Wallach-Alpen																			3.5	0.0	12/2030	12/2030
118	763-01	763-01	Leitung Budberg-Eversael																			1.5	0.0	12/2030	12/2030
119	764-01	764-01	Umbindungen Anschlussleitungen Sonsbeck-Oberhausen																			1.0	0.0	12/2030	12/2030
120	765-01	765-01	GDRM-Anlage Glehn II																			0.1	0.0	12/2030	12/2030
121	766-01	766-01	GDRM-Anlage Hamborn I																			0.1	0.0	12/2030	12/2030
122	767-01	767-02	Leitung Elbe Süd-Achim																			100.0	0.0	12/2025	12/2026
123	768-01	768-01	Leitung Hassel-Westen																			8.0	0.0	12/2030	12/2030

1 Project idea
2 Basic brief/ feasibility study
3 Design planning/ regional planning procedure
4 Detailed/approval planning/planning approval procedure/planning permission procedure/approval process pursuant to the Federal Immissions Control Act (BImSchG)/acquisition of rights of way
5 Procurement of materials and services/ construction preparation and start of construction/installation/construction
6 Commissioning project conclusion/ completion

Future project steps
(Foreseeable) delay if procedural progress is not optimal
Planned change

Source: Transmission system operators

Figure 14: Implementation status of the measures (reporting date: 1 January 2022)



Source: Transmission system operators, schematic diagram

For greater clarity, the map shows the pipelines and compressor stations identified under the attribute ‘type of measure’ in the NDP gas database.

4.4 Measures with a planned change in commissioning dates

The measures listed below with a planned change in the commissioning date (e.g. due to a change in the L-to-H-gas conversion planning) refer to changes compared to the scheduled commissioning dates presented in the Implementation Report 2021. The presentation is based on the reporting date of 1 January 2022.

ZEELINK 1 GDRM-Anlage St. Hubert und Verbindungsleitung (ID 204-02c)

The GPCM station St. Hubert ('GDRM-Anlage St. Hubert') is required for the conversion from L-gas to H-gas. The first conversion step is planned for March 2022. The GPCM station will therefore be commissioned in March 2022.

The implementation time adjustment of this expansion measure has no effect on the planned date of capacity provision.

ZEELINK 1 GDRM-Anlage Stolberg und Verbindungsleitung (ID 204-02d)

The GPCM station Stolberg ('GDRM-Anlage Stolberg') is required for the conversion from L-gas to H-gas. The GPCM station will be commissioned in March 2022.

The implementation time adjustment of this expansion measure has no effect on the planned date of capacity provision.

Überspeisung Embsen (ID 301-01)

In accordance with the change in the commissioning of the Brunsbüttel LNG terminal announced by the operator, the commissioning of the necessary expansion measure can also be changed to November 2025.

GDRM-Anlage Asbeck (ID 333-02)

The GPCM station Asbeck ('GDRM-Anlage Asbeck') is required for the conversion from L-gas to H-gas. The first conversion step is planned for August 2022. The GPCM station will therefore be commissioned in August 2022.

The implementation time adjustment of this expansion measure has no effect on the planned date of capacity provision.

GDRM-Anlage Altena (ID 435-03)

The GPCM station Altena ('GDRM-Anlage Altena') is required for the conversion from L-gas to H-gas. The first conversion step is planned for April 2022. The GPCM station will therefore be commissioned in April 2022.

The implementation time adjustment of this expansion measure has no effect on the planned date of capacity provision.

Erweiterung VDS Embsen (ID 503-03b)

The expansion of the CS Embsen ('VDS Embsen') by a third unit is needed due to increased usage requirements. During the course of the project, potential for accelerated commissioning was identified in order to accommodate the increased utilisation requirements at an early stage.

Leitungsverbindung EPT-Rysum – Rysum-Folmhusen (ID 504-01a)

Reversal of the CS Rysum ('VDS Rysum') is required for the reversion of volumes for the security of supply in the Netherlands. During the course of the project, it has emerged that commissioning of the measure can take place in 2022 instead of October 2023.

GDRM-Anlage Embsen (ID 635-01)

The expansion of the GPCM station Embsen ('GDRM-Anlage Embsen') is necessary because of the increasing demand for power in the context of gas transport for security of supply in the Netherlands. Commissioning of the measure is now planned for December 2025.

The time adjustment of the implementation of this expansion measure has no effect on the planned time of capacity provision as the assigned measure CS Wittenburg ('VDS Wittenburg - ID 633-02') is delayed.

Leitung Elbe Süd–Achim (ID 636–02)

This measure is needed to divert the gas volumes of the LNG terminals planned in the GUD system. The change in the commissioning of the LNG terminal announced by the operators makes it necessary to hold off on the transmission capacity until December 2026.

GDRM-Anlage Achim (ID 639-01)

The expansion of GPCM station Achim ('GDRM-Anlage Achim') is necessary because of the increasing demand for power in the context of gas transmission for security of supply in the Netherlands. Commissioning of the measure is now planned for December 2025.

The time adjustment of the implementation of this expansion measure has no effect on the planned time of capacity provision as the assigned measure CS Wittenburg ('VDS Wittenburg - ID 633-02') is delayed.

4.5 Measures with a delay

4.5.1 Measures with a delay that has already occurred

Delays have occurred in the following measures compared to the 2021 Implementation Report:

Anbindung Heilbronn (ID 112-03)

The commissioning of the Heilbronn connection ('Anbindung Heilbronn') could not take place on schedule due to the lengthy planning approval procedure in the Stuttgart administrative district.

Due to the foreseeable delay, commissioning and capacity provision will take place in December 2022.

GDRM-Anlage Kempershöhe und Verbindungsleitung (ID 335-02a)

The commissioning of the Kempershöhe GPCM station and connecting pipeline ('GDRM-Anlage Kempershöhe und Verbindungsleitung') could not take place on schedule due to delays in the approval process.

Impacts on the planned date of capacity provision and the L-to-H-gas conversion will be avoided by additional temporary construction measures.

Leitungen Wipperfürth-Niederschelden (ID 335–02b)

Commissioning of a subproject of the Wipperfürth-Niederschelden pipelines measure ('Leitungen Wipperfürth-Niederschelden') could not take place on schedule due to delays in the approval procedure.

The implementation time adjustment of this expansion measure has no effect on the planned date of capacity provision. The measure is scheduled to be commissioned on time before the start of the L-to-H-gas conversion.

Leitung Erftstadt-Euskirchen (ID 440-02)

Commissioning of the Erftstadt-Euskirchen pipeline ('Leitung Erftstadt-Euskirchen') could not take place on schedule due to delays in the construction process caused by the heavy rain and flooding in the region in 2021.

The implementation time adjustment of this expansion measure has no effect on the planned date of capacity provision. The measure is scheduled to be commissioned on time before the start of the L-to-H-gas conversion.

GDRM-Anlage Euskirchen und Verbindungsleitung (ID 448-01)

Commissioning of the GPCM station Euskirchen and connecting pipeline ('GDRM-Anlage Euskirchen und Verbindungsleitung') could not take place on schedule in 2021 due to delays in the construction process caused by the heavy rain and flooding in the region.

The implementation time adjustment of this expansion measure has no effect on the planned date of capacity provision. The measure is scheduled to be commissioned on time before the start of the L-to-H-gas conversion.

Leitung Walle–Wolfsburg (ID 501–02a)

The commissioning of the Walle – Wolfsburg pipeline ('Leitung Walle – Wolfsburg') was scheduled for October 2021.

Due to unforeseeable delays in the approval process, commissioning and capacity provision will now take place in January 2022.

Armaturenstation Iserlohn Hennen (ID 654-02)

The commissioning of the valve station Iserlohn Hennen ('Armaturenstation Iserlohn Hennen') could not take place on schedule due to delays in the approval procedure.

The implementation time adjustment of this expansion measure has no effect on the planned date of capacity provision. The measure is scheduled to be commissioned on time before the start of the L-to-H-gas conversion.

4.5.2 Measures with a foreseeable delay

The measures listed below with a foreseeable delay compared to the 2021 Implementation Report refer exclusively to delays compared to the scheduled commissioning dates shown in the NDP gas database.

VDS Legden (ID 416-02)

Commissioning of the CS Legden ('VDS Legden') is not expected to take place on schedule due to delays in the approval process.

It is not currently possible to rule out an impact on the planned date of capacity provision.

VDS Mörsch (Nordschwarzwaldleitung) (ID 417-02)

Commissioning of the CS Mörsch ('VDS Mörsch (Nordschwarzwaldleitung)') will probably be postponed due to delays in the planning and approval process under the Bundes-Immissionsschutzgesetz (Federal Immission Control Act – BImSchG), which is partly attributable to the pandemic.

Due to the foreseeable delay of the second expansion stage, the commissioning and thus capacity provision of the last machine unit is expected in August 2024.

VDS Elten (ID 422-01)

Due to problems with the unexploded ordnance survey and delays in the approval process, construction work started later than planned. The machine unit has already been delivered and is available for testing.

With commissioning expected by December 2023, there are no restrictions on the capacities and conversion steps to be envisaged in the Scenario Framework.

Verlängerung Anbindung Heilbronn (SEL 1) (ID 449-02)

In the Heilbronn connection extension ('Verlängerung Anbindung Heilbronn (SEL 1)') measure, there are delays in the construction process due to the extensive protection measures for protected species, and thus commissioning will likely be postponed.

Due to the foreseeable delay, commissioning and capacity provision is now expected in December 2024.

GDRM-Anlage Pfuhl (Steinhäule) (ID 450-01)

Commissioning of the GPCM station in Pfuhl (Steinhäule) ('GDRM-Anlage Pfuhl (Steinhäule)') will be postponed due to the more time-consuming procurement of materials and services.

The material and procurement costs have increased significantly. The higher total costs exceed a value limit, which makes an EU-wide tender for procurement mandatory. The multi-phase process of an EU-wide tender is considerably more extensive than the originally planned award procedure and therefore leads to a significant extension of the entire procurement process.

Due to the foreseeable delay, commissioning is expected to take place in December 2023. It is not currently possible to rule out an impact on the planned date of capacity provision.

VDS Sayda (ID 507-01m)

In the context of a technological comparison with measure ID 507-01m ('Neubau Verdichterstation Sayda' – new construction of Sayda compressor station), the concept of the design planning was revised, and a new EU tendering procedure was initiated.

This change in the schedule also affects an adjustment to commissioning and capacity provision from December 2023 to July 2024.

**GPCM station Lubmin II ('GDRM-Anlage Lubmin II' – ID 631-01),
GPCM station landing terminal Greifswald – system expansion 3
('GDRM-Anlage Anlandestation Greifswald – Anlagenerweiterung 3' – ID 632-01),
CS Wittenburg ('VDS Wittenburg' – ID 633-02)**

The measures are needed for security of supply in the Netherlands. The timetable was adjusted as part of the detailed planning. This provides for a planned commissioning of the GPCM stations in September 2026 and the compressor station in December 2026.

Based on currently available information, Nord Stream 2 is not expected to be commissioned in the foreseeable future. Work on the NEL expansion project 'VDS Wittenburg', which has already been started, was therefore limited to what is absolutely necessary. It is not currently possible to rule out a further impact on the commissioning dates and the planned time of capacity provision.

4.6 Further measures without final investment decision

No FID have been made by the transmission system operators for the following measures. The measures are therefore not part of the current transmission network and were not reflected in the initial network for the modelling of the Gas Network Development Plan 2022–2032.

With the measure 'Süddeutsche Erdgasleitung (SEL)', planning is being pursued that originated before the regulation of the gas transmission networks. The route runs mainly through Baden-Württemberg, but partly through Hessen and Bayern. The route section, which mainly runs through Baden-Württemberg, has a total length of around 260 km and runs from Lampertheim to Amerdingen.

The SEL is divided into five sections. Based on the reported capacity requirements in Baden-Württemberg, three of these SEL sections were identified in the modelling as currently requiring supply (ID 449-02, ID 612-01, ID 614-01).

The analyses carried out by terranets bw GmbH (terranets) on the development of capacity requirements make it necessary to consider potential pipeline systems that can contribute to the creation of additional transmission capacity. Considering the upcoming developments in terms of capacity requirements in the coming years, the SEL as a whole represents a central infrastructure system with diversified entry to supply Baden-Württemberg in line with demand. Some of these developments are triggered by the Kohleausstiegsgesetz (German Fossil-Fuel Phase-Out Act). The limited number of potential power plant locations in Baden-Württemberg, which will continue to be regionally concentrated in the greater Stuttgart and Heilbronn areas, can be connected to the high-pressure gas network via the SEL. The emerging developments for Baden-Württemberg in the context of the energy transition and the fuel switch make a complete realisation of the SEL appear foreseeable. A demand-oriented supply of the Baden-Württemberg system from the upstream transmission networks can be facilitated efficiently and sustainably via potent and diversifiable entry points.

The original motivation of the SEL for the sustainable and flexible supply of Baden-Württemberg and southern Germany thus remains fully valid.

4.7 Summary

The following results can be noted regarding the implementation status of the Network Development Plan measures:

- As part of the analysis of the implementation status (reporting date: 1 January 2022), 123 measures were considered.
- In the Gas Network Development Plan 2022–2032, 49 measures have fulfilled the prerequisite for inclusion in the initial network.
- Compared to the 2021 Implementation Report, 27 measures have been put into operation and 17 measures are currently under construction.
- Due to recently gained planning insights, the planned commissioning date was changed for 10 measures.
- Delays that have occurred and are foreseeable were reported for 16 measures.

5 Development of the L-gas supply

5 Development of the L-gas supply – security of supply scenario

According to section 15a(1) EnWG, the transmission system operators are required to consider the impact of conceivable supply disruptions in connection with security of supply in the Network Development Plan. A joint approach of the transmission system operators was outlined in the Scenario Framework, which addresses these aspects in the context of the market area conversion. Due to the reduced L-gas availability in the German market, the detailed conversion planning up to 2030 needs to be further specified. Furthermore, the analysis of the L-gas balances up to 2030 will make an important contribution to ensuring security of supply. In addition to German production, the focus is on the available entry capacities from storage facilities and at cross-border interconnection points.

Apart from editorial adjustments, the L-to-H-gas conversion planning presented here corresponds to the planning published in summer 2022 from the Interim Status for the Network Development Plan 2022–2032 [FNB Gas, Zwischenstand 2022]. An updated planning status will become part of the implementation report on the Gas Network Development Plan 2022–2032.

5.1 Description of the situation

Part of the German gas market is supplied with low calorific methane (L-gas). L-gas comes exclusively from German and Dutch production. High-calorific methane (H-gas) mainly comes from Norway and Russia or arrives in Germany via LNG terminals. The two different groups of methane properties must be transported within defined limits in separate systems for technical and calibration reasons. For network areas that are supposed to be supplied with gas of a different quality, the appliances must be converted.

L-gas production in Germany is in continuous decline. The remaining German L-gas volumes should continue to be produced and fed into the transmission networks as long as possible.

The declining L-gas production has a significant impact in terms of the available annual volumes in Germany and the available capacities. Since October 2020, there has also been a continuous decline in the L-gas capacity available from the Netherlands. The German transmission system operators are therefore in regular communication with the Dutch transmission system operator Gasunie Transport Services B. V. (GTS) in order to harmonise and update the planning assumptions for future L-gas imports.

The L-to-H-gas conversion planning already described in the previous Network Development Plans and implementation reports is updated below. For this purpose, experience from previous conversions and a current view of the gas import situation from the Netherlands have been incorporated into the Gas Network Development Plan 2022–2032.

All evaluations and balances in Chapters 5.4 and 5.5 are based on the status of the conversion planning as of 1 October 2021, which is also presented in the NDP gas database. Chapters 5.7.3 and 5.7.4 describe the changes in the L-to-H-gas conversion planning compared to the 2021 Implementation Report as well as potential changes beyond that report. Chapter 5.9 describes the situation of production entry after the market area conversion.

5.2 Converted areas and experiences from the conversion so far

Converted areas

Since the start of the L-to-H-gas conversion in 2015, 51 areas with a total of around 1.55 million appliances have been converted (see Table 21). This corresponds to around 30 % of the total number of appliances to be converted by 2029.

In the GUD network, the first conversion area in Schneverdingen was already initiated in 2015. In 2016, the conversion of the larger areas of Walsrode and Fallingbostel followed. From 2017 to 2020, further conversion areas from Nienburg to Hanover and the Bremen/Achim area were successfully converted from L-gas to H-gas. In 2021, a total of around 192,000 appliances were converted from L-gas to H-gas. The 'Bremen Nord/Osterholz Scharmbeck/Bremerhaven/Cuxhaven' area included the first storage facility to be converted, underground storage facility UGS Lesum, which was emptied and refilled with H-gas to the extent that H-gas quality could be established in the storage facility within one year.

In the OGE network, the conversion to H-gas began in 2017. By 2021, conversions were carried out in a total of 22 conversion areas in the OGE network area. In 2021, a total of around 259,000 appliances in the federal states of Nordrhein-Westfalen, Rheinland-Pfalz and Hessen were successfully converted from L-gas to H-gas. The upstream supply of parts of the city of Düsseldorf and other cities in the Rhineland was also converted to H-gas via the ZEELINK pipeline that went into operation in 2021.

At Thyssengas, a total of around 73,000 appliances were converted to H-gas in 2021. The largest conversion area was the Aggertal pipeline area with 42,000 appliances in 2021.

At Nowega, the 'Munster Gockenholz' area was converted to H-gas in 2021.

In the GTG Nord network, the 'EWE Zone Teil II' area with 40,000 appliances was converted in 2021. Furthermore, a partial conversion of the 'Nüttermoor/Huntorf' storage facility was carried out.

Overall, the conversion volume implemented in Germany since 2015 corresponds to an annual consumption volume of around 89 TWh and a capacity of 24 GWh/h.

Table 21: Converted areas 2015–2021

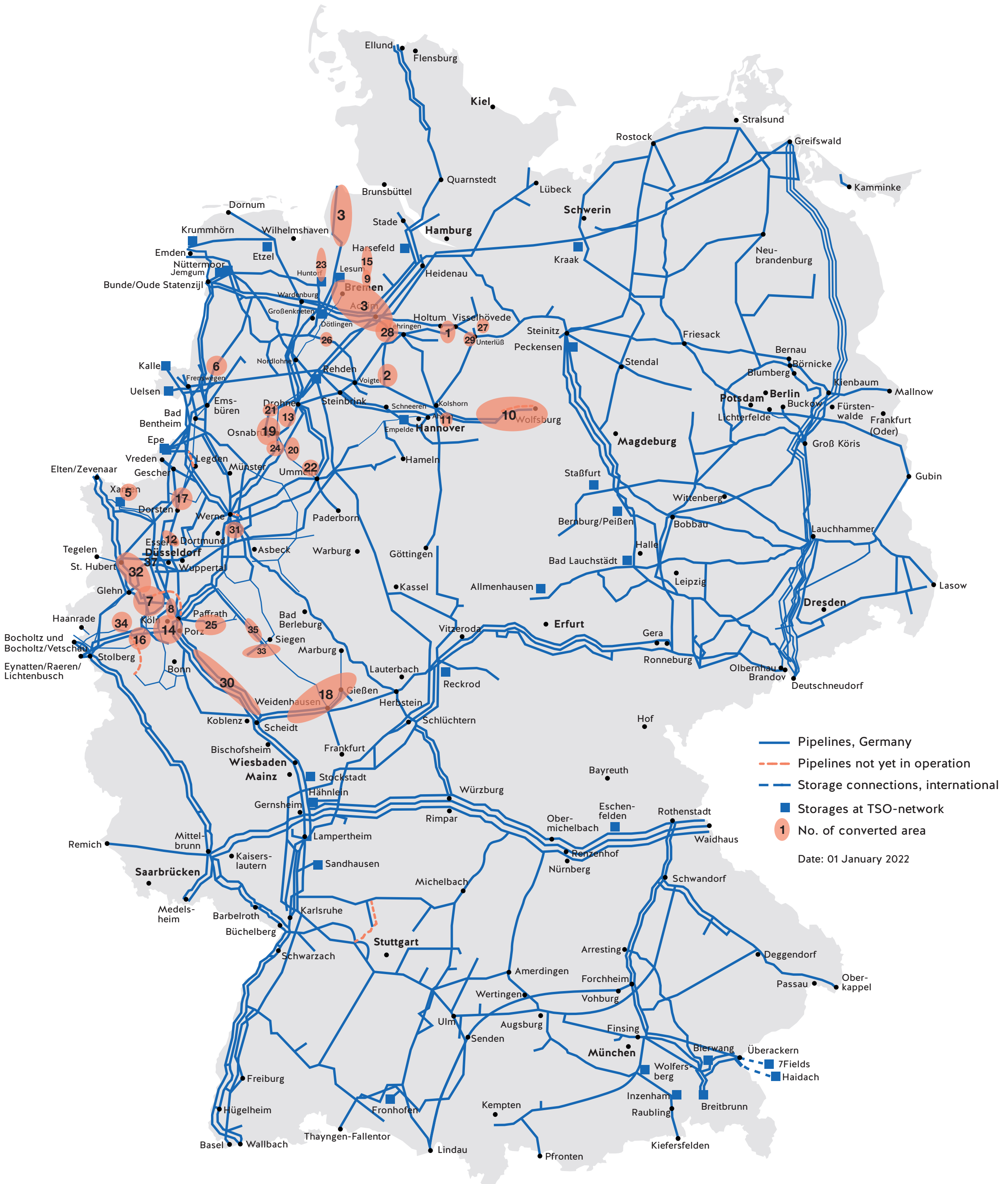
No. in the Gas NDP 2022–2032	Conversion area	Transmission system operators	Time of conversion	Estimated number of appliances
1	Schneverdingen	GUD	2015	8,000
1	Walsrode/Fallingbostel	GUD	2016	12,000
3	Achim	GUD	2017	23,000
2	Nienburg/Neustadt/Hannover Nord	GUD	2017	44,000
3	Bremen/Delmenhorst	GUD	2017	15,000
4	Teutoburger Wald 1	OGE	2017	2,000
5	Hüthum	Thyssengas	2017	10,000
6	Emsland 1*	Nowega	2017	–
7	Dormagen*	OGE	2017	–
8	Leverkusen*	OGE	2017	–
9	Posthausen I	GTG	2018	4,000
3	Bremen/Delmenhorst	GUD	2018	77,000
10	Hannover Ost/Wolfsburg	GUD	2018	61,000
11	Peine	GUD	2018	15,000
12	Essen*	OGE	2018	–
13	Teutoburger Wald 2	OGE	2018	5,000
14	Köln*	OGE	2018	–
15	Posthausen II	GTG	2019	48,000

No. in the Gas NDP 2022–2032	Conversion area	Transmission system operators	Time of conversion	Estimated number of appliances
3	Bremen/Delmenhorst	GUD	2019	42,000
10	Hannover Ost/Wolfsburg	GUD	2019	60,000
16	Bonn	OGE	2019	11,000
17	Marl*	OGE	2019	–
18	Mittelhessen	OGE	2019	63,000
19	Osnabrück	OGE	2019	64,000
20	Teutoburger Wald 3	OGE	2019	15,000
21	Teutoburger Wald 4	OGE	2019	3,000
22	Teutoburger Wald 6	OGE	2019	13,000
23	EWE Zone Teil I	GTG	2020	60,000
3	Bremen/Delmenhorst	GUD	2020	52,000
10	Hannover Ost/Wolfsburg	GUD	2020	74,000
24	Teutoburger Wald 5*	Nowega	2020	–
24	Teutoburger Wald 5	OGE	2020	39,000
25	Aggertal pipeline	OGE	2020	7,000
25	Aggertal pipeline	Thyssengas	2020	39,000
16	Bonn	OGE	2020	25,000
18	MIttelhessen	OGE	2020	92,000
26	EWE Zone Teil I und II	GTG	2021	40,000
3	Bremen Nord/Osterholz Scharmbeck/Bremerhaven/Cuxhaven	GUD	2021	86,000
10	Hannover Ost/Wolfsburg	GUD	2021	93,000
27	Unterlüß-Gockenholz*	GUD	2021	–
28	Verden	GUD	2021	13,000
29	Munster-Gockenholz Region	Nowega	2021	6,000
18	Mittelhessen	OGE	2021	69,000
30	Mittelrhein	OGE	2021	106,000
31	Oberaden*	OGE	2021	–
32	Rheinland	OGE	2021	49,000
33	Westerwald/Sieg	OGE	2021	35,000
25	Aggertal pipeline	Thyssengas	2021	42,000
34	Bergheim 1	Thyssengas	2021	14,000
35	Oberbergisches Land	Thyssengas	2021	10,000
32	Rheinland	Thyssengas	2021	7,000

* no distribution networks

Source: Transmission system operators

Figure 15: Converted areas 2015–2021



Source: Transmission system operators, schematic diagram

Experiences from the conversion so far

The technical network expansion measures required for the L-to-H-gas conversion were completed on time by the transmission system operators. In this context, the timely commissioning of the ZEELINK pipeline should be highlighted due to its importance for the L-to-H-gas conversion.

The conversion of the areas took place on the switching dates that were specified between the participants in the conversion schedules. Distribution system operators, power plants, industrial customers and, for the first time, storage operators were affected. As part of the conversion, around 1.55 million appliances have been converted so far.

COVID-19 pandemic did not cause any time delays in the L-to-H-gas conversion in 2021. In 2020, there were still delays due to COVID-19 pandemic. Most of the delays were offset throughout the year in 2020, and a single switching step involving around 6,000 appliances was offset in 2021.

The transmission system operator must notify the customer of the conversion at least 38 months in advance. Whenever possible, a longer period should be chosen for optimal coordination between all parties involved and to implement any necessary technical upgrades.

For conversions of very large networks, network sections can be designated as pilot conversion areas. These pilot conversion areas, which are converted first, can give the parties involved greater security for the rest of the market area conversion.

Regular coordination between transmission system operators and distribution system operators is necessary to meet switching deadlines and provide capacity. After completion of the conversion concept, detailed planning is usually carried out by the distribution system operators and their conversion service providers. Any changes resulting from this planning must be coordinated with the transmission system operator. Any changes in capacity demand should be taken into account by the respective distribution system operators when internal orders are submitted.

Fluctuating gas qualities led to challenges in the conversion for some distribution system operators, as gas-fuelled appliances have to be adjusted to a reference Wobbe index after the gas quality conversion. By potentially providing data on the quality parameters 'calorific value' and 'Wobbe index' automatically, a process optimisation can be achieved on both sides.

Furthermore, it has become evident that the processing of 'residual consumers' can be particularly critical for smooth handling of the conversion. These are consumers who could not be reached in time by the distribution system operator. This can lead to situations where the corresponding appliances could not be switched over until shortly before the conversion or, in some cases, could not yet be collected. The timely initiation of suitable measures, such as blocking processes, is necessary in order to keep the agreed switching date.

The arrival of the H-gas was preferred in the morning hours in the previous switching operations. This is due to the conversion work that has to be carried out directly in the industrial plants. It is also attributable to the peak utilisation in the morning in order to distribute the H-gas as quickly as possible in the distribution networks. The arrival of the H-gas depends on different parameters (e.g. pipeline pressure, acceptance by the connected network points with or without temperature dependency), especially on longer pipeline sections. In the past, the time interval for the arrival of the H-gas could be easily estimated based on the supply forecast by the consumers. In individual cases, longer intervals may occur, or configurations may arise in which the forecast time intervals do not correspond to the preferences of all customers connected to the pipeline system.

5.3 Gas import situation from the Netherlands

In recent years, more earthquakes have occurred in the vicinity of the Groningen field, which are deemed to be linked to Natural Gas production. On 8 January 2018 as well as on 22 May 2019, earthquakes with a magnitude of 3.4 on the Richter scale each shook the Groningen region. The 2019 earthquake in particular has led to considerable political pressure in the Netherlands to end production in Groningen as soon as possible.

In order to take the risks from Natural Gas production into account, the Dutch Ministry of Economic Affairs has announced that regular Natural Gas production in the Groningen region will cease at the start of the 2022/23 gas year. At the same time, in order to ensure security of supply even in the event of cold spells or failures of the Dutch conversion plants, part of the Groningen field will remain active as a capacity reserve with minimal production. Investigations are currently underway into the point in time at which the Groningen field can be completely closed as a capacity reserve. [Ministerie van Economische Zaken en Klimaat 2022a]

For the current gas year 2021/2022, the Dutch Ministry of Economic Affairs had set a production volume of 3.9 billion m^3. [Ministerie van Economische Zaken en Klimaat 2021] In January 2022, the ministry announced that this production volume would have to be increased. Various variants with production volumes of up to 7.6 billion m^3 are being considered based on an average temperature trend. The increase in production volume is blamed on a delay in the commissioning of the conversion plants in Zuidbroek, the Netherlands, and the increased volume demand from Germany (cf. Chapter 5.5). According to the Ministry of Economic Affairs, the termination of regular Groningen production as of the 2022/2023 gas year is still planned. [Ministerie va Economische Zaken en Klimaat 2022a]

In March 2022, the Dutch Ministry of Economic Affairs [Ministerie van Economische Zaken en Klimaat 2022b] specified that the production volume in Groningen will probably only have to be increased to 4.6 billion m^3. The fact that the increase could be reduced compared to previous considerations is also attributable to the mild winter, which suggests lower gas consumption due to the weather.

The increase in the permitted production volume ensures that the increased import demand from the Netherlands assumed in Chapter 5.5 compared to previous planning from the Implementation Report for the Gas Network Development Plan 2020–2030 is also covered on the production side.

The transmission system operators are in close contact with GTS in this regard and to coordinate the respective plans in the Netherlands and Germany. Since 2019, exchange at an international level has also taken place in particular via the 'Task Force Monitoring L-Gas Market Conversion', which was established on the initiative of the Dutch Ministry of Economic Affairs. Within the framework of the aforementioned task force, a report is prepared every six months under the leadership of the respective ministries of economic affairs from the Netherlands, Belgium, France and Germany in order to report to the Dutch parliament on the measures taken to reduce L-gas demand and L-gas production, among other things. The fifth report of the task force was published in March 2022. [Ministry of Economic Affairs and Climate Policy 2022] The Task Force provides an ideal platform to ensure harmonised planning assumptions with a high degree of transparency. This ensures that the Germany-wide L-gas capacity and volume demand presented in the following chapters are included as integral components in Dutch production planning.

5.4 L-gas capacity balance 2030

The L-gas capacity balance compares the expected L-gas capacity demand according to current conversion planning with the available entry capacities, which consist of production, imports, storage and conversion.

The individual items of the L-gas balance 2030 are explained in more detail below.

5.4.1 Domestic production

The development of production capacities shown in Table 22 is based on the information provided by the BVEG on 18 May 2021. As in the past, a security discount has been applied to the production capacities by the BVEG.

Compared to the 2020 forecast, which was the basis for the 2021 Implementation Report, the capacity forecast for the sum of the Elbe-Weser and Weser-Ems areas has been significantly reduced from 2022 onwards (up to −17 % depending on the year). The regional effects of this significant decrease are described in Chapter 5.1.

Table 22: Capacity forecast according to BVEG

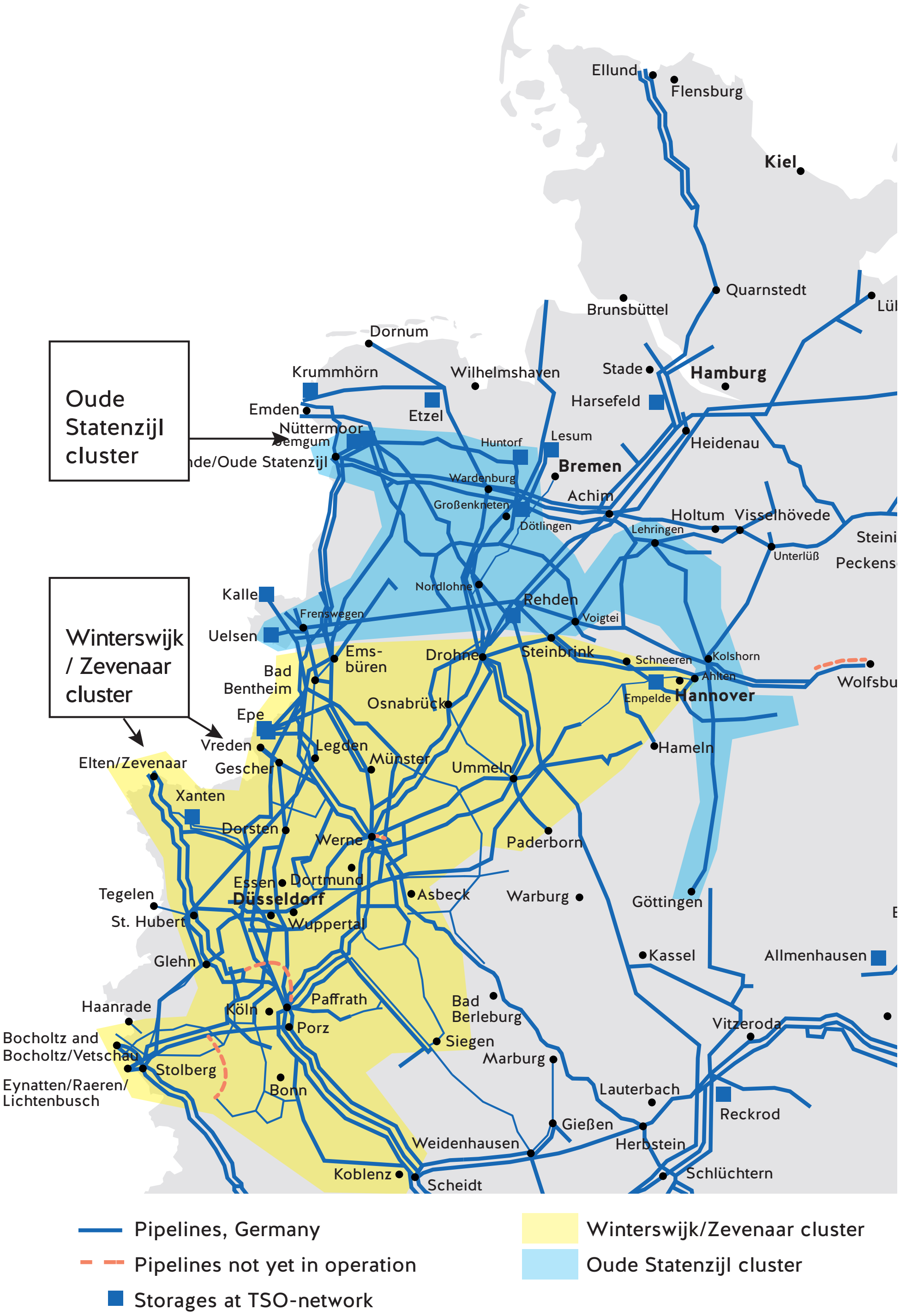
Year	Elbe-Weser region with security discount according to BVEG 2021	Weser-Ems area with security discount according to BVEG 2021	Sum of both areas with security discount according to BVEG 2021	Sum of both areas with security discount according to BVEG 2021	Sum of both areas with security discount according to BVEG 2020	Difference between BVEG 2021 and 2020
	L-gas				L-gas	
	million m³/h			GWh/h	GWh/h	
2021	0.25	0.29	0.54	5.3	6.0	−0.7
2022	0.22	0.27	0.49	4.8	5.6	−0.8
2023	0.23	0.24	0.46	4.5	5.5	−0.9
2024	0.21	0.22	0.43	4.2	4.9	−0.8
2025	0.19	0.19	0.38	3.7	4.4	−0.7
2026	0.18	0.17	0.35	3.4	4.0	−0.6
2027	0.16	0.15	0.31	3.0	3.5	−0.5
2028	0.14	0.14	0.28	2.7	3.1	−0.4
2029	0.13	0.12	0.25	2.4	2.8	−0.3
2030	0.11	0.11	0.22	2.2	2.4	−0.3
2031	0.10	0.09	0.19	1.9	2.0	−0.1
2032	0.09	0.08	0.17	1.7	–	–

Source: Transmission system operators based on [BVEG 2020], [BVEG 2021]

5.4.2 Imports from the Netherlands

The largest contribution on the entry side is made by imports from the Netherlands, which account for more than 60 % of the L-gas supply capacity in gas year 2021/2022. A distinction must be made between the import clusters of Oude Statenzijl and Winterswijk/Zevenaar (cf. Figure 16).

Figure 16: Import points from the Netherlands



Source: Transmission system operators, schematic diagram

Part of the import capacity from the Netherlands is made available on the German side via interruptible capacities, since the import needed in winter to cover peak demand cannot be transported securely in off-peak periods in summer months.

The decline in production in the Netherlands leads to a gradual reduction in L-gas export capacity to Germany. The capacity in the L-gas capacity balance is therefore assumed to decrease in linear fashion.

The import capacities presented in Table 23 have been agreed with GTS and are unchanged compared to the Gas Network Development Plan 2020–2030 and the 2021 Implementation Report.

Table 23: Allocation of the L-gas import capacity to the cross-border interconnection points

Gas year	Oude Statenzijl	Zevenaar, Winterswijk	Total
	GWh/h		
2021/2022	7.0	31.2	38.2
2022/2023	7.0	26.4	33.4
2023/2024	7.0	21.6	28.6
2024/2025	7.0	16.9	23.9
2025/2026	7.0	12.1	19.1
2026/2027	3.0	11.3	14.3
2027/2028	2.2	7.3	9.5
2028/2029	2.2	2.6	4.8
2029/2030	0.0	0.1	0.1

Source: Transmission system operators

It is possible to blend Groningen gas with H-gas to obtain an L-gas in line with the German Technical and Scientific Association for Gas and Water (Deutschen Vereins des Gas- und Wasserfaches e. V.; DVGW) G260 specification with a high calorific value and Wobbe index. Operationally, blending is used within the scope of ability and capability. Opportunities for blending H-gas into the L-gas system exist in the Netherlands and in the GUD and GTG Nord network.

The blending of H-gas is not reflected in the L-gas capacity balance due to the uncertain availability.

5.4.3 L-gas storage facilities

The exit capacity of the L-gas storage facilities listed in Table 24 that is reflected in the L-gas balance is 17.0 GWh/h in gas year 2021/2022.

The L-gas balance considers the capacities that are technically feasible for transport with the current L-gas network. The Lesum storage facility was converted to H-gas in 2021 and is therefore no longer presented in the table. Due to the progressive L-to-H-gas conversion and the resulting decline in L-gas demand, the capacity at the Nüttermoor/Huntorf storage facility has been reduced.

Table 24: Storage capacities of the L-gas storage facilities on the transmission network

Gas year 2021/2022	Empelde	Epe	Nüttermoor/Huntorf	Total
Capacity reflected in the L-gas balance	GWh/h			
	1.6	9.0	6.4	17.0

Source: Transmission system operators

Any demand for capacity in excess of this amount would lead to a network expansion in the L-gas network or, possibly, to a capacity reallocation at cross-border interconnection points or German production points. The necessary expansion in the L-gas network is not considered sustainable by the transmission system operators in light of the L-to-H-gas conversion.

Table 25 shows the development over time of the exit capacities assumed by the transmission system operators for the Empelde, Epe and Nüttermoor/Huntorf storage facilities.

Table 25: Development of the scheduled exit capacities of the L-gas storage facilities

Gas year	Empelde	Epe	Nüttermoor/Huntorf	Total
	GWh/h			
2021/2022	1.6	9.0	6.4	17.0
2022/2023	1.6	9.0	5.0	15.6
2023/2024	1.6	7.0	3.7	12.3
2024/2025	1.6	5.5	1.9	9.0
2025/2026	1.6	5.0	0.2	6.8
2026/2027	1.6	3.5	0.0	5.1
2027/2028	1.6	2.5	0.0	4.1
2028/2029	1.6	2.0	0.0	3.6
2029/2030	0.0	0.0	0.0	0.0

Source: Transmission system operators

With regard to the conversion of L-gas storage facilities, the transmission system operators are in continuous dialogue with storage facility operators and the BNetzA.

5.4.4 Conversion

Another option for offsetting declining L-gas volumes and imports is the use of technical conversion facilities. In this process, L-gas is conditioned by adding nitrogen or air to an H-gas stream in accordance with the DVGW worksheet G 260.

The transmission system operators contrasted an L-to-H-gas switchover and conversion for special network situations and scheduled technical conversion to represent exit capacities in the following two cases:

Conversion plant Nowega in Rehden
The conversion plant in the network area of Nowega was expanded and has a total capacity of maximum 2.4 GWh/h since Q2/2021.

Conversion plant Thyssengas in Broichweiden
The existing conversion plant has firm capacities. In the event of demand peaks, this enables a secured entry of 250 MWh/h into a regional L-gas system until this system is also converted to H-gas in 2027.

5.4.5 Demand for exit capacities

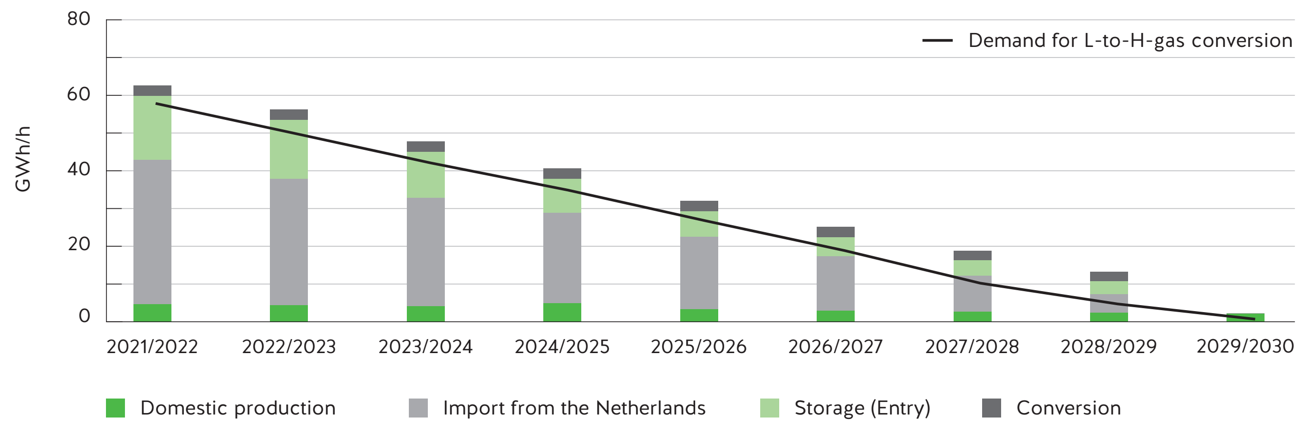
The capacity requirements of the distribution system operators correspond to the plausibility-tested long-term forecasts or internal orders used as a basis in the Gas Network Development Plan 2022–2032. The capacity requirements of industrial customers and power plants were also updated.

Compared to the 2021 Implementation Report, there are further changes in the remaining L-gas demand due to advanced conversion planning and early conversions of certain conversion areas.

5.4.6 Germany-wide capacitive L-gas balance

Figure 17 and Table 26 show the Germany-wide L-gas capacity balance.

Figure 17: Germany-wide capacitive L-gas balance



Source: Transmission system operators

Table 26: Germany-wide capacitive L-gas balance

Gas year	Domestic production	Imports from the Netherlands	Storage facility Entry	Conversion	Total	L-gas demand	L-gas demand excluding L-to-H gas conversion
	GWh/h						
2021/2022	4.5	38.2	17.0	2.7	62.3	57.7	57.7
2022/2023	4.3	33.4	15.6	2.7	56.0	50.3	57.6
2023/2024	4.0	28.6	12.3	2.7	47.5	42.2	58.0
2024/2025	3.5	23.9	9.0	2.7	39.1	35.0	57.9
2025/2026	3.2	19.1	6.8	2.7	31.8	26.9	57.5
2026/2027	2.9	14.3	5.1	2.7	24.9	19.0	57.0
2027/2028	2.6	9.5	4.1	2.4	18.6	10.4	57.6
2028/2029	2.3	4.8	3.6	2.4	13.1	4.9	57.6
2029/2030	2.1	0.1	0.0	0.0	2.1	0.1	57.6

Source: Transmission system operators

Overall, the updates to the planning assumptions in the present Gas Network Development Plan 2022–2032 result in only minor changes in the L-gas demand balance compared to the results of the 2021 Implementation Report.

5.5 L-gas quantity balance

In the present Gas Network Development Plan 2022–2032, an updated L-gas quantity balance is established to reflect the developments since the publication of the 2021 Implementation Report, in the same way as the establishment of the L-gas capacity balance. The focus here is on the results of the analysis of the 2020/2021 gas year.

This is how the transmission system operators want to ensure that the availability of sufficient L-gas volumes (quantity balance) during the entire period of the market area conversion is made transparent in addition to hedging of the expected capacity peaks (capacity balance).

A reduction in consumption, as in the LNGplus security of supply variants in H-gas, was not applied in L-gas. A possible adjustment of the L-gas requirements will be considered in the 2023 Implementation Report. Therefore, the results presented in the L-gas chapter refer to the contents of the Scenario Framework 2022 confirmed by the BNetzA on 20 January 2022.

5.5.1 Basic procedure

Compared to the Gas Network Development Plan 2020–2030, the expected demand development was adjusted by the transmission system operators in the present Gas Network Development Plan 2022–2032.

As already presented in the Scenario Framework (cf. consultation document SF Gas Network Development Plan 2022–2032, Chapter 4.1, State Analysis), German methane consumption has been relatively constant over the last 10 years and has increased slightly in recent years, in particular due to gas-based electricity and heat generation. The methane consumption of industry and commerce, trade and services is influenced by factors such as economic fluctuations. It has been at a relatively constant level since 2010, while methane consumption by households has increased in recent years.

These developments show that the predicted efficiency gains and consumption declines have not yet materialised in reality. The transmission system operators therefore use the 'Scenario I dena-TM95 with TSO adjustment' ('Szenario I dena-TM95 mit FNB-Anpassung') published in the SF Gas Network Development Plan 2022–2032 as a new basis for the expected volume development (cf. consultation document SF Gas Network Development Plan 2022–2032, Page. 42, Figure 5). This scenario shows a slight increase in gas demand in the medium term.

In planning terms, this results in additional L-gas demand compared to the previous forecast, as this increase was not included in the previously assumed scenarios. A slightly declining gas demand was assumed in this area (cf. SF Network Development Plan 2020–2030, Page 51, Table 19).

The distinction between a cold year and an average year remains unchanged compared to the previous planning approaches in order to take the broadest possible development range of the volume demand into account.

5.5.2 Analysis of gas year 2020/2021 and effects on the L-gas quantity balance

Analysis of gas year 2020/2021

Gas year 2020/2021 was slightly warmer than an average year. L-gas consumption in Germany was therefore slightly lower than assumed.

The L-gas demand of end consumers amounted to 187.5 TWh and was thus 3.4 TWh below the planning assumptions of 190.9 TWh in the 2021 Implementation Report. Adjusted to the temperatures of gas year 2020/2021, the planned quantity of the 2021 Implementation Report for gas year 2020/2021 is 187.5 TWh. The deviation between planned quantity and actual demand is therefore entirely attributable to the temperature effect.

