Draft Scenario Framework for the Gas and Hydrogen Network Development Plan 2025

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Legal notice

Scenario Framework for the Gas and Hydrogen Network Development Plan 2025

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Executive summary

Executive summary

The reduction of greenhouse gas emissions, expansion of renewable energies and greater energy efficiency are cornerstones of German and European energy and climate policy, with Germany aiming to achieve greenhouse gas neutrality by 2045.

Following the latest amendment to the German Energy Industry Act (EnWG), Germany's gas transmission system operators are obliged under section 15b EnWG to draw up a Scenario Framework showing at least three scenarios that cover the range of probable developments under the government's climate and energy goals for the next ten to 15 years. Three further scenarios must address the year 2045, subject to the same proviso. The requirements of the Energy Industry Act thus change the focus of the Network Development Plan from a primarily demand-based approach to a scenario-based approach focussing on climate protection targets.

This Scenario Framework forms the basis for the first integrated Gas and Hydrogen Network Development Plan, with the hydrogen core network marking the start of hydrogen transmission infrastructure development in Germany. In its first stage, the core network will provide the foundation for the hydrogen ramp-up in Germany. It will be reviewed and further developed as part of the second stage of the Gas and Hydrogen Network Development Plan. For this purpose, the gas transmission system operators joined forces with the electricity transmission system operators in early 2024 to conduct a Germany-wide survey of infrastructure requirements for the electricity and hydrogen networks. The results of the survey have been incorporated into this Scenario Framework, thereby allowing other industries and sectors that could not be taken into account for the hydrogen core network to be considered for future hydrogen scale-up plans.

The scenario-based analyses have been derived from the long-term scenarios developed by the Federal Ministry for Economic Affairs and Climate Action (BMWK), with the T45 Electricity*, T45 RedEff and T45 H2 scenarios employed to show the widest possible range of potential developments for a hydrogen ramp-up and methane demand. This allows the modelling process to explore the effects of an increased use of electricity accompanied by low hydrogen demand (T45 Electricity*) compared to a moderate to intensive use of hydrogen (T45 H2) on the transmission infrastructure. The T45 RedEff scenario also assumes a lower efficiency increase and thus a higher energy demand overall.

The demand-oriented analyses are based on the demand reports for methane received from the distribution system operators (long-term forecasts), industrial customers and power plants as well as the available capacity reservations and capacity expansion claims submitted for power plants and LNG facilities pursuant to sections 38/39 of the German Gas Network Access Regulation (GasNZV). For hydrogen, these are essentially based on the results of the hydrogen market survey and the distribution system operators' long-term hydrogen forecasts.

The discrepancy between the demand reports for methane and the climate policy-based energy scenarios illustrates the market uncertainty associated with the far-reaching transformation process. This uncertainty is prompting distribution system operators and industrial customers to be conservative in their methane demand forecasts, which deviate substantially from the assumptions underlying the climate policy-based energy scenarios. Future developments, such as the municipal heating plans, the approval of the hydrogen core network and the development of an international hydrogen market, will gradually have to provide clarity in order to reduce this uncertainty. The political framework also plays a decisive role here. The gas transmission system operators therefore believe it is necessary to perform both scenario-based and demand-oriented modelling.

Against this background, the gas transmission system operators propose the following modelling variants for the Gas and Hydrogen Network Development Plan 2025.

Table 1: Modelling variants for the Gas and Hydrogen Network Development Plan 2025

No.	Scenario	Energy source	Modelling year		
			2030	2037	2045
1	Focus on electricity	Methane	---	x	x
		Hydrogen	---	x	x
2	Focus on hydrogen	Methane	---	x	x
		Hydrogen	---	x	x
3	Focus on reduced efficiency	Methane	---	---	x
		Hydrogen	---	---	x
4	Focus on security of supply (demand-orientated)	Methane	x	x	---
		Hydrogen	---	x	---

Source: Gas transmission system operators

By submitting the draft Scenario Framework 2025 to the regulatory authority on 1 July 2024, the Coordination Office is complying with the requirements of section 15b EnWG. The regulatory authority will publish the draft on its website and then put it out to consultation. The Scenario Framework 2025 is to be approved within six months of submission of the draft. Here, the regulatory authority is expected take the results of the public participation process into account.

Based on the approved Scenario Framework 2025, the gas transmission system operators and the regulated operators of hydrogen transmission networks will then draw up the integrated Gas and Hydrogen Network Development Plan 2025.

The Scenario Framework 2025 is based on the following figures for methane and hydrogen.

Table 2: Methane figures for the different scenarios / modelling variants

Parameters	Unit	Scenario 1		Scenario 2		Scenario 3		Scenario 4*	
		2037	2045	2037	2045	2037	2045	2030	2037
Methane demand (quantity)									
Total	TWh (net calorific value)	280	0	271	11	332	8	> 700	450-600
thereof buildings		95	0	79	1	82	1	---	---
thereof industry		116	0	92	1	115	2	---	---
thereof transport		7	0	69	9	28	5	---	---
thereof conversion		63	0	31	0	106	0	---	---
Methane demand (capacity, without cross-border IPs)									
Total	GWh/h (gross calorific value)	97	0	82	0	101	0	361	232
thereof buildings		38	0	35	0	36	0	---	---
thereof industry		23	0	18	0	23	0	---	---
thereof transport		1	0	9	0	4	0	---	---
thereof conversion		36	0	20	0	38	0	---	---
Installed gas power plant capacity									
Total	GW_e	44	60	32	38	73	101	---	---
of which methane		16	0	10	0	19	0	---	---

* Scenario 4 is based on reported demand data which was generally transmitted as capacity. There is no differentiation for the individual sectors and this is not required for the modelling exercise. The methane demand values for the years 2030 and 2037 in this scenario are estimates provided by the transmission system operators.

Source: Gas transmission system operators based on [BMWK 2024] and their own assumptions; the numbers have been partially interpolated and rounded.

Table 3: Hydrogen figures for the different scenarios / modelling variants

Parameters	**Unit**	**Scenario 1**		**Scenario 2**		**Scenario 3**		**Scenario 4***
		2037	**2045**	**2037**	**2045**	**2037**	**2045**	**2037**
Hydrogen demand (quantity)								
Total	TWh (net calorific value)	111	371	317	694	---	458	---
thereof buildings		0	0	67	107	---	0	---
thereof industry		75	289	191	437	---	315	---
thereof transport		0	0	39	111	---	0	---
thereof conversion		36	83	21	39	---	143	---
Hydrogen demand (capacity, without cross-border IPs)								
Total	GWh/h (gross calorific value)	79	192	120	232	---	268	---
thereof buildings		0	0	32	50	---	0	---
thereof industry		16	60	40	91	---	66	---
thereof transport		0	0	5	15	---	0	---
thereof conversion		64	132	44	76	---	202	---
Installed gas power plant capacity								
Total	GW_e	44	60	32	38	---	101	---
of which hydrogen		28	60	22	38	---	101	---
Installed PtG capacity								
Total	GW_e	38	68	68	110	---	61	---
Share of hydrogen imports								
Domestic production	TWh (net calorific value)	88	155	174	272	---	130	---
Hydrogen import		23	216	143	422	---	328	---
Share of H2 imports	%	21	58	45	61	---	72	---
IP import capacity	GWh/h	9	85	56	166	---	129	---
IP export capacity		4	5	4	5	---	5	---
Working gas volume of hydrogen storage facilities								
H2 storage capacity	TWh (net calorific value)	23	71	12	72	---	105	---

* Scenario 4 is based on reported demand data which was generally transmitted as capacity. In this modelling variant, the gas transmission system operators decide how much capacity should be taken into consideration for the modelling exercise, the aim being to fully exploit the potential of the hydrogen core network so as to accommodate as many demand reports as possible.

Source: Gas transmission system operators based on [BMWK 2024] and own assumptions; the numbers have been partially interpolated and rounded.

Introduction

1

1 Introduction

Germany aims to be climate-neutral by 2045, an ambitious goal that places enormous demands on the transformation of our energy system. A key element in ensuring a secure, affordable and climate-neutral energy supply is the development of a reliable hydrogen infrastructure.

To ensure that the market ramp-up is as efficient as possible, Germany's future hydrogen network will largely be made up of repurposed natural gas pipelines currently in use. At the same time, the transmission pipeline system, which will continue to be operated with methane, will still play a central role in maintaining security of supply over the coming years. Harmonising the various requirements of the methane and hydrogen networks in the best possible way will require integrated planning of both network infrastructures.

The legal foundations for this endeavour were laid over recent weeks and months. After the German government set the groundwork for a hydrogen core network in a first stage with its amendment to the EnWG, which came into force on 29 November 2023, the second stage was reached on 16 May 2024 with another EnWG amendment, which provides for the hydrogen core network to be continuously developed in the future as part of an integrated network planning process for both gas and hydrogen.

In accordance with section 15a EnWG, the gas transmission system operators and the regulated operators of hydrogen transmission systems will draw up a national Network Development Plan for the gas and hydrogen transmission pipeline systems every two years from 2025. This integrated Gas and Hydrogen Network Development Plan will be preceded by a Scenario Framework jointly drawn up in accordance with section 15b EnWG. Section 15a EnWG also provides for the establishment of a Coordination Office, which will support the network planning process from now on.

The gas transmission system operators believe that integrated network development planning provides an opportunity to accelerate the ramp-up of the hydrogen economy and to exploit the various synergies between the gas and hydrogen infrastructure, and that it will also lay the foundation for further developing the hydrogen core network across Germany over the coming years in line with demand.

Comprehensive cross-sectoral planning, however, will also have to take account of the interplay between gas/hydrogen infrastructure and the electricity sector in a way that goes beyond what is legally required. This interplay is the result of the operation of power-to-gas (PtG) plants as well as gas and hydrogen-fired power plants. For this reason, the gas transmission system operators conducted a market survey together with the electricity transmission system operators from 7 February 2024 to 22 March 2024 to gather data on future hydrogen production, storage and use as well as electricity consumption by large consumers. The respondents reported some 2,000 hydrogen and PtG projects, which were incorporated into the development of the present scenarios. These results make an important contribution to sector coupling.

From town gas to natural gas, from the liberalisation of the gas market to the energy transition: The history of the gas sector has always been a history of profound change. The gas transmission system operators are entirely committed to this challenge and will actively help shape the transition to a climate-neutral energy future. Integrating hydrogen and green gases into the existing network infrastructure will facilitate a significant, swift and cost-effective contribution to decarbonisation. However, a sustainable and resilient energy system can only be created in an open dialogue between all market participants that takes account of all interactions between the different sectors. This Scenario Framework makes an important contribution to facilitating this dialogue.

Timeline and legal basis

2

2 Timeline and legal basis

With its amendment to the German Energy Industry Act (EnWG), the German government has provided the legal basis for the transformation of the country's gas infrastructure. This means that the development of gas and hydrogen networks will be integrated in future. Starting in 2025, the gas transmission system operators and regulated operators of hydrogen transmission networks[1] will draw up their integrated Gas and Hydrogen Network Development Plan every two years. The establishment of the Coordination Office at FNB Gas in accordance with section 15a EnWG on 30 May 2024 was a milestone for the process. The Coordination Office's tasks include, in particular, coordinating the process of preparing and submitting the draft Scenario Framework for approval by the regulator and coordinating the process of preparing and submitting the integrated Gas and Hydrogen Network Development Plan for confirmation by the regulatory authority. Figure 1 illustrates the network development planning process for gas and hydrogen.

Network development planning is based on the Scenario Framework. The Scenario Framework is meant to explore at least three demand scenarios covering a range of probable developments over the next ten to 15 years, which are based on the German government's climate and energy policy goals. A further three scenarios are to examine the development of gas and hydrogen demand for the year 2045 with a range of probable developments that are aligned with the statutory and other climate and energy policy goals of the German government. In consultation with the electricity transmission system operators and the German Federal Network Agency for Electricity, Gas, Telecommunication, Post and Railway (BNetzA), the modelling years 2037 and 2045 have been defined for the integrated Gas and Hydrogen Network Development Plan 2025.

On 1 July 2024, the Coordination Office submitted the draft Scenario Framework 2025 to the regulatory authority for publication on its website. The draft will thus be put out to consultation, allowing comments to be submitted by the public, including actual or potential network users, as well as affected network operators, especially operators of gas distribution systems, hydrogen networks that do not constitute a transmission system, other pipeline infrastructure that can be converted to hydrogen pipelines, and electricity grids. The Scenario Framework 2025 should be approved within six months of submission of the draft to the regulatory authority. In its approval, the regulatory authority is expected take the results of the public participation process into account.

Based on the approved Scenario Framework 2025, the transmission system operators and the regulated operators of hydrogen transmission networks are to carry out the modelling of the nationwide expansion planning for the gas and hydrogen infrastructure. In addition, the Network Development Plan should provide an overview of the implementation status of the network expansion measures mentioned in the most recently published Network Development Plan. In the event of delays in the implementation of measures, the main reasons should be stated. The Gas and Hydrogen Network Development Plan 2025 should also contain information on the status of implementation of the hydrogen core network.

