FNB Gas
DIE FERNLEITUNGSNETZBETREIBER

Gas Network Development Plan 2022–2032

Scenario Framework

Consultation

Transmission system operators

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FNB Gas DIE FERNLEITUNGSNETZBETREIBER

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Scenario framework

Gas Network Development Plan 2022–2032 commissioned by the German transmission system operators (TSOs)

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Executive summary

Executive summary

Hydrogen and green gases are playing an important role in the transformation of the energy system. The transmission system operators started work on the planning of a hydrogen infrastructure in the Gas Network Development Plan 2020-2030, in which they have shown that a hydrogen infrastructure can already be made available in the medium term.

For the Gas Network Development Plan 2022–2032, the transmission system operators conducted the second WEB and Green Gases Market Survey (Wasserstoffabfrage Erzeugung und Bedarf – hydrogen generation and demand survey), in which 500 project reports were received. In addition to the demand-based planning for the existing natural gas network, the growing importance of hydrogen and green gases demands its own modelling variant.

To model the natural gas infrastructure, the transmission system operators propose a base variant that is, from their perspective, based on suitable assumptions concerning a demand-based and forward-looking expansion of the network.

This document provides an outlook on the development of the demand for methane and hydrogen up to 2032 and beyond to 2050. The basis for this is provided by the dena-TM95 scenario, which has been adapted by the transmission system operators to the current trends in the energy sector and shows the potential of gaseous energy sources for the decarbonisation process.

In addition to the domestic demand for hydrogen of 191 TWh (low calorific value) for the period up to 2032, the demand for 2040 and for 2050 were also reported in the WEB and Green Gases Market Survey. The reported demand for hydrogen amounts to around 342 TWh (low calorific value) in 2040 and around 476 TWh (low calorific value) in 2050.

The future demand for methane shows a stable development up to the target planning year of 2032. Thus, the infrastructure for the transport of methane continues to have a great importance. The transmission system operators continue to put great importance to the secure supply of their customers and take planned additional demand and connection requests into account.

In order to achieve a more integrated network planning between the energy carriers electricity and gas in the future, adjustments to the existing processes of network development planning are necessary in addition to the prior discussions on energy and climate policy goals. The electricity and gas transmission system operators intend to continue the dialogue with the BNetzA in order to initiate the next steps for synchronising the network development planning.

Introduction 1

1 Introduction

With a network extending approximately 40,000 km in length, the German transmission networks form the backbone of the gas infrastructure in Germany and constitute with over 30 cross-border interconnection points the hub at the heart of Europe. The distribution networks that are fed by the transmission network are more than 470,000 km long. With gas infrastructure that is being expanded to meet demand, the German transmission system operators are making an essential contribution to a secure energy supply.

The secure supply of natural gas is crucial for Germany's energy system and its position as an economic hub especially in the short and medium term. The transmission system operators continue to address this task with a sense of great responsibility.

The existing gas infrastructure will play a decisive role in the energy system of the future, as very large volumes of renewable energy can be both shipped through and stored in Germany and used to securely cover seasonal or short-term production and demand peaks. Through the integration of hydrogen and green gases in the existing infrastructure, a significant contribution can be made swiftly and cost-efficiently to the reduction of greenhouse gas emissions.

Hydrogen and green gases constitute flexible, storable and cost-efficient energy sources. Power-to-gas (PtG) in particular offers great and so far unused potential for sector coupling. Intelligently connecting gas, electricity, heating and mobility infrastructure, sector coupling is one of the crucial levers for the successful implementation of the energy transition.

The transmission system operators started work on the planning for the expansion of hydrogen infrastructure in the last Gas Network Development Plan 2020–2030, where they showed that this can already be made available in the medium term.

In the view of the transmission system operators, the expansion of economic and demand-based gas infrastructure will be possible only if there is an integrated methane and hydrogen network plan. In this way, it can be ensured that the future production potential of hydrogen and green gases can be optimally combined with the potential applications of today and of the future.

For this reason, the transmission system operators conducted a new WEB and Green Gases Market Survey (Wasserstoffabfrage Erzeugung und Bedarf – hydrogen generation and demand survey) of green gas projects from 11 January 2021 to 16 April 2021 in order to identify the demand for transporting hydrogen. The demand for transporting methane and hydrogen will be identified and planned based on this survey and other input parameters. This procedure will create a secure planning basis for market participants and open up a variety of potential uses for hydrogen.

The primary task of gas network operators is to plan, prepare and carry out the conversion of natural gas transport systems. Various reasons can be cited for this:

- Connecting sources and sinks through pipeline infrastructure extending across state borders is the traditional task of transmission system operators.
- The choice of locations for P2G facilities has to be made by the market participants in consultation with the gas and electricity transmission system operators. In this way, plants providing grid services can be positioned optimally within both the electricity and gas grids, and the costs of expanding the grid infrastructures can be reduced.
- In the last few years, the transmission system operators have shown that integrated planning for converting L-gas to H-gas is the best way to carry out the conversion optimally, effectively and quickly.

The Gas Network Development Plan has proved successful as a central management instrument for L-to-H-gas conversion, especially for the long-term planning of the conversion. The involvement of the relevant market participants is ensured by a variety of public consultation processes. Furthermore, the close connection between L-to-H-gas conversion and network expansion can be taken into account by mapping the L-to-H-gas conversion in the Gas Network Development Plan. The aspects relevant for the L to H-gas conversion can also be applied in similar fashion to any conversion to hydrogen.

With this document, the transmission system operators fulfil their statutory duty to produce the Scenario Framework pursuant to Section 15a of the Energiewirtschaftsgesetz (EnWG – German Energy Industry Act). The transmission system operators present scenarios with different development paths up to 2050 that take the political target of a climate-neutral energy transition into consideration.

With this Scenario Framework, the transmission system operators create the basis for their modelling of flows and the network expansions measures that will be derived from that. The proposed modelling variants build in principle on the Gas Network Development Plan 2020–2030. A hydrogen variant is again examined in addition to the base variant.

Timeline 2

2 Timeline of the Scenario Framework and the Gas Network Development Plan 2022–2032

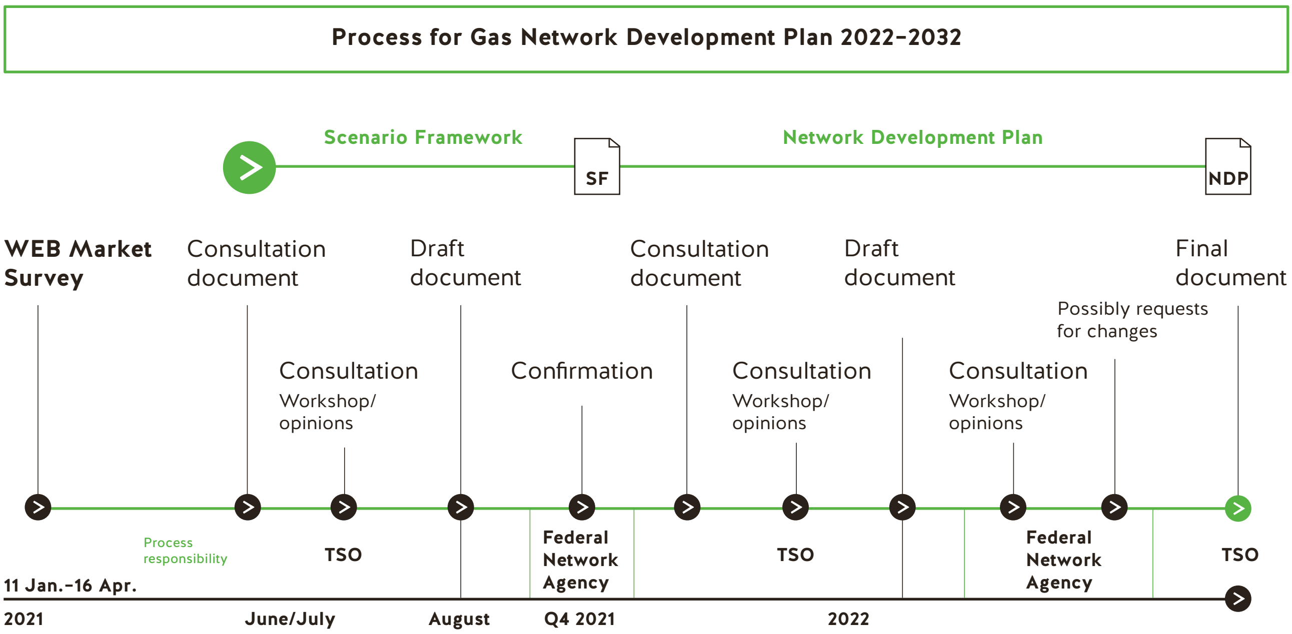
With the publication of the consultation document for the Scenario Framework 2022 on 21 June 2021, the transmission system operators have reached an important milestone on the path to the Gas Network Development Plan 2022–2032. The Scenario Framework 2022 will be published for consultation from 21 June 2021, to 16 July 2021, when the general public and the market will be given the opportunity to express their views on it. The consultation workshop will also be held on 1 July 2021.

After the consultation period has ended, the views that have been received will be assessed and the result of the consultation will be incorporated in the draft Scenario Framework 2022. The transmission system operators plan to submit the revised Scenario Framework 2022 to the BNetzA in August 2021. The regulatory authority will then take the results of the public consultation into consideration and subsequently confirm the Scenario Framework 2022.

The transmission system operators will carry out the modelling for the Network Development Plan on the basis of the confirmed Scenario Framework 2022. They will then open up the Network Development Plan for consultation. After the consultation period has ended, the views that have been received will be assessed and the result of the consultation will be incorporated in the draft Gas Network Development Plan 2022–2032.

The BNetzA will subsequently give a hearing once more to all actual and potential network users concerning the draft Gas Network Development Plan 2022–2032 that has been submitted by the transmission system operators and publish the results. The regulatory authority can subsequently request changes to the Gas Network Development Plan, which have to be incorporated by the transmission system operators within three months.

Figure 1: Overview of the Scenario Framework for the Gas Network Development Plan 2022–2032



Source: Transmission system operators

Synchronisation of the Network Development Plan processes for electricity and gas

In addition to the discussion on an upstream process for taking targets in energy and climate policy into account (cf. dena Network Study III), adjustments to the existing processes involved in the Network Development Plan are also necessary in order to achieve a network plan that is more closely integrated between the energy sources electricity and gas in the future.

A consensus on the consideration of joint framework parameters in the processes of both the electricity and gas network development plans is emerging here. Moreover, the parties involved agree that an assessment of possible development paths depends essentially on identifying cross-sector potential for optimisation.

A comparison between the electrical and gas network planning of the electricity and gas transmission system operators is currently guaranteed through the mutual consideration of individual planning assumptions, such as existing and new build power plants, scale of electrolysis capacity and potential locations. Reference is thus made in the processes to draw up the planning assumptions, which are conducted one after the other, to the document that has previously been approved and confirmed by the BNetzA.

Against the background of planning that is optimised on a cross-sector basis and that is envisaged and required by the electricity and gas transmission system operators, this procedure that has been practised up to now should be further improved.

For example, defining parameters for an integrated electricity and gas energy system will require both that the planning horizons are standardised and that the actual planning processes are handled synchronously. Only in this way can it be ensured that the same premises will be assumed in the relevant processes.

The electricity and gas transmission system operators intend to continue the dialogue with the BNetzA in order to initiate the next steps towards synchronising the network development plans.

Capacity demand pursuant to sections 38/39 GasNZV – WEB and Green Gases Market Survey

3

3 Capacity demand pursuant to sections 38/39 GasNZV – WEB and Green Gases Market Survey

This chapter presents the criteria that have been revised by the transmission system operators for considering capacity reservations/capacity expansion claims in accordance with sections 38/39 of the Gasnetzzugangsverordnung (GasNZV – German Gas Network Access Regulation) (cf. chapter 3.1). It then explains the consideration of power plants (cf. chapter 3.2), storage facilities (cf. chapter 3.3), LNG facilities (cf. chapter 3.4) and production facilities (cf, chapter 3.5). New projects based on the capacity reservations/capacity expansion claims pursuant to sections 38/39 GasNZV that have been submitted to the transmission system operators are addressed in particular here. Chapter 3.6 reports the results from the WEB and Green Gases Market Survey, which the transmission system operators conducted from 11 January 2021 to 16 April 2021.

3.1 Criteria for considering capacity reservations and capacity expansion claims pursuant to sections 38/39 GasNZV

Storage, production and LNG facilities and also power plants are taken into consideration based on the capacity reservations/capacity expansion claims pursuant to sections 38/39 GasNZV that have been submitted to the transmission system operators. The transmission system operators published a survey on the website of FNB Gas on 11 January 2021 in order to take new projects with claims pursuant to sections 38/39 GasNZV into consideration in the Scenario Framework 2022. The cut-off date for the review of projects for consideration in the consultation document of the Scenario Framework 2022 was 31 March 2021. Applications for capacity reservation pursuant to section 38 GasNZV that had not yet been decided by 31 March 2021 are taken into provisional consideration in the consultation document of the Scenario Framework 2022 on account of the processing times. The following criteria, which were published on the FNB Gas website on 11 January 2021, are applied for including projects with capacity reservations/capacity expansion claims pursuant to sections 38/39 GasNZV in the Scenario Framework 2022.

- The capacity demand of a project for which the application for capacity reservation pursuant to section 38 GasNZV had been approved by 1 July 2020 is taken into consideration in the Scenario Framework 2022 if a capacity reservation had been made by 31 March 2021. A precondition for an effective capacity reservation is the payment of the annual reservation fee by the connection applicant (section 38 (3) sentence 6 in conjunction with section 38 (4) sentence 2 GasNZV).
- The capacity demand of a project for which the application for capacity reservation pursuant to section 38 GasNZV has been approved is not taken into consideration in the Scenario Framework 2022 if the applicant has not made use of the option to make a reservation.
- The capacity demand of a project for which the application for capacity reservation pursuant to section 38 GasNZV had been rejected by 1 July 2020 is not taken into consideration in the Scenario Framework 2022 if a capacity expansion claim pursuant to section 39 GasNZV had not been asserted by 31 March 2021.
- The capacity demand of a project for which the application for capacity reservation pursuant to section 38 GasNZV was approved between 1 July 2020 and 31 March 2021 is taken into consideration in the Scenario Framework 2022 if a capacity reservation is made by the end of the consultation period on 16 July 2021 and the applicant has verifiably not withdrawn from its connection planning in the meantime. A precondition for an effective capacity reservation is the payment of the annual reservation fee by the connection applicant (section 38 (3) sentence 6 in conjunction with section 38 (4) sentence 2 GasNZV).
- The capacity demand of a project for which the application for capacity reservation pursuant to section 38 GasNZV is approved between 31 March 2021 and 16 July 2021 is taken into consideration in the Scenario Framework 2022 if a capacity reservation is made by 1 August 2021 and the applicant has verifiably not withdrawn from its connection planning in the meantime. A precondition for an effective capacity reservation is the payment of the annual reservation fee by the connection applicant (section 38 (3) sentence 6 in conjunction with section 38 (4) sentence 2 GasNZV).
- The capacity demand of a project for which the application for capacity reservation pursuant to section 38 GasNZV has not been decided on by the end of the consultation period on 16 July 2021 on account of the processing times pursuant to section 38 is taken into consideration in the Scenario Framework 2022 if the applicant has verifiably not withdrawn from its connection planning in the meantime.

- A capacity expansion claim pursuant to section 39 GasNZV that was already included in the Gas Network Development Plan 2020–2030 is taken into consideration in the Scenario Framework 2022 if the binding implementation schedule pursuant to section 39 (2) GasNZV has been finalised by 31 March 2021 or the payment of the flat-rate planning fee pursuant to section 39 (3) GasNZV has been made by the applicant and the applicant has verifiably not withdrawn from its connection planning in the meantime. This criterion is not applied, as the change request concerning the Gas Network Development Plan 2020–2030 was published after the cut-off date of 1 February 2021 published in the criteria of 11 January 2021. The relevant capacity expansion claim pursuant to section 39 GasNZV is taken into consideration in the Scenario Framework 2022 if the applicant has verifiably not withdrawn from its connection planning in the meantime.

- A capacity expansion claim pursuant to section 39 GasNZV that was not included in the Gas Network Development Plan 2020–2030 and was submitted by 31 March 2021 is taken into consideration in the Scenario Framework 2022 if the implementation schedule pursuant to section 39 (2) GasNZV has been finalised by the end of the consultation period on 16 July 2021 or the payment of the flat-rate planning fee pursuant to section 39 (3) GasNZV has been made by the applicant and the applicant has verifiably not withdrawn from its connection planning in the meantime. Projects are also taken into consideration in the Scenario Framework 2022 if the applicant and the transmission system operators are conducting concrete negotiations on the implementation schedule and the network connection at least at the present moment and the applicant has furnished proof that their project has made specific planning progress.

- A capacity expansion claim pursuant to section 39 GasNZV that has been submitted between 31 March 2021 and 16 July 2021 is taken into consideration if the applicant has verifiably not withdrawn from its connection planning in the meantime.

The transmission system operators have had to specify various reporting dates for defining the criteria for including projects with capacity reservations / capacity expansion claims in accordance with sections 38 / 39 GasNZV. The reasons for this are described below:

- 31 March 2021 was selected as the reporting date for compiling the consultation document for the Scenario Framework 2022 in order to enable the necessary information for the publication to be prepared. This reporting date was published on the FNB Gas website in January.

- 1 July 2020 was selected as the reporting date in order to identify “old” capacity reservations / capacity expansion claims pursuant to sections 38 / 39 GasNZV. This is because this reporting date is roughly one year before the start of the consultation for the Scenario Framework 2022 and is necessary in the view of the transmission system operators in order to appropriately assess requests where the project has not recorded any progress.

- The reporting date of 16 July 2021 is set as the time limit by which capacity reservations / capacity expansion claims pursuant to sections 38 / 39 GasNZV can still be made on the one hand. On the other, activities specified depending on the criterion have to be carried out by no later than this reporting date for a project to be taken into consideration in the Scenario Framework 2022. The consultation period for the Scenario Framework 2022 ends on this date. The reporting date of 1 August 2021 applies for current applications for capacity reservation pursuant to section 38 GasNZV that have been approved between 31 March 2021 and 16 July 2021. This is the last possible time by which the transmission system operators can still incorporate current developments in the Scenario Framework 2022.

The projects that are currently considered and not considered as of the reporting date of 31 March 2021 are listed in the chapters 3.2 to 3.5 below. The transmission system operators point out that the inclusion of some current capacity reservations / capacity expansion claims pursuant to sections 38 / 39 GasNZV in the Draft Scenario Framework 2022 is still open based on the criteria that have been formulated. This is flagged accordingly in the tables in the following chapter. Furthermore, there is the possibility that further capacity reservations / capacity expansion claims pursuant to sections 38 / 39 GasNZV will be received by the transmission system operators by the end of the consultation period for the Scenario Framework 2022.

3.2 Power plants

The systemically important gas power stations on the network of the transmission system operators are presented to begin with in chapter 3.2.1. Which new gas power plants are taken into consideration pursuant to sections 38/39 GasNZV in the consultation document of the Scenario Framework 2022 on the basis of the criteria described above and which are currently not considered are presented afterwards (cf. chapter 3.2.2). The special network operating equipment in southern Germany is then described (cf. chapter 3.2.3).

3.2.1 Systemically important power plants

Table 1 shows the systemically important gas power plants that are connected directly to the network of the transmission system operators. The detailed list of power plants with all systemically important power plants is published in the NDP gas database.

Table 1: Systemically important power plants connected directly to the network of the transmission system operators

No.	Power plant number	Name of power plant	Scheduled exit capacity (MWh/h)	TSO	Allocation point	2027	2032
1	BNA0172	Dampfkraftwerk BGH – O1	710	bayernets GmbH	–	BZK	BZK
2	BNA0374	Staudinger 4	1,914	OGE	–	FZK	FFZK
3	BNA0514	Rheinhafen-Dampfkraftwerk, Karlsruhe	740	OGE	Wallbach	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 1, Nuremberg	0**	OGE	–	–	–
8	BNA0745	Franken 1 2, Nuremberg	0**	OGE	–	–	–
9	BNA0857	Rüsselsheim gas and steam plant	445	OGE	–	FZK	FZK
10	BNA0994	Gemeinschaftskraftwerk Irsching 5	1,700	OGE	–	FFZK	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 GmbH	–	FZK	FZK
			180	bayernets GmbH	Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn, Wolfersberg, Inzenham- West USP	fDZK	fDZK
14	BNA1248b	HKW 3 UPM Schongau	150	bayernets GmbH	–	FZK	FZK
			70	bayernets GmbH	Haiming 2-7F/bn, USP Haidach, Haiming 2-RAGES/bn, Wolfersberg, Inzenham-West USP	fDZK	fDZK

* Not published for reasons of third-party trade secrets
** Dual firing

Source: Transmission system operators based on power station lists and notices relating to systemically important gas power stations from the BNetzA, BNetzA 2021a, BNetzA 2021b

The systemically important power plants connected to the network of the transmission system operators are modelled by the transmission system operators in the Gas Network Development Plan 2022–2032 for the target years 2027 and 2032. None of the power plants shown in table 1 can be found in the currently published power plant decommissioning list of the BNetzA.

3.2.2 Consideration of new gas power plants in the Scenario Framework

In accordance with the criteria described in chapter 3.1, the following power plant requests pursuant to sections 38/39 GasNZV are taken into consideration in the consultation document for the Scenario Framework 2022.

Table 2: Plans for the construction of new gas power stations on the network of the transmission system operators taken into consideration in the consultation document of the Scenario Framework 2022 (reporting date: 31 March 2021)

TSO	Federal Network Agency number	Project name	Gas type (H-gas / L-gas)	Gas connection capacity [MW]	Status	Consideration in the consultation document of the SF 2022 (yes / no)	Consideration in the draft document of the SF 2022 (yes / no / open)	Allocation point	Reason / applicable criterion (updated 31 March 2021)
bayernets	BNAP 114	GK Leipheim (Block 1)	H-gas	950	Section 39 GasNZV	yes	yes	Überackern 2, Überackern	• Implementation schedule finalised, • Flat-rate planning fee paid, • Connection applicant has not withdrawn, • Special network operating equipment
bayernets	BNAP 219	GK Leipheim (Block 2)	H-gas	950	Section 39 GasNZV	yes	yes	Überackern 2, Überackern	• Implementation schedule finalised, • Flat-rate planning fee paid, • Connection applicant has not withdrawn
bayernets	BNAP 124	KW Gundremmingen	H-gas	1,500	Section 39 GasNZV	yes	yes	Haiming 2-7F /bn, USP Haidach, Haiming 2-RAGES/bn	• Implementation schedule finalised, • Planning fee not paid, • Connection applicant has not withdrawn
GASCADE	not published	Staudinger	H-gas	–*	Section 38 GasNZV	yes	yes	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	• Capacity reservation made, • Connection applicant has not withdrawn
GUD	not published	Kraftwerk Mehrum	H-gas	1,450	Section 38 GasNZV	yes	open	will be defined in the course of the modelling	• Section 38 application not yet decided
GUD	BNAP 116	GHWW VW2	H-gas	920	Section 39 GasNZV	yes	yes	Ellund, Greifswald, UGS Harsefeld, UGS Uelsen, UGS Etzel, UGS Jemgum EWE	• Implementation schedule finalised, • Flat-rate planning fee paid, • Connection applicant has not withdrawn
OGE	BNAP 180	Kraftwerk Scholven	H-gas	40	Section 38 GasNZV	yes	yes	Epe H storage facility	• Capacity reservation made, • Connection applicant has not withdrawn
OGE	BNAP 215	Kraftwerk Irsching	H-gas	1,000	Section 38 GasNZV	yes	yes	Speicher Bierwang, Speicher Breitbrunn, Haiming 2 7F	• Capacity reservation made, • Connection applicant has not withdrawn, • Special network operating equipment

TSO	Federal Network Agency number	Project name	Gas type (H-gas / L-gas)	Gas connection capacity [MW]	Status	Consideration in the consultation document of the SF 2022 (yes / no)	Consideration in the draft document of the SF 2022 (yes / no / open)	Allocation point	Reason / applicable criterion (updated 31 March 2021)
OGE	not published	Kraftwerk Biblis	H-gas	973	Section 38 GasNZV	yes	yes	Dornum	• Capacity reservation made, • Connection applicant has not withdrawn, • Special network operating equipment
terranets	BNAP 137	Gasturbine Heilbronn	H-gas	1,200	Section 39 GasNZV	yes	yes	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	• Implementation schedule finalised, • Flat-rate planning fee paid, • Connection applicant has not withdrawn
terranets	BNAP 135	GuD-Anlage Altbach	H-gas	1,200	Section 39 GasNZV	yes	yes	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	• Project included in Gas NDP 2020–2030, • Connection applicant has not withdrawn
terranets	BNAP 231	GuD-Anlage Marbach	H-gas	800	Section 39 GasNZV	yes	yes	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	• Project included in Gas NDP 2020–2030, • Connection applicant has not withdrawn
terranets	not published	GuD-Anlage Aalen	H-gas	316	Section 39 GasNZV	yes	yes	Haiming 2-7F /bn, USP Haidach, Haiming 2-RAGES / bn	• Project included in Gas NDP 2020–2030, • Connection applicant has not withdrawn
terranets b	not published	KWK-Anlage AUDI AG Werk Neckarsulm	H-gas	120	Section 39 GasNZV	yes	yes	Eynatten, Mallnow, Sp. Rehden, Jemgum I, Jemgum III, Nüttermoor, Bobbau	• Project included in Gas NDP 2020–2030, • Connection applicant has not withdrawn
Thyssengas	BNAP 125	GuD-KW Herne	H-gas	1,191	Section 39 GasNZV	yes	yes	Epe / Xanten I (UGS-E; Innogy)	• Implementation schedule finalised, • Flat-rate planning fee paid, • Connection applicant has not withdrawn

* Not published for reasons of third-party trade secrets

Source: Transmission system operators

In accordance with the criteria described in chapter 3.1, various power plant requests pursuant to sections 38 / 39 GasNZV are not taken into consideration in the consultation document for the Scenario Framework 2022. A distinction has to be drawn here, however, between requests that could still be taken into consideration in the Draft Scenario Framework 2022 depending on the criterion after the consultation and those that can no longer be considered irrespective of any development up to 1 August 2021.