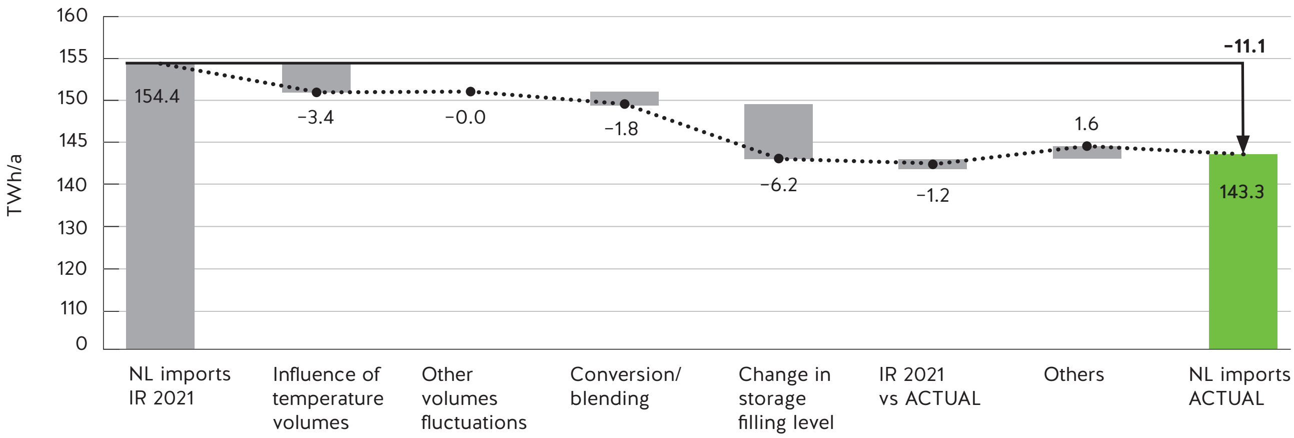
The L-gas share of German production in gas year 2020/2021 was 37.5 TWh, around 1.2 TWh above the transmission system operators' planning assumptions of 36.3 TWh (taking the TSO security discount into account).

The filling level of the gas storage facilities as of 1 October 2021 was 6.2 TWh lower than the planning assumption, of which 2.2 TWh is attributable to the conversion of L-gas storage facilities to H-gas in the 2020/2021 gas year. The technical conversion from H-gas to L-gas was 1.8 TWh higher than assumed.

In total, the effects described above led to imports from the Netherlands amounting to 143.3 TWh in gas year 2020/2021, 11.1 TWh below the planning assumptions of 154.4 TWh. Of this difference, 6.2 TWh are attributable to the storage effect and 3.4 TWh to the temperature effect.

Figure 18 shows the factors influencing the import volumes from the Netherlands in gas year 2020/2021 in graphical form.

Figure 18: Import volumes from the Netherlands, actual flows in gas year 2020/2021 and planning assumptions



Source: Transmission system operators

Effects on the L-gas quantity balance

The deviations in import volumes observed in gas year 2020/2021 between the planned volumes and the actual volumes are mainly attributable to the storage balance and the temperature effect.

In the volume planning, the storage facilities are basically considered to be volume-neutral in agreement with GTS. In other words, it is assumed that the filling level at the end and beginning of the gas year is identical for planning purposes. In this respect, the Dutch Natural Gas production or conversion in gas year 2020/2021 could be relieved by 6.2 TWh compared to the planning. Of this, around 2.2 TWh is a special effect due to the conversion of German L-gas caverns to H-gas, and around 4 TWh is the filling level changes adjusted for this special effect. They could possibly lead to a corresponding increase in imports in the current gas year.

5.5.3 L-gas quantity balances for Germany

The individual items of the L-gas quantity balances up to the year 2032 are explained in more detail below, taking the analysis results of gas year 2020/2021 into account.

L-gas demand

As a result of the incipient market area conversion, parts of the L-gas volumes are replaced by H-gas every year and thus the total L-gas demand is continuously reduced. The parallel volume development in end consumer energy demand (cf. Chapter 5.5) is assumed in two different variants:

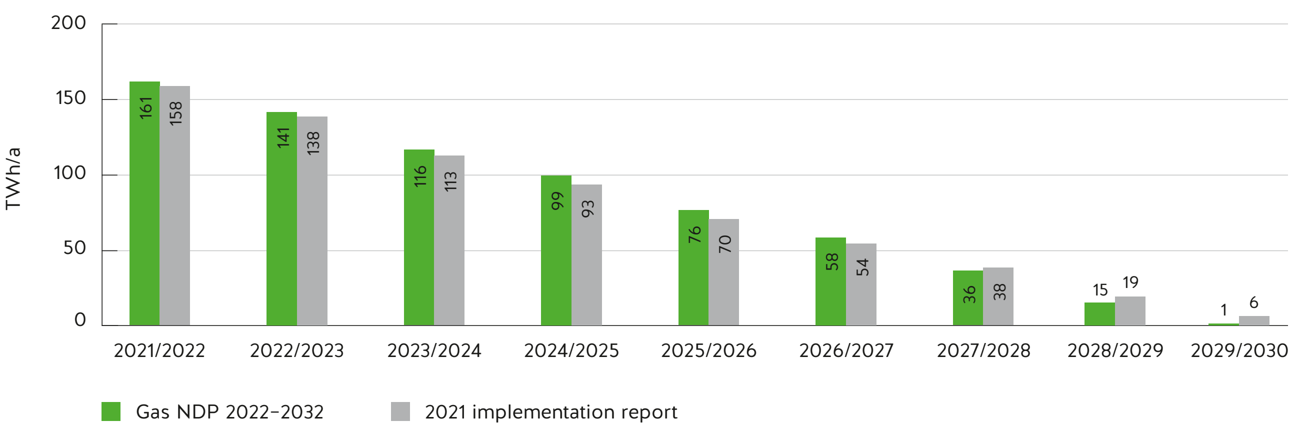
- **Cold year**
  In this variant, the L-gas volume demand for the period from April 2012 to March 2013 is taken as the starting value for gas year 2020/2021. This is followed by a temperature adjustment to a cold year. Finally, the volume development according to scenario I of the Scenario Framework for the Gas Network Development Plan 2022–2032 is assumed.

- **Average year**
  In this variant, the L-gas volume demand for the period from April 2012 to March 2013 is taken as the starting value for gas year 2021/2022. This is followed by a temperature adjustment to the temperature average of the years 1991 to 2013. Finally, the volume development according to scenario I of the Scenario Framework for the Gas Network Development Plan 2022–2032 is assumed.

The temperature adjustment is carried out with the help of the degree day figures of the corresponding years and the degree day figure of the long-term average. These values are derived from information on the degree day figures according to VDI Guideline 3807. The daily degree day figures indicate the difference between the daily mean temperatures and a specified mean room temperature of 20.0 °C. The degree day figure of the coldest year since 1991 is used to estimate L-gas consumption in a cold year.

Compared to the planning assumptions of the 2021 Implementation Report, the adjusted demand development results in the additional demand of 3–6 TWh p. a. shown in Figure 19.

Figure 19: L-gas demand in Gas Network Development Plan 2022–2032 vs. Implementation Report 2021

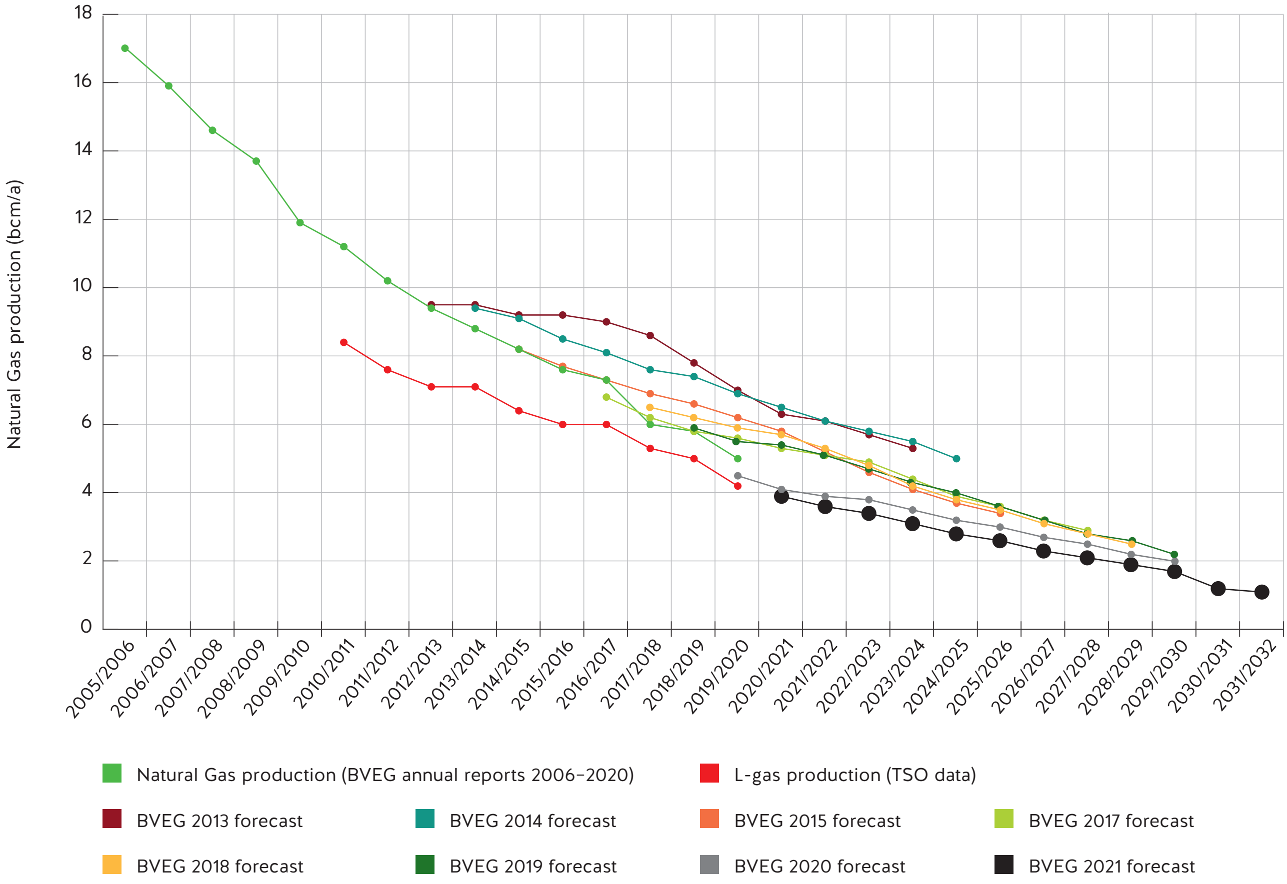


Source: Transmission system operators

Domestic production

Figure 20 shows the historical and projected development of German Natural Gas production in the period 2005/2006 to 2032/2033.

Figure 20: Production in the Elbe-Weser and Weser-Ems regions



Source: Transmission system operators based on [BVEG 2007–2021], [BVEG 2021]

The production data for the years 2006 (corresponding to gas year 2005/2006) to 2020 (gas year 2019/2020) are based on the figures published by the BVEG for the two most important German production regions of Elbe-Weser and Weser-Ems [BVEG 2007–2021]. For the period from 2021 onwards, the values are based on the BVEG's forecast of regional Natural Gas production from May 2021 [BVEG 2021]. This current forecast by the BVEG shows a significant decline in German L-gas production from 2021 onwards, which is again noticeably lower than the forecast figures of recent years.

Based on the production figures of the past years, the transmission system operators consider it appropriate to leave the security discount for German production unchanged so that (considering a security buffer of 10 %) 90 % of the BVEG forecast is reflected as the L-gas share of German production in the quantity balance until 2023. Thereafter, the security buffer is gradually increased to 20 % and at the end of the forecast period to 30 %.

Imports from the Netherlands

In consultation with GTS, the German transmission system operators have decided to increase the import assumptions of the Gas Network Development Plan 2020–2030. They based their decision on the increased L-gas demand compared to the previous planning and the declining German production forecast in order to prevent a shortfall in the quantity balance.

The increased import demand reported to GTS is shown together with the previously agreed import demand in Table 27:

Table 27: Import demand from the Netherlands in Gas Network Development Plan 2022–2032 vs. Implementation Report 2021 for a cold and average year

Gas year	Gas NDP 2022 Import Netherlands Cold year	Gas NDP 2022 Import Netherlands Average year	IR 2021 Import Netherlands Cold year	IR 2021 Import Netherlands Average year	Gas NDP 2022 vs. IR 2021 additional demand Netherlands Cold year	Gas NDP 2022 vs. IR 2021 additional demand Netherlands Average year
	TWh/a					
2021/2022	142.2	128.3	135.1	121.1	7.1	7.2
2022/2023	122.0	109.8	116.9	104.7	5.1	5.1
2023/2024	100.6	90.6	96.1	85.8	4.5	4.8
2024/2025	84.3	75.8	76.9	68.5	7.4	7.3
2025/2026	61.8	55.3	55.9	51.4	5.9	3.9
2026/2027	43.4	39.4	42.8	39.4	0.6	0.0
2027/2028	29.7	27.3	29.7	27.3	0.0	0.0
2028/2029	11.1	10.2	11.1	10.2	0.0	0.0
2029/2030	0.3	0.3	0.3	0.3	0.0	0.0

Source: Transmission system operators

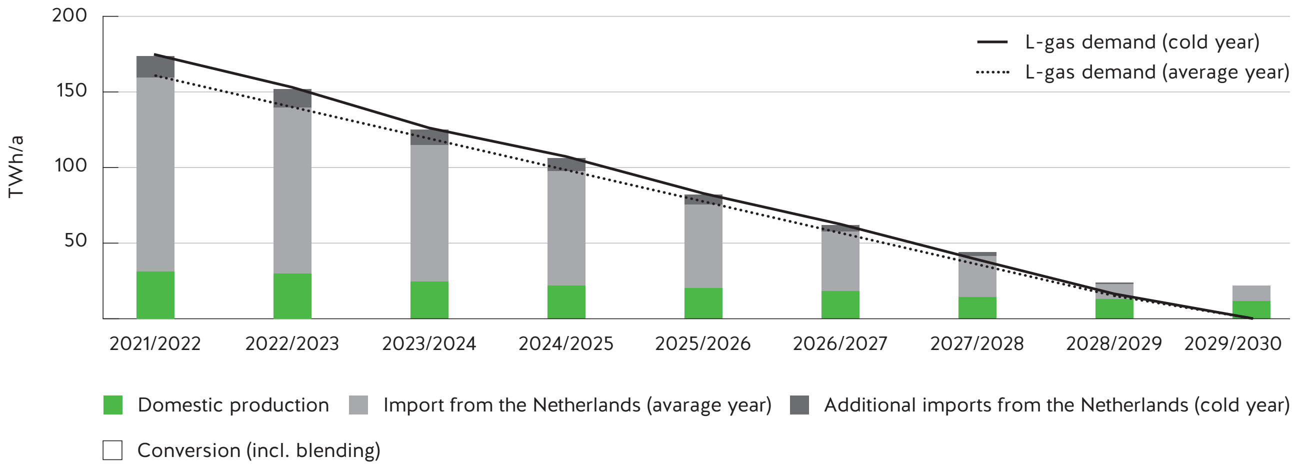
Germany-wide L-gas quantity balance

Figure 21 and Table 28 show the results of the Germany-wide L-gas quantity balance. The updated demand assumptions are compared with the current forecast for domestic production and the updated import assumptions from the Netherlands. The goal is to provide a more transparent presentation of the changes in the quantity balance resulting from the updated production and demand development.

Moreover, quantities from conversion were included in the quantity balance. These quantities include the addition of nitrogen or air to an H-gas stream (conversion in the strict sense) and addition of H-gas to L-gas (also referred to as 'blending'). Until now, these quantities were not included in the balance due to the unsecured availability. Based on the empirical values of the last few years and in light of the resulting balance shortfall, the transmission system operators have decided to include the conversion quantities listed in Figure 21 and Table 28 in the quantity balance.

From gas year 2026/2027 onwards, prioritising the conversion area of Salzgitter with around 110,000 appliances from 2030 to 2027 has a reducing effect on the volume demand.

Figure 21: Germany-wide L-gas quantity balance



Source: Transmission system operators

Table 28: Germany-wide L-gas quantity balance for a cold and average year

Gas year	**L-gas demand** Cold year	**L-gas demand** Average year	**Domestic production**	**Conversion** (incl. blending)	**Import from Netherlands** Cold year (total)	**Import from Netherlands** Cold year (Oude Statenzijl)	**Import from Netherlands** Average year (total)	**Import from Netherlands** Average year (Oude Statenzijl)
	TWh/a							
2021/2022	174.6	160.7	31.5	1.0	142.2	45.7	128.3	41.5
2022/2023	153.0	140.8	30.0	1.0	122.0	42.6	109.8	38.8
2023/2024	126.1	116.1	24.5	1.0	100.6	39.9	90.6	36.7
2024/2025	107.2	98.7	21.9	1.0	84.3	38.2	75.8	35.2
2025/2026	82.8	76.3	20.2	0.8	61.8	21.7	55.3	19.2
2026/2027	62.5	57.6	18.3	0.8	43.5	9.2	39.4	8.2
2027/2028	39.1	36.0	14.3	0.5	29.7	7.7	27.3	7.4
2028/2029	16.4	15.1	12.9	0.5	11.1	7.7	10.2	7.4
2029/2030	0.5	0.5	11.7	0.0	0.3	0.0	0.3	0.0

Source: Transmission system operators

5.6 Number of annual appliance conversions

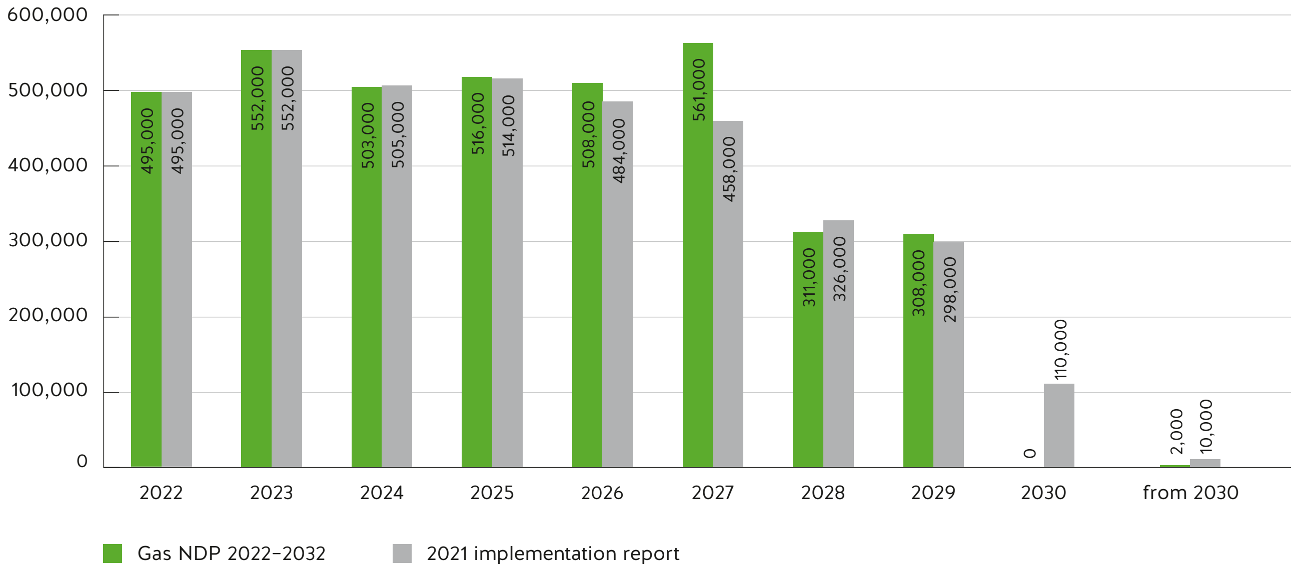
The year 2022 is already the eighth year with appliance conversions as part of the market area conversion. Until 2021, the number of appliances to be converted each year was continuously increased. This made it possible to establish the necessary processes and build up qualified personnel resources to handle a high volume of appliance conversions in the coming years. As part of the detailed planning of the distribution system operators, there were no significant changes in the conversion planning up to 2026 compared to the 2021 implementation report.

For efficient balancing, it became necessary to prioritise conversion areas for subsequent years. In 2027, this will increase the number of appliances to be converted. This achieves a market-driven decrease in the number of appliances after 2027 and avoids idle phases for conversion service providers.

By 2026, the concepts for implementing the market area conversion in the affected areas have been largely agreed with the distribution system operators and connection customers.

The plans for the conversion period from 2027 onwards are being expedited and continuously stabilised. Figure 22 shows the comparison of the number of appliances to be converted compared to the 2021 Implementation Report.

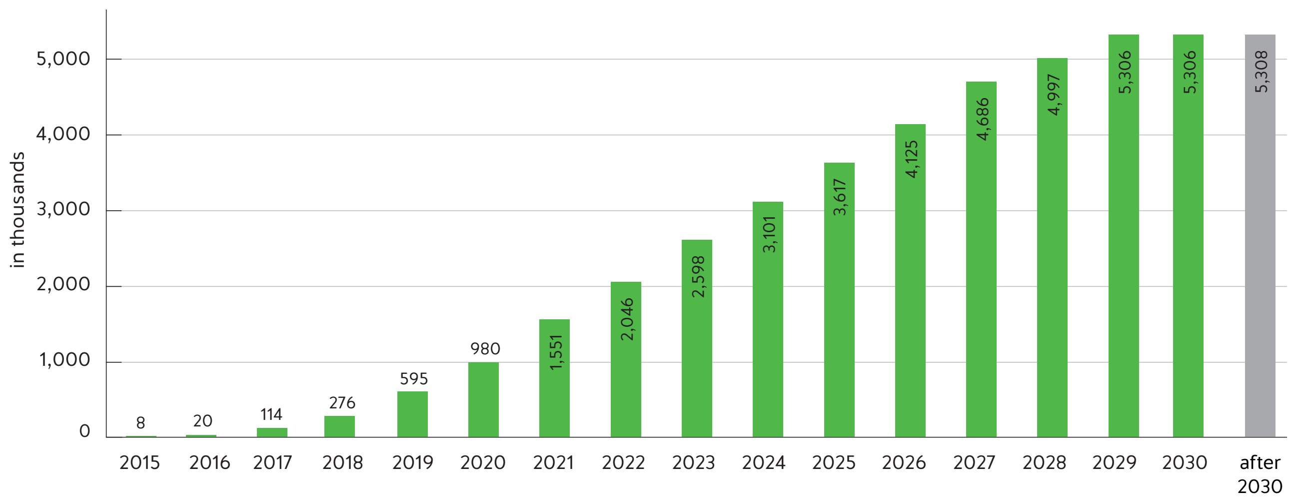
Figure 22: Number of appliances to be converted per year in the designated conversion areas until 2030



Source: Transmission system operators

Figure 23 shows the cumulative number of consumer appliances to be converted for the period of the market area conversion.

Figure 23: Cumulative number of appliances to be converted from 2015 until 2030 and beyond



Source: Transmission system operators

5.7 Conversion areas

5.7.1 Determination of the conversion areas

The conversion of network areas to a supply with H-gas is very complex from an organisational point of view. It also involves considerable expenses due the necessary conversion of the appliances to the changed gas quality and assurance of the H-gas transport. The areas were very carefully selected, bearing the security of supply across all network levels in mind. This will continue to be achieved only through close cooperation with the distribution system operators. The described concepts of the conversion areas were fleshed out in collaboration with the distribution system operators and agreed in binding terms in conversion schedules.

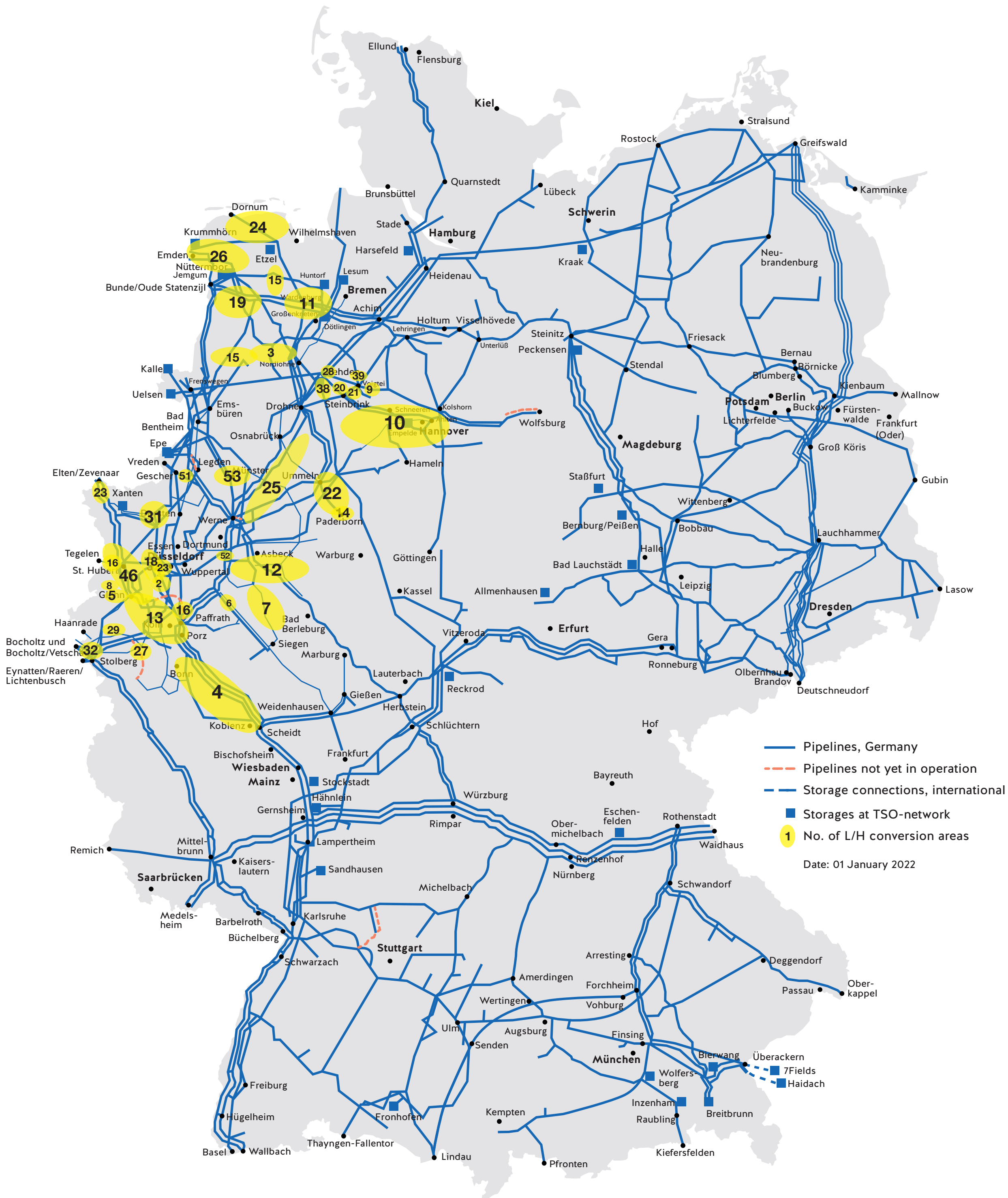
A list of all directly and indirectly connected distribution system operators and their allocation to the conversion areas can be found in the NDP gas database. Furthermore, if detailed plans are already available, the dependencies of different conversion areas with regard to the conversion sequence are described in the NDP Gas database.

The L-to-H-gas conversion planning is carried out in a continuous process that is subject to constant adjustments until it is contractually confirmed. A reporting date of 1 October 2021 was selected for the present Gas Network Development Plan 2022–2032. Changes to the conversion planning received after 1 October 2021 can only be reviewed and reflected in the 2023 Implementation Report. Potential changes that have occurred after that date are therefore not part of the balances and evaluations above.

5.7.2 Overview of the conversion areas

Figure 24 shows the conversion areas for the years up to 2027. The size of the areas highlighted in yellow indicates the power requirement of the area to be converted.

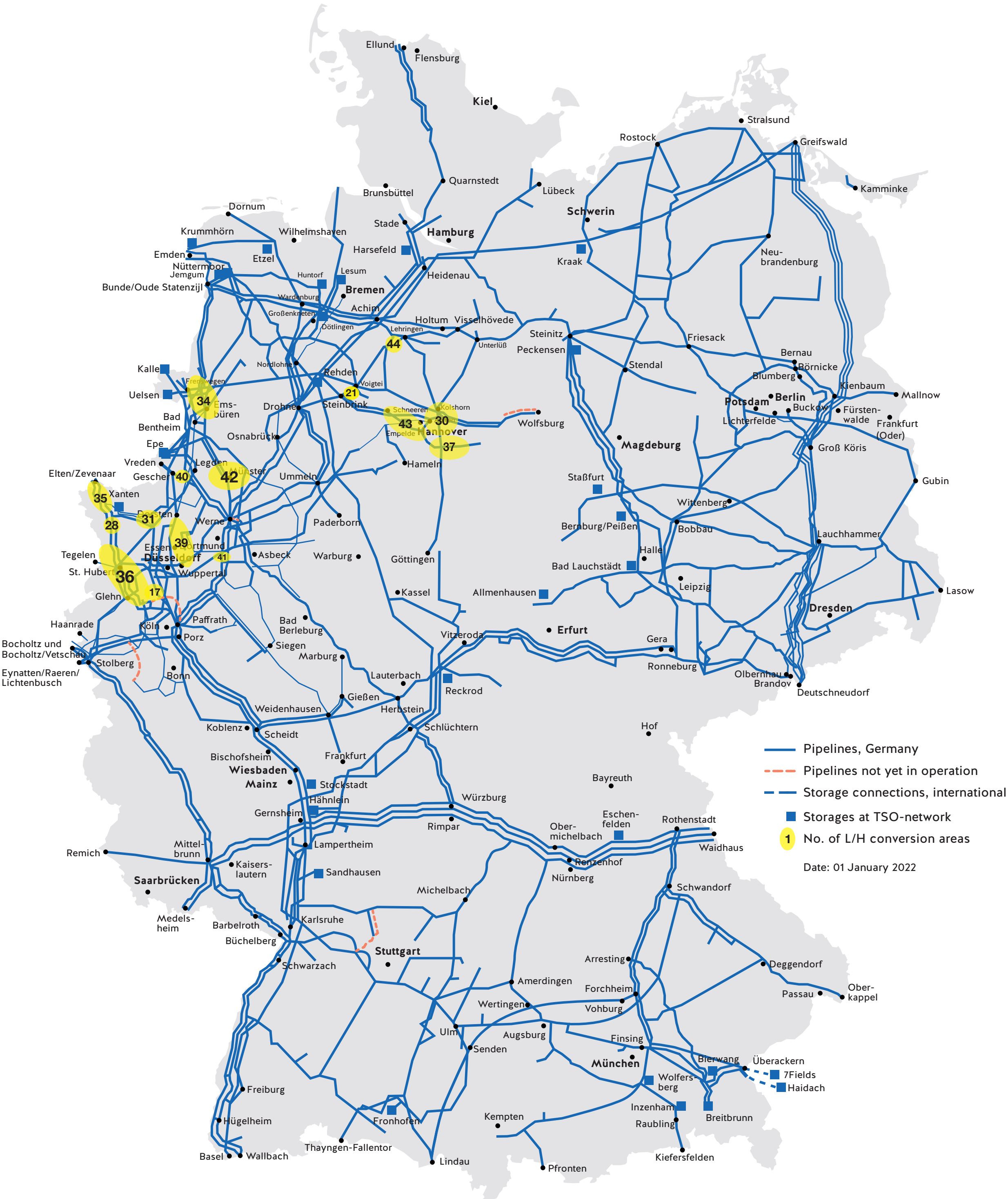
Figure 24: L-to-H-gas conversion areas until 2027



Source: Transmission system operators, schematic diagram

Figure 25 shows the conversion areas for the years 2028 to 2030.

Figure 25: L-to-H-gas conversion areas 2028 to 2030



Source: Transmission system operators, schematic diagram

Table 29 shows an overview of all conversion areas up to the year 2030. A detailed list of the conversion areas with network interconnection points and network incorporation points can also be found in the NDP gas database. Each of the indicative conversion dates refer to the specified calendar year.

Table 29: Overview of the L-to-H-gas conversion areas

No.	L-to-H-gas conversion area	Transmission system operators	Conversion date Gas NDP Plan 2020–2030
1	Bergisches Land	OGE/Thyssengas	2022
2	Düsseldorf	OGE/Thyssengas	
3	EWE Zone Teil III	GTG	
4	Middle Rhine	OGE	
5	Mönchengladbach	Thyssengas	
6	Oberbergisches Land	OGE/Thyssengas	
7	South Westphalia	OGE	
8	Viersen-Meerbusch	OGE/Thyssengas	
4	Middle Rhine	OGE	2023
8	Viersen-Meerbusch	OGE/Thyssengas	
9	Voigtei area	Nowega	
10	Drohne-Ahlten	OGE	
11	EWE Zone Teil IV	GTG	
12	Hagen-Iserlohn-Ergste	OGE	
13	Cologne-Bergisch Gladbach	OGE/Thyssengas	
14	Paderborn	OGE	
1	Bergisches Land	OGE	2024
10	Drohne-Ahlten	OGE	
13	Cologne-Dormagen	OGE/Thyssengas	
14	Paderborn	OGE	
15	EWE Zone Teil V	GTG	
16	Kaldenkirchen	OGE	
17	Rehden-Bassum	Nowega	
10	Drohne – Ahlten	OGE	2025
13	Cologne-Dormagen	OGE/Thyssengas	
18	Düsseldorf-Neus	OGE/Thyssengas	
19	EWE Zone Teil VI	GTG	
20	Lemförde area	Nowega	
21	Petershagen	Nowega	
2	Düsseldorf	OGE/Thyssengas	2026
22	Bielefeld/Paderborn	GUD	
23	Emmerich	Thyssengas	
24	EWE Zone Teil VII	GTG	
25	Werne-Ummeln-Drohne	OGE	
38	Rehden-Lengerich area	Nowega	

No.	L-to-H-gas conversion area	Transmission system operators	Conversion date Gas NDP Plan 2020–2030
25	Werne-Ummeln-Drohne	OGE	2027
26	EWE Zone Teil VIII	GTG	
27	Hürth/Brühl/Bergheim 2	Thyssengas	
28	Kapellen	Thyssengas	
29	Rommerskirchen/Blatzheim	Thyssengas	
29	Rommerskirchen/Kerpen	OGE	
30	Salzgitter III	Nowega	
31	Sonsbeck-Dorsten	OGE	
31	Sonsbeck-Oberhausen	Thyssengas	
32	Weisweiler/Düren	Thyssengas	
33	Zone Westnetz	GTG	
34	Emsland II	Nowega	2028
35	Kalkar/Uedem/Aldekerk	Thyssengas	
36	Krefeld-Langenfeld	OGE/Thyssengas	
37	Salzgitter I	Nowega	
21	Petershagen Messlinger Straße	Nowega	2029
31	Sonsbeck-Dorsten	OGE	
39	Dorsten-Leichlingen	OGE	
40	Gescher	OGE	
41	Hagen	OGE	
42	Münsterland	OGE	
43	Salzgitter II	Nowega	
44	Voigtei (GUD)	GUD	

Source: Transmission system operators

5.7.3 Changed conversion areas compared to the 2021 Implementation Report

Compared to the 2021 Implementation Report, the following changes have occurred in the conversion areas:

Table 30: Changed conversion areas compared to the 2021 Implementation Report (reporting date: 1 October 2021)

No.	Changed L-to-H-gas conversion area	Transmission system operators	Conversion date Gas NDP Plan 2020–2030	Conversion date IR 2021
25	Werne-Ummeln-Drohne	OGE	2026/2027	2026–2029
38	Rehden-Lengerich area	Nowega	2026	2029
28	Kapellen	Thyssengas	2027	2028
30	Salzgitter III	Nowega	2027	2030
35	Kalkar/Uedem/Aldekerk	Thyssengas	2028	2028
42	Münsterland	OGE	2029	2029
44	Voigtei (GUD)	GUD	2029	2030

Source: Transmission system operators

At the request of a distribution system operator, the conversion of appliances in the Münster area was postponed from the years 2027 and 2028 to 2029. The conversion of the appliances will therefore no longer take place in the Werne – Ummeln – Drohne conversion area, but in the Münsterland conversion area. The Werne – Ummeln – Drohne 2028 conversion area is no longer applicable.

An industrial customer in the Werne – Ummeln – Drohne conversion area was brought forward from 2029 to 2026. The Werne – Ummeln – Drohne 2029 conversion area is no longer applicable. The entire conversion of the Werne – Ummeln – Drohne area will take place in 2026 and 2027.

In the Nowega network area, the conversion of the Salzgitter III area was brought forward from 2030 to 2027 in order to satisfy current developments in the L-gas market. Furthermore, the Rehden-Lengerich area was brought forward from 2029 to 2026, as the necessary upstream infrastructure of GUD in Reiningen will already be converted to H-gas in 2026.

In order to maintain redundant supply routes and to avoid prolonged separation of distribution neworks, the Hamb/Kapellen/Aldekerk area planned for conversion in 2028 was separated into the Kapellen and Kalkar/Uedem/Aldekerk areas. The new Kapellen conversion area is only planned for conversion in 2027.

Bringing forward the conversion of the Voigtei area (GUD) to 2029 was necessary due to prioritising the Salzgitter III area of Nowega. This means that the conversion of the Nowega areas will already be completed by 2029. Consequently, there will also be an infrastructure conversion jointly operated by GUD and Nowega, which is connected to the Voigtei area (GUD).

5.7.4 Possible changes in L-to-H-gas conversion planning

The development of concepts in the context of L-to-H-gas conversion planning is highly advanced up to 2026 and has already been finalised to a large extent.

The transmission system operators have developed initial conversion concepts for the years 2027 to 2029. The transmission system operators are in constant contact with the relevant distribution system operators to further specify and coordinate the conversion concepts. This may still result in changes in these conversion years.

5.8 Remaining L-gas market 2030

The remaining L-gas market results from the specifications of the conversion areas up to the year 2030. The area ‘in production area/upstream’ of GUD is supplied directly from the surrounding production. The conversion of this area must be started before production can no longer cover the capacity demand of the downstream point L157-Visselhövede. GUD, participating producers and the corresponding distribution system operator are in close communication about this topic. A conversion of the area in 2029 is currently being considered. The details still need to be worked out with the distribution system operator.

The Haanrade area is a stand-alone network downstream of the Dutch transport system. The conversion of this area will depend on the conversion concept of GTS. Since no distribution networks are supplied via the stand-alone network, the conversion concept does not have any significant effects on resource planning for the appliance conversion.

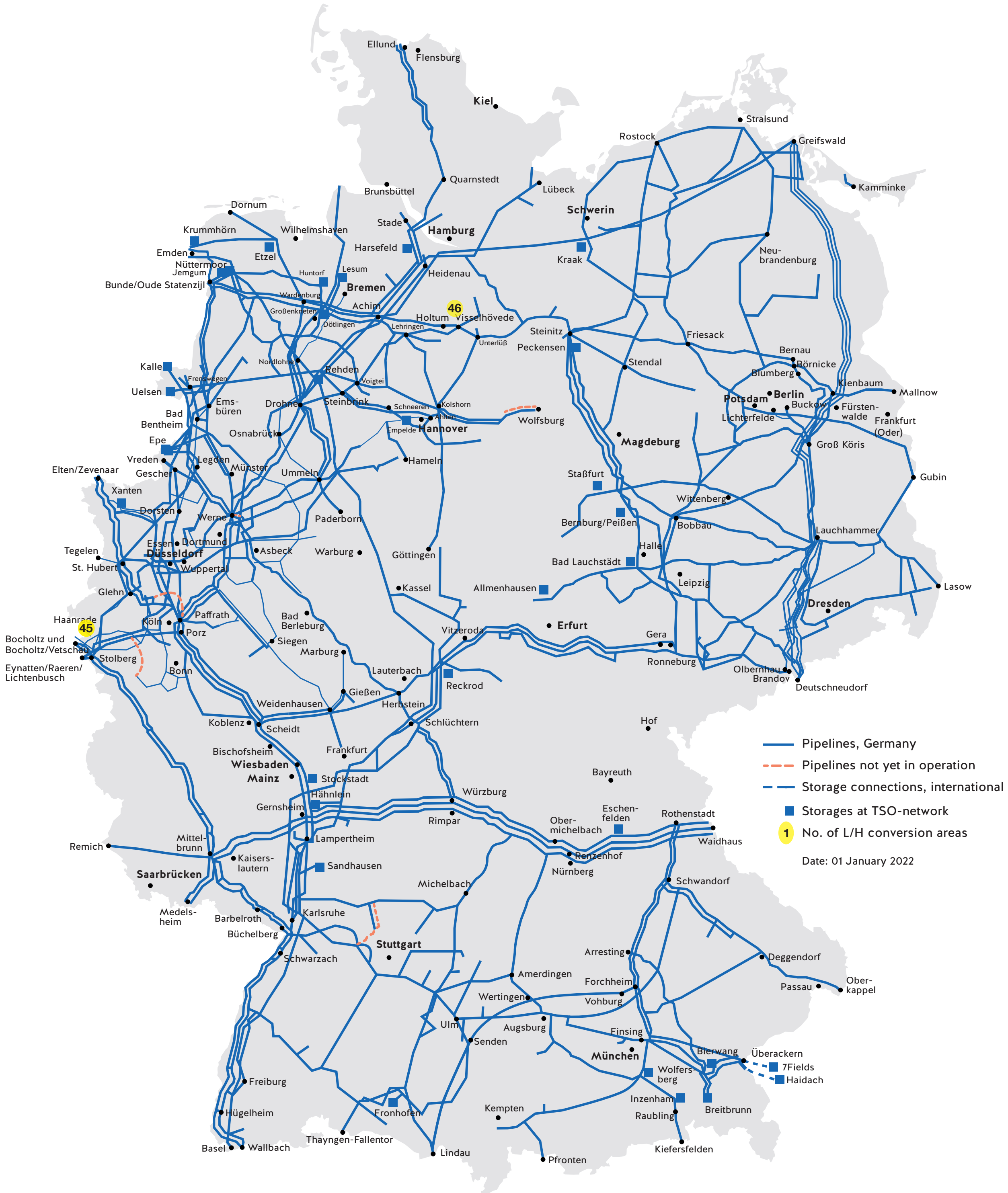
Table 31: Remaining L-gas market after 2030

No.	L-to-H-gas conversion area	Transmission system operators	Conversion date Gas NDP Plan 2020–2030
45	Haanrade	Thyssengas	after 2030
46	in production area/upstream	GUD	

Source: Transmission system operators

The remaining L-gas market after 2030 is shown in Figure 26.

Figure 26: Remaining L-gas market after 2030



Source: Transmission system operators, schematic diagram

Considering the current BVEG forecast based on currently available information, the remaining L-gas production can continue to be injected at corresponding entry points throughout the year and blended with H-gas, even after conversion of all conversion areas.

5.9 Rerouting of German production

According to the current planning, the L-gas market in Germany will evolve into a stand-alone supply infrastructure by 2029 with connection to most of Germany's production. Such a development of the remaining market in turn requires that sufficient flexibility can be made available through integration of storage and conversion capacities to ensure two premises:

- Security of supply for customers supplied with L-gas must continue to be guaranteed.

- For technical and economic reasons, it should be possible to produce L-gas volumes evenly.

Maintaining the L-gas market and thus the marketability of the remaining domestic production volumes is in the economic interest of the producers as well as the national economy. However, it must be ensured that no unreasonable, additional or unjustifiable costs are passed on to all transport customers for maintenance of the L-gas market. This would lead to false economic incentives and cancel out the economic benefit of the remaining production.

Most of the remaining German production must be blended with the H-gas system after the complete conversion of the Salzgitter area in 2029. The ability of the H-gas network to absorb L-gas production while complying with the lower limits of the calorific value and Wobbe index must be investigated. To this end, the transmission system operators will collaborate with the producers to prepare an outlook on whether the remaining L-gas can be added/blended.

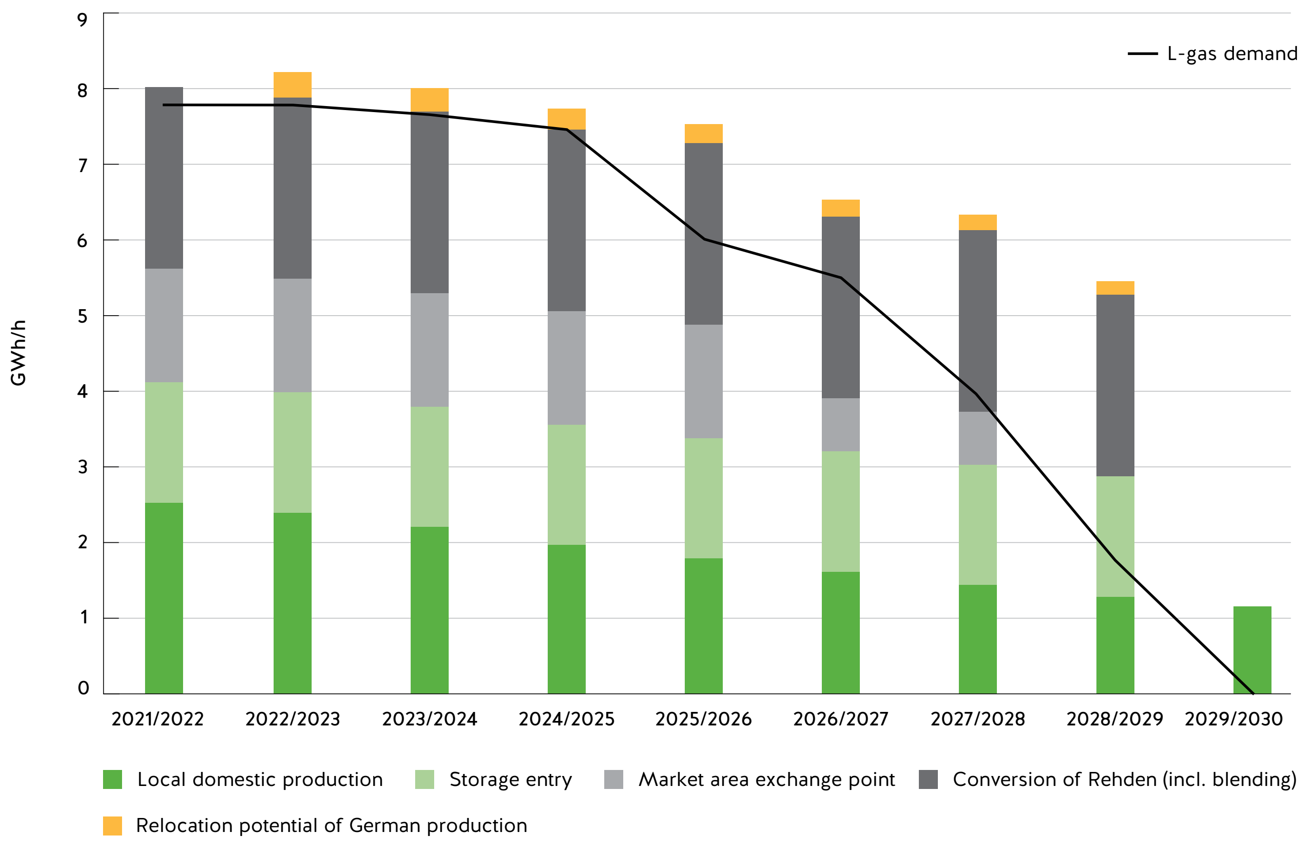
Potential seasonal restrictions on rerouting of regional production injections will be examined, if necessary, even after the conversion of the affected points to H-gas. In this context, local relocation potential will also be considered in order to enable the greatest possible usability of German Natural Gas production in L-gas throughout the year.