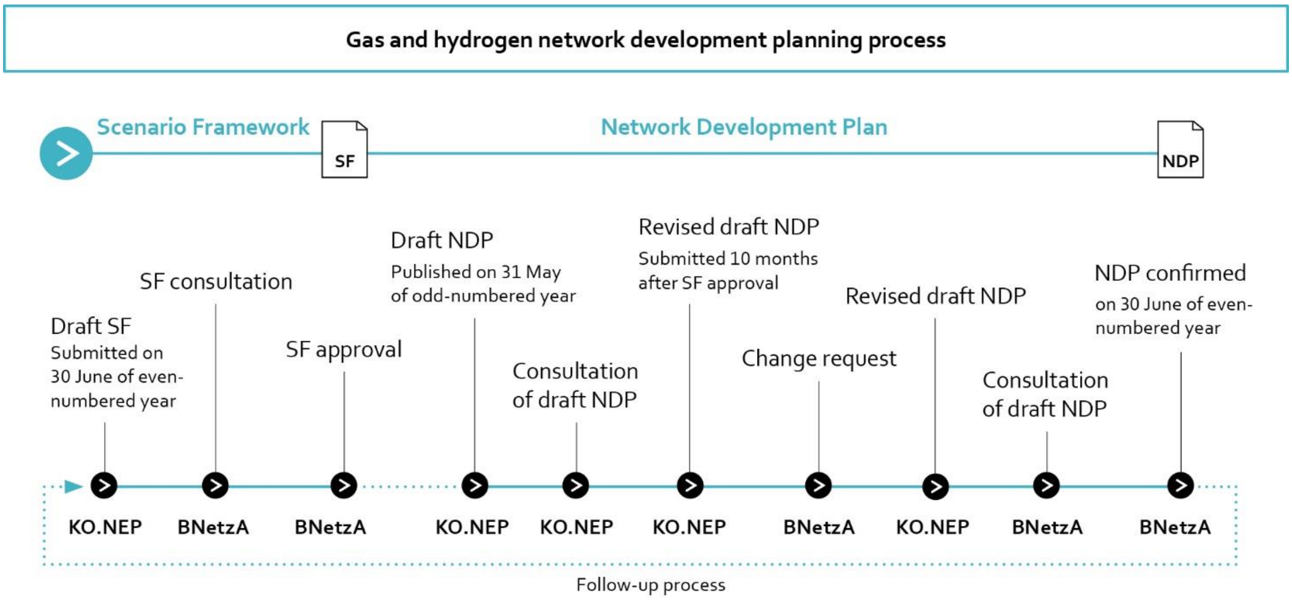
The Coordination Office is expected to publish the draft Gas and Hydrogen Network Development Plan 2025 by 31 May 2025. Again, there will be a period of public consultation during which the general public, including actual or potential network users as well as affected network operators will have the opportunity to comment. At the end of the consultation period, the comments received will be analysed and the draft Gas and Hydrogen Network Development Plan 2025 will be revised based on the results of the consultation.

The regulatory authority will then receive the reviewed and revised draft of the Gas and Hydrogen Network Development Plan 2025 from the Coordination Office. This needs to happen no later than ten months after the approval of the Scenario Framework 2025 by the BNetzA's coordination office. The regulatory authority will then check the submitted Network Development Plan for Gas and Hydrogen for

1 When this document was prepared, there were no regulated operators of hydrogen transmission networks.

compliance with the corresponding legal requirements for the preparation of the Gas and Hydrogen Network Development Plan 2025. The regulatory authority can request that the gas transmission system operators and the regulated operators of hydrogen transmission networks amend the submitted Gas and Hydrogen Network Development Plan 2025 without delay. The Coordination Office is then obliged to submit the amended Gas and Hydrogen Network Development Plan 2025 to the regulatory authority without delay. The regulatory authority needs to confirm the Gas and Hydrogen Network Development Plan 2025 by 30 June 2026 at the latest.

Figure 1: Gas and hydrogen network development planning process



Source: Gas transmission system operators

Input variables for modelling 3

3 Input variables for network modelling

This chapter provides an overview of the current development of gas demand (cf. chapter 3.1) and describes the input variables used for methane network modelling (cf. chapter 3.2) and hydrogen network modelling (cf. chapter 3.3).

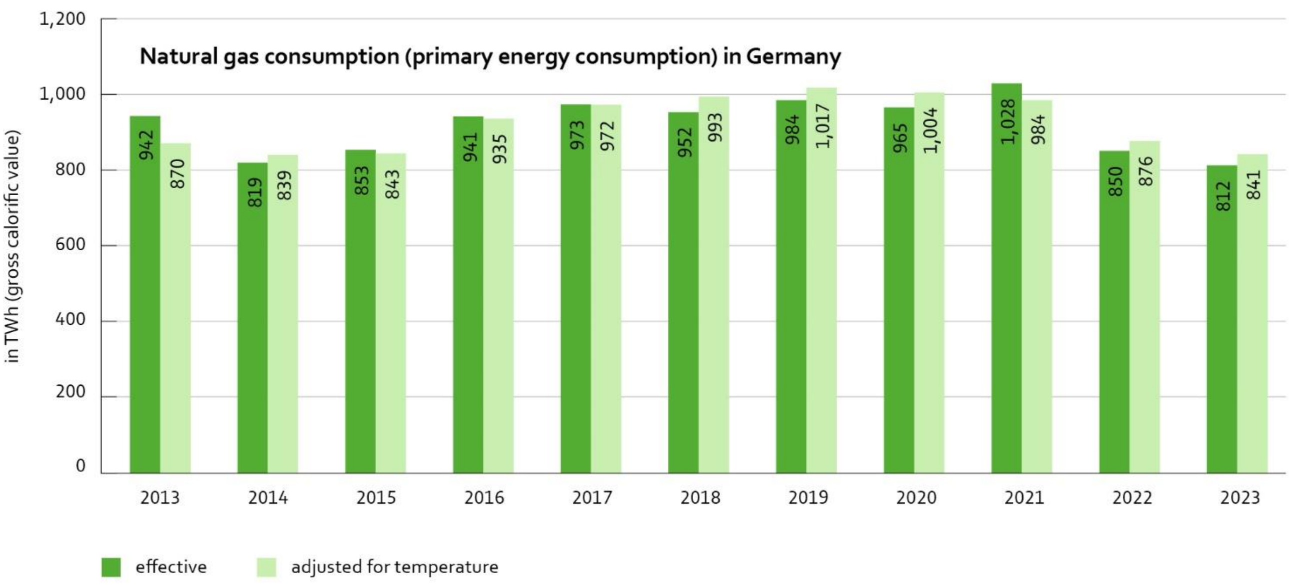
Developing the Integrated Gas and Hydrogen Network Development Plan with due consideration for the latest hydrogen and methane demand figures requires a defined pipeline network. As the hydrogen core network is still awaiting approval at the time this document was drawn up, the status of the repurposed pipelines included in the core network is not yet fully resolved. The gas transmission system operators therefore decided to include all repurposed pipelines incorporated into the hydrogen core network in the hydrogen modelling process for the Gas and Hydrogen Network Development Plan 2025. This means pipelines currently used for methane and intended for conversion to hydrogen by 2032. The connection options and the capacity situation may change compared to the current methane network status, particularly for privileged capacity in accordance with sections 38/39 GasNZV and biogas plants, as well as for all other requirements.

The gas transmission system operators wish to point out that they receive continuous updated feedback from market participants in addition to the demand surveys conducted. For the Scenario Framework 2025, the transmission system operators have defined deadlines for data collection, so feedback received after such dates was disregarded.

3.1 Trends in gas demand up to 2023 (state analysis)

Natural gas consumption in Germany fell by 4.3 % to 812 TWh in 2023, the lowest level since the first half of the 1990s. Developments in the gas industry in 2023 were characterised by the impact of the war of aggression in Ukraine, a still comparatively high price level, cost-saving measures and a subdued economy.

Figure 2: Natural gas consumption (primary energy consumption) in Germany



Note: Figures for 2023 are provisional.

Source: Gas transmission system operators based on [BDEW 2024]

With regard to the different consumption sectors, the picture is more varied.

Due to the economic downturn, the continued relatively high price level and intersectoral structural change, gas consumption in industry has fallen. In 2023, industrial consumption of natural gas as an energy source, but also as a raw material, fell again by around 10 % from the already low level of 2022 to around 273 TWh, the lowest level in the last ten years.

The use of natural gas as a fuel in the power and heating plants of the electricity and heating suppliers increased slightly over the course of the year due to the price competitiveness regained in comparison to other energy sources, totalling 103 TWh, which is unchanged from the previous year.

According to initial estimates, private households consumed around 267 TWh of natural gas in 2023, around 4.5 % less than in the previous year. An analysis of the data provided by Trading Hub Europe (THE) shows that private households and smaller commercial enterprises (standard load profile customers) consumed less natural gas compared to the previous heating period with similarly cold days.

According to initial data, natural gas consumption by companies in the trade, commerce & services sector, of which almost 90 % is used for space heating purposes, also declined. The economic downturn intensified this decline in consumption, resulting in a decrease of around 6.5 % to around 90 TWh by the end of 2023.

The following chart summarises natural gas sendout by customer.

Figure 3: Natural gas consumption by customer groups in Germany

Source: Gas transmission system operators based on [BDEW 2024] (Destatis, AGEB, BDEW, as of 02/2024)

With a share of almost 50 %, natural gas heating systems continue to dominate existing building stock in Germany, followed by oil heating systems. Since 1 January 2024, it has been mandatory for every heating system installed in a new residential area in Germany to obtain at least 65 % of its energy from renewable sources. In new buildings outside of new development areas and in existing buildings, the requirement only has to be implemented once a municipal heat plan is in place – according to the Heat Planning Act (WPG), this must be the case by 30 June 2026 in large cities with a population of more than 100,000 and by 30 June 2028 in smaller municipalities (with a population of up to 100,000). The municipal heat plan is intended to inform citizens and businesses whether they can expect to be connected to a district heating system or should opt for another climate-friendly heating option.

Table 4: Heating systems in building stock in Germany

Year	Number of homes in million 1)	Gas 2)	District heating	Electricity	Electric HP	Heating oil	Other 3)
		Share in %					
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
2021	43.1	49.4	14.2	2.6	2.8	24.8	6.2
2022	43.4	49.3	14.2	2.6	3.0	24.7	6.2
2023*	43.7	48.3	15.2	1.8	5.7	23.4	5.6

* preliminary

1) Number of homes in buildings with living space, heating system available
2) Includes bio natural gas and liquid gas
3) Wood, wood pellets, other biomass, coke/coal, other heating energy

Source: Gas transmission system operators based on [BDEW 2024]

In recent years, electric heat pumps and district heating have steadily gained market share in the new-build sector. This trend continued in 2023. An electric heat pump was installed in more than every second new-build home and district heating in every fourth new-build home. By contrast, construction activity in 2023 was at its lowest level in the last ten years, with around 245,000 homes approved.

Table 5: Market shares of energy sources in new construction

Year	Number of homes 1)	Natural gas	Electric HP	District heating	Electricity	Heating oil	Wood, wood pellets	Other 3)
		Share in %						
2013	262,452	48.3	22.5	19.8	0.7	0.8	6.4	1.5
2014	270,995	49.9	19.9	21.5	0.6	0.7	6.1	1.3
2015	294,021	50.3	20.7	20.8	0.7	0.7	5.3	1.5

Year	Number of homes 1)	Natural gas	Electric HP	District heating	Electricity	Heating oil	Wood, wood pellets	Other 3)
		Share in %						
2016	337,265	44.4	23.4	23.8	0.9	0.7	5.3	1.5
2017	329,033	39.3	27.2	25.2	0.7	0.6	5.5	1.6
2018	332,098	38.6	28.8	25.2	1.1	0.5	4.4	1.4
2019	248,275	36.8	29.8	26.5	1.1	0.5	4.1	1.2
2020	354,935	33.2	35.5	24.4	1.3	0.3	4.1	1.3
2021	370,631	26.2	43.6	22.7	1.4	0.3	4.5	1.3
2022	344,630	17.4	50.7	23.7	1.6	0.2	4.9	1.5
2023*	245,500	10.6	56.5	25.2	1.8	0.1	4.3	1.5

* preliminary

1) New residential units authorised for construction; up to 2012 in new buildings to be constructed and existing buildings

Source: Gas transmission system operators based on [BDEW 2024] (Federal Statistics Office, State Statistics Offices; as of 12/2023)

3.2 Input variables for methane network

This chapter describes the input variables used for modelling the methane network. Chapter 3.2.1 provides a detailed summary of the capacity reservations and capacity expansion claims received by the German gas transmission system operators under sections 38/39 of the German Gas Network Access Regulation (GasNZV), explaining how these have been taken into consideration for the Scenario Framework 2025. This is followed by an overview of the demand reports received for existing power plants connected to the gas transmission system (cf. chapter 3.2.2), the current situation for system-relevant gas power plants connected to the transmission system (cf. chapter 3.2.3) as well as the demand reported by industrial consumers connected to the transmission system (cf. chapter 3.2.4), and then the distribution system operators' long-term forecasts (cf. chapter 3.2.5). Chapter 3.2.6 provides a summary of the available demand reports for the period up until 2035. The current gas production forecast for Germany and current L-gas developments are summarised in chapter 3.2.7 . Other topics addressed below include biomethane injection into the gas network (cf. chapter 3.2.8), the baseline data and developments for methane at cross-border IPs (cf. chapter 3.2.9) as well as the incremental process (cf. chapter 3.2.10) and the sufficient level of freely allocable entry and exit capacity (cf. chapter 3.2.11).