Table 3: Plans for the construction of new gas power stations on the network of the transmission system operators not taken into consideration in the consultation document of the Scenario Framework 2022 (reporting date: 31 March 2021)

TSO	Federal Network Agency number	Project name	Gas type (H-gas / L-gas)	Gas connection capacity [MW]	Status	Consideration in the consultation document of the SF 2022 (yes / no)	Consideration in the draft document of the SF 2022 (yes / no / open)	Allocation point	Reason / applicable criterion (updated 31 March 2021)
ONTRAS	not published	Innovatives Hybridkraftwerk Boxberg	H-gas	40	Section 39 GasNZV	no	open	–	• Implementation schedule not finalised, • Planning fee not paid
ONTRAS	not published	Innovatives Hybridkraftwerk Jänschwalde	H-gas	1,000	Section 39 GasNZV	no	open	–	• Implementation schedule not finalised, • Planning fee not paid
ONTRAS	not published	GUD Schwarze Pumpe	H-gas	973	Section 39 GasNZV	no	open	–	• Implementation schedule not finalised, • Planning fee not paid
ONTRAS	not published	Innovative hybrid power plant, Lippendorf	H-gas	1,450	Section 38 GasNZV	no	open	–	• Reservation fee not yet paid
Thyssengas	BNAP XX15	GuD-KW Walsum	H-gas	950	Section 38 GasNZV	no	no	–	• Application approved, • No capacity reservation made, • No payment of the annual reservation fee made

Source: Transmission system operators

3.2.3 Special network operating equipment in southern Germany

The consideration of new gas power plants has been described in chapter 3.2.2. Some of the new gas power stations in southern Germany that are taken into consideration in the Scenario Framework 2022 are used as special network operating equipment.

Pursuant to section 11 (3) EnWG, the electricity transmission system operators can commission third parties to build and operate special network operating equipment in order to guarantee the security and reliability of the electricity supply system. The special network operating equipment is used exclusively to guarantee the security and reliability of the transmission network and is not available to the market. The electricity transmission system operators submitted analyses on this to the BNetzA in February 2017 that show the need for the special network operating equipment. The studies by the electricity transmission system operators had the objective of identifying the need for special network operating equipment for the period between the scheduled shutdown of the nuclear power plants in southern Germany and the completion of the necessary expansion of the electricity network. The BNetzA reviewed the need for special network operating equipment identified by the electricity transmission system operators for southern Germany in accordance with section 11 (3) EnWG and confirmed a demand totalling 1,200 MW_e [BNetzA 2017].

The electricity transmission system operators Amprion, TenneT and TransnetBW conducted tenders each with capacity of 300 MW_e for four regions in southern Germany. The results of the contract awards are presented in the table below.

Table 4: Overview of contract awards in tenders for special network operating equipment

Batch group	Electricity TSO	Region	Contract awarded	Location	Operator	In use at the latest form
A	Amprion	Southern Hesse / northern Bavaria	November 2020	Biblis	RWE	01.10.2022
B	Transnet BW	Baden-Wuerttemberg	August 2019	Marbach	EnBW AG	01.10.2022
C	Amprion	Bavarian Swabia	February 2021	Leipheim	GKL	05.08.2023
D	TenneT	Southern Bavaria	January 2019	Irsching	Uniper	01.10.2022

Source: Transmission system operators on the basis of Amprion 2021, Amprion 2020, Tennet 2019, Transnet BW 2019

The Irsching, Biblis and Leipheim power plants each with capacity of 300 MW_e are taken into consideration as special network operating equipment in the Scenario Framework 2022. As the Marbach power plant is to be fired with light heating oil, it is not taken into consideration in the Scenario Framework 2022.

3.3 Storage facilities

The role played by the gas storage facilities in the supply of energy is discussed in chapter 3.3.1. Chapter 3.3.2 then shows which storage facilities are taken into consideration in the Scenario Framework 2022 on the basis of the criteria described above and which are not considered.

3.3.1 Role of the storage facilities

Natural gas storage facilities primarily serve to provide a balance between constant natural gas supply at cross-border import points as well as production plants and the consumption of natural gas by end users that fluctuates sharply depending on the temperature.

The use of storage facilities that is beneficial for the network means that the transmission systems can be dimensioned in an economically sensible way and the overall system can be optimised in terms of efficient utilisation. Furthermore, the storage facilities are technically capable of providing larger gas volumes quickly and locally during peak loads or in the event of a physical bottleneck in the network (e. g. by providing balancing energy). The storage facilities can thus make an important contribution to the security of supply and system stability. The increasing use of storage facilities from commercial perspectives in the trading sector means, however, that a function of the storage facilities that is beneficial for the network cannot be guaranteed if other general conditions are not in place.

In a similar way as in the previous network development plans, the transmission system operators intend to estimate an average storage capacity of no less than 35% as planning premises in the peak load situation also for the Gas Network Development Plan 2022–2032 on the basis of an initial situation that has remained unchanged.

3.3.2 Consideration of storage projects in the Scenario Framework

In accordance with the criteria described in chapter 3.1, the following storage projects pursuant to sections 38 / 39 GasNZV are taken into consideration in the consultation document for the Scenario Framework 2022.

Table 5: Storage projects on the network of the transmission system operators taken into consideration in the consultation document of the Scenario Framework 2022 (reporting date: 31 March 2021)

TSO	Project name	Gas type (H-gas / L-gas)	Gas connection capacity [MW]	Status	Consideration in the consultation document of SR 2022 (yes/no)	Consideration in the draft document of the SF 2022 (yes / no / open)	Reason / applicable criterion (updated 31 March 2021)
bayernets	Speicher Nussdorf/ Zagling (7F)	H-gas	346 entry / 230 exit	Section 39 GasNZV	yes	yes	• Implementation schedule finalised, • Flat-rate planning fee paid, • Connection applicant has not withdrawn

Source: Transmission system operators

3.4 LNG facilities

The current situation involving planned LNG facilities with a connection to the transmission system in Germany is described in chapter 3.4.1. Chapter 3.4.2 then shows which new LNG facilities are taken into consideration in the Scenario Framework 2022 on the basis of the criteria described above.

3.4.1 Current situation involving LNG facilities in Germany

The construction of LNG facilities in Germany, the accompanying connection to the transmission system and the related provision of capacity were already the subject of the last two gas network development plans that have been published.

While the project developer of the Wilhelmshaven LNG facility withdrew the capacity reservation pursuant to section 38 GasNZV, the project owners of the LNG facilities in Stade and Brunsbüttel are continuing with the plans.

Additional capacity reservations / capacity expansion claims pursuant to sections 38 / 39 GasNZV for the expansion of the capacity of the planned LNG plants in Brunsbüttel and Stade are available to the transmission system operators for the Gas Network Development Plan 2022–2032.

Brunsbüttel

The Brunsbüttel LNG plant project was included in the Gas Network Development Plan 2018–2028 as the result of an application to expand capacity pursuant to Section 39 GasNZV. The expansion measures necessary to provide the entry capacity of 8.7 GW were confirmed by the BNetzA.

The terminal operator asserted a second capacity expansion claim pursuant to section 39 GasNZV in August 2019 and additionally submitted a further application to reserve additional capacity pursuant to section 38 GasNZV on 29 March 2021. This application had not been decided on by 31 March 2021 on account of the processing times pursuant to section 38 GasNZV. The transmission system operators will take the LNG project in Brunsbüttel into consideration in the Gas Network Development Plan 2022–2032 in accordance with the stated criteria.

Stade

An application to reserve capacity pursuant to section 38 GasNZV was submitted for the planned LNG facility in Stade for the first time in June 2019. As it was not possible to provide the requested capacity, the project developer asserted their capacity expansion claim in accordance with section 39 GasNZV. The resulting expansion plans were confirmed by the BNetzA in the Gas Network Development Plan 2020–2030.

The project developer's updated plan provides for a significant increase on the capacity that was originally envisaged. Other capacity expansion claims pursuant to section 39 GasNZV were consequently asserted in November 2020 and in March 2021.

3.4.2 Consideration of LNG facilities in the Scenario Framework

After the criteria described in chapter 3.1 are applied and the current situation presented in chapter 3.4.1 is taken into consideration, the following requests for LNG facilities pursuant to sections 38 / 39 GasNZV are included in the consultation document of the Scenario Framework 2022.

Table 6: LNG facilities on the network of the transmission system operators taken into consideration in the consultation document of the 2022 scenario report (reporting date: 31 March 2021)

TSO	Project name	Gas type (H-gas / L-gas)	Gas connection capacity [MW]	Status	Consideration in the consultation document of the SF 2022 (yes / no)	Consideration in the draft document of the SF 2022 (yes / no / open)	Reason / applicable criterion (updated 31 March 2021)
GUD	LNG-Terminal Stade	H-gas	9,300	Section 39 GasNZV	yes	yes	• Project included in Gas NDP 2020–2030, • Connection applicant has not withdrawn
GUD	LNG-Terminal Stade	H-gas	6,950	Section 39 GasNZV	yes	yes	• Project included in Gas NDP 2020–2030, • Connection applicant has not withdrawn
GUD	LNG-Terminal Stade	H-gas	5,450	Section 39 GasNZV	yes	yes	• Project included in Gas NDP 2020–2030, • Connection applicant has not withdrawn
GUD	LNG-Terminal Brunsbüttel	H-gas	8,700	Section 39 GasNZV	yes	yes	• Project included in Gas NDP 2020–2030, • Connection applicant has not withdrawn
GUD	LNG-Terminal Brunsbüttel	H-gas	1,975	Section 39 GasNZV	yes	yes	• Project included in Gas NDP 2020–2030, • Connection applicant has not withdrawn
GUD	LNG-Terminal Brunsbüttel	H-gas	3,125	Section 38 GasNZV	yes	open	• Section 38 application not yet decided

Source: Transmission system operators

Based on the scope of these applications, the transmission system operators will present the specific modelling approach for the LNG facilities in the Gas Network Development Plan 2022–2032.

3.5 Production facilities

Like storage facilities, power plants and LNG facilities, production facilities are also privileged facilities within the meaning of sections 38 / 39 GasNZV. After the criteria described in chapter 3.1 are applied, this application for a production facility pursuant to section 38 GasNZV is included in the consultation document of the Scenario Framework 2022.

Table 7: Production facilities on the network of the transmission system operators taken into consideration in the consultation document of the Scenario Framework 2022 (reporting date: 31 March 2021)

TSO	Project name	Gas type (H-gas / L-gas)	Gas connection capacity [MW]	Status	Consideration in the consultation document of the SF 2022 (yes / no)	Consideration in the draft document of the SF 2022 (yes / no / open)	Reason / applicable criterion (updated 31 March 2021)
GUD	Produktion Area of Dalum	H-gas	624	Section 38 GasNZV	yes	open	Section 38 application not yet decided

Source: Transmission system operators

3.6 WEB and Green Gases Market Survey

Following the presentation of the criteria for considering projects from the WEB and Green Gases Market Survey in chapter 3.6.1, an overview of the project reports is provided in chapter 3.6.2. Chapter 3.6.3 then presents detailed results from the WEB and Green Gases Market Survey and describes the consideration of the project reports in the Gas Network Development Plan 2022–2032.

3.6.1 Criteria for considering projects reported in the WEB and Green Gases Market Survey

Criteria for projects for the generation of and the demand for hydrogen and green gases for consideration in the consultation document of the Scenario Framework 2022

The transmission system operators launched the survey of projects for the generation of and the demand for hydrogen and green gases for the Scenario Framework 2022 on 11 January 2021. At the same time, the transmission system operators published the following criteria for hydrogen and green gas projects that will apply in the Scenario Framework 2022.

- A project plan can be taken into consideration in the consultation documents of the Scenario Framework 2022 if a report has been submitted in the course of the WEB and Green Gases Market Survey from 11 January 2021 to 16 April 2021.
- The report has to be submitted to a transmission system operator using the published form. Updated versions of plans already reported in the Scenario Framework for the Gas Network Development Plan 2020–2030 have to be reported again.
- A project plan is taken into consideration in the consultation document of the Scenario Framework 2022 if the requested information for consideration of a connection to the transmission network is included in full in the published form and its plausibility has been verified by the transmission system operators.
- A project plan is taken into consideration in the consultation document of the Scenario Framework 2022 if the entry fields that are flagged accordingly in the form for the WEB and Green Gases Market Survey can be published.

Criteria for projects for the generation of and the demand for hydrogen and green gases for consideration in the modelling for the Gas Network Development Plan 2022–2032

Furthermore, the project developers are required to furnish proof of the actual implementation intention as a prerequisite for consideration in the modelling for the Gas Network Development Plan 2022–2032. In this respect, the project developer is requested to enter into a statement of intent – in the sense of a memorandum of understanding (MoU). The subject matter of the MoU should be agreements on the following aspects:

a. Definition of the implementation date, the capacity and the gas quality requirements,
b. Introduction of a management concept for adjusting the relevant entry and exit capacities,
c. Obligation to enter into a binding implementation schedule (including payment of a flat-rate planning fee) after the general legal and regulatory conditions (including provision of feed-in pressure, network charges, network access conditions) have been clarified, in so far as these are regulated in a commercially reasonable way for all the parties involved.

A project plan will be taken into consideration 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.

Other requirements for implementing network expansion measures for hydrogen projects

Following the decision on the change request related to the Gas Network Development Plan 2022–2032 from the BNetzA (expected in the fourth quarter of 2022), the individual project developer undertakes to enter into an implementation schedule with the following regulatory content:

a. Payment of a flat-rate planning fee to be determined,
b. Obligation to enter into a network connection contract,
c. Obligation to make a binding capacity booking on the regulatory terms and conditions defined with the BNetzA.

It is expressly pointed out that the creation of the necessary general legal and regulatory conditions for the construction, operation and financing of hydrogen networks by the legislature, the federal government and the regulatory authority competent for the transmission system operators is a necessary precondition for entering into a binding implementation schedule as well as for the implementation of relevant new-build and conversion projects.

Supplementary notes relating to distribution system operators

Reports from the distribution system operators were explicitly requested in the course of the WEB and Green Gases Market Survey in order to achieve the goal of obtaining a comprehensive overview of the hydrogen and green gas projects. Accordingly, hydrogen and green gas projects of the distribution system operators and in the supply areas of the distribution system operators have to be reported by the respective distribution system operator using the WEB and Green Gases Market Survey form.

At the same time, a process to amend the form in order to issue the long-term forecast in accordance with the Cooperation Agreement was launched by the transmission system operators. It is planned here to add the option of reporting any corresponding reduced demand for natural gas (e.g. in the event of the substitution of natural gas by hydrogen as the result of a project that has been reported).

Accordingly, if it is planned to connect a hydrogen or green gas project to the distribution system or demand for hydrogen for creating a hydrogen-natural gas blend is produced and a substitution of natural gas results here, the project plan can be taken into consideration in the Gas Network Development Plan 2022–2032 by having the distribution system operator to whose network the project plan is to be connected take this into consideration in the reporting of its long-term forecast.

3.6.2 Overview of the WEB and Green Gases Market Survey

The transmission system operators have conducted the WEB and Green Gases Market Survey for hydrogen and green gases for the Scenario Framework 2022. 500 project reports were submitted in the period from 11 January 2021 to 16 April 2021. These are presented in appendix 2. Moreover, there were 121 other feedback reports and 42 duplicate reports that were not subsequently considered. Table 8 below provides a full overview of the reported projects per federal state.

The transmission system operators have classified the feedback as follows:

- Category 1: Reports of projects for 2022 to 2050 from project owners and distribution system operators of relevance for the transmission network,
- Category 2: Reports of storage projects,
- Category 3: Reports of other projects from DSO,
- Category 4: Reports of projects from abroad,
- Category 5: Reports of projects on the distribution system not of relevance for the transmission network,
- Category 6: Other project reports (incomplete project reports, zero reports and reports that were not approved for publication).

The number of project reports (PR) received based on the parameters classification of the projects, entry / exit and gas type is presented in table 8. Numerous duplicate reports have already been identified in the course of the assessment of the WEB and Green Gases Market Survey and are indicated in appendix 2. It cannot be ruled out, however, that further duplicate reports (e.g. two project reports for actually one specific project for which there are currently still alternative locations) will be contained in the project overview. The transmission system operators will aim to identify these when the Gas Network Development Plan 2022–2032 is drawn up.

Table 8: Overview of the reports for the WEB and Green Gases Market Survey

Federal state	PR 2022–2050	PR Storage facilities	PR on blending (DSOs) 2022–2050	PR Interna-tional	PR DSO network	Feed in (source)	Withdrawal (sink)	Hydrogen	Synthetic methane	Biome-thane	Electro-lyser
BW	20	–	43	–	–	11	55	62	–	4	7
BY	24	1	9	2	3	14	32	39	–	3	6
BE	2	–	1	–	–	1	3	3	–	1	–
BB	9	–	1	–	–	5	5	9	–	1	4
HB	1	–	–	–	–	1	1	1	–	–	1
HH	8	–	3	–	–	4	8	11	–	1	2
HE	9	–	10	–	–	3	17	19	–	–	3
MV	12	–	5	–	–	13	5	17	–	1	9
NI	68	3	15	3	–	44	51	88	1	2	26
NW	105	3	72	–	1	41	154	175	–	7	26
RP	8	–	8	–	1	2	16	16	–	2	–
SH	13	–	1	1	–	12	3	15	–	–	11
SL	–	–	1	–	2	1	2	3	–	–	1
SN	2	–	6	–	1	2	7	9	–	1	2
ST	12	–	5	–	–	8	10	15	–	3	4
TH	1	–	5	–	–	–	6	6	–	–	–
Total	**294**	**7**	**185**	**6**	**8**	**162**	**375**	**488**	**1**	**26**	**102**

Source: Transmission system operators

The table below shows the total entry and exit capacities and volumes for the various gas types as well as the sum of the reported electrolysis capacity.

Table 9: Results of the reports of all projects

	Unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2040	2050
Hydrogen entry capacity	GW_{th}	0.1	0.3	0.8	2.2	4.9	14.3	20.2	24.9	38.3	42.8	47.1	97.8	153.1
Hydrogen entry volume per year	TWh	1	1	3	11	23	82	106	131	196	216	233	467	783
Hydrogen exit capacity	GW_{th}	0.9	1.4	2.7	5.2	6.7	10.1	12.2	15.7	29.4	36.8	58.9	124.3	193.7
Hydrogen exit volume per year	TWh	5	7	12	26	34	54	63	85	145	180	231	427	598
Synthetic methane entry capacity	GW_{th}	–	–	–	–	–	7.8	7.8	8.4	8.4	9.0	9.0	9.7	11.6
Synthetic methane entry volume per year	TWh	–	–	–	–	–	68	68	74	74	79	79	85	102
Biomethane entry capacity	GW_{th}	0.1	0.1	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5
Biomethane entry volume per year	TWh	1	1	1	2	2	2	2	2	2	2	3	3	3
Electrolysis capacity	GW_e	0.2	0.4	0.8	3.0	4.6	7.8	10.8	13.4	24.5	26.7	28.9	47.9	56.3

Source: Transmission system operators

The results are presented in aggregate below based on the categories and the further procedure planned as part of the modelling of the Gas Network Development Plan 2022–2032 is outlined. A complete list of the project reports can be found in Appendix 2.

3.6.3 Results of the market survey and consideration in the Gas Network Development Plan 2022–2032

Category 1: Reports of projects for 2022 to 2050 from project owners and distribution system operators of relevance for the transmission network

The table below shows the sum of the entry and exit capacities and volumes for hydrogen, synthetic methane and biomethane as well as the total electrolysis capacity for this project category.

Table 10: Results of the reports of projects for 2022 to 2050 from project owners and distribution system operators of relevance for the transmission network

	Unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2040	2050
Hydrogen entry capacity	GW_{th}	0.1	0.3	0.7	2.1	3.1	10.0	13.7	16.3	25.4	27.8	30.2	54.7	91.7
Hydrogen entry volume per year	TWh	1	1	3	11	17	67	83	100	153	167	179	340	607
Hydrogen exit capacity	GW_{th}	0.9	1.4	2.5	4.9	6.0	8.9	9.9	12.9	22.6	28.1	31.3	49.8	52.7
Hydrogen exit volume per year	TWh	5	7	11	25	32	50	56	76	125	154	169	222	269
Synthetic methane entry capacity	GW_{th}	–	–	–	–	–	7.8	7.8	8.4	8.4	9.0	9.0	9.7	11.6
Synthetic methane entry volume per year	TWh	–	–	–	–	–	68	68	74	74	79	79	85	102
Biomethane entry capacity	GW_{th}	0.0	0.0	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Biomethane entry volume per year	TWh	0	0	0	1	1	1	1	1	1	1	1	1	1
Electrolysis capacity	GW_e	0.2	0.4	0.8	3.0	4.2	6.9	9.4	11.5	21.5	23.6	25.8	40.8	49.1

Source: Transmission system operators

The reported entry and exit capacities and volumes form the fundamental basis for the modelling of the hydrogen variant (cf. chapter 10.3). The reports that fulfil the criteria in accordance with 3.6.1, especially where the relevant project owners have entered into a memorandum of understanding (MoU) with the transmission system operators by 1 October 2021, are taken into consideration in the modelling. The transmission system operators approach the project developers to this end. The modelling is carried out for 2027 and 2032.

The reported electrolysis capacity is also taken into consideration. If necessary, these are not taken over directly into the modelling, however, but combined with the electrolysis capacity pursuant to the Electricity Network Development Plan to begin with (also see chapter 7.2 on this).

In addition to project reports for hydrogen, project reports for biomethane and synthetic methane (SNG) were also received in the course of the WEB and Green Gases Market Survey. The connection of a biogas plant to the gas transmission network is regulated by law in Part 6, "Biogas", of the Gas Network Access Regulation. In accordance with section 3 EnWG, biogas includes both biomethane and SNG, the vast majority of which has been produced from renewable energy sources. The transmission system operators accordingly check the project reports to see if they should be considered in the methane modelling of the hydrogen variant of the Gas Network Development Plan 2022–2032 if the process for the network connection requests at the responsible transmission system operator has been concluded by 1 October 2021. Moreover, these projects are also taken into consideration in the base variant (cf. chapter 10.2).

Category 2: Reports of storage projects

The table below shows the sum of the entry and exit capacities and volumes of reported storage projects for hydrogen for this project category.

Table 11: Results of the reports of storage projects

	Unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2040	2050
Hydrogen entry capacity	GW_{th}	–	–	0.1	0.1	0.2	0.7	1.0	1.1	3.1	3.7	4.2	15.8	24.1
Hydrogen entry volume per year	TWh	–	–	0	0	0	1	2	2	5	6	6	24	36
Hydrogen exit capacity	GW_{th}	–	–	0.1	0.1	0.4	0.6	1.0	1.0	2.9	3.6	4.1	14.2	21.8
Hydrogen exit volume per year	TWh	–	–	0	0	1	1	2	2	5	6	6	24	36
Synthetic methane entry capacity	GW_{th}	–	–	–	–	–	–	–	–	–	–	–	–	–
Synthetic methane entry volume per year	TWh	–	–	–	–	–	–	–	–	–	–	–	–	–
Biomethane entry capacity	GW_{th}	–	–	–	–	–	–	–	–	–	–	–	–	–
Biomethane entry volume per year	TWh	–	–	–	–	–	–	–	–	–	–	–	–	–
Electrolysis capacity	GW_e	–	–	–	–	–	–	–	–	–	–	–	–	–

Source: Transmission system operators

The reported storage capacity is also taken into account in the preparation of the hydrogen variant. The reports that fulfil the criteria in accordance with 3.6.1 and where the relevant project owners have entered into an MoU with the transmission system operators by 1 October 2021, are taken into consideration in the modelling. The transmission system operators approach the project developers to this end. The modelling is carried out for 2027 and 2032.

Category 3: Reports of other projects from DSO

The table below shows the sum of the entry and exit capacities and volumes for hydrogen and biomethane for this project category.

Table 12: Results of the reports of other projects from DSO

	Unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2040	2050
Hydrogen entry capacity	GW_{th}	–	–	–	–	–	–	–	–	–	–	–	–	–
Hydrogen entry volume per year	TWh	–	–	–	–	–	–	–	–	–	–	–	–	–
Hydrogen exit capacity	GW_{th}	–	0.0	0.1	0.2	0.3	0.5	1.2	1.6	3.7	4.8	23.3	70.1	118.9
Hydrogen exit volume per year	TWh	–	0	0	1	1	2	4	6	14	19	54	180	290
Synthetic methane entry capacity	GW_{th}	–	–	–	–	–	–	–	–	–	–	–	–	–
Synthetic methane entry volume per year	TWh	–	–	–	–	–	–	–	–	–	–	–	–	–
Biomethane entry capacity	GW_{th}	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3
Biomethane entry volume per year	TWh	1	1	1	1	1	1	1	1	1	1	1	1	2
Electrolysis capacity	GW_e	–	–	–	–	–	–	–	–	–	–	–	–	–

Source: Transmission system operators

In the view of the transmission system operators, the reported exit capacities and volumes for blending into the methane network of the distribution system operators are not project plans with potential expansion relevance. It is therefore not planned to enter into an MoU.

Instead, the transmission system operators conduct what is known as a “hydrogen review” for these reports for 2032, which is based on the modelling results of the hydrogen variant 2032. This does not constitute a separate modelling procedure.

The hydrogen review first examines what network interconnection points and exit zones could be supplied with hydrogen without further network expansion measures on the basis of the results of the hydrogen variant for 2032.

It is then examined in this process whether blending might be possible or even if the possibility might already exist for converting initial areas or individual network interconnection points to 100% hydrogen. In a similar way to the planning process for the L-to-H-gas conversion, first potential “hydrogen conversion areas” could thus be identified.

The transmission system operators do not see a comprehensive and possibly gradual increase in the blending of hydrogen into the methane transmission networks in Germany at the transmission network level as practical in principle. This kind of blending would not ensure a constant proportion of hydrogen, which is essential for various customers, including some industrial customers, CNG filling stations or household customers for example. Accordingly, complex and expensive measures would be necessary in order to separate the blended hydrogen from the methane again when necessary. This would furthermore be necessary at cross-border interconnection points if neighbouring countries do not permit any or only minor blending in the transmission network. On the other hand, it may not be possible to supply all network interconnection points equally with methane and hydrogen at the same time.