Based on currently available information, considering the current BVEG forecast and some technically necessary adjustments at existing stations, the remaining L-gas production can continue to be injected and mixed with H-gas at corresponding entry points throughout the year from 2029 onwards.

5.10 L-gas balance Nowega

As part of the current L-to-H-gas conversion planning, the L-gas market to be supplied by German production from 2027 onwards is largely located in Nowega's network area. Due to topological network and hydraulic restrictions, a local evaluation is necessary, especially in the later years of the L-to-H-gas conversion, as not all L-gas volumes will be available locally. It should be emphasised here that the requirements for reliability of the available instruments to cover the capacity demand are very high, as the alternative provision by supra-regional L-gas control energy will be severely limited.

Figure 27: Local L-gas capacity balance Nowega



Source: Transmission system operators

Figure 27 shows the results of the local L-gas capacity balance of Nowega. The updated demand assumptions are compared with the current forecast for domestic production, the updated capacities for market area exchange points and the capacities from storage and conversion facilities. The objective is a more transparent presentation of the local development of Nowega's network area, which contains large parts of the remaining L-gas market. In the exchange with German producers, additional shift potentials of German production volumes could be identified that can contribute locally to covering the balance.

5.11 Summary

The transmission system operators have considered the following points in this chapter:

- Determination and presentation of the capacity and quantity balance for L-gas, considering local conditions until 2030, and presentation of the number of appliances to be converted from L-gas to H-gas per year
- Further development of the conversion planning presented in the 2021 Implementation Report as well as the overview of all L-gas conversion areas; it should be noted that the conversion areas were adjusted in order to achieve optimised utilisation of resources
- Consideration of the current detailed plans (reporting date: 1 October 2021) of the distribution system operators
- Consideration of the number of gas appliances to be converted per year
- Identification of specific expansion measures to secure supply in order to offset the decline in L-gas in good time
- Continued coordination of the conversion of storage facilities
- Consideration of the remaining L-gas market, the required structuring instruments and the study on blending the remaining L-gas production volume

A list of all network operators affected by the conversion as well as an allocation of the respective conversion year is published in the NDP gas database.

6 Development of H-gas supply

6 Development of H-gas supply – security of supply scenarios

The framework conditions for network planning in Germany have changed fundamentally in 2022. Specifically, the replacement of Russian gas imports and the political objective of building LNG terminals in Germany will have a considerable impact on future network planning.

Accordingly, due to the current geopolitical situation, which will change the energy system in the long term, as well as the requirement of the BNetzA in accordance with the partial new decision to confirm the 2022 Scenario Framework, the transmission system operators have carried out network calculations within the scope of the LNGplus and LNG security of supply variants. The respective H-gas capacity balances and source distributions of the LNGplus security of supply variants are presented in Chapter 6.1. For the LNG security of supply variants, the H-gas capacity balances and source distributions can be found in Chapter 6.2.

In the end, Chapter 6.3 presents the H-gas capacity balance and source distribution of the base variant, which is based on the confirmed 2022 Scenario Framework.

6.1 Development of H-gas supply – LNGplus security of supply variants

In this chapter, the transmission system operators present the additional modelling variants according to the new partial decision of the BNetzA on 11 November 2022 on the Scenario Framework for the Gas Network Development Plan 2022–2032. In order to adequately reflect the changed energy-related and geopolitical circumstances, the transmission system operators consider three additional variants. They are considered in addition to the modelling variants presented in Chapters 6.1 and 6.2.

With the partial new decision of the BNetzA, the transmission system operators were obligated to carry out further network simulations for complete replacement of Russian natural gas entrys affecting Germany, not taking Russian natural gas transits into account. Furthermore, a supply of South Eastern Europe and a reduction in gas consumption must be taken into account.

The decrease in natural gas consumption and output assumed in all LNGplus variants was determined according to the procedure described in Chapter 6.1.1.

6.1.1 Security of supply variant LNGplus A – Focus sections 38/39

Within the scope of the calculations in LNGplus variant A, all capacity reservations/capacity expansion claims in accordance with sections 38/39 GasNZV for LNG that were submitted to the transmission system operators for entry capacities of German LNG terminals by the reporting date of 30 September 2022 are to be taken into account. Consideration must also be given if the entry capacity contained in the requests are not required in full to ensure security of supply.

Consideration of the exit capacity

The H-gas demand is the sum of the capacity demand of the exit points (cross-border interconnection points, distribution system operators, industrial customers, gas power plants), the additional H-gas demand resulting from the L-to-H-gas conversion and the gas demand for the conversion from H-gas to L-gas.

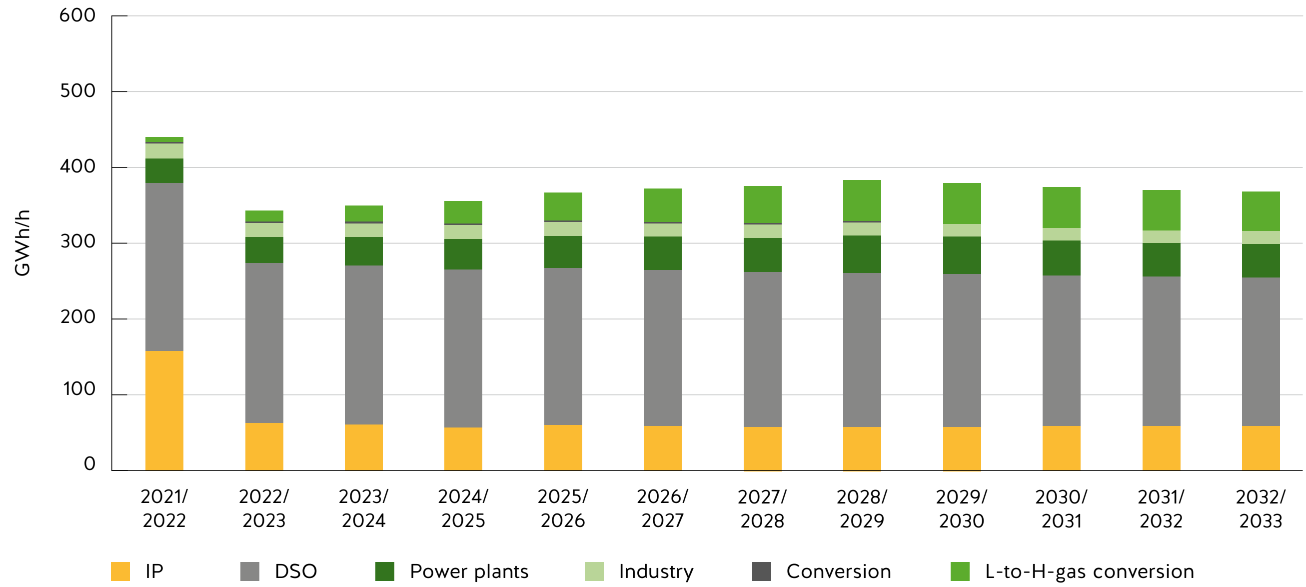
In all LNGplus variants, the following adjustments have been applied to the capacity demand on the exit side compared to the assumptions described in Chapters 6.2 and 6.3 (cf. Chapter 3.2):

- For the distribution system operators and industry sectors as well as for the L-to-H-gas conversion, a flat natural gas consumption reduction of 15 % and 9.4 % capacity reduction respectively has been assumed until 2032, compared to the starting value of gas year 2021/2022.
- The substitution potentials from the conversion from natural gas to hydrogen determined in the WEB Market Survey were assumed to be reduced in the respective customer groups of distribution system operators, industry and power plants, since a corresponding supply of hydrogen is assumed.
- Apart from the assumed substitutions with hydrogen, the capacity requirements of the power plants are unchanged.

- The exit capacities at the cross-border interconnection points were reduced by the capacity intended for transits from Russia.
- In order to ensure the supply of South Eastern Europe, the exit capacity to the Czech Republic was increased by 23 GWh/h.

The resulting demand developments in the LNGplus modelling variants are presented in Figure 28 and Table 32.

Figure 28: Development of the H-gas capacity demand in the LNGplus variants



Source: Transmission system operators

Table 32: Data on H-gas capacity demand in the LNGplus variants

Gas year	IP	DSO	Power plants	Industry	Conversion	L-to-H-gas conversion	Total exit
	GWh/h						
2021/2022	158	224	33	19	2	7	443
2022/2023	61	214	34	19	2	15	345
2023/2024	56	213	38	19	2	22	348
2024/2025	56	211	41	18	2	30	358
2025/2026	59	210	43	18	2	37	368
2026/2027	59	209	44	18	2	46	377
2027/2028	59	207	45	18	1	50	381
2028/2029	59	206	50	17	1	55	388
2029/2030	59	204	49	17	0	54	384
2030/2031	59	201	46	17	0	54	377
2031/2032	59	200	44	17	0	54	374
2032/2033	59	199	44	17	0	53	372

Source: Transmission system operators

Due to the demand adjustments, the H-gas capacity demand decreases by 71 GWh/h to 372 GWh/h by gas year 2032/2033 compared to gas year 2021/2022.

Consideration of the entry capacities

Production and Storage facility

Production and exit capacities/potentials are applied analogously to the base variant and the LNG security of supply variant (cf. Chapter 6.3).

Cross-border interconnection points

A feed-in of Russian gas quantities is not assumed. This applies to the capacities planned for the supply of Germany as well as the capacity planned for transits from Russia.

LNG

To compensate for the Russian gas volumes, additional entry capacities from German LNG terminals are assumed in accordance with the capacity reservations/capacity expansion entitlements available on the reporting date of 30 September 2022 in accordance with sections 38/39 GasNZV in the amount of 182 GWh/h.

H-gas capacity balance for modelling year 2032/2033

The resulting H-gas capacity balance for modelling year 2032/2033 is presented in Table 33.

Table 33: Germany-wide H-gas capacity balance of LNGplus variant A in gas year 2032/2033

Gas year 2032/2033	LNGplus variant A
	GWh/h
Entry	459
Exit	372
Excess coverage	**87**

Source: Transmission system operators

Due to the high LNG entry capacity of 182 GWh/h, there is an excess coverage of 87 GWh/h in the balance.

As the BNetzA stipulates that the LNG entry capacities must be included in full in variant A, the transmission system operators have made the following adjustments to balance the accounts:

- Consideration of exit capacities to the neighbouring countries Denmark, the Netherlands, Belgium and France totalling 45 GWh/h, which correspond to the capacities existing today,
- Reduction of IP entry capacities by 46 GWh/h, so that an injection from German LNG terminals alone and partial quantities from the Netherlands and Norway (no LNG from neighbouring European countries, primarily pipeline-bound gas from Norway) were taken into account.

Table 34: Germany-wide H-gas capacity balance of LNGplus variant A in gas year 2032/33 after adjustment of the balance surplus

Gas year 2032/2033	LNGplus variant A
	GWh/h
Entry	413
Exit	417
Additional demand	**4.4**

Source: Transmission system operators

The adjustment of the IP entry and exit capacities, together with the H-gas source distribution, which provides for the allocation of some power plants to allocation points to Bavarian storage facilities as well as cross-border interconnection points to Switzerland and Austria of 4.4 GWh/h, results in a balanced account.

H-gas source distribution for modelling year 2032/2033

Since the H-gas capacity balance is covered, the H-gas source distribution only shows the allocation of some power plants with allocation points according to Table 35.

Table 35: H-gas source distribution for gas year 2032/2033 of LNGplus variant A

H-gas source distribution	Modelling variant LNGplus A
	GWh/h
Total exit	–417
Total entry	413
Balance	**–4.4**
Distribution of the additional H-gas demand via the H-gas source distribution:	
Total	**4.4**
– North East region (0 %)	0.0
– West/South West region (40.1 %)	1.8
– South/South East region (59.9 %)	2.6
Distribution of additional H-gas demand in the regions:	
Total North East region	**0.0**
Total West/South West region	**1.8**
– of which Gersteinwerk power plant, allocation point: Eynatten (OGE)	0.8
– of which Biblis power plant, allocation point: Eynatten (OGE)	1.0
Total South/South West region	**2.6**
– of which KW Leipheim 1+2 power plant, allocation point: Überackern, Überackern 2, Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn	1.9
– of which RDK 4 power plant, allocation point: Wallbach (OGE)	0.7

Source: Transmission system operators

Table 36: Additional capacities at cross-border interconnection points based on the H-gas source distribution of LNGplus variant A in gas year 2032/2033

Cross-border interconnection points	Transmission system operator	Entry/Exit	Capacity type	LNGplus A: Additional capacities 2032/2033 [GWh/h]
Eynatten	OGE	Entry	fDZK	0.8
Eynatten	OGE	Entry	fDZK	1.0
Überackern, Überackern 2	bayernets	Entry	fDZK	1.9
Wallbach	OGE	Entry	fDZK	0.7

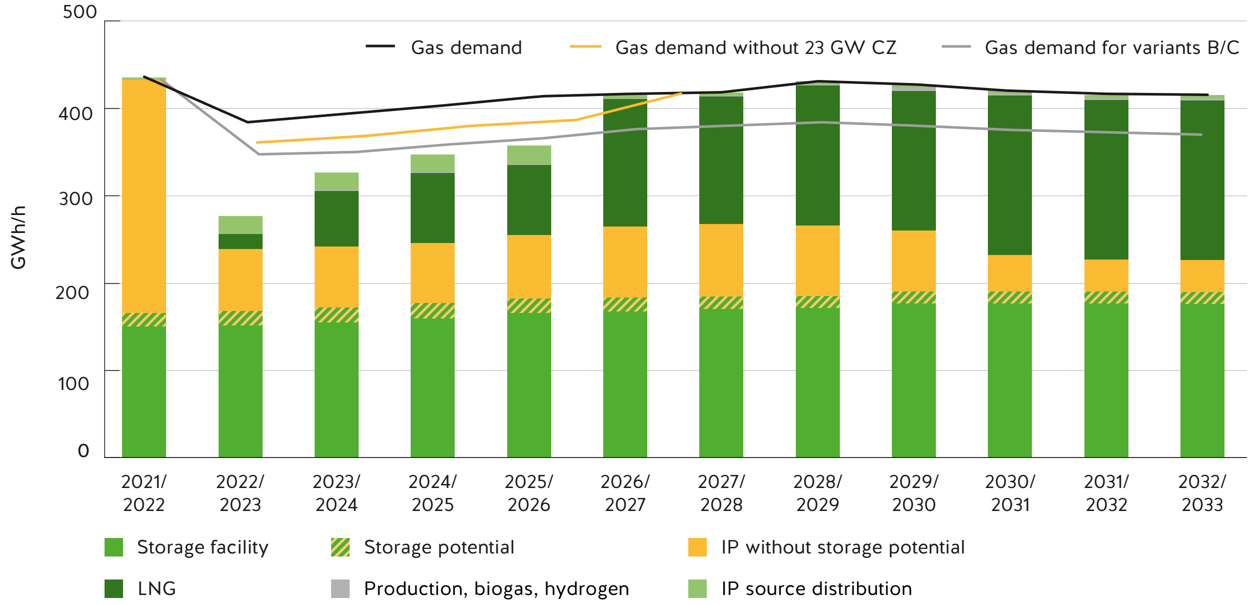
Source: Transmission system operators

H-gas capacity balance and source distribution until the modelling year 2032/2033

In addition to modelling year 2032/2033, the transmission system operators have carried out analyses of the balance coverage of the capacity demand up to modelling year 2032/2033.

The result of these tests is shown in Figure 29 and Table 37.

Figure 29: Germany-wide H-gas capacity balance of LNGplus variant A



Source: Transmission system operators

Table 37: Data on Germany-wide H-gas capacity balance of LNGplus variant A

Gas year	Storage facility	Storage potential	IP	LNG	Production, biogas, hydrogen	Total entry	Total exit	Additional demand	IP source distribution entry
	GWh/h								
2021/2022	152	16	266	0	1	434	443	9	2
2022/2023	154	16	71	17	1	258	385	127	20
2023/2024	157	17	70	63	1	308	394	85	20
2024/2025	162	17	69	80	1	329	404	75	20
2025/2026	168	16	73	80	1	337	414	77	21
2026/2027	170	15	82	145	1	412	417	4	4
2027/2028	173	13	84	145	1	416	420	4	4
2028/2029	174	13	81	160	1	428	433	4	4
2029/2030	179	13	70	160	3	424	429	4	4
2030/2031	179	13	42	182	2	418	422	4	4
2031/2032	179	13	38	182	2	414	418	4	4
2032/2033	179	13	37	182	2	413	417	4	4

Source: Transmission system operators

The H-gas balance is covered from gas year 2026/2027 onwards due to the adjustments at cross-border interconnection points described above. Until the LNG entry capacities are available in gas year 2026/2027, the H-gas balance is underserved, provided that exit capacities to the neighbouring countries Denmark, the Netherlands, Belgium and France are also applied in the initial years. Without the exit capacities of around 45 GWh/h, the capacity is almost balanced – apart from gas year 2022/2023.

Moreover, the existing entry capacities at the cross-border interconnection points were reduced by 46 GWh/h to balance the system. Thus, LNGplus variant A shows that additional entry capacities of German LNG terminals amounting to 182 GWh/h are not required.

6.1.2 Security of supply variant LNGplus B – Focus LNG

In the LNGplus B security of supply variant, priority is to be given to entry capacities of German LNG terminals. The additional capacities required to meet demand must be applied at Western European cross-border interconnection points.

Consideration of the exit capacities

In the security of supply variant LNGplus B, the same adjustments were applied to the capacity demand on the exit side as in the security of supply variant LNGplus A.

The resulting demand developments are presented in Figure 28 and Table 32.

Consideration of the entry capacities

Production and Storage facility

Production and exit capacities/potentials are applied analogously to the base variant and the LNG security of supply variant (cf. Chapter 6.3)

Cross-border interconnection points

A feed-in of Russian gas quantities is not assumed. This applies to the enery rates planned for the supply of Germany as well as the capacities planned for transits from Russia.

LNG

To compensate for the Russian gas volumes, additional entry capacities from German LNG terminals are assumed. The basis for the respective approach of the entry capacities is the cluster formation presented in Chapter 3.2.6 based on the available LNG requests as well as the transport capability of the transmission network available in the respective years. Accordingly, the transmission system operators have limited the LNG terminal capacity within the clusters in the interest of efficient network expansion and have assumed an LNG entry capacity of 83 GWh/h for modelling year 2032/2033.

The capacity demand exceeding this amount to cover the H-gas capacity balance is covered through cross-border interconnection points via the H-gas source distribution.

H-gas capacity balance for modelling year 2032/2033

The resulting H-gas capacity balance for modelling year 2032/33 is presented in Table 38.

Table 38: Germany-wide H-gas capacity balance of LNGplus variant B in gas year 2032/2033

Gas year 2032/2033	LNGplus variant B
	GWh/h
Entry	359
Exit	372
Additional demand	**13.2**

Source: Transmission system operators

The balance comparison of the entry and exit capacities results in an additional demand of 13 GWh/h for modelling year 2032/2033.

H-gas source distribution for modelling year 2032/2033

The additional demand of around 13 GWh/h needs to be covered by applying additional entry capacities at cross-border interconnection points.

Accordingly, the transmission system operators have investigated the possibility of additional entry capacities from the Western European countries of Belgium, France and the Netherlands with LNG terminals.

As a result of the analyses, entry capacities from Belgium (cross-border interconnection point Eynatten/Raeren/Lichtenbusch), France (cross-border interconnection point Medelsheim) and the Netherlands (cross-border interconnection point Bunde/Oude Statenzijl) are used to cover the additional demand. Furthermore, some power plants are provided with allocation points to storage facilities and cross-border interconnection points.

The additional demand resulting from the H-gas capacity balance is distributed to the allocation points listed in Table 39 according to this measure.

Table 39: H-gas source distribution for gas year 2032/2033 of LNGplus variant B

H-gas source distribution	Modelling variant LNGplus B
	GWh/h
Total exit	–372
Total entry	359
Balance	**–13.2**
Distribution of the additional H-gas demand via the H-gas source distribution:	
Total	**13.2**
– North East region (0 %)	0.0
– West/South West region (80 %)	10.6
– South/South East region (20 %)	2.6
Distribution of additional H-gas demand in the regions:	
Total North East region	
Total West/Souh West region	**10.6**
– of which Gersteinwerk power plant, allocation point: Eynatten (OGE)	0.8
– of which power plant Biblis: Allocation point: Eynatten (OGE)	1.0
– of which Medelsheim	4.2
– of which Bunde/Oude	0.6
– of which Eynatten/Raeren/Lichtenbusch	4.0
Total South/South East region	**2.6**
– of which KW Leipheim 1+2 power plant, allocation point: Überackern, Überackern 2, Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn	1.9
– of which RDK 4 power plant, allocation point: Wallbach (OGE)	0.7

Source: Transmission system operators

Apart from the allocation points for power plants, the capacities at cross-border interconnection points listed in Table 40 represent additional capacities compared to the capacities included in the NDP gas database.

Table 40: Additional capacities at cross-border interconnection points based on the H-gas source distribution of LNGplus variant B in gas year 2032/2033

Cross-border interconnection point	Transmission system operator	Entry/Exit	Capacity type	LNGplus B: Additional capacities 2032/2033 [GWh/h]
Bunde/Oude	GASCADE, GUD	Entry	FZK	0.6
Eynatten	OGE	Entry	fDZK	0.8
Eynatten	OGE	Entry	fDZK	1.0
Eynatten/Raeren/Lichtenbusch	Fluxys, OGE, Thyssengas	Entry	FZK	4.0
Medelsheim	GRTD, OGE	Entry	FZK	4.2
Überackern, Überackern 2	bayernets	Entry	fDZK	1.9
Wallbach	OGE	Entry	fDZK	0.7

Source: Transmission system operators

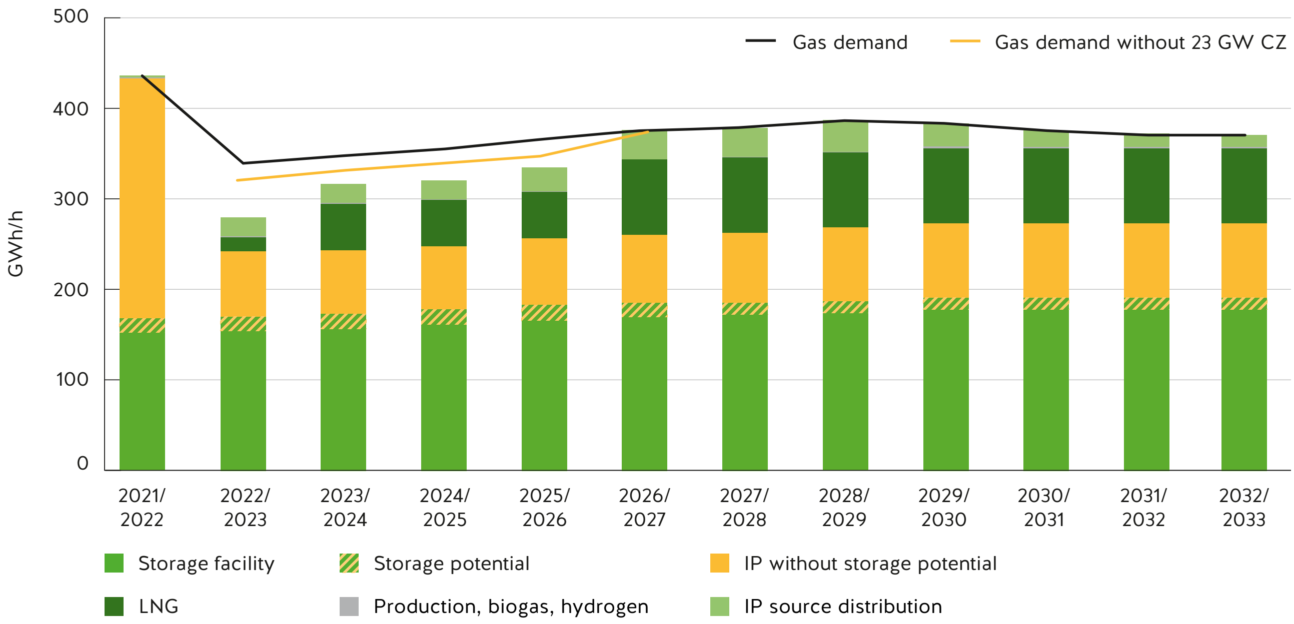
H-gas capacity balance and source distribution until the modelling year 2032/33

In addition to modelling year 2032/2033, the transmission system operators have carried out investigations to cover the capacity demand up to modelling year 2032/2033.

In this context, it was examined whether additional benefits from the neighbouring countries of Belgium, France and the Netherlands could be used to cover the balance sheet in the years of 2032 and 2033.

The result of these tests is shown in Figure 30 and Table 41.

Figure 30: Germany-wide H-gas capacity balance of LNGplus variant B



Source: Transmission system operators

Table 41: Data on Germany-wide H-gas capacity balance of LNGplus variant B

Gas year	Storage facility	Storage potential	IP	LNG	Production, biogas, hydrogen	Total Entry	Total exit	Additional demand	IP source distribution entry
	GWh/h								
2021/2022	152	16	266	0	1	434	443	9	2
2022/2023	154	16	72	16	1	258	345	87	21
2023/2024	157	17	71	51	1	298	348	51	21
2024/2025	162	17	70	51	1	301	358	57	21
2025/2026	168	16	74	51	1	310	368	59	26
2026/2027	170	15	76	83	1	345	377	32	32
2027/2028	173	13	78	83	1	349	381	32	32
2028/2029	174	13	82	83	1	352	388	35	35
2029/2030	179	13	82	83	3	359	384	25	25
2030/2031	179	13	82	83	2	359	377	18	18
2031/2032	179	13	82	83	2	359	374	15	15
2032/2033	179	13	82	83	2	359	372	13	13

Source: Transmission system operators

Starting in gas year 2026/2027, the balance can be covered by additional supply from the neighbouring countries Belgium, France and the Netherlands as well as the LNG entry capacities that will then be fully available.

Until gas year 2025/2026, on the other hand, the H-gas capacity balance is significantly underserved, as the LNG entry capacities are in the ramp-up phase. The supply of South Eastern Europe with an additional 23 GWh/h can therefore not be guaranteed in the next few years to cover the balance during peak loads.

The network expansion was determined for gas year 2032/2033. Accordingly, the network expansion measures can provide additional firm capacities of around 83 GWh/h from German LNG terminals and 13 GWh/h at cross-border interconnection points.

According to the H-gas capacity balance, in some cases higher capacities will be required in the intermediate years up to gas year 2032/2033 (cf. Table 41) than in the target year 2032/2033. These capacities could be made available through interruptible capacities.

If these interruptible capacities are to be converted into firm capacities by gas year 2032/2033, it must be done outside the NDP process.

6.1.3 Security of supply variant LNGplus C – Focus IP

In the LNGplus C security of supply variant, entry capacities of Western European cross-border interconnection points need to be considered with high priority. The additional capacities required to meet demand are expected to be provided by German LNG terminals.

Consideration of the exit capacities

In the LNGplus C security of supply variant, the same adjustments were applied to the capacity requirements on the exit side as in the LNGplus B security of supply variant.

The resulting demand developments therefore correspond to the results shown in Figure 28 and Table 32.

Consideration of the entry capacities

Production and Storage facility

Production and exit capacities/potentials are also applied analogously to the base variant and the LNG security of supply variant.

Cross-border interconnection points

A feed-in of Russian gas quantities is not assumed. This applies to the capacities planned for the supply of Germany as well as the capacities planned for transits from Russia.

To compensate for the Russian gas volumes, additional potential entry capacities from Western European cross-border interconnection points are assumed with high priority. This is especially true in light of the fact that neighbouring network operators from Belgium, Denmark, France and the Netherlands have signalled that additional capacities could be made available at cross-border interconnection points bordering Germany.

LNG

To further cover the H-gas capacity balance, additional entry capacities from German LNG terminals are assumed. The basis for the respective approach of the entry capacities is the cluster formation presented in Chapter 3.2.6 based on the available LNG requests as well as the transport capability of the transmission network available in the respective years.

H-gas capacity balance for modelling year 2032/33

The resulting H-gas capacity balance is presented in and Table 42.

Table 42: Germany-wide H-gas capacity balance of LNGplus variant C in gas year 2032/2033

Gas year 2032/2033	LNGplus variant C
	GWh/h
Entry	341
Exit	372
Additional demand	**31.3**

Source: Transmission system operators

The balance comparison of the entry and exit capacities results in an additional demand of 31.3 GWh/h for modelling year 2032/2033.

H-gas source distribution for modelling year 2032/2033

The additional demand of around 31.3 GWh/h resulting for the modelling year 2032/2033 needs to be covered by applying additional entry capacities at cross-border interconnection points.

According to the specifications of the BNetzA, higher entry capacities at the corresponding cross-border interconnection points to Germany are to be assumed and the remaining demand should be covered by German LNG entry capacities.

Accordingly, the transmission system operators have investigated the possibility of additional entry capacities from the Western European countries of Belgium, France and the Netherlands.

As a result of the analyses, entry capacities from Belgium (cross-border interconnection point Eynatten/Raeren/Lichtenbusch), France (cross-border interconnection point Medelsheim), the Netherlands (cross-border interconnection point Bunde/Oude Statenzijl) as well as Denmark (cross-border interconnection point Ellund) are used to cover the additional demand. Furthermore, some power plants are provided with allocation points to storage facilities and cross-border interconnection points.

The additional demand resulting from the H-gas capacity balance is distributed to the allocation points listed in Table 43 according to this measure.

Table 43: H-gas capacity balance for gas year 2032/2033 of LNGplus variant C

H-gas capacity balance	Modelling variant LNGplus C
	GWh/h
Total exit	-372
Total entry	341
Balance	**–31.3**
Distribution of the additional H-gas demand via the H-gas source distribution	
Total	**31.3**
– North East region (7.3 %)	2.3
– West/South West region (84.2 %)	26.4
– South/South East region (8.4 %)	2.6
Distribution of additional H-gas demand in the regions	
Total North East region	**2.3**
– thereof Wallbach	2.3
Total West/South West region	**26.4**
– of which Gersteinwerk power plant, allocation point: Eynatten (OGE)	0.8
– of which Biblis power plant, allocation point: Eynatten (OGE)	1.0
– of which Medelsheim	4.2
– of which Bunde/Oude	12.2
– of which Eynatten/Raeren/Lichtenbusch	8.2
Total South/South East region	**2.6**
– of which KW Leipheim 1+2 power plant, allocation point: Überackern, Überackern 2, Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn	1.9
– of which RDK 4 power plant, allocation point: Wallbach (OGE)	0.7

Source: Transmission system operators

Apart from the allocation points for power plants, the capacities at cross-border interconnection points listed in Table 43 represent additional capacities compared to the capacities included in the NDP gas database.

Table 44: Additional capacities at cross-border interconnection points based on the H-gas source distribution of LNGplus variant C in gas year 2032/2033

Cross-border interconnection point	Transmission system operator	Entry/Exit	Capacity type	LNGplus C: Additional capacities 2032/2033 [GWh/h]
Bunde/Oude	GASCADE, GUD	Entry	FZK	12.2
Ellund	GUD	Entry	FZK	2.3
Eynatten	OGE	Entry	fDZK	0.8
Eynatten	OGE	Entry	fDZK	1.0
Eynatten/Raeren/Lichtenbusch	Fluxys, OGE, Thyssengas	Entry	FZK	4.0
Eynatten/Raeren/Lichtenbusch	GASCADE	Entry	FZK	4.2
Medelsheim	GRTD, OGE	Entry	FZK	4.2
Überackern, Überackern 2	bayernets	Entry	fDZK	1.9
Wallbach	OGE	Entry	fDZK	0.7

Source: Transmission system operators

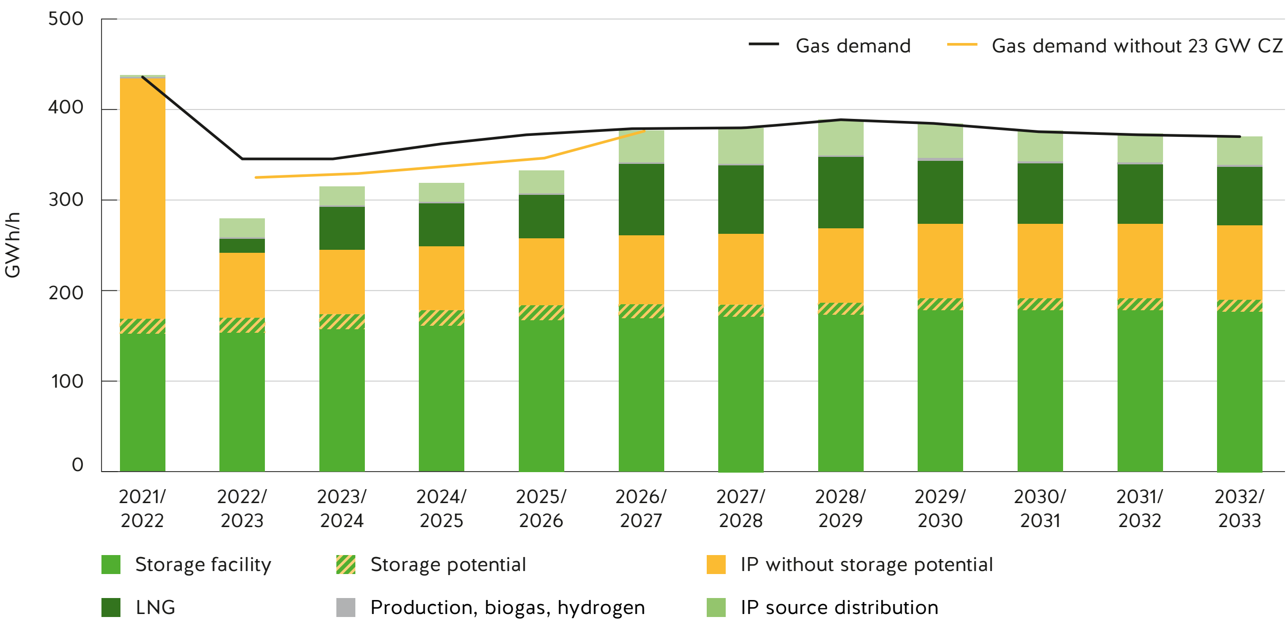
H-gas capacity balance and source distribution until the modelling year 2032/2033

In addition to modelling year 2032/2033, the transmission system operators have carried out investigations to cover the capacity demand up to modelling year 2032/2033.

It was examined whether additional capacities from the neighbouring countries Belgium, France, the Netherlands and Denmark as well as additional LNG entry capacities can be used to cover the balance in the years leading up to 2032/2033.

The result of these tests is shown in Figure 31 and Table 45.

Figure 31: Germany-wide H-gas capacity balance of LNGplus variant C



Source: Transmission system operators

Table 45: Data on Germany-wide H-gas capacity balance of LNGplus variant C

Gas year	Storage facility	Storage potential	IP	LNG	Production, biogas, hydrogen	Total Entry	Total exit	Additional demand	IP source distribution entry
	GWh/h								
2021/2022	152	16	266	0	1	434	443	9	2
2022/2023	154	16	72	16	1	258	345	87	21
2023/2024	157	17	71	48	1	295	348	54	21
2024/2025	162	17	70	48	1	298	358	60	21
2025/2026	168	16	74	48	1	306	368	62	26
2026/2027	170	15	76	80	1	342	377	35	35
2027/2028	173	13	78	76	1	342	381	39	39
2028/2029	174	13	82	80	1	349	388	39	39
2029/2030	179	13	82	70	3	346	384	38	38
2030/2031	179	13	82	67	2	343	377	34	34
2031/2032	179	13	82	66	2	341	374	32	32
2032/2033	179	13	82	65	2	341	372	31	31

Source: Transmission system operators

Starting in gas year 2026/2027, the balance can be covered by additional supply from the neighbouring countries Belgium, France, the Netherlands and Denmark as well as the available LNG entry capacities.

Until gas year 2025/2026, on the other hand, the H-gas capacity balance is significantly underserved, as the LNG entry capacities are in the ramp-up phase. The supply of South Eastern Europe with an additional 23 GWh/h can therefore not be guaranteed in the next few years to cover the balance during peak loads.

The network expansion was determined for gas year 2032/2033. Accordingly, the network expansion measures can provide additional firm capacities of around 65 GWh/h from German LNG terminals and 31 GWh/h at cross-border interconnection points.

According to the H-gas capacity balance, in some cases higher capacities will be required in the intermediate years up to gas year 2032/2033 (cf. Table 45) than in the target year 2032/2033. These capacities could be made available through interruptible capacities.

If these interruptible capacities are to be converted into firm capacities by gas year 2032/2033, it must be done outside the NDP process.

6.2 Development of H-gas supply – LNG security of supply variants

Apart from editorial revisions, this chapter corresponds to Chapter 6.2 from the Interim Status of the Gas Network Development Plan 2022–2032.

In order to promote the diversification of the German gas supply and its independence from individual sources or transport chains as quickly as possible, the transmission system operators were requested by BNetzA in February 2022 to separately calculate further modelling variants (LNG security of supply variants) in addition to preparing the Gas Network Development Plan 2022–2032.

The transmission system operators have complied with this request and are presenting the results below. First, Chapter 6.2.1 lists the entry capacities through LNG. This is followed in Chapter 6.2.2 by a description of the reduction in Russian entry capacities. Then, in Chapter 6.2.3, the effects on the H-gas balance and the H-gas source distribution are presented. Chapter 6.2.4 describes how additional demand is taken into account.

6.2.1 LNG entry capacities in the LNG security of supply variants

In accordance with the specifications of the BNetzA and the supplements of the transmission system operators (cf. Chapter 3.2.7), the variants are to be used to investigate the extent to which extend the potential German LNG terminals could substitute Russian natural gas imports and what network expansion measures this would entail. The following entry capacities are calculated for the LNG security of supply variants.

Table 46: LNG entry capacities in the LNG security of supply variants in gas year 2032/2033

Gas year 2032/2033	LNG variant 1	LNG variant 2	LNG variant 2.1
		GWh/h	
Brunsbüttel	13.8	13.8	13.8
Rostock	–	10	21.7
Stade	21.7	–	–
Wilhelmshaven	26.0	26.0	26.0
Total	**61.5**	**49.8**	**61.5**

Source: Transmission system operators

6.2.2 Reduction of Russian entry capacities in the LNG security of supply variants

In accordance with BNetzA's requirements, the transmission system operators have reduced the entry capacities of the cross-border interconnection points by 48 GWh/h in LNG security of supply variants 1 and 2.1. This corresponds to about half of the total Russian entry for the German market. In the security of supply variant 2, the entry capacity is reduced by 36.3 GWh/h. The following table shows the distribution of the reduction among the cross-border interconnection points.

Table 47: Reduction of Russian entry capacities in the LNG security of supply variants in gas year 2032/2033

Gas year 2032/2033	LNG variant 1	LNG variant 2	LNG variant 2.1
	GWh/h		
Lubmin II	13.0	13.0	13.0
Mallnow	23.0	11.3	23.0
Waidhaus	12.0	12.0	12.0
Total	**48.0**	**36.3**	**48.0**

Source: Transmission system operators

6.2.3 Germany-wide H-gas capacity balance

The following shows the Germany-wide H-gas capacity balance of the LNG security of supply variants in gas year 2032/2033.

The exclusion of Nord Stream 2 as well as the consideration of LNG entry capacities according to Chapter 6.2.1 and the reduction of Russian entry capacities according to Chapter 6.2.2 result in an entry capacity of 429 GWh/h and an exit capacity of 470 GWh/h.

Accordingly, an additional demand of around 41 GWh/h needs to be reflected in the H-gas source distribution.

Table 48: Germany-wide H-gas capacity balance in gas year 2032/2033 of the LNG security of supply variants

Gas year 2032/2033	LNG variants 1, 2, 2.1
	GWh/h
Entry	429
Exit	470
Additional demand	**41**

Source: Transmission system operators

6.2.4 H-gas source distribution and consideration of additional demand

The additional demand of around 41 GWh/h of the H-gas capacity balance in the LNG security of supply variants determined in Chapter 6.2.3 needs to be covered by applying additional entry capacities at cross-border interconnection points.

According to the BNetzA specifications, a maximum utilisation of Western European LNG terminals and the resulting higher entry capacities at the corresponding cross-border interconnection points to Germany are to be assumed.

Accordingly, the transmission system operators have investigated the possibility of additional entry capacities from the Western European countries of Belgium, France and the Netherlands with LNG terminals.

As a result of the analyses, entry capacities from Belgium (cross-border interconnection point Eynatten/Raeren/Lichtenbusch), France (cross-border interconnection point Medelsheim) and the Netherlands (cross-border interconnection point Bunde/Oude Statenzijl) are used to cover the additional demand. In the LNG security of supply variants, around 78 % of the additional demand is thus covered from the west/south-west region.

Table 49: H-gas capacity balance for gas year 2032/2033 of the LNG security of supply variants

H-gas capacity balance 2032/2033	**LNG variants 1, 2, 2.1**
	GWh/h
Distribution of the additional H-gas demand via the H-gas source distribution:	
Total	**40.6**
– North East region (0 %)	0.0
– West/South West region (78 %)	31.7
– South/South East region (22 %)	8.9
Distribution of additional H-gas demand in the regions:	
Total North East region	**0.0**
Total West/South West region	**31.7**
– of which Gersteinwerk power plant, allocation point: Eynatten (OGE)	0.8
– of which Medelsheim	4.5
– of which Bunde/Oude	8.9
– of which Eynatten/Raeren/Lichtenbusch	17.5
Total South/South East region	**8.9**
– of which KW Leipheim 1+2 power plant, allocation point: Überackern, Überackern 2, Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn	1.9
– of which RDK 4 power plant, allocation point: Wallbach (OGE)	0.7
– of which Biblis power plant, allocation point: Waidhaus (OGE)	1.0
– of which Oberkappel	2.1
– of which Wallbach	3.2

Source: Transmission system operators

With regard to the Medelsheim cross-border interconnection point, a consideration of an additional entry capacity of 4.5 GWh/h results in a balanced reduction of the exit capacity in the direction of France. At the cross-border interconnection points Eynatten/Raeren/Lichtenbusch and Bunde/Oude, the physical entry to Germany increases.

The capacities at cross-border interconnection points listed in Table 50 represent additional capacities compared to the capacities included in the NDP gas database.

Table 50: Additional capacities at cross-border interconnection points based on the H-gas source distribution of the LNG security of supply variants in gas year 2032/2033

Cross-border interconnection point	Transmission system operator	Entry/exit	Capacity type	LNG variants, additional capacities 2032/2033 [GWh/h]
Bunde/Oude	GASCADE, GUD	Entry	FZK	8.9
Eynatten	OGE	Entry	fDZK	0.8
Eynatten/Raeren/Lichtenbusch	OGE, Fluxys, Thyssengas	Entry	interruptible	12.1
Eynatten/Raeren/Lichtenbusch	GASCADE	Entry	FZK	5.4
Medelsheim	OGE, GRTD	Entry	interruptible	4.5
Oberkappel	OGE, GRTD	Entry	interruptible	2.1
Überackern	bayernets	Entry	fDZK	1.9
Waidhaus	OGE	Entry	fDZK	1.0
Wallbach	OGE	Entry	fDZK	0.7
Wallbach	OGE, Fluxys	Entry	interruptible	3.2

Source: Transmission system operators

6.3 Development of H-gas supply in the base variant

Apart from editorial revisions, this chapter corresponds to Chapter 6.1 from the interim status of the Gas Network Development Plan 2022–2032.

In this chapter, the base variant is considered in accordance with the confirmation of the Scenario Framework. First, the H-gas capacity balance is presented (cf. Chapter 6.3.1 ff). This is followed by a comparison of the demand with the H-gas capacity balance of the Gas Network Development Plan 2020–2030 (cf. Chapter 6.3.7), the presentation of the H-gas source distribution (cf. Chapter 6.3.8) and a description of the consideration of the additional demand according to the H-gas source distribution (cf. Chapter 6.3.9). Chapter 6.3.10 shows the result of the additional demand according to the H-gas source distribution before Chapter 6.3.11 summarises the results of this chapter.

6.3.1 H-gas capacity balance

The H-gas capacity balance 2032 examines whether sufficient H-gas capacity is available to cover the expected gas demand development. In this case, the entry capacities available during peak load, consisting of firm capacities plus any interruptible capacities, are compared with the expected consumption.

The main assumptions for the H-gas capacity balance are listed below:

- The H-gas capacity balance considers a peak load situation. The required entry capacity is determined by the exit demand (peak load demand).
- The capacities applied at the cross-border interconnection points are based on the respective technically available capacities.
- Seasonal use is assumed for storage facilities. During peak load, removal from storage is assumed.
- Distribution system operators are assumed to have the plausibility-tested capacities according to the NDP gas database (cycle ‘2022 – NDP Consultation’).
- Industrial customers are assumed to have the capacities according to the NDP gas database (cycle ‘2022 – NDP Consultation’).

- Conversions from areas currently supplied with L-gas to a supply with H-gas are included in the analysis accordingly.
- New gas power plants are taken into account in accordance with Chapter 3.2.2.
- The LNG terminals are fully included with capacities according to the NDP gas database (cycle '2022 – NDP Consultation') as freely allocable capacities (frei zuordenbare Kapazitäten – FZK). Part of the LNG terminal capacity is reduced at competing cross-border interconnection points and storage facilities.

6.3.2 Germany-wide H-gas capacity balance

The capacity demand in H-gas increases from 443 GWh/h to 535 GWh/h in the period under consideration from 2021/2022 to 2032/2033 (cf. Table 51). The main reasons for this are the L-to-H-gas conversion, new power plants and the increased demand in the Netherlands assumed by GTS for security of supply reasons.