3.2.1 Capacity requirements pursuant to sections 38/39 GasNZV for power plants, storage and production facilities as well as LNG facilities

This chapter presents the gas transmission system operators' revised criteria for considering capacity reservations / capacity expansion claims pursuant to sections 38/39 GasNZV (cf. chapter 3.2.1.1) and explains how power plants, storage facilities, LNG facilities and production facilities are taken into account for the Scenario Framework 2025 (cf. chapter 3.2.1.2).

Due to the new statutory requirements in the Energy Industry Act, there is a procedural change compared to the earlier network development planning processes, whereby the Scenario Framework is no longer put out to consultation by the gas transmission system operators but by the BNetzA. According to the BNetzA, this means that any requests received by the gas transmission system operators during this consultation period and therefore after submission of the Scenario Framework, or any later submission directly to the BNetzA, will be disregarded. Accordingly, only requests received by the gas transmission system operators by 1 May 2024 can be considered for the Scenario Framework 2025 and in the Gas and Hydrogen Network Development Plan 2025.

3.2.1.1 Criteria for considering capacity reservations and capacity expansion claims according to sections 38/39 GasNZV

To determine the gas transmission capacities required, the transmission system operators asked market participants to submit their capacity reservations and capacity expansion claims pursuant to sections 38/39 GasNZV for storage facilities, production and LNG facilities and power plants from 12 February 2024. The deadline set for reporting these capacity reservations and capacity expansion claims was 1 May 2024. To this end, the transmission system operators had published the following criteria on the FNB Gas website, which had to be met in order to be included in the Scenario Framework 2025.

Capacity reservations according to section 38 GasNZV

- The capacity required for a project for which the capacity reservation application pursuant to section 38 GasNZV has been approved will be incorporated into the Scenario Framework 2025 if a capacity reservation has been made by 1 May 2024. The prerequisite for an effective capacity reservation is the payment of the annual reservation fee by the party requesting connection to the system (section 38 (3) sentence 6 in conjunction with section 38 (4) sentence 2 GasNZV).
- The capacity required for a project for which the capacity reservation application pursuant to section 38 GasNZV was not approved by 1 May 2024 due to the deadlines pursuant to section 38 GasNZV will be incorporated into the Scenario Framework 2025 if the party requesting connection to the system has not withdrawn from its connection plans by 1 May 2024.
- The capacity required for a project for which the capacity reservation application pursuant to section 38 GasNZV was rejected will be incorporated into the Scenario Framework 2025 if a capacity expansion claim pursuant to section 39 GasNZV was submitted by 1 May 2024.

Capacity expansion claims according to section 39 GasNZV

- A capacity expansion claim pursuant to section 39 GasNZV, which was included in the Gas Network Development Plan 2022-2032, will be incorporated into the Scenario Framework 2025 if the party requesting connection to the system has not withdrawn from its connection plans by 1 May 2024. In addition, the mandatory project delivery schedule pursuant to section 39 (2) GasNZV must have been completed by 1 May 2024 or the payment by the party requesting connection to the system of the flat planning fee pursuant to section 39 (3) GasNZV must have been made.
- A capacity expansion claim pursuant to section 39 GasNZV, which was submitted after the confirmation of the Scenario Framework 2022 of 20 January 2022 or after the partial re-notification of the confirmation of the Scenario Framework 2022 of 11 November 2022 for LNG facilities, or which was not taken into account in the modelling of the Gas Network Development Plan 2022-2032 and was submitted by 1 May 2024, will be included in the Scenario Framework 2025 if the party requesting connection to the system has not withdrawn from its connection plans by 1 May 2024.

The following chapter lists the projects currently included and not included in the Scenario Framework as of 1 May 2024.

3.2.1.2 Consideration of capacity requirements pursuant to sections 38/39 GasNZV

This chapter describes how the existing capacity reservations and capacity expansion claims pursuant to sections 38/39 GasNZV for power plants, storage facilities, LNG and production facilities are taken into account in the Scenario Framework 2025.

Power plants

This chapter explains which new gas power plants are taken into account in the Scenario Framework 2025 pursuant to sections 38/39 GasNZV based on the criteria described above, and which ones are not taken into account. The modelling of newbuild power plants in the Gas and Hydrogen Network Development

Plan 2025 is generally carried out using the capacity product fDZK, which is why fundamental statements are subsequently made for the allocation points of the fDZK product.

In accordance with the information provided in chapter 3.2.1.1 the following requests from power plants are taken into consideration for the Scenario Framework 2025 pursuant to sections 38/39 GasNZV. All requests relate to the H-gas area.

Table 6: New gas power plants taken into consideration pursuant to sections 38/39 GasNZV as of 1 May 2024

No.	TSO	Project name/ location	Gas connection capacity [MWh/h]	Status	Assignment point*	Applicable criterion (as at 1 May 2024)
1	bayernets	GK Leipheim (Block 2)	950	section 39 GasNZV	Überackern 2, Überackern, Haiming 2-7F/bn, U-Storage Haidach, Haiming 2-RAGES/bn	• Project delivery schedule completed • Flat planning fee paid • Party requesting connection has not withdrawn its plans
2	bayernets	Kraftwerk Gundremmingen	1,600	section 39 GasNZV	Überackern 2, Überackern, Haiming 2-7F/bn, U-Storage Haidach, Haiming 2-RAGES/bn	• Project delivery schedule completed • Flat planning fee paid • Party requesting connection has not withdrawn its plans
3	GASCADE	(KWK-)Wärme-erzeugungsanlage Knapsack	280	section 38 GasNZV	determined as part of modelling process	• Section 38 request approved • Capacity reservation made • Annual capacity reservation fee paid • Party requesting connection has not withdrawn its plans
4	GASCADE	BHKW Profen Village	33	section 38 GasNZV	determined as part of modelling process	• Section 38 request approved • Capacity reservation made • Annual capacity reservation fee paid • Party requesting connection has not withdrawn its plans
5	GASCADE	GKW Hanau	107	section 38 GasNZV	determined as part of modelling process	• Section 38 request approved • Capacity reservation made • Annual capacity reservation fee paid • Party requesting connection has not withdrawn its plans
6	GASCADE	Rechenzentrum Frechen	71	section 38 GasNZV	determined as part of modelling process	• Party requesting connection has not withdrawn its plans
7	GASCADE	Weisweiler II	1,600	section 38 GasNZV	determined as part of modelling exercise	• Section 38 request approved • Capacity reservation is made • Annual capacity reservation fee paid

No.	TSO	Project name/ location	Gas connection capacity [MWh/h]	Status	Assignment point*	Applicable criterion (as at 1 May 2024)
						• Party requesting connection has not withdrawn its plans
8	GUD	Kraftwerk Mehrum	1,450	section 39 GasNZV	Dornum, Emden, UGS Harsefeld, UGS Uelsen, UGS Etzel, UGS Jemgum EWE	• Flat planning fee paid • Party requesting connection has not withdrawn its plans
9	GUD	Kraftwerk Mehrum	200	section 39 GasNZV	Ellund, Dornum, Emden, UGS Harsefeld, UGS Uelsen, UGS Etzel, UGS Jemgum EWE	• Not part of the NDP 2022 • Party requesting connection has not withdrawn its plans
10	OGE	Bergkamen	2,300	section 38 GasNZV	determined as part of modelling	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
11	OGE	H2-Ready Gas- und Dampfturbinenkraft werk Scholven	1,670	section 38 GasNZV	determined as part of modelling process	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
12	OGE	H2-Ready Gas- und Dampfturbinenkraft werk Staudinger	1,670	section 38 GasNZV	determined as part of modelling process	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
13	OGE	Hamm Westphalia	1,250	section 38 GasNZV	determined as part of modelling process	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
14	OGE	Hürth	1,600	section 39 GasNZV	Eynatten/Raeren	• Not part of the NDP 2022 • Party requesting connection has not withdrawn its plans
15	OGE	RDK Karlsruhe	2,400	section 38 GasNZV	determined as part of modelling process	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
16	OGE	Werne	1,500	section 38 GasNZV	Eynatten/Raeren	• Section 38 request approved • Capacity reservation is made • Annual capacity reservation fee paid • Party requesting connection has not withdrawn its plans
17	ONTRAS	GuD Kraftwerk Rostock	1,620	section 39 GasNZV	determined as part of modelling process	• Not part of NDP 2022 • Party requesting connection has not withdrawn its plans

No.	TSO	Project name/ location	Gas connection capacity [MWh/h]	Status	Assignment point*	Applicable criterion (as at 1 May 2024)
18	ONTRAS	GuD Kraftwerk Schkopau	1,565	section 39 GasNZV	determined as part of modelling process	• Flat planning fee paid • Party requesting connection has not withdrawn its plans
19	ONTRAS	GuD Schwarze Pumpe	1,665	section 39 GasNZV	Deutschneudorf-EUGAL	• Project delivery schedule completed • Flat planning fee paid • Party requesting connection has not withdrawn its plans
20	ONTRAS	Innovatives Hybrid-Kraftwerk Boxberg	1,665	section 39 GasNZV	Deutschneudorf-EUGAL	• Project delivery schedule completed • Flat planning fee paid • Party requesting connection has not withdrawn its plans
21	ONTRAS	Innovatives Hybrid-Kraftwerk Jänschwalde	1,665	section 39 GasNZV	Deutschneudorf-EUGAL	• Project delivery schedule completed • Flat planning fee paid • Party requesting connection has not withdrawn its plans
22	ONTRAS	Innovatives Hybrid-Kraftwerk Lippendorf	1,665	section 38 GasNZV	VGS Storage Hub	• Section 38 request approved • Capacity reservation is made • Annual capacity reservation fee paid • Party requesting connection has not withdrawn its plans
23	terranets	Gasturbine Heilbronn	1,200	section 39 GasNZV	Eynatten, Rehden storage facility, Bunde, Jemgum I, Jemgum III, Nüttermoor	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
24	terranets	GuD Marbach	1,650	section 38 GasNZV	Eynatten, Rehden storage facility, Bunde, Jemgum I, Jemgum III, Nüttermoor	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
25	terranets	GuD-Anlage Aalen	316	section 39 GasNZV	Überackern 2, Überackern, Haiming 2-7F/bn, U-Storage Haidach, Haiming 2-RAGES/bn	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
26	terranets	GuD-Anlage Altbach - HKW2	1,060	section 39 GasNZV	Eynatten, Rehden storage facility, Bunde, Jemgum I, Jemgum III, Nüttermoor	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans

No.	TSO	Project name/ location	Gas connection capacity [MWh/h]	Status	Assignment point*	Applicable criterion (as at 1 May 2024)
27	terranets	Altbach CCGT power plant - HKW3	860	section 39 GasNZV	Eynatten, Rehden storage facility, Bunde, Jemgum I, Jemgum III, Nüttermoor	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
28	terranets	Mannheim CCGT power plant	1,600	section 39 GasNZV	Eynatten, Rehden storage facility, Bunde, Jemgum I, Jemgum III, Nüttermoor	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
29	Thyssengas	RWE Neurath	1,600	section 39 GasNZV	Zevenaar H	• Not part of the NDP 2022 • Party requesting connection has not withdrawn its plans
30	Thyssengas	RWE Niederaussem	800	section 39 GasNZV	Zevenaar H	• Not part of the NDP 2022 • Party requesting connection has not withdrawn its plans
31	Thyssengas	RWE Voerde	1,600	section 39 GasNZV	Zevenaar H	• Not part of the NDP 2022 • Party requesting connection has not withdrawn its plans
32	Thyssengas	Steag Datteln	2,640	section 38 GasNZV	determined as part of modelling process	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
33	Thyssengas	Steag Duisburg-Walsum	1,925	section 38 GasNZV	determined as part of modelling process	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
34	Thyssengas	Steag Herne Block 4	1,420	section 38 GasNZV	determined as part of modelling process	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
35	Thyssengas	Voerde Schleusenstraße	808	section 38 GasNZV	Zevenaar H	• Section 38 request not yet decided • Party requesting connection has not withdrawn its plans
Total			**46,006**			
- already included in Gas NDP 2022			**16,486**			
- new requests			**29,519**			