Parts of the transmission network would have to be duplicated in this event. From the perspective of the transmission system operators, it is desirable to convert selected network interconnection points directly and completely to hydrogen. The L-to-H-gas conversion, which has been successfully carried out in Germany in phases since 2015, has been planned on the basis of exactly this approach. Accordingly, the transmission system operators are using the reports received from the distribution system operators and the modelling results of the hydrogen variant 2032 to identify initial ideas for a possible regional use of hydrogen in the heating market. This can be achieved only in close and intensive co-operation with the distribution system operators.

The transmission system operators welcome the active participation and the numerous reports of the distribution system operators. Some reports already include exit demand before 2032. This illustrates the efforts being made by the distribution system operators to quickly accelerate the decarbonisation in particular of the heating market. These reports will also be included in the hydrogen review for 2032. There is also no plan to enter into an MoU here.

More information for 2040 and 2050 can be found in chapter 7.4. The transmission system operators reserve the right to conduct further assessments before the Gas Network Development Plan 2022–2032 is published.

Category 4: Reports of projects from abroad

The table below shows the sum of the entry and exit capacities and volumes for hydrogen as well as the total electrolysis capacity for project reports from abroad.

Table 13: Results of the reports of projects from abroad

	Unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2040	2050
Hydrogen entry capacity	GW_{th}	–	–	–	–	1.6	3.6	5.5	7.4	9.8	11.2	12.6	27.2	37.2
Hydrogen entry volume per year	TWh	–	–	–	–	5	14	21	29	38	43	48	104	139
Hydrogen exit capacity	GW_{th}	–	–	–	–	–	–	–	–	–	–	–	–	–
Hydrogen exit volume per year	TWh	–	–	–	–	–	–	–	–	–	–	–	–	–
Synthetic methane entry capacity	GW_{th}	–	–	–	–	–	–	–	–	–	–	–	–	–
Synthetic methane entry volume per year	TWh	–	–	–	–	–	–	–	–	–	–	–	–	–
Biomethane entry capacity	GW_{th}	–	–	–	–	–	–	–	–	–	–	–	–	–
Biomethane entry volume per year	TWh	–	–	–	–	–	–	–	–	–	–	–	–	–
Electrolysis capacity	GW_{e}	–	–	–	–	0.4	0.9	1.4	1.9	3.0	3.0	3.0	7.0	7.0

Source: Transmission system operators

The reported entry and exit capacities and volumes from abroad are taken into consideration in the modelling of the hydrogen variant as potential imports and exports. More detailed information on the consideration of the reports from abroad can also be found in chapter 7.3. In this respect, the transmission system operators request further opinions and additional information on delivery capacity and volumes at cross-border interconnection points as part of the consultation. The reported projects in the course of the distribution of hydrogen sources are taken into consideration in the Gas Network Development Plan 2022–2032. It is not therefore planned to enter into an MoU.

Category 5: Reports of projects on the distribution system not of relevance for the transmission network

The table below shows the sum of the entry and exit capacities and volumes for hydrogen and biomethane as well as the electrolysis capacity for this project category.

Table 14: Results of the reports of projects on the distribution system not of relevance for the transmission network

	Unit	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2040	2050
Hydrogen entry capacity	GW_{th}	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
Hydrogen entry volume per year	TWh	0	0	0	0	0	0	0	0	0	0	0	0	1
Hydrogen exit capacity	GW_{th}	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3
Hydrogen exit volume per year	TWh	0	0	0	0	0	1	1	2	2	2	2	2	2
Synthetic methane entry capacity	GW_{th}	–	–	–	–	–	–	–	–	–	–	–	–	–
Synthetic methane entry volume per year	TWh	–	–	–	–	–	–	–	–	–	–	–	–	–
Biomethane entry capacity	GW_{th}	–	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Biomethane entry volume per year	TWh	–	0	0	0	0	0	0	0	0	0	0	0	0
Electrolysis capacity	GW_e	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2

Source: Transmission system operators

Project reports where no connection to the transmission network is planned and there is thus no relevance for the network expansion are therefore not directly taken into consideration in the modelling of the hydrogen variant and are listed here only for information purposes.

However, the reported electrolysis capacity is taken into consideration in any combination with the Electricity Network Development Plan that may be necessary. A presentation of this procedure is described in chapter 7.2.

Category 6: Other project reports

In addition to the reports of categories 1–5 presented above, the transmission system operators also received forms that contained incomplete data or where data was completely missing, forms where the project developers did not give approval for the projects to be published in the Gas Network Development Plan and forms that arrived after the deadline of 16 April 2021 had expired. In accordance with the criteria drawn up for considering reports in the Gas Network Development Plan 2022–2032 (cf. chapter 3.6.1), these are classified as other project reports and cannot be taken into consideration in the modelling of the hydrogen variant.

Trends in gas demand 4

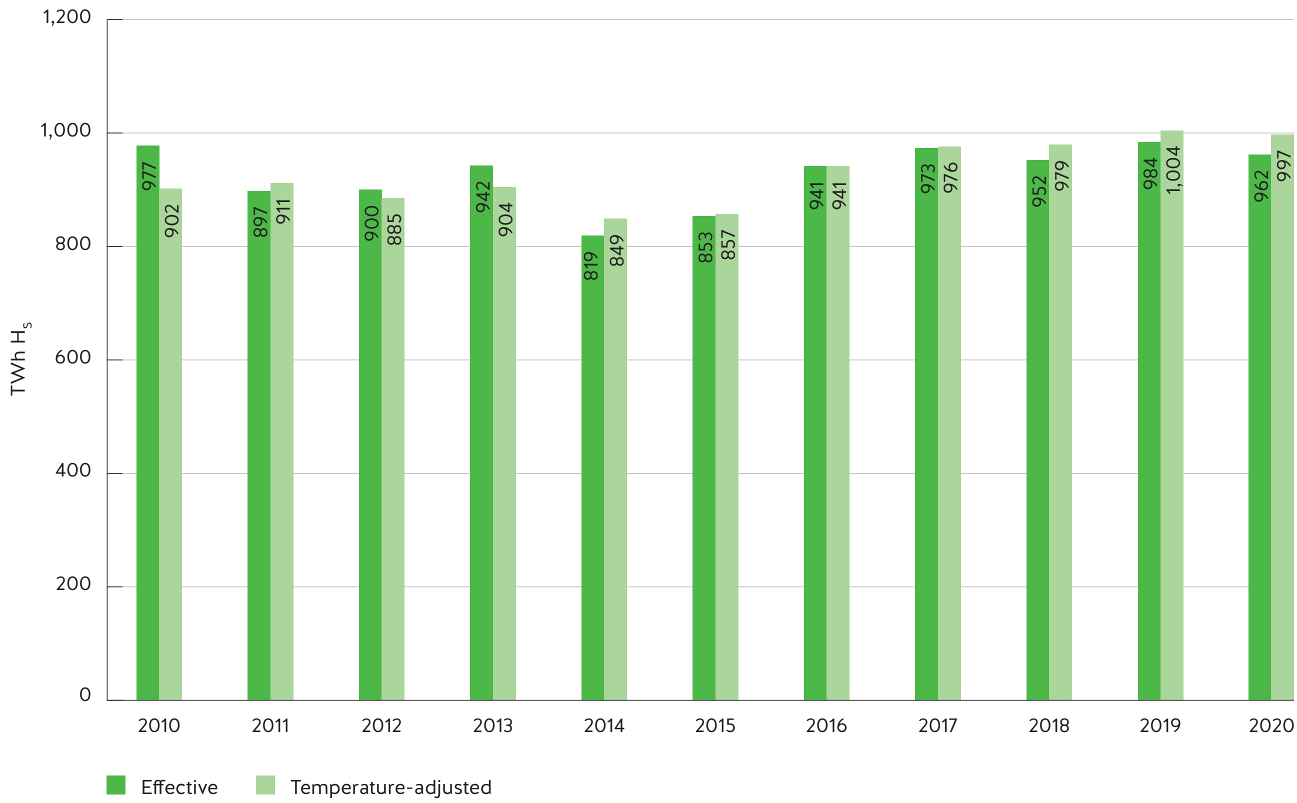
4 Trends in gas demand

This chapter deals with the trends in gas demand in Germany. Following the state analysis of gas consumption since 2010 (cf. chapter 4.1), various future gas demand trends for Germany are subsequently examined and specific gas demand scenarios are defined for this Scenario Framework (cf. chapter 4.2).

4.1 State analysis

The demand for gas is compiled from the final energy demand for gas, gas usage in the transformation sector (generation of electricity and heating) and non-energy gas consumption.

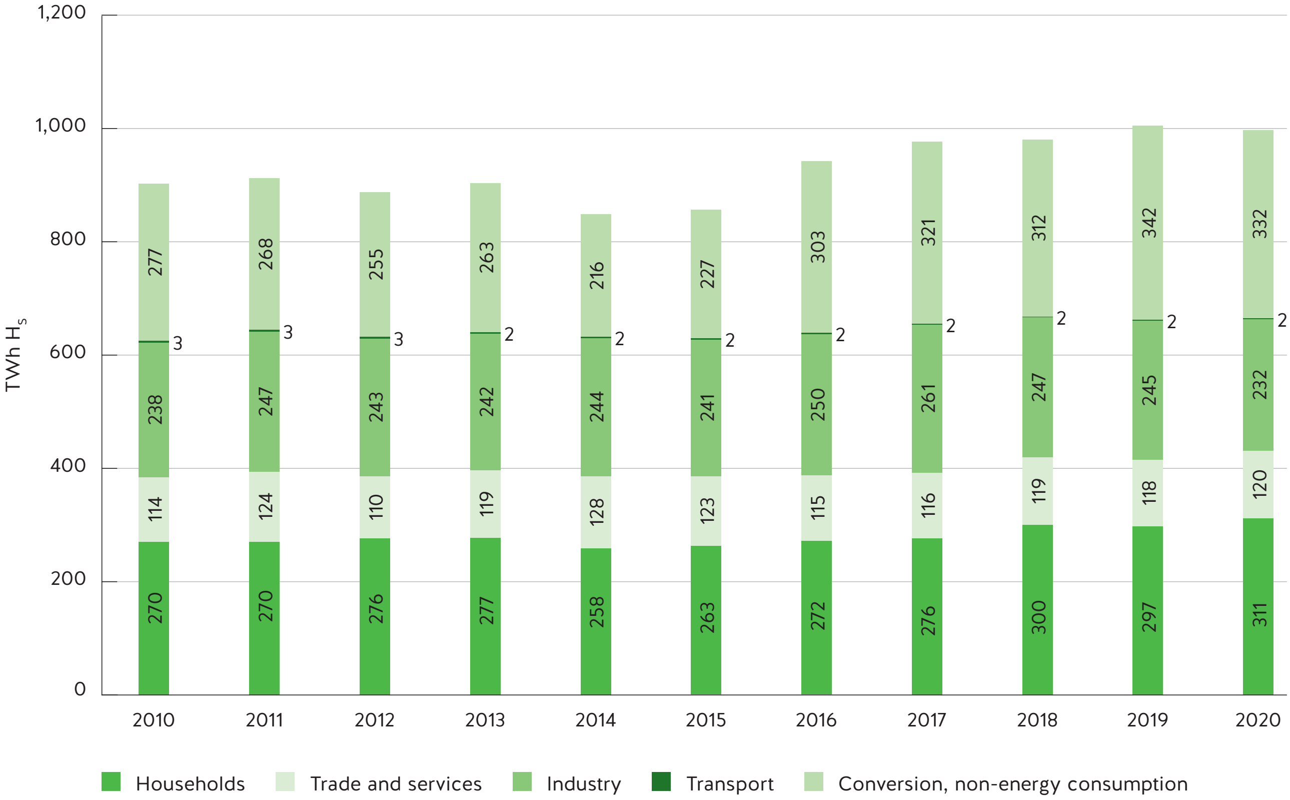
Figure 2: Consumption of natural gas (primary energy consumption) in Germany in TWh (H_s, calorific value)



Source: BDEW 2021/AG Energiebilanzen 2021 (primary energy consumption, natural gas), calculation by the transmission system operators (temperature-adjusted values)

The temperature-adjusted consumption of natural gas in Germany, which is presented in figure 2, was between 850 TWh and 1,000 TWh in the last 10 years and increased between 2014 and 2019.

Figure 3: Temperature-adjusted consumption of natural gas in Germany by sector in TWh (H_S, calorific value)



Note: NEV – Nichtenergetischer Verbrauch – non-energy consumption, part of the energy source not used for energy (e.g. as raw material for chemical processes)

Source: BDEW 2021/AG Energiebilanzen 2021 (final energy consumption, natural gas), calculation by the transmission system operators (temperature-adjusted values)

The trend in the temperature-adjusted consumption of natural gas in Germany by sector, which is presented in figure 3, shows that the transformation sector, i.e. in particular the gas-based generation of electricity and heating, accounted for a considerable proportion of the fluctuating consumption trends and has risen significantly since 2015.

In contrast, the consumption of natural gas by industry and by the commerce, trade and services sector, which is influenced by economic fluctuations, has stayed at a relatively constant level since 2010, while the consumption of natural gas in households has increased in the past few years.

The relatively high new construction activity of the last few years continued in 2020 with around 320,000 approved apartments. The market share of natural gas in new buildings has fallen from previously around 50% in 2000 to around 34% now. Electric heat pumps and district heating have continually gained market shares in new buildings in the last few years (cf. table 15). In the housing stock, the market share of natural gas heating systems has been around 50% since 2010 (cf. table 16).

Table 15: Market shares of energy sources in new buildings

Year	Number of apartments[1]	Natural gas[2]	Electric heat pumps	District heating	Electricity	Fuel oil	Wood, wood pellets	Others[3]
		Share in %						
2010	164,540	50.2	23.5	14.6	1.0	1.8	5.0	4.1
2011	200061	50.1	22.6	16.3	0.9	1.5	5.6	2.5
2012	211,155	48.5	23.8	18.6	0.6	0.9	6.3	1.4
2013	254,250	48.3	22.5	19.8	0.7	0.8	6.4	1.5
2014	264,332	49.9	19.9	21.5	0.6	0.7	6.1	1.3
2015	285,282	50.3	20.7	20.8	0.7	0.7	5.3	1.5
2016	329,000	44.4	23.4	23.8	0.9	0.7	5.3	1.5
2017	300,349	39.3	27.2	25.2	0.7	0.6	5.5	1.6
2018	302,209	38.6	28.8	25.2	1.1	0.5	4.4	1.4
2019	311,156	36.8	29.8	26.5	1.1	0.5	4.1	1.2
2020*	320,255	33.8	35.7	23.5	1.3	0.3	4.2	1.3

* provisional up to November 2020

1) New residential units approved for construction; up to 2012 in new buildings to be constructed, from 2013 additionally in existing buildings
2) Including bio natural gas

Source: BDEW 2021 on the basis of the Statistisches Bundesamt (German Federal Statistical Office), state statistical offices, updated February 2021

Table 16: Heating structure of the housing stock

Year	Number of apartments in million[1]	Gas[2]	District heating	Electricity	Electric heat pumps	Fuel oil	Others[3]
		Share in %					
2010	40.3	49.0	12.8	3.4	1.0	28.9	4.9
2011	40.4	49.1	12.9	3.2	1.1	28.3	5.4
2012	40.6	49.2	13.1	3.1	1.2	27.8	5.6
2013	40.8	49.2	13.3	3.0	1.4	27.2	5.9
2014	41.0	49.3	13.5	2.9	1.5	26.8	6.0
2015	41.3	49.3	13.6	2.8	1.7	26.5	6.1
2016	41.5	49.4	13.7	2.7	1.8	26.3	6.1
2017	41.7	49.4	13.8	2.6	2.0	26.1	6.1
2018	42.0	49.4	13.9	2.5	2.2	25.9	6.1
2019	42.3	49.5	14.0	2.6	2.4	25.3	6.2
2020*	42.6	49.5	14.1	2.6	2.6	25.0	6.2

* provisional

1) Number of apartments in buildings with living area; heating present
2) Including bio natural gas and liquefied gas
3) Wood, wood pellets, other biomass, coke / coal, other heating energy

Source: BDEW 2021, updated February 2021

4.2 Trends in gas demand

A distinction has to be drawn in principle between the terms scenario and modelling variant. Two scenarios for the development of gas demand in Germany are presented below in the Scenario Framework 2022. The modelling variants, which are described in detail in chapter 10, form the basis for the modelling in the Gas Network Development Plan 2022–2032. There is no connection between the gas demand scenarios presented here and the modelling variants for the Gas Network Development Plan 2022–2032 presented in chapter 10, as the transmission system operators use specific demand reports in their modelling variants as a result of the requirements of the BNetzA.

In light of the challenges posed by the energy transition, an outlook up to 2050 is additionally provided.

EU climate law pursues the goal of reducing greenhouse gas emissions in the EU as a mandatory requirement and achieving climate neutrality by 2050. The target for 2030 is to cut emissions by 55% compared with 1990 levels.

On 29 April 2021, the German Federal Constitutional Court ruled that constitutional objections to the German Climate Protection Act can be successfully upheld in part [BVG 2021]. Against this background, the federal government decided on 12 May 2021 to increase the German climate targets. National greenhouse gas emissions are now set to be reduced by 65% (previously 55%) from 1990 levels by 2030. The target of greenhouse gas neutrality is accordingly to be reached as early as 2045.

The reduction of greenhouse gas emissions, the expansion of renewable energy sources and the increase in energy efficiency are key targets of European and German energy and climate policy. The general conditions of energy and climate policy form an important foundation for the large number of existing scenarios for energy and gas demand.

In the Scenario Framework 2020, the dena-TM95 scenario was examined in greater detail as a possible vision of the future. dena-TM95 is a recognised technology mix scenario, in which a high use of methane is assumed, while hydrogen still plays a limited role. From today's perspective, however, hydrogen will play a more significant role in the course of the energy transition. The transmission system operators have therefore decided to adjust the dena-TM95 scenario for the Scenario Framework 2022 with the support of the Four-Management consulting firm.

The transmission system operators have here analysed both the supply and the demand side in light of a heavier use of hydrogen. Various studies were consulted and numerous discussions were held with experts in order to answer detailed questions.

Ultimately, hydrogen will be increasingly used in place of methane, as the production of hydrogen represents a more energy-efficient solution in comparison with synthetic methane. Imports of hydrogen will make a significant contribution when it comes to covering demand.

Other studies that also increasingly highlight the role to be played by hydrogen are currently in progress, but have not yet been published and it was therefore not possible to use them in this scenario framework.

Prognos AG analysed renowned studies and publications on the future development of gas demand and gas supply in Germany on behalf of the transmission system operators for the Scenario Framework 2022. Based on the general conditions outlined above, the focus is placed in principle on the scenarios that achieve an emissions reduction ratio of 95% by 2050 as a minimum compared with 1990 levels. Gas demand is understood in the following to be the demand for methane (natural gas, biomethane as well as synthetic gases) and hydrogen.

Table 17 below contains a list of the gas demand scenarios for Germany that have been analysed.

Table 17: Studies and scenarios considered

Study	Scenarios	
dena study [dena 2018] "dena-Leitstudie Integrierte Energiewende" ("dena study on the integrated energy transition")	Electrification scenario	−95% (dena-EL95)
	Technology mix scenario	−95% (dena-TM95)
BDI study [BDI 2018] "Klimapfade für Deutschland" ("Climate paths for Germany")	Target scenario: global climate protection	−95% (BDI-G95)
NECP scenarios [BMWi 2020a] "Integrierter Nationaler Energie- und Klimaplan" ("Integrated National Energy and Climate Plan")	Climate protection scenario	−87.5% (NECP-KSP 87.5)
Agora Energiewende (energy transition think tank), Agora Verkehrswende (transport transition think tank), Stiftung Klimaneutralität (Climate Neutrality Foundation) [Agora Energiewende 2020] "Klimaneutrales Deutschland" ("Climate-neutral Germany")	KNDE	−100% (KNDE 100)
Forschungszentrum Jülich (research centre) [FZJ 2019] "Kosteneffiziente und klimagerechte Transformationsstrategie für das deutsche Energiesystem bis zum Jahr 2050" ("Cost-efficient and climate-friendly transformation strategy for the German energy system up to 2050")	Scenario 95	−95% (FZJ 95)
Fraunhofer ISE [ISE 2020] "Wege zu einem klimaneutralen Energiesystem" ("Roads to a climate-neutral energy system")	Reference scenario	−95% (ISE 95)
TSOs / FourManagement on the basis of dena [FourMan 2020] "Entwicklung der Wasserstoffwirtschaft – Netz der Zukunft" ("Development of the hydrogen economy – Network of the future")	Scenario I	−95% (dena-TM95 / TSOs)

Source: Agora Energiewende 2020, BDI 2018, BMWi 2020a, dena 2018, TSOs / FourMan 2020, FZJ 2019, ISE 2020

Brief description of the studies / scenarios

dena-EL95: The "dena-EL95" scenario in the dena study assumes a higher degree of electrification in all sectors in comparison with the "dena-TM95" scenario. This leads, however, to a further increase in the demand for electricity. In this scenario, hydrogen and synthetically produced energy sources are taken into consideration when they are urgently required. Fossil natural gas and biomethane are other gaseous energy sources.

Agora Energiewende: The study "Klimaneutrales Deutschland (KNDE)" ("Climate-neutral Germany") by Agora Energiewende et. al. shows a path to achieving climate neutrality in 2050 that is optimised from a cost perspective. Hydrogen plays an important role alongside electricity in this scenario. Demand for hydrogen in 2050 amounts to around 270 TWh. Other synthetic energy sources are also used in the scenario in addition to hydrogen. Overall, demand for hydrogen and other synthetic fuels and feedstocks totalling 432 TWh is produced for 2050. Fossil natural gas is no longer used in 2050. Demand for biomethane amounts to 46 TWh.

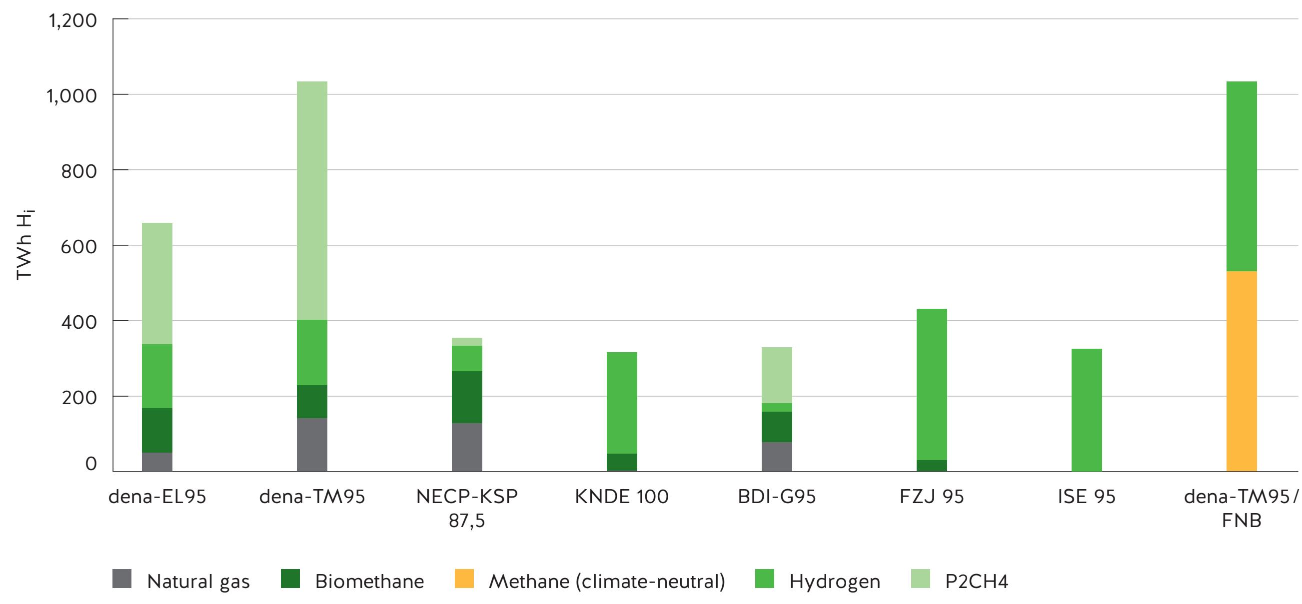
BDI: In the "BDI-G95" scenario, the "Klimapfade für Deutschland" ("Climate paths for Germany") study of the BDI describes a technical measure with which it will be possible to achieve the reduction target in an economically cost-efficient and socially acceptable way. Hydrogen is regarded as a game-changer that could potentially make it easier to achieve the climate targets in the coming decades. The study regards the operational readiness of hydrogen as something that cannot be foreseen and therefore assumes a figure of only 23 TWh will be available to achieve the targets. As complete decarbonisation is not envisaged in the scenario, fossil natural gas is still in use. Hydrogen and synthetic methane are other gaseous energy sources.

ISE: The study "Wege zu einem klimaneutralen Energiesystem" ("Roads to a climate-neutral energy system") of the Fraunhofer Institute for Solar Energy Systems ISE shows the reduction in energy-related greenhouse gas emissions in several consistent scenarios. In the "ISE 95" scenario, a reduction in greenhouse gas emissions of at least 95% by 2050 is pursued. Hydrogen plays an important role in decarbonisation and is the only remaining gaseous energy source in 2050 in this scenario, where it provides 325 TWh.

FZJ: The study "Kosteneffiziente und klimagerechte Transformationsstrategie für das deutsche Energiesystem bis zum Jahr 2050" ("Cost-efficient and climate-friendly transformation strategy for the German energy system up to 2050") of the Forschungszentrum Jülich (FZJ – research centre) includes two scenarios showing CO_2 reduction strategies for achieving the climate protection targets in Germany. In the "FZJ 95" scenario, hydrogen is used in all sectors except for the production of chemical raw materials. Demand is correspondingly high at around 400 TWh in 2050. Moreover, a small proportion of fossil natural gas is also still in use in this scenario.

The large number of scenarios considered show a broad range of possible developments in the demand for gas. To achieve the climate protection targets, the composition of the gas demand must also change and shift to climate-neutral gases (cf. figure 4).