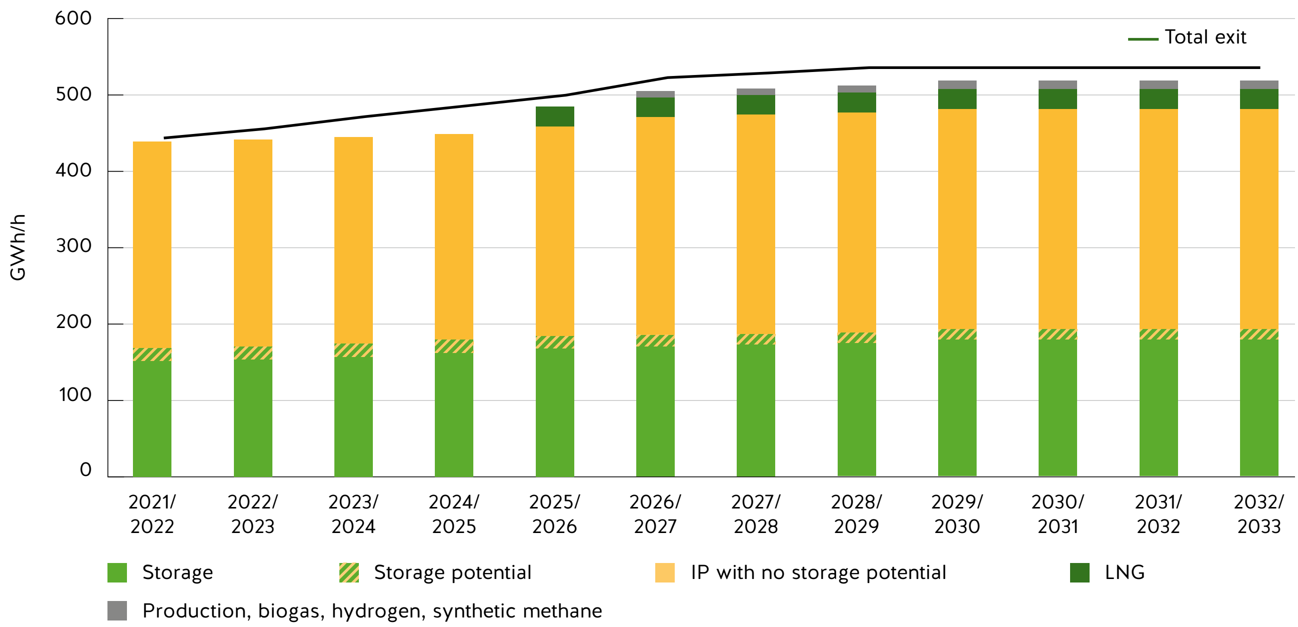
The H-gas volume increases from 439 GWh/h to 517 GWh/h in the period under consideration from 2021/2022 to 2032/2033 (cf. Table 51). The main reasons for this are an increased capacity provision at the storage facilities, increased entry at the Greifswald and Lubmin II cross-border interconnection points to supply the Netherlands, new LNG terminals and the entry of synthetic methane.

In total, there is an additional H-gas demand of 20 GWh/h and 18 GWh/h for the modelling years 2027/2028 and 2032/2033, respectively. It is distributed to cross-border interconnection points according to the H-gas source distribution as explained in Chapter 6.3.8.

Part of the entry capacity required to meet demand can alternatively be made available from cross-border interconnection points or from storage facilities ('storage potential'). The transmission system operators have determined this additional storage capacity with a reduction in the capacity of cross-border interconnection points in the same way as the procedure in the Gas Network Development Plan 2020–2030.

Production including biogas and synthetic methane with injections into the H-gas network makes a contribution of 8 GWh/h to demand coverage for modelling year 2027/2028 and 11 GWh/h for modelling year 2032/2033.

Figure 32: Germany-wide H-gas capacity balance of the base variant



Source: Transmission system operators

Table 51: Data on Germany-wide H-gas capacity balance of the base variant

Gas year	Storage facility	Storage potential	Cross-border interconnection points	LNG	Production, biogas, hydrogen, synthetic methane	Total entry	Total exit	Additional demand
	GWh/h							
2021/2022	152	16	270	0	1	439	443	4
2022/2023	154	16	271	0	1	440	455	15
2023/2024	157	17	270	0	1	445	471	26
2024/2025	162	17	269	0	1	449	485	36
2025/2026	168	16	274	26	1	484	499	15
2026/2027	170	15	285	26	8	505	522	17
2027/2028	173	13	287	26	8	508	528	20
2028/2029	174	13	288	26	9	509	535	26
2029/2030	179	13	288	26	11	516	535	18
2030/2031	179	13	288	26	11	517	535	18
2031/2032	179	13	288	26	11	517	535	18
2032/2033	179	13	288	26	11	517	535	18

Source: Transmission system operators

6.3.3 Consideration of cross-border interconnection points and LNG terminals (entry)

To cover the exit demand, the transmission system operators first apply the provision of available capacities at the LNG terminals as well as at the cross-border interconnection points in the H-gas capacity balance, as it is assumed that their entry capacities remain unaffected by potential storage level restrictions. The storage facilities are then used to cover the capacity, taking local transport conditions into account. Overall, the capacity provision of the cross-border interconnection points increases from 286 GWh/h to 327 GWh/h in the period under consideration. These capacities also include the LNG terminals and the storage potential.

The transmission system operators consider two planned LNG terminals at the Brunsbüttel and Stade locations with a total capacity of 35.5 GWh/h in the H-gas capacity balance.

In accordance with the confirmed Scenario Framework, the existing capacity expansion claims pursuant to section 39 GasNZV are considered in competition with corresponding cross-border interconnection points and storage facilities in the network area of Gasunie Deutschland and are recognised as FZK.

The transmission system operators assume that simultaneous operation of both LNG terminals at full capacity and the competing entry points at cross-border interconnection points and storage facilities will not occur in a peak load situation in winter. Therefore, at the competing entry points, the capacity shifted to the LNG entry points is reduced by a total of 9.2 GWh/h, analogous to the Gas Network Development Plan 2020–2030. The entry capacity used in the peak load situation thus increases by 26.3 GWh/h.

6.3.4 Consideration of storage facilities (entry)

Storage facilities are included in the H-gas capacity balance in the same way as in the Gas Network Development Plan 2020–2030. In conclusion, there is an increase in the capacity provided by storage facilities. This increase results from the conversion of L-gas storage facilities to H-gas as well as an additional capacity contribution from existing storage facilities, which can be taken into account to a greater extent due to the increasing H-gas demand.

Analogous to the procedure in the Gas Network Development Plan 2020–2030, the transmission system operators have determined the additional potential of the storage facilities compared to the cross-border interconnection points. To determine this potential, the transmission system operators used fill level-dependent storage data for the storage facilities currently connected to the transmission network.

For those storage facilities that were included in the H-gas capacity balance with a lower capacity than the exit capacity possible at a 35 % storage level, the transmission system operators examined what additional capacity contribution can be provided from the corresponding storage facilities. In this case, the capacity provision of capacitively competing cross-border interconnection points is reduced accordingly.

The additional potential of storage facilities that were not assumed to have at least the exit capacity available at a filling level of 35 % results in a total of approximately 16 GWh/h for gas year 2021/2022 and approximately 13 GWh/h for gas year 2032/2033 (cf. Table 52).

36 % of the H-gas capacity demand in gas year 2032/2033 will thus be covered by German storage facilities in the H-gas capacity balance (192 GWh/h of 535 GWh/h).

6.3.5 Consideration of German production (entry)

In the German production regions Elbe-Weser and Weser-Ems, there are also fields that are only fed into the H-gas network: Imbrock, Groothusen, Leer and, after the market area conversion, the Munster field. The BVEG forecast does not include a breakdown of the individual volumes.

The production capacity of these fields has averaged around 335 MW in recent years. This capacity was updated with the average annual percentage decrease of the BVEG forecast and reflected accordingly in the H-gas capacity balance.

From gas year 2029/2030 onwards, the remaining L-gas production of approx. 2.1 GWh/h according to the production forecast is also taken into account. The reason for this is the market area conversion, which will be almost completed by this time. In addition, because of this conversion, the remaining German L-gas production will have to be blended with H-gas. This value is also updated according to the BVEG forecast.

The biogas entry in H-gas increases from 380 MW to 488 MW from the 2021/2022 period under consideration to the 2032/2033 period under consideration and is reflected accordingly in the H-gas balance.

6.3.6 Consideration of the demand (exit)

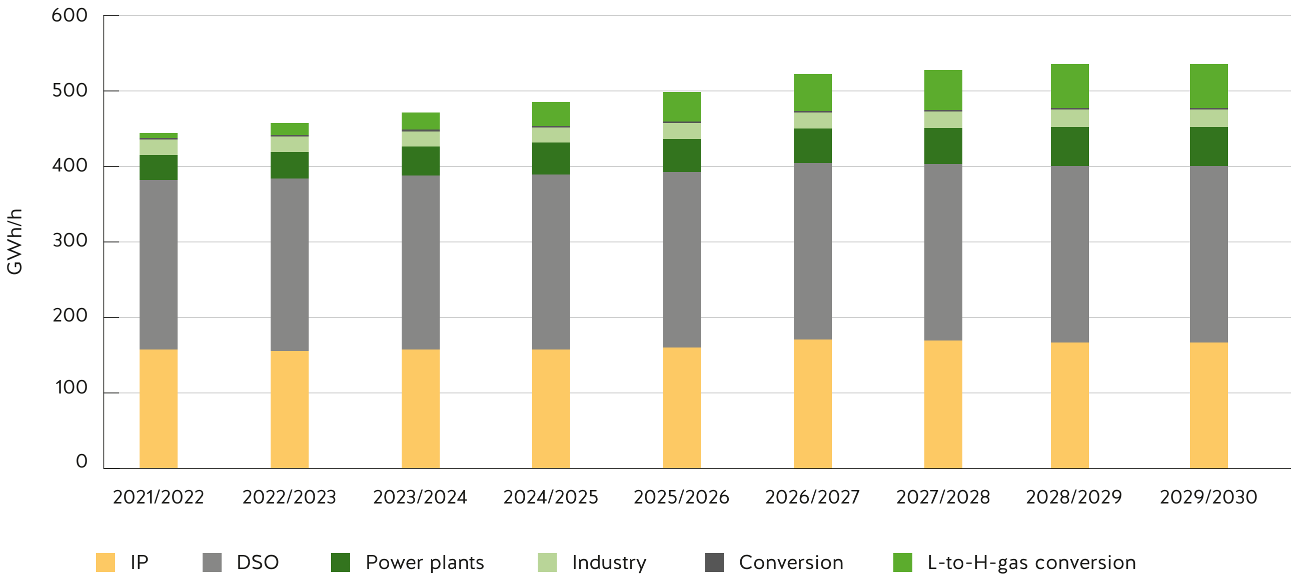
The H-gas capacity demand is the sum of the capacity demand

- of the H-gas exit points (cross-border interconnection points, distribution system operators, industrial customers, gas power plants),
- of the additional H-gas capacity demand resulting from the L-to-H-gas conversion, and
- of the H-gas capacity demand for the conversion from H-gas to L-gas.

In the period under consideration, the H-gas capacity demand increases by about 92 GWh/h from 443 GWh/h in gas year 2021/2022 to 535 GWh/h in gas year 2032/2033. Of this demand, about 59 GWh/h in gas year 2032/2033 is attributable to the additional H-gas capacity demand due to the conversion (cf. Table 52). The additional exit demand at the cross-border interconnection points of around 9 GWh/h by gas year 2032/2033 is mainly attributable to the increased exit demand to the Netherlands in the event of a peak load situation.

The remaining growth is mainly distributed between the L-to-H-gas conversion and the connection of new gas power plants as well as increasing demand from industrial customers and downstream network operators.

Figure 33: Development of the H-gas capacity demand of the base variant



Source: Transmission system operators

Table 52: Data on the H-gas capacity demand of the base variant

Gas year	Cross-border interconnection points	Distribution system operator	Power plants	Industry	Conversion	L-to-H-gas conversion	Total exit
	GWh/h						
2021/2022	158	224	33	20	2	7	443
2022/2023	156	228	35	20	2	16	455
2023/2024	158	230	38	20	2	23	471
2024/2025	158	231	42	20	2	32	485
2025/2026	160	232	44	21	2	39	499
2026/2027	171	233	46	21	2	49	522
2027/2028	170	233	47	22	1	54	528
2028/2029	167	233	52	23	1	59	535
2029/2030	167	233	52	23	0	59	535
2030/2031	167	233	52	23	0	59	535
2031/2032	167	233	52	23	0	59	535
2032/2033	167	233	52	23	0	59	535

Source: Transmission system operators

Compared to the Gas Network Development Plan 2020–2030, the methane demand has increased further. Therefore, an analysis of this development is provided in Chapter 6.3.7.

6.3.7 H-gas capacity demand compared to the Gas Network Development Plan 2020–2030

The Gas Network Development Plan follows a demand-based capacity approach. In accordance with the legal provisions, this is based on existing and new demands as well as the internal orders of the distribution system operators.

In light of the energy transition and the statutory climate protection targets up to 2045, the development of the requested demands according to the demand-based capacity approach is of particular importance.

As already illustrated in Chapter 6.3.6, the demands of distribution system operators, industry and power plants reported in the present Gas Network Development Plan continue to rise, with particularly significant increases in the power plant sector. The comparison with the values of the Gas Network Development Plan 2020–2030 shown in Table 53 shows that the demands reported for gas year 2029/2030 for the Gas Network Development Plan 2022–2032 have increased by 24 GWh/h in total.

Table 53: H-gas capacity demand in gas year 2029/2030 of distribution system operators, industry and power plants compared to the Gas Network Development Plan 2020–2030

Gas year 2029/2030	Gas Network Development Plan 2022–2032	Gas Network Development Plan 2020–2030	Difference
	GWh/h		
Distribution system operators*	292	287	5
Industry	23	17	6
Power plants	52	39	13
Total	**367**	**343**	**24**

* Sum of the H-gas capacity demand of the distribution system operators and the L-to-H-gas conversion

Source: Transmission system operators

The capacity requirements of the distribution system operators have increased moderately for the gas year 2029/2030 under consideration compared to the Gas Network Development Plan 2020–2030. The increase is partly attributable to market area conversions brought forward (cf. Chapter 5). By contrast, the capacity requirements of the transmission system operators' direct industrial and power plant customers have increased significantly for the gas year 2029/2030 under consideration compared to the Gas Network Development Plan 2020–2030. In addition to new connections and increased demand from industrial customers, the expansion of gas power plants necessitated by the nuclear and fossil-fuel phase-out is the main reason for this increase. Since there are also enquiries on the entry side, among other things due to new LNG terminals, the demand for additional entry capacity has not increased according to the source distribution in Chapter 6.3.10. Correspondingly, this can be explained by the aforementioned reasons and not by declining demand.

These developments illustrate the difficulties in bringing the current demand-based capacity approach in line with climate protection targets. Moreover, the efficiency gains and declines in consumption that have been forecast for many years have not yet materialised in reality (cf. Scenario Framework 2022, Chapter 4.1, State Analysis).

Against this background, BNetzA has obligated the transmission system operators to develop a concept for a scenario-based approach as part of the confirmation of the Scenario Framework 2022. In this concept, the current demand-based capacity approach must be combined with the scenario-based approach, especially in the longer-term perspective. To this end, the transmission system operators are asked to review the current procedure for the Network Development Plan as a whole, including the modelling variants, as well as the various capacity products and modelling approaches per customer group. The objective is to identify levers that can be used to achieve greater consideration of the climate targets by 2045. The key aspects of an initial concept are supposed to be presented in the consultation document of the Gas Network Development Plan 2022–2032.

6.3.8 H-gas source distribution

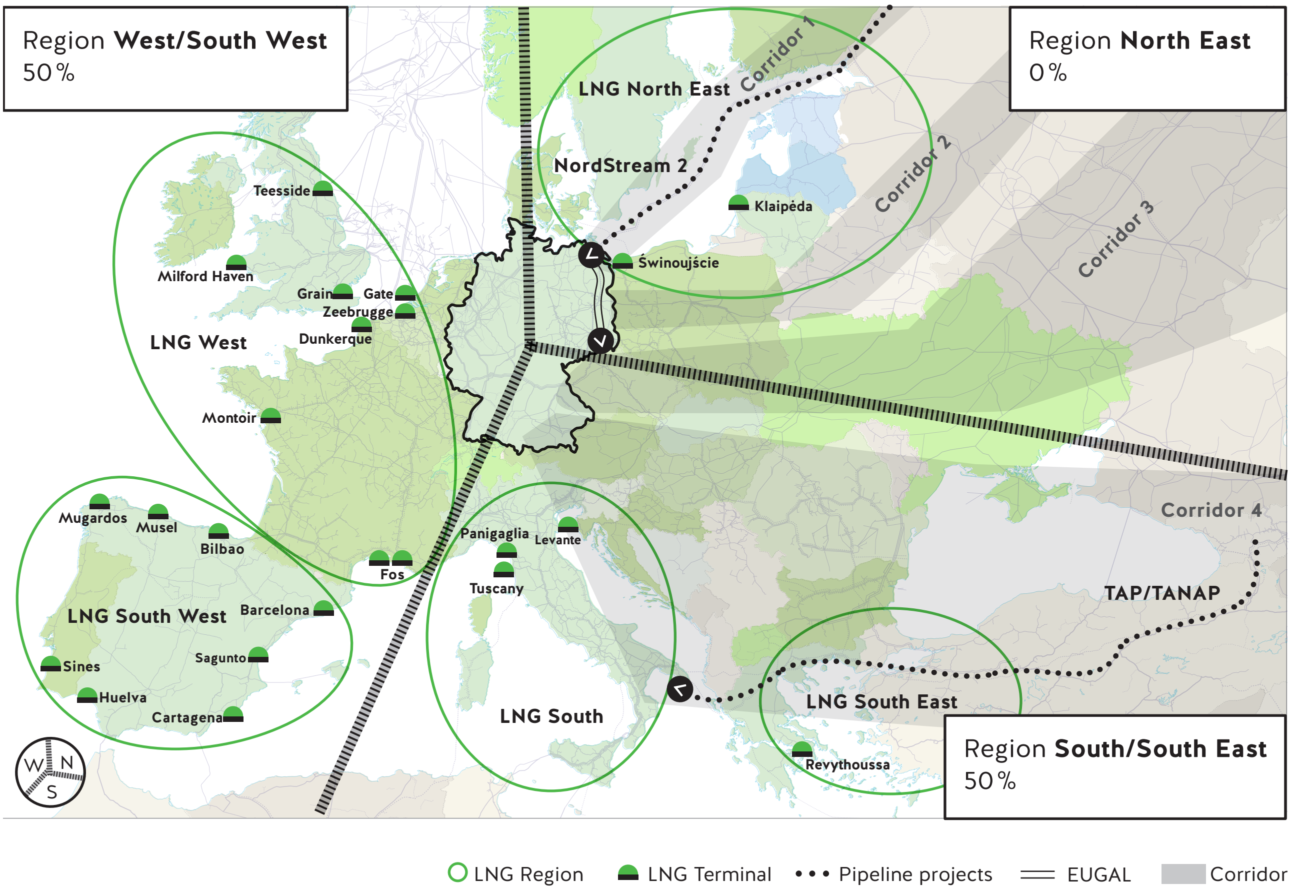
Due to declining domestic production and the L-to-H-gas conversion, the H-gas import demand in Germany will increase in the coming years.

The transmission system operators used a model for the first time in the Gas Network Development Plan 2013. It has been updated in subsequent Network Development Plans in order to estimate the effects of future expansions of the H-gas import infrastructure to Europe on the German transmission network. Considering the respective current Ten-Year Network Development Plan (TYNDP) and the information contained therein on the development of consumption and volume as well as the infrastructure projects, it is estimated from which regions additional methane could be transported to Europe or Germany.

The transmission system operators have updated the proven, accepted model in the 2022 Scenario Framework confirmed by BNetzA. Overall, the percentage distribution by region is as follows (cf. Figure 34):

- North East region share: 0 %,
- West/South West region share: 50 %,
- South/South East region share: 50 %

Figure 34: Coverage of the additional European demand until 2032



Source: ENTSOG, Transmission system operators, schematic diagram

6.3.9 Consideration of the additional demand based on the H-gas source distribution

In the Scenario Framework 2022, the transmission system operators analysed the developments at the cross-border interconnection points in the chapter 'Gas exchange between Germany and its neighbouring countries'. For all cross-border interconnection points at which the German transmission network is connected to the networks of neighbouring countries, an assessment was made for inclusion of the additional demand for gas resulting from the H-gas source distribution. The cross-border interconnection points were assigned to individual regions according to the H-gas source distribution.

The transmission system operators specifically used the following criteria to assess the potential of the respective cross-border interconnection point:

a. Information from network development plans of adjacent neighbouring countries/network operators as well as from plans of neighbouring transmission system operators to increase entry capacities at the cross-border interconnection points.

b. Information from the TYNDP 2020 on planned investment measures in the transport infrastructure of neighbouring countries and the development of capacities at cross-border interconnection points.

c. Capacity demand in the neighbouring network area to cross-border interconnection points (e.g. due to market area conversion or additional demand from gas power plants).

d. Covering the additional demand through optimised network expansion measures.

e. Consideration of the high LNG import potential in the TYNDP 2020 by reducing the exit capacities at cross-border interconnection points (no physical import).

In addition, the following aspects are taken into account in the selection:

- Production decreases in the Netherlands and Denmark.
- Special characteristics of individual network areas (e.g. upstream or downstream pipeline systems are not able to meet the increased capacity demand).
- Special characteristics of individual cross-border interconnection points (e.g. pure exit point).

Based on this information, the transmission system operators have identified the cross-border interconnection points listed in Table 54 for consideration in the H-gas source distribution of the Gas Network Development Plan 2022–2032 for the modelling years 2027/2028 and 2032/2033:

Table 54: Considered cross-border interconnection points in the H-gas source distribution of the base variant

Cross-border interconnection point	Country	Region	Criterium	Explanation
Bunde/Oude Statenzijl	Netherlands	Western/ South Western Europe	c	Not applied as only one criterion is met.
Bocholtz-Vetschau	Netherlands	Western/ South Western Europe	c	Not applied as only one criterion is met.
Elten/Zevenaar	Netherlands	Western/ South Western Europe	c	Not applied as only one criterion is met.
Vreden	Netherlands	Western/ South Western Europe	c	Not applied as only one criterion is met.
Eynatten/Raeren/ Lichtenbusch	Belgium	Western/ South Western Europe	a, c, d	The additional demand of the West/Southwest region was fully allocated to the cross-border interconnection point Eynatten/Raeren/Lichtenbusch, as the Belgian transmission system operator Fluxys Belgium SA has confirmed several times that Belgium can provide up to 13 bcm/a (with additional potential up to 20 bcm/a) for the German market from the LNG facilities in Zeebrugge and Dunkirk (France) via this cross-border interconnection point. The cross-border interconnection point is therefore included in the source distribution.
Medelsheim*	France	Western/ South Western Europe	d, e	Not applied, as the additional H-gas demand is applied via Eynatten/ Raeren/Lichtenbusch.
Wallbach	Switzerland	South/ South Eastern Europe	a, b, c, d	The measure 'Reversierung TENP' (ID 305-02) was completed in 2021. The entry capacity at the Wallbach cross-border interconnection point for transports from Italy through Switzerland amounts to 10 GWh/h. The cross-border interconnection point is therefore included in the source distribution.
Überackern	Austria	South/ South Eastern Europe	a, b, c	Possible increase in entry capacity based on the capacities allocated in the Coordinated Gas Network Development Plan (KNEP 2021). The cross-border interconnection point is therefore included in the source distribution.
Überackern 2	Austria	South/ South Eastern Europe	a, b, c	Possible increase in entry capacity based on the capacities allocated in the Coordinated Gas Network Development Plan (KNEP 2021). The cross-border interconnection point is therefore included in the source distribution.
Oberkappel	Austria	South/ South Eastern Europe	a, d	Possible increase in entry capacities due to additional pipeline construction projects in the TYNDP. The cross-border interconnection point is therefore included in the source distribution.
Waidhaus	Czech Republic	South/ South Eastern Europe	a	The Waidhaus cross-border interconnection point was taken into account as an allocation point for the Biblis power plant in the source distribution. This is based on the fact that additional volumes are available there and no network expansion is required for the allocated capacity.

* The transmission system operators point out to transmission customers that freely allocable exit capacities, which are offered in the annual auction at this point but not booked, may under certain circumstances be shifted away from the Medelsheim point or VIP France – Germany to satisfy internal orders.

Source: Transmission system operators

Due to the significantly increased total demand in H-gas (despite considering the LNG terminals in Brunsbüttel and Stade), all cross-border interconnection points that fulfil at least two of the criteria listed above are taken into account in the source allocation of the Gas Network Development Plan 2022–2032. The amount of additional capacities to be taken over in the modelling variants can be found in the following Chapter 6.3.10.

6.3.10 Additional demand according to H-gas source distribution

The H-gas capacity capacity is shown in Table 55. In the modelling year 2027/2028, Germany has a shortfall of 19.9 GWh/h and in the modelling year 2032/2033 a shortfall of 17.8 GWh/h. The additional demand resulting from the H-gas capacity balance is allocated to allocation points in accordance with the Scenario Framework 2022. They are shown in Table 54.

In accordance with the Scenario Framework 2022, the transmission system operators have not allocated any additional capacities from the North East region. This results in a share of around 50 % for the West/South West region and a share of around 50 % for the South/South East region.

Furthermore, the transmission system operators point out that the values stated in Table 55 do not necessarily represent additional firm capacities over and above the existing technically available capacities. Existing capacities are primarily used to cover the H-gas capacity balance. The designation 'additional demand' for these cross-border interconnection points is to be understood as referring to capacities that are required for proper balancing to cover peak loads and are thus not needed throughout the year. Primarily, cross-border interconnection points that can be deployed in the entry and in the exit direction are used, so that a reduction in the exit capacity can actually be applied for these cross-border interconnection points to avoid additional network expansion.

Table 55: H-gas capacity balance for the years 2027/2028 and 2032/2033 of the base variant

H-gas capacity balance	2027/2028	2032/2033
	GWh/h	
Total exit (demand)	–528.3	–534.5
Total entry	508.4	516.7
– of which cross-border interconnection point and production	335.0	337.8
– of which storage facilities	173.4	178.8
Balance	**–19.9**	**–17.8**
Distribution of the additional H-gas demand via the H-gas source distribution:		
Total	**19.9**	**17.8**
– North East region (0 %)	**0.0**	0.0
– West/South West region (50 %)	9.9	8.9
– South/South East region (50 %)	9.9	8.9
Distribution of additional H-gas demand in the regions:		
Total North East region	**0.0**	**0.0**
Total West/South West region	**9.9**	**8.9**
– of which Gersteinwerk power plant, allocation point: Eynatten (OGE)	0.8	0.8
– of which Eynatten/Raeren/Lichtenbusch	9.1	8.1
Total South/South East	**9.9**	**8.9**
– of which KW Leipheim 1+2 power plant, allocation point: Überackern, Überackern 2, Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn	1.9	1.9
– of which RDK 4 power plant, allocation point: Wallbach (OGE)	0.7	0.7
– of which Biblis power plant, allocation point: Waidhaus (OGE)	1.0	1.0
– of which Oberkappel	3.1	2.1
– of which Wallbach	3.2	3.2

Source: Transmission system operators

The capacities at cross-border interconnection points shown in Table 56 represent additional capacities compared to the capacities included in the NDP gas database.

Table 56: Additional capacities at cross-border interconnection points based on the H-gas source distribution of the base variant

Cross-border interconnection point	Transmission system operators	Entry/exit	Capacity type	Additional capacities 2027/2028 [GWh/h]	Additional capacities 2032/2033 [GWh/h]
Eynatten	OGE	Entry	fDZK	0.8	0.8
Eynatten/Raeren/Lichtenbusch	OGE, Fluxys, Thyssengas	Entry	interruptible	9.1	8.1
Oberkappel	OGE, GRTD	Entry	interruptible	3.1	2.1
Überackern	bayernets	Entry	fDZK	1.9	1.9
Waidhaus	OGE	Entry	fDZK	1.0	1.0
Wallbach	OGE	Entry	fDZK	0.7	0.7
Wallbach	OGE, Fluxys	Entry	interruptible	3.2	3.2

Source: Transmission system operators

6.3.11 Summary

In this chapter, the transmission system operators considered the various aspects of the H-gas supply. The focus was on the balancing consideration of the cross-border interconnection points, LNG terminals and storage facilities as well as the distribution of the required additional demand among the cross-border interconnection points. The transmission system operators would like to summarise the most important points at this point as follows:

- To cover the exit demand, the transmission system operators first apply the provision of available capacities at the LNG terminals as well as at the cross-border interconnection points in the H-gas capacity balance, as it is assumed that their entry capacities remain unaffected by potential storage level restrictions.
- Storage facilities are then used to cover demand, taking local transport conditions into account.
- Part of the entry capacity required to meet demand can alternatively be made available from cross-border interconnection points or from storage facilities (‘storage potential’).
- The allocation of the balance-based additional demand according to the H-gas source distribution to the identified cross-border interconnection points is based on the criteria and considerations of the transmission system operators presented in this chapter.
- The reported capacity demand for gas year 2029/2030 in the Gas Network Development Plan 2022–2032 has increased by 24 GWh/h in total.

Results of the modelling variants 7

7 Results of the modelling variants

Chapter 7.1 presents the criteria for determining the network expansion costs of the methane measures. Chapter 7.2 describes the necessary regulatory prerequisites for realisation of the network expansion measures by the transmission system operators. Chapter 7.3 then presents the results of the LNGplus modelling variants. Chapter 7.4 presents the results of the LNG modelling variants and Chapter 7.5 is dedicated to the base variant.

7.1 Criteria for determining the network expansion costs

The additional capacity requirements derived from the modelling results are implemented in network expansion measures. The transmission system operators must specify the investments associated with the network expansion measures in detail. Uniform planned cost concepts are used to ensure comparability of the measures. Standard conditions are assumed, and a blanket risk premium is applied. Due to the specific characteristics of the respective measures, the actual costs will usually deviate from these standard values.

It is important for the transmission system operators to point out that no conclusions can be drawn from the investment figures calculated using this method regarding the actually incurred investments in specific measures. Hence, the figures are only indicated for comparison purposes.

For the cost calculation, the transmission system operators use the specific cost rates listed in the following tables, unless the transmission system operators already have measure-specific estimates, which are highlighted in the NDP gas database.

The specific cost assumptions for the plant types gas pipelines, compressor stations, larger GPCM stations and valve stations are shown below.

Cost calculation for gas pipelines

Table 57: Planned cost estimates for gas pipelines in Euro/m

DN*	DP** 70	DP 80	DP 100
mm	Euro/m		
400	1,390	1,400	1,410
500	1,540	1,550	1,570
600	1,680	1,690	1,770
700	1,850	1,880	1,970
800	2,020	2,070	2,180
900	2,210	2,260	2,400
1,000	2,450	2,510	2,690
1,100	2,560	2,700	2,910
1,200	2,840	2,930	3,180
1,400	3,560	3,710	4,050

* DN – standard diameter in millimetres
** DP – pressure level in bar

Source: Transmission system operators

Cost calculation for compressor stations

Table 58: Planned cost estimates for compressor stations

Cost data in EUR 1,000 per MW Installed driving power per station		Compressor station complexity		
		Simple	Medium	High
Performance classes per machine unit	< 10 MW	4,710	5,230	5,760
	10–20 MW	3,660	4,190	4,710
	> 20 MW	2,620	3,140	3,660
Transport volume of the station	Euro/(Nm³/h)	10	20	20

Source: Transmission system operators

Cost calculation for GPCM stations

Table 59: Planned cost estimates for GPCM stations

Plant capacity	Costs DP 100	Preheating costs DP 100	Total costs DP 100
m³/h	EUR million		
500,000	7.6	1.0	8.7
1,000,000	10.9	1.6	12.5
2,000,000	14.1	2.1	16.2

Source: Transmission system operators

Cost calculation for valve stations

The costs for the construction of valve stations are determined via an individual cost estimate.

7.2 Necessary regulatory requirements

The preparation and modelling of the Gas Network Development Plan 2022–2032 is currently heavily overshadowed by the geopolitical events in Europe due to Russia's war of aggression on Ukraine. Since the adoption of the Scenario Framework in January 2022, politicians and the BNetzA have repeatedly defined new and fundamentally effective supply premises to be solved. The ultimate goal is to completely avoid imports of Russian natural gas.

Even though the final expansion programme of the Gas Network Development Plan 2022–2032 is far from being fixed, it is already clear at this point that the transmission system operators will face extraordinary challenges to make multi-billion euros investments as quickly as possible in order to substitute the natural gas deliveries from Russia that have so far arrived at Germany's eastern border with LNG deliveries at the northern and western German borders. This will require a massive conversion of the German natural gas system in order to continue to guarantee the security of supply in Germany.

At the same time, the transmission system operators are facing another challenge: The increasingly ambitious climate protection goals in Europe and Germany make it seem certain that natural gas transport on its current scale will no longer be in demand from 2045 onwards while maintaining the 'CO_2-net-zero target'. However, the current regulatory system of the EnWG and the Gasnetzentgeltverordnung (GasNEV - Gas Network Charges Ordinances) provides for imputed amortisation periods of 55 to 65 years for steel pipelines. A pipeline whose construction has thus gone into operation by 2022 can therefore only expect full amortisation by 2077 – depending on the year of commissioning. This example illustrates that transmission system operators run the risk of no longer being able to amortise their assets – at least if they cannot be expected to be used for hydrogen transport. In the meantime, the BNetzA has addressed this issue. With its definition of imputed useful lives of natural gas pipeline infrastructures ('KANU') (BK9-22/614), the agency has permitted significant flexibility to the useful lives for all assets that will be capitalised from 2023 onwards. For LNG connection facilities, this applies to all assets capitalised from 2022 onwards. The transmission system operators expressly welcome this move, although a corresponding flexibility is also necessary for existing facilities.

The investment measures are intended to create the transport capacities to facilitate technical and physical transfer of the LNG volumes to the gas transmission network within the meaning of section 39b (3) sentence 2 GasNZV. Additionally, they are intended to bring them to all demanders at any time in the German entry/exit transport system. Consequently, it is necessary to confirm that the expansion projects are permanently necessary for operation as defined in the EnWG and are assessed as permanently efficient network expansion by the BNetzA. The latter is also highly relevant, since these expansions must not be at the expense of the efficiency of the expanding network operators, even after a possible settlement of the war activities and the associated possible resumption of the gas supply from the Russian Federation or other producing regions. Although such a development may seem difficult to imagine today, it can by no means be ruled out given the very long payback period.

7.3 Security of supply variants LNGplus

The basics for the LNGplus variants are described in Chapter 3.2.6. The LNGplus security of supply variants were modelled exclusively for the year 2032. A description of the identified expansion measures can be found in the NDP gas database under the tile 'Expansion measures'.

Chapter 4 defines the initial network for the modelling as of the reporting date on 1 January 2022. According to the definition, the initial network measures presented in Chapter 4 are not a result of the modelling; accordingly, they are not presented in Chapter 7.

Due to the increased public interest in the implementation status of measures relevant for the development of new import opportunities and the expansion of existing import routes, the status of these measures will be reported in the NDP gas database as of 1 October 2022. All other measures are reported as of 1 January 2022.

This means that the measures 'Einbindung VDS Folmhusen im H-Gas' (ID 300-2) and 'Erweiterung VDS Embsen' (ID 503-03b) as of 1 October 2022 fulfil the criteria of the initial network. However, they are not presented in chapters 4.2 and 7.

Furthermore, for the modelling of the LNGplus security of supply variants, it should be noted that for the rapid provision of transport capacities for LNG terminals as of the reporting date on 1 October 2022, some new measures already fulfil the criteria of the initial network. These measures were also not presented in chapters 4.2 and 7. This also concerns the 'Leitung WAL Teil 1' (ID 851-01) and the 'GDRM-Anlage Wilhelmshaven' (ID 853-01) and 'GDRM-Anlage Friedeburg-Horsten' (ID 855-01). According to the definition, these measures are not a result of the modelling and are therefore not presented in Chapter 7 either.

7.3.1 Results of security of supply variant LNGplus A

Security of supply variant LNGplus A leads to the following results:

Table 60: Results security of supply variant LNGplus A

Summary of the results of the LNGplus A variant	Until end of 2032
Pipeline [km]	1,062
Compressor stations (additional capacity and necessary reversals) [MW]	249
Investments [in EUR billion]*	5.4
– Network expansion measures from the Gas Network Development Plan 2020–2030 (without LNG)	1.8
– LNG measures	3.2
– Further new network expansion measures from the Gas Network Development Plan 2022–2032	0.4
*rounded values	

Source: Transmission system operators

In the LNGplus security of supply variant A, an expansion with an investment volume of around EUR 5.4 billion is determined for the year 2032. In this security of supply variant, LNG terminals are connected in Brunsbüttel, Lubmin, Rostock, Stade and Wilhelmshaven.

With the new measures from the Gas Network Development Plan 2022–2032 aimed at further transport of LNG volumes in the transmission system to provide firm capacities for LNG terminals and at adaptation of the transmission network to changed load flows, the cost item 'LNG measures' includes investments of around EUR 3.2 billion.

Moreover, there are further measures with an investment volume of around EUR 1.8 billion, which have already been confirmed in the Gas Network Development Plan 2020–2030. The share of further new measures for power plants, industry, L-to-H gas conversion and distribution system operators in the Gas Network Development Plan 2022–2032 in the total investments is around EUR 0.4 billion.

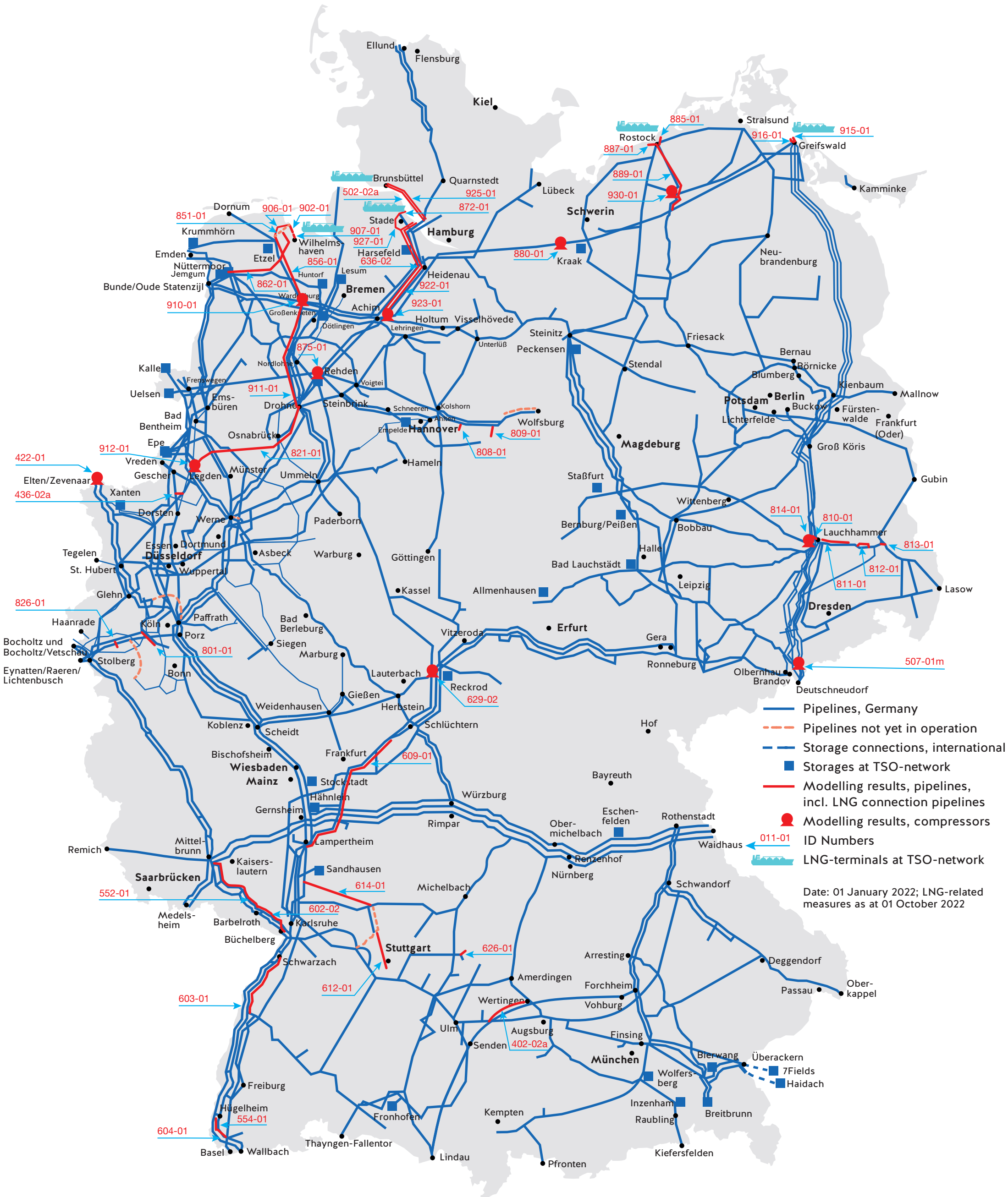
As a result, it can be stipulated that security of supply variant LNGplus A leads to the largest network expansion due to the large number of LNG requests.

The investments for the connection measures of the LNG terminals in Brunsbüttel, Lubmin, Rostock and Stade (ID 502-02a, 502-03b, 872-01, 873-01, 874-01, 885-01, 886-01, 889-01, 915-01, 916-01, 925-01, 926-01, 927-01, 928-01, 929-01, 930-01) amount to about EUR 0.9 billion.

Furthermore, there are network expansion measures (ID 300-02, 503-03b, 851-01, 853-01, 855-01) that currently already meet the criteria for an initial network measure, which were not yet included in Table 17 of Chapter 4 as of the reporting date on 1 January 2022. The investments for this amount to around EUR 0.1 billion.

The network expansion measures are listed in detail in the NDP gas database and are presented in the following figure.

Figure 35: Network expansion measures of security of supply variant LNGplus A until the end of 2032, incl. the LNG connecting pipelines



Source: Transmission system operators, schematic diagram

7.3.2 Results of security of supply variant LNGplus B

Security of supply variant LNGplus B leads to the following results:

Table 61: Results security of supply variant LNGplus B

Summary of the results of the LNGplus B variant	Until end of 2032
Pipeline [km]	805
Compressor stations (additional capacity and necessary reversals) [MW]	165
Investments [in EUR billion]*	4.1
– Network expansion measures from the Gas Network Development Plan 2020–2030 (without LNG)	1.8
– LNG measures	1.9
– Further new network expansion measures from the Gas Network Development Plan 2022–2032	0.4
*rounded values	

Source: Transmission system operators

In the LNGplus security of supply variant B, an expansion with an investment volume of around EUR 4.1 billion is determined for the year 2032. In this security of supply variant, LNG terminals are connected in Brunsbüttel, Lubmin, Rostock, Stade and Wilhelmshaven.

With the new measures from the Gas Network Development Plan 2022–2032 aimed at further transport of LNG volumes in the transmission network to provide firm capacities for LNG terminals and at adaptation of the transmission network to changed load flows, the cost item 'LNG measures' includes investments of around EUR 1.9 billion.

Moreover, there are further measures with an investment volume of around EUR 1.8 billion, which have already been confirmed in the Gas Network Development Plan 2020–2030. The share of further new measures for power plants, industry, L-to-H gas conversion and distribution system operators in the Gas Network Development Plan 2022–2032 in the total investments is around EUR 0.4 billion.

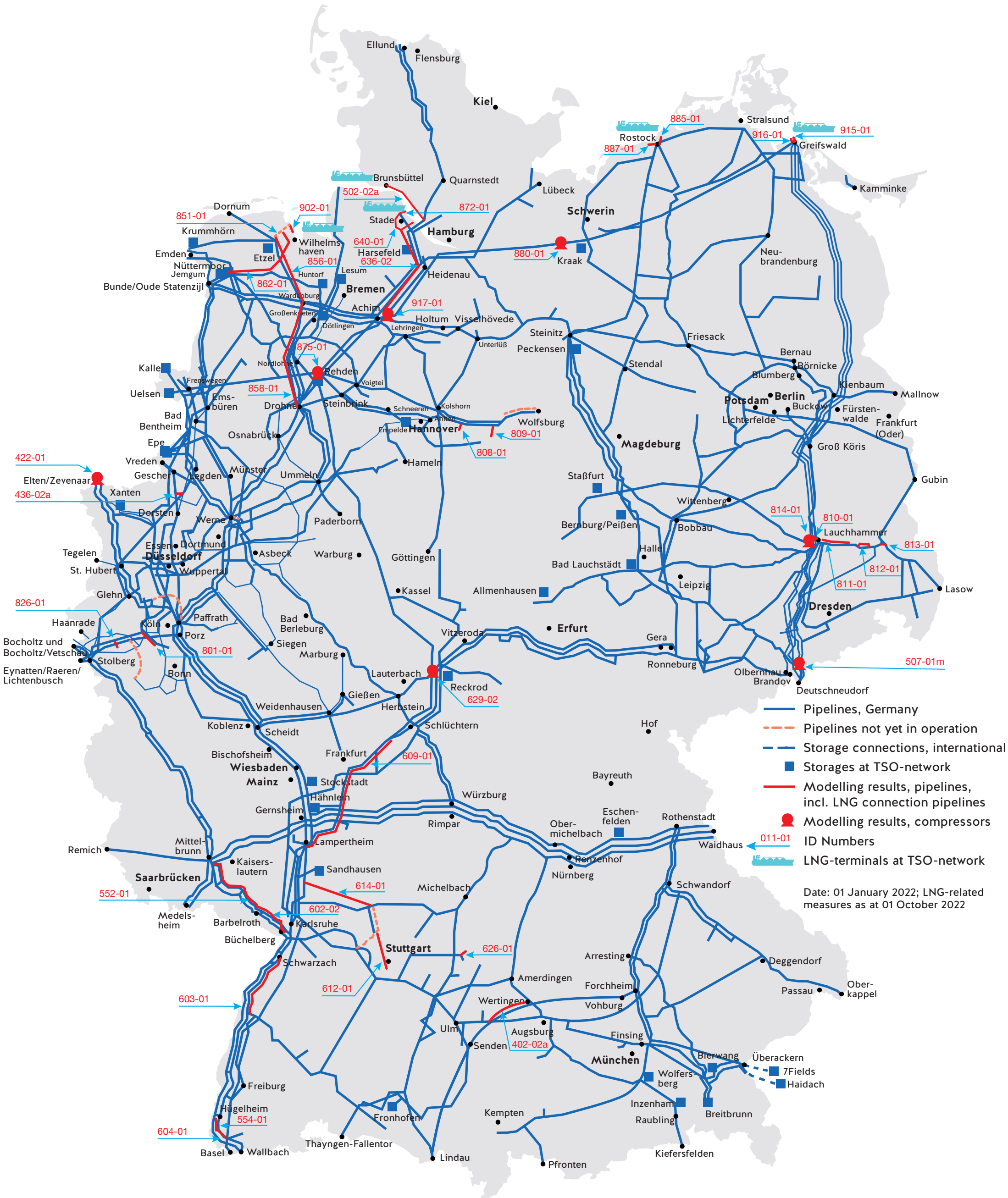
As a result, it can be stipulated that the LNGplus B security of supply variant has the lowest investments among the LNGplus security of supply variants in terms of network expansion.

The investments for the connection measures of the LNG terminals in Brunsbüttel, Lubmin, Rostock and Stade (ID 502-02a, 502-03b, 640-02, 641-02, 872-01, 873-01, 874-01, 885-01, 886-01, 915-01, 916-01) amount to around EUR 0.5 billion.

Furthermore, there are network expansion measures (ID 300-02, 503-03b, 851-01, 853-01, 855-01) that currently already meet the criteria for an initial network measure, which were not yet included in Table 17 of Chapter 4 as of the reporting date on 1 January 2022. The investments for this amount to around EUR 0.1 billion.

The network expansion measures are listed in detail in the NDP gas database and are presented in the following figure.