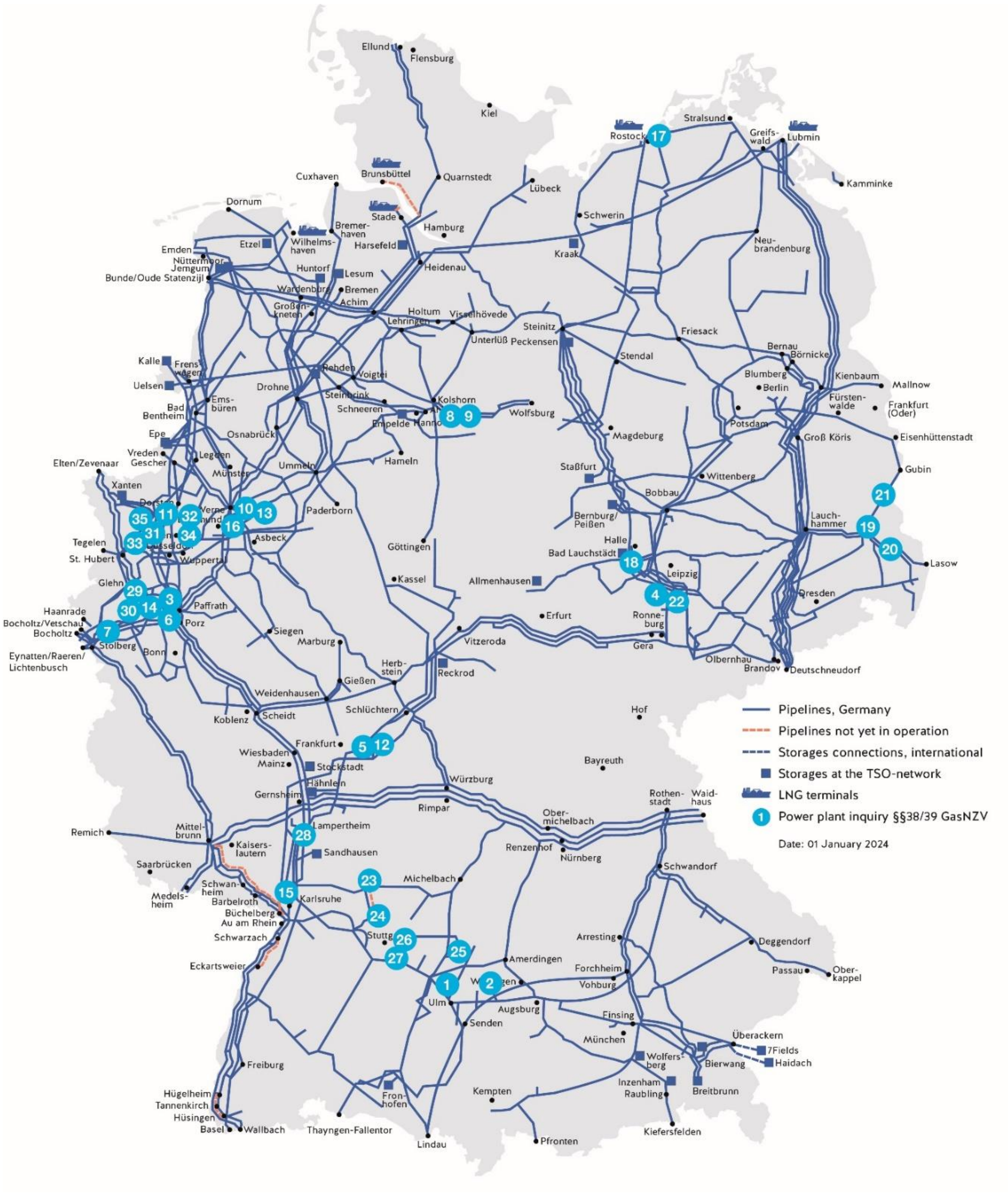
* The allocation points mentioned are decisive for the modelling exercise. An allocation of the cross-border IPs to the bookable points (VIP) can be found in the Gas NDP Database.

Source: Gas transmission system operators

The total number of power plant requests pursuant to sections 38/39 GasNZV has roughly doubled to around 46 GWh/h compared to the power plant requests from the Gas Network Development Plan 2022-2032 (around 23 GWh/h in total). Compared to the previous Gas Network Development Plan 2022-2032, the new power plant requests received that were taken into account in accordance with the criteria amount to a total capacity of around 29.5 GWh/h.

The following diagram shows the locations of the new gas power plant construction plans on the gas transmission system operator's network included in the Scenario Framework 2025. The allocation is based on the consecutive number from the previous Table 6.

Figure 4: New gas power plants included as of 1 May 2024 pursuant to sections 38/39 GasNZV



Source: Gas transmission system operators, schematic diagram

In accordance with the information provided in chapter 3.2.1.1 the following power plant requests pursuant to sections 38/39 GasNZV are not considered in the Scenario Framework 2025.

Table 7: New gas power plants not included pursuant to sections 38/39 GasNZV as of 1 May 2024

No.	TSO	Project name/location	Gas connection capacity [MWh/h]	Status	Assignment point	Applicable criterion (as at 1 May 2024)
1	bayernets	Kraftwerk Zolling	1,300	section 38 GasNZV	---	• Positive decision on application • No capacity reservation made • No payment of annual reservation fee
2	Thyssengas	Hürth	1,500	section 38 GasNZV	---	• Application rejected • No application pursuant to section 39 GasNZV submitted to Thyssengas
		Total	**2,800**			

Source: Gas transmission system operators

Criteria for the liquidity assessment and the selection of allocation points for new power plants

Since the Gas Network Development Plan 2013, the gas transmission system operators have been using the efficient power plant product fDZK (firm dynamically allocable capacity) for modelling supply to new power plants as agreed with the BNetzA in order to avoid any additional development of the methane transmission system.

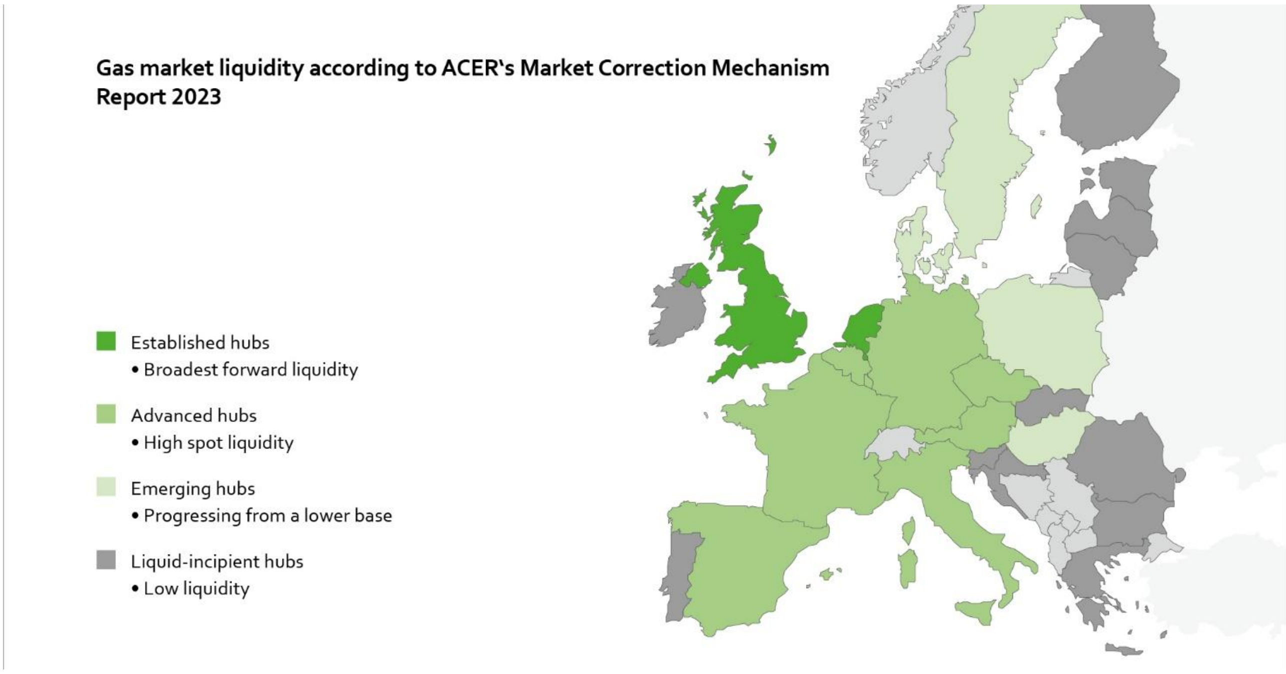
The power plant product fDZK ensures that power plants are supplied with firm capacities, albeit not exclusively via the German virtual trading point, but rather, if required for network-related reasons, via specific storage facilities, LNG facilities or cross-border IPs that offer access to virtual trading points abroad.

The transmission system operators and the power plant operators usually contact each other in the course of determining the allocation points and generally reach an agreement on this.

Liquidity at virtual trading points

To assess the liquidity of virtual trading points, the transmission system operators refer to publications by the European regulatory authority ACER. The Market Correction Mechanism Effects Assessment Report published in March 2023, which does not yet take into account the effects of the Russian war of aggression in Ukraine, contains, among other things, the information shown in Figure 5 on the liquidity of European virtual trading points.

Figure 5: Gas market liquidity according to ACER's Market Correction Mechanism Report 2023



Source: Gas transmission system operators based on [ACER 2023]

According to ACER, the liquidity at the virtual trading points in Germany's neighbouring countries can be classified as follows:

- "Broad liquidity": UK, Netherlands,
- "High liquidity": Belgium, France, Italy, Austria, Czech Republic,
- "Improving liquidity": Poland, Denmark.

From the gas transmission system operators' perspective, the liquidity of allocation points in countries with "broad liquidity" or "high liquidity" was therefore guaranteed before the start of the Russian war against Ukraine.

The Russian war against Ukraine has profoundly changed the energy industry landscape in Germany and Europe and has had an impact on the liquidity of trading points in Europe.

In its 2023 Market Monitoring Report, ACER describes the fundamental impact of the events of summer 2022 on the liquidity of trading hubs as follows:
"Hub trading volumes remained robust despite the surge in trading margins caused by the record-high prices. However, the trading environment was more challenging."

With regard to the liquidity of trading points in 2023, ACER notes:
"Gas trading activity increased in 2023 in comparison to 2022. Growth was concentrated at the Dutch Title Transfer Facility. The rise is associated with a more stable demand-supply outlook and a more favourable gas trading environment (e.g. lower relative and absolute margin requirements). Greater liquidity at gas hubs results in a more competitive and resilient EU gas market."

Apart from the positive liquidity developments at the trading points, the diversification of imports into the Trading Hub Europe (THE) market area, e.g. through the creation of additional LNG import capacities in Germany and neighbouring Western European countries, will also help to increase the liquidity of the trading markets. In addition, the Gas Network Development Plan 2022-2032 provides for an expansion of firm transmission capacities into these trading markets.

The gas transmission system operators therefore assume that the allocation points Bunde (Netherlands), Eynatten (Belgium), Wallbach (Italy, France), Überackern/Überackern 2 (Austria) and Deutschneudorf-EUGAL (Czech Republic), which are currently used, will continue to see sufficient liquidity.

For the allocation points Dornum and Emden (Norway – not considered by ACER), which are key import points for Norwegian methane, the gas transmission system operators consider liquidity to be guaranteed.

The transmission system operators also see sufficient liquidity at the Ellund allocation point (Denmark, "Improving liquidity" status). The analyses conducted by the Danish network operator Energinet.dk (ENDK) show that the availability of methane will at least remain the same and that there is a trend towards a potential increase in available capacities. These analyses were presented in chapter 8.3 of the Scenario Framework for the Gas Network Development Plan 2022-2032. The supply of gas in Denmark has increased significantly due to the completion of the Baltic Pipe and the recommissioning of the Tyra field.

The Central European Gas Hub (CEGH) is reached via the cross-border IPs Überackern and Überackern 2. Central and Eastern European gas volumes are traded at the CEGH. Gas volumes reach this Central European trading point via Slovakia at the Baumgarten cross-border IP, even after the start of the war in Ukraine. It can therefore be assumed that the CEGH and therefore also the cross-border IPs Überackern and Überackern 2 have sufficient liquidity. Overall, the south-east European region is largely supplied with gas via Turkey and Ukraine.

Liquidity of LNG facilities

All entry and exit points located in Germany are assigned to the nationwide Trading Hub Europe (THE) market area. The Cooperation Agreement between Operators of Gas Supply Networks (KoV) defines an entry point as a point within the market area at which a shipper can transfer gas from border crossings, domestic sources and production plants, LNG facilities, biogas plants or from storage facilities to a network operator's pipeline network. LNG entries are therefore treated the same as entries from other gas sources and also serve to secure the supply of methane to the market area. The assumption that LNG entry points maintain a certain liquidity is confirmed by their designation in the Cooperation Agreement between Operators of Gas Supply Networks. In Europe and other parts of the world, LNG is part of a reliable and secure energy supply. There is a global market with several producing and importing countries, which is seen by gas transmission system operators as an important additional liquidity component in the methane supply to Germany following the discontinuation of Russian gas supplies. In addition, LNG facilities have an intermediate storage function ensuring the availability of entry capacity.