Figure 4: Trends in gas demand in the scenarios under review up to 2050 in TWh (H_i, calorific value)



Source: Agora Energiewende 2020, BDI 2018, BMWi 2020a, dena 2018, TSOs / FourMan 2020, FZJ 2019, ISE 2020

For the Scenario Framework 2022, the transmission system operators decided to consider the following scenarios, which map the range of possible developments in the demand for gas, in more detail:

- **Scenario I: dena-TM95 scenario with adjustments by TSOs / FourManagement (dena-TM95 / TSO)**
  This scenario is based on the dena-TM95 Scenario. The technology mix scenario assumes a broad variation in the technologies and energy sources used. In this scenario, a 95% reduction in greenhouse gases from 1990 levels is achieved by 2050. The dena-TM95 scenario was already included as an element of the Scenario Framework 2020. It has now been adapted by the transmission system operators in cooperation with the FourManagement consulting firm in order to do justice to the increasing importance of hydrogen, which is also reflected in the federal government's National Hydrogen Strategy. The total gas quantity structure in the dena-TM95 scenario was essentially kept constant here and a shift from methane demand towards hydrogen demand was carried out. Furthermore, shares accounted for by oil were substituted by methane and hydrogen, while it was assumed that hydrogen was used in the production of primary energy and district heating on a pro rata basis. Scenario I takes a high gas proportion into consideration, including a high share of hydrogen in particular, and is therefore relevant for the design of the gas infrastructure. The scenario was included by the transmission system operators, as it reflects the potential of gas in the decarbonisation process.

- **Scenario II: NECP scenario with climate protection programme (NECP KSP)**
  The goal of the integrated National Energy and Climate Plan (NECP) is to improve the coordination of European energy and climate policy in order to achieve the climate targets in 2030. In accordance with the regulations [EC 2018], all EU member states have to draw up an NECP for the period from 2021 to 2030. The first NECP drafts had to be sent to the EU Commission as early as 31 December 2018. The final version of the German NECP was adopted by the German cabinet on 10 June 2020 and subsequently sent to the EU Commission [BMWi 2020a]. Against this background, the NECP scenarios are of a great importance at the European level. The German NECP contains a reference scenario and a scenario with a climate protection programme. Reference is made in the Scenario Framework 2022 to the scenario with the climate protection programme up to 2050.

In this scenario, a reduction of around 87.5% in greenhouse gases from 1990 levels is achieved by 2050. The importance of hydrogen also increases in this scenario, but the development lags behind the targets of the National Hydrogen Strategy. The transmission system operators assume that the increasing importance of hydrogen will also be reflected in the future NECP process.

Tables 18 and 19 below show the total German gas usage in the scenarios examined, which is presented in terms of calorific value (H_i) in each case in deviation from the other presentations in the Scenario Framework 2022. This presentation makes it easier to compare with other energy scenarios. It is broken down into methane (natural gas, biomethane as well as synthetic gases) and hydrogen. Figure 5 provides a graphic presentation of the trends in gas demand in the scenarios.

Table 18: Development of German gas demand in scenario I, temperature-adjusted, presented as low calorific value (H_i)

Gas consumption by sector	2019	2022	2027	2032	2040	2050
	TWh H_i					
Synthetic methane	**913**	**925**	**940**	**903**	**697**	**529**
Final energy consumption	602	578	550	523	434	342
Private households / commerce, trade and services	377	349	314	278	212	138
Industry	223	223	221	182	131	114
Transport	2	6	16	63	92	91
Non-energy consumption	40	53	69	83	42	5
Transformation sector	271	294	320	297	221	182
Hydrogen	**0**	**3**	**27**	**92**	**315**	**504**
Demand sectors	0	3	25	86	217	321
Private households / commerce, trade and services	0	0	1	3	15	22
Industry	0	2	21	75	142	204
Transport	0	1	2	8	60	95
Non-energy consumption	0	0	0	1	68	136
Transformation	0	0	2	4	30	47
Total gas	**913**	**928**	**966**	**995**	**1,012**	**1,033**
Demand sectors	602	581	576	609	652	663
Private households / commerce, trade and services	377	349	315	281	227	159
Industry	223	225	242	257	273	318
Transport	2	7	18	71	152	186
Non-energy consumption	40	53	69	84	110	141
Transformation	271	294	322	301	251	229

Source: BDEW / AG Energiebilanzen, calculation of the transmission system operators (temperature-adjusted values), dena 2018, transmission system operators / FourManagement 2020

Table 19: Development of German gas demand in scenario II, temperature-adjusted, presentation as low calorific value (H_i)

Gas consumption by sector	2019	2022	2027	2032	2040	2050
	TWh H_i					
Synthetic methane	**913**	**908**	**881**	**777**	**570**	**286**
Final energy consumption	602	547	483	429	301	171
Private households / commerce, trade and services	377	343	302	257	176	101
Industry	223	198	167	149	100	53
Transport	2	5	14	23	26	17
Non-energy consumption	40	32	33	32	24	18
Transformation sector	271	329	366	316	245	97
Hydrogen	**0**	**1**	**7**	**11**	**40**	**68**
Demand sectors	0	1	2	7	38	67
Private households / commerce, trade and services	0	0	0	0	0	0
Industry	0	0	0	2	26	43
Transport	0	1	2	5	11	24
Non-energy consumption	0	0	0	0	0	0
Transformation	0	0	5	4	2	1
Total gas	**913**	**909**	**889**	**788**	**610**	**354**
Demand sectors	602	547	486	436	339	238
Private households / commerce, trade and services	377	343	302	257	176	101
Industry	223	198	167	151	126	96
Transport	2	6	16	28	38	41
Non-energy consumption	40	32	33	32	24	18
Transformation	271	329	370	320	248	98

Source: BDEW / AG Energiebilanzen, calculation of the transmission system operators (temperature-adjusted values), BMWi 2020a

Figure 5: Graphic presentation of the trends in gas demand (methane, hydrogen) in the scenarios considered in more detail up to 2050 in TWh (H_i, calorific value)

Source: dena 2018, transmission system operators / FourManagement 2020, BMWi 2020a

Trends in total gas demand

Scenario I shows gas demand increasing slightly overall, where it is assumed that only renewable gases are used in 2050. Demand for hydrogen will increase significantly. In this scenario, the demand for hydrogen develops up to 2030 in the order of magnitude shown by the National Hydrogen Strategy. This sees hydrogen use of around 90 TWh to 110 TWh up to 2030 [BMWi 2020b].

In scenario II, on the other hand, gas demand declines over the long term. The importance of hydrogen also increases in this scenario, but the development lags behind the targets of the National Hydrogen Strategy.

Final energy consumption

In scenario I, there is a slight decline in the final energy consumption of methane between 2019 and 2032. In contrast, the final energy consumption for hydrogen constantly increases in this period. This can be attributed in particular to increased use of hydrogen in industry and in the transport sector. Overall, the final energy consumption for gas (methane and hydrogen) rises slightly up to 2032. From 2032 to 2050, the substitution effect intensifies and hydrogen is increasingly used, while demand for methane falls continually. Despite increases in efficiency in many areas of consumption, the demand for hydrogen grows, as new applications (e.g. hydrogen in steel production or use as a material in the chemicals industry) are also added.

In scenario II, a slightly sharper decline in the final energy consumption of methane arises in the 2019 to 2032 period under review in comparison with scenario I. Here, too, the consumption of hydrogen increases in the same period, albeit at a significantly lower level. Overall, the final energy consumption for gas (methane and hydrogen) falls significantly up to 2032. Subsequently, the final energy consumption of methane continues to fall up to 2050 in scenario II, while the final energy consumption of hydrogen increases. The rise in the consumption of hydrogen takes place in scenario II to a significantly lower extent than in scenario I, however.

Transformation sector

The restructuring of the energy system faces a large number of challenges. The issues of grid reserves, grid stability equipment and systemically important power plants, among other things, are of particular relevance here for the power plant park when it comes to guaranteeing the stability of the electricity supply system. These factors exert a significant influence on the gas power plants and connected load. A partial conversion to hydrogen also takes place here in the medium and long term. The sections below thus refer to natural gas, methane and hydrogene power plants.

For the gas demand of the power plants, the development path of gas-fired power generation has been analysed using the power plant model of Prognos AG. The starting points for the modelling are the list of power plants, i.e. the BNetzA list of the current stock of power plants and of additional and decommissioned capacity in Germany [BNetzA 2021a] and the current capacity reservations pursuant to Section 38 GasNZV submitted to the transmission system operators and capacity expansion claims pursuant to Section 39 GasNZV. Information from the BDEW's list of power plants is additionally used [BDEW 2019]. As in the previous scenario frameworks, a regionally unspecified addition of local CHP plants is made in line with the Electricity Network Development Plan.

Power plants listed by the BNetzA as systemically important continue to be listed up to 2032, unless they are slated for decommissioning in accordance with the BNetzA power plant decommissioning list. Plants that will reach the end of their life of 45 years by 2032 are replaced in principle on a structurally identical basis only if district heating supply is present at the location. In accordance with the procedure described for considering (new) gas power plants, the following installed capacity of gas power plants in Germany up to 2032 is produced. The results of the selected scenarios have been recognised for 2040 and 2050.

Table 20: Electrical power plant capacity (net) installed in gas power plants in Germany

Gas power plants in Germany Net power plant capacity	2020	2022	2027	2032	2040	2050	Change 2032 from 2020	Change 2032 from 2022	Change 2050 from 2022
	GW_e						Percent		
Scenario I	29	31	36	37	63	57	32	19	79
Scenario II	29	31	36	37	44	45	32	19	41

Source: Prognos AG

The studies that provide the basis for scenarios I and II show a higher installed gas power plant capacity for 2032 than is presented table 20. For example, the installed gas power plant capacity in 2030 lies between 48 GW_e and 75 GW_e in the dena scenarios [dena 2018]. In the NECP scenario with the climate protection programme, the installed gas power plant capacity in 2032 is around 41 GW_e. Some projects for new gas power stations that are planned as part of the coal phase-out are already included in the additional construction based on table 20.

In the scenarios examined, gas usage in the transformation sector increases in the medium term (cf. tables 18 and 19). In scenario I, gas usage remains at a higher level up to 2050. The use of hydrogen in the transformation sector remains at a relatively low level in scenarios I and II.

The transmission system operators take the new gas power plants connected directly to the transmission network into consideration in the modelling of the Gas Network Development Plan 2022–2032 in accordance with the criteria described in chapter 3.1. The studies that have been examined assume a higher gas power plant capacity over the long term. The transmission system operators will take additional power plant capacity into consideration using the established processes (e.g. Sections 38/39 GasNZV, internal orders/long-term forecasts, BNetzA power plant list).

Selection of the scenario for the long-term dimensioning of infrastructure

Based on the assessment of the transmission system operators, hydrogen and green gases will play a key role in the decarbonisation of the energy supply required to meet the climate protection targets. Their increasing importance is also shown in the results of the WEB and Green Gases Market Survey (cf. chapter 3.6). Against this background, the transmission system operators have decided to use scenario I for the long-term planning of robust gas infrastructure.

Regional breakdown of gas demand

The results of the determination of the gas demand for Germany are broken down on a regional basis, i.e. the gas demand is allocated down to the individual district. The following distribution factors are used here:

- To identify the final energy consumption, the non-energy consumption, the gas demand of the district heating plants and the internal consumption in the transformation sector on a regional level, the databases of Prognos AG, in which demand has been analysed at the district level using a regional model, will be taken into account. For hydrogen as an energy source, use is additionally made of the results of the WEB and Green Gases Market Survey (cf. chapter 3.6) and internal TSO analyses.
- To identify the electricity and heat generation from gas on a regional level, the findings of the European electricity market model of Prognos AG will be applied. The location of the power plants included in the list of power plants of the BNetzA serves as a basis for the regional breakdown.

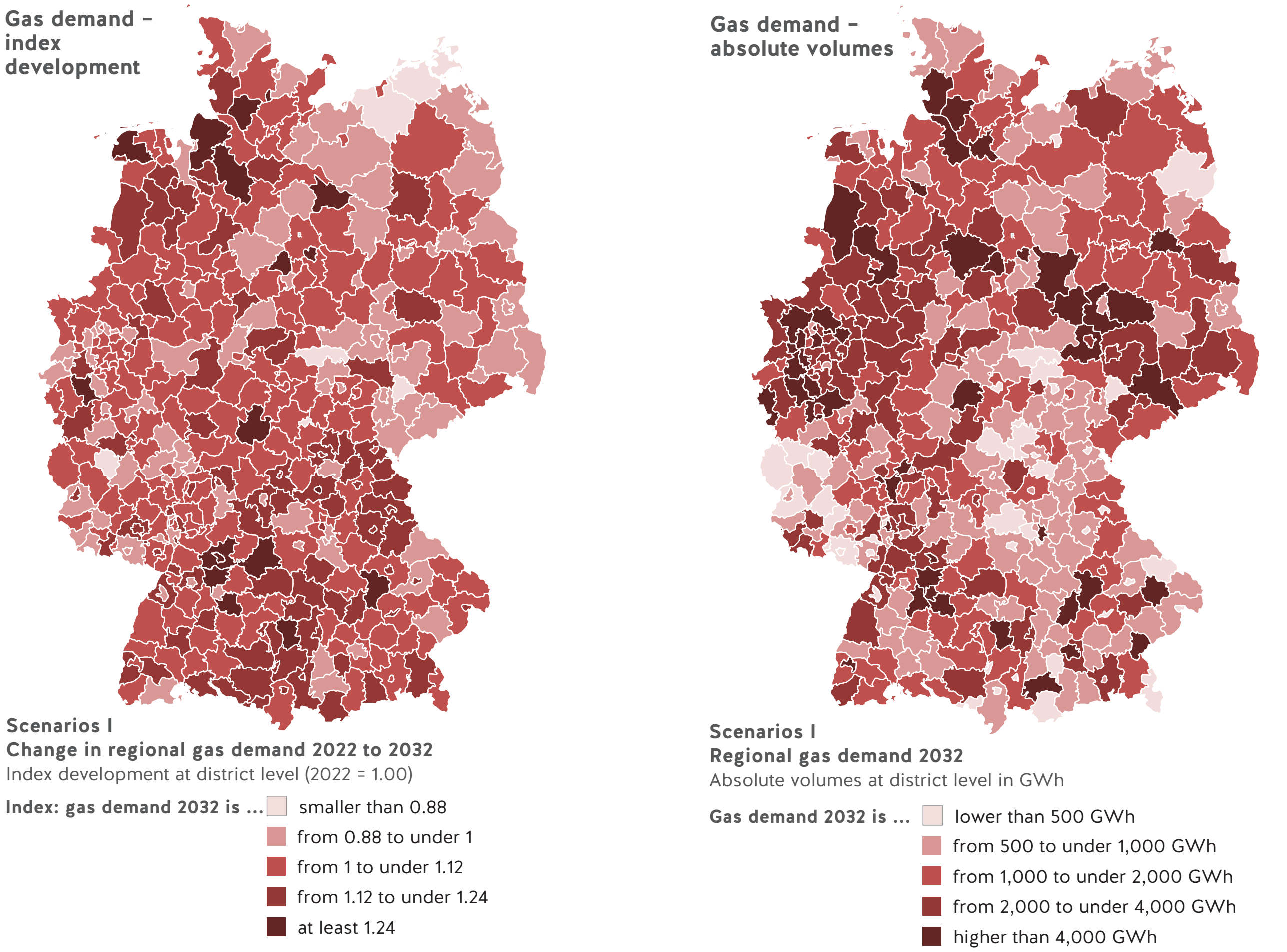
Note on the map view below

The regional breakdown is carried out for scenario I: the trends in gas demand at the district level are presented in the map below as an index development (cf. figure 6 on the left) for the period from 2022 to 2032. An index of 1.00 in 2032 is thus equivalent to a constant gas demand. The selected colour scale additionally illustrates how the trends in the individual districts are developing relative to each other.

The figures below illustrate the trends in the entire gas demand in the consumption sectors private households, commerce, trade and services and industry / power plants. The map on the right in figure 6 illustrates the absolute gas demand in scenario I, while the map on the left illustrates the relative development in the period under review up to 2032.

Gas demand at the district level is heavily dependent on regional characteristics, such as the establishment of industrial and power plant locations and the connection rate for apartments to the gas network. Overall development up to 2032 foresees trends such as a more positive demographic and economic growth in southern Germany.

Figure 6: Scenario I: Regional gas demand for 2032 in total



Source: Prognos AG

Gas supply 5

5 Gas supply

This chapter deals with past and future trends in and an assessment of the gas supply in Germany. The procedure for analysing the gas supply is described in chapter 5.1. The subsequent chapters present an assessment of the trends in conventional natural gas production (cf. chapter 5.2) as well as in biomethane injection and in the supply of hydrogen (cf. chapter 5.3). A summary presentation of the Germany-wide gas supply, including a regional breakdown, is subsequently provided in Chapter 5.4.

5.1 Procedure

Domestic production of natural gas and petroleum gas, the generation and injection of biomethane as well as hydrogen are taken into consideration in the assessment of the trends in the gas supply in Germany up to 2032. The following sources are available for this:

- Domestic production of natural gas: The development path is taken from a current study by the Bundesverband Erdgas, Erdöl und Geoenergie e.V. (BVEG – German Federal Association of Natural Gas, Petroleum and Geoenergy) [BVEG 2021].
- Injection of biomethane: The Germany-wide regionalisation of the injection of biomethane for providing electricity and heating is based on the assessment of the Federal Network Agency's current 2020 monitoring report [BNetzA/BKartA Monitoring report 2021] and the project list for biomethane injection published by Deutsche Energie-Agentur GmbH (dena – German Energy Agency) [dena 2021]. Furthermore, the projects for biomethane plants additionally reported in the WEB and Green Gases Market Survey (cf. chapter 3.6) are taken into account in the trends.
- Hydrogen: An assessment of how hydrogen supply is developing in Germany is made on the basis of the National Hydrogen Strategy and the WEB and Green Gases Market Survey (cf. chapter 3.6).

5.2 Natural gas production

The forecast of the regional natural gas production in Germany up to 2032 is based on the current projection of the BVEG for the two most important production regions (Elbe-Weser excluding "Altmark" and Weser-Ems excluding “Ostfriesland”) as well as for Germany as a whole.

Table 21: Projection of natural gas production and capacity

	Elbe-Weser region (excluding "Altmark")			Weser-Ems region (excluding "Ostfriesland")				Germany as a whole	
	Production	Capacity (8,000 h)		Production	Capacity (8,000 h)		Production	Production	Capacity
	L-gas			L-gas (full blending capacity, Großenkneten)			L-gas + H-gas		
		according to planning	with safety margin		according to planning	with safety margin			
Year	Million m³	1,000 m³/h	1,000 m³/h	Million m³	1,000 m³/h	1,000 m³/h	Million m³	Million m³	1,000 m³/h
2021	2,189	274	251	1,757	319	292	2,522	5,226	661
2022	1,963	245	223	1,615	295	267	2,329	4,851	615
2023	1,997	250	225	1,420	264	238	2,085	4,688	594
2024	1,882	235	211	1,252	240	215	1,897	4,381	554
2025	1,697	212	187	1,103	217	192	1,713	3,919	496
2026	1,598	200	175	986	195	171	1,539	3,592	454
2027	1,469	184	158	878	178	153	1,398	3,275	414
2028	1,324	166	140	771	160	135	1,259	2,953	373
2029	1,203	150	125	687	146	122	1,150	2,681	339
2030	1,099	137	112	609	134	109	1,052	2,441	308
2031	1,003	125	99	196	116	92	910	2,131	269
2032	941	118	91	183	107	83	841	1,977	249

*Germany as a whole contains the two main production areas Elbe-Weser (excluding "Altmark") and Weser-Ems (excluding "Ostfriesland") as well as the production and capacity of other small regions.

Source: BVEG 2021

The data on production and on "capacity according to planning" are based on the data from the BVEG. As the planned capacity was not reached in the last few years, the table produced by the BVEG for the Elbe-Weser (excluding "Altmark") and Weser-Ems (excluding "Ostfriesland") regions additionally shows the "capacity with safety margin".

The supply of natural gas in Germany is low outside of the two main production regions. The other production regions include "Between Oder/Neisse and Elbe", "North of the Elbe", "West of the Ems", "Thuringian Basin", "Upper Rhine Valley" and "Pre-Alps". All the future gas production of these regions is calculated from the total German production less the production of the "Elbe-Weser" and "Weser-Ems" regions. This remaining sum is distributed to the smaller production regions up to 2032 based on their current share of production (as of 2020).

Natural gas production is usually presented in cubic metres in the gas industry. To make it easier to compare values, they have been converted into TWh in the Scenario Framework 2022.

Table 22: German natural gas production in various units

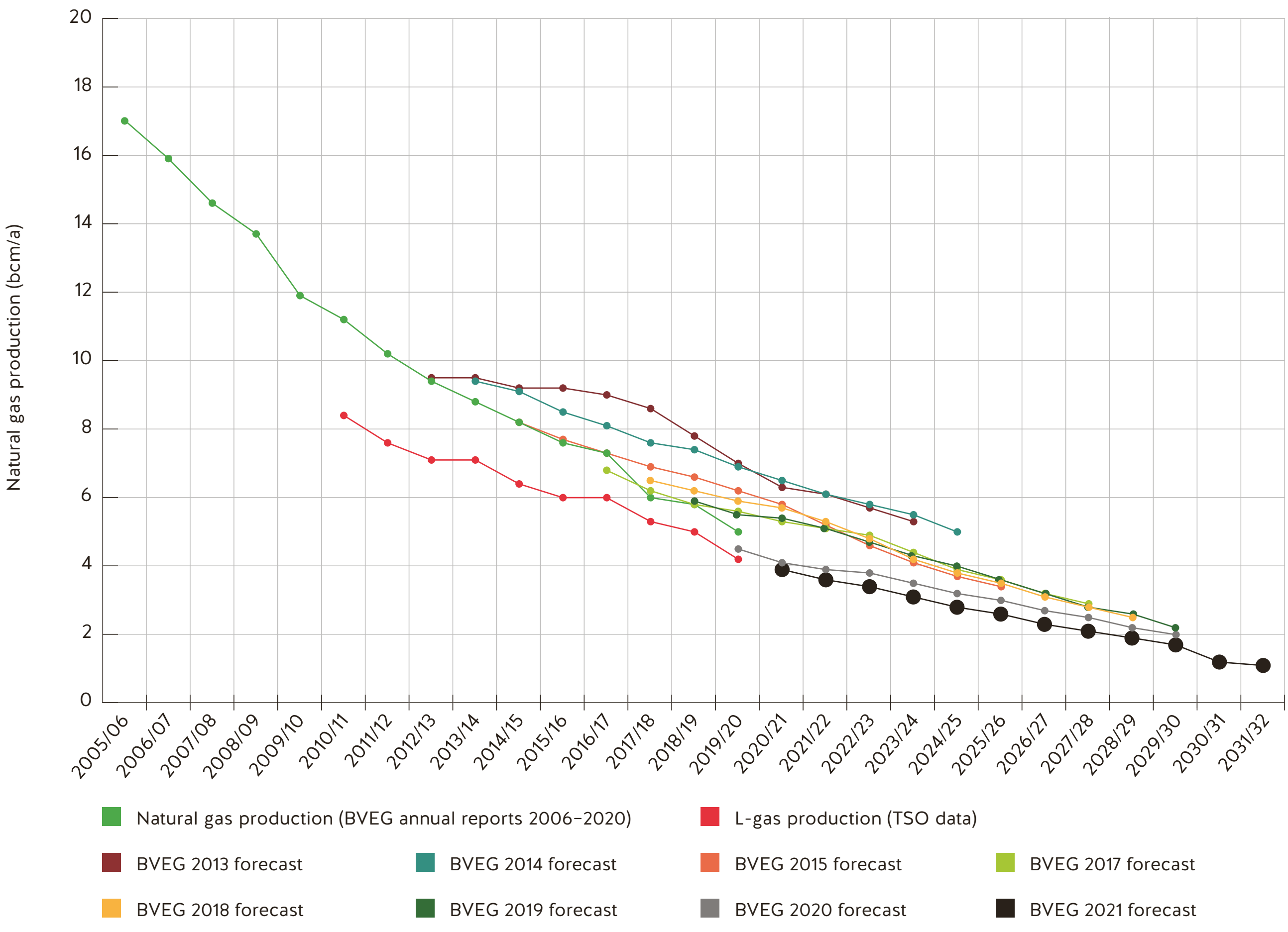
Natural gas production in Germany Scenario I and II	Unit	2019	2022	2027	2032	Change 2027 from 2019	Change 2032 from 2019
Conventional gas	billion m³*	6.1	4.9	3.3	2.0	–46%	–67%
Conventional gas	TWh H_s	59	47	32	19		
Conventional gas	TWh H_i	54	43	29	18		

* Quantities relate to natural gas with a uniform high calorific value (H_s) of 9.7692 kWh/m³.

Source: Prognos AG, BVEG 2021

Figure 7 shows the historical and forecast development of German L-gas production in the period from 2006 to 2032 for the Elbe-Weser and Weser-Ems regions.

Figure 7: Natural gas production in the Elbe-Weser and Weser-Ems production regions



Source: Transmission system operators on the basis of BVEG 2007–2021, BVEG 2021

The production data for the years from 2006 to 2020 is based on the figures published by the BVEG for the two most important production regions Elbe-Weser and Weser-Ems [BVEG 2007–2021]. For the period from 2021 onwards, the values are based on the BVEG's projections of regional natural gas production up to 2032.

German production was used as the basis in the L-gas quantity balances of the previously published network development plans using the BVEG's forecasts for natural gas production in the Elbe-Weser and Weser-Ems supply region, while taking a safety margin on the volume side into consideration.

The current BVEG forecast shows a significant decline in German L-gas production from 2021 onwards, which in turn falls noticeably short of the forecast values of the last few years. The effects of the BVEG's new production forecast on the Germany-wide L-gas quantity balance are analysed by the transmission system operators in the course of the modelling of the Gas Network Development Plan 2022–2032. It seems conceivable at the moment, however, that this decline currently forecast by the BVEG could have an impact on the security of supply in L-gas.

In view of these developments, the transmission system operators again point out that as high a share of German production as possible should be provided as L-gas. Achieving this goal does not lie within the transmission system operators' immediate sphere of influence. From the perspective of the transmission system operators, there is an urgent need for action to create appropriate additional instruments and market incentives. The transmission system operators consider prompt discussions at the political and regulatory level to be necessary and will be happy to make themselves available for this.

5.3 Trends in the supply of hydrogen and green gases

5.3.1 Injection of biomethane

The stat analysis and assessment of the development of the injection of biomethane has been carried out using the Federal Network Agency's current 2020 monitoring report [BNetzA/BKartA Monitoring report 2021] and the injection atlas on biomethane injection published by dena [dena 2021].