Figure 36: Network expansion measures of the LNGplus B security of supply variant until the end of 2032, incl. the LNG connecting pipelines



Source: Transmission system operators, schematic diagram

7.3.3 Results of the LNGplus C security of supply variant

Security of supply variant LNGplus C leads to the following results:

Table 62: Results security of supply variant LNGplus C

Summary of the results of the LNGplus C variant	Until end of 2032
Pipeline [km]	805
Compressor stations (additional capacity and necessary reversals) [MW]	175
Investments [in EUR billion]*	4.2
– Network expansion measures from the Gas Network Development Plan 2020–2030 (without LNG)	1.8
– LNG measures	1.9
– Further new network expansion measures from the Gas Network Development Plan 2022–2032	0.4
*rounded values	

Source: Transmission system operators

In the LNGplus security of supply variant C, an expansion with an investment volume of around EUR 4.2 billion is determined for the year 2032. In this security of supply variant, LNG terminals are connected in Brunsbüttel, Lubmin, Rostock, Stade and Wilhelmshaven.

With the new measures from the Gas Network Development Plan 2022–2032 aimed at further transport of LNG volumes in the transmission network to provide firm capacities for LNG terminals and at adaptation of the transmission network to changed load flows, the cost item 'LNG measures' includes investments of around EUR 1.9 billion.

Moreover, there are further measures with an investment volume of around EUR 1.8 billion, which have already been confirmed in the Gas Network Development Plan 2020–2030. The share of further new measures for power plants, industry, L-to-H gas conversion and distribution system operators in the Gas Network Development Plan 2022–2032 in the total investments is around EUR 0.4 billion.

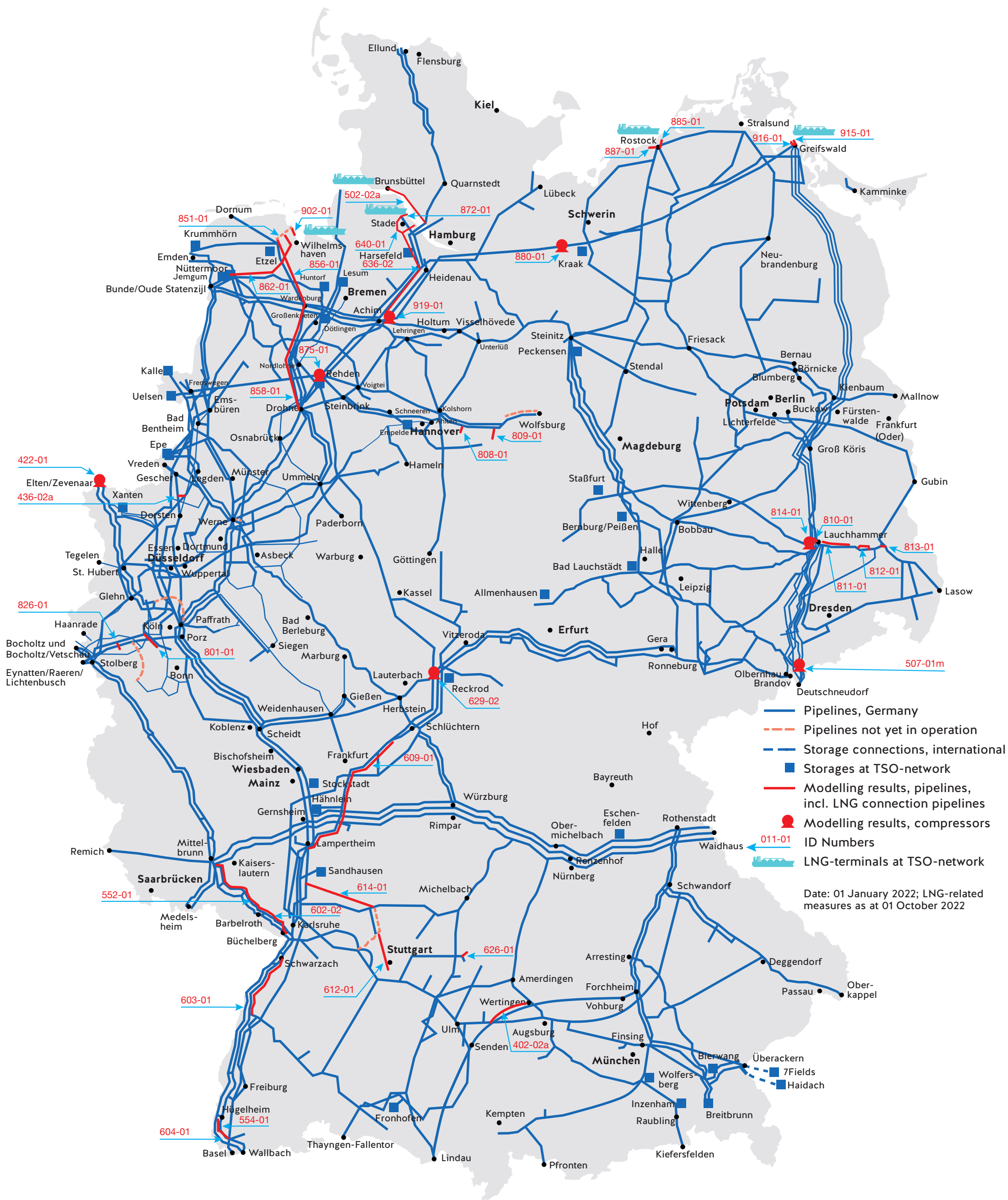
As a result, it can be stipulated that the LNGplus C security of supply variant features higher investments in terms of network expansion than the most cost-effective LNGplus B security of supply variant.

The investments for the connection measures of the LNG terminals in Brunsbüttel, Lubmin, Rostock and Stade (ID 502-02a, 502-03b, 640-02, 641-02, 872-01, 873-01, 874-01, 885-01, 886-01, 915-01, 916-01) amount to around EUR 0.5 billion.

Furthermore, there are network expansion measures (ID 300-02, 503-03b, 851-01, 853-01, 855-01) that currently already meet the criteria for an initial network measure, which were not yet included in Table 17 of Chapter 4 as of the reporting date on 1 January 2022. The investments for this amount to around EUR 0.1 billion.

The network expansion measures are listed in detail in the NDP gas database and are presented in the following figure.

Figure 37: Network expansion measures for the LNGplus C security of supply variant until the end of 2032, incl. the LNG connecting pipelines



Source: Transmission system operators, schematic diagram

7.3.4 Allocation of network expansion measures for LNG terminals of the LNGplus security of supply variants

In this chapter, the transmission system operators allocate the network expansion measures that cover the capacity requirements for LNG terminals and cross-border interconnection points to the LNGplus security of supply variants. The allocation of the network expansion measures to the LNG terminals and cross-border interconnection points can be found in the NDP gas database.

Table 63: Allocation of the network expansion measures to the LNGplus security of supply variants

ID No.	Network expansion measure	LNGplus A	LNGplus B	LNGplus C
301-01	Überspeisung Embsen	x	x	x
636-02	Leitung Elbe Süd-Achim	x	x	x
637-02	Anpassung Verdichter Achim	x	x	x
638-01	Vorwärmung Embsen	x	x	x
821-01	Leitung Drohne-Legden	x		
822-01	GDRM-Anlage Drohne 2 und Verbindungsleitung	x	x	x
823-01	GDRM-Anlage Legden 2 und Verbindungsleitung	x		
854-01	GDRM-Anlage Wilhelmshaven 3, Heppenser Groden und Verbindungsleitung	x		
856-01	Leitung Etzel – Wardenburg	x	x	x
857-01	GDRM-Anlage Wardenburg und Verbindungsleitung	x	x	x
858-01	Leitung Wardenburg-Drohne		x	x
862-01	Leitung Sande Nüttermoor/Jemgum	x	x	x
863-01	GDRM-Anlage Westerstede	x	x	x
864-01	GDRM-Anlage Sande	x	x	x
865-01	GDRM-Anlage Leer und Verbindungsleitung	x	x	x
875-01	Erweiterung der VS Rehden	x	x	x
880-01	Neubau VS Wittenburg	x	x	x
882-02	Umbau der EST Lubmin 2	x	x	x
883-01	Erweiterung der GDRM Radeland 2	x	x	x
887-01	Verbindungsleitung Rostock-Marienehe	x	x	x
888-01	GDRM-Anlage Vorweden	x	x	x
901-01	GDRM-Anlage Wilhelmshaven 2, Voslapper Groden und Verbindungsleitung	x	x	x
902-01	WAL Teil 2	x	x	x
903-01	Erweiterung GDRM-Anlage Friedeburg – Horsten 1 und Verbindungsleitung	x	x	x
904-01	Automatisierung Reversierung Medelsheim - Mittelbrunn		x	x
905-01	Deodorierungsanlage Medelsheim		x	x
906-01	WAL Teil 4	x		
907-01	WAL Teil 3	x		
908-01	Erweiterung GDRM-Anlage Wilhelmshaven 2, Voslapper Groden und Verbindungsleitung	x		
909-01	GDRM-Anlage Friedeburg - Horsten 2 und Verbindungsleitung	x		
910-01	Verdichterstation Wardenburg	x		
911-01	Leitung Wardenburg-Drohne	x		
912-01	Erweiterung Verdichterstation Legden	x		
913-01	Verbindung EUGAL-JAGAL-OPAL	x	x	x
914-01	Verbindung OPAL-STEGAL	x	x	x
917-01	VDS Achim/Embsen		x	
918-01	GDRM-Anlage Achim/Embsen		x	
919-01	VDS Achim/Embsen			x
920-01	GDRM-Anlage Achim/Embsen			x
921-01	Reversierung VDS Quarnstedt		x	x
922-01	Loop-Leitung Elbe Süd - Achim	x		
923-01	VDS Achim/Embsen	x		
924-01	GDRM-Anlage Achim/Embsen	x		

Source: Transmission system operators

7.4 LNG security of supply variants

The basis for the LNG variants is described in Chapter 3.2.6. The LNG security of supply variants were modelled exclusively for the year 2032. A description of the identified expansion measures can be found in the NDP gas database under the tile ‘Expansion measures’.

According to the definition, the initial network measures presented in Chapter 4 are not a result of the modelling. Accordingly, these measures are not presented in Chapter 7.

The transmission system operators have made adjustments compared to the Interim Status of the Gas Network Development Plan 2022–2032 for network expansion measures with LNG reference (reporting date 1 October 2022).

7.4.1 Results of LNG security of supply variant 1

LNG security of supply variant 1 leads to the following results:

Table 64: Results of LNG security of supply variant 1

LNG security of supply variant 1	Until end of 2032
Pipeline [km]	933
Compressor stations (additional capacity and necessary reversals) [MW]	243
Investments [in EUR billion]*	4.7
– Network expansion measures from the Gas Network Development Plan 2020–2030 (without LNG)	1.9
– LNG measures	2.5
– Further new network expansion measures from the Gas Network Development Plan 2022–2032	0.4
*rounded values	

Source: Transmission system operators

In LNG security of supply variant 1, an expansion with an investment volume of around EUR 4.7 billion is determined for the year 2032. In this security of supply variant, LNG terminals are connected in Brunsbüttel, Stade and Wilhelmshaven.

With the new measures from the Gas Network Development Plan 2022–2032 aimed at further transport of LNG volumes in the transmission network to provide firm capacities for LNG terminals and at adaptation of the transmission network to changed load flows, the cost item ‘LNG measures’ includes investments of around EUR 2.5 billion.

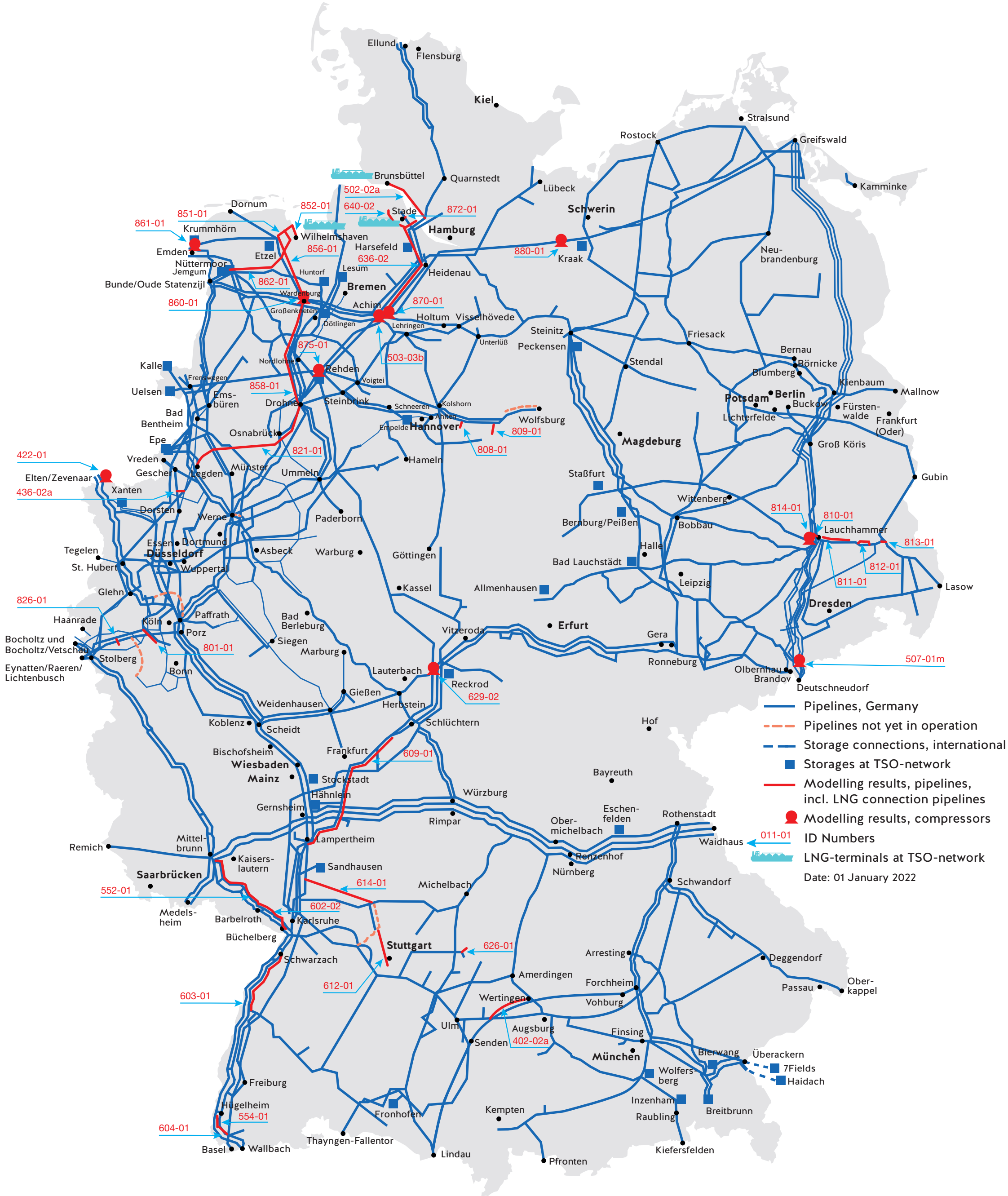
Moreover, there are further measures with an investment volume of around EUR 1.9 billion, which have already been confirmed in the Gas Network Development Plan 2020–2030. This item is reduced compared to the base variant, as some measures from the base variant are omitted. The share of new measures in the Gas Network Development Plan 2022–2032 (e.g. for the connection of industry, L-to-H gas conversion measures and distribution system operators) in the total investments is around EUR 0.4 billion.

In conclusion, it can be stipulated that the large number of new measures in the Gas Network Development Plan 2022–2032 in LNG security of supply variant 1 correspond to those in the base variant. For the LNG connection measures, which serve to ensure security of supply, there is a relatively small increase here compared to the base variant. This can be attributed to the changed assumptions for the connection of LNG measures in this LNG security of supply variant.

The investments for the connection measures of the LNG terminals in Brunsbüttel, Stade and Wilhelmshaven (ID 502-02a, 502-03b, 640-02, 641-02, 872-01, 873-01, 874-01) amount to around EUR 0.4 billion.

The resulting network expansion measures are listed in detail in the NDP gas database and are presented in the following figure.

Figure 38: Network expansion measures of LNG security of supply variant 1 until the end of 2032, incl. the LNG connecting pipelines



Source: Transmission system operators, schematic diagram

7.4.2 Results of LNG security of supply variant 2

LNG Security of Supply Variant 2 leads to the following results:

Table 65: Results of LNG security of supply variant 2

LNG security of supply variant 2	Until end of 2032
Pipeline [km]	933
Compressor stations (additional capacity and necessary reversals) [MW]	213
Investments [in EUR billion]*	4.3
– Network expansion measures from the Gas Network Development Plan 2020–2030 (without LNG)	1.9
– LNG measures	2.1
– Further new network expansion measures from the Gas Network Development Plan 2022–2032	0.4
*rounded values	

Source: Transmission system operators

In LNG security of supply variant 2, an expansion with an investment volume of around EUR 4.3 billion is determined for the year 2032. In this modelling variant, LNG terminals are connected in Brunsbüttel, Rostock and Wilhelmshaven.

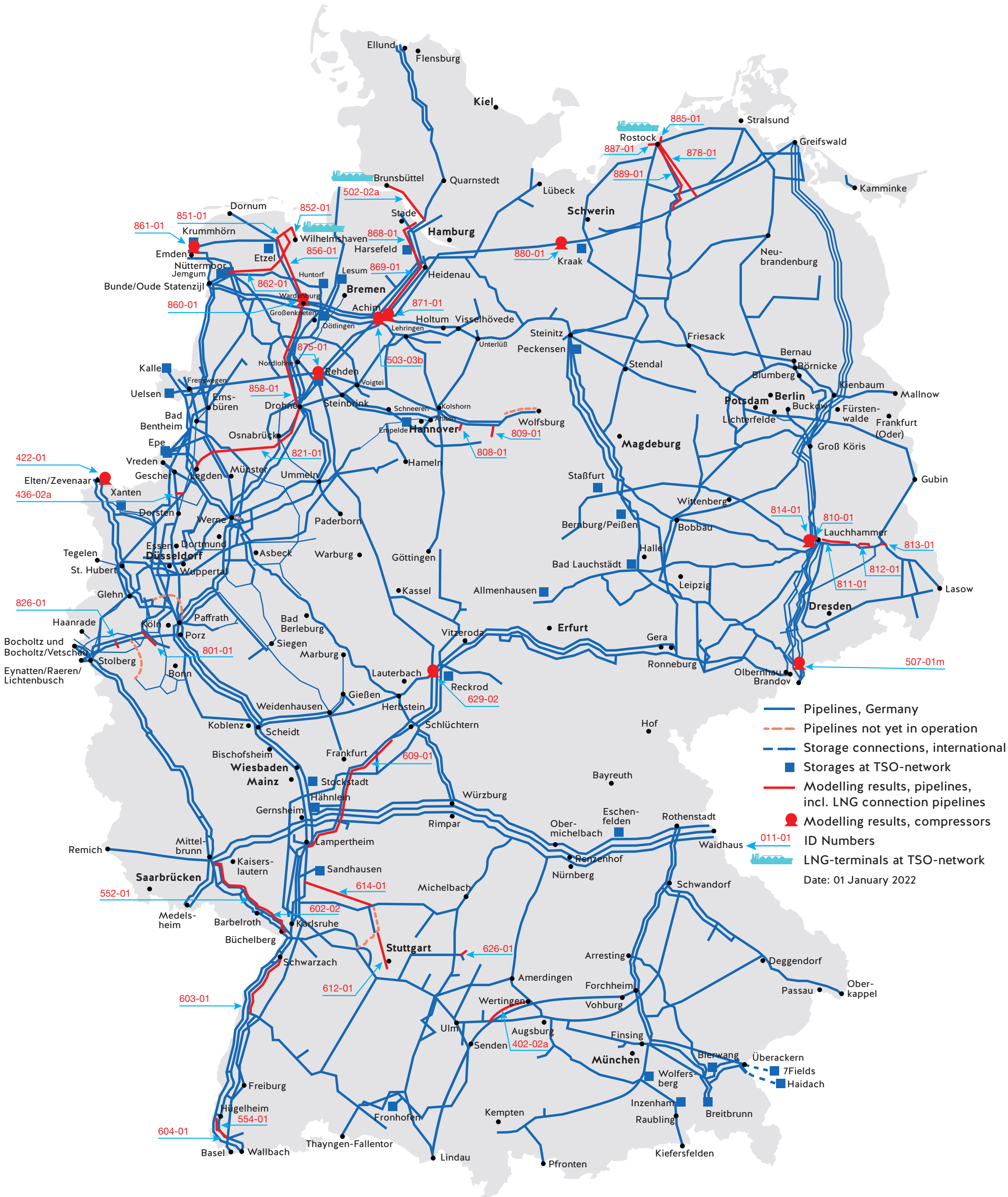
With the new measures from the Gas Network Development Plan 2022–2032 aimed at further transport of LNG volumes in the transmission network to provide firm capacities for LNG terminals and at adaptation of the transmission network to changed load flows, the cost item 'LNG measures' includes investments of around EUR 2.1 billion. Moreover, there are further measures with an investment volume of around EUR 1.9 billion, which have already been confirmed in the Gas Network Development Plan 2020–2030. The share of new measures in the Gas Network Development Plan 2022–2032 (e.g. for the connection of industry, L-to-H gas conversion measures and distribution system operators) in the total investments is around EUR 0.4 billion.

For the LNG connection measures, which serve to ensure security of supply, there is an increase in investment compared to LNG security of supply variant 1 due to the connection of the Rostock site.

The investments for the connection measures of the LNG terminals in Brunsbüttel, Rostock and Wilhelmshaven (ID 502-02a, 502-03b, 874-01, 885-01, 886-01 and alternatively 878-01/879-01 or 889-01/890-01) amount to EUR 0.4–0.5 billion. Two variants were investigated for connection of the LNG terminal in Rostock, which explains why a range is given for the connection measures.

The resulting network expansion measures are listed in detail in the NDP gas database and are presented in the following figure.

Figure 39: Network expansion measures of LNG security of supply variant 2 until the end of 2032, incl. the LNG connecting pipelines



Source: Transmission system operators, schematic diagram

7.4.3 Results of LNG security of supply variant 2.1

LNG Security of Supply Variant 2.1 leads to the following results:

Table 66: Results of LNG security of supply variant 2.1

LNG security of supply variant 2.1	Until end of 2032
Pipeline [km]	933
Compressor stations (additional capacity and necessary reversals) [MW]	213
Investments [in EUR billion]*	4.3
– Network expansion measures from the Gas Network Development Plan 2020–2030 (without LNG)	1.9
– LNG measures	2.1
– Further new network expansion measures from the Gas Network Development Plan 2022–2032	0.4
*rounded values	

Source: Transmission system operators

In LNG security of supply variant 2.1, an expansion with an investment volume of around EUR 4.3 billion is determined for the year 2032. In this security of supply variant, LNG terminals are connected in Brunsbüttel, Rostock and Wilhelmshaven. Compared to LNG security of supply variant 2, the LNG terminal capacity at the Rostock site has more than doubled from 10.0 GWh/h to 21.7 GWh/h.

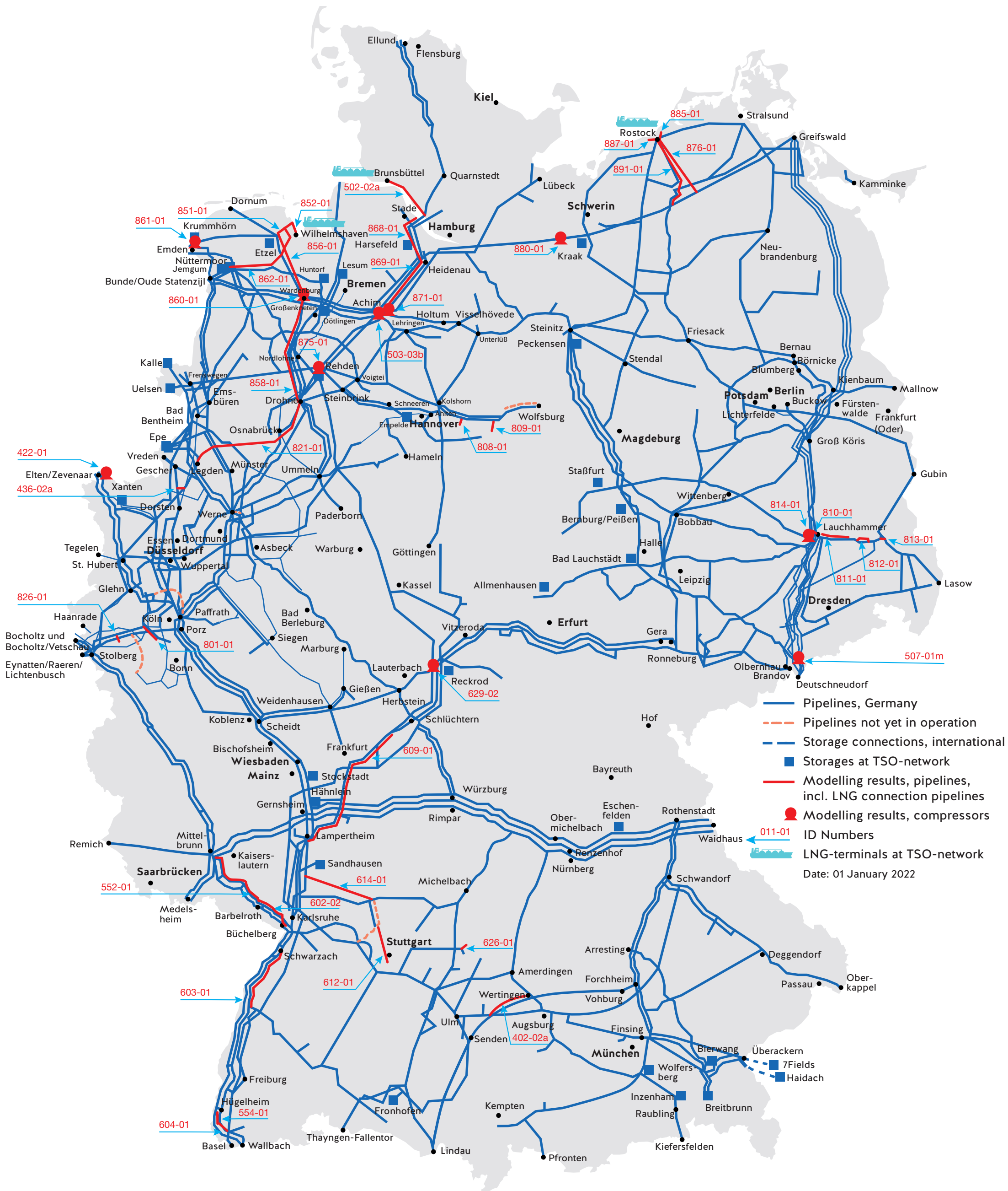
With the new measures from the Gas Network Development Plan 2022–2032, which partly serve to provide firm capacities for LNG terminals, the cost item ‘LNG measures’ comprises investments of around EUR 2.1 billion. Moreover, there are further measures with an investment volume of around EUR 1.9 billion, which have already been confirmed in the Gas Network Development Plan 2020–2030. The share of new measures in the Gas Network Development Plan 2022–2032 (e.g. for the connection of industry, L-to-H gas conversion measures and distribution system operators) in the total investments is around EUR 0.4 billion.

For the LNG connection measures, which serve to ensure security of supply, there is only a relatively small increase in investment compared to LNG security of supply variant 2 despite the significant increase in LNG terminal capacity in Rostock.

The investments for the connection measures of the LNG terminals in Brunsbüttel, Rostock and Wilhelmshaven (ID 502-02a, 502-03b, 874-01, 885-01, 886-01 and alternatively 876-01/877-01 or 891-01/892-01) amount to EUR 0.5 billion. Two variants were investigated for connection of the LNG terminal in Rostock, which explains why a range is given for the connection measures.

The resulting network expansion measures are listed in detail in the NDP gas database and are presented in the following figure.

Figure 40: Network expansion measures of LNG security of supply variant 2.1 until the end of 2032, incl. the LNG connecting pipelines



Source: Transmission system operators, schematic diagram

7.5 Base variant

The modelling results for the years 2027 and 2032 are described below. A description of the identified expansion measures can be found in the NDP gas database under the tile 'Expansion Measures'.

According to the definition, the initial network measures presented in Chapter 4 are not a result of the modelling. Accordingly, these measures are not presented in Chapter 7.

The transmission system operators have made adjustments compared to the interim status of the Gas Network Development Plan 2022–2032 for network expansion measures with LNG reference (reporting date 1 October 2022).

7.5.1 Results of the base variant

The base variant leads to the following results:

Table 67: Results of base variant

Summary of the results of the base variant	Until end of 2027	Until end of 2032
Pipeline [km]	870	870
Compressor stations (additional capacity and necessary reversals) [MW]	186	186
Investments [in EUR billion]*	4.1	4.2
– Network expansion measures from the Gas Network Development Plan 2020–2030 (without LNG)	2.0	2.1
– LNG measures (incl. SNG)	1.7	1.7
– Further new network expansion measures from the Gas Network Development Plan 2022–2032	0.4	0.4
*rounded values		

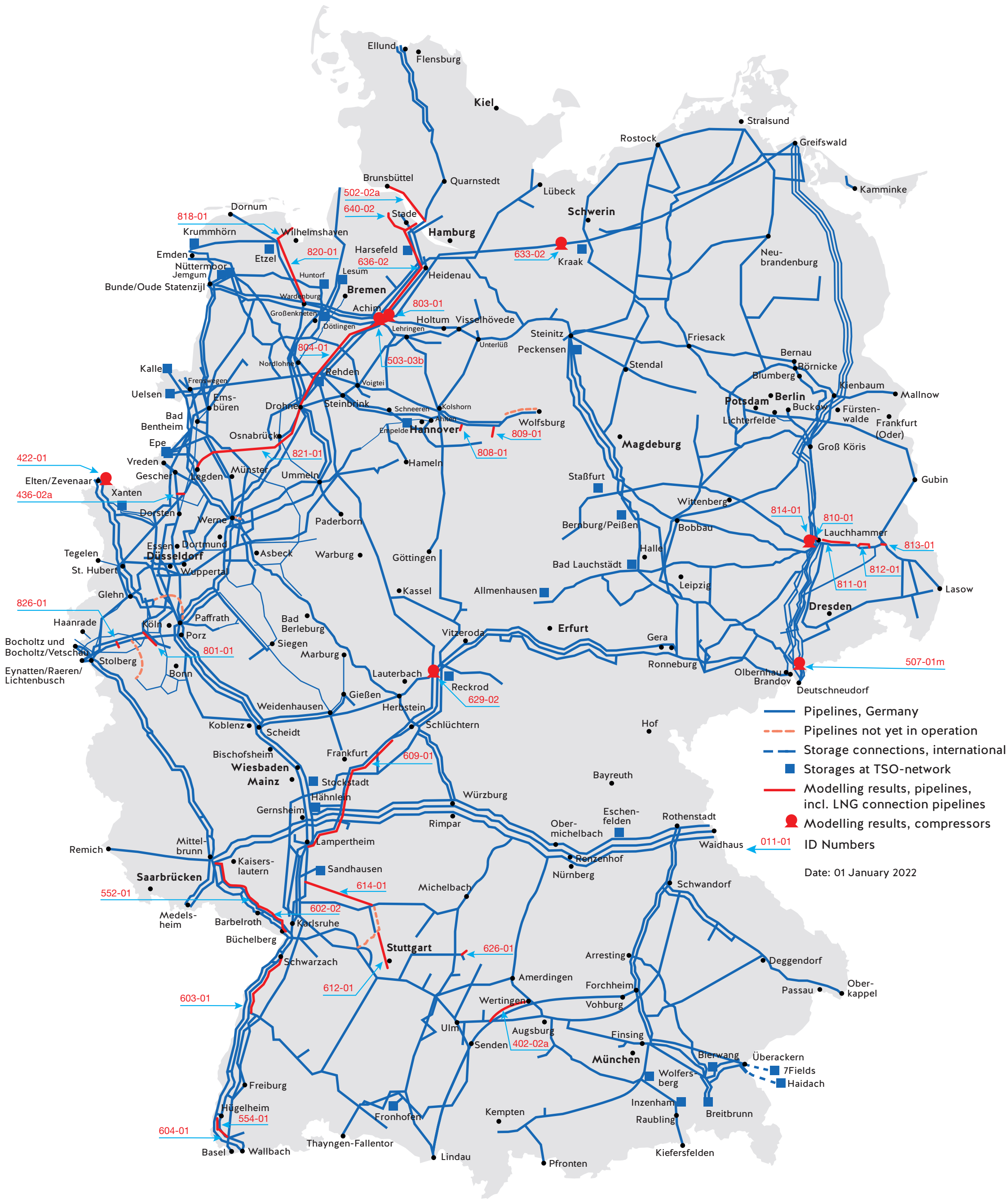
Source: Transmission system operators

In the base variant, an expansion with an investment volume of around EUR 4.2 billion is determined for the year 2032. The results between the modelling years 2027 and 2032 differ only slightly. The base variant already includes measures for LNG terminals from the Gas Network Development Plan 2020–2030, which were also the result of the modelling in the base variant of the current Gas Network Development Plan 2022–2032. With the new measures from the Gas Network Development Plan 2022–2032, which partly serve to establish firm capacities for LNG and SNG plants, the cost item 'LNG measures (incl. SNG)' comprises investments of around EUR 1.7 billion. Moreover, there are further measures with an investment volume of around EUR 2.1 billion, which have already been confirmed in the Gas Network Development Plan 2020–2030. The share of new measures in the Gas Network Development Plan 2022–2032 (e.g. for the connection of industry, L-to-H gas conversion measures and distribution system operators) in the total investments is around EUR 0.4 billion.

The investments for the connection measures of the LNG terminals in Brunsbüttel and Stade (ID 502-02a, 502-03b, 640-02, 641-02) amount to around EUR 0.4 billion.

The resulting network expansion measures are listed in detail in the NDP gas database and are presented in the following figure.

Figure 41: Network expansion measures of the base variant until the end of 2027/2032, incl. the LNG connecting pipelines



Source: Transmission system operators, schematic diagram

7.5.2 Allocation of network expansion measures for new and system-relevant gas power plants

The transmission system operators have taken new gas power plants into account in the modelling based on the confirmation of the Scenario Framework. In the confirmation of the Scenario Framework, the BNetzA also instructed the transmission system operators to identify all network expansion measures that contribute to meeting the capacity requirements for planned gas power plants. The transmission system operators have implemented this requirement in Table 68 below.

Table 68: Allocation of network expansion measures that cover the capacity requirements for new and system-relevant power plants, among other things

ID No.	Network expansion measure	Only necessary for power plant	Planned new gas power plants																						New system-relevant gas power plants			
			GK Leipheim Block 1*	GK Leipheim Block 2	KW Gundremmingen	Kraftwerk Zolling*	Kraftwerk Mehrum	GHKW VW2	Salzgitter plant	Uelzen plant*	Kraftwerk Scholven*	Kraftwerk Irsching*	Kraftwerk Biblis*	Innovatives Hybrid-Kraftwerk Boxberg	Innovatives Hybrid-Kraftwerk Jänschwalde	GuD Schwarze Pumpe	Innovatives Hybrid-Kraftwerk Lippendorf*	Gasturbine Heilbronn	GuD Altbach	GuD Marbach	GuD Aalen	KWK-Anlage AUDI AG Werk Neckarsulm	GuD Mannheim	GuD Herne	Trianel Gaskraftwerk Hamm*	Cuno Heizkraftwerk Herdecke*	Knapsack I	Gersteinwerk*
302-01	Leitung Datteln-Herne	x																						x				
402-02a	AUGUSTA (Leitung Wertingen-Kötz)			x	x																x							
402-02b	GDRM-Anlage Wertingen 2			x	x																x							
402-02c	GDRM-Anlage Kötz			x	x																x							
417-02	VDS Mörsch (Nordschwarz-waldleitung)																	x										
449-02	Verlängerung Anbindung Heilbronn (SEL1)																	x	x	x								
501-02a	Leitung Walle-Wolfsburg	x						x																				
501-03e	Erweiterung GDRM-Anlage Unterlüß							x																				
609-01	Leitung Wirtheim-Lampertheim																	x	x	x		x	x					
610-01	GDRM-Anlage Wirtheim																	x	x	x		x	x					
611-01	GDRM-Anlage Lampertheim																	x	x	x		x	x					
612-01	Leitung Löchgau-Altbach (SEL 2)																		x	x								
614-01	Leitung Heidel-berg-Heilbronn (SEL 3)																	x	x	x		x						

ID No.	Network expansion measure	Only necessary for power plant	Planned new gas power plants																						New system-relevant gas power plants			
			GK Leipheim Block 1*	GK Leipheim Block 2	KW Gundremmingen	Kraftwerk Zolling*	Kraftwerk Mehrum	GHKW VW2	Werk Salzgitter	Werk Uelzen*	Kraftwerk Scholven*	Kraftwerk Irsching*	Kraftwerk Biblis*	Innovatives Hybrid-Kraftwerk Boxberg	Innovatives Hybrid-Kraftwerk Jänschwalde	GuD Schwarze Pumpe	Innovative hybrid power plant Lippendorf*	Gasturbine Heilbronn	GuD-Anlage Altbach	GuD-Anlage Marbach	GuD-Anlage Aalen	KWK-Anlage AUDI AG Werk Neckarsulm	GuD-Anlage Mannheim	GuD-KW Herne	Trianel Gaskraftwerk Hamm*	Cuno Heizkraftwerk Herdecke*	Knapsack I	Gersteinwerk*
616-01	GDRM-Anlage Heidelberg																	x	x	x		x						
618-01	GDRM-Anlage Heilbronn																	x	x	x		x						
626-01	Leitung Aalen-Essingen																				x							
629-02	VDS Reckrod																	x	x	x		x	x					
630-01	GDRM-Anlage Lampertheim 5																	x	x	x		x	x					
642-01	GDRM-Anlage Ludwigshafen																	x	x	x		x	x					
801-01	Anschlussleitung Köln Süd 2																										x	
802-01	Armaturenstation Lauchhammer													x	x	x												
806-01	GDRM-Anlage Lehringen	x					x		x																			
807-01	GDRM-Anlage Kolshorn	x					x		x																			
808-01	Leitung Hämelerwald-Mehrum	x					x																					
809-01	Leitung Sophiental-Salzgitter	x							x																			
810-01	Leitung Anbindung Lauchhammer	x												x	x	x												
811-01	Leitung Lauchhammer-Großkoschen	x												x	x	x												
812-01	Leitung Bergen-Burg	x												x	x	x												
814-01	VDS Lauchhammer	x												x	x	x												
815-01	GDRM-Anlage Lauchhammer	x												x	x	x												

* No expansion requirement is necessary for these power plants or corresponding measures are already in operation.

Source: Transmission system operators

7.5.3 Allocation of network expansion measures for LNG terminals in the base variant scenario

The transmission system operators have taken new LNG terminals into account in the modelling based on the confirmation of the Scenario Framework. In the confirmation of the Scenario Framework, the BNetzA also instructed the transmission system operators to identify all network expansion measures that contribute to meeting the capacity requirements for these LNG terminals. The transmission system operators have implemented this requirement in Table 69 below.

Table 69: Allocation of network expansion measures that cover the capacity requirements for new LNG terminals, among other things

ID No.	Network expansion measure	Only necessary for LNG terminals	Planned new LNG terminals Brunsbüttel and Stade
301-01	Überspeisung Embsen		x
636-02	Leitung Elbe Süd-Achim	x	x
637-02	Anpassung Verdichter Achim	x	x
638-01	Vorwärmung Embsen		x
803-01	VDS Achim/Embsen	x	x
804-01	Leitung Achim/Embsen-Drohne	x	x
805-01	GDRM-Anlage Drohne III	x	x
820-01	Leitung Etzel-Wardenburg		x
821-01	Leitung Drohne-Legden		x
822-01	GDRM-Anlage Drohne 2 und Verbindungsleitung		x
823-01	GDRM-Anlage Legden 2 und Verbindungsleitung		x

Source: Transmission system operators

Hydrogen variant 8

8 Hydrogen variant

Basic framework conditions

For preparation of the Gas Network Development Plan 2020–2030, the transmission system operators had determined the transport demand for hydrogen for the first time in the context of a market partner survey. For this purpose, the potential producers and consumers of hydrogen were surveyed. The targeted conversion of transport infrastructure to hydrogen and the construction of new facilities are intended to link producers and consumers and ultimately enable a sustainable switch from methane to hydrogen.

Even though the identified hydrogen expansion measures could not be confirmed in the Gas Network Development Plan 2020–2030 due to the lack of a legal regulatory framework, the fact that a foundation stone for a supraregional hydrogen transmission network was laid was met with broad approval in politics, administration and the market. The Gas Network Development Plan was thus recognised as a transparency platform. The transmission system operators have taken this positive feedback as an opportunity to carry out another WEB Market Survey for the preparation of the Gas Network Development Plan 2022–2032 and to continue the development of a Germany-wide hydrogen transmission network. The numerous responses to the WEB Market Survey and the resulting conclusion of MoUs show the great demand for hydrogen transport capacity and thus the need to develop a national hydrogen infrastructure.

The transmission system operators have long-standing experience in joint network planning, within the framework of network development plans and in particular in the conversion of transmission networks from L-gas to H-gas. Accordingly, the transmission system operators are able to identify existing Natural Gas pipelines across operators that can potentially be converted for hydrogen transport. Furthermore, the transmission system operators, in collaboration with other potential hydrogen infrastructure operators, have completed the modelling of a national hydrogen network. The common goal of all stakeholders is to achieve the ambitious goal of the German government of climate neutrality for Germany by 2045 as early as possible and to exploit existing infrastructure potential.

In the amendment request to the Gas Network Development Plan 2020–2030, the BNetzA had not been able to confirm hydrogen conversion measures and new construction measures of hydrogen infrastructure due to the lack of regulatory framework conditions. It was only possible to confirm natural gas-enhancing measures for the development of the hydrogen network if there was an assured demand for hydrogen transport. Even with the amendment of the EnWG in July 2021, neither integrated nor separate gas and hydrogen network development planning was implemented in the legal framework. However, section 113b of the EnWG was amended to include the identification of gas supply lines that could be converted to hydrogen use in the future.

Beyond this, however, there is no legal framework to treat hydrogen network planning with gas network development planning in an integrated process to optimise the overall system. The legally assigned tasks of the transmission system operators with regard to hydrogen network development planning currently consist of their contribution to the joint report on the current state of expansion of the hydrogen network and the development of future hydrogen network planning with the target year 2035. Based on this report, the BNetzA can make recommendations for the legal implementation of a binding Hydrogen Network Development Plan (Hydrogen Report) persuant to section 28q EnWG.

The hydrogen network shown in the Gas Network Development Plan 2022–2032 was created in a complex process, taking the transport needs into account. The transmission system operators are convinced that they can use it to work out a hydrogen transmission network that meets demand. Nevertheless, due to the lack of specifications in the current regulatory framework, this hydrogen network cannot represent a binding pre-determination for future hydrogen network planning. For rapid development of a hydrogen infrastructure, there would be an urgent need to create this framework and enable binding integrated network planning for gas and hydrogen, in which an optimisation of the overall system of methane and hydrogen networks can be realised.

The capacity products for hydrogen must be developed in a growing market, taking the transport needs of customers into account. Within the framework of hydrogen network modelling, firm capacities were considered.

Additional uncertainties due to geopolitical developments

In addition to the still unclear legal and regulatory framework conditions, Russia's war of aggression against Ukraine added considerable uncertainties to the development of the gas market. This makes reliable and resilient network development difficult at the present time. Consequently, the transmission system operators have not carried out any methane modelling for the hydrogen variant in the Gas Network Development Plan 2022–2032. They have therefore also refrained from identifying new Natural Gas-enhancing measures for the hydrogen network planning.

The determined hydrogen network of the hydrogen modelling is based on the underlying MoU requirements. It is also aligned with the results of the Gas Network Development Plan 2020–2030 and the pipeline reports of the transmission system operators and other potential hydrogen network operators as well as with existing parallel pipeline systems in the transmission network. Based on this information, an examination was carried out to determine which routes are suitable for the construction of a hydrogen network.

In consultation with the BNetzA, the transmission system operators are currently examining various options for securing Germany's gas supply without Russian gas or with less Russian gas (cf. Chapter 7). In addition to conversions and expansions, the options first and foremost require a modified use of the existing gas network adapted to the new framework conditions. Until a decision is made on implementation of the options, it is hardly possible to make a reliable statement on the cost-reducing conversion of existing pipelines and facilities from methane transport to hydrogen transport. The costs for provision of the hydrogen infrastructure for the years 2027/2032 should therefore be regarded as indicative (cf. Chapter 8.4). These developments in the gas market will be taken up in the upcoming Scenario Framework; preparation of this report will begin at the end of 2022 or beginning of 2023.

Accelerating the development of the hydrogen infrastructure is essential to achieving climate neutrality and ensuring security of supply. It is therefore an obvious choice for the transmission system operators to integrate hydrogen network planning into the Gas Network Development Plan 2022–2032 based on the reported requirements of the WEB Market Survey and aligned with the joint modelling. This is in line with the expectations of the market participants, project sponsors and distribution system operators and thus puts the transmission system operators and the other potential hydrogen network operators in a position to continuously expedite the follow-up processes.

8.1 Results of the WEB Market Survey after MoU and after confirmation of the 2022 Scenario Framework

Hydrogen and green gases play an important role in the transformation of the energy system. In the last Gas Network Development Plan 2020–2030, the transmission system operators started planning for the development of a hydrogen infrastructure and showed that this can already be made available in the medium term.

For the Gas Network Development Plan 2022–2032, the transmission system operators carried out the second WEB Market Survey. It was launched by the transmission system operators on 11 January 2021 for the 2022 Scenario Framework; project registrations were possible until 16 April 2021. More than 500 project registrations were received as part of this market survey. The project list was published in the 2022 Scenario Framework.

With the launch of the WEB Market Survey, the transmission system operators also published criteria for hydrogen and green gas projects that were applied in the 2022 Scenario Framework and the Gas Network Development Plan 2022–2032. In order for a project to be considered in the modelling for the Gas Network Development Plan 2022–2032, the BNetzA requires that the binding nature of the notified projects is increased. The transmission system operators have complied with this requirement by concluding MoUs. A project proposal is taken into account in the Gas Network Development Plan 2022–2032 if the MoU has been agreed with the transmission system operator by 1 October 2021 at the latest. This MoU is intended to confirm the actual intention to implement the project. On 25 November 2021, the transmission system operators published an updated project list on the FNB Gas website, showing the projects for which an MoU has been concluded [FNB Gas, SR 2021a].

The BNetzA confirmed the 2022 Scenario Framework on 20 January 2022 [BNetzA 2022]. In this confirmation, the BNetzA also referred to the consideration of the projects from the WEB Market Survey for hydrogen modelling in the Gas Network Development Plan 2022–2032 (cf. Chapter 8.1.2).

The following shows how many MoUs were concluded, which hydrogen capacities were registered within the framework of the MoUs and which hydrogen capacities are to be considered in the Gas Network Development Plan 2022–2032 following the confirmation of the 2022 Scenario Framework.