Liquidity of storage facilities

Storage facilities make an important contribution to security of supply and system stability, as they are technically capable of providing large volumes of gas quickly and locally at peak load or in the event of physical network congestions, as has been demonstrated in the wake of Russia's war of aggression against Ukraine. They are part of the supply portfolio of many merchant companies, allowing them to access storage volumes with great flexibility. Moreover, the allocation of storage facilities as entry points for the supply of power plants with fDZK offers customers the advantage that they can freely choose the source of the gas that they inject into storage for the power plant, meaning that they can choose among all trading points.

Where possible, the gas transmission system operators will select several storage facilities as allocation points for a power plant, which will significantly increase the availability of methane.

In cases where only storage facilities are designated as allocation points, these allocations are agreed with the power plant operators or are made at their express request. In these cases, storage facilities are therefore generally suitable allocation points for the power plant product, as the availability of gas is sufficiently guaranteed here in the event of a demand.

Selection of allocation points for new power plants

In addition to sufficient liquidity as a basic prerequisite for the selection of an allocation point, the gas transmission system operators also consider the criteria listed below for the selection of allocation points:

- Network structure and proximity to the power plant: Optimisation of the transmission route from the allocation point to the power plant (no additional network expansion required).
- Hybrid points: Possibility of using counterflow capacities for optimised use of the gas transmission system. High availability of gas when required.
- Capacity bookings: Option to book capacities in the event of a request.
- Diversification: The gas transmission system operators aim to diversify the allocation points overall. A distribution across different point types (cross-border IPs, LNG, storage facilities) and different supply directions to optimise network operation (cf. previous chapters) will improve overall operation. Where possible, the allocation of several points to a single power plant will significantly increase the availability of methane.

Based on these criteria, the gas transmission system operators will define allocation points for the new Scenario Framework 2025 requests and check whether they are still up to date for the power plants that already had an allocation point in the Gas Network Development Plan 2022-2032.

Storage facilities

The gas transmission system operators have not received any capacity reservations or capacity expansion claims pursuant to sections 38/39 GasNZV for storage facilities as of 1 May 2024.

LNG facilities

This chapter describes the current situation of the planned LNG facilities to be connected to the gas transmission network in Germany. It then shows which LNG facilities are considered in the Scenario Framework 2025 based on the criteria described above.

Current situation of LNG facilities in Germany

The construction of LNG facilities in Germany, the associated connection to the gas transmission network and the corresponding provision of capacities were already the subject of the most recently published gas network development plans.

For the Gas and Hydrogen Network Development Plan 2025, the gas transmission system operators have received the following capacity reservations or capacity expansion claims pursuant to sections 38/39 GasNZV for the planned LNG facilities in Wilhelmshaven, Brunsbüttel, Stade, Lubmin, Mukran and Rostock.

Wilhelmshaven

In the Gas Network Development Plan 2022-2032, the LNG entry points in the security of supply variants LNGplus B and C were divided into different clusters and the entry capacities were limited according to demand. For the Wilhelmshaven cluster, the entry capacities were limited to 26 GWh/h and the required network expansion was determined. According to the Gas Network Development Plan 2022-2032 currently in place, a network expansion from Etzel via Wardenburg to Drohne is required to provide the necessary transmission capacities. This project will be implemented by OGE and is due for commissioning on 31 December 2027.

An LNG Floating Storage and Regasification Unit (FSRU) has been in operation in Wilhelmshaven since January 2023. The FSRU is connected to OGE's gas transmission system.

The capacity of 10.6 GWh/h requested for this FSRU in accordance with section 38 GasNZV could not be made permanently firm available . Therefore, the project developer has reduced its capacity expansion claim in accordance with section 39 GasNZV on the basis of updated information on the actual demand compared to the original request and claimed 6.7 GWh/h. The flat planning fee for the entry capacity of 6.7 GWh/h has been paid.

An additional permanent land-based LNG terminal is scheduled for commissioning in 2028. The project developer for this terminal has requested 26 GWh/h of entry capacity in accordance with section 38 GasNZV and, due to the unavailability of this capacity, has asserted its expansion claim in full in accordance with section 39 GasNZV. With the entry capacities in the Wilhelmshaven cluster limited to a total of 26 GWh/h in the Gas Network Development Plan 2022-2032, the asserted network expansion claims will not be met in full. Accordingly, the transmission capacities will have to be shared between the project developers. The flat planning fee for the entry capacity of 19.3 GWh/h has been paid.

Both network expansion applications fulfil the criteria for inclusion in the Scenario Framework 2025.

In addition to the two terminals described above, a second FSRU is scheduled to go into operation in Wilhelmshaven on a temporary basis in the second half of 2024. This FSRU will be operated for a limited period until the above-mentioned permanent, land-based LNG terminal at the Wilhelmshaven site goes into operation in 2028.

<u>Brunsbüttel</u>

For the Gas Network Development Plan 2022-2032, there was a total capacity expansion claim pursuant to section. 39 GasNZV for onshore and seaward entries of 29.3 GWh/h. 15.5 GWh/h of the capacity related to seaward entry via FSRU at the Brunsbüttel site. There are currently requests at the Brunsbüttel site in accordance with section 39 GasNZV totalling 13.8 GWh/h for onshore entry.

The pipeline between Brunsbüttel and Hetlingen required to transport the regasified LNG volumes was completed in January 2024 and commissioned by GUD in March 2024. Prior to the completion of this pipeline, volumes from the FSRU in Brunsbüttel had been fed into GUD's network via an existing DSO pipeline between Brunsbüttel and Klein Offenseth since March 2023. This gas transfer from the FSRU in Brunsbüttel is scheduled to end with the commissioning of the onshore LNG terminal at the Brunsbüttel site.

<u>Stade</u>

For the Gas Network Development Plan 2022-2032, there was a total capacity expansion claim pursuant to section 39 GasNZV of 21.7 GWh/h for onshore entries and 10.15 GWh/h for seaward entries via FSRU pursuant to section 38 GasNZV at the Stade site. There are currently onshore entry requests pursuant to section 39 GasNZV totalling 21.7 GWh/h at the Stade site.

The pipeline required to ship the regasified LNG volumes from the onshore LNG plant in Stade will be completed in 2026. For the period prior to the completion of this pipeline, an initial connection was made in March 2024 by a short, newly built pipeline link between the FSRU site in Stade and GUD's existing network in order to transfer volumes from the FSRU into GUD's network. FSRU transfers into the pipeline network in Stade will end with the commissioning of the onshore LNG terminal at the Stade site.

Lubmin (BEG_Port)

For the Network Development Plan 2022-2032, there were total capacity reservations in accordance with section 38 GasNZV of 66.5 GWh/h for onshore and seaward entries. At the BEG_Port site, 6.0 GWh/h were reserved.

The FSRU located in the Lubmin harbour basin will be relocated to the BEG site in 2024.

Mukran (BEG)

For the Network Development Plan 2022-2032, capacity reservations in accordance with section 38 GasNZV totalling 66.5 GWh/h were available for onshore and seaward entries. The high capacity reservation was the result of a competition situation which was resolved in the course of 2023. Capacity reservations of 10.0 GWh/h have been made for the BEG site in accordance with section. 38 GasNZV. This results in a total of 16.0 GWh/h at the BEG site (transfer of 6.0 GWh/h from BEG_Port).

The offshore connection pipeline between the Lubmin infrastructure node and the BEG entry terminal in Mukran was completed in January 2024. Gas has been transferred into the pipeline system via an FSRU since the beginning of March 2024. The FSRU previously located at the BEG_Port entry point in Lubmin will be relocated to the BEG site in 2024 where it will feed in gas as a second FSRU.

Rostock

For the Gas Network Development Plan 2022-2032, a capacity expansion claim in accordance with section 39 GasNZV of 1.5 GWh/h with seaward entry at the Rostock harbour site has been submitted. A project delivery plan is currently being drawn up (Q2/2024).

Consideration of LNG facilities in the Scenario Framework

Based on the criteria described in chapter 3.2.1.1 , and taking into account the current situation as described above, the gas transmission system operators have received the following requests for LNG facilities pursuant to sections 38/39 GasNZV as of 1 May 2024.

Table 8: LNG facilities taken into consideration pursuant to sections 38/39 GasNZV as of 1 May 2024

No.	TSO	Project name/ location	Gas connection capacity [MWh/h]	Status	Applicable criterion (as at 1 May 2024)
1	OGE	Wilhelmshaven	26,000	section 39 GasNZV	• Flat planning fee paid for 19.3 GWh/h • Party requesting connection has not withdrawn its plans
	OGE	Wilhelmshaven	6,700	section 39 GasNZV	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
Total Wilhelmshaven cluster			**32,700**		
2	GUD	Brunsbüttel	8,700	section 39 GasNZV	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
	GUD	Brunsbüttel	1,975	section 39 GasNZV	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
	GUD	Brunsbüttel	3,125	section 39 GasNZV	• Flat planning fee paid • Party requesting connection has not withdrawn its plans

No.	TSO	Project name/ location	Gas connection capacity [MWh/h]	Status	Applicable criterion (as at 1 May 2024)
3	GUD	Stade	9,300	section 39 GasNZV	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
	GUD	Stade	6,950	section 39 GasNZV	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
	GUD	Stade	5,450	section 39 GasNZV	• Project delivery schedule finalised • Flat planning fee paid • Party requesting connection has not withdrawn its plans
Total Lower Elbe cluster			**35,500**		
4	GASCADE	Lubmin/Mukran	10,000	section 38 GasNZV	• Section 38 request approved • Capacity reservation is made • Annual capacity reservation fee paid
5	ONTRAS	Rostock	1,500	section 39 GasNZV	• Not part of the NDP 2022 • Party requesting connection has not withdrawn its plans
Total for Baltic Sea cluster			**11,500**		
Total for all clusters (LNG facilities)			**79,700**		

Source: Gas transmission system operators

In their Gas Network Development Plan 2022-2032, the gas transmission system operators had already combined the requested capacities of LNG facilities that impact on a network area, thereby forming clusters. Very high capacity requests in a cluster would have resulted in large network expansions within the relevant network area and beyond. For this reason, the gas transmission system operators have limited the LNG capacity within the clusters to ensure efficient network expansion and the fastest possible project delivery and have defined the network expansion required for this purpose.

In their Gas and Hydrogen Network Development Plan 2025, the transmission system operators again limit the capacity in the Wilhelmshaven cluster to the level specified in the Gas Network Development Plan 2022-2032 so as to rule out additional network expansion, which would not have been achievable in a timely manner due to the long delivery times. In the Lower Elbe and Baltic Sea clusters, the LNG capacity requests to be taken into account in accordance with the criteria have been included in full. Table 9 shows the LNG capacity taken into account in the Framework Scenario 2025 in the respective clusters.

Table 9: LNG facilities taken into consideration pursuant to sections 38/39 GasNZV for the modelling of the Gas and Hydrogen Network Development Plan 2025

No.	TSO	Cluster	Project name/location	Gas connection capacity [MWh/h]
1	OGE	Wilhelmshaven	Wilhelmshaven	26,000
2	GUD	Lower Elbe	Brunsbüttel, Stade	35,500
3	GASCADE, ONTRAS	Baltic Sea	Lubmin, Rostock	11,500
Total all clusters				**73,000**

Source: Gas transmission system operators

The following figure shows the locations of the LNG facilities included in the Scenario Framework 2025 on the gas transmission pipeline system. The allocation is based on the consecutive number from the previous Table 8.

Figure 6: LNG facilities included as of 1 May 2024 pursuant to sections 38/39 GasNZV

Note: Map as of 1 January 2024

Source: Gas transmission system operators, schematic diagram

Based on the criteria described in chapter 3.2.1.1 the following LNG requests according to sections 38/39 GasNZV have not been considered in the Scenario Framework 2025.

Table 10: LNG facilities not included pursuant to sections 38/39 GasNZV as of 1 May 2024

No.	TSO	Project name/ location	Gas connection capacity [MWh/h]	Status	Applicable criterion (as at 1 May 2024)
1	GASCADE	Lubmin	49,400	section 38 GasNZV	Party requesting connection has withdrawn its plans

Source: Gas transmission system operators

Production facilities

The gas transmission system operators have no capacity reservations or capacity expansion claims pursuant to sections 38/39 GasNZV for production facilities as of 1 May 2024.