The facilities for biomethane injection currently in operation have been broken down by region on the basis of the injection atlas [dena 2021]. Information on biomethane production plants under construction and in planning can be found in the dena injection atlas. It is assumed for the future trends in biomethane injection that these plants will be commissioned and improved utilisation of the biomethane production plants will be achieved in the long term.

Table 23: Injection of biomethane in Germany

	Unit	2019	2022	2027	2032	Change 2027 from 2019	Change 2032 from 2019
Injection of biomethane	TWh H_s	9	10	11	11	15%	18%
Injection of biomethane	TWh H_i	8	9	10	10		

Source: Prognos AG, dena 2021, BNetzA / BKartA Monitoring report 2020

In addition, requests for biomethane facilities totalling 2.3 TWh for 2027 and 2.8 TWh for 2032 (each in calorific value, H_s) were received in the course of the WEB and Green Gases Market Survey.

5.3.2 Hydrogen

On the subject of the generation of hydrogen, the National Hydrogen Strategy writes: "Strong, sustainable and domestic hydrogen production and use that makes a contribution to the energy transition – a "home market" – is essential for starting up a market for hydrogen technologies and their export. Generation capacity for electricity from renewable energy sources (especially wind and solar) must be consistently increased further in order to use hydrogen economically and sustainably over the long term." It is assumed that "in the medium and long term [...] Germany will also import hydrogen to a considerable extent". For this reason the National Hydrogen Strategy envisages "integration of hydrogen in existing energy partnerships and [the] development of new partnerships with strategic export and import countries."

The development in hydrogen demand in Germany is estimated in Chapter 4.2. Covering this demand for hydrogen is a key question for the future hydrogen economy. The National Hydrogen Strategy states: "The federal government sees a demand for hydrogen of approximately 90 to 110 TWh by 2030. In order to cover part of this demand, generation plants with a total capacity of up to 5 GW_e, including the offshore and onshore energy production required for this, will need to be built in Germany by 2030. This is equivalent to green hydrogen production of up to 14 TWh [assumption: 4,000 full load hours and an average efficiency rate of the electrolysis plants of 70 per cent] and a required volume of renewable electricity of up to 20 TWh."

It is assumed in the Scenario Framework 2022 that the hydrogen of around 14 TWh specified in the National Hydrogen Strategy will be generated as a minimum in Germany in 2030, with this volume rising to around 20 TWh by 2032.

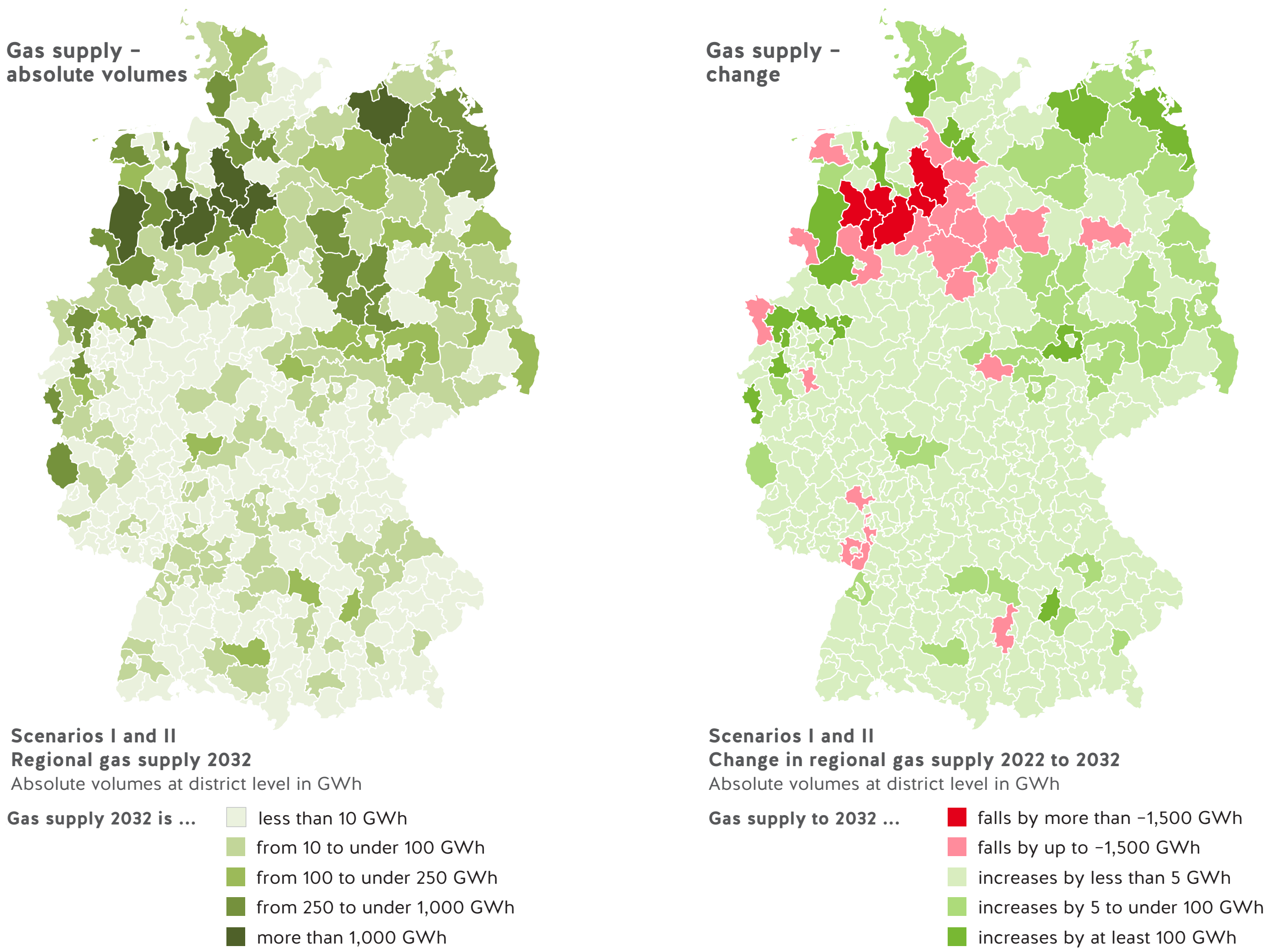
The results of the WEB and Green Gases Market Survey (cf. chapter 3.6) show that there are currently project reports for electrolysers totalling around 21 GW_e for Germany up to 2030. This value exceeds by a considerable amount the 5 GW_e mentioned in the National Hydrogen Strategy. For 2050, the value derived from the reported domestic projects is 49 GW_e. The hydrogen injection volume of the projects reported in the WEB and Green Gases Market Survey comes to around 607 TWh (calorific value) in 2050. In comparison, the dena-TM95 scenario shows domestic P2G production in 2050 of around 164 TWh (calorific value, H_i), and added to this are imports of P2G totalling 744 TWh (calorific value, H_i).

Injection volumes for synthetic methane have been reported in the WEB and Green Gases Market Survey from 2027 onwards. The recognition of synthetic methane is dispensed at this juncture at the moment, as no use is made of synthetic methane before 2030 in the dena-TM95 scenario.

5.4 Total gas supply

The total regional gas supply from domestic production, biomethane and hydrogen production in 2032 and its change from 2022 is presented in the following illustration. The decline in the production of natural gas in Germany can clearly be seen in the map on the right in figure 8, in which the absolute change in gas supplies is presented.

Figure 8: Regional gas supplies in 2032 and change from 2022 (absolute in GWh)



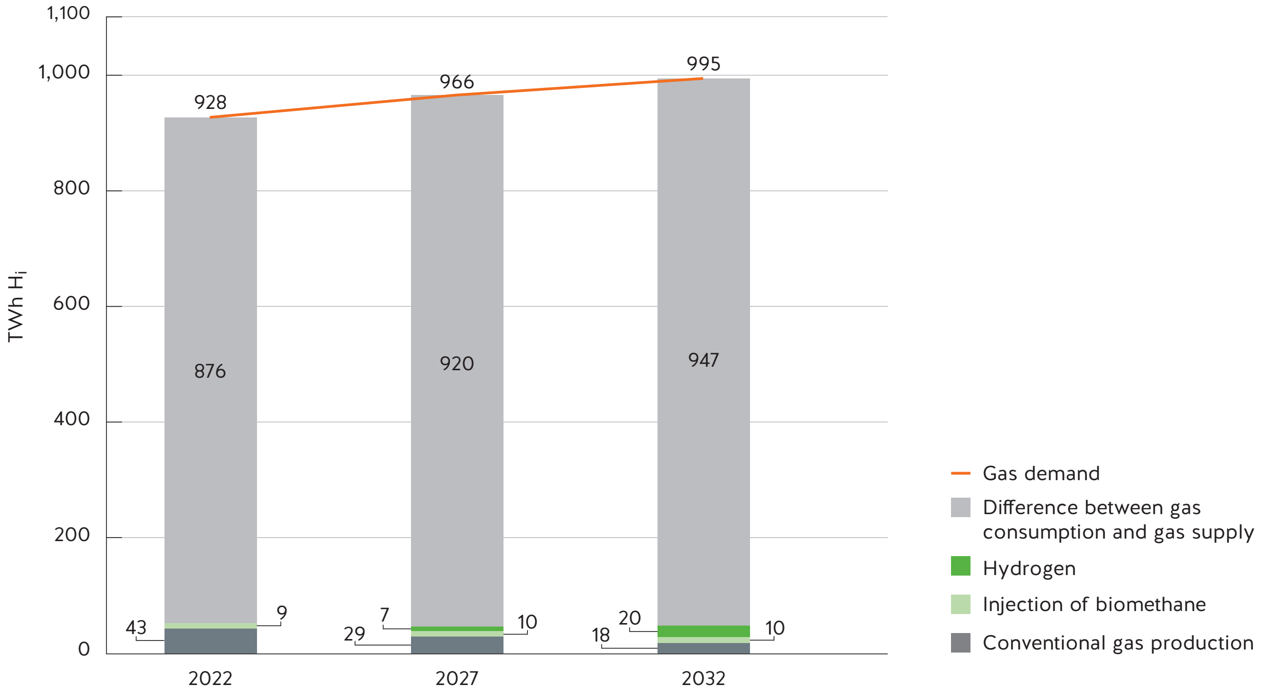
Source: Prognos AG

6 Comparison of gas demand and gas supply

6 Comparison of gas demand and gas supply in Germany

Based on the gas demand scenarios presented, a difference arises between gas demand and gas supply (excluding transit quantities). This difference is shown in figure 9 below and in Table 24. This consideration involves a simple quantity balance based on the detailed gas demand scenarios considered, for example without differentiating between L-gas and H-gas volumes. The results of the WEB and Green Gases Market Survey are not included in the values presented, as reference is made here to the national hydrogen strategy. The balances relevant for the network modelling are first presented in the Gas NDP 2022–2032.

Figure 9: Development of the difference between gas demand and gas supply in Germany according to scenario I (H_i, low calorific value)



Source: Transmission system operators

Table 24: Development of the difference between gas demand and gas supply in Germany according to scenario II (H_i, low calorific value)

Results of scenario I presented as low calorific value (H_i)	2022	2027	2032
	TWh H_i		
Gas demand	928	966	995
Gas supply	52	46	48
– Conventional gas production	43	29	18
– Injection of biomethane	9	10	10
– Hydrogen	0	7	20

Source: Transmission system operators

Hydrogen and green gases 7

7 Hydrogen and green gases

Chapter 7 deals with the subject of hydrogen and green gases. In chapter 7.1, the planned basic procedure for taking hydrogen and green gases into consideration in the Gas Network Development Plan 2022–2032 is described. The consideration of the Electricity Network Development Plan is subsequently outlined in chapter 7.2. The distribution of hydrogen sources is the subject of chapter 7.3. Finally, chapter 7.4 looks ahead to 2040 and 2050.

7.1 Description of the basic procedure relating to hydrogen and green gases

The modelling of the hydrogen variant (formerly the green gas variant in the Gas Network Development Plan 2020–2030) is based essentially on the methodology first introduced in the Gas Network Development Plan 2020–2030).

The hydrogen variant consists of two modelling elements:

- **Methane modelling:** Review of which pipelines of the existing transmission system can be converted from natural gas to hydrogen. Where necessary, this may also include identifying reinforcement measures in the natural gas network to enable the conversion of the natural gas infrastructure. Furthermore, the addition of hydrogen, biomethane or synthetic methane to the existing natural gas network is modelled.
- **Hydrogen modelling:** Transportation of hydrogen in a separate hydrogen network (converted natural gas pipelines or new hydrogen network expansion measures).

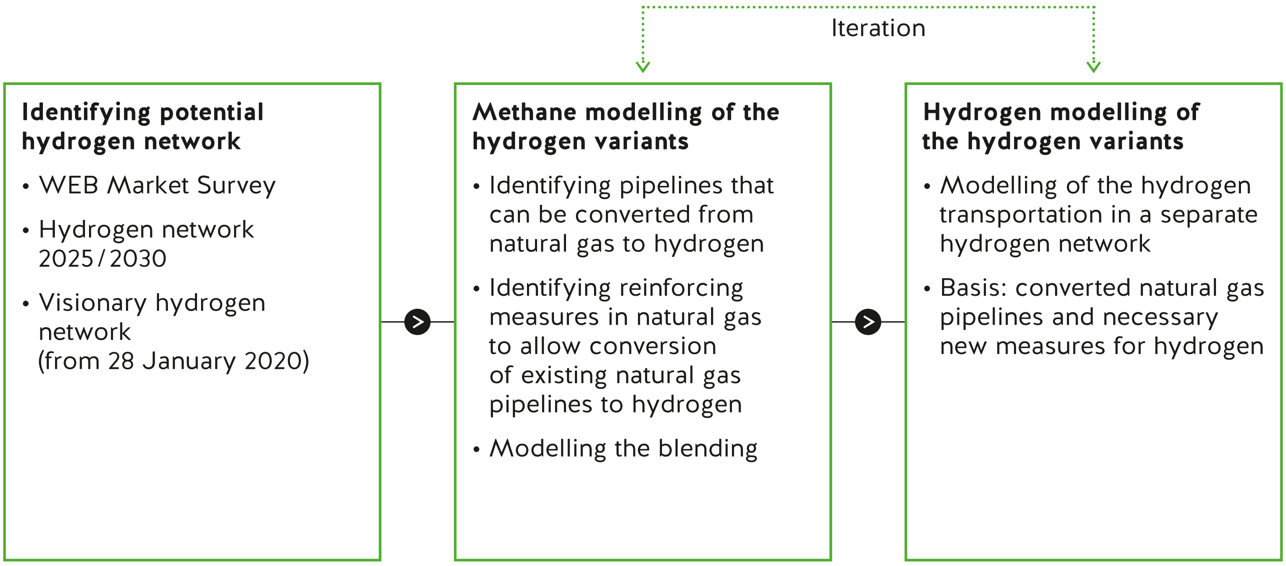
The selection of the modelling for the specific project depends on whether hydrogen pipelines converted for transport are available or whether it makes more sense to build new hydrogen pipelines. If this is not possible, the addition of pure hydrogen to the natural gas network is examined. For project reports that concern biomethane and synthetic methane, injection into the natural gas network is envisaged in principle.

The procedure can be presented here as follows:

1. Identify a potential hydrogen network (basis: WEB and Green Gases Market Survey (cf. chapter 3.6), hydrogen network 2025 / 2030 of the Gas Network Development Plan 2020–2030 and the visionary hydrogen network published by FNB Gas on 28 January 2020).
2. On the basis of the information provided by step 1, the pipelines that can be converted from natural gas to hydrogen are identified, as are any necessary reinforcement measures in the natural gas network to enable existing natural gas pipelines to be converted to hydrogen (methane modelling of the hydrogen variant).
3. Modelling of hydrogen transport in a separate hydrogen network consisting of the convertible natural gas pipelines that have been identified and of necessary new measures for hydrogen (hydrogen modelling).

The figure below shows the basic procedure. The individual steps are then described in detail.

Figure 10: Modelling procedure



Source: Transmission system operators

7.1.1 Identifying the potential hydrogen network

The starting point for identifying the potential hydrogen network is provided by the results of the WEB and Green Gases Market Survey, which was carried out from 11 January 2021 to 16 April 2021, the 2025/2030 hydrogen network identified in the Gas Network Development Plan 2020–2030 and the visionary hydrogen network published by FNB Gas on 28 January 2020.

Extending over 1,200 km in length, the hydrogen network 2030 from the Gas Network Development Plan 2020–2030 essentially connects demand points in North Rhine-Westphalia and Lower Saxony with green gas projects for generating hydrogen located in northern Germany. The starting point for the hydrogen network 2030 was provided by the market survey conducted by FNB Gas on green gas projects (now the WEB and Green Gases Market Survey) of 12 July 2019.

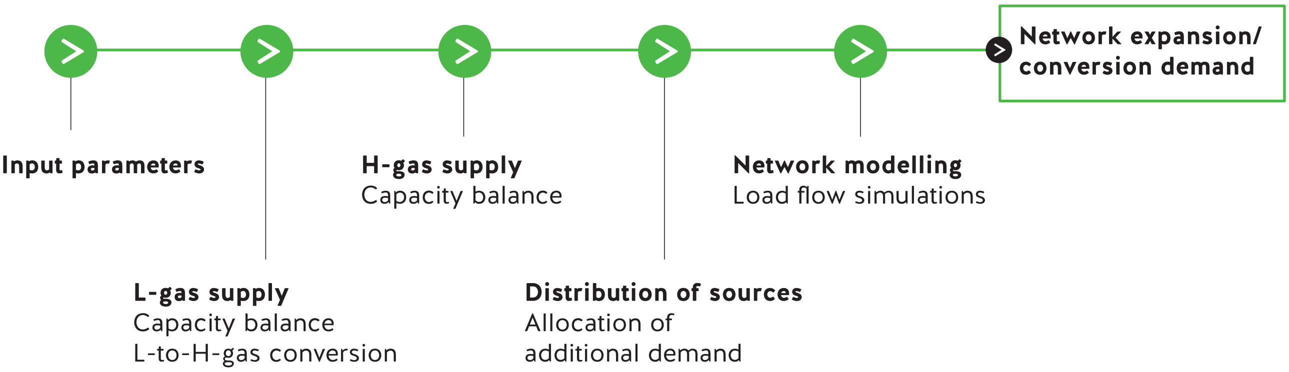
The visionary hydrogen network of the transmission system operators presented in January 2020 contains an initial, possible future vision for a transregional hydrogen network. The pipelines presented in the network connect regions where hydrogen is produced and regions where hydrogen is consumed by using natural gas infrastructure that is largely (over 90%) already in place. It comprises a total length of around 5,900 km and will be further developed on the basis of new findings in the Gas Network Development Plan 2022–2032.

In a first stage of the analysis, pipelines from the above-mentioned hydrogen network through which the projects in the WEB and Green Gases Market Survey for 2027 and 2032 could be achieved are selected. This produces a “potential hydrogen network” for the next step of the study.

7.1.2 Methane modelling for the hydrogen variant

The basic procedure for the methane modelling of the hydrogen variant is presented in figure 11.

Figure 11: Basic procedure for the methane modelling of the hydrogen variant



Source: Transmission system operators

The basis for the methane modelling is the base variant of the Gas Network Development Plan 2022–2032. The methane modelling examines which pipelines of the potential hydrogen network can be removed from the natural gas network so that the future demand for methane can still be covered by the remaining pipelines, thereby achieving an overall optimum for the secure supply of methane and hydrogen from the perspective of the transmission system operators. If this is the case, the identified sections of pipeline are available in principle for hydrogen transportation.

The analysis also includes an examination of whether it will be possible to use longer sections of a pipeline in the potential hydrogen network, e.g. by building a new, shorter natural gas pipeline, to transport hydrogen.

The transmission system operators would like to point out at this juncture that the identified potential hydrogen pipelines are natural gas pipelines needed for natural gas transportation. However, in conjunction with the expansion of the natural gas network, demand for natural gas can also be met without these pipelines.

The following principles for the removal of natural gas pipelines in the modelling are produced from this:

1. Pipeline for transporting hydrogen necessary;
2. Capacity presentation in the methane network can be guaranteed in principle without the pipeline;
3. Minor investments in the methane infrastructure to enable the conversion of natural gas pipelines to hydrogen while maintaining the supply of capacity.

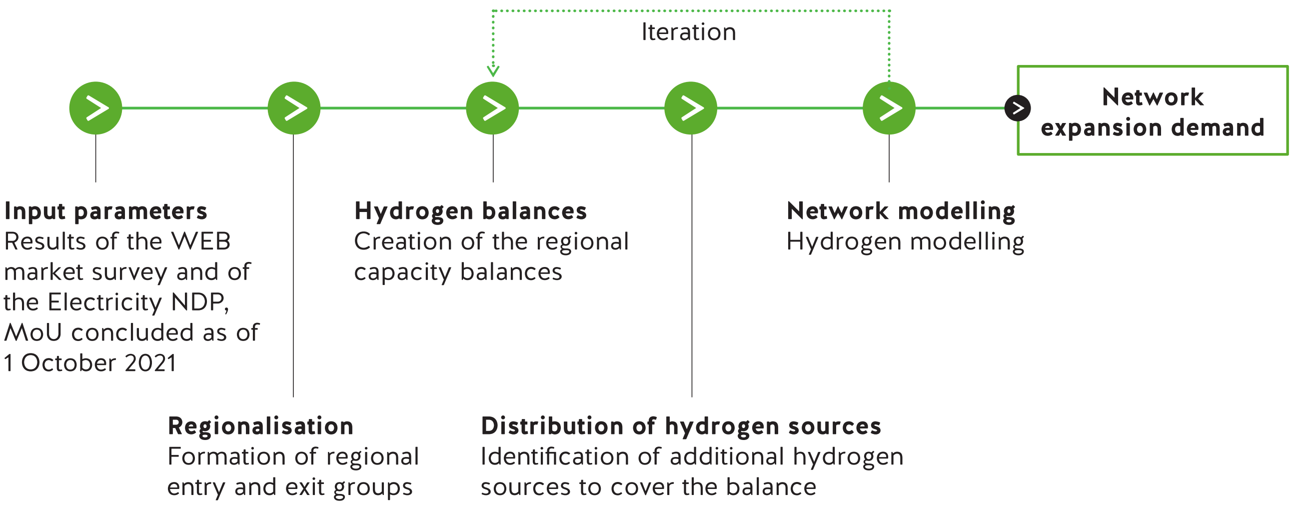
Regarding blending, the transmission system operators intend in a similar way to the procedure in the Gas Network Development Plan 2020–2030 to use a maximum blending concentration of 2% by volume as the basis in the planning. The definition is carried out on the basis of the assessment that the most extensive tolerability of the methane-hydrogen blend is produced among consumers up to this limit concentration without triggering a significant need for investment both in the network infrastructure and on the consumer side. The transmission system operators do not rule out the possibility that higher blending concentrations will also become feasible in the future.

Hydrogen injection requests for addition are subject in principle to the check of whether the blended gas is compatible with the gas property requirement in accordance with the currently applicable rules and regulation and is interoperable with gas infrastructure directly and indirectly affected in the system.

7.1.3 Hydrogen modelling for the hydrogen variant

The basic procedure for the hydrogen modelling of the hydrogen variant is presented in figure 12.

Figure 12: Basic procedure for the hydrogen modelling of the hydrogen variant



Source: Transmission system operators

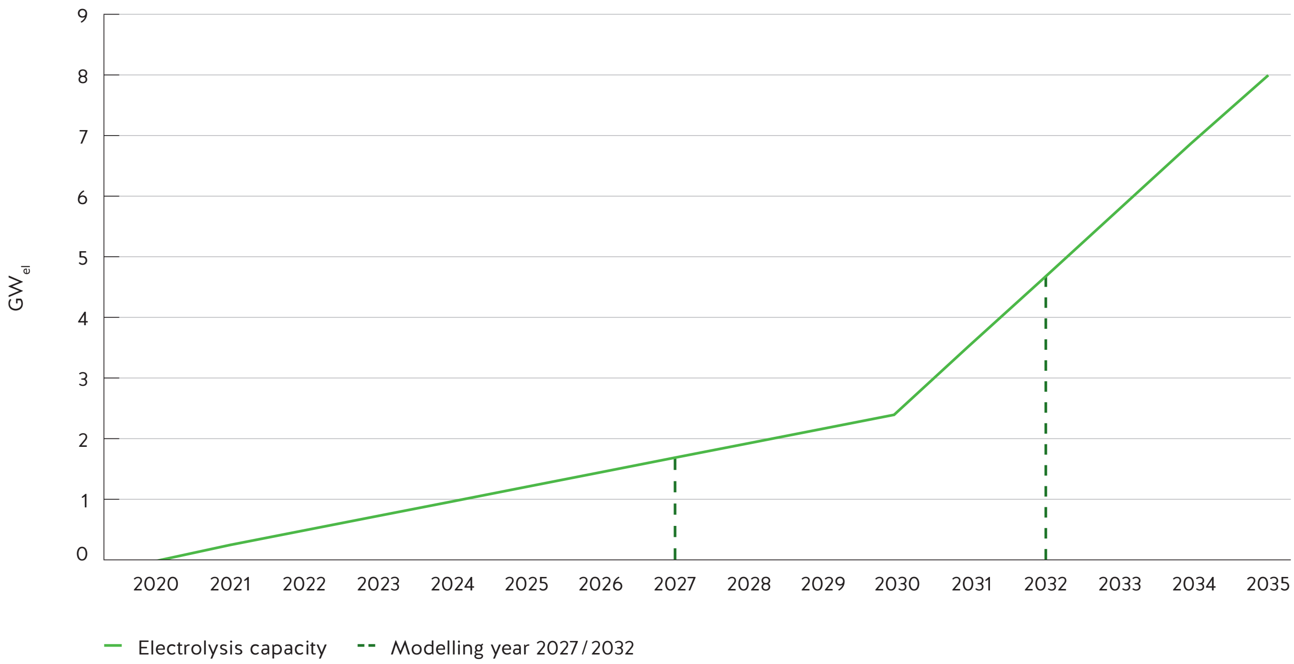
The starting point is provided by the input parameters of the network modelling of the hydrogen variant, i.e. the project reports of the WEB and Green Gases Market Survey as at 16 April 2021 (if an MoU has been entered into with the respective project managers by 1 October 2021) as well as the results of the Electricity Network Development Plan 2021–2032 (Electricity NDP). Taking these input parameters into account, regional entry/exit groups are created in the next step. After the relevant groups are formed, hydrogen capacity balances are drawn up for the regions that have been identified and the hydrogen capacity demand additionally necessary to cover the energy balance based on the results of the WEB and Green Gases Market Survey and the Electricity NDP is determined. The additional hydrogen demand required is subsequently allocated on the basis of these results to the entry points identified in the course of the distribution of hydrogen sources. The network modelling of the transmission system operators is then performed, where the necessary network expansion requirement is identified. Iterations are carried out in the course of the modelling if necessary in order to determine the expansion of the hydrogen network.