8.1.1 MoU agreements

In the 2022 Scenario Framework, the transmission system operators welcomed the active participation in the WEB Market Survey. The transmission system operators have classified the project registrations in the 2022 Scenario Framework into the following categories:

1 Projects for the years 2022–2050 of the project sponsors and distribution system operators with relevance for the transmission network,

2 Registrations of storage projects,

3 Registrations of other projects in the distribution network,

4 Registrations of projects from abroad,

5 Registrations of projects on the distribution network without relevance to the transmission network, and

6 Other project registrations (incomplete project registrations, zero reports and registrations that have not consented to publication).

For further hydrogen network planning at the transmission level, the conclusion of an MoU was planned for categories 1 and 2. The following table shows the number of WEB projects in these two categories for which an MoU was concluded.

Table 70: MoUs concluded for the project registrations of the WEB Market Survey

WEB project registrations	Description	Number of WEB project registrations	Number of WEB project registrations with MoU
Category 1	Projects for the years 2022–2050 of the project sponsors and distribution system operators with relevance for the transmission network	294	250
Category 2	Registrations of storage projects	7	7

Source: Transmission system operators

For 257 of the 301 WEB reports in categories 1 and 2 (around 85 %), an MoU could be concluded in accordance with the described procedure in the 2022 Scenario Framework. In addition, two MoUs were concluded for projects in category 5.

8.1.2 Results after conclusion of the MoU and after confirmation of the 2022 Scenario Framework

Conclusion of an MoU is a prerequisite for projects to be considered as input parameters in the Gas Network Development Plan 2022–2032. Moreover, in the confirmation of the 2022 Scenario Framework [BNetzA 2022], the BNetzA has set requirements for the consideration of WEB projects in the Gas Network Development Plan 2022–2032.

In the confirmation of the 2022 Scenario Framework, the transmission system operators are requested in accordance with Agenda Item 9 to only consider electrolysis projects and the associated hydrogen entry capacity and hydrogen entry quantity from 2029 one year later.

The background to this BNetzA requirement is the large number of electrolysis projects registered in the WEB Market Survey. The BNetzA states the following in its confirmation of the 2022 Scenario Framework:

'[...] A look at the total electrolysis capacity of projects with a concluded MoU in 2030 shows that this is significantly higher than the 10 GW proposed in the coalition agreement. [...] Considering the target value from the coalition agreement and the funding to be expected for such projects, the 10 GW electrolysis capacity for 2030 specified in the coalition agreement should therefore serve as a benchmark for infrastructure planning. In order to achieve this target, Agenda Item 9 obliges the transmission system operators, as part of the modelling of the hydrogen variant, for all projects from Appendix 2 that involve hydrogen injection via an electrolyser, to only apply the values planned for each year from 2029 for the electrolysis capacity as well as the coupled hydrogen entry capacity and hydrogen entry quantity per year in the respective subsequent year' [BNetzA 2022].

After conclusion of the MoU and after implementation of the requirements of the confirmation of the 2022 Scenario Framework by the BNetzA, the following electrolysis capacities as well as quantities and capacities for hydrogen are the result. Only the period up to 2032 is relevant for the hydrogen variant in the Gas Network Development Plan 2022–2032. The fields with differences after conclusion of the MoU and after confirmation of the 2022 Scenario Framework by the BNetzA are marked in grey.

Table 71: Results after MoU and after confirmation of the 2022 Scenario Framework

	Unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2040*	2050*
Results after MoU conclusion														
Electrolysis capacity	GW_e	0.2	0.5	0.9	2.6	3.9	4.8	7.4	9.4	18.3	20.5	22.7	37.7	46.0
H2 entry volume per year	GW_e	0.7	1.4	2.5	9.9	17.3	67.0	83.6	100.3	155.9	171.5	183.9	361.7	641.2
H2 entry capacity per year	GW_e	0.1	0.4	0.7	1.9	3.3	9.7	13.8	16.5	27.8	30.8	33.8	69.5	114.7
H2 exit volume per year	TWhth	4.5	6.4	10.3	23.1	30.9	49.2	55.1	75.5	125.6	155.5	171.6	238.8	297.3
H2 exit capacity per year	GW_e	0.9	1.2	2.3	4.7	6.1	9.3	10.5	13.7	25.2	31.3	35.0	51.4	71.2
H2 additional capacity demand	GW_e	0.8	0.8	1.6	2.8	2.8	−0.4	−3.3	−2.8	−2.6	0.4	1.2	−18.1	−43.5
Results after confirmation of the 2022 Scenario Framework by the BNetzA														
Electrolysis capacity	GW_e	0.2	0.5	0.9	2.6	3.9	4.8	7.4	7.4	9.4	18.3	20.5	37.7	46.0
H2 entry volume per year	TWhth	0.7	1.4	2.5	9.9	17.3	67.0	83.6	94.2	130.5	166.2	178.5	361.7	641.2
H2 entry capacity per year	GW_e	0.1	0.4	0.7	1.9	3.3	9.7	13.8	15.0	21.5	29.2	32.2	69.5	114.7
H2 exit volume per year	TWhth	4.5	6.4	10.3	23.1	30.9	49.2	55.1	75.5	125.6	155.5	171.6	238.8	297.3
H2 exit capacity per year	GW_e	0.9	1.2	2.3	4.7	6.1	9.3	10.5	13.7	25.2	31.3	35.0	51.4	71.2
H2 additional capacity demand	GW_e	0.8	0.8	1.6	2.8	2.8	−0.4	−3.3	−1.3	3.7	2.1	2.8	–	–

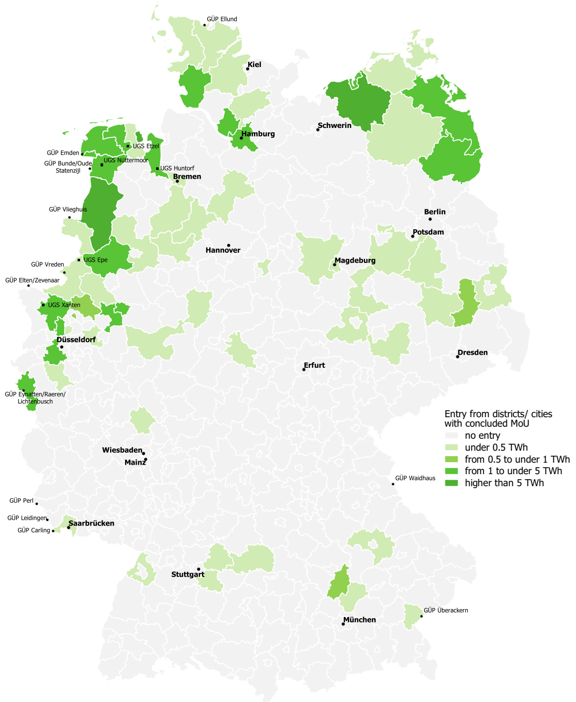
* The years 2040 and 2050 are not relevant for the modelling of the Gas Network Development Plan 2022–2032; therefore, they were not confirmed by the BNetzA.

Source: Transmission system operators

In accordance with the BNetzA's specifications, the realisation or expansion of electrolysis plants is postponed by one year from 2029 onwards; consequently, the electrolysis capacities in 2028 and 2029 are identical. This shift continues until 2032. The entry quantities and capacities of these electrolysis projects slow down from 2029 to 2032. For the modelling year 2032, MoU projects with an electrolysis capacity of 22.7 GW_e are available; after the BNetzA's confirmation, this value is reduced to 20.5 GW_e . For 2030, electrolysis projects with a capacity of around 9.4 GW_e are taken into account. This value is in the order of magnitude of the target value of 10 GW_e from the current coalition agreement.

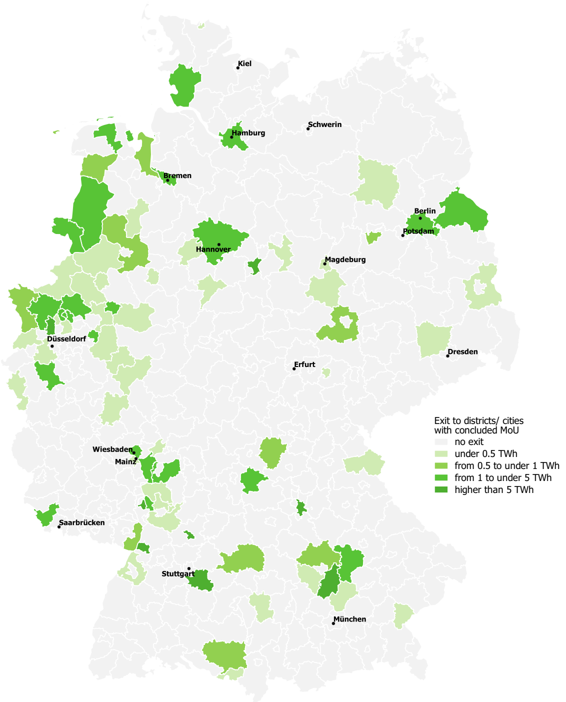
The following figures also show the regional distribution of the registered hydrogen projects for 2032 (quantities for injection and withdrawal) of the project registrations with an MoU and after confirmation by the BNetzA.

Figure 42: Registered WEB hydrogen entries with MoU in 2032



Source: Transmission system operators and other potential H2 system operators, schematic diagram

Figure 43: Registered WEB hydrogen exits with MoU in 2032



Source: Transmission system operators and other potential H2 system operators, schematic diagram

8.2 Hydrogen modelling

The following chapter first touches on the process of joint hydrogen modelling of transmission system operators and other potential hydrogen network operators (cf. Chapter 8.2.1). Chapter 8.2.2 describes the pipeline network infrastructure registrations of other potential hydrogen network operators and transmission system operators for the hydrogen network. The basic procedure of the individual process steps is described in Chapter 8.2.3. Chapters 8.2.4 to 8.2.7 describe the modelling preparations, present the agreed scenarios and derive the hydrogen balances as well as the additional hydrogen demand for the years 2027 and 2032. Chapter 8.2.8 is dedicated to the hydrogen subnetworks.

8.2.1 Process of joint hydrogen modelling by transmission system operators and other potential hydrogen network operators

In order to exploit existing infrastructure potential as early as possible, the transmission system operators have invited other potential hydrogen network operators via several calls to actively participate in the modelling of a national hydrogen network. This is another way to ensure that as much of the existing infrastructure as possible is included in the hydrogen network modelling process.

On 5 October 2021, the transmission system operators called on the operators of pipeline network infrastructure for the first time to register existing or specifically planned pipeline systems for the transport of hydrogen. A total of 22 pipeline infrastructure registrations were submitted in this survey.

Due to additional parties in the market expressing interest, on 17 December 2021, the transmission system operators extended their call for registration of infrastructures for consideration in the hydrogen variant of the Gas Network Development Plan 2022–2032 until 18 March 2022. The registered pipeline network infrastructures were considered in the hydrogen variant of the Gas Network Development Plan 2022–2032. The results of both surveys can be found in Chapter 8.2.2.

Part of the survey on 17 December 2021 also extended an invitation to current and potential hydrogen network operators to work together with the transmission system operators on a transparent process for the joint development of the future hydrogen network by mid-March 2022. Twelve companies accepted this invitation by 31 January 2022. The process was completed in mid-March with a mutually satisfactory result for all participants, which is described in detail in Chapter 8.2.3.

The process for the hydrogen network modelling began on 21 March 2022 with the involvement of the participants in the process development as well as the pipeline network infrastructure operators who reported the corresponding infrastructure within the framework of the aforementioned surveys.

The development of the hydrogen variant and the associated hydrogen modelling of the Gas Network Development Plan 2022–2032 was carried out by all interested prospective hydrogen network operators. In addition to the transmission system operators, 18 other potential hydrogen network operators participated in the hydrogen modelling. They are: Avacon Netz GmbH, Bayernwerk Netz GmbH, Creos Deutschland Wasserstoff GmbH i.G., e-netz Südhessen AG, E.ON SE, Evonik Operations GmbH, EWE NETZ GmbH, Gasnetz Hamburg GmbH, N-ERGIE Netz GmbH, NBB Netzgesellschaft Berlin-Brandenburg mbH & Co. KG, Netz Leipzig GmbH, Netze BW GmbH, Nord-West-Oelleitung GmbH, Ruhr Oel GmbH bp Gelsenkirchen, SachsenNetze GmbH, SHNG Schleswig-Holstein-Netz GmbH, TanQuid GmbH & Co. KG and Westnetz GmbH.

Transmission system operators, pipeline and infrastructure companies and distribution system operators, as well as a few others, were involved in the modelling and data provision. Therefore, it was crucial to hire a consulting company that supports the transmission system operators and the other potential hydrogen network operators and carries out evaluations. The consulting company Prognos was commissioned as a neutral intermediary for all project participants to guarantee confidentiality of certain information from the registered projects of the WEB Market Survey.

8.2.2 Notifications of pipeline network infrastructure of other potential hydrogen network operators and transmission system operators for the hydrogen network

Last year, the transmission system operators called on pipeline network infrastructure operators to register existing and specifically planned pipeline systems for the transport of hydrogen for consideration in the hydrogen variant of the Gas Network Development Plan 2022–2032.

With this invitation, the transmission system operators wanted to ensure that as many of the transport requirements resulting from the WEB Market Survey as possible can be provided efficiently at an early stage. The responses, together with the transmission system operators' pipeline network sections that can be converted to hydrogen, form the basis for the potential hydrogen network modelling.

By 18 March 2022, the transmission system operators had received 218 relevant registrations for modelling up to the year 2032. The detailed results of the existing and specifically planned pipeline systems for transport of hydrogen for consideration in the hydrogen variant of the Gas Network Development Plan 2022–2032 are available for download on the FNB Gas website [FNB Gas 2022].

There are 44 registrations from other potential hydrogen network operators. The transmission system operators, for their part, have submitted 174 pipeline projects. In total, pipelines with a length of around 6,365 km have been registered. Of these, 68 % (4,352 km) were registered as conversion pipelines. The share of newly constructed pipelines amounts to 32 % (2,013 km). The pipelines are distributed over the diameter classes shown in Table 72. The reported operating pressures range from 10 to 100 bar.

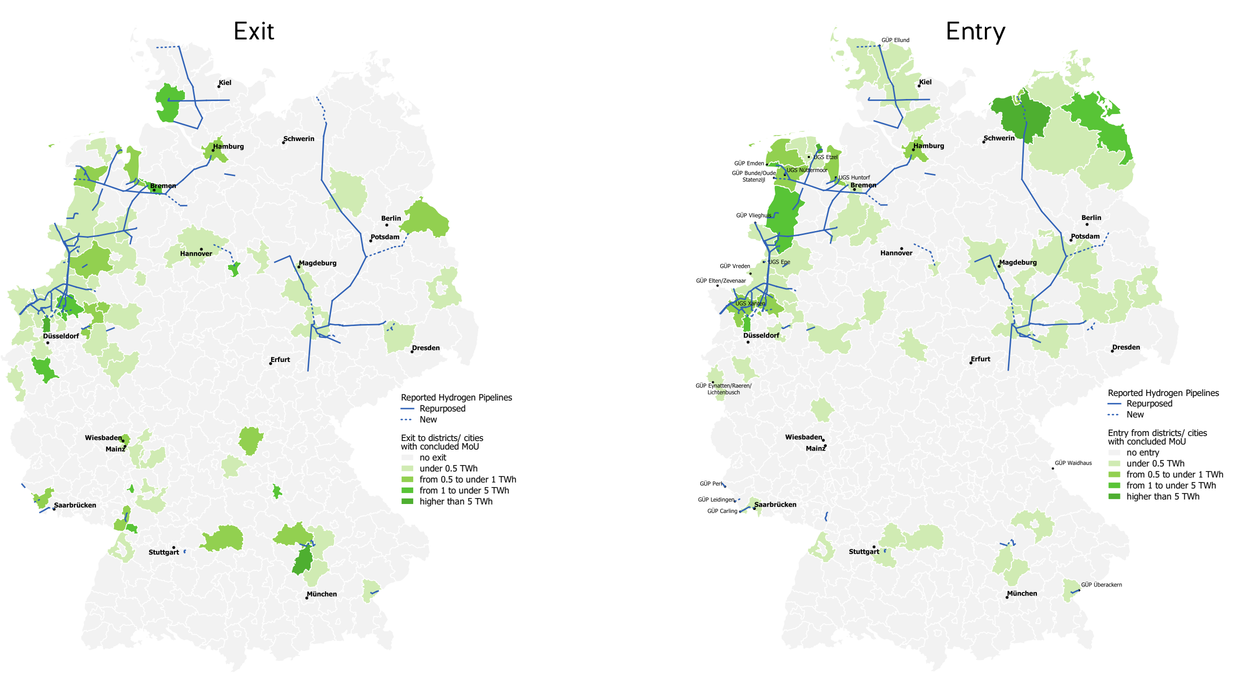
Table 72: Registered pipelines per diameter class

Class	A	B	C	D	E	F	G
Nominal width DN [mm]	>1,000	700–999	500–699	350–499	225–349	110–224	up to 109
Length [km]	571.4	2,307.5	1,733.6	884.5	374.1	474.7	19.4

Source: Transmission system operators and other potential H2 network operators

For the modelling year 2027, the registered pipeline network infrastructures result in the hydrogen network shown in Figure 44.

Figure 44: Hydrogen networks 2027 based on the registered pipeline network infrastructure

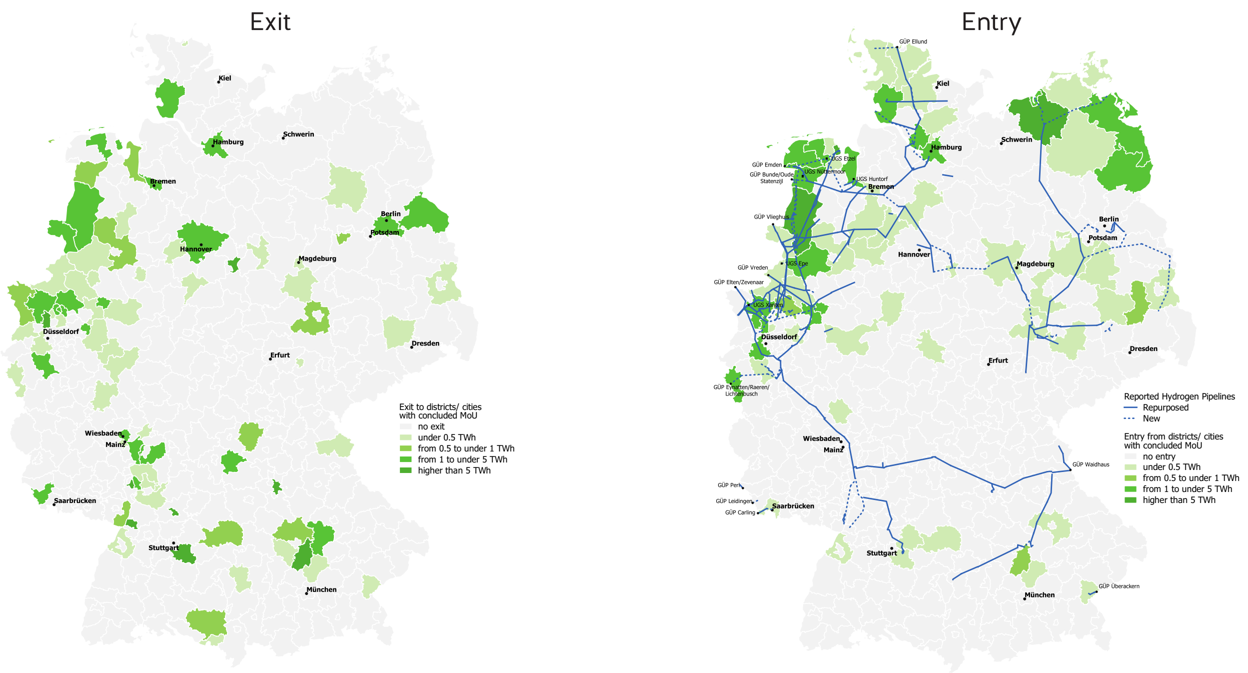


Source: Transmission system operators and other potential H2 system operators, schematic diagram

Based on the registered pipeline network infrastructure, there is still no coherent Germany-wide hydrogen network in 2027. In the following sub-chapters, the subnetworks North, North-West and East are outlined and presented in the context of balancing and hydrogen source distribution.

For the modelling year 2032, the interconnected Germany-wide hydrogen network presented in Figure 45 is the result of the registered pipeline network infrastructures.

Figure 45: Hydrogen network 2032 based on the registered pipeline network infrastructure

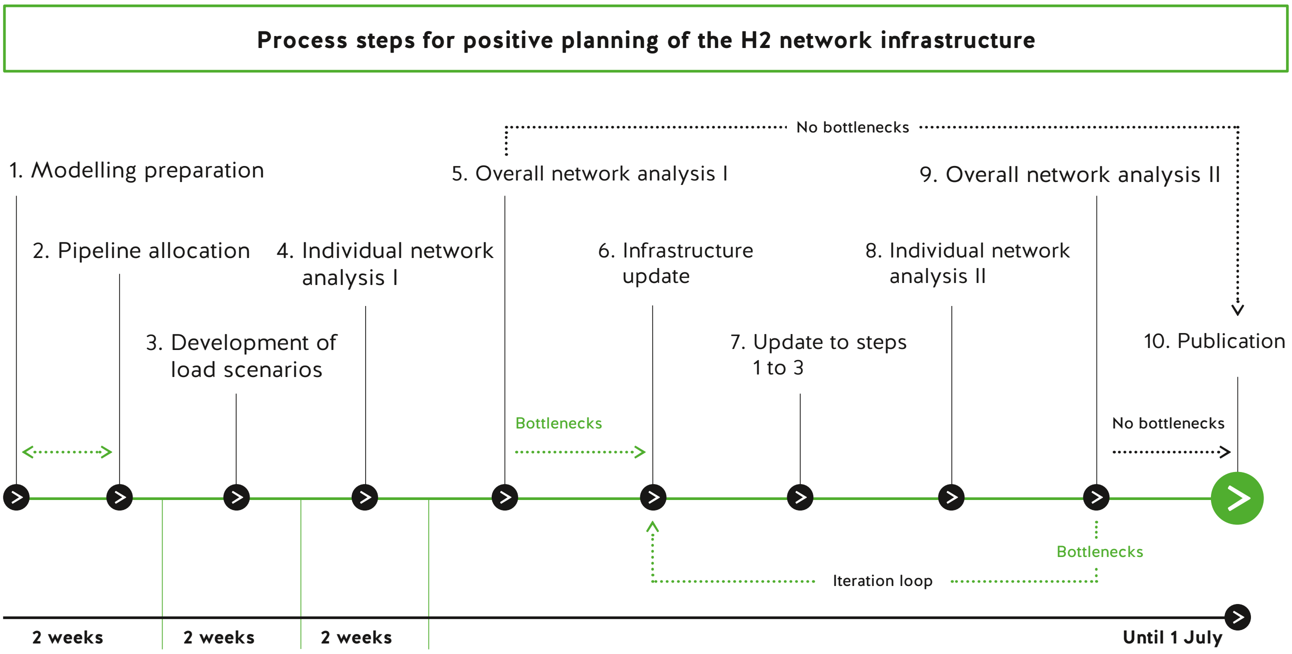


Source: Transmission system operators and other potential H2 system operators, schematic diagram

8.2.3 Basic procedure

The entire process flow from modelling preparation to publication of the results is shown in schematic form in Figure 46:

Figure 46: Process steps for positive planning of the hydrogen network infrastructure



Source: Transmission system operators and other potential H2 network operators

Description of the individual process steps

1. Modelling preparation (cf. Chapter 8.2.4)

- For demands for which an MoU has been concluded with a transmission system operator (Appendix 2 [FNB Gas, SR 2021b]), the transmission system operator identifies a suitable pipeline (its own property or another party's property) at which a network connection point should be considered for one or more MoUs. The following objective technical criteria are decisive for the selection:
  - Distance to the network connection point,
  - Consideration of spatial planning resistance such as crossing of nature conservation areas, bodies of water, military areas, etc.
  - Capacity of alternatively located infrastructure, if of importance for network planning.
- Each transmission system operator reports the network connection points with the respective assigned MoUs to a neutral service provider (Prognos).
- Prognos compiles a list of all network connection points with details of the total entry and exit capacities per network connection point. The list is available to all potential hydrogen network operators involved in modelling.
- In the event of connection to the infrastructure of another transmission system operator, the latter can reject this connection within one week with proper justification.
- The location of the network connection points are made available to all potential hydrogen network operators involved in the modelling in a node/edge list to be drawn up by the transmission system operators.

- If it is not possible to allocate entry or exit demands to specific pipelines, these demands are allocated to the rural or urban district to which they are geographically allocated in Appendix 2 [FNB Gas, SR 2021b].
- Districts for which there are still demands from Appendix 2 [FNB Gas, SR 2021b] and which could not be allocated to a network connection point are included in a 'watch list'. This watch list is available to all potential hydrogen network operators involved in modelling.

2. Pipeline allocation (cf. Chapter 8.2.4)

- If two or more transport infrastructures are similarly suited to fulfilling the same transport task, they are considered on equal terms. Among other factors, orientation cost rates could be used for decision-making. For example, the orientation cost rates for the transport infrastructure used in the Gas Network Development Plan are suitable for this purpose. They are to be expanded by suitable factors to take the fundamental additional or reduced costs for hydrogen-compatible components into account.
- The owners of pipelines that are to be converted to hydrogen can nominate themselves for implementation.
- For projects that already exist today (e.g. IPCEI), the applicants can nominate themselves for implementation (nomination results from funding application, etc.).
- Newly constructed pipelines resulting from the ongoing process of hydrogen network planning 2022–2032 can generally be implemented by any company. All interested parties for the construction are named. If there are several interested parties, the allocation remains open within the framework of this Network Development Plan process.

3. Development of load scenarios (cf. Chapters 8.2.5, 8.2.6 and 8.2.7)

- Load scenarios are required to map and simulate different load flow situations.
- The load scenarios were prepared by the transmission system operators and discussed; if necessary, they were also further developed with all other potential hydrogen network operators.
- Prognos prepared the balances for the defined load scenarios based on Appendix 2 [FNB Gas, SR 2021b] and the list of network connection points and determined the balance surplus or shortfall in the scenarios and modelling years.
- In cases of balance shortfall, the transmission system operators develop proposals for balance compensation ('hydrogen source distribution'). These proposals are discussed with all other potential hydrogen network operators and developed further if necessary.

4. Individual network calculation I (cf. Chapter 8.4)

- Voluntary individual assessment (calculation) by the potential hydrogen network operators participating in the modelling to determine whether the infrastructure considered so far is sufficient in their opinion.
- The assessment is based on the available infrastructure data, demand and load scenarios.

5. Overall network analysis I (cf. Chapter 8.4)

- Joint summary of the feedback and interpretation of the results.
- If the infrastructure is sufficient, proceed with step 10.

6. Infrastructure update (cf. Chapter 8.4)

- If the infrastructure from step 5 is not sufficient, additional pipelines and compressors can be brought in by the potential hydrogen network operators involved in the modelling to supply the districts included in the watch list in step 1 or to eliminate bottlenecks.
- In general, existing pipelines as well as newly constructed pipelines, regulators, valves or compressors can be considered.
- The information on the newly introduced pipelines and compressors is available to all potential hydrogen network operators involved in the modelling.

7. Update to steps 1 to 3 (cf. Chapter 8.4)

- Based on the infrastructure data provided before the start of the process and the additional infrastructure from step 6, the districts with demand that cannot be reached are identified.
- The watch list from step 1 is updated and made available to all potential hydrogen network operators involved in the modelling.
- New network connection points and allocation of MoUs to them are added in Appendix 2 [FNB Gas, SR 2021b].
- The balances resulting from the load scenarios and the hydrogen source distribution from step 3 are adjusted if necessary.

8. Individual network calculation II (cf. Chapter 8.4)

- Voluntary individual assessment (calculation) of step 6 by the potential hydrogen network operators participating in the modelling to determine whether the infrastructure considered so far is sufficient in their opinion.
- The assessment is again based on the available infrastructure data, demands and load scenarios.

9. Overall network analysis II (cf. Chapter 8.4)

- Joint summary of the feedback and interpretation of the results.
- If the infrastructure is sufficient, proceed with step 10.
- If the infrastructure is not sufficient, the process starts again with step 5.

10. Publication (cf. Chapter 8.4)

- The results of the hydrogen modelling are published in the Gas Network Development Plan 2022–2032.

The results of the individual process steps are described below.

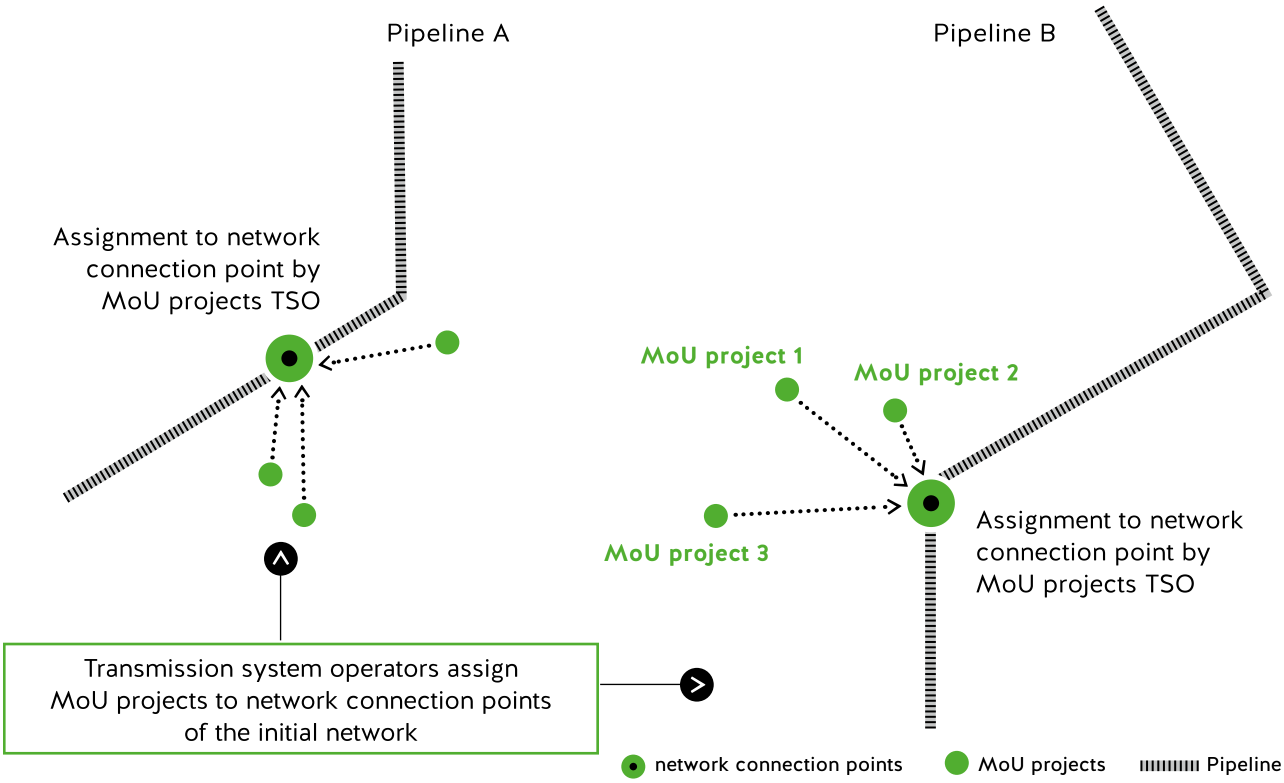
8.2.4 Modelling preparation and pipeline allocation

Prior to the start of modelling, a data exchange took place between the transmission system operators and the other potential hydrogen network operators. This data exchange included

- the entry and exit requirements from the WEB Market Survey published in the updated Appendix 2 [FNB Gas, SR 2021b] dated 25 November 2021, for which an MoU was concluded,
- the H2 inital network 2030 of the Gas Network Development Plan 2020–2030 (publication in May 2020),
- the result of the first pipeline data survey (publication in December 2021), and
- the result of the second pipeline data survey including the reported pipeline data from the transmission system operators (publication on 29 March 2022).

In light of contractual confidentiality obligations of the transmission system operators vis-à-vis the project sponsors, the transmission system operators and other potential hydrogen network operators are not allowed to communicate certain detailed information from the surveyed data with each other. The transmission system operators and the other potential hydrogen network operators have therefore agreed to have their respective surveys anonymised by a neutral consulting firm. That company also summarises the information in a manageable way for network planning. For this purpose, network connection points were formed within the network. These combine the data from several projects (entry and exit) located in the vicinity of a registered/introduced pipeline. These network connection points must be located on the installed pipeline. To enable network modelling, it is necessary to specify the position of the network connection point on the pipeline. For this purpose, length specifications of defined start and end nodes on an installed pipeline up to the installed network connection point, which were recorded in a node/edge list, are suitable.

Figure 47: Creation of network connection points through several MoU projects



Source: Transmission system operators and other potential H2 network operators

8.2.5 Scenarios

A review of scenarios is necessary for the design of the hydrogen network for strongly changing load situations. Based on the results of the WEB Market Survey with concluded MoU published in Appendix 2 [FNB Gas, SR 2021b], the transmission system operators, in coordination with the other potential hydrogen network operators, have defined five scenarios for preparation of the hydrogen balances in addition to the results of the WEB Market Survey according to Appendix 2 [FNB Gas, SR 2021b] (Scenario 0), which are described below.

Key assumptions for the load situations are either the existence of an electricity surplus, so that hydrogen can be produced, or a power shortage ('Dunkelflaute') resulting in low hydrogen production from electrolysers.

Entry projects are divided into volatile (less than 5,500 full utilisation hours) and non-volatile projects (more than 5,500 full utilisation hours). The classification is based on an evaluation of the full utilisation hours of the entry projects reported in accordance with Appendix 2 [FNB Gas, SR 2021b]. For the year 2032, the average number of utilisation hours of the entry projects was around 5,000 full utilisation hours, with around 1/3 of the projects having more than 6,000 full utilisation hours and around 2/3 having no more than 5,000 full utilisation hours. With that in mind, a value of 5,500 full utilisation hours was used as the limit for differentiation.

Scenario 1: PtG

In the Power to Gas (PtG) scenario, surplus electrical energy is available. It can be used to produce hydrogen and inject it into the transmission network and storage facilities. Additional entry capacities from storage facilities are not required to meet demand. As there is surplus electricity, no hydrogen-based electricity generation is assumed in this scenario.

- Entry capacity: Entry projects 100 %, storage 0 %
- Exit capacity: Power plants 0 %, storage 100 %

Scenario 2: 'Dunkelflaute'

In this scenario, there is a power shortage due to calm or low winds and simultaneous darkness; additionally, no hydrogen is produced from electrolysers or via volatile entry projects that would otherwise be fed into hydrogen networks. Additional entry capacities from storage facilities and additional hydrogen-based electricity generation is required in this scenario.

- Entry capacity: Volatile entry projects 0 %, non-volatile entry projects 100 %, storage 100 %
- Exit capacity: Power plants 100 %, storage 0 %

Scenario 3: PtG + 50 % large-scale projects

The scenario 'PtG + 50 % large-scale projects' assumes an electricity surplus as in scenario 1. However, in contrast to scenario 1, only 50 % of the entry capacity from large-scale projects (capacity > 1 GW) is used. As in scenario 1, additional entry capacities from storage facilities and additional hydrogen-based electricity generation are not required.

- Entry capacity: Entry projects > 1 GW: 50 %, others 100 %, storage 0 %
- Exit capacity: Power plants 0 %, storage 100 %

Scenario 4: 'Dunkelflaute' + 50 % large-scale projects

As in Scenario 2, the 'Dunkelflaute + 50 % large-scale projects' scenario assumes a power shortage due to calm or low winds and simultaneous darkness and no hydrogen generation from electrolysers or via volatile entry projects. Furthermore, in contrast to scenario 2, 50 % of the hydrogen produced from large-scale projects (capacity > 1 GW) is used for network entry. Additional entry capacities from storage facilities and additional hydrogen-based electricity generation are required in this scenario.

- Entry capacity: non-volatile entry projects > 1 GW: 50 %, other non-volatile entry projects 100 %, volatile entry projects 0 %, storage 100 %
- Exit capacity: Power plants 100 %, storage 0 %

Scenario 5: Partial load case

As in scenario 1, the 'partial load case' scenario assumes the existence of surplus electrical energy so that hydrogen can be produced and fed into the transmission network and storage facilities. Additional entry capacities from storage facilities and additional hydrogen-based electricity generation are not required. The remaining exits are set at 60 % in the assumed partial load case in order to reflect the case of temporarily lower hydrogen use.

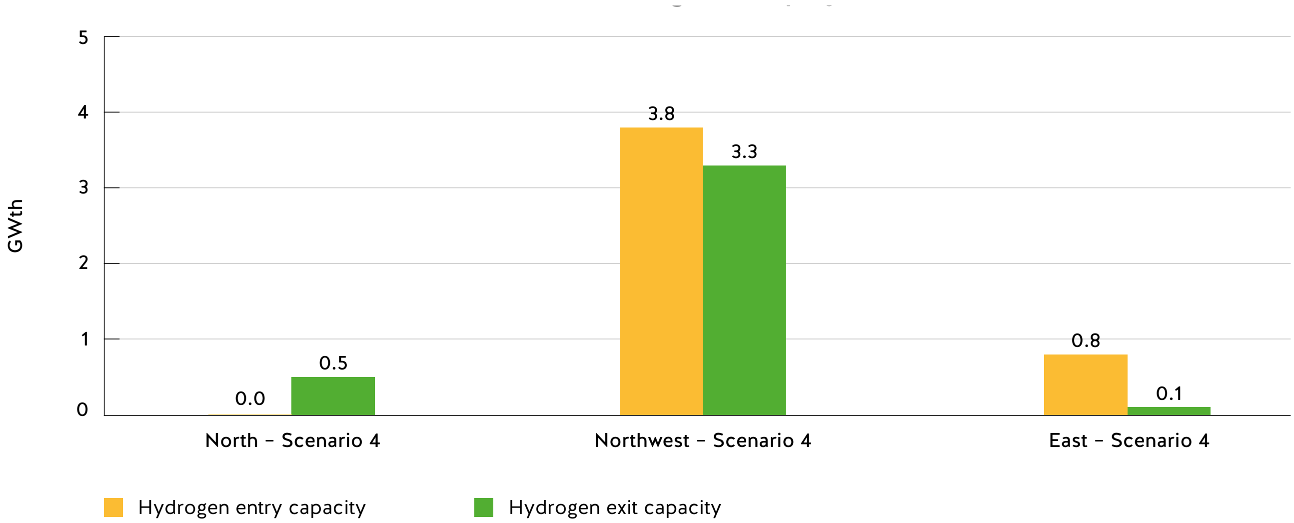
- Entry capacity: Entry projects 100 %, storage 0 %
- Exit capacity: Power plants 0 %, storage 100 %, other exits 60 %

8.2.6 Hydrogen balances 2027 and 2032

Hydrogen balance 2027

The respective entry and exit capacities for the subnetworks North, North-West (NW) and East are shown only for Scenario 4 ('Dunkelflaute' + 50 % large-scale projects) in Figure 48, as this scenario has the lowest entry capacities and thus the largest balance shortfall.

Figure 48: Hydrogen balance – entry/exit capacities in 2027 for the subnetworks North, North-West (NW) and East for the 'Dunkelflaute + 50 % large-scale projects' scenario'



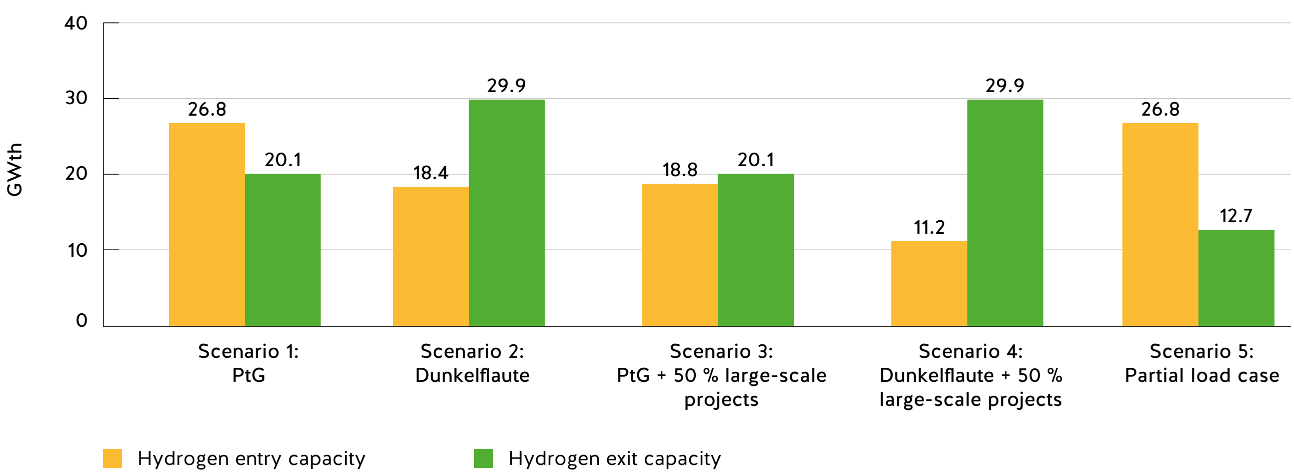
Source: Transmission system operators and other potential H2 network operators

There is a balance shortfall in the North subnetwork and a balance surplus in the North-West and East subnetworks.

Hydrogen balance 2032

The respective entry and exit capacities in the corresponding scenarios for the largely interconnected Germany-wide hydrogen network are presented in Figure 49.

Figure 49: Hydrogen balance – entry/exit capacities 2032 for the Germany-wide network



Source: Transmission system operators and other potential H2 network operators

The scenarios represent a broad spectrum of balance surplus and shortfalls, with the balance shortfall being greatest in scenario 4 ('Dunkelflaute' + 50 % large-scale projects).

Beyond that, some subnetworks remain that need to be looked at individually (cf. Chapter 8.2.8).

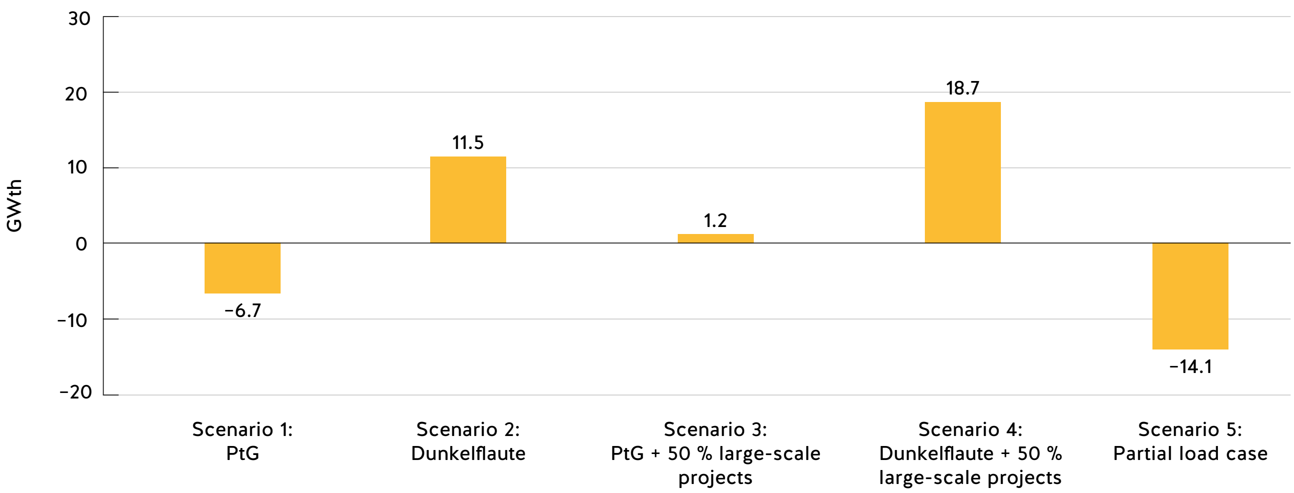
8.2.7 Additional hydrogen demand in 2027 and 2032 for Germany

Modelling year 2032

In the 'Dunkelflaute + 50 % large-scale projects' scenario, the additional hydrogen demand in Germany is around 18.7 GW.

Since it can be assumed that the German entry potential was reported by the project developers and storage operators in the WEB Market Survey, the additional demand must be covered by imports.

Figure 50: Hydrogen balances – entry/exit capacities 2032 by scenario



Source: Transmission system operators and other potential H2 network operators

The following information sources were analysed to assess and evaluate the neighbouring potential countries for hydrogen imports:

- The comments submitted during the consultation on the Scenario Framework of the Gas Network Development Plan 2022–2032,
- The project registrations from abroad submitted as part of the WEB Market Survey,
- Information from existing studies on potential supply sources, in particular the European Hydrogen Backbone Initiative (EHB) study,
- Information from discussions with potential project sponsors and foreign transmission system operators,
- Information from press releases and other publications.

Based on this information, the following assessments were made with regard to consideration of neighbouring countries in the hydrogen source allocation:

Netherlands
According to the consultation statement by GTS, up to 5.9 GWh/h can be provided from the Netherlands via the cross-border interconnection points of Oude Statenzijl, Vlieghuis and Zevenaar in 2032 for the German market without additional network expansion in the Netherlands. The cross-border interconnection points of Oude Statenzijl, Vlieghuis and Zevenaar are therefore included in the hydrogen source distribution.

Belgium
According to the consultation statement by Fluxys SA, hydrogen of up to 4 GWh/h can be supplied to the German market from Belgium via the cross-border interconnection point of Eynatten from 2030 onwards. The Eynatten cross-border interconnection point is therefore included in the H2 source distribution.

France
According to the consultation statement by GRTgaz, hydrogen of up to 55 TWh/a can be provided from France starting in the mid-2030s, including via hydrogen imports from Spain, but also through hydrogen production in France. As the modelling years 2027 and 2032 are considered in the current Network Development Plan and, according to the statement by GRTgaz, hydrogen from France is not yet available for export – apart from regional projects ('mosaHYc') – the cross-border interconnection point of Medelsheim is not included in the hydrogen source distribution in the current Network Development Plan.

Czech Republic
According to the statement by Net4Gas, hydrogen from Ukraine and Slovakia as well as hydrogen from North Africa can be made available for the German market via the Czech transport system and the Italian supply route. The EHB classifies North Africa and Ukraine as important potential hydrogen supply countries outside the EU based on their high PV potential. Therefore, imports from North Africa and Ukraine (or South Eastern Europe) via the Waidhaus cross-border interconnection point are included in the hydrogen source distribution.

Austria
According to the statement by GCA, significant hydrogen volumes can be provided at the cross-border interconnection points of Überackern and Oberkappel by 2030 via the hydrogen infrastructure required for transport. The EHB classifies North Africa and Ukraine as important potential hydrogen supply countries outside the EU based on their high PV potential. Hydrogen from Ukraine as well as hydrogen from North Africa via the Italian supply route can thus be made available for the German market. Therefore, imports from North Africa and Ukraine (or South Eastern Europe) via the cross-border interconnection point of Überackern are assumed for the supply of the Altötting subnetwork.