3.2.2 Capacity requirements of existing power plants connected to the gas transmission system

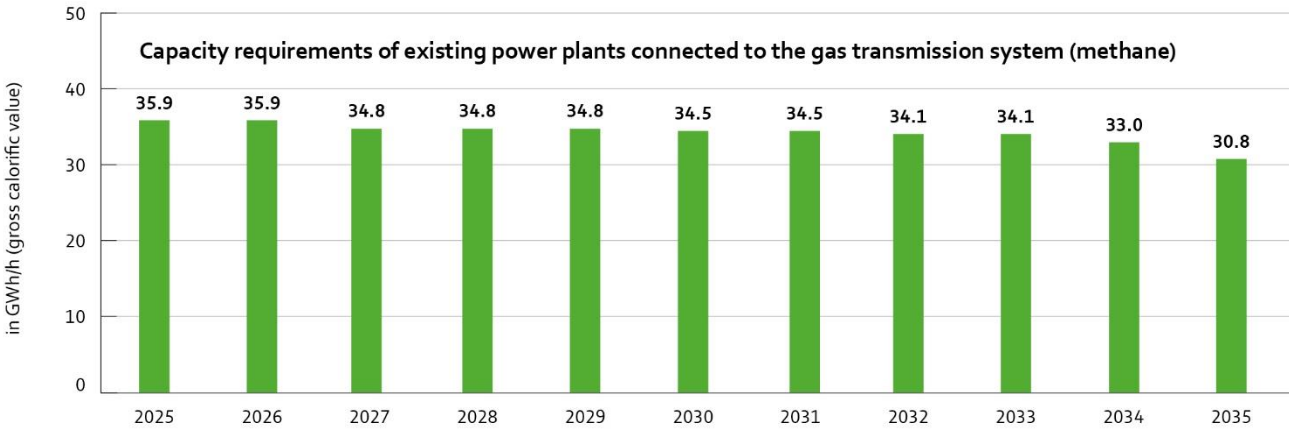
The gas transmission system operators have asked the operators of power plants directly connected to their pipeline system (including system-relevant power plants) to estimate their future capacity requirements for methane. In some cases, a substitution of methane by other energy sources, such as hydrogen, was reported.

For existing power plants that did not respond or only provided a rough estimate of their future capacity requirements, the previous capacity requirements were extrapolated (up until 2035).

The results of the survey clearly show that existing power plant customers expect a continuous decline in their capacity requirements of around 5 GWh/h until 2035, with the largest annual change or reduction in capacity recorded at the turn of the year 2034/2035 (around 2 GWh/h).

The following figure shows the result of the survey. Additional requirements were not taken into account here. If a request was made pursuant to sections 38/39 GasNZV, these are listed in chapter 3.2.1.2 .

Figure 7: Capacity requirements of existing power plants connected to the gas transmission system (methane)



Source: Gas transmission system operators

3.2.3 System-relevant power plants

The following table shows the gas power plants that are currently categorised as system-relevant by the BNetzA and are directly connected to the gas transmission pipeline system. The detailed power plant list with all system-relevant power plants is included in Annex 3.

Table 11: System-relevant power plants connected to the gas transmission system

No.	TSO	Project name	Gas connection capacity [MWh/h]	Allocation point (fDZK)	Capacity product
1	bayernets	Dampfkraftwerk BGH - O1	550	---	FZK
			160	Überackern 2, U-Storage Haidach	fDZK
2	bayernets	UPM Schongau DKW T4+T5	75	---	FZK
			180	Überackern, Überackern 2, Haiming 2-7F/bn, U-Storage Haidach, Haiming 2-RAGES/bn, Wolfersberg, Inzenham West U-Storage	fDZK
3	bayernets	UPM Schongau HKW 3 GT+DT	150	---	FZK
			70	Überackern, Überackern 2, Haiming 2-7F/bn, U-Storage Haidach, Haiming 2-RAGES/bn, Wolfersberg, Inzenham West U-Storage	fDZK
4	bayernets	bnBm Gaskraftwerk Leipheim	950	Überackern 2, Überackern, Haiming 2-7F/bn, U-Storage Haidach, Haiming 2-RAGES/bn	fDZK

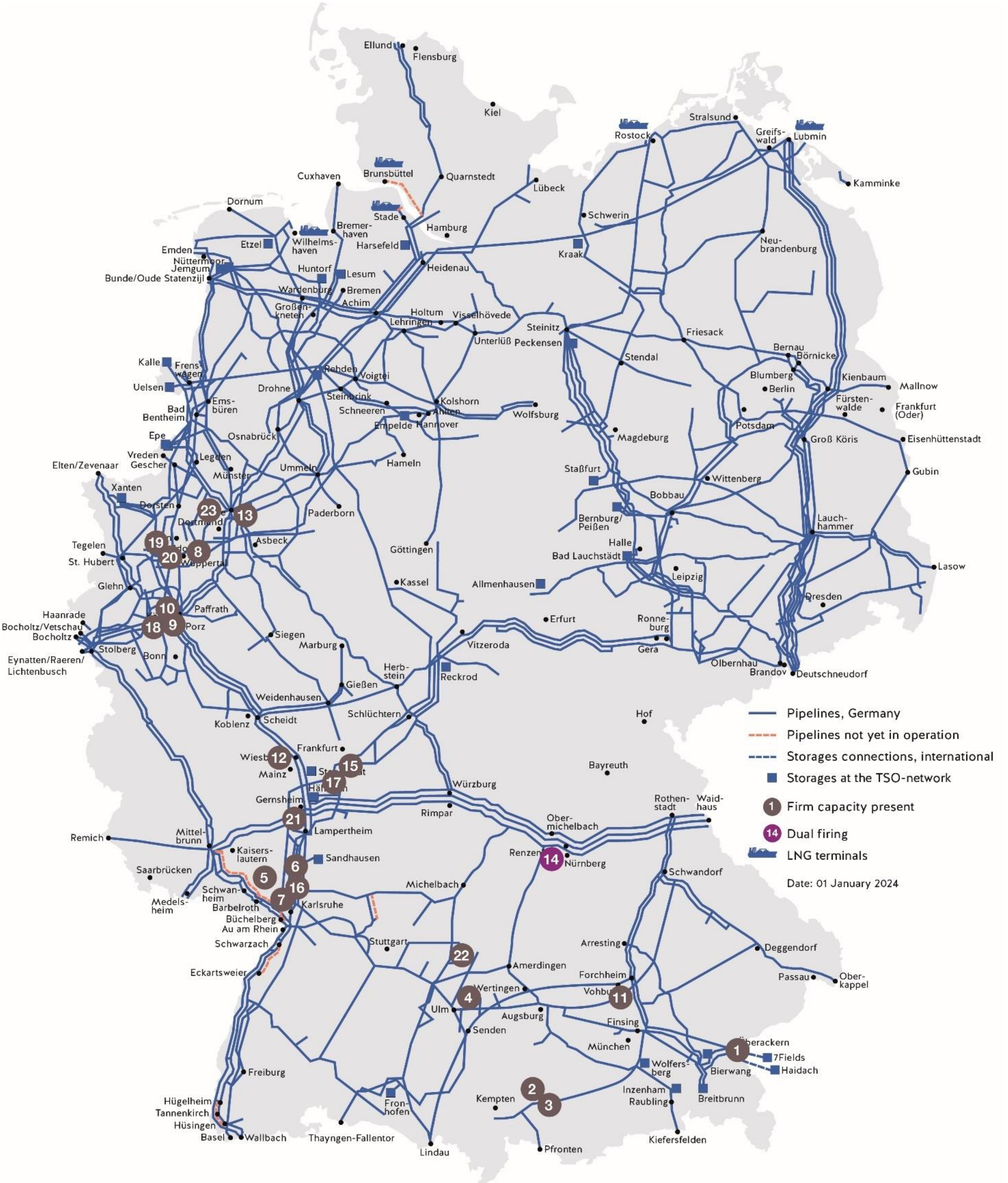
No.	TSO	Project name	Gas connection capacity [MWh/h]	Allocation point (fDZK)	Capacity product
5	GASCADE	Kraftwerk GuD Mitte DT10-12, Ludwigshafen	---*	---	FZK
6	GASCADE	Kraftwerk GuD Süd GT1-2/DT, Ludwigshafen	---*	---	FZK
7	GASCADE	HKW Wörth	---*	---	FZK
8	GASCADE	Cuno Heizkraftwerk Herdecke H6	---*	Eynatten	fDZK
9	GASCADE	GT/DT Niehl 2 RheinEnergie	---*	---	FZK
10	GASCADE	GuD Niehl 3 Rheinenergie	---*	---	FZK
11	OGE	Irsching 4 Irsching 5 GT1/2, DT Irsching 6	1,700 (FZK), 2,100 (fDZK)	Haiming 2 7F, Bierwang storage facility, Breitbrunn storage facility	FZK, fDZK
12	OGE	Mainz KW3 GT31/DT32 Mainz KW2 DT 27	1,500	---	FZK
13	OGE	Trianel Gaskraftwerk Hamm Block 10 Trianel Gaskraftwerk Hamm Block 20	1,800	---	FZK
14	OGE	Franken DT1, Nürnberg Franken DT2/GT2, Nürnberg	0**	---	---
15	OGE	Staudinger 4	1,914	---	FZK
16	OGE	Rheinhafen-Dampfkraftwerk, RDK 4S DT+GT. Karlsruhe	740	Wallbach	fDZK
17	OGE	GuD-Heizkraftwerk M120, Rüsselsheim	420	---	FZK
18	OGE	Kraftwerk Knappsack II	840	---	FZK
19	OGE	HKW III Block B, Duisburg	550	---	FZK
20	OGE	SWD KWL AGuD, Düsseldorf	230	---	FZK
21	OGE	bnBM Gaskraftwerk Biblis	973	---	FZK
22	terranets	HKW Aalen	77	---	FZK
23	Thyssengas	GuD Herne	1,268	Emden EMS/EPT, Epe/Xanten I (UGS-E; Innogy)	fDZK

* No publication due to business secrets of third parties
** Dual-fuel facility

Source: Gas transmission system operators based on BNetzA power plant list, incl. system-relevant gas power plants [BNetzA 2024]

The following diagram shows the locations of the current system-relevant gas power plants connected to the network of the gas transmission system operators as per the Scenario Framework 2025. The allocation is based on the consecutive number from the previous Table 11.

Figure 8: System-relevant gas power plants connected to the gas transmission system



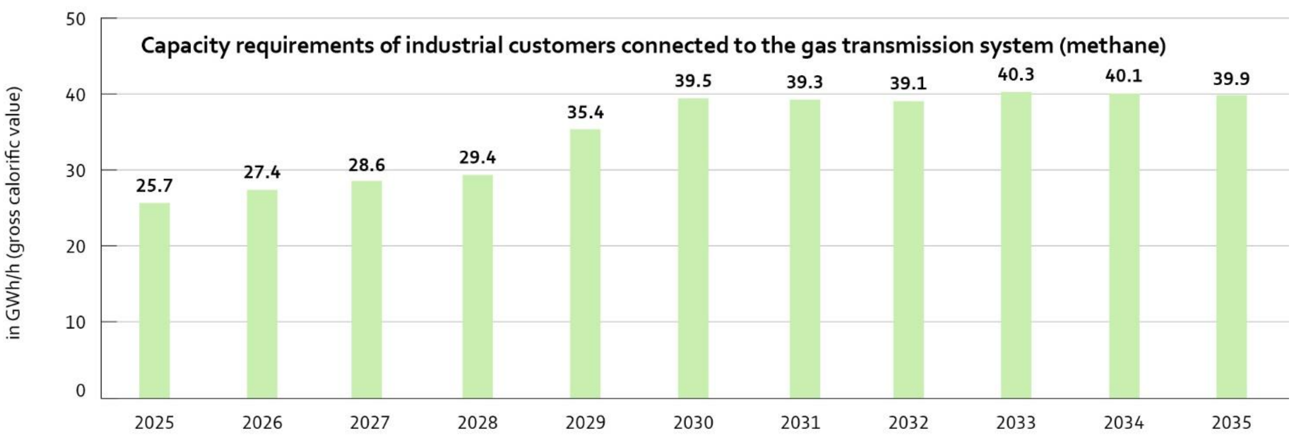
Source: Gas transmission system operators based on [BNetzA 2024], schematic representation

3.2.4 Transmission capacity requirements by industry

Given today's statutory and political targets, the general assumption made in previous Gas Network Development Plans that methane demand would remain unchanged is incompatible with climate protection goals. The gas transmission system operators therefore asked industrial customers directly connected to their pipeline network to estimate their future methane capacity requirements, with due consideration for expected process developments, increases in efficiency or the substitution of methane with other energy sources, such as hydrogen. The customers were told that their non-binding feedback would not have any direct impact on their current connection capacities. The customers provided feedback on around half of their current demand.

The developments expected by the industrial customers do not result in any significant decrease in the reported capacity requirements for any gas transmission system operator. The significant rise in capacity requirements of around 10 GWh/h between 2028 and 2035 reported by industry is the result of considerable additional demand at a few exit points as well as new customer connections. For industrial customers who did not respond or only provided a rough estimate of their future capacity requirements, the previous capacity requirements were extrapolated (up until 2035).