7.2 Consideration of electrolysis capacity from the Electricity NDP

In a similar way to the procedure in the Gas Network Development Plan 2020–2030, the transmission system operators aim to take the assumptions on the electrolysis capacity made by the electricity transmission system operators and confirmed by the BNetzA into account in the Gas Network Development Plan 2022–2032 in addition to the results of the WEB and Green Gases Market Survey.

As the electricity network development plans do not map the specific modelling years of 2027 and 2032 that are to be examined by the Gas Network Development Plan 2022–2032, these have to be determined by means of an interpolation. The transmission system operators intend to open up the selected approach for the interpolation, presented below in figure 13, for consultation.

Figure 13: Interpolation of the electrolysis capacity for the modelling years 2027 and 2032



Source: Transmission system operators

The Electricity Network Development Plan 2035 (2021), with the target year set as 2035, does not come within the range of the modelling period of the Gas Network Development Plan 2022–2032 under consideration here. The transmission system operators therefore propose using both the Electricity Network Development Plan 2030 (2019) and the Electricity Network Development Plan 2035 (2021) as the basis in order to determine the electrolysis capacity for 2027 and 2032. To this end, scenario C is selected as the basis, as this scenario best maps the federal government's plans in the National Hydrogen Strategy from the perspective of the transmission system operators. Accordingly, the National Hydrogen Strategy envisages installed total electrolysis capacity of 5 GW_e for 2030, while another 5 GW_e will be developed by 2035 or by 2040 at the latest.

2030 is specified by the Electricity Network Development Plan 2030 (2019) and 2035 is specified by the Electricity Network Development Plan 2035 (2021), both by using scenario C. The reported electrolysis capacity with subsequent methanisation is not examined here, as it is the pure hydrogen generation capacity that is intended to be taken into consideration. Electrolysis capacity of 2.4 GW_e for 2030 and capacity of 8 GW_e for 2035 is thus produced. The transmission system operators assume installed electrolysis capacity of 0 GW_e for 2020. Electrolysis capacity of 1.7 GW_e for 2027 and capacity totalling of 4.6 GW_e for 2032 is thus produced by the linear interpolation.

To avoid projects being taken into consideration twice, the results of the WEB and Green Gases Market Survey are combined with the identified electrolysis capacity of the Electricity Network Development Plan in the Gas Network Development Plan 2022–2032. This concerns the electrolysis capacity to be considered from the WEB and Green Gases Market Survey after the MoU has been presented by 1 October 2021 (cf. chapter 3.6).

7.3 Distribution of hydrogen sources for 2027 and 2032

By reference to various studies and the market survey for hydrogen and green gases that they carried out for their part, the transmission system operators already pointed out with the publication of the Gas Network Development Plan 2020–2030 that the demand for hydrogen in Germany cannot be covered by the available domestic electrolysis capacity alone. Accordingly, it is necessary to tap other supply sources for a well-adjusted hydrogen balance. In the National Hydrogen Strategy, the federal government describes how the majority of the hydrogen to cover future demand would have to be imported and how this demand could not be serviced only with the local production of green hydrogen.

It can be derived from the overview of the WEB and Green Gases Market Survey presented by the transmission system operators in chapter 3.6 that an additional hydrogen supply might also be necessary in the Gas Network Development Plan 2022–2032. The transmission system operators will therefore use additional sources of hydrogen supply to bridge the gap in demand. These are:

- Imports of hydrogen;
- Domestic production of hydrogen through the use of onshore wind farms eligible for the renewable energy sources subsidy;
- Storage facilities, especially for structuring volatile sources and for covering peak loads.

The additional sources of hydrogen supply that are listed are described in detail below.

Imports of hydrogen

The transmission system operators already saw in the Gas Network Development Plan 2020–2030 considerable potential for equalising the hydrogen energy balance in transnational imports from neighbouring states. The Netherlands in particular was shown here to be a suitable source thanks to concrete major projects. Numerous project developments involving hydrogen generation capacity in other countries show that hydrogen can be imported to Germany from other sources of supply. In accordance with the National Hydrogen Strategy, the federal government is committed to tapping this potential for hydrogen imports.

In the course of the WEB and Green Gases Market Survey, six projects reports were received according to chapter 3.6.3 from foreign project owners or network operators with an entry capacity totalling around 12.6 GW_{th} for 2032.

In order to determine additional hydrogen import capacity, the transmission system operators are asking foreign network operators, primarily from neighbouring states, to express their views in the course of the consultation on the Scenario Framework 2022 with concrete or forecast capacity data especially for the 2027 and 2032 modelling years.

Domestic hydrogen production from wind turbines

A large number of onshore wind turbines will come to the end of the 20-year subsidy from the Renewable Energy Sources Act in the next few years. The remaining subsidy could lead in future to the wind turbines being operated uneconomically, with the consequence that some of them may be shut down and decommissioned. So that this renewable energy potential is not lost, the transmission system operators see an opportunity to integrate these turbines in the production of hydrogen by means of power-to-gas technology and to provide for their ongoing use. The annual accounts of the electricity transmission system operators for the core energy market data register will be consulted to determine the potential for hydrogen generation from wind power. The evaluation produces wind energy potential up to 2032 totalling around 29 GW_e. Based on this potential, the transmission system operators intend to examine the results of the WEB and Green Gases Market Survey and take an appropriate capacity into consideration as part of the distribution of hydrogen sources.

Hydrogen storage facilities

The transmission system operators see gas storage facilities as an essential building block of a functioning hydrogen network. The transmission system operators already saw in the Gas Network Development Plan 2020–2030 considerable potential for equalising the hydrogen energy balance in the consideration of additional storage capacity. Although storage facilities do not constitute hydrogen generation plants in the technical sense, they can nevertheless make a contribution to the structuring and have the ability to cover peak loads in part as required by withdrawing the hydrogen that has been stored. In the course of the WEB and Green Gases Market Survey, seven project reports were received according to chapter 3.6.3 from storage system operators that together can provide entry capacity of around 4.2 GW_{th} in 2032 for the transmission network.

In addition to the coverage of peak loads, a large working gas volume is also necessary when considering gas storage facilities in the hydrogen network, as the electrolysis capacity will not be available at all times and throughout the year. In this respect, the question arises for the transmission system operators of whether other storage capacity should be taken into consideration in addition to the capacity already reported. The transmission system operators are therefore calling, in the course of the consultation on the Scenario Framework 2022 and especially for 2027 and 2032, for views on the consideration of other storage capacity and volumes extending beyond the WEB and Green Gases Market Survey.

Next steps

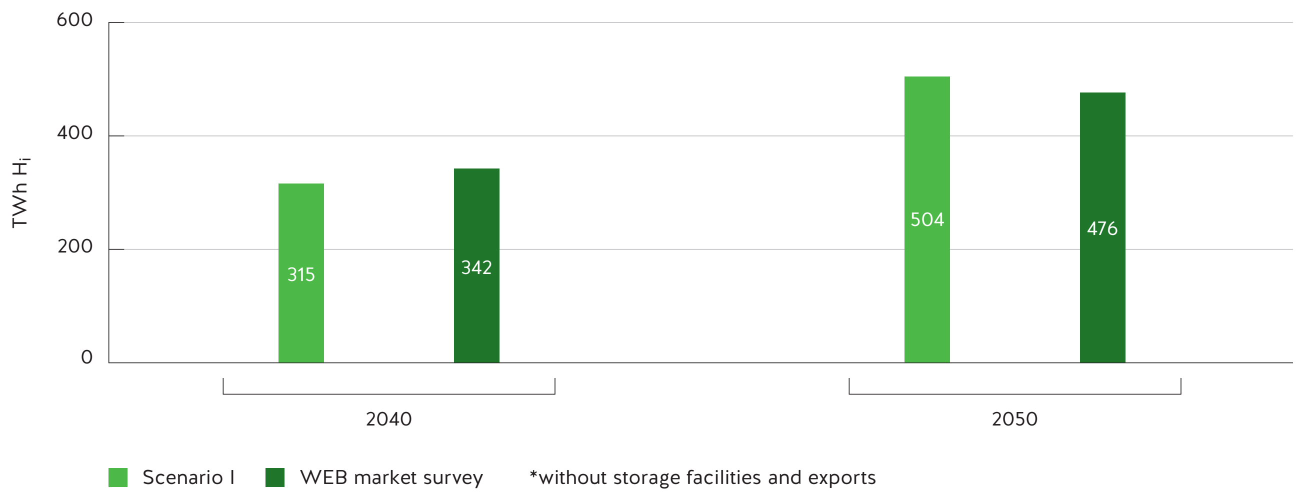
MoUs need to be entered into by 1 October 2021 for the hydrogen projects reported in the course of the WEB and Green Gases Market Survey in order to gradually increase the commitment. After the MoUs are entered into, a hydrogen energy balance will be drawn up from the now concrete reports in the WEB and Green Gases Market Survey and in due consideration of the electrolysis capacity of the Electricity NDP when the Gas Network Development Plan 2022–2032 is prepared. Furthermore, the views on additional hydrogen import capacity and storage potential will be evaluated and a distribution of hydrogen sources for covering the hydrogen energy balance will be drawn up.

7.4 Outlook for hydrogen 2040 and 2050

In addition to the demand for hydrogen for the period up to 2032, the demand for 2040 and for 2050 were also reported in the WEB and Green Gases Market Survey. Although these two years are not an integral part of the modelling, the reported demand enables a comparison with scenario I presented in the document (cf. figure 14).

The reported demand for hydrogen shown by the WEB and Green Gases Market Survey amounts to around 342 TWh (calorific value) in 2040 and to around 476 TWh (calorific value) in 2050. These values are thus within the order of magnitude of scenario I.

Figure 14: Comparison of the hydrogen demand* for 2040 and 2050, presented in TWh (H_i, calorific value)



Source: Transmission system operators

Gas exchange
Germany | Neighbouring countries

8

8 Gas exchange between Germany and its neighbouring countries

This chapter presents current trends in the incremental capacity process (cf. chapter 8.1). The assumptions and results related to the distribution of H-gas sources are then described (cf. chapter 8.2), before the developments at the cross-border interconnection points are addressed in chapter 8.3. Chapter 8.4 presents the virtual interconnection points (VIPs).

8.1 Incremental capacity

Regulation (EU) 2017/459 (NC CAM) came into force in 2017. This provides for a European process for incremental capacity. By using this instrument, the capacity demand of the shippers is intended to be included in a sustainable further development of the gas transmission infrastructure in a market-based process using this instrument.

Established in 2017, the process starts at least every two years at the annual auction with a non-binding market survey of the demand for additional cross-market area capacity. The transmission system operators will subsequently publish analyses of this demand. If the capacity required can be provided without expansion, the process ends. Otherwise, the transmission system operators publish a draft of their project proposal for creating the transmission capacity that is in demand, including a technical study. Following a public consultation, they review the draft document and submit the project proposal to the BNetzA for approval. Depending on this approval, supply levels with incremental capacity are offered at the next annual auction. An economic test is carried out after the bookings. The BNetzA examines in this whether a project for incremental capacity will actually be implemented. To this end, incremental capacity must be booked on a scale that covers a reasonable part of the expected project costs.

In the course of the 2019–2021 incremental capacity cycle, incremental entry and exit capacity for the following market area borders will be offered in the annual auction on 5 July 2021.

Table 25: Overview of the incremental entry and exit capacity offered in the annual auction on 5 July 2021

Entry / exit	from	to	Capacity product
Exit	THE	Switzerland	Dynamically allocable capacity
Entry	Russia	THE	Upgrade dynamically allocable capacity -> freely allocable capacity
Entry	Russia	THE	Freely allocable capacity
Entry	Poland (E-Gas Transmission System)	THE	Freely allocable capacity
Entry	Poland TGPS	THE	Freely allocable capacity
Entry	Denmark	THE	Freely allocable capacity

Source: Transmission system operators

The auctions will take place during the consultation phase of the Scenario Framework 2022.

Binding bookings that pass the economic test will be included in the draft Scenario Framework 2022 and will be taken into consideration in the modelling of the Gas Network Development Plan.

The documents on the 2019–2021 incremental capacity cycle are published on the homepage at www.fnb-gas-capacity.de.

With the annual auctions on 5 July 2021, the 2021-2023 incremental capacity cycle begins. Its results will be included at the earliest, however, in the scenario framework for the Gas Network Development Plan 2024–2034.

8.2 Distribution of H-gas sources

The decline in its own production and the conversion from L-gas to H-gas mean that the import demand for H-gas will increase in Germany in the coming years.

The transmission system operators used a model to be able to estimate the effects of future extensions of the infrastructure for importing H-gas into Europe on the German transmission networks for the first time as part of the Gas Network Development Plan 2013, which then continued to be developed in the subsequent network development plans.

Which regions additional natural gas could be shipped to Europe and Germany from, is assessed in this process while taking into consideration the current TYNDP and the information it contains on the trends in the consumption and the supply of natural gas and the development of the infrastructure projects.

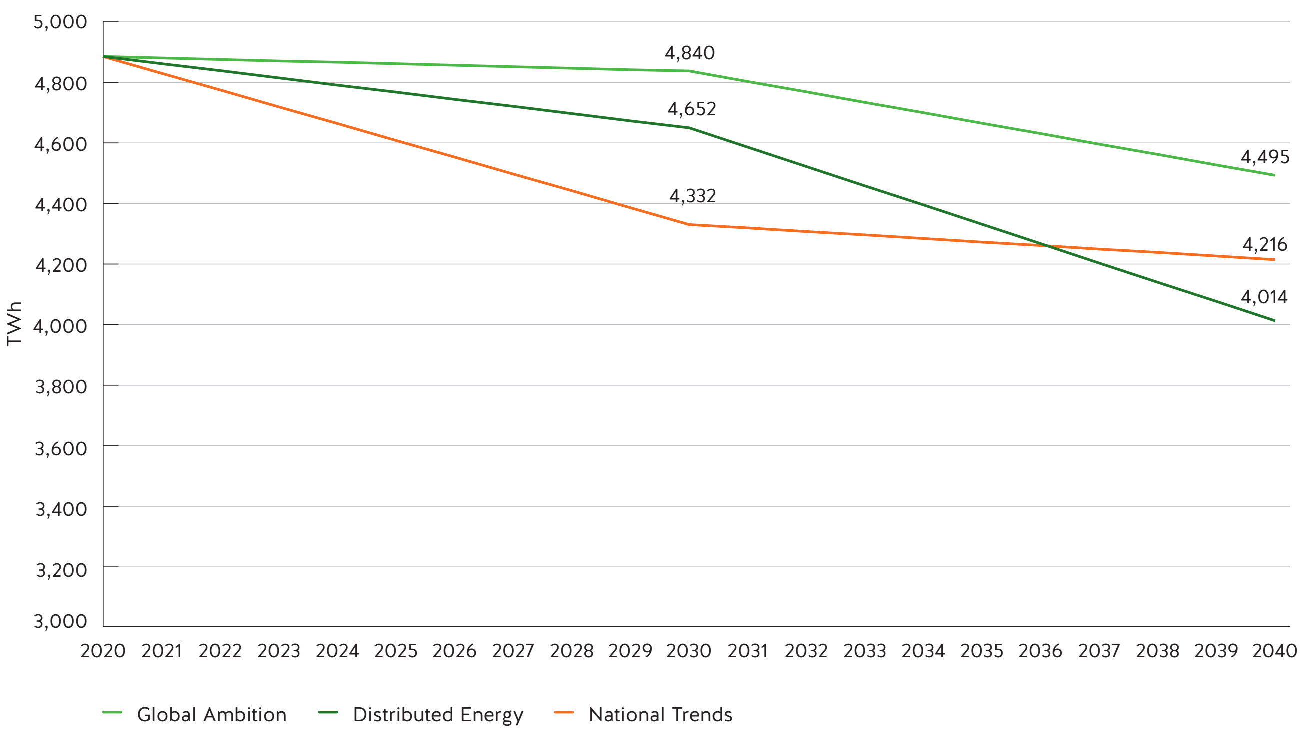
A key element of the methodology that is used is the assumption of increasing natural gas consumption in Europe that is filed in the previous TYNDP and that is covered in accordance with the model approach assumed by the transmission system operators primarily by new infrastructure projects and additionally by unused LNG capacity.

The regional allocation of the infrastructure projects is then used to produce the results of the distribution of H-gas sources together with the assumptions on the use of the LNG terminals, i.e. the import regions and their pro rata contribution to the coverage of the additional demand.

On the basis of the data in the current TYNDP 2020, the development of European gas consumption up to 2040 in the three scenarios “National Trends”, “Distributed Energy” and “Global Ambition”, that is presented in figure 15, is produced. In addition to the 28 EU states, Switzerland, Bosnia Herzegovina, Serbia and North Macedonia are presented.

In the final analysis, gas demand in Europe declines both up to 2030 and up to 2040 in all three scenarios.

Figure 15: Development of gas demand in Europe according to TYNDP 2020



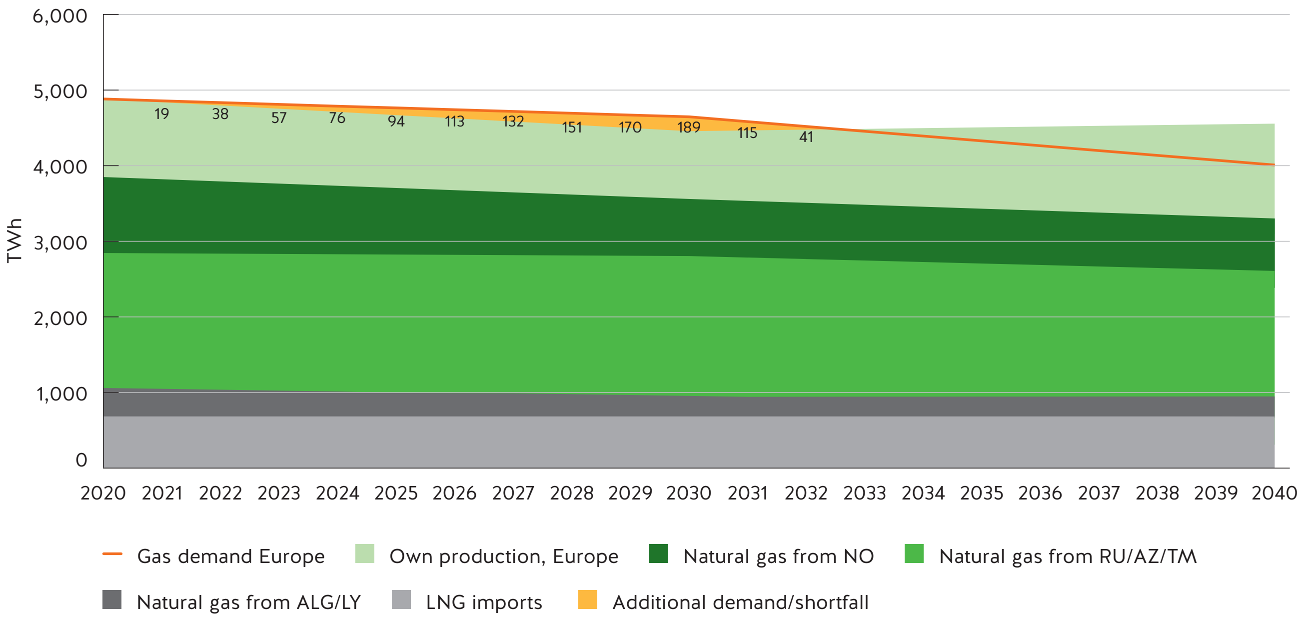
Source: Transmission system operators on the basis of the TYNDP 2020

In the same way as in the procedure in the previous gas network development plans for the demand side, the middle road in the TYNDP is taken into consideration. The "Distributed Energy" scenario thus forms the basis for drawing up the balance. In accordance with the approval of the Scenario Framework 2021–2035 of the Electricity Network Development Plan of 26 June 2020, this scenario also provides the basis for the scenarios in the Electricity Network Development Plan.

On the supply side, the mean value from each of the minimum and maximum scenarios derived from the "Distributed Energy" scenario for pipeline deliveries is taken as the basis, while the LNG supply is assumed to be constant across all years at the level of the base year of 2020 that is assumed in the planning.

As the internal European and Norwegian production volumes are in decline, an additional planning import demand of around 189 TWh (around 18 bcm/a) in relation to the base year is produced for 2030 together with the assumed development of the gas demand. The energy balance import demand is reduced to around 41 TWh (around 4 bcm/a) for the 2032 modelling year, before an energy balance surplus is produced in the subsequent years. In comparison, the additional import demand for 2030 based on the TYNDP 2018 was around 57 bcm/a.

Figure 16: Development of supply and demand in Europe on the basis of the "Distributed energy" scenario of the TYNDP 2020



Source: Transmission system operators on the basis of the TYNDP 2020

As the trends in supply assumed in the planning refer to the middle road and the maximum of all sources of supply for 2030 in the "Distributed Energy" scenario comes to more than 6,000 TWh, no additional infrastructure projects are necessary in terms of the energy balance to cover the gas demand in Europe alongside the sources of supply already taken into consideration previously.

This assessment can also be found together with other detailed information on the supply side in the "Scenario report on the TYNDP 2020" from ENTSOG:

"The supply potential assessment run by ENTSOG and discussed with stakeholders in July 2019 concludes that for all scenarios, the import potentials are high enough to ensure the supply and demand adequacy of the EU until 2050. This is despite the decline of the conventional indigenous production."

The impact of the expansion of the import infrastructure projects on Germany is determined within the framework of the distribution of H-gas sources.

As the assessment of the TYNDP 2020 shows, the forecast gas demand in Europe can be covered by the existing import infrastructure, including the Nord Stream 2 and TAP projects already taken into account in the Gas Network Development Plan 2020–2030.

This is also reflected in the fact that the TYNDP 2020 does not include any more extensive, additional infrastructure projects for tapping new sources of supply for Europe where a final investment decision has been made to that effect (apart from a few expansions to existing LNG terminals).

The assumptions on the distribution of H-gas sources that were made in the Gas Network Development Plan 2020–2030 have thus proved to be robust when set against the infrastructure assumptions in the TYNDP 2020.

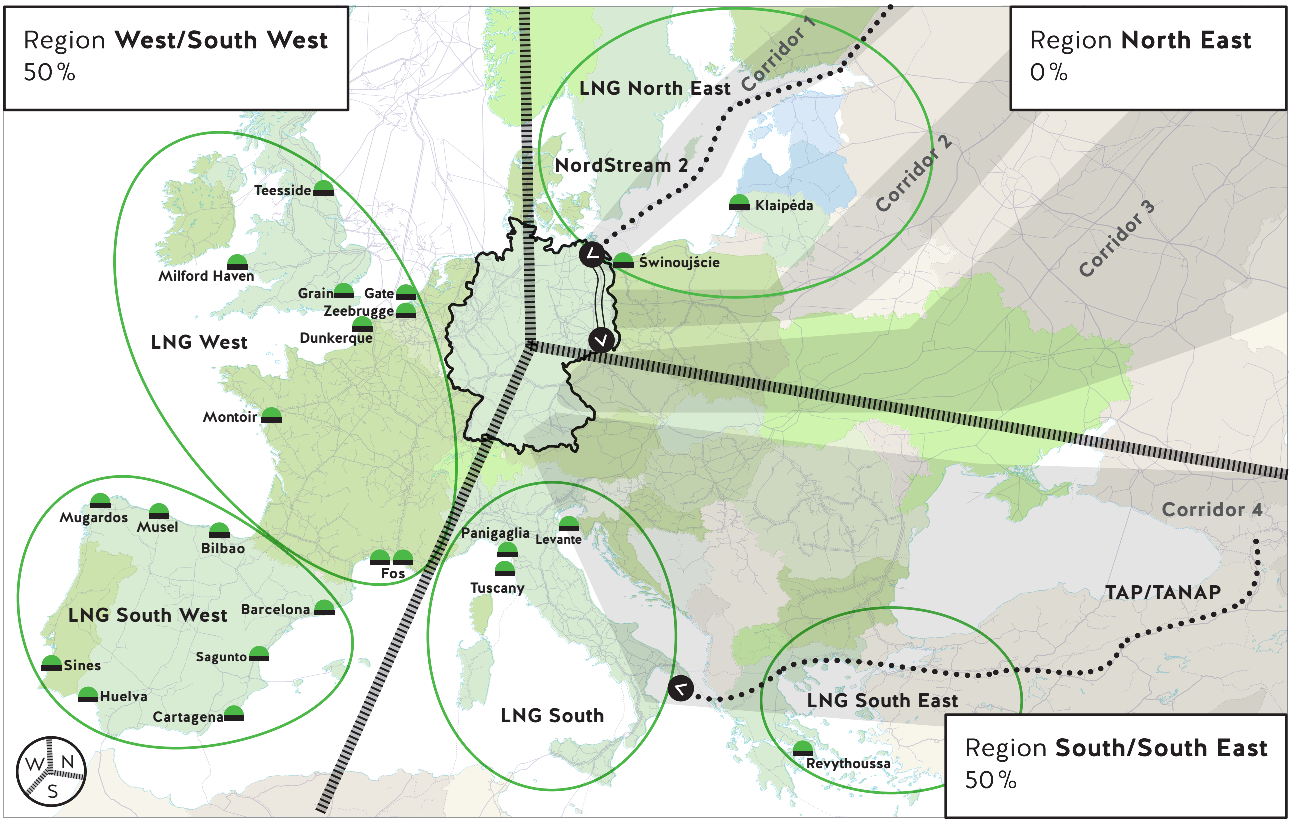
The transmission system operators therefore propose to take over the assumptions made as part of the distribution of H-gas sources in the Gas Network Development Plan 2020–2030 as the basis for the Gas Network Development Plan 2022–2032, whereby the stability and continuity of the previous planning assumptions are guaranteed.

The transmission system operators expect that, similar to the assumptions of the Gas Network Development Plan 2020–2030, the additional German demand can be covered by the “West / South West” region and the “South / south-east” region, with each accounting for around 50%, via the Nord Stream 2 and TAP / TANAP pipeline projects and also the well-developed European LNG infrastructure.