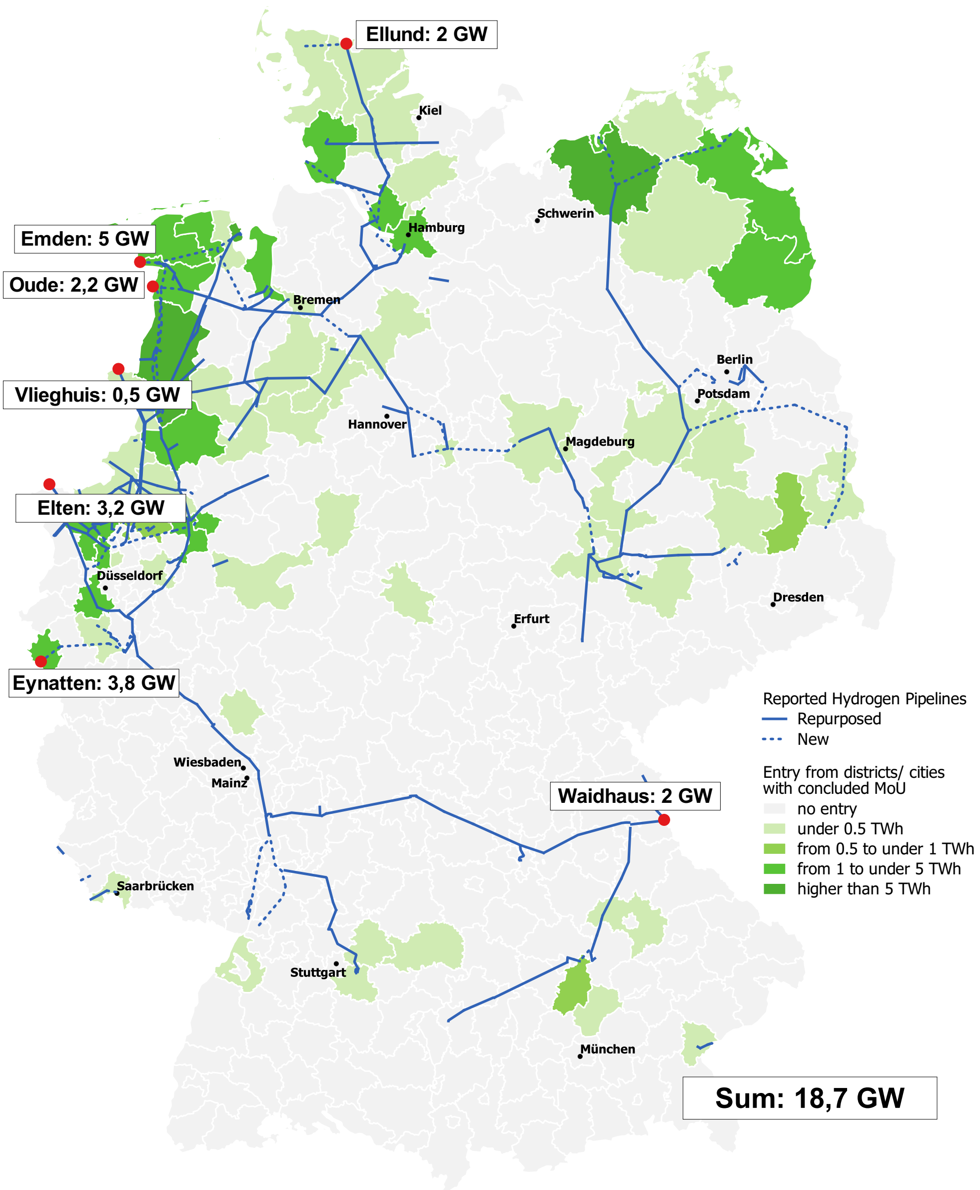
Denmark
In the WEB Market Survey, the project developer registered the project 'Green Hydrogen Hub Denmark' with entry capacities of 245 MW in 2027 and 700 MW in 2032. In addition to hydrogen production via electrolysis, the project includes hydrogen storage. Furthermore, the 'North Sea Wind Power Hub' project with the participation of the Danish operator energinet was registered in the WEB Market Survey, which also includes potential hydrogen supplies to Denmark from wind farms planned in the North Sea. Therefore, imports from Denmark via the cross-border interconnection point of Ellund are included in the hydrogen source distribution.

Norway
According to the statement by the Norwegian operator Equinor, it sees a demand of 0.4 GW in 2027 and 2.5 GW in 2032 for the transport of hydrogen from Norway via the Netherlands to Germany. Moreover, Equinor states that the possibility of importing hydrogen from Norway to Germany via converted existing or new pipelines or via blending is being investigated. In the coming decade, around 2 million tonnes (approx. 79 TWh) of hydrogen per year could be imported via this route. Imports from Norway via the border crossing point of Emden are therefore included in the hydrogen source distribution.

To cover the additional demand of 18.7 GW in 2032 resulting from the scenario 'Dunkelflaute + 50 % large-scale projects', the transmission system operators apply the following capacity provisions from neighbouring countries:

- Denmark: 2.0 GW (Basis: WEB reports 'Green Hydrogen Hub Denmark' and 'North Sea Wind Power Hub')
- Norway: 5.0 GW (basis: statement by Equinor)
- Netherlands: 5.9 GW (basis: statement by GTS)
- Belgium: 3.8 GW (basis: statement by Fluxys)
- Czech Republic: 2.0 GW (basis: statement by NEt4Gas)

Figure 51: Hydrogen source distribution result for the year 2032

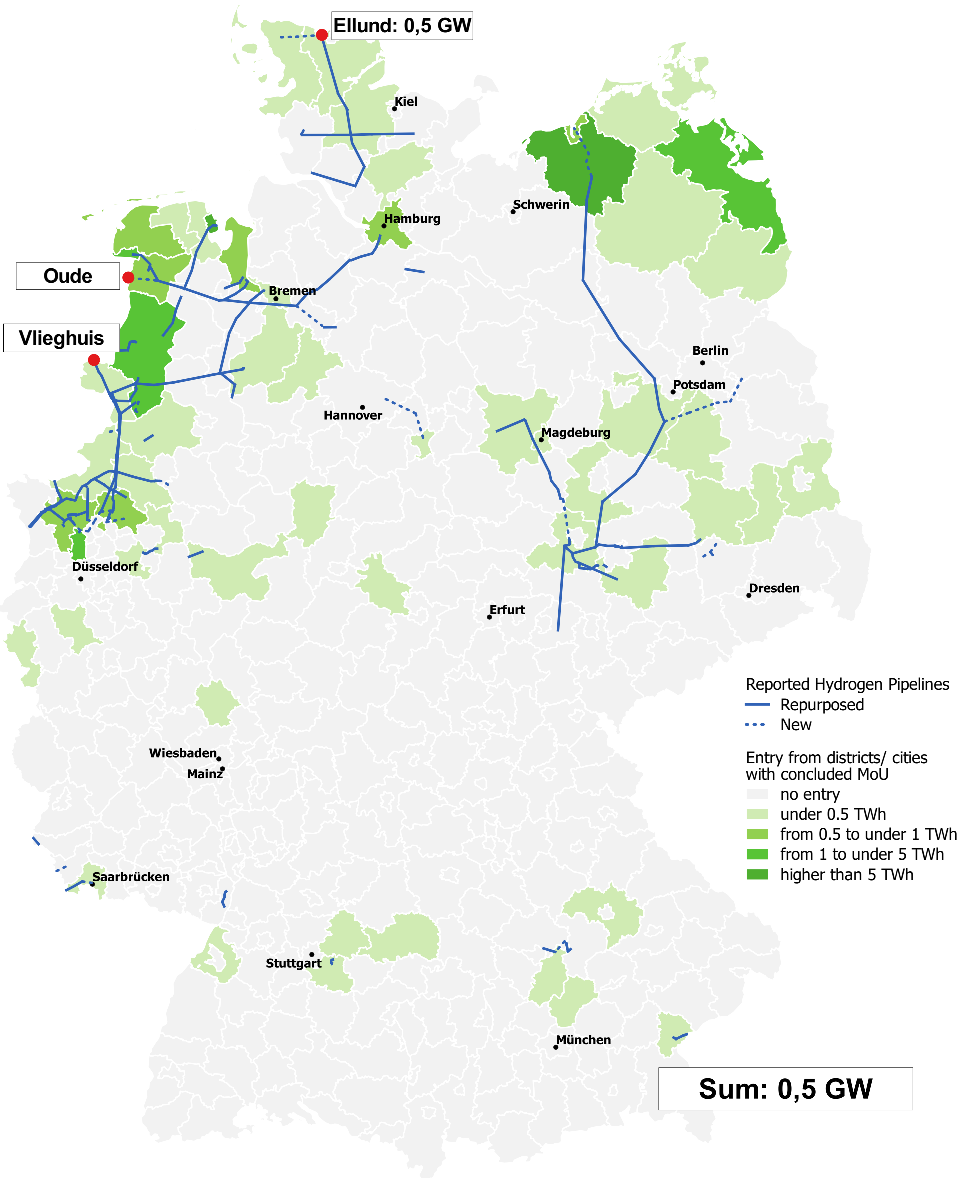


Source: Transmission system operators and other potential H2 system operators, schematic diagram

Modelling year 2027

The North subnetwork has a balance shortfall of around 0.5 GW, while the other two subnetworks, North-West and East, have a balance surplus. As the North subnetwork is connected to Denmark via the cross-border interconnection point of Ellund, the coverage of the additional hydrogen demand via Denmark based on the WEB report 'Green Hydrogen Hub' (245 MW) and the WEB report of the project 'North Sea Wind Power Hub' is assumed.

Figure 52: Result of hydrogen source distribution for the North subnetwork in 2027



Source: Transmission system operators and other potential H2 system operators, schematic diagram

8.2.8 Further subnetworks

For the years 2027 and 2032, additional subnetworks were modelled, individually examined and subjected to a balance analysis and a fluid mechanics analysis.

For the majority of these subnetworks, specific projects with entry and exit requirements already exist and MoUs have already been submitted as part of the WEB Market Survey. The subnetworks form the basis of local/regional focal points of demand for the market ramp-up of hydrogen. In addition to conversion measures from methane pipelines to hydrogen, new construction measures such as hydrogen pipelines and GPCM stations are needed for this scenario.

For the Germany-wide supra-regional hydrogen transmission network in 2032 and for the three larger North, North-West and East subnetworks in 2027, registrations from foreign project sponsors, producers and transmission network operators were taken into account in order to even out the hydrogen quantity balance via source distribution. Specific quantities can be allocated to smaller subnetworks through project reports from neighbouring countries.

Subnetworks in 2027

Table 73 lists the subnetworks for the year 2027.

Table 73: Allocation of the subnetworks in 2027 to the federal states

Subnetworks in 2027	Federal state/states
Altötting	Bayern
Cloppenburg-Emsland	Niedersachsen
Emsland	Niedersachsen
Ennepe-Ruhr-Kreis	Nordrhein-Westfalen
Esslingen	Baden-Württemberg
Germersheim	Baden-Württemberg
Hannover-Peine	Niedersachsen
Kelheim-Eichstätt	Bayern
Kreis Steinfurt	Nordrhein-Westfalen
Kreis Wesel	Nordrhein-Westfalen, Niedersachsen
Lüneburg	Niedersachsen
Merzig-Wadern	Saarland
Nord-West	Nordrhein-Westfalen, Niedersachsen
Ost	Mecklenburg-Vorpommern, Sachsen-Anhalt, Thüringen, Sachsen and Brandenburg
Pinneberg (offshore)	Schleswig-Holstein
Regionalverband Saarbrücken	Saarland
Saarlouis	Saarland
Nord	Schleswig-Holstein

Source: Transmission system operators and other potential H2 network operators

- The three larger North, North-West and East subnetworks were described in detail in the previous chapters.
- The subnetworks in Saarland (Merzig-Wadern, Saarbrücken Regional Association and Saarlouis) are connected within the framework of the cross-border project ‘mosaHYc’ in France and can be supplied through this system.
- For the Altötting subnetwork in Bayern, the connection to the Austrian cross-border interconnection point is projected for the years 2027 and 2032. Specifically, the needs arising from industry in the Burghausen chemical triangle are to be covered by this. Moreover, following the WEB Market Survey for the Altötting subnetwork, further hydrogen requirements have already been requested that have not yet been reflected in the hydrogen modelling in terms of capacity.

- Within the Kehlheim-Eichstätt subnetwork near Ingolstadt in Bayern, the participating industrial locations of the 'HyPipe Bavaria/H2-Cluster Ingolstadt' project will be interconnected through a regional hydrogen transmission network by 2027. By 2027, the subnetwork will not yet be connected to the overarching Germany-wide transmission network; a connection is planned here for 2030.
- The Steinfurt district subnetwork cannot be connected to the Germany-wide transmission network until 2032. In 2027, the source and sink can be connected via a pipeline converted to hydrogen.
- However, no MoU projects have been registered for the subnetworks of Cloppenburg-Emsland, Esslingen, Hannover-Peine, Wesel district, Lüneburg and Pinneberg (OS).
- For the subnetworks of Germersheim, Ennepe-Ruhr district and Emsland there are MoU requirements that could not be connected to another subnetwork by 2027. In these subnetworks, there is oversupply (Emsland) or undersupply (Germersheim and Ennepe-Ruhr district).

Subnetworks in 2032

The subnetworks shown in Table 73 from the year 2027 will predominantly develop into a supra-regional Germany-wide hydrogen transmission network by the year 2032. For the year 2032, only a few subnetworks still exist. Table 74 lists these subnetworks for the year 2032.

Table 74: Allocation of the subnetworks in 2032 to the federal states

Subnetworks in 2032	Federal state/states
Altötting	Bayern
Lüneburg	Niedersachsen
Merzig-Wadern	Saarland
Nienburg (Weser)	Niedersachsen
Saarbrücken Regional Association	Saarland
Rhein-Kreis Neuss	Nordrhein-Westfalen
Saarlouis	Saarland

Source: Transmission system operators and other potential H2 network operators

- The subnetworks in Saarland (Merzig-Wadern, Saarbrücken Regional Association and Saarlouis) are connected within the framework of the cross-border project 'mosaHYc' in France and can be supplied through this system.
- For the Altötting subnetwork in Bayern, the connection to the Austrian cross-border interconnection point is projected for the years 2027 and 2032. Specifically, the needs arising from industry in the Burghausen chemical triangle are to be covered by this. Moreover, following the WEB survey for the Altötting subnetwork, further hydrogen requirements have already been requested that have not yet been reflected in the hydrogen modelling in terms of capacity.
- No MoU projects were reported within the subnetworks of Lüneburg, Nienburg (Weser) and Rhein-Kreis Neuss.

8.3 Natural Gas reinforcing measures from the Gas Network Development Plan 2020–2030

In the Network Development Plan 2020–2030, the transmission system operators developed a hydrogen transmission network based on the capacity requirements of a market partner survey. To this end, measures for the construction of new hydrogen infrastructure and the conversion of transport infrastructure to hydrogen were proposed. In order to ensure the unrestricted provision of transport capacities by the transport infrastructure, the construction of new transport infrastructure (reinforcing measures in the Natural Gas network) was also proposed on a small scale.

This new construction of transport infrastructure (ID no 760–768, 436-02b) is part of the binding Gas Network Development Plan 2020–2030. These measures are included in the Gas Network Development Plan to avoid delays for the rapid market ramp-up as defined and desired at a political level in the National Hydrogen Strategy. The new construction measures related to the transport infrastructure will be implemented when the demand-triggering hydrogen infrastructure projects are realised.

The results of the hydrogen modelling show that all transport infrastructures stipulated in the Gas Network Development Plan 2020–2030 for conversion to hydrogen are still required for development of the hydrogen network. In order to convert this infrastructure to hydrogen, the new transport infrastructure construction measures already included in the Gas Network Development Plan 2020–2030 are still necessary to provide the capacities to be maintained. As stated at the beginning of Chapter 8, the transmission system operators have not identified any new Natural Gas reinforcing measures for the Gas Network Development Plan 2022–2032.

Table 75: Natural Gas reinforcing measures from the Gas Network Development Plan 2020–2030

ID number	Name of the expansion measure	Transmission system operator
436–02b	Leitung Heiden Borken-Dorsten	OGE
760–01	Leitung Rehden-Diepholz	Nowega
761–01	Leitung Egenstedt-Clauen	Nowega
762–01	Leitung Wallach-Alpen	Thyssengas
763–01	Leitung Budberg-Eversael	Thyssengas
764–01	Umbindungen Anschlussleitungen Sonsbeck-Oberhausen	Thyssengas
765–01	GDRM-Anlage Glehn II	Thyssengas
766–01	GDRM-Anlage Hamborn I	Thyssengas
767–02	Leitung Elbe Süd-Achim	GUD
768–01	Leitung Hassel-Westen	GUD

Source: Transmission system operators

8.4 Network expansion measures from hydrogen modelling

Since the publication of the pipeline network infrastructures for the development of the potential German hydrogen network in the Gas Network Development Plan 2022–2032 dated 29 March 2022 [FNB Gas 2022], additional pipeline sections (new construction as well as conversion) have been included in coordination with all potential hydrogen network operators involved in the modelling. The main goal is to eliminate bottlenecks and to connect further hydrogen projects for which an MoU has been concluded to the hydrogen network. The results of the hydrogen network planning are presented in Appendix 3. In collaboration with the other potential hydrogen network operators, the transmission system operators completed a list of existing and planned pipeline network infrastructures as part of the hydrogen network planning. The cost calculation was based on the orientation cost rates of the transport infrastructure assumed in the Gas Network Development Plan. They were expanded by suitable factors to account for basic additional or reduced costs for hydrogen-compatible components. The transmission system operators refrain from publishing the orientation cost rates in this document due to possible market effects. Overall, the hydrogen modelling leads to the following results:

Table 76: Results of the hydrogen modelling

	Until end of 2027	Until end of 2032
Technical parameters*, **		
Mainline compressor	0–25 MW	0–245 MW
Lead compressor	0 MW	0–100 MW
Pipelines	2,900–3,000 km	7,600–8,500 km
– Pipelines to be converted	2,000–2,200 km	4,900–5,900 km
– Newly constructed pipelines	800–900 km	2,300–2,900 km
Control systems (quantity)	1–4	4–18
Investments in hydrogen modelling*, **		
Mainline compressor	EUR 0–0.2 billion	EUR 0–1.6 billion
Lead compressor***	EUR 0 billion	EUR 0–0.7 billion
Pipelines	EUR 2.1–2.8 billion	EUR 7.4–9.6 billion
– Pipelines to be converted	EUR 0.7 billion	EUR 2.1–2.9 billion
– Newly constructed pipelines	EUR 1.4–2.1 billion	EUR 4.9–7.1 billion
Control systems	EUR 2–21 million	EUR 14–135 million
Total costs ('cost range')	**EUR 2.3–2.8 billion**	**EUR 8.1–10.2 billion**

* Rounded values
** Total pipeline length and investment cannot be derived by combining the pipelines to be converted and the new pipelines
*** Bearing of costs still to be clarified, cf. Chapter 8.5

Source: Transmission system operators and other potential H2 network operators

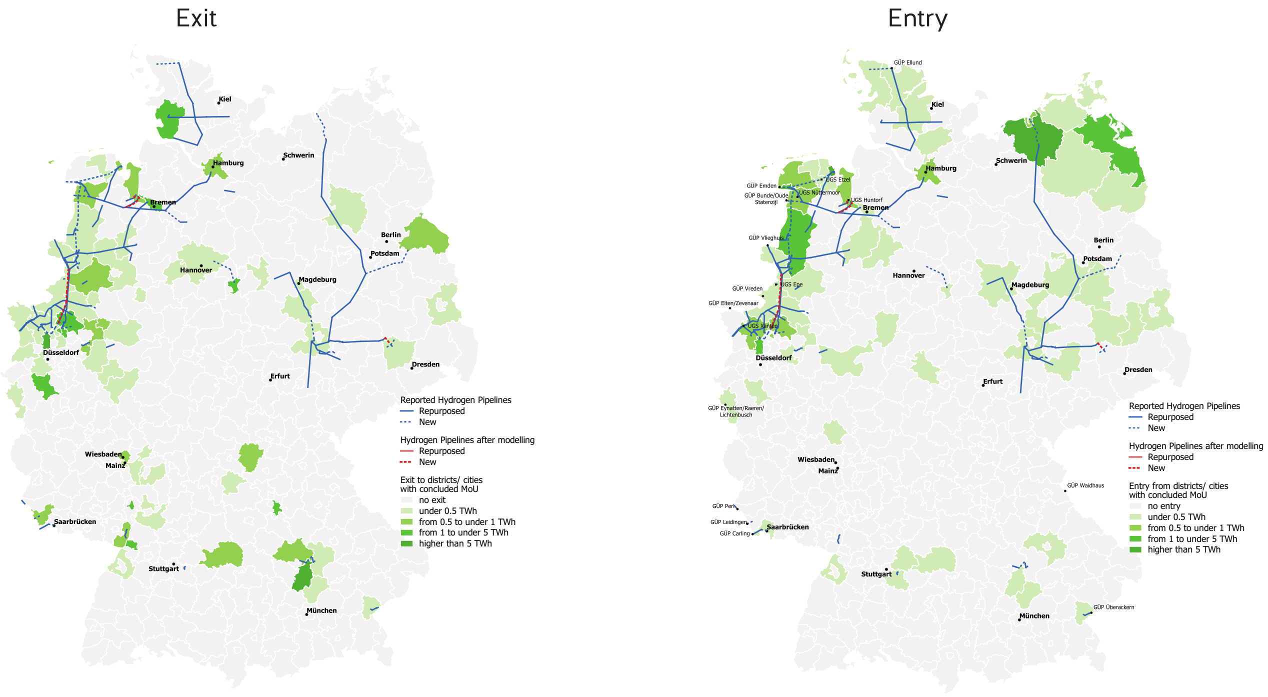
Among other things, the hydrogen network in the hydrogen modelling and the associated investments are based on the underlying MoU requirements. The transport capacity based on the WEB Market Survey has increased tenfold compared to the Gas Network Development Plan 2020–2030, which is reflected in the scope of the hydrogen network and thus also in the required investments.

The variance of the results in Table 76 is attributable to the fact that the transmission system operators and the other potential hydrogen network operators have partly developed different solutions for the transport task. These different solutions lead to the emergence of alternatives, and the total pipeline length cannot be derived by combining the pipelines to be converted and the new pipelines.

Due to the dynamics in the gas market described in Chapter 8, a final assessment of which pipelines actually need to be built or converted is not possible at the present time. The specified costs should therefore be regarded as indicative.

The following figures show all hydrogen measures (pipelines to be converted and new pipelines). A distinction is made in the maps between the pipeline registrations as of 18 March 2022 and the additional pipelines determined within the scope of hydrogen modelling.

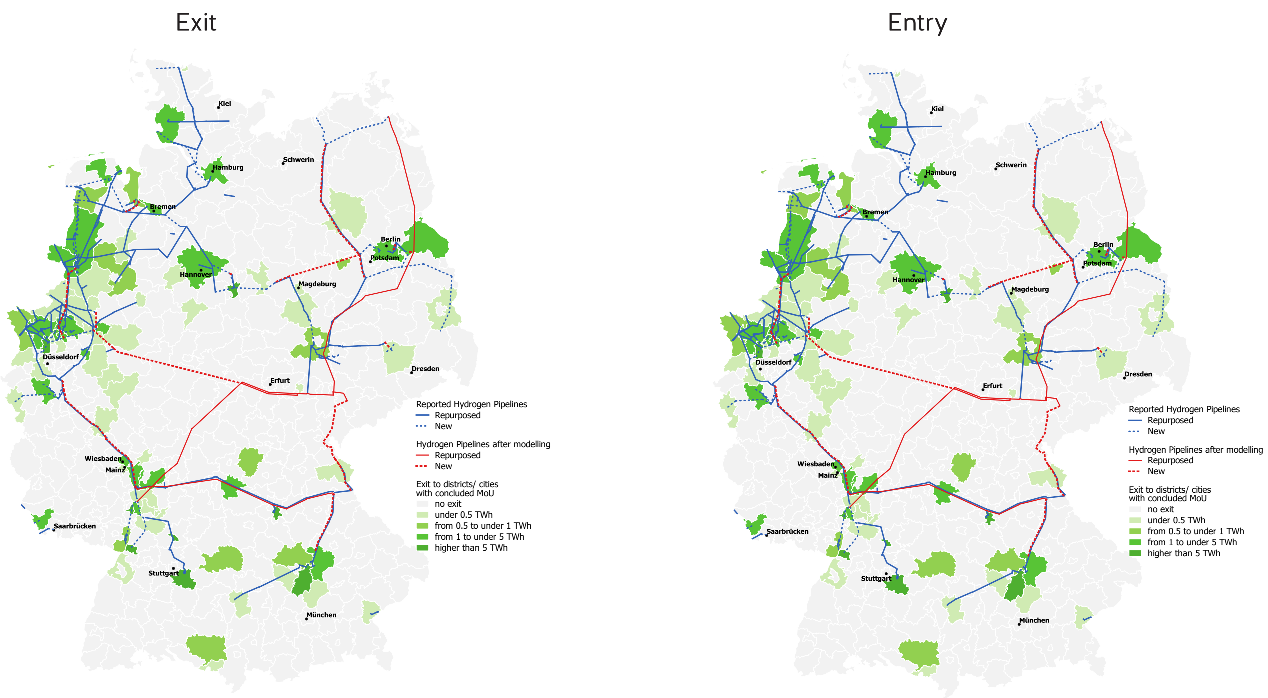
Figure 53: Network expansion measures for hydrogen variant 2027



Note: Alternative expansion measures to fulfil the same transport task within a hydrogen corridor are not shown in the expansion maps. However, they are described in Appendix 3.

Source: Transmission system operators and other potential H2 system operators, schematic diagram

Figure 54: Network expansion measures for hydrogen variant 2032



Note: Alternative expansion measures to fulfil the same transport task within a hydrogen corridor are not shown in the expansion maps. However, they are described in Appendix 3.

Source: Transmission system operators and other potential H2 system operators, schematic diagram

An updated table with the MoU and WEB reports was also published on the FNB Gas website (Appendix 2). Due to the confirmation of the 2022 Scenario Framework (cf. Chapter 8.1.2), adjustments were made here. Additional columns were added to show which MoU projects can be connected to the identified hydrogen network in the years 2027 and 2032.

As a result of the hydrogen modelling, more than 230 MoU projects (about 90 %) could be achieved with the hydrogen network. A small proportion of the MoU projects could currently not be considered for the following reasons, amongst others:

- Ratio of network expansion demand and requested transport demand,
- Distance to the hydrogen network,
- Clustering not yet reasonably possible.

Discussions on the respective project-specific backgrounds will be held between the transmission system operators and the MoU project sponsors.

8.5 Further hydrogen modelling measures

Connection infrastructures are required for the projects registered in the WEB Market Survey conducted by the transmission system operators. For the exit, these connection infrastructures usually consist of a connecting pipeline and a GPCM station. For entry into the transmission network, it may be necessary to add another compressor to increase the pressure of the hydrogen entry to the required level. In a similar way to the procedure for methane, the measures resulting from the connection of these projects or plants to the potential hydrogen network were not presented.

The costs for lead and mainline compressors are shown in Table 76. The locations of possible compressors vary depending on the identified solution paths of the transmission system operators and are largely dependent on future developments in the hydrogen market. Therefore, they are not listed in the measures for specific locations. Moreover, the bearing of costs for potential lead compressors for hydrogen at cross-border interconnection points still needs to be clarified.

In addition, for cause-based allocation of hydrogen transport costs, metering systems at the property borders of the network-connecting hydrogen network operators are generally required. However, cost-efficient balancing first requires further configuration of the hydrogen metering system, clarification of market roles and the network access model, including the development of cross-network balancing in order to optimise investments. In light of the outstanding activities for the aforementioned points, the designation of metering facilities at property and border crossings is omitted in the result of the hydrogen modelling.

Control facilities that are required to connect pipelines with different pressure levels are the result of network modelling. Accordingly, they are part of the hydrogen network planning in the present Gas Network Development Plan 2022–2032. Due to the large number of measures, they are not presented individually. The costs for the control systems are therefore shown in summary format.

8.6 Hydrogen Review

In the Scenario Framework 2022 the transmission system operators announced that they would carry out the so-called 'Hydrogen Review' for the year 2032 on the basis of the WEB reports of the category 3 (reports from further projects on the expected demand in the distribution network).

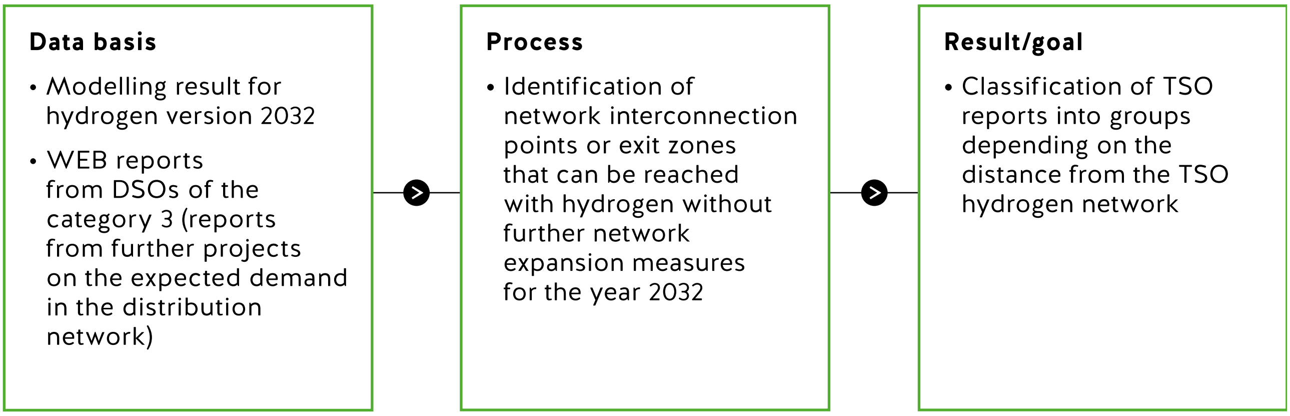
The objective of the Hydrogen Review is to identify network interconnection points or exit zones of the distribution system operators that can be reached with a hydrogen infrastructure based on the results of the hydrogen variant for the year 2032 without further network expansion measures by the transmission system operators. Furthermore, it examines whether a simultaneous supply with methane would be feasible for the identified network interconnection points, so that blending would be possible on the distribution network level. If it were possible to convert the first areas or individual network interconnection points in these networks to 100 % hydrogen, the first potential 'Hydrogen conversion areas' could be identified analogously to the planning process for the L-to-H-gas conversion.

The L-to-H-gas conversion, which has been gradually implemented in Germany since 2015 with great success, was planned using this very approach. Accordingly, the transmission system operators determine the first regions for a potential initial use of hydrogen in the distribution system based on the registrations received from the distribution system operators and the modelling results of hydrogen variant 2032.

8.6.1 Basic procedure

This section describes the basic procedure for the Hydrogen Review, as shown in Figure 55.

Figure 55: Basic procedure for the Hydrogen Review



Source: Transmission system operators

Initially, WEB reports of the distribution system operators are identified that can be reached with a hydrogen infrastructure based on the results of the hydrogen variant for the year 2032 without further network expansion measures by the TSOs. If this is not possible, the distance to the nearest hydrogen network of the transmission system operators is determined.

Figure 56 shows how the reports of the distribution system operators were divided into two groups for this purpose:

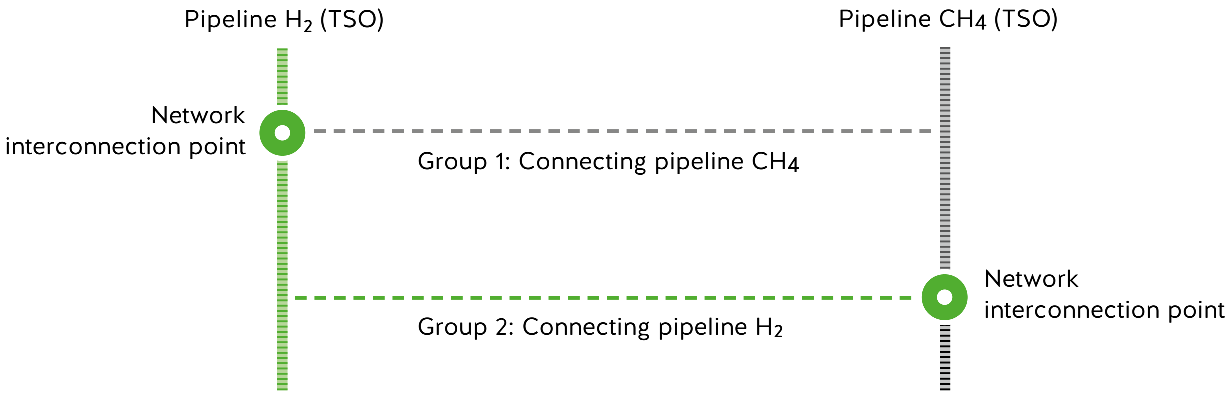
Group 1

- Existence of an existing network interconnection point in the respective exit zone on a pipeline to be converted to hydrogen.
- Conversion to 100 % hydrogen is generally possible. In this case, it is assumed that blending at DSO level would not be sustainable.
- In principle, however, blending at DSO level would be possible, provided a connection to the TSO methane network is established.

Group 2

- No existing network interconnection point in the respective exit zone on a pipeline to be converted to hydrogen (network interconnection point remains in the methane network).
- Conversion to 100 % hydrogen as well as possibility of blending at DSO level would exist, if a connection to the TSO hydrogen network is established.

Figure 56: Schematic diagram for grouping of WEB reports by the distribution system operators



Source: Transmission system operators

The possibility of blending at distribution network level is always dependent on a corresponding connection to the methane or hydrogen network being established to enable simultaneous supply with methane and hydrogen.

The individual steps of the Hydrogen Review are as follows:

Data basis:

- Basic data of the WEB reports of category 3
- Results of hydrogen variant 2032

Process steps:

Step 1: Consideration of the category 3 reports of the WEB Market Survey

Step 2: Individual TSO determination of the network interconnection point for the reporting distribution system operator

Step 3: Classification of the WEB reports into two groups based on the location of the associated network interconnection point in relation to the hydrogen network:

Group 1: Network interconnection point is located on the pipeline to be converted

Group 2: Network interconnection point is not located on the pipeline to be converted

Step 4: Determination of the distance of the network interconnection point to the hydrogen network of the transmission system operators (only required for group 2; for group 1 distance is always 0 km)

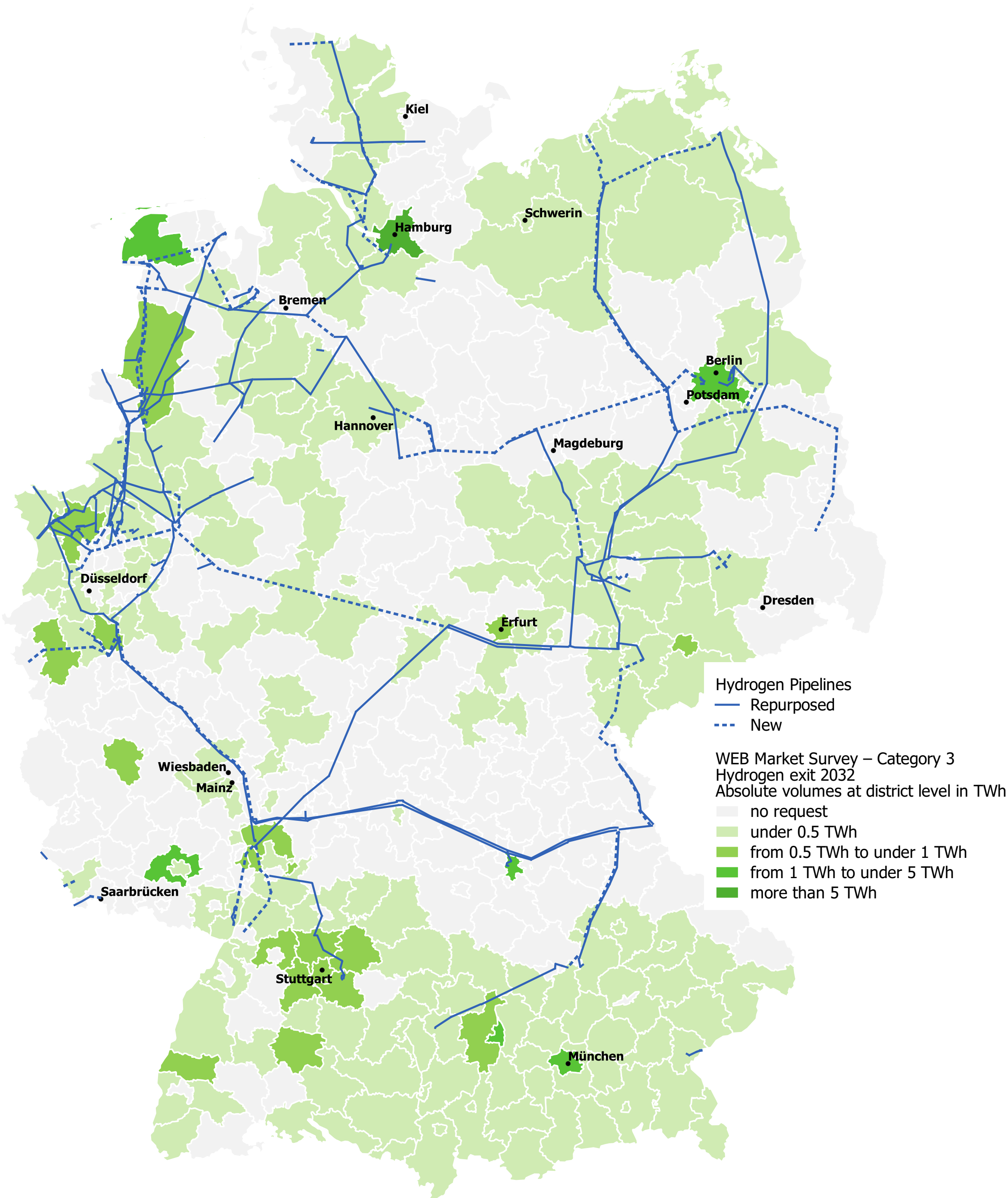
For WEB reports submitted by the system operators that are downstream of the distribution system and thus have no direct connection to the transmission network, it is first checked whether the intermediate distribution system operator has also submitted a category 3 demand declaration. If this is the case, it is assumed that this distribution system operator can also supply its downstream system operator with a methane-hydrogen mixture or 100 % hydrogen. In the event that the respective distribution system operator has not submitted a demand notification, the transmission system operators must determine the distance of the hydrogen network to the network area of the requesting system operator.

The results of the hydrogen check are a purely geographical consideration. A modelling of the reported demand and a topological network planning have not been carried out and are still pending for a binding connection request. The results are therefore not to be regarded as a binding supply commitment. They merely provide an indication of which network areas in the distribution network could be reached with a hydrogen infrastructure by 2032 without triggering upstream expansion measures in the transmission network (excluding small-scale or pipeline reconfiguration measures to adapt the network topology).

8.6.2 Results of the Hydrogen Review

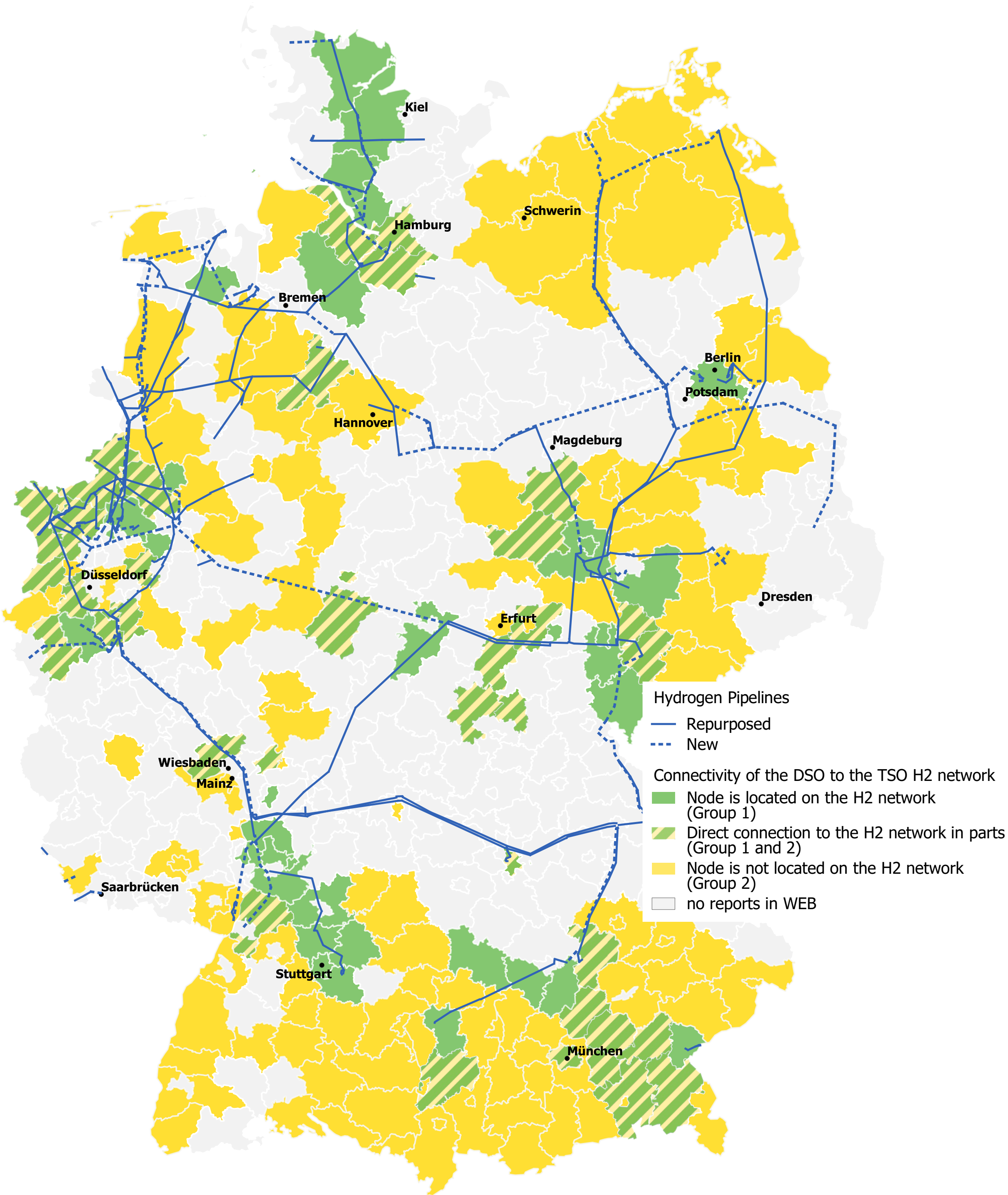
Around 32 % of the distribution network operators' WEB reports (category 3) can be assigned to group 1 (network interconnection point is located on a pipeline to be converted to hydrogen). These distribution networks therefore already have an Network interconnection point to the potential hydrogen network. Subject to a respective detailed topological network review and the possibility of converting the other customers on the respective pipeline, these zones or areas could be supplied with hydrogen as a priority. The detailed results of the Hydrogen Review for all category 3 requests are presented in Appendix 5.

Figure 57: WEB reports of the category 3 and hydogen network for the year 2032



Source: Transmission system operators, schematic diagram

Figure 58: Results of the hydogen review for the year 2032



Source: Transmission system operators, schematic diagram

As the presentation of results in Figure 58 shows, the 2032 hydrogen network already reaches numerous areas for which the distribution system operators have reported a corresponding hydrogen demand. On the other hand, expansion measures in the form of connecting pipelines would be required to supply the majority of the distribution network operators involved. This illustrates both the existing potential for continuous development and the need for expansion of the hydrogen infrastructure.

8.6.3 Outlook

As part of the WEB Market Survey, numerous distribution system operators submitted a hydrogen demand report for the first time in accordance with the DVGW Guidelines [DVGW, H2vorOrt, VKU 2022a] prepared for this purpose. In the long term, these requirements must be recorded in a structured manner by the distribution system operators via the creation of the Gas Network Area Transformation Plan (GTP). The GTP is the central instrument for the planning processes of the distribution system operators for the transformation of the distribution system [DVGW, H2vorOrt, VKU 2022b]. It can thus be assumed that, with regard to future network development planning, more and more distribution network operators will determine their hydrogen requirements and, among other things, report them to the transmission network operators via the GTP. The substituted methane demands are in turn expected to allow for a higher degree of pipeline conversion, which will further increase the size of the hydrogen network and thus allow it to reach more distribution network areas. The transmission system operators have presented a detailed process for hydrogen network planning in the report on the initial preparation of the Hydrogen Report pursuant to section 28q EnWG. A central component of the Hydrogen Report is the conversion planning at distribution network level and the interaction with the GTP [FNB Gas, H2 2022].

From the perspective of the transmission system operators, these concepts together with the network development plan form a good foundation for synchronising and upgrading hydrogen network planning at transmission network level and conversion planning in the distribution network.

Network expansion proposal 9

9 Network expansion proposal

In order to reduce Europe's dependence on Russian gas imports and to build the necessary transport infrastructure for LNG imports, the measures to expand the transport network require considerable financial resources, which must be provided by the transmission system operators. The costs arising from the network expansion are passed on via the network charges. All those involved in the development of the Gas Network Development Plan must therefore pay particular attention to ensuring that the network expansion makes overall economic sense from a long-term perspective. They must also ensure that it remains economically reasonable for the investing companies in light of the ever shorter commitment periods of transport customers. Above all, this requires a stable and sustainable regulatory framework with a risk-adequate interest rate and appropriate depreciation periods.

This Chapter considers the network expansion measures identified by the transmission system operators as part of the Gas Network Development Plan 2022–2032. The measures required to connect the LNG terminals to the transmission network are shown for information purposes only. Therefore, the associated costs for the LNG connection measures are in addition to the investment amounts shown in Table 77.

In the previous network development planning, the required network expansion measures were determined for the fifth and tenth year in the respective Network Development Plan. Deviating from this procedure, the transmission system operators have determined the required network expansion measures of the LNGplus security of supply variants for the year 2032 in accordance with the new partial decision for the confirmation of the Scenario Framework 2022 and, on the basis of the existing regulatory framework, assumed the fastest possible commissioning for them. Network expansion measures can be completed much faster if the conditions for accelerated project progress are met, e.g., by inclusion in the Gesetz zur Beschleunigung des Einsatzes verflüssigten Erdgases (LNGG – Act to Accelerate Use of Liquefied Natural Gas). However, this has not yet been the case for all LNGplus potentials.

In the new partial decision of the Scenario Framework 2022, the BNetzA obligated the transmission system operators to determine the solution with the lowest possible network expansion while simultaneously implementing the necessary network expansion measures as quickly as possible.

Security of supply variant LNGplus A has significantly higher network expansion costs compared to security of supply variants LNGplus B and C. Moreover, implementation of parts of the necessary network expansion measures can only take place later. Furthermore, the capacity and quantity balances show that the requested 182 GWh/h for LNG terminals are not required for the supply of Germany and the neighbouring European countries. Therefore, security of supply variant LNGplus A will not be considered as a network expansion measures.