Figure 9: Capacity requirements of industrial customers connected to the gas transmission system (methane)



Source: Gas transmission system operators

Should the modelling work done as part of the Gas and Hydrogen Network Development Plan 2025 show that these additional capacities necessitate network expansion measures, then any implementation of such measures would be subject to the condition that a project timetable is drawn up together with the requesting industrial customer and a contractual arrangement for a long-term capacity booking is agreed.

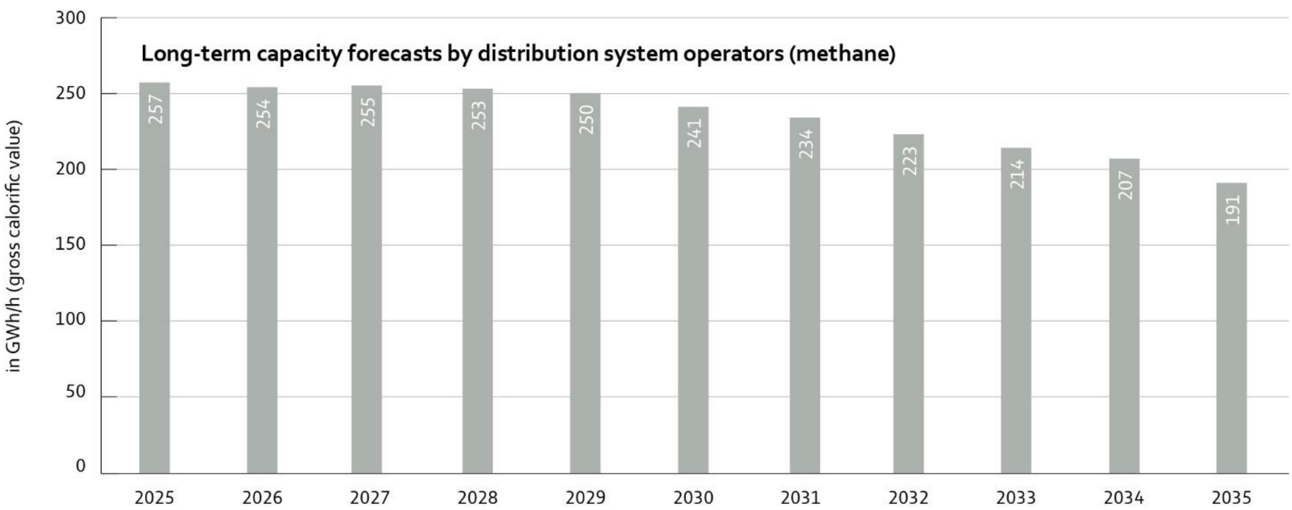
3.2.5 Long-term methane capacity forecasts by distribution system operators

The changed legal framework conditions for the NDP process requires (among other things) a change of the deadlines for submitting long-term forecasts, which are set out in section 16 of the Cooperation Agreement (KoV). A revised version of the KoV amended to allow for these changes is to come into force on 1 October 2024. In addition to the new deadlines, section 16 will, for the first time, include a long-term hydrogen forecast. To be able to take account of updated capacity requirements by distribution system operators for the 2025 network development planning process before the amended KoV comes into force, the transmission system operators conducted a survey in the first quarter of 2024 on the methane capacity forecast for 2025-2035 (update of the long-term methane capacity forecast of 15 July 2023 now extended up until 2035).

The methane capacity requirements reported by the distribution system operators were checked for plausibility to the extent that increases in capacity were only taken into consideration if the distribution system operator provided a comprehensible justification.

The following chart shows the result of the survey conducted by the gas transmission system operators in the first quarter of 2024 on the development of methane capacity requirements among the distribution system operators.

Figure 10: Long-term capacity forecasts by distribution system operators (methane)



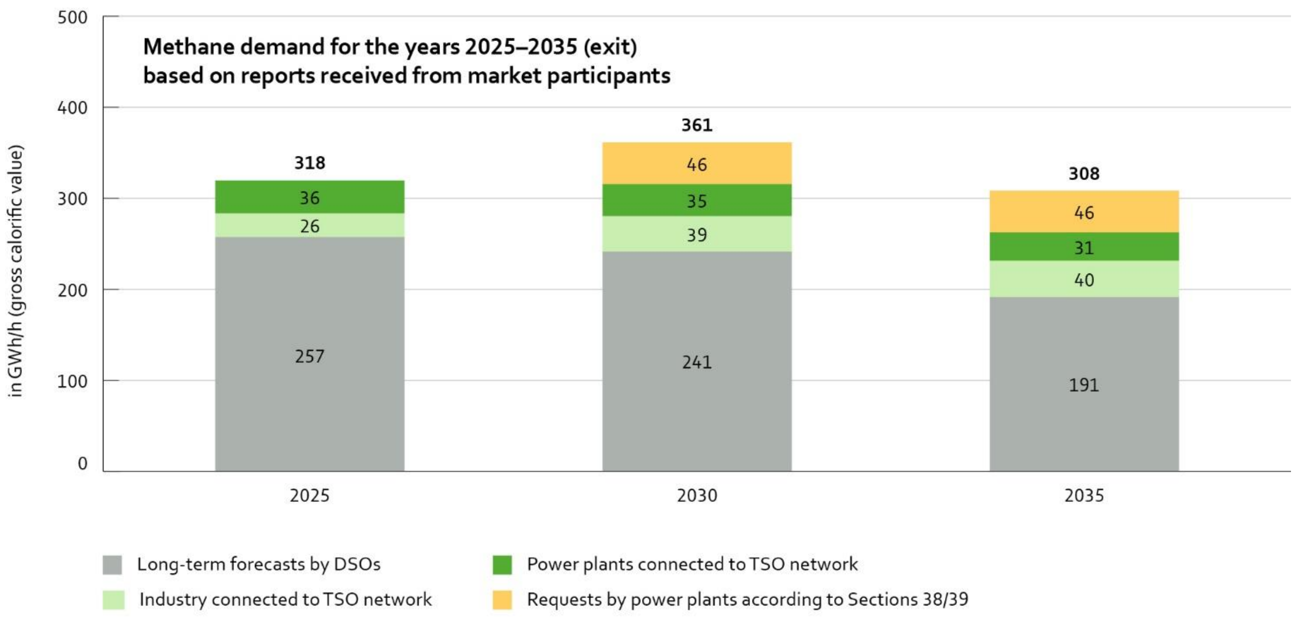
Source: Gas transmission system operators

According to the data provided by the distribution system operators, the methane capacity demand will fall by around 26 % during the period under review from 2025 to 2035. It should be noted that the decline in the long-term capacity requirements is to a large extent due to the assumed switch to hydrogen. The long-term forecasts for methane are detailed in the Gas NDP Database (Database Cycle "2025 - SR"). Based on the current capacity requirements reported by the distribution system operators, the distribution system operators' long-term forecast would have to decrease significantly more between 2036 and 2045 in order to achieve the statutory target of climate neutrality by 2045.

3.2.6 Summary of exit capacity requirements up until 2035 based on reported demand

The following figure is a summary of the demand reports comprising the DSOs' long-term forecasts (cf. chapter 3.2.5), the demand predicted by industrial customers and existing power plants connected to the gas transmission system (cf. chapter 3.2.4 and 3.2.2), and the connection requests from power plant operators to be taken into account pursuant to sections 38/39 GasNZV from 2025 to 2035 (cf. chapter 3.2.1.2).

Figure 11: Methane demand for the years 2025-2035 (exit) based on reports received from market participants



Source: Gas transmission system operators

The demand reports show a significant increase in capacity requirements by industrial customers and power plants connected to the gas transmission system. This compares with a decrease in demand from DSOs according to their long-term forecasts. As a result, there is an additional demand for exit capacity of around 35 GWh/h for 2030 compared to the LNGplus C modelling variant from the Gas Network Development Plan 2022-2032 with its capacity demand of 325 GWh/h for the gas year 2029/2030. The exit capacity at cross-border IPs of 59 GWh/h remains unchanged. As the entry infrastructures in the LNGplus C modelling variant were already exhausted in terms of capacity, incorporating the additional capacities could entail network expansion measures that would not be sustainable, as total demand in 2035 will again be below the demand of the LNGplus C modelling variant from the Gas Network Development Plan 2022-2032.

As part of the transformation of the energy system towards climate neutrality in 2045, many large consumers (e.g. industry, power plants) intend to switch to methane in the short to medium term in order to be able to use hydrogen in the long term. Based on the demand reports received, this will lead to an increased need for methane capacity, especially in the ramp-up phase of the hydrogen network. The discrepancy between the available demand reports and methane capacity requirements in climate-policy-oriented energy scenarios will be reduced by an appropriate selection of scenarios and modelling variants for the Gas and Hydrogen Network Development Plan 2025 (cf. chapter 4).

The difference between the methane demand reports shown and the overall expected continuous decline in methane demand up until 2045 illustrates the uncertainty surrounding the transformation process. Future developments, such as the creation of municipal heating plans, the approval of the hydrogen core network or the development of a global hydrogen market, will gradually provide clarity here. The existing uncertainties are currently leading to conservative methane demand forecasts by distribution system operators and industrial customers and therefore to major deviations compared to the assumptions of the climate policy-orientated energy scenarios. In some cases, it can be assumed that customers are also planning "dual connections" (methane and hydrogen) in order to keep their options open depending on external conditions. The uncertainties outlined above also have an impact on the Gas and Hydrogen Network Development Plan 2025. The gas transmission system operators are unable to resolve the conflict of objectives between demand reports and energy scenarios. The aim must rather be to reduce the uncertainties as quickly as possible. It is for politicians to ensure a stable, reliable and future-oriented statutory framework.

3.2.7 L-gas input variables

Following the description of current developments in L-gas (cf. chapter 3.2.7.1), this chapter presents the current gas production forecast for Germany (cf. chapter 3.2.7.2).

3.2.7.1 Current L-gas developments

The natural gas used in Germany is divided into L-gas and H-gas. L-gas ("low-calorific gas") has a lower gross calorific value. H-gas ("high-calorific gas") has a higher methane content and therefore a higher gross calorific value.

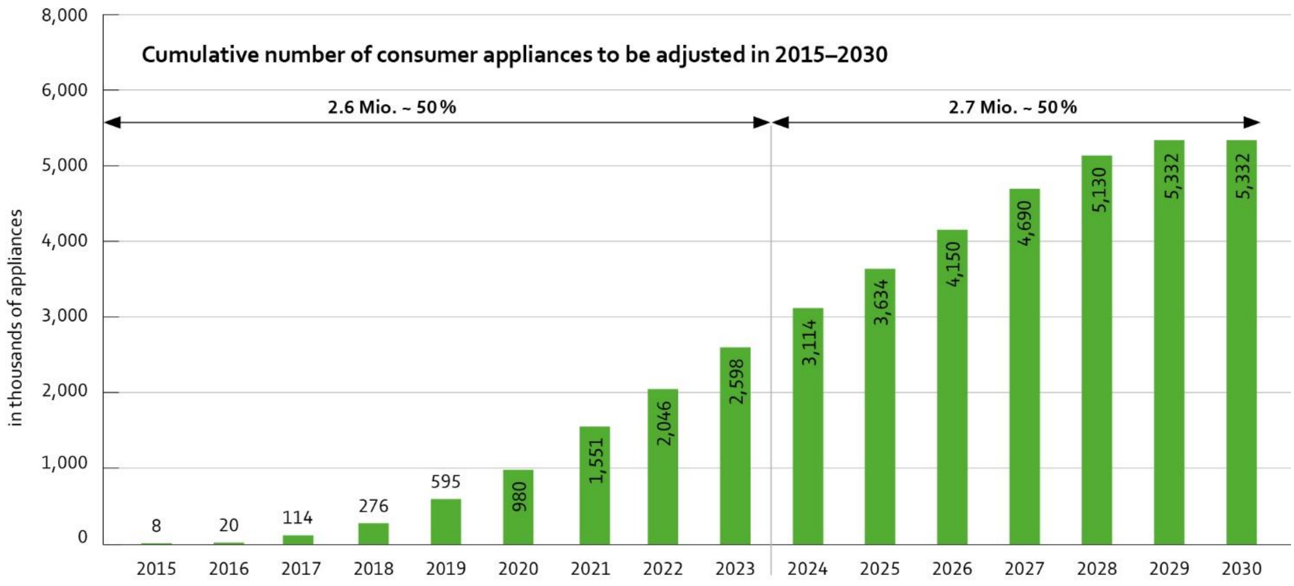
Part of the German gas market is supplied with L-gas. L-gas originates solely from German and Dutch gas fields. H-gas is mainly imported from Norway or shipped to Germany as LNG. For technical and calibration reasons, the two different methane qualities are transported within defined limits in separate pipeline systems. In network areas switched to a different quality, the end user appliances have to be adjusted to the other calorific value.