Overall, the following percentage distribution by region is produced (cf. figure 17):

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

Figure 17: Distribution of H-gas sources



Source: ENTSOG, TSO

LNG Region · LNG Terminal · Pipeline projects · EUGAL · Corridor

Reports from the market participants in the course of the consultation on the present Scenario Framework 2022 on additional projects that have not previously been considered and that are as concrete as possible to cover the demand for H-gas in Germany will be gladly received and accordingly examined by the transmission system operators.

8.3 Trends at interconnection points

This chapter examines the trends at the cross-border interconnection points. The table below shows how the individual German cross-border interconnection points are taken into consideration within the framework of the distribution of H-gas sources in the modelling of the Gas Network Development Plan 2022–2032. Additional statements on the Überackern 2 and Ellund cross-border interconnection points are subsequently presented.

Table 26: Consideration of the cross-border interconnection points in the distribution of H-gas sources

Cross-border interconnection point	Country	Region	Comment / criterion
The following cross-border interconnection points are applied in the distribution of H-gas sources and the amount of the capacity to be taken over is reviewed in the course of the production of the H-gas balance for the Gas Network Development Plan 2022–2032.			
Bocholtz-Vetschau	Netherlands	Western / South-western Europe	Possible increase in the entry capacity through additional sales potential on a regional basis as the market area conversion progresses.
Eynatten / Raeren / Lichtenbusch	Belgium	Western / South-western Europe	Possible increase in entry capacity as a result of potential from LNG facilities.
Medelsheim	France	Western / South-western Europe	Possible application of entry capacity in counterflow as a result of potential from LNG facilities. The transmission system operators point out to the shippers that exit free allocable capacity that was offered at this point in the annual auction, but not booked, can potentially be shifted away from the Medelsheim point and the French-German VIP in order to satisfy internal orders.
Wallbach	Switzerland	Southern / South-eastern Europe	Possible application of entry capacity after reverse flow from TENP.
Überackern	Austria	Southern / South-eastern Europe	Possible increase in the entry capacity on the basis of the capacity reported in the network development plan (KNEP 2020).
Überackern 2	Austria	Southern / South-eastern Europe	
Oberkappel	Austria	Souther / South-eastern Europe	Possible increase in the entry capacity as a result of additional pipeline construction projects in the TYNDP.
The application of the following cross-border interconnection points is reviewed in the distribution of H-gas sources in the course of the production of the H-gas balance for the Gas Network Development Plan 2022–2032.			
Bunde / Oude Statenzijl	Netherlands	Western / South-western Europe	Potential entry capacity after the L-gas infrastructure has been converted to H-gas.
Vreden	Netherlands	Western / South-western Europe	
Elten / Zevenaar	Netherlands	Western / South-western Europe	
The following cross-border interconnection points are not applied in the distribution of H-gas sources.			
Dornum, Emden EPT	Norway	Western / South-western Europe	No increase in the entry capacity planned in accordance with TYNDP 2020.
Tegelen	Netherlands	Western / South-western Europe	Additional feed-in from the Netherlands could be carried out in this network area only when the L-to-H-gas conversion has also been completed on the Dutch side. This is not planned at the moment.
Haanrade	Netherlands	Western / South-western Europe	Regionally limited stand-alone network.
Bocholtz	Netherlands	Western / South-western Europe	The H-gas import capacity is planned in full. An increase in the import capacity would therefore bring with it an immediate need for the expansion of the northern TENP transmission system.
Remich	Luxembourg	Western / South-western Europe	Purely exit points, no reverse flow envisaged.
RC Basel	Switzerland	Southern / South-eastern Europe	
RC Thayngen-Fallentor	Switzerland	Southern / South-eastern Europe	

Cross-border interconnection point	Country	Region	Comment / criterion
The following cross-border interconnection points are not applied in the distribution of H-gas sources.			
RC Lindau	Austria	Southern / South-eastern Europe	Purely exit points, no reverse flow envisaged. bayernets provides additional freely allocable capacity totalling 300,000 kWh / h annually in the period from 1 April to 1 October.
Kiefersfelden-Pfronten zone	Austria	Southern / South-eastern Europe	Purely exit points, no reverse flow envisaged. Additional technical capacity totalling 250,000 kWh / h was offered in the 2020 annual auction. As the additional capacity was not fully booked by the shippers, the capacity not booked was transferred – following prior notification to Prisma – to other demand points.
Waidhaus	Czech Republic	Southern / South-eastern Europe	An increase in the import capacity would bring with it an immediate need for the expansion of the MEGAL transmission system.
Brandov-STEGAL	Czech Republic	Southern / South-eastern Europe	No increase in the entry capacity planned in accordance with TYNDP 2020.
Olbernhau II	Czech Republic	Southern / South-eastern Europe	Purely exit point, no reverse flow envisaged.
Deutschneudorf	Czech Republic	Southern / South-eastern Europe	No increase in the entry capacity planned in accordance with TYNDP 2020.
Deutschneudorf-EUGAL	Czech Republic	Southern / South-eastern Europe	Purely exit point, no reverse flow envisaged.
GCP GAZ-SYSTEM / ONTRAS	Poland	North-east	No increase in the entry capacity, as no additional sources of supply have been identified based on the source distribution.
Mallnow	Poland	North-east	
Greifswald	Russian Federation	North-east	
Lubmin II	Russian Federation	North-east	
Ellund	Denmark	North-east	

Source: Transmission system operators

Austria: Überackern 2 cross-border interconnection point

Technical exit capacity (exit A / entry DE) of around 7.3 GWh / h and technical entry capacity (exit DE / entry A) of around 4.8 GWh / h is reported in the current KNEP 2020. bayernets reports technical exit capacity (exit DE / entry A) of 9.0 GWh / h and technical entry capacity (exit DE / entry A) of approximately 9.6 GWh / h (cf. NDP gas database). Moreover, additional demand for free allocable capacity (exit DE / entry A) at the Überackern 2 cross-border interconnection point totalling 2,500 MWh / h is presented in the KNEP 2020, as previously in the KNEPs of the last few years. By reference to the incremental capacity process, the transmission system operators will not take this demand into account in the modelling for the Gas Network Development Plan 2022–2032.

A project included by Gas Connect Austria (GCA) in the KNEP 2018 (GCA-2018 / 01), which was intended to cover the above-mentioned additional demand among other things through the construction of a new compressor station in Überackern, will not be pursued further at the request of the Austrian regulatory authority.

In order to respond to the current discussions and efforts to connect markets simply and cost-efficiently with each other with a view to achieving climate neutrality and in the interests of the European Union, GCA and bayernets have developed an intelligent and modern solution. The "Trading Region Upgrade Do It Yourself" (TRUD!Y) service will enable shippers in Germany to obtain supplies directly through the Central European Gas Hub (CEGH), the virtual trading point in the eastern market area. The regulatory feasibility of extending the service to Switzerland and the Tirol market area is currently being examined.

Further information on TRUD!Y is available on the bayernets website.

Denmark: Ellund cross-border interconnection point

On the basis of its own analyses of short and medium-term load flow scenarios, the Danish network operator Energinet.dk (ENDK) has derived a demand for entry capacity (DK to DE) in the order of between 1.0 GW and 1.5 GW at the Ellund cross-border interconnection point and addressed this demand with FNB Gas in the course of preparing the Scenario Framework 2022. The demand is based on the planned resumption of production in the Tyra field as well as on the planned commissioning of Baltic Pipe. With the availability of these two sources of supply, a need would arise to be able to export gas volumes to Germany using fixed transport capacity on the basis of relevant market signals.

Beyond the existing incremental capacity process, the German transmission system operates do not see any possibility of including fixed entry capacity at the Ellund cross-border interconnection point in the Scenario Framework 2022.

As this involves a request for entry capacity in the direction of Germany, it cannot be a request in the context of the security of supply in Denmark.

Furthermore, it appears likely to the German transmission system operators that the natural gas extracted in the North Sea can alternatively be shipped and imported also via existing cross-border interconnection points. After the operator of the Wilhelmshaven LNG facilities cancelled its capacity reservation, the capacity at the Norwegian cross-border interconnection point that was reduced in this respect in the Gas Network Development Plan 2020–2030 was allocated back. A higher entry capacity at the Norwegian cross-border interconnection points was thus achieved again overall.

Based on the statements of ENDK, it was not readily apparent that the gas flows that can be expected will feature the necessary degree of commitment in order to be regarded as securely available also in the peak load case.

The German transmission system operators therefore refer in this connection to the incremental capacity process, which is intended as a market-based procedure for covering commercially based capacity demand.

8.4 Virtual interconnection points

In accordance with Article 19(9) of Regulation (EU) 2017/459 (NC CAM), the transmission system operators are required to set up virtual interconnection points (VIPs) at the market area borders where shippers can book capacity. Available capacity at the physical cross-border interconnection points of the transmission system operators involved is marketed at the VIP. However, it has not yet been possible to set up all the VIPs, as there is still a need to clarify specific requirements arising from the regulation in order to implement them in accordance with the NC CAM.

An overview of the existing VIPs as well as those still planned is presented in table 27. The VIPs existing at the reporting date of 1 April 2021 are presented in the NDP gas database.

Table 27: Overview of the VIPs for Germany (updated 1 April 2021)

VIP	Associated IP	Competent TSO	ITSO	Start date	End date
VIP-TTF-NCG-H	Bocholtz (Fluxys TENP) Oude Statenzijl (OGE), Bocholtz (OGE), Bocholtz-Vetschau (TG)	OGE	GTS	01.04.2020	01.10.2021
VIP-TTF-NCG-L	Elten (OGE), Vreden (OGE), Tegelen (OGE), Zevenaar (TG)	TG	GTS	01.04.2020	01.10.2021
VIP-TTF-GASPOOL-H	Bunde (GASCADE), Oude Statenzijl H (GUD)	GUD	GTS	01.04.2020	01.10.2021
VIP-TTF-GASPOOL-L	Oude Statenzijl L-Gas (GTG NORD), Oude Statenzijl (GUD)	GUD	GTS	01.04.2020	01.10.2021
VIP Belgium-NCG	Eynatten / Raeren (Fluxys TENP), Eynatten (TG), Eynatten / Raeren (OGE)	OGE	Fluxys Belgium	01.07.2019	01.10.2021
VIP France-Germany	Medelsheim (GRTD), Medelsheim (OGE)	GRTD	GRTgaz France	01.03.2019	
VIP Germany-CH	Wallbach (Fluxys TENP), Wallbach (OGE)	Fluxys TENP	Fluxyswiss, SwissGas	01.07.2019	
VIP Oberkappel	Oberkappel (OGE), Oberkappel (GRTD)	OGE	GCA	01.03.2019	
VIP Waidhaus NCG	Waidhaus (GRTD), Waidhaus (OGE)	OGE	Net4Gas	01.03.2019	
VIP Brandov-GASPOOL	Olbernhau II (GASCADE), Brandov-STEGAL (GASCADE), IP Deutschneudorf EUGAL Brandov (Fluxys, GASCADE, GUD, ONTRAS), Brandov-OPAL (OGT), Deutschneudorf (ONTRAS)	GASCADE	Net4Gas	01.11.2018	
VIP L GASPOOL-NCG	Zone OGE L, Ahlten, Steinbrink	Nowega	OGE	01.11.2018	01.10.2021
VIP L GASPOOL-NCG	Zone GUD L, Ahlten, Steinbrink	OGE	Nowega, GUD	01.11.2018	01.10.2021
GCP GAZ-SYSTEM / ONTRAS	Lasow (ONTRAS), Gubin (ONTRAS), Kamminke (ONTRAS)	ONTRAS	GAZ-System	01.04.2016	
VIP	**Associated IP**	**Competent TSO**	**ITSO**	**Planned start date**	**End date**
VIP TTF-THE H-Gas	Bocholtz (Fluxys TENP), Bunde (GASCADE), Oude Statenzijl H (GUD), Oude Statenzijl (OGE), Bocholtz (OGE), Bocholtz-Vetschau (TG)	GUD	GTS	01.10.2021	
VIP TTF-THE L-Gas	Oude Statenzijl L-Gas (GTG NORD), Oude Statenzijl (GUD), Elten (OGE), Vreden (OGE), Tegelen (OGE), Zevenaar (TG)	TG	GTS	01.10.2021	
VIP THE-ZTP	Eynatten / Raeren (Fluxys TENP), Eynatten (GASCADE), Eynatten / Raeren (OGE), Eynatten (TG)	OGE	Fluxys Belgium	01.10.2021	
VIP DK-THE	Ellund (GUD), Ellund (OGE)	OGE	ENERGINET	01.10.2021	

Source: Transmission system operators

The two market areas GASPOOL and NCG will be combined into the Trading Hub Europe (THE) market area on 1 October 2021. As a result, VIPs at the market area interconnection points of GASPOOL and NCG that have already been set up will no longer be necessary.

Furthermore, cross-border interconnection points and VIPs of GASPOOL and NCG will be consolidated. Bookings at existing VIPs will be transferred to the new joint VIPs. The Brandov-GASPOOL VIP and the Waidhaus NCG VIP for the Net4Gas market area will be continued separately.

Security of supply 9

9 Security of supply

In line with Section 15a (1) EnWG, assumptions concerning the impact of conceivable disruptions to supply are made in the Scenario Framework 2022.

- The transmission system operators looked in depth at several security of supply scenarios in the Gas Network Development Plans 2018–2028 and 2020–2030. On the one hand, the security of supply scenario – Development of the L-gas supply – was fleshed out and detailed in greater depth. On the other, the security of supply scenario – Development of the H-gas supply – was investigated using an up-to-date, detailed H-gas capacity balance up to 2030 and the additional demand identified in the energy balance was allocated to the identified interconnection points in accordance with the distribution of H-gas sources.
- Furthermore, the transmission system operators presented the TENP security of supply variant, which investigates the effects of any limited availability of the transport capacity of the TENP system that may persist over a longer term, as part of the Gas Network Development Plan 2018–2028.

In its prevention and emergency plans for gas, the BMWi will carry out a risk assessment in accordance with Article 7 of the Regulation (EU) 2017/1938 (security of supply regulation) for Germany in cooperation with the BNetzA and with the support of the gas industry. In addition to the national analysis, this risk assessment also includes a regional analysis, which has to be carried out within the relevant risk groups in accordance with Annex 1 of the security of supply regulation.[1] The risk report derived from the assessment on the consequences of potential disruptions in the gas infrastructure both for the supply situation in Germany and within the risk groups will be notified to the EU Commission. The prevention and emergency plans will subsequently be published and submitted to the EU Commission, which will send an opinion, including possible recommendations for changes, to the BMWi within four months; the relevant recommendations for changes are not obligatory here. The BMWi has to furnish comprehensive reasons for not taking these recommendations into consideration, however.

The BMWi published the "Report on the status and development of security of supply in the area of the supply of natural gas" (monitoring report pursuant to section 63 EnWG), which was updated in June 2020 [BMWi 2020c]. In summary, it is stated among other things:

"The results of the report allow the conclusion that the security of supply concept in Germany has proven its worth. The gas supply companies have guaranteed in the past and in the reporting period – even following changes in the general conditions – a high standard of security of supply up to now, with the result that the supply of gas in Germany has previously always been ensured. In the light of the dependence on imports, the differentiation of the market roles played by the companies, the long lead times until a project is completed and the high capital intensity of the investments in the gas sector, further developments have to be carefully monitored and analysed."

Against this background, there is no need in the opinion of the transmission system operators for the Gas Network Development Plan 2022–2032 to model a hypothetical disruption to supply. Rather, the transmission system operators see the necessity of further detailing the in-depth conversion plans up to 2030 on account of the future reduction in the availability of L-gas for the German market. Furthermore, the Germany-wide availability of H-gas needs to be examined and presented in an up-to-date H-gas balance up to 2032. The available injection volumes from storage facilities and at interconnection points are considered in more detail here among other things.

1 Germany is a member of the "Eastern gas supply" and "North Sea gas supply" risk groups.

9.1 Development of the L-gas supply

The development of the L-gas supply and of the L-to-H-gas conversion is described in this chapter in terms of the security of supply issue. Following a short description of the current situation (cf. chapter 9.1.1), the situation involving gas imports from the Netherlands (cf. chapter 9.1.2) and domestic production (cf. chapter 9.1.3) will be addressed. Finally, an outlook on the planned procedure in the Gas Network Development Plan 2022–2032 is given (cf. chapter 9.1.4).

9.1.1 Description of the situation

Part of the German gas market is supplied with low calorific value natural gas (L-gas). L-gas originates entirely from production in Germany and the Netherlands. High calorific value natural gas (H-gas) comes primarily from Norway and Russia or arrives in Germany at LNG facilities. The two different groups of natural gas must be shipped in separate systems within defined limits for technical and calibration reasons. Action has to be taken for areas of the network that are to be supplied with gas of a different quality, which includes modifying the consumer appliances that use the gas.

L-gas production in Germany is in continual decline. The remaining German L-gas reserves will continue to be extracted and injected into the natural gas transmission network for as long as possible. The decline in L-gas production has significant impacts in terms of both the annual volumes available in Germany and the capacity that is available. The L-gas capacity available from the Netherlands has additionally experienced a steady decline since October 2020. For this reason, the German transmission system operators take part in regular exchanges 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.

9.1.2 Situation involving gas imports from the Netherlands

The last few years have seen an increase in the number of earthquakes in the area around the Groningen field, which are regarded as being linked to the extraction of natural gas. Earthquakes measuring 3.4 on the Richter scale shook the Groningen region on both 8 January 2018 and 22 May 2019. The earthquake in 2019 in particular triggered significant political pressure in the Netherlands to end production in the Groningen field as quickly as possible.

In order to take the risks arising from natural gas production into consideration, the Dutch Ministry of Economic Affairs and Climate Policy announced that the regular production of natural gas in the Groningen area would be suspended from 2022 onwards. The Groningen field remains active with minimal production so as to be able to safeguard the security of supply also in particular situations at the same time. It is currently being examined whether the Dutch “Grijpskerk” natural gas storage facility can be used as a capacity reserve from 2022 onwards as an alternative, for example for shortfalls in the gas infrastructure during a cold period [Ministerie van Economische Zaken en Klimaat 2020a].

A production volume in Groningen of initially 11.8 billion m^3 was planned for the 2019/2020 gas year [Ministerie van Economische Zaken en Klimaat 2019], which was then reduced in March 2020 to 10.7 billion m^3 [Ministerie van Economische Zaken en Klimaat 2020b]. In fact, a gas volume of 8.7 billion m^3 [GTS 2020] was produced, benefiting essentially from the mild temperatures in the 2019/2020 gas year.

The Dutch Ministry of Economic Affairs and Climate Policy has set a production volume of 8.1 billion m^3 for the 2020/2021 gas year, while the prospect of a figure of around 4 billion m^3 is held out for the subsequent 2021/2022 gas year. These volumes each apply for average annual temperatures, where the permitted production volume will be adjusted up or down on the basis of a defined formula according to how temperatures actually develop.

According to information from the Dutch Ministry of Economic Affairs and Climate Policy, the following four conditions have to be fulfilled in order to be able to guarantee that regular Groningen production will be discontinued from 2022 onwards [Ministerie van Economische Zaken en Klimaat 2020a]:

1. Commissioning of an additional conversion facility in Zuidbroek,
2. Scheduled reduction in L-gas demand in the L-gas buyer countries of Belgium, Germany and France,
3. Sufficient H-gas import options,
4. Further availability of the Norg gas storage facility beyond 2022.

The transmission system operators maintain close contact with GTS in this connection and also in order to coordinate the relevant plans in the Netherlands and Germany. Since 2019 in particular, there has also been exchanges at the international level through the "Task Force Monitoring L-Gas Market Conversion", which was established on the initiative of the Dutch Ministry of Economic Affairs. This task force, under the leadership of the respective ministries for the economy of the Netherlands, Belgium, France and Germany, produces a report semi-annually to report to the Dutch parliament on matters including measures to reduce L-gas sales / production. The task force's third report was published in February 2021. The task force offers an ideal platform for guaranteeing harmonised planning assumptions with high transparency.

9.1.3 Domestic production

The development of production capacity presented in the table below is based on the data from the BVEG from May 2021. The production capacities have been furnished with a safety margin by the BVEG. The forecast additionally includes a breakdown of production capacity by L-gas and H-gas.

Table 28: Capacity forecast in accordance with BVEG

Year	Elbe-Weser region with safety margin according to BVEG 2021	Weser-Ems region with safety margin according to BVEG 2021	Sum of both regions with safety margin according to BVEG 2021	Sum of both regions with safety margin according to BVEG 2021	Sum of both regions with safety margin according to BVEG 2020	Difference between BVEG 2021 and BVEG 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 on the basis of BVEG 2021, BVEG 2020

The current BVEG forecast shows a significant decline of up to 17% in German L-gas production from 2021 onwards. This forecast deviates considerably from the previous forecast and leads to a shortfall in regional capacity balances. It seems conceivable at the moment that this decline currently forecast by the BVEG could have an impact on the security of supply in L-gas.

The transmission system operators point out that a reliable production forecast forms the basis for the long-term conversion planning. A response in terms of network planning to the massive decline as early as 2021 is therefore not possible.

9.1.4 Outlook for the Gas Network Development Plan 2022–2032

The transmission system operators intend to present the following points in the Gas Network Development Plan 2022–2032:

- Determination and presentation of the capacity and volume balances for the coming years for L-gas in consideration of the local conditions until the end of the market area conversion in 2030,
- Development of a forecast for the period up to 2030 to guarantee the security of supply using the sources that will then still be available (domestic production, Empelde underground gas storage facility, Rehden conversion facility),
- Further development of the conversion planning presented in the 2021 implementation report as well as the overview of all L-gas conversion areas,
- Adjustment of the conversion areas in order to achieve optimal utilisation of the resources,
- Consideration of the available up-to-date detailed plans of the distribution system operators,
- Consideration of the number of gas appliances to be modified per year,
- Identification of specific expansion measures to secure supply,
- Continuation of the coordination for converting storage facilities,
- Consideration of the remaining L-gas market, the structuring instruments required and the investigation relating to the blending of the remaining L-gas production volume.

The current L-to-H-gas conversion process is presented in the Gas Network Development Plan 2022–2032. The reporting date for coordination of the conversion projects between the distribution and transmission system operators is 1 October 2021. It will be possible to take conversion amendments received after 1 October 2021 into consideration only in the 2023 implementation report.

9.2 Development of the H-gas supply

The transmission system operators see a need to continue also to examine the availability of H-gas alongside the reduced L-gas availability.

The requirements resulting for gas infrastructure from the implementation of the energy transition will be examined by the transmission system operators with regard to the development of the H-gas supply.

The following points that will exert a considerable influence on the supply of H-gas will additionally be presented by the transmission system operators in the Gas Network Development Plan 2022–2032:

- Discussion of the consideration of the entry capacities (cross-border interconnection points, storage facilities, conversion, production and LNG facilities),
  - Key assumptions here are that cross-border interconnection points are taken into consideration in principle as part of the technical capacity and that seasonal employment can be assumed for storage facilities, where retrieval is assumed in the peak load case,

- Breakdown of the exit capacity by groups with particular requirements (power plants, industry, distribution system operators, cross-border interconnection points),
- Determination and presentation of the H-gas capacity balance up to 2032,
- Determination of additional demand on the basis of the H-gas capacity balance,
- Allocation of any additional import demand at individual cross-border interconnection points as well as discussion on the procedure for the allocation based on the distribution of H-gas sources (cf. Chapter 8.2).

9.3 Interruptions

The transmission system operators have conducted detailed investigations into historical interruptions in the 2013 to 2018–2028 Gas Network Development Plans. It has regularly been stated here that historical interruptions can at most serve as an indication for more in-depth investigations of the future trends at the interconnection points in question. Viewed in isolation, historical interruptions do not represent a basis for an expansion decision. The trends in future disruptions cannot be assessed on account of the large number of measures that are already under construction and regulatory changes, such as the introduction of VIPs and, in particular, the market area merger.

The transmission system operators explicitly point out that the planned and unplanned disruptions to firm and interruptible capacity are published on the online platforms of the transmission system operators. Furthermore, data on disruptions is also published on the ENTSOG transparency platform.

Against this background, the transmission system operators dispense with a separate assessment of the historical disruptions in the Gas Network Development Plan 2022–2032.

Modelling and modelling variants 10

10 Modelling and modelling variants

In this chapter the transmission system operators put forward modelling variants for the Gas Network Development Plan 2022–2032. Chapter 10.1 provides an overview of the modelling variants envisaged. The modelling of the base variant is subsequently described in chapter 10.2. Chapter 10.3 describes the modelling of the hydrogen variant. Chapter 10.4 explains the calculation of the demand for market-based instruments (hereinafter: NewCap calculation) for the modelling. The planned design variant for Baden-Württemberg is described in chapter 10.5, and this is followed by discussions on the subject of the phase-out of coal in chapter 10.6. The base network criteria that the transmission system operators envisage for including measures from the Gas Network Development Plan 2020–2030 in the base network for the modelling of the Gas Network Development Plan 2022–2032 are described in Chapter 10.7.

10.1 Overview of the modelling variants

This Scenario Framework 2022 forms the basis for the creation of the Gas Network Development Plan 2022–2032. The transmission system operators propose a network modelling variant (base variant). Furthermore, the security of supply scenarios in L-gas and H-gas up to 2032 are updated.

The BNetzA continues to require the transmission system operators to produce the network modelling for a coal phase-out variant based on the Kohleverstromungsbeendigungsgesetzes (KVBG – Coal-fired Power Generation Termination Act). The variant is further designed in consultation with the BNetzA.

Building on the Gas Network Development Plan 2020–2030, the transmission system operators are continuing to integrate hydrogen and green gases in the existing gas infrastructure and are identifying the measures necessary for this by modelling a hydrogen variant.

As a result of the statutory requirements in the selection of the modelling variants to be calculated for the Gas Network Development Plan 2022–2032, the transmission system operators face the challenge of mapping key future developments on the one hand and, on the other, of limiting themselves in the calculations to a scope of work that is feasible within the given time frame. Modelling load flow scenarios and determining the expansion demand triggered as a result is a highly complex, laborious and time-consuming procedure. The modelling in the combined market area increases the complexity and the coordination work between the transmission system operators.

Against this background, the transmission system operators envisage the following selection and specification for the modelling in the Gas Network Development Plan 2022–2032 (cf. table 29).