Security of supply variants LNGplus B and C differ with regard to Germany's supply routes. In the LNGplus B security of supply variant, Germany is increasingly supplied via direct LNG imports from the North Sea and Baltic Sea coasts. Conversely, in the LNGplus C security of supply variant, Germany is increasingly supplied via LNG capacities from neighbouring European countries.

With approximately EUR 4.1 billion, the **LNGplus B security of supply variant** is slightly cheaper than the LNGplus C security of supply variant with a cost of approximately EUR 4.2 billion, since it requires less investment in the transport infrastructure.

Security of supply variant LNGplus B thus meets the BNetzA's objective from the new partial decision of the Scenario Framework 2022 to determine the most efficient solution from a network perspective from security of supply variants LNGplus B and C. From the BNetzA's point of view, this means choosing the lowest possible network expansion while simultaneously implementing the necessary network expansion measures as quickly as possible.

The direct LNG import options for Germany are higher than in security of supply variant LNGplus C. Moreover, higher eastern LNG injection is favourable for utilisation of the existing transport infrastructure in Germany.

With approximately EUR 4.2 billion, the **LNGplus C security of supply variant** is slightly more expensive than the LNGplus B security of supply variant with a cost of approximately EUR 4.1 billion.

By increasing cross-border capacities to our neighbouring countries in Western Europe, the LNGplus C security of supply variant largely uses existing infrastructure and LNG terminals in the respective neighbouring countries. Because of the geographically widely distributed Western European cross-border interconnection points and German LNG injections in the LNGplus C security of supply variant, the transmission system operators see an advantage over the larger LNG injections limited to the three clusters Wilhelmshaven, Lower Elbe and Baltic Sea in the LNGplus B security of supply variant in terms of flexibility and diversification of the various import routes, security for critical infrastructure and thus also for security of supply.

Since security of supply variants LNGplus B and C require similar investment costs in the transmission network, the transmission system operators are initially refraining from formulating a specific network expansion proposal and would like to put the network expansion measures of security of supply variants LNGplus B and C out for consultation.

The transmission system operators plan to formulate a network expansion proposal, taking into account the consultation results and other comments on the draft document of the Network Development Plan Gas 2022–2032.

The goal of the security of supply variants LNGplus is to quickly increase the available entry capacity and simultaneously identify an efficient and sustainable network expansion. The transmission system operators meet this objective with a view to the current status of LNG terminal planning. The network expansion measures for the provision of LNG capacities should be largely realised until 2026. Full implementation of these network expansion measures is planned by 2028. The prerequisite for an accelerated project development are significantly shorter approval procedures. This can be achieved, for example, by including the potentials in the LNGG. However, this has not yet been the case for all LNGplus potentials.

Security of supply variants LNGplus B and C describe network expansion measures in which the capacity of new LNG terminals as well as existing capacities via western cross-border interconnection points can be used. The transmission system operators point out that, depending on the actually implemented LNG systems and their planned entry capacities, the required network expansion may change due to the framework conditions, which have not been conclusively clarified, as well as due to future political decisions. In addition to future political decisions, this dynamic is particularly attributable to the fact that only some of the implementation schedules for the capacity expansion requirement under section 39 GasNZV have been completed to date. From today's perspective, the completion of the outstanding implementation schedules is still subject to uncertainties and strongly influences the respective LNG locations and the associated network expansion measures.

The detailed cost breakdown for the expansion of the transport infrastructure is as follows:

Table 77: Network expansion measures of the transmission system operators until the end of 2032

Summary of the results of the LNGplus variants	LNGplus variant A	LNGplus variant B	LNGplus variant C
Pipeline [km]	1,062	805	805
Compressor stations (additional capacity and necessary reversals) [MW]	249	165	175
Investments [in EUR billion]*	5.4	4.1	4.2
– Network expansion measures from the Gas Network Development Plan 2020–2030 (without LNG)	1.8	1.8	1.8
– LNG measures	3.2	1.9	1.9
– Further new network expansion measures from the Gas Network Development Plan 2022–2032	0.4	0.4	0.4
* rounded values			

Source: Transmission system operators

A list of the network expansion measures can be found in Appendix 6. All details on the network expansion measures, connection measures and the initial network measures are contained in the in the cycle '2022 – NDP Consultation'.

Further aspects of the network expansion proposal

Brunsbüttel and Stade LNG terminals

The provision of transport capacity for the LNG terminal in Brunsbüttel and/or Stade requires expansion measures in the GUD network in the form of a pipeline connection between Elbe South (Elbe Süd) and Achim and the creation of new compressor capacity at the Achim/Embsen site. Only the dimensioning of the transport pipeline and the compressor station depends on whether only one or both terminals are built on the specified scale.

Commissioning one year earlier than the designated commissioning date is possible for the above measures under favorable conditions, in particular by including the pipeline in the LNGG or enabling comparable acceleration potentials.

Lubmin LNG terminal

For the LNG injection in Lubmin, measures with identical dimensioning are planned to provide the transport capacities due to the special location in relation to the NEL and EUGAL pipelines. Consequently, depending on market demand, a higher and earlier entry is possible, which is deviating from the capacity utilisation assumed in the modelling for the LNGplus B and C security of supply variants.

Wilhelmshaven LNG terminal

For the onward transport of LNG quantities from Wilhelmshaven beyond Etzel additional transport capacities are required. These will be created with the Etzel-Wardenburg pipeline including the construction of the Wardenburg GPCM station and the expansion of the Friedeburg-Horsten 1 GPCM station as well as the Wardenburg-Drohne pipeline including the Drohne 2 GPCM station.

Considering the usual project duration, the commissioning of the Etzel-Wardenburg pipeline and the GPCM stations will take place at the end of 2026. A significantly earlier commissioning, at the earliest in winter 2024/2025, is possible under favorable conditions, in particular through the inclusion of the pipeline in the LNGG or the enabling of comparable acceleration potentials.

Considering the usual project duration, the commissioning of the Wardenburg-Drohne pipeline and the GPCM stations, will take place at the end of 2027. A significantly earlier commissioning, at the earliest in winter 2025/2026, is possible under favorable conditions, in particular due to the inclusion of the pipeline in the LNGG or the enabling of comparable acceleration potentials.

Medelsheim/VIP France–Germany cross-border interconnection point

The cross-border interconnection point, which until 2022 was only operated as an exit point in the direction of France, has been used for the physical transport of gas from France since October 2022 as part of the diversification of gas sources.

In France, natural gas is odorised with a sulphur-containing substance at all network levels, whereas in Germany it is only odorised at distribution level. For a transitional period until 30 April 2024, the BNetzA, in its determination BK9-22/606-1 ('VOLKER') dated 8 November 2022, granted transmission system operators recognition of possible damages in the German network resulting from the deviation of the odorized gas from the gas quality standard DVGW G260 as volatile costs. After this period, it may be necessary to clean, (in other words, deodorise) the gas quantities to be taken over from France using a technical system.

For security of supply variants LNGplus B and C of the Gas Network Development Plan 2022–2032, the transmission system operators in question, GRTgaz Deutschland and Open Network Europe, are planning to build a deodorisation facility at the Medelsheim site. It will be designed for a constant gas flow of around 400,000 m^3/h, which corresponds to 4.2 GWh/h or 100 GWh/d. However, the two transmission system operators will only be able to make a final investment decision when the following conditions are met:

1. The deodorisation facility is required if the relevant national stringent sulphur limits in Germany (which are prescribed for the 2nd gas family by the DVGW G260 worksheet dated September 2021) are maintained permanently beyond 2023 and remain relevant for gas transport. Permanent operation of the deodorisation system must be technically feasible based on the present conditions. The remaining gas specifications of European gas quality standard EN 16726 are in full compliance for the gas to be taken over from France.
2. In France, a technical capacity within the meaning of Regulation (EU) 715/2009 article 2 (18) in the amount of at least 4.2 GWh/h is created and offered in the direction of Germany.

A confirmation of the measure should be made by the BNetzA in the amendment request to the Gas Network Development Plan 2022–2032 under the aforementioned conditions.

Further additions to the draft document

For efficient and demand-oriented construction of a future hydrogen transport network, it had already become apparent in the last Network Development Plan that it is necessary to carry out network expansion measures in natural gas so that pipelines that are currently being used in natural gas can be rapidly converted to hydrogen use. These network expansion measures were not opposed or removed by the BNetzA in the request for amendment on 19 March 2021 to the Gas Network Development Plan 2020–2030. The transmission system operators were instructed to implement these measures with ancillary provisions so as not to cause any delays for the rapid market ramp-up, which was politically defined and desired in the National Hydrogen Strategy.

In light of multiple adjustments and changes in the preparation process of the Gas Network Development Plan 2022–2032 and the corresponding time and procedural delays, the transmission system operators initially focused in this consultation document on the necessary network expansion measures in natural gas to maintain the security of supply with natural gas. The transmission system operators will therefore deal with the network expansion measures required in natural gas for the conversion of currently used natural gas pipelines to hydrogen in the period up to the submission of the draft document.

Outlook for future Network Development Plans 10

10 Outlook for future Network Development Plans

The restructuring of the energy supply in Germany also places new demands on network development planning. In the future, this must be done in a more cross-sectoral manner and within the scope of a holistic view of energy scenarios that take electricity and gas, including hydrogen, into account. This is the only way to facilitate an economically advantageous interconnection of the energy infrastructures under consideration of the energy and climate policy objectives.

10.1 Developing the hydrogen infrastructure

The ramp-up of the hydrogen market in the EU is a central building block in the development of a carbon-neutral and secure energy system. The current geopolitical situation makes it all the more urgent to accelerate this market ramp-up. The basic prerequisite for this is the rapid availability of an efficient hydrogen infrastructure.

The development of a hydrogen economy requires a growing hydrogen infrastructure at the transport level, which connects the production centres in Germany and abroad with the storage facilities and consumers in Germany. The development of this hydrogen transport infrastructure must be fully integrated into the gas network development planning, as large parts of the existing methane network can be used by converting to hydrogen and supplemented by closing gaps or building new ones. This enables cost-optimised and resource-efficient development of a hydrogen infrastructure in Germany. The conversion of methane pipelines for hydrogen transport requires integrated and iterative modelling of the transmission networks within the framework of the Gas Network Development Plan. This is necessary because, in addition to the hydrogen ramp-up, the supply of methane, transits and, in the future, increasingly the supply of biomethane, synthetic methane and LNG must be ensured. A separate Network Development Plan for hydrogen is therefore not expedient and would be economically inefficient. In this respect, the transmission system operators are clearly in favour of introducing an integrated planning process for the methane and hydrogen networks. Hence, in order to continue to use existing synergies with the proven processes in the Gas Network Development Plan in the future, they have developed a corresponding concept for integrated gas network planning within the framework of the Hydrogen Report pursuant to section 28q EnWG.

In addition to the integrated planning of methane and hydrogen networks, further framework conditions are necessary to ensure a rapid market ramp-up. Above all, an approach to hydrogen production without limitation to specific technologies is needed in order to meet the high demand early on, to exploit the potential of converted infrastructure and thus to be able to advance the decarbonisation of consumers.

10.1.1 Regulation of hydrogen networks in Germany

The current regulatory framework for hydrogen networks contains a number of hurdles for transmission system operators that prevent the rapid development of the hydrogen infrastructure.

The amendment to the EnWG of 16 July 2021 created an initial legal basis for the development of a hydrogen infrastructure and a transitional regulatory framework. In this temporary legal framework, hydrogen network operators supplement the previous operator roles (TSO, DSO, etc.) of transport infrastructure (cf. section 3 lit. 10b. EnWG).

So far, hydrogen network operators have only been subject to regulation if they have declared themselves in accordance with section 28j (3) EnWG and a positive needs assessment of their hydrogen infrastructures could be proven by the BNetzA in accordance with section 28p EnWG. The provisions of the EnWG for hydrogen networks (sections 28j to 28p) apply exclusively to regulated hydrogen network operators (in individual cases also to unregulated ones). Transmission system operators are not explicitly mentioned in the aforementioned paragraphs.

For a quicker conversion to hydrogen and efficient development of the hydrogen infrastructure, the transmission system operators consider it necessary to create a stable regulatory framework beyond the existing transitional regulation, in which the necessary long-term investments can be safely implemented. Joint regulation and financing of the methane and hydrogen infrastructure is the best and quickest way to achieve this objective. It can avoid prohibitively high charges and enable predictable, plannable tariffs in the market ramp-up phase of the hydrogen market as well as in the phase of declining methane demand.

10.1.2 Conversion of methane pipelines to hydrogen

The procedure for converting methane pipelines to hydrogen is regulated under section 113b EnWG. The transmission system operators can identify pipelines that can be converted to hydrogen in the future as part of the preparation phase of the Gas Network Development Plan. The resulting expansion measures necessary to reinforce the methane network are permissible to a minor extent. For the conversion of pipelines to hydrogen, it must be ensured that the remaining transmission network can meet the capacity demands on which the Scenario Framework is based. Pursuant to the currently applicable EnWG regulations, only then does the BNetzA carry out an ad-hoc review of the adequacy of the concerned hydrogen infrastructures in accordance with section 28p EnWG. This in turn is a prerequisite for an operator of hydrogen networks to be able to operate within the regulatory framework at all.

From the perspective of the transmission system operators, the prerequisites outlined in the EnWG for potential conversions of methane pipelines are not sufficiently defined to handle secure and efficient network planning. For the ad hoc review of the adequacy of demand, the pipelines to be converted require proof that they can be removed from the methane network without restricting the security of methane supply. This proof must be provided by the corresponding indication in the Gas Network Development Plan. In the confirmation of the Scenario Framework 2022 on pages 39 ff., the BNetzA explains how negative planning on the methane side and positive planning on the hydrogen side must be distinguished from each other. Transmission system operators consider it questionable whether this very linear process already contains the necessary flexibility that would be required for the dynamic development of the hydrogen network and the simultaneous maintenance of gas security of supply in a changing gas market. For example, it is to be expected that several conversion options from the methane network would be possible to cover hydrogen demand, between which a trade-off must take place that adequately satisfies the hydrogen and methane network development. A rigid timeline in which the first step would always be an irreversible designation of individual gas assets as 'removable' would not do justice to this process and is counterproductive to an optimised overall network consideration. Moreover, the lack of flexibility in integrating the dynamically and interdependently evolving gas and hydrogen transport needs slows down the development of the hydrogen networks. This is due to the fact that the transmission system operators would be forced to prioritise gas transport needs according to the precautionary principle. The transmission system operators feel that a target-oriented solution to this dilemma lies in joint regulation or network planning of methane and hydrogen by the transmission system operators in accordance with the target concept addressed in section 112b EnWG.

10.1.3 Regulation of hydrogen networks in the European Union

The European Commission published the draft of the so-called 'Domestic Hydrogen and Gas Market Package' on 15 December 2021. The changes to the currently existing regulations for the European single market for gas are supposed to be supplemented with regulations for the use of renewable and low-CO_2 gases in the existing gas infrastructure along with specifications for the development of a hydrogen infrastructure and a hydrogen market.

The fundamental separation of methane and hydrogen networks as well as the proposed regulations on unbundling, financing, costing and charging as well as on network development planning in the new EU regulatory framework represent considerable hurdles and risks for the development of the infrastructure for the transport of hydrogen in Germany. A rapid market ramp-up for hydrogen would thus be significantly delayed, if not prevented.

The currently planned vertical unbundling regulations pose an existential threat to the development of the German hydrogen network, because they stipulate a time limit on the independent transmission operator (ITO) model for hydrogen network operators by the end of 2030. This model is widespread and proven in the European gas sector. Ending it would thus effectively exclude a large part of all existing European transmission system operators from the hydrogen transport business. This would mean that the current ITO TSO would already have to sell their hydrogen network under construction after 2030. This prospect would inhibit investments and thus the rapid development of the hydrogen network and is particularly critical for Germany, which lies at the centre of a future EU H2 backbone.

Furthermore, the proposed regulations on horizontal unbundling prohibit the joint operation of methane and hydrogen networks and thus go beyond the requirements that apply to unbundling between electricity and methane networks. The proposed obligation for additional unbundling of methane and hydrogen network operators in terms of corporate law, information and organisation prevents manifestation of the enormous synergy potential that exists in the joint operation of methane and hydrogen networks. Prohibiting the exchange of information and the use of joint services has a devastating impact on any collaborative efforts.

In order to ensure efficient and resource-saving development of the hydrogen infrastructure, it is absolutely necessary that the existing and proven unbundling rules for gas are transferred to hydrogen. Uniform unbundling rules create plannability for the transmission system operators for investments in the hydrogen infrastructure and enable efficient use of synergies. The ITO model, which has proven itself in the gas sector, must also be permanently possible for hydrogen network operation, and the horizontal unbundling requirements must allow for network operation of hydrogen and methane networks in the same company. Moreover, the horizontal unbundling regulations (e.g. informational unbundling) must be revised to enable integrated methane network planning for methane and hydrogen.

10.2 Hydrogen Report pursuant to section 28q EnWG

One component of the EnWG amendment of July 2021 is the report on the initial preparation of the Hydrogen Report pursuant to section 28q EnWG. Hydrogen network operators who have submitted a declaration pursuant to section 28j (3) EnWG must submit the Hydrogen Report to the BNetzA together with the transmission system operators by no later than 1 September 2022. Hydrogen network operators who have not submitted a declaration pursuant to section 28j (3) EnWG must cooperate to the extent necessary for proper preparation of the report. Primarily, they must provide the information required for the preparation. Based on the report, the BNetzA may make recommendations for the legal implementation of a binding network development plan for hydrogen.

The transmission system operators submitted the Hydrogen Report to the BNetzA on time on 1 September 2022 and subsequently published it. The report was presented to the interested public in a webinar held jointly with the distribution system operators on 25 October 2022.

10.3 Holistic view of the energy system for electricity and gas (methane and hydrogen)

Against the background of energy and climate policy objectives, the holistic consideration of energy supply infrastructures is of utmost importance. The transmission system operators are dealing intensively with this topic at various points and are also in close communication with other transmission system operators (gas, hydrogen and electricity). For example, Chapter 10.4 of this consultation document on the Gas Network Development Plan 2022–2032 contains a concept on how climate policy goals can be reflected in the future as part of network development planning. Furthermore, within the context of the Hydrogen Report (cf. Chapter 10.2), the transmission system operators describe a corresponding process for a holistic consideration of the energy system. Among other things, it considers the central interfaces and interactions between electricity and gas network planning (methane and hydrogen).

10.4 Concept for appropriate consideration of the legally stipulated climate targets

In the confirmation of the Scenario Framework 2022 [BNetzA 2022], the transmission system operators were instructed by the BNetzA, in accordance with Agenda Item 3, to develop a concept on how the requirements of the Climate Protection Act can be reflected in the Network Development Plan in the future – in particular with regard to the climate neutrality to be achieved by 2045.

In the following chapter, the transmission system operators address various aspects that are supposed to be dealt with in this context in accordance with section II B 1.3 of the confirmation of the Scenario Framework 2022 of the BNetzA.

10.4.1 Concept for integrating the demand-based capacity approach with a scenario-based one

So far, the data queries of the transmission system operators have formed the basis for the modelling variants in the Gas Network Development Plan. Among others, they include the internal orders and long-term forecasts of the distributors, the L-to-H-gas conversion planning as well as th e WEB Market Survey, as a special foundation for the modelling of the hydrogen variant. This approach is important for the modelling of the network infrastructure in order to be able to guarantee a demand-oriented, secure and resilient gas supply in Germany.

The exclusively demand-based modelling with an observation period of a maximum of t+10 years defined in accordance with section 15a EnWG does not sufficiently consider the political goal of climate neutrality by 2045 in the previous network development planning. In order to include this goal more effectively in network development planning for gas (hydrogen and methane), the demand-based modelling variants should be expanded to include a scenario-based consideration. It should cover a period of at least t+15 years and continue on a rolling basis. Up to the year of inception, 2030, it is conceivable to set the focus of the Gas Network Development Plan (hydrogen and methane) on 2045 as the target year.

The subsequent Gas Network Development Plans (from the year of inception 2032) should go beyond 2045 as a rolling period of t+15 years. An extension of the Gas Network Development Plan (hydrogen and methane) to include a scenario-based modelling variant would also create a stronger connection to the Electricity Network Development Plan. The modelling periods considered there all exceed the period of t+10 years.

Nevertheless, the transmission system operators point out that a purely scenario-based approach for the consideration periods t+5 and t+10 years is unsuitable for the Gas Network Development Plan. In the short to medium term, security of supply must continue to have priority in network planning and must therefore be primarily demand-based. Nevertheless, an additional comparison with potential future consumption developments, as would be determined in the context of holistic energy scenarios,[1] is also useful in a demand-based modelling approach. Especially for planning of the hydrogen infrastructure, the increasing demand for hydrogen transport capacities could be considered at an early stage in order to avoid bottlenecks and any resulting expansion measures in the long term.

The challenge here is to assume a realistic development of consumption during the transition from demand-based to scenario-based modelling. Especially for the scenario-based analysis, selecting an adequate data basis is elementary. Consequently, the long-term demand reports of the network customers in the electricity and gas network (hydrogen and methane) should be considered in the creation of the energy scenarios. This is the only way to ensure that the scenarios are plausible in terms of their feasibility and show a sensible development path under consideration of actual consumption developments. This combination of demand-based and scenario-based consideration is absolutely necessary in order to

- be able to continue to fulfil the supply task with high priority,
- be able to assess how and in which regions the various energy carriers or sources (hydrogen, methane, electricity and district heating) will develop in the long term, and
- be able to deduce at an early stage which measures need to be taken to reflect these developments in the transmission network.

Focusing solely on either demand reports or energy scenarios does not meet these requirements. Only the combination of both perspectives ensures that the network-based energy supply can make its essential contribution to achieving the statutory climate targets and simultaneously continues to guarantee a secure energy supply.

In the report on the initial preparation of the Hydrogen Report, the transmission system operators are required, among other things, to submit a concept on how future hydrogen network development planning could be structured. Since the development of a hydrogen transport infrastructure and the resulting widespread use of hydrogen can make a significant contribution to achieving the climate targets, the integration of the demand-based capacity approach with a scenario-based capacity approach is also an essential part of this report.

1 Cross-system energy scenarios assume a holistic perspective of the demand and supply of various energy sources, including hydrogen, methane, electricity and heat.

10.4.2 Assessment of various aspects of the gas network development planning process

Capacity products

Modelling industrial customers with fDZK

The product fDZK has been developed for the supply of power plants with changing load profiles and temporarily high capacity demands in order to meet the privileged requirement according to sections 38/39 GasNZV of prompt provision of firm capacities in a demand-oriented and cost-efficient way.

The application of fDZK to new/additional demands of industrial customers does not do justice to the very different consumption pattern of this customer group compared to power plant customers. The majority of additional demand arises from existing industrial customers. For the existing smaller and medium-sized industrial customers, dual procurement would lead to unjustifiable additional expenditure, especially in case of a parallel offer of FZK at the virtual trade point (VTP) and fDZK in the event of congestion at the balancing entry point. Furthermore, the selection of suppliers is reduced to a few qualified companies with experience in trading at various trading points (VTP, cross-border interconnection points, storage facilities). This leads to a reduction in liquidity at the VTP.

Furthermore, the offer of two firm capacity products (FZK and fDZK) at the network connection point requires that a booking sequence and use of the products is determined within the context of an individual settlement agreement. As a rule, only one measurement will be installed at the respective network connection point, so that the measurement results must be itemised to align with the products. The separate settlement agreement to be concluded with each industrial customer is not a suitable procedure for mass use.

From the point of view of the transmission system operators, the modelling of industrial customers with fDZK would not be conducive to specific market demands and consumption patterns and would lead to a restriction of the free supplier choice.

Modelling of existing power plants with fDZK

Existing power plants that have not received an fDZK product due to an expansion claim according to section 39 GasNZV are modelled and marketed with FZK for their firm capacity shares in the current modelling. As a rule, these power plants are located on pipeline systems that feature high performance in the historical network expansion and thus enable the free allocability of firm exit capacities. The source distribution provides the corresponding pipeline systems with a sufficiently even distribution of the entry load flows. If one of the flow-mechanically close entry points is reduced in its capacity, be it by the reduction of the source due to the decrease of the methane supply or by politically caused reduction of the supplies, more distant entry points would have to be used as balancing entry points in case of a conversion to a fDZK product. However, this is already ensured in the course of establishing free allocability. If more distant balancing entry points are avoided, it can be assumed that the closer entry points will be used more in the source distribution, which simplifies the maintenance of free allocability. Thus, no significant network-relieving effect can be expected from a change in the capacity product for existing power plants. Rather, it would raise the question again as to why such product adjustments do not take place for existing power plants connected to distribution networks, which is ruled out by the systematics of internal ordering. It can therefore be assumed that other measures, such as a revision of the framework conditions for internal ordering with regard to the perpetuity guarantee and the long-term forecast, are likely to have a much stronger positive effect against the background of falling total methane consumption.

LNG power supply – security of supply

Partial fDZK entry capacity for LNG capacities

Transmission system operators are called upon to keep the extent of expansion measures for the transport of conventional methane as low as possible by using suitable capacity products efficiently.

Among other things, limited capacity products are supposed to be examined. The transmission system operators feel that it should be considered whether some of the new entry capacities can be offered as fDZK entry capacity. The allocation would be limited to a defined group of storage facilities in each case. This would promote the required minimum filling of the storage facilities during the summer/autumn. Moreover, specific transport routes could be assumed in the modelling. The quantities could also be transported away from the storage facilities via the capacities offered there (bFZKtemp or FZK).

This could help avoid having to consider the simultaneous use of entry capacities of LNG terminals and storage in the transmission system in the planning (in an additive manner).

In addition to fDZK for LNG entry capacities to storage facilities, the transmission system operators also consider LNG entry capacities to cross-border interconnection points suitable.

Swap option at European level

The transmission system operators feel that the avoidance of bottlenecks is a suitable measure while taking over methane from LNG terminals by swapping competing entry quantities at cross-border interconnection points to another congestion-free entry point in the German network with the help of other transmission system operators. Among other things, this also requires large-scale relocation options (through swap agreements) agreed at European level among the transmission system operators, which make it possible to bypass the bottlenecks in the German market area.

Storage swap agreements

In the opinion of the transmission system operators, the use of storage facilities is a suitable way to resolve situations in which a bottleneck arises due to high take-over capacities of LNG terminals.

In order to maximise the transport capacity of the methane fed into the network at the LNG terminals, it should be possible to use storage facilities located in the vicinity of the plants in order to avoid network bottlenecks in the network areas behind them.

The share of methane that cannot be transported due to a temporary transport bottleneck is temporarily stored in the storage facility. At the same time, methane is withdrawn from storage in energy-equivalent quantities beyond the bottleneck. Balancing takes place as soon as the corresponding bottleneck has dissolved.

Utilisation of swap potential by LNG tankers

The transmission system operators are of the opinion that there should be an option of being able to divert LNG tankers by sea to other facilities than the one originally planned. This management among the facilities serves to maximise transport into the German transmission networks.

This way, bottleneck-proof use of the facilities can be ensured when taking over LNG volumes; interruptions could also be minimised during maintenance work on the transmission network. In this context, the compatibility of the tankers with the LNG terminals and the port infrastructure must especially be taken into account. The different sea depths and passage restrictions could have a limiting effect. For example, an LNG operating company could perfectly plan the slots in Germany with the transmission system operators. In this case, the optimal injections for each ship could be planned between the LNG terminal operator and the transmission system operators.

10.4.3 Plausibility check and further development of the long-term forecasts of the distribution system operators

The submission of a long-term forecast by the distribution system operators is regulated in section 16 of the Kooperationsvereinbarung Gas (KoV – Cooperation Agreement Gas). The update of the internal order or reserve capacity for the next 10 years is the starting point. The specification of the long-term forecast by the distribution system operator is non-binding. Nevertheless, it must be considered in the preparation of the Gas Network Development Plan by the transmission system operators in accordance with the BNetzA. Particularly in light of the long-term conversion from methane to hydrogen in the various sectors, the assurance of a firm minimum level of natural gas capacity (perpetuity guarantee) may stand in the way of the transformation of customers and networks to hydrogen.

So far, the long-term forecast only shows in which sectors the development trends of capacity and output demand take place. Specifying qualitative categories like ‘declining’, ‘constant’ or ‘increasing’ increases the comprehensibility of these assessments on the part of the distribution network operators. The following indicators can also be included in the planning and analysis of the long-term forecast:

- Long-term development potential of sector-specific energy efficiencies
- The ratio of, among others, household, industrial and power plant customers in the network area
- The ratio of old to new buildings and the planned modernisation rate
- Local projects and subsidy programmes
- The proportion and form of new construction as well as planned heating structures
- Specifics of increasing internal ordering (e.g. heated living space in m^2)

The development and application of these indicators is the responsibility of the distribution network operators. In order to obtain a valid basis for network planning within the framework of the Gas Network Development Plan, the transmission system operators, in collaboration with the distribution system operators, perform the plausibility check of the long-term forecast required by section 16(3) KoV and thus benefit from more transparency.

Furthermore, the consideration of the natural gas perpetuity guarantee stands in the way of the further development and transformation of the methane network in the medium to long term.

For the transformation of the gas supply away from fossil methane to hydrogen, the gas-related energy demand must therefore be considered holistically.

The proven process of market-space conversion from L-gas to H-gas provides solutions that facilitate the change of gas type and simultaneously allow the conversion and continued use of existing infrastructure.

This requires an adjustment in the KoV that reduces the methane lifetime guarantee obligation for the transmission system operators in a binding manner over time, but encourages or guarantees the coverage of the customers’ energy demand with hydrogen.

This way more and more pipelines can be converted from the methane network to the hydrogen network in a stable process. Hydrogen can then be made available to a broad share of customers without relying exclusively on the construction of new hydrogen pipelines.

In addition to the plausibility check of the long-term forecasts of the distribution network operators, this section addresses their continuous development. In Chapter 10.4.1, ‘Concept for integrating the demand-based capacity approach with a scenario-based one’, the transmission system operators already show the emerging area of tension between demand-based and scenario-based planning approaches. Within the context of network development planning, it has so far been possible to regularly establish that, contrary to expectations, actual gas demand is not dropping. However, the transmission system operators do not see an artificial or even restrictive reduction in the demand for gas as a goal, especially since this would not be compatible with the statutory supply task, but rather increasingly with the transition to using carbon-neutral or climate-friendly gases.

The influence of the long-term forecasts of the distribution system operators in the creation of holistic energy scenarios should ensure that the scenarios are plausible in terms of their feasibility and show a sensible development path under consideration of actual consumption developments. Otherwise, the resulting discrepancies would pose key challenges for network development planning. These include:

- Dealing with a foreseeable shortfall in demand for hydrogen for a certain point in time.For example, this case could arise through a temporally extended long-term forecast by the distribution system operators, insofar as the reported demand for hydrogen cannot be covered, either

  > due to insufficient availability of hydrogen as an energy carrier, or

  > due to a lacking hydrogen infrastructure in the area.

  The aim is to prevent that customers can no longer be supplied due to a lack of hydrogen availability. Rather, the goal should be to prevent such a situation by setting the political course quickly to build up national hydrogen production and synchronously promote a Europe-wide hydrogen infrastructure network. This is necessary to enable a connection to international production sources and to ensure the rapid development of the national hydrogen network for the most reliable and comprehensive supply possible in Germany.

- Dealing with regions that have both hydrogen and methane demand.

  The analysis of common energy scenarios showed that after regionalisation of gas demand (includes demand for hydrogen and methane), the picture emerges that even in 2045 almost every region in Germany has a demand for both hydrogen and methane (synthetic). To satisfy such a demand structure, almost the entire network infrastructure would have to be doubled, which is not practical for various reasons. The option of primarily supplying network areas with a gaseous energy carrier is more expedient. To achieve this, the introduction of a statutory inducement right for the transmission system operator should be examined. With such an inducement right, comparable in principle to the current section 19a EnWG for the conversion from L-gas to H-gas, the conversion of certain network areas to hydrogen could be achieved by a defined deadline. It should be discussed whether such an inducement right should be linked to certain criteria relating to the downstream consumer and network structure. This could be supported by the fact that the selective supply of sensitive consumers who, for example, cannot use hydrogen for energy or need methane for material use, could also be carried out by local PtG plants including methanation, biogas plants or, in for very small quantities, by trailers, depending on the amount of capacity. The next challenge arises from this possible approach.

- Dealing with customers who refuse the supply of an energy carrier (hydrogen or methane) proposed by the transmission system operators and/or as a consequence cannot meet the climate targets.

  To prevent such a situation, close and early coordination between transmission system operators and their customers is imperative. An early dialogue offers customers on the transmission network the opportunity to prepare themselves sufficiently for a potentially imminent pipeline conversion process to hydrogen and, supported by the above-mentioned right of the transmission system operator to induce the process, to make appropriate preparations. If, for various reasons, it is still not possible for a customer to switch to hydrogen as an energy carrier in general or at the appropriate time, individual solutions can be found. Regardless of the various challenges and possible solution options, one thing must always be kept in mind: In the end, it must be possible to cover the energy performance balance for the customer at all times.

For the continuous development of the overall process, close collaboration and coordination with the distribution system operators is absolutely necessary. Initial discussions hereto between transmission and distribution system operators have already taken place, especially during the preparation of the Hydrogen Report.

At the level of the distribution system operators, 33 companies from the gas industry discussed together with the DVGW in October 2020 within the setting of the 'H2vorOrt' project how the future regional and secure supply of carbon-neutral gases can be specifically designed. Consequently, the DVGW, together with H2vorOrt and the Verband kommunaler Unternehmen e. V. (VKU - German Association of Local Public Utilities), is working on a transformation process of the gas distribution networks and initiated the first-time creation of the GTP across all distribution network operators. The GTP is made up of individual plans of the distribution network operators and considers the 'H2 readiness' of networks and plants, technical conversions of individual network sections based on this, as well as further concepts for achieving climate neutrality.

A more detailed process description and a concept for hydrogen network planning were submitted to the BNetzA by the transmission system operators as part of the preparation of the Hydrogen Report on 1 September 2022.

10.4.4 Further development of integrated network planning (hydrogen and methane)

For the transmission system operators, the term 'integrated network planning' refers to the network planning integration of hydrogen and methane network planning as part of the further development of a holistic view of the energy system. It is economically efficient and technically possible to develop the hydrogen infrastructure from the methane network and to convert existing methane pipelines for exclusive transport of hydrogen. This presupposes that both networks are also considered as a unit in terms of network planning and that network planning is carried out in an integrated manner. This is very important because, in addition to the hydrogen ramp-up, the supply of methane (increasingly biomethane and synthetic methane) and transits to neighbouring countries must continue to be ensured.

A holistic view of the energy system is necessary. With the help of holistic energy scenarios, this planning will primarily take place in the following areas:

- In the use of a common, upstream set of assumptions that finds its way into the scenario-based modelling of the electricity, methane and hydrogen networks,
- through close coordination processes for the consistent location of central interconnecting elements, such as PtG plants, and
- the synchronisation of the gas and electricity Network Development Plans.

The common set of assumptions should be the result of an upstream process. The operators of electricity, methane and hydrogen networks at transmission, pipeline and distribution network level should be central stakeholders in such a process. This is imperative, as their expertise enables them to critically question the feasibility of a scenario, among other things. A scenario that is highly unlikely to be realised by the existing and yet to be built energy infrastructure does not bring any added value. An evaluation of complete energy scenarios is therefore not expedient without the expertise of the infrastructure operators.

The common set of assumptions should include the following parameters, among others:

- Electricity, hydrogen and methane production and demand; regionalised by sector
- Import and export capacities for electricity, hydrogen and methane; by country of origin
- Methane should be distinguished between fossil (natural gas) and carbon-neutral (biogas, synthetic methane) energy sources
- Storage capacities for electricity, hydrogen and methane
- Electrolysis capacity for PtG plants (differentiated according to on- and off-site as well as offshore plants) and power plant capacity for electricity and heat generation as well as their connected loads and full load hours
- Development paths for renewable energy generation

This list represents the minimum requirements in the opinion of the transmission system operators that would allow using such an assumption set sensibly. The parameters must be supplemented accordingly with other input parameters relevant for electricity network modelling.

In the interest of more mutually coordinated planning processes, the timing of Network Development Plans for gas and electricity should be harmonised. Such a synchronisation would have to be stipulated by the legislator in the EnWG in a timely manner. The transmission system operators would like to emphasise once again that in these synchronisation cases, separate Scenario Frameworks and Network Development Plans should continue to be drawn up. The goal should only be a common scenario basis and chronological harmonisation. Further processes, e.g. for the long-term forecast, the TYNDP and Incremental Capacity, must be reflected in the corresponding harmonisation process.

10.4.5 Consideration of the pipeline conversion process from methane to hydrogen

As part of the preparation of the Hydrogen Report in accordance with section 28q EnWG, the transmission system operators were already in close contact with the operators of the regional distribution networks. One of the central topics in this close coordination was the consideration of the pipeline conversion process from methane to hydrogen. For a detailed description of the hydrogen conversion process, the transmission system operators refer to the publication of the Hydrogen Report of 1 September 2022.

10.4.6 Consideration of the network-optimised allocation of electrolysers from the perspective of distribution and transmission system operators

Current developments regarding the determination of network-optimised locations for PtG plants have led to the conclusion that an isolated consideration of the topic within the scope of the Gas Network Development Plan does not make sense. Accordingly, the transmission system operators refer to the activities in connection with the dena network study 3 and the follow-up project Systementwicklungsstrategie (SES - System Development Strategy), which is supposed to be continued under the leadership of the BMWK.

10.4.7 Conclusion

The areas of activity presented in this chapter illustrate the clear vision of the transmission system operators and the ideas on how they can use their infrastructure to make a significant contribution to implementing the requirements of the Climate Protection Act and achieving climate neutrality by 2045 and beyond. The conversion of methane networks to hydrogen can ensure the security of supply, economic efficiency as well as environmental compatibility of the energy supply in the long term. The geopolitical situation not only highlights the importance of these three factors, but also emphasises the relevance of a fourth dimension: the speed of transformation. Germany will only succeed in continuing to guarantee a secure, low-cost and environmentally compatible energy supply if the transformation of the methane networks, both for the development of new sources and for the transport of hydrogen, is expedited as much as possible.

The scope for action of the transmission system operators is currently limited by the existing legal framework. Thus, the implementation of many of the proposed measures or processes is not possible. It is therefore even more important that politicians and legislators promptly create a clear framework for implementing the measures described in this chapter. To this end, with the publication of the Hydrogen Report, the transmission system operators have developed 12 specific recommendations to the BNetzA as well as to the legislator. The rapid implementation of these recommendations is a prerequisite for the success of the decarbonisation of the network-based energy infrastructure and the ramp-up of the hydrogen economy. For a detailed description of this transformation and planning process, the transmission system operators refer to the Hydrogen Report published on 1 September 2022 pursuant to section 28q EnWG.

Appendices

Appendix 1: Analysis of the additional demands of the distribution system operators

In accordance with operative provision 10 of the confirmation of the Scenario Framework 2022, the transmission system operators were required to specify the distribution system operators for which additional demand of more than 3 % was determined for 2027 compared to the internal orders for 2022 according to their plausible long-term forecasts. For these distribution system operators, the specific additional demand must be reported in total as well as the share attributable to the connection of new network areas with household customers. The transmission system operators have fulfilled this obligation with this appendix:

https://fnb-gas.de/wp-content/uploads/2022/12/EN_FNB_Gas_2022_Annex_1_Analysis-of-additional-demands.pdf

Appendix 2: Overview of all project reports within the framework of the WEB and Green Gases Market Survey

A detailed overview of all project notifications within the scope of the WEB and Green Gases Market Survey is published on the website of the FNB Gas in the form of an Excel file:

https://fnb-gas.de/wp-content/uploads/2022/12/2022_12_16_Konsultation-NEP-2022_Anlage-2_Projektmeldungen-WEB.xlsx

Appendix 3: Results of pipeline network infrastructures for the development of the potential German hydrogen network within the Gas NDP 2022–2032

The results of the pipeline network infrastructures for the development of the potential German hydrogen network within the Gas NDP 2022–2032 are published on the website of FNB Gas in the form of an Excel file:

https://fnb-gas.de/wp-content/uploads/2022/12/2022_12_16_Konsultation-NEP-2022_Anlage-3_Ergebnisliste_Leitungsnetzinfrastruktur.xlsx

Appendix 4: Overview maps of pipeline network infrastructures for the development of the potential German hydrogen network within the Gas NDP 2022–2032

The overview maps of the pipeline network infrastructures for the development of the potential German hydrogen network within the Gas NDP 2022–2032 are published on the website of FNB Gas in the form of a PDF file:

https://fnb-gas.de/wp-content/uploads/2022/12/2022_12_16_Konsultation-NEP-2022_Anlage-4_Uebersichtskarten-Leitungsnetzinfrast.pdf

Appendix 5: Hydrogen Review Results

The results of the Hydrogen Review are published in the following Appendix on the website of FNB Gas:

https://fnb-gas.de/wp-content/uploads/2022/12/EN_FNB_Gas_2022_Annex_5_Hydrogen_Review_Results.pdf

Appendix 6: Network expansion measures

The table provides an overview of the network expansion measures in the various modeling variants of the Gas Network Development Plan 2022-2032:

https://fnb-gas.de/wp-content/uploads/2022/12/EN_FNB_Gas_2022_Annex_6_Network-expansion-measures.pdf

Glossary

Transmission system operators

bayernets	bayernets GmbH
Ferngas	Ferngas Netzgesellschaft mbH
Fluxys	Fluxys TENP GmbH
Fluxys D	Fluxys Deutschland GmbH
GASCADE	GASCADE Gastransport GmbH
GRTD	GRTgaz Deutschland GmbH
GTG Nord	Gastransport Nord GmbH
GUD	Gasunie Deutschland Transport Services GmbH
LBTG	Lubmin-Brandov Gastransport GmbH
NGT	NEL Gastransport GmbH
Nowega	Nowega GmbH
OGE	Open Grid Europe GmbH
OGT	OPAL gastransport GmbH & Co. KG
ONTRAS	ONTRAS Gastransport GmbH
terranets	terranets bw GmbH
Thyssengas	Thyssengas GmbH

Other abbreviations

bar	Pressure in relation to sea level
bFZK(temp)	Bedingt feste frei zuordenbare Kapazität – conditionally firm freely allocable capacity: capacity is fixed if usage/gas flow-dependent conditions are met (temperature-dependent)
BImSchG	Bundes-Immissionsschutzgesetz – Federal Immission Control Act
BMWK	Bundesministerium für Wirtschaft und Klimaschutz - German Federal Ministry of Economics and Climate Protection
BNetzA	Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen – German Federal Network Agency for Electricity, Gas, Telecommunication, Post and Railways
BVEG	Bundesverband Erdgas, Erdöl und Geoenergie e. V. – German Federal Association for Natural Gas, Petroleum and Geoenergy
CS	Compression station
dena	Deutsche Energie-Agentur – German Energy Agency
DN	Standard diameter
DP	Design pressure
DSO	Distribution system operator
DVGW	Deutscher Verein des Gas- und Wasserfaches e. V. – German Technical and Scientific Association for Gas and Water
EHB	European Hydrogen Backbone Initiative
Entry	Injection

ENTSOG	European Network of Transmission System Operators Gas
EnWG	Energiewirtschaftsgesetz – Energy Industry Act
EUGAL	Europäische Gas-Anbindungsleitung – European Gas Pipeline Link
Exit	Withdrawal
fDZK	Feste dynamisch zuordenbare Kapazität – firm dynamically allocable capacity: Capacity is fixed if it can be used without a VTP for balanced transmission between entry and exit capacities with a nomination obligation.
FID	Final investment decision
FSRU	Floating Storage and Regasification Units
FZK	Frei zuordenbare Kapazitäten – freely allocable capacity, enables booked entry and exit capacities to be used without stipulating a transmission path
GasNEV	Gasnetzentgeltverordnung – Gas Network Charges Ordinances
GasNZV	Verordnung über den Zugang zu Gasversorgungsnetzen/Gasnetzzugangsverordnung German Gas Network Access Regulation
GCA	Gas Connect Austria GmbH
GPCM	Gas pressure control and measuring station
Green gases	Hydrogen and synthetic methane
GTP	Gas Network Area Transformation Plan
GTS	Gasunie Transport Services B. V.
GuD	Gas-und-Dampf – gas and steam (plant)
GWh	Gigawatt hour
H2	Hydrogen
H-gas	Natural gas with a high calorific value
ID	Identification number
IP	(cross-border) interconnection point
IPCEI	Important Projects of Common European Interest
IR	Implementation Report
ITO	Independent Transmission Operator
KNEP	Koordinierter Netzentwicklungsplan – Coordinated Network Development Plan (of Gas Connect Austria)
KoV	Kooperationsvereinbarung – co-operation agreement between the operators of gas supply networks located in Germany
kWh	Kilowatt hour
Lead compressor	Compressor units used at cross-border interconnection points in order to increase the injection pressure into the transmission network and to guarantee the transport of gas
L-gas	Natural gas with a low calorific value
LNG	Liquefied natural gas
LNGG	Gesetz zur Beschleunigung des Einsatzes verflüssigten Erdgases – Act to Accelerate Use of Liquefied Natural Gas

Loop	Pipeline laid parallel to an existing pipeline
m^3	Cubic metre. Unless otherwise specified, a volume at normal conditions is to be understood by this.
Mainline compressor	Compressor units used in a transport pipeline to compensate for pressure loss and to ensure the transport of gas
MBI	Market-based instruments
MEGAL	Mittel-Europäische Gasleitung(sgesellschaft) – Central European Gas Pipeline (company)
MIDAL	Mitteldeutsche Anbindungsleitung – Central German connecting pipeline
MOP	Maximum Operating Pressure
MoU	Memorandum of Understanding
MWh	Megawatt hour
NDP	Network Development Plan
NEL	Nordeuropäische Erdgas-Leitung – Northern Europe Natural Gas Pipeline
NETG	Nordrheinische Erdgastransportgesellschaft (gas shipper)
NewCap	Model for determining the market-based instruments
NC CAM	Network Codes Capacity Allocation Mechanisms
Nm^3	Normkubikmeter – standard cubic metre
NIP	Network interconnection point
OPAL	Ostsee-Pipeline-Anbindungsleitung – Baltic Sea pipeline link
PCI	Project of Common Interest
PtG	Power-to-Gas
SEL	Süddeutsche Erdgasleitung – Southern German Gas Pipeline
SES	Systementwicklungsstrategie - System Development Strategy
SF	Scenario Framework
SNG	Synthetic Natural Gas
TAP	Trans-Adriatic Pipeline
TENP	Trans Europa Naturgas Pipeline
THE	Trading Hub Europe
TSO	(Gas) transmission system operator
TWh	Terawatt hour
TYNDP	Ten-Year Network Development Plan (from ENTSOG)
UGS	Underground gas storage
VIP	Virtual Interconnection Point
VTP	Virtual Trading Point
VKU	Verband kommunaler Unternehmen e. V. – German Association of Local Utilities
WEB	Wasserstoffabfrage für Erzeugung und Bedarf und Grüne Gase - Hydrogen Generation and Demand and Green Gases Market Survey

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