Table 29: Modelling variants in the Scenario Framework 2022

<table>
<tr><th>Modelling variant</th><th>Base variant
2027</th><th>Base variant
2032</th><th>L-gas balance
2032</th><th>H-gas balance
2032</th><th>NewCap
Base variant</th></tr>
<tr><td>Designation</td><td>B.2027</td><td>B.2032</td><td>L.2032</td><td>H.2032</td><td>N.2027, N.2032</td></tr>
<tr><td>Calculation</td><td>complete 2027</td><td>complete 2027</td><td>Balance analysis</td><td>Balance analysis</td><td>NewCap calculation</td></tr>
<tr><td>Reporting date</td><td>31.12.2027</td><td>31.12.2032</td><td>01.10.2032</td><td>01.10.2032</td><td>01.10.2027,
01.10.2032</td></tr>
<tr><td>Distribution system operators (internal orders)</td><td>Initial value:
Internal orders 2022, development 2023–2027: the 10-year forecast of the DSOs, the plausibility of which has been verified.</td><td>Development 2028–2032: constant updating upon growth. Plausible declines are taken into account.</td><td rowspan="11">Security of supply scenario L-gas 2032, analysis of the long-term L-gas balances up to 2032</td><td rowspan="11">Security of supply scenario H-gas 2032, analysis of the long-term H-gas capacity balance up to 2032</td><td rowspan="11">Calculation of the costs of the market-based instruments (MBI) for the base variant up to 2032</td></tr>
<tr><td>H-gas sources</td><td colspan="2">Additional demand in accordance with chapter 8.2 of the Scenario Framework 2022</td></tr>
<tr><td>IP / VIP</td><td colspan="2">Inventory according to “2022 – SR Konsultation” database cycle, need for expansion in line with chapter 8 of the Scenario Framework 2022 in due consideration of the TYNDP</td></tr>
<tr><td>Use of MBIs</td><td colspan="2">Use of market-based instruments for planning purposes</td></tr>
<tr><td>L-to-H-gas conversion</td><td colspan="2">Modelling of the conversion areas, including conversions up to 2033 in order to identify the necessary network expansions measures up to 31 December 2032</td></tr>
<tr><td>Underground gas storage facilities</td><td colspan="2">Inventory according to “2022 – SR Konsultation” database cycle, new build according to chapter 3.3.2: 100% temperature-dependent capacity (TaK)</td></tr>
<tr><td>Power plants</td><td colspan="2">Inventory according to “2022 – SR Konsultation” database cycle, systemically important power plants currently directly connected on an interruptible basis according to chapter 3.2.1, new build according to chapter 3.2.2, 100% firm dynamically allocable capacity (fDZK)</td></tr>
<tr><td>LNG</td><td colspan="2">New build in accordance with chapter 3.4</td></tr>
<tr><td>Industry</td><td colspan="2">Existing capacity is constantly updated until 2032, consideration of the binding additional demand according to chapter 10.2, freely allocable capacity approach (FZK)</td></tr>
<tr><td>Biomethane</td><td colspan="2">Inventory according to “2022 – SR Konsultation” database cycle, new build according to chapte</td></tr>
<tr><td>Hydrogen and synthetic methane</td><td colspan="2">Inventory according to “2022 – SR Konsultation” database cycle</td></tr>
</table>

Source: Transmission system operators

<table>
<tr><th>Modelling variant</th><th>Hydrogen variant 2027</th><th>Hydrogen variant 2032</th><th>Design variant for Baden-Württemberg 2032 (only terranets)</th><th>Coal phase-out variant</th></tr>
<tr><td>Designation</td><td>G.2027</td><td>G.2032</td><td>A.2032</td><td>K.2030</td></tr>
<tr><td>Calculation</td><td>complete 2027</td><td>complete 2032</td><td>complete 2032</td><td rowspan="13">In consultation with the BNetzA</td></tr>
<tr><td>Reporting date</td><td>31.12.2027</td><td>31.12.2032</td><td>31.12.2032</td></tr>
<tr><td>Distribution system operators (internal orders)</td><td>Initial value: Internal orders 2022, development 2023–2027: the 10-year forecast of the DSOs, the plausibility of which has been verified.</td><td>Development 2028–2032: constant updating upon growth. Plausible declines are taken into account.</td><td>Start value: Internal orders 2022, development: the 10-year forecast of the DSOs of terranets up to and including 2032, the plausibility of which has been verified</td></tr>
<tr><td>H-gas sources</td><td colspan="2">As base variant</td><td>Updates on the basis of the additional demand from terranets compared with the base variant</td></tr>
<tr><td>IP / VIP</td><td colspan="3">As base variant</td></tr>
<tr><td>Use of MBIs</td><td colspan="3">no calculation</td></tr>
<tr><td>L-to-H-gas conversion</td><td colspan="3" rowspan="6">As base variant</td></tr>
<tr><td>Underground gas storage facilities</td></tr>
<tr><td>Power plants</td></tr>
<tr><td>LNG</td></tr>
<tr><td>Industry</td></tr>
<tr><td>Biogas</td></tr>
<tr><td>Hydrogen and synthetic methane</td><td colspan="2">Consideration of concrete projects in the WEB Market Survey if an MoU is in place by 1 October 2021 (in accordance with chapter 3.6), modelling in accordance with chapter 10.3</td><td>As base variant</td></tr>
</table>

Source: Transmission system operators

10.2 Explanation of the base variant for the modelling of the Gas Network Development Plan 2022–2032

The procedure and input parameters of the base variant are described below:

- Full calculation for 2027 and 2032.
- The cut-off date for the calculation of the network expansion measures is 31 December of the year in question. Accordingly, the commissioning dates of the network expansion measures is generally set as 31 December of the calculation year.
- **Capacity demand of the distribution system operators:**
  With its decision of 11 December 2015 on the confirmation of the scenario framework for the Gas Network Development Plan 2016–2026, operative provision 6a, the BNetzA defined the consideration of the capacity demand of the distribution system operators as obligatory. The transmission system operators therefore provide for an appropriate consideration for the Scenario Framework 2022. With the decision of the BNetzA, the direct reference to a gas demand scenario of the Scenario Framework 2022 is dispensed with. The political requirements recognised there and in particular the climate protection targets here are thus not taken into full consideration.
  - Initial value: internal orders of 2022.
  - Development from 2023 to 2027: the verified 10-year forecast of the distribution system operators in accordance with section 16 of the cooperation agreement up to and including 2027.
  - Development 2028–2032: constant updating.
- **For the verification of plausibility, the transmission system operators apply the following procedure:**
  - If the forecast value for 2027 is higher or lower than the order value for 2022, a verifiable justification by the distribution system operator is required for this. The premises of the long-term forecast (assumed sectoral trends, including verifiable justifications) that are indicated by the distribution system operators in Part B of the form for the internal order are used by the transmission system operators to verify the plausibility. If justifications are not provided or cannot be verified, the transmission system operator will contact the distribution system operator in accordance with section 16 (3) of Cooperation Agreement X in order to develop a coordinated forecast. Should a joint assessment of the capacity demand not be produced, it may be necessary to consult the BNetzA.
- **Gas exchange with neighbouring countries at the interconnection points and H-gas sources:**
  - Existing capacity according to NDP gas database cycle “2022 – SR Konsultation”.
  - Distribution of any additional demand based on distribution of H-gas sources (cf. chapter 8.2) to cross-border interconnection points.
- **Underground gas storage facilities:**
  - Consideration of existing storage facilities according to “2022 – SR Konsultation” Gas NDP database cycle.
  - Consideration of new storage facilities and storage facility expansions in accordance with chapter 3.3.2 in the amount of the requested capacity as 100% firm temperature-dependent capacity (TaK).
- **Power plants:**
  - Consideration of existing power plants according to “2022 – SR Konsultation” Gas NDP database cycle.
  - Consideration of new power plants in accordance with chapter 3.2.2, taking the criteria into account in the amount of the requested capacity at 100% firm dynamically allocable capacity (fDZK).
  - Consideration of systemically important power plants on the network of the transmission system operators in accordance with chapter 3.2.1.
- **LNG facilities:**
  - Consideration in accordance with chapter 3.4.2.

- **Production:**
  - Consideration of new production injections into the network of the transmission system operators in accordance with chapter 3.5 in the amount of the requested capacity.
- **Industry:**
  - Updating of the existing capacity up to 2032 (constant capacity demand), unless there are any divergent capacity reports from industrial customers.
  - Consideration of the binding additional demand requested by industrial customers if the request has been received by the transmission system operators by 15 July 2021. Verification of the plausibility of the requested additional demand is envisaged by 31 August 2021.
- **Biomethane within the meaning of section 3 EnWG 10c**
  - Inventory: injections into the transmission network are recognised in accordance with the "2022 – SF consultation" database cycle.
  - WEB and Green Gases Market Survey: the transmission system operators check the project reports to see if they should be considered in the base variant of the Gas Network Development Plan 2022–2032 only if the process for the network connection requests at the responsible transmission system operator has been concluded by 1 October 2021.
- **L-to-H-gas conversion**
  - Modelling of the conversion areas, including conversions up to 2033, in order to identify the necessary network expansion measures up to 31 December 2032.
- **L-gas balance 2032:**
  - Analysis of the long-term L-gas balances up to 2032, cf. chapter 9.1.
- **H-gas balance 2032:**
  - Analysis of the long-term H-gas capacity balance up to 2032, cf. chapter 9.2.

10.3 Explanation of the hydrogen variant for the modelling in the Gas Network Development Plan 2022–2032

The integration of hydrogen and green gases in the existing gas infrastructure will increasingly gain in importance in order to achieve the climate protection targets. In addition to the retrofitting of the existing gas infrastructure to increasing proportions of hydrogen, the repurposing of existing gas and storage infrastructure from natural gas to hydrogen is of major importance for the efficient and prompt integration of hydrogen and green gases.

The integration of green gases and the expansion of hydrogen infrastructure as part of the energy supply infrastructure has to be taken into consideration in the Gas Network Development Plan 2022–2032 in order to lay today the foundations for the requirements of the energy supply of tomorrow.

The hydrogen variant consists of two modelling elements that build on each other, the methane modelling element and the hydrogen modelling element. The transmission system operators have included in the modelling only the projects that are intended to be connected to the transmission network.

An explanation of the modelling procedure can be found in chapter 7.1.

The hydrogen variant is modelled by the transmission system operators in the Gas Network Development Plan 2022–2032 based on the following premises:

- Full calculation for 2027 and 2032.
- The cut-off date for the calculation of the network expansion measures is 31 December of the year in question.

- **The following key input parameters are recognised here in a way that is identical to the specifications of the base variant:**
  - Capacity demand of the distribution system operators for the 2027 modelling year
  - Gas exchange with neighbouring countries at the cross-border interconnection points and H-gas sources
  - Underground gas storage facilities
  - Power plants
  - LNG facilities
  - Industry
  - Biomethane
  - WEB and Green Gases Market Survey: the transmission system operators check the project reports to see if they should be considered in the methane modelling of the hydrogen variant of the Gas Network Development Plan 2022–2032 only if the process for the network connection requests at the responsible transmission system operator has been concluded by 1 October 2021.
  - L-to-H-gas conversion

- **Deviations in the recognition of the key input parameters of the base variant are made for the capacity demand of the distribution system operators for the 2032 modelling year**
  - Development 2028–2032: the value for 2027 is updated constantly where the long-term forecast after 2027 increases. Plausible declines, for example as a result of the substitution of natural gas by hydrogen, are taken into account.

- **For the verification of plausibility, the transmission system operators apply the following procedure:**
  - If the forecast value for 2027 is higher or lower than the order value for 2022, a verifiable justification by the distribution system operator is required for this. The premises of the long-term forecast (assumed sectoral trends, including verifiable justifications) that are indicated by the distribution system operators in Part B of the form for the internal order are used by the transmission system operators to verify the plausibility. If justifications are not provided or cannot be verified, the transmission system operator will contact the distribution system operator in accordance with section 16 (3) of Cooperation Agreement X in order to develop a coordinated forecast. Should a joint assessment of the capacity demand not be produced, it may be necessary to consult the BNetzA.

- **Hydrogen, biomethane and synthetic methane**
  - Development up to 2032: projects with concrete implementation plans arising from the WEB and Green Gases Market Survey that fulfil the criteria in accordance with chapter 3.6.1 are taken into account if a memorandum of understanding is in place by 1 October 2021.

- **Hydrogen balance 2032:**
  - Analysis of the long-term hydrogen capacity balance up to 2032, cf. Chapter 7.3.

10.4 Explanation of the NewCap calculation for the modelling in the Gas Network Development Plan 2022–2032

In accordance with the Gas Network Access Regulation (GasNZV), the two German market areas NCG and GASPOOL have to be combined into one market area by no later than 1 April 2022. The transmission system operators will implement the merger on 1 October 2021.

With the new combined market area, one of the most attractive and most liquid gas hubs in Europe will be created. The German transmission system operators have worked on the structure of this new market area in co-operation with the market area managers as well as the market participants and the BNetzA and are on the point of finalising it.

10.4.1 Capacities for the Gas Network Development Plan 2022–2032

In accordance with the wording of Section 21 GasNZV, the stated goal is "to increase the liquidity of the gas market" by combining the existing market areas. In fulfilment of this statutory requirement, it is thus necessary to transfer the capacity existing in the two separate market areas of GASPOOL and NCG, if possible in terms of quantity and quality, into capacity in a Germany-wide market area as far as possible.

As already described in the Gas Network Development Plan 2020–2030, the considerable enlargement of the market area means that this significant upgrading of capacity cannot be guaranteed, however, without investment measures or the use of other instruments. As significant investment measures cannot be realised until the market area merger is implemented and, moreover, seem inefficient, methods for maintaining capacity even without further structural measures have been developed by the transmission system operators with a view to ensuring a secure and, at the same time, cost-efficient energy supply. The core point in the development of these methods is the use of market-based instruments (MBI).

10.4.2 NewCap in the Gas Network Development Plan 2022–2032

The identification of the expansion measures based on the new system in a market area is carried out in the Gas Network Development Plan 2022–2032 using the same approach that was adopted in the Gas Network Development Plan 2020–2030. To this end, an assessment will take place as part of the modelling to determine whether the use of MBIs or an expansion of the network is advantageous.

The calculations in the Gas Network Development Plan 2022–2032 are made for the base variant.

10.4.3 Assessment of the long-term capacity demand

The BNetzA lays down the following stipulations for the transmission system operators in the change request for the Gas Network Development Plan 2020–2030:

"As already stated by the Federal Network Agency (BNetzA) in the KAP+ procedure, the forthcoming scenario framework for the Gas NDP 2022–2032 should already include findings on the demand for firm freely allocable capacity in a Germany-wide market area. The Federal Network Agency therefore requests the transmission system operators to continue the discussion on the long-term capacity demand. The long-term goal of the process is to define capacity demand that is coordinated with the market and can be adequately verified in a Germany-wide market area at the latest in the Scenario Framework for the Gas NDP 2024–2034."

In response to this, the transmission system operators already stated in the Gas Network Development Plan 2020–2030: "Rather, the transmission system operators propose gathering experience first with the 2020 and 2021 annual auctions and the bookings of the 2021 / 2022 gas year made during the year in order to create a valid basis for developing criteria. Furthermore, the test phase of the oversubscription and buyback system (or at least a meaningful part of that) should be used in order to enable, on the basis of the findings, a well-founded, appropriate balance between the oversubscription and buyback system on the one hand and section 9 (3) GasNZV on the other."

The transmission system operators remain of the view that criteria can be meaningfully assessed and thus also drawn up only after the 2021 / 22 gas year. Furthermore, the fundamental question concerning the future application in accordance with section 9 (4) or section 9 (3) GasNZV should also be clarified. Closely connected with this is the question of the coverage of the costs – in the opinion of the transmission system operators, the costs for MBIs must have a neutral impact on the profit of the transmission system operators and may not exert an influence on the efficiency comparison.

Irrespective of this, the transmission system operators would like to use the current consultation process for the Scenario Framework 2022 to include the market participants already at this stage and get their ideas on possible criteria for the long-term capacity demand.

Findings from the 2020 and 2021 annual auctions, in which the planned market area merger was taken into consideration for the period after 1 October 2021, are available in the period in which the Scenario Framework 2022 will be prepared and opened up to consultations.

The transmission system operators ask the following questions on the consultation:

- To what extent do the market participants see the auction results for the long-term products as an indicator of a measure of the capacity demand in a Germany-wide market area?
- How do the market participants see the role of the short-term bookings when determining criteria for the long-term capacity demand?
- In addition to the results of the auctions and possibly the short-term bookings, what other criteria play a role here?

10.5 Explanations on the design variant for Baden-Württemberg

The background to the consideration of a design variant for Baden-Württemberg is the interplay arising from continual increases in the demand for capacity as well as the already high utilisation of the high-pressure network in Baden-Württemberg.

The initial consideration in the Gas Network Development Plan 2020–2030 enabled terranets bw to ensure in its network planning that the continuing growth in capacity of the distribution system operators was incorporated in the full extent.

The developments within the distribution systems are significant here. For terranets bw, these account for the largest share of the gas capacity to be provided in Baden-Württemberg. Growth of 10% within ten years make these developments an essential element of the network expansion planning. Current analyses confirm the forecasts of the distribution system operators and additionally suggest that a further concentration of new connections in the heating market can be expected.

In divergence from the base variant, the design variant therefore considers only the 2032 modelling year while using the 10-year forecast of of the distribution system operators instead of constant updates from 2027 in the terranets bw network area in Baden-Württemberg.

terranets bw is conducting complete modelling and identification of the necessary measures and their dimensioning in its network area. In the process, terranets bw is coordinating the delivery capacity at the existing network incorporation points with the transmission system operators bayernets, Fluxys TENP, GASCADE, GRTgaz Deutschland and Open Grid Europe, which are upstream in terms of flow mechanics. The indications of the additional delivery capacity are presented transparently as part of the Gas Network Development Plan 2022–2032.

10.6 Explanations on the phase-out of coal

The Gesetz zur Reduzierung und zur Beendigung der Kohleverstromung (Kohleverstromungsbeendigungsgesetz, KVBG – Coal-fired Power Generation Termination Act) was passed in 2020. The energy policy recommendations of the Commission on Growth, Structural Change and Employment ("Coal Commission") to successively reduce coal-fired power generation in Germany and end it completely by no later than 2038 were implemented by the Coal-fired Power Generation Termination Act.

As a result of this act, the BNetzA has been given a variety of tasks in order to implement the phase-out of coal. Accordingly, the BNetzA has to determine pursuant to section 54 (4) KVBG whether the existing gas supply networks are sufficient for enabling coal and lignite-fired plants to be retrofitted for gas as the energy source. For this review, the BNetzA requires the transmission system operators, as they draw up the Gas Network Development Plan 2022–2032, to carry out appropriate modelling using the defined criteria.

Initial discussions between the BNetzA and the transmission system operators have taken place on developing the criteria and designing the coal phase-out variant.

10.7 Criteria for including measures from the Gas Network Development Plan 2020–2030 in the base network for the modelling of the Gas Network Development Plan 2022–2032

The base network forms the basis for the modelling of the transmission systems for identifying the network expansion demand that is additionally required.

The base network defined for the modelling of the transmission systems comprises the current stock of the transmission system, measures put into operation set against the previous gas network development plans and set against the previous implementation reports as well as measures currently under construction.

Furthermore, the transmission system operators intend, in the same way as the previous procedure, to include other selected measures from the previous gas network development plans in the base network. The following criteria of the Gas Network Development Plan 2020–2030 are to be used as of the reporting date of 1 January 2022 for the selection of additional measures for the base network of the Gas Network Development Plan 2022–2032:

- The final investment decision (FID) by the transmission system operators has been made and
- the approvals under public law that are required for the measure are available.

The measures included in the base network are treated in the network simulation in the same way as pipelines and plants that already form part of the existing network. Measures included in the base network can thus no longer be the result of the modelling. They are thus in fact given the status of the existing network.

Appendices

Appendix 1: NDP gas database

The transmission system operators have updated the NDP gas database for the Scenario Framework 2022 and provide this for the public at http://www.nep-gas-datenbank.de.

The NDP gas database contains the following information for the base variant for the cycle of the Scenario Framework 2022 (name of the cycle in the NDP gas database: "2022 – SR Konsultation"):

- Capacities (cross-border interconnection points/VIP, storage facilities, power plants, LNG facilities, industry, production, biomethane, synthetic methane, hydrogen)

The base variant forms the foundation for the hydrogen variant and the design variant for Baden-Württemberg. Additional capacity data for the hydrogen variant, especially for hydrogen and the project reports from the WEB and Green Gases Market Survey, will be provided for the Gas Network Development Plan 2022–2032 only after conclusion of the MoU is entered into. This also applies for the design variant for Baden-Württemberg; here, too, the additional information (long-term forecasts of the distribution system operators on the terranets bw network) will also be added to the Gas Network Development Plan 2022–2032.

The capacities as of 1 January of the year in question are presented in the NDP gas database. Thus the capacities as at 1 January 2032 are shown for 2032, for example. Expansion measures for 2027 are identified in the modelling for the Gas NDP 2022–2032, some of which can only be completed at the end of 2027 (implementation periods of up to six years). It is therefore planned to estimate the capacities for 1 January 2028 in the modelling. For reasons of consistency, 31 December 2032 is therefore also used as the basis for the 2032 modelling year. Therefore it is planned to set the capacities for 1 January 2033 in the modelling.

The full list of gas power stations can additionally be found in the NDP gas database at the following link: https://www.nep-gas-datenbank.de:8080/app/#!/stammdaten/netzanschlusspunkte/kraftwerke

In accordance with the resolution of the Federal Network Agency on the "Approval of an oversubscription and buyback system for the transmission system operators to offer additional capacity in the nationwide market area ("KAP+")" (reference: BK7-19-037), the transmission system operators use an oversubscription system within the framework of the merger of the market areas. The oversubscription and buyback system is required, as the technical capacity after the market area merger will no longer be available to the same extent as before. In accordance with the above-mentioned resolution, the marketable capacity consists of technical capacity and additional capacity.

The capacity (technically available capacity – TC) indicated within the framework of the Gas Network Development Plan 2022–2032 and the accompanying NDP gas database accordingly includes both technical capacity and additional capacity.

Appendix 2: Results of the WEB and Green Gases Market Survey

Detailed information on the project reports from the WEB and Green Gases Market Survey are published in the form of an Excel file on the FNB Gas website.

https://www.fnb-gas.de/en/network-development-plan/scenario-framework/scenario-framework-2022/

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

BKartA	Bundeskartellamt – German competition authority
BNetzA	Bundesnetzagentur für Elektrizität, Gas, Telekommunikation, Post und Eisenbahnen – German Federal Network Agency for Electricity, Gas, Telecommunication, Post and Railways
bnBM	Besondere netztechnische Betriebsmittel – special network operating equipment
BVEG	Bundesverband Erdgas, Erdöl und Geoenergie e. V. – German Federal Association of Natural Gas, Petroleum and Geoenergy, formerly Wirtschaftsverband Erdöl- und Erdgasgewinnung (WEG – German Industrial Association of Oil and Gas Producers)
BZK	Beschränkt zuordenbare Kapazität – conditional allocable capacity: capacity can be used only subject to an allocation condition. No virtual trading point access.
CHP	Combined heat and power
CNG	Compressed Natural Gas
dena	Deutsche Energie-Agentur – German Energy Agency
DZK	Dynamisch zuordenbare Kapazität – dynamically allocable capacity. Capacity is fixed if it can be used without a VHP for balanced transmission between entry and exit capacities with a nomination obligation.
EE	Erneuerbare Energien – renewable energies
EEG	Gesetz für den Ausbau erneuerbarer Energien – Renewable Energy Sources Act

ENTSOG	European Network of Transmission System Operators Gas
EnWG	Energiewirtschaftsgesetz – Energy Industry Act
EUGAL	Europäische Gas-Anbindungsleitung – European gas pipeline link
fDZK	Feste dynamisch zuordenbare Kapazität – firm dynamically allocable capacity
FID	Final investment decision
TSO	(Gas) transmission system operator
FZK	Frei zuordenbare Kapazitäten – free allocable capacity, enables booked entry and exit capacities to be used without stipulating a transmission path.
GasNZV	Verordnung über den Zugang zu Gasversorgungsnetzen / Gasnetzzugangsverordnung German Gas Network Access Regulation
GCA	Gas Connect Austria GmbH
GHD	Gewerbe / Handel / Dienstleistungen - commerce / trade / services
GTS	Gasunie Transport Services B. V.
IP	Interconnection point
KNEP	Koordinierter Netzentwicklungsplan – Co-ordinated network development plan (of Gas Connect Austria)
KoV	Kooperationsvereinbarung Gas – Gas cooperation agreement
KSP	Klimaschutzprogramm - Climate protection program
KVBG	Kohleverstromungsbeendigungsgesetz – German Coal-fired Power Generation Termination Act
LNG	Liquefied natural gas
MBI	Market-based instruments
MoU	Memorandum of Understanding
NC CAM	Network code on capacity allocation mechanisms in gas transmission systems
NCG	NetConnect Germany
NECP	National Energy and Climate Plan
NEL	Nordeuropäische Erdgas-Leitung – Northern Europe Natural Gas Pipeline
NDP	Network Development Plan
NEV	Nichtenergetischer Verbrauch – non-energy consumption
NWS	Nationale Wasserstoffstrategie – National hydrogen strategy
OPAL	Ostsee-Pipeline-Anbindungsleitung (Baltic Sea pipeline link)
PR	Project reports
PtG	Power-to-Gas
PtX	Power-to-X
PV	Photovoltaics

SNG	Synthetisches Methangas – synthetic methane
SR	Scenario Framework
STEGAL	Sachsen-Thüringen-Erdgas-Leitung (natural gas pipeline)
TaK	Temperaturabhängige Kapazität – temperature-dependent capacity: capacity is fixed within and interruptible outside a defined temperature range.
TAP	Trans Adriatic Pipeline
TANAP	Trans-Anatolian Natural Gas Pipeline
TENP	Trans Europa Naturgas Pipeline
THE	Trading Hub Europe
TTF	Title Transfer Facility
TC	Technical capacity
TYNDP	Ten-Year Network Development Plan (from ENTSOG)
UGS	Underground gas storage
VTP	Virtual trading point
VIP	Virtual interconnection point
DSO	Distribution system operator
WEB	Wasserstoffabfrage Erzeugung und Bedarf – hydrogen generation and demand survey
WEB Market Survey	WEB and Green Gases Market Survey

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