In recent years, an increasing number of earthquakes have occurred in the vicinity of the Groningen gas field in the Netherlands, which have been linked to methane production. These have led to considerable political pressure to end Groningen production as quickly as possible. In spring 2024, following significant reductions in production over recent years, a law was passed in the Netherlands that finally ended methane production from the Groningen field with immediate effect. L-gas transported to Germany now comes exclusively from conversion plants built in the Netherlands.

The German gas transmission system operators are in regular contact with the Dutch gas transmission system operator Gasunie Transport Services B.V. (GTS) in order to harmonise and update the planning assumptions for future L-gas imports. This exchange takes place both directly between the network operators and via the "Task Force Monitoring L-Gas Market Conversion", which was established on the initiative of the Dutch Ministry of Economic Affairs. This ensured that the German gas transmission system operators' planning assumptions regarding L-gas imports from the Netherlands were incorporated into the decision-making process for the termination of production in Groningen.

As described in chapter 3.2.7.2 , L-gas production in Germany is also declining. In order to counter the decline in domestic and foreign volumes, the transmission system operators are gradually converting the areas supplied with L-gas to H-gas. Since the start of the L-to-H-gas conversion in 2015, a total of 75 areas with a total of around 2.6 million end user appliances have been converted up until the end of 2023. This corresponds to around 50 % of the appliances to be converted by 2029. In total, the conversion volume achieved in Germany since 2015 corresponds to an annual consumption of around 139 TWh and a capacity of 40 GWh/h. In 2029, the conversion of the areas formerly supplied with L-gas will be almost complete. According to current plans, only the "Haanrade" conversion area, which is supplied via the Netherlands, is not scheduled for conversion by then.

Figure 12: Cumulative number of consumer appliances to be adjusted in 2015-2030



Source: Gas transmission system operators

The most recent update on the L-to-H-gas conversion was published by the transmission system operators on 23 April 2024 in their "Zwischenbericht L-H-Gas-Umstellung 2024". The next update is scheduled to be published as part of the Gas and Hydrogen Network Development Plan 2025.

3.2.7.2 Domestic production

The forecast for regional natural gas production in Germany up until 2045 is based on the current BVEG forecast (April 2024) for the two most important production regions of Elbe-Weser (excluding Altmark) and Weser-Ems (excluding East Frisia), as well as Germany as a whole. The following table shows the values of the BVEG baseline forecast 2024. The BVEG has also issued a "Forecast 2024 + Development", which includes development projects.

Table 12: Natural gas production forecast for 2024-2045 (BVEG baseline forecast)

Year	Elbe-Weser region (without Altmark, without development projects)		Weser-Ems region (excluding East Frisia, Großenkneten until 2030)			Germany as a whole (excluding development projects and Großenkneten until 2030)	
	Production L-gas	Capacity (8,000 h)	Production L-gas	Capacity (8,000 h) *	L- and H-gas production	Production	Capacity
	million m³	1,000 m³/h	million m³	1,000 m³/h	million m³	million m³	1,000 m³/h
2024	1,645	205	1,695	286	2,269	3,977	504
2025	1,576	197	1,695	286	2,254	3,873	490
2026	1,513	189	1,716	263	2,077	3,627	459
2027	1,401	175	1,535	250	1,971	3,407	431
2028	1,303	163	1,381	221	1,747	3,085	390
2029	1,193	149	1,242	197	1,555	2,782	352

Year	Elbe-Weser region (without Altmark, without development projects)		Weser-Ems region (excluding East Frisia, Großenkneten until 2030)			Germany as a whole (excluding development projects and Großenkneten until 2030)	
	Production L-gas	Capacity (8,000 h)	Production L-gas	Capacity (8,000 h) *	L- and H-gas production	Production	Capacity
	million m³	1,000 m³/h	million m³	1,000 m³/h	million m³	million m³	1,000 m³/h
2030	1,017	127	1.145	180	1,418	2,467	313
2031	905	113	337	43	472	1,285	161
2032	833	104	311	40	445	1,182	149
2033	763	95	281	36	416	1,081	136
2034	706	88	261	33	395	1,001	126
2035	652	81	240	31	376	924	116
2036	552	81	218	29	354	799	114
2037	375	53	197	26	314	599	83
2038	343	48	179	24	304	546	76
2039	314	44	163	22	274	499	69
2040	285	40	149	20	266	455	63
2041	255	36	138	18	241	412	57
2042	240	34	113	14	222	362	49
2043	201	28	106	14	203	316	42
2044	194	27	102	13	204	304	41
2045	188	26	99	13	186	296	40

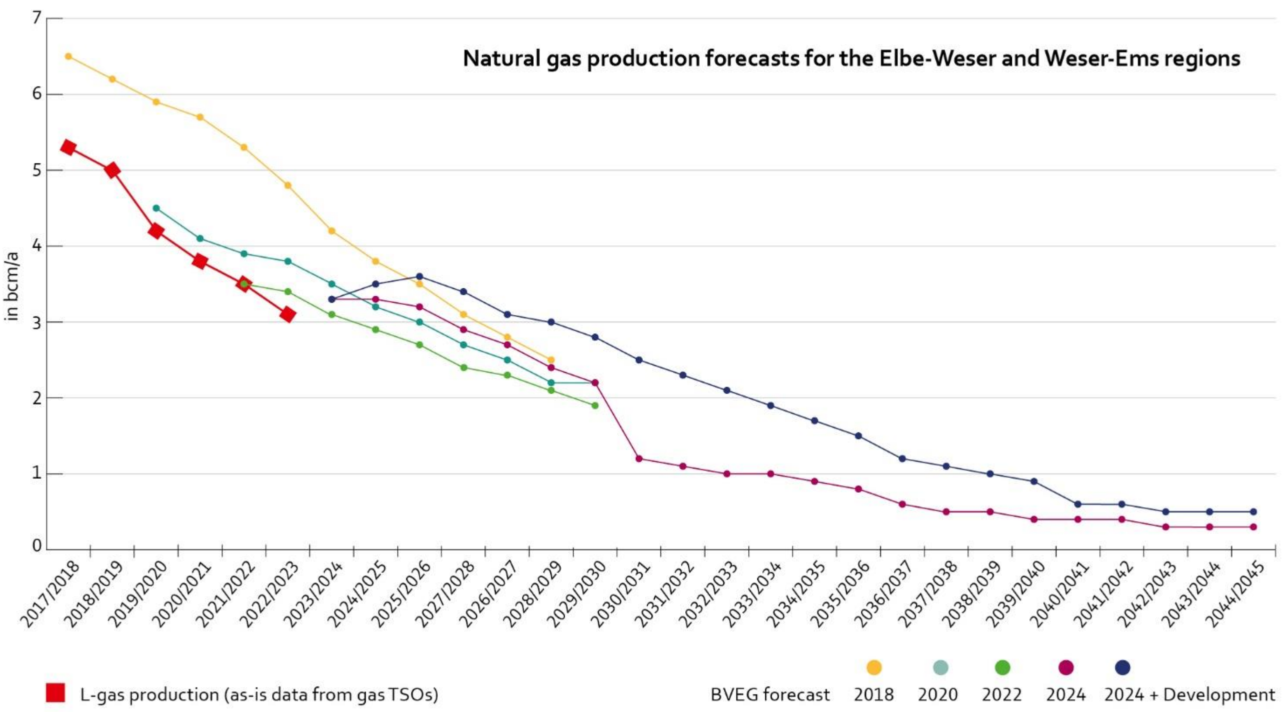
* Including Großenkneten in L-gas, full blending capacity Großenkneten

Source: Gas transmission system operators based on [BVEG 2024]

The information on production volumes and capacities is based on data from the BVEG. Outside the two most important production regions of Elbe-Weser (excluding Altmark) and Weser-Ems (excluding East Frisia), the volume of natural gas in Germany is low. The other production regions include "Zwischen Oder/Neiße und Elbe", "Nördlich der Elbe", "Westlich der Ems", "Thüringer Becken", "Oberrheintal" and "Alpenvorland". Future total gas production in these regions is calculated from the total German production minus the production volumes in the Elbe-Weser and Weser-Ems regions. In addition to the predicted production volumes up to and including 2045 shown here, German natural gas producers have also indicated a further development path for the provision of additional production volumes. However, given the significant deviations from the trajectories of the previous forecasts, further planning will be primarily based on normal path developments (baseline forecast).

Figure 13 shows the historical and forecast development of German L-gas production between 2018 and 2045 in the Elbe-Weser and Weser-Ems regions.

Figure 13: Natural gas production forecasts for the Elbe-Weser and Weser-Ems regions



Source: Gas transmission system operators based on [BVEG 2018-2024]

The figures for the two main production regions of Elbe-Weser and Weser-Ems for the period from 2018 to 2030 are based on BVEG's past forecasts. For the period from 2031 up to and including 2045, the gas producers have presented two forecast paths based on recent developments, which take account of factors such as the potential development of additional production sources. The "BVEG 2024 + Development" path includes potential production volumes from development projects and the continued operation of Großenkneten up to and including 2040, resulting in a significantly smaller decline in production volumes compared to the previous forecasts. By contrast, the standard forecast is based on the last BVEG forecast from 2023 until 2029 and shows a moderate downward trend thereafter.

The gas transmission system operators are analysing the effects of BVEG's new production forecast on the Germany-wide L-gas quantity balance as part of their modelling work for the Gas and Hydrogen Network Development Plan 2025. However, it appears conceivable at present that these developments predicted by BVEG could create challenges when it comes to transporting volumes produced, particularly with regard to blending with H-gas.

The transmission system operators have stated once again that the highest possible proportion of German production must be provided as L-gas up to and including 2029. Achieving this target is beyond the direct control of the gas transmission system operators. From their perspective, there is an urgent need for action to create appropriate instruments and market incentives. Moreover, as the L-to-H-gas conversion progresses, there are increasing seasonal challenges, as production volumes must be guaranteed in summer when system load is low, while in winter during peak load periods the production volumes alone are not sufficient to meet demand in some L-gas network areas.

With the end of the L-to-H-gas conversion in 2029, the German production volumes will be derived exclusively through blending in H-gas areas. The potential consideration of any additional volumes according to BVEG's "Forecast 2024 + Development" will be examined as part of the modelling work for the upcoming Gas and Hydrogen Network Development Plan 2025.

3.2.8 Biomethane injection

The as-is analysis and assessment of the development of biomethane injection was carried out using the current 2023 monitoring report published by the BNetzA and the Federal Cartel Office [BNetzA/BKartA 2023] and the biomethane injection atlas (*Einspeiseatlas zur Biomethaneinspeisung*) published by the Deutsche Energie-Agentur GmbH (dena) [dena 2023]. In 2022, a total of 238 plants fed around 10.2 TWh (net calorific value) of biomethane into the gas pipeline network each year.

Based on the biomethane injection atlas [dena 2023], the biomethane injection plants in service were grouped into regional clusters. The atlas also contains information on upgrading plants under construction or planned. For the future development of biomethane injection, it is assumed that these plants will be commissioned and that the capacity utilisation of biomethane plants will improve in the long term.

Digression on biomethane: interpretation of current developments

As regards the underlying assumptions for future biomethane injection, it should be noted that these were selected based on the preliminary anchor points of the system development strategy drawn up by the Federal Ministry for Economic Affairs and Climate Action. According to the strategy, it is unlikely that the injection and transportation of biomethane will go beyond connecting isolated solutions. Hence, injection and transportation will most likely not be part of long-term supra-regional transmission system planning. The reason provided here is that the system development strategy currently envisages a national generation capacity of ten TWh per year, which is based on the 2023 monitoring report [BNetzA/BKartA 2023] and information from the biomethane injection atlas [dena] from 2022. The sharp increase in injection requests at transmission and distribution network level from 2023 and Q1/2024 is not considered. According to the 2023 report for the gas network area transformation plan (GTP, p. 17/18) published by the German Technical and Scientific Association for Gas and Water (DVGW) [DVGW 2023], the distribution system operators received 233 injection requests for 2023, which, if they were to go ahead, would lead to an approximate doubling of the biomethane injection plants currently in service in Germany. The GTP numbers do not include injection requests at transmission system level.

The gas transmission system operators note that the biomethane injection assumptions made in the system development strategy are in stark contrast to the requirements of the REPowerEU plan and the amended European Union Internal Gas Market Directive and Regulation. According to clause 5 of the Commission Staff Working Document of 18 May 2022, the European Commission plans to deliver on the REPowerEU plan by increasing the sustainable production of biomethane to 35 billion m³ by 2030 and by promoting the modification and harmonisation of existing infrastructure as well as the development of new infrastructure for the transportation of more biomethane via the EU gas network. Moreover, according to the document, national strategies for sustainable biogas and biomethane production must be developed and utilised or incorporated into the National Energy and Climate Plans (NECP). In this regard, the transmission system operators note that Germany's updated NECP of 3 November 2023 (chapter 3.1.3, p. 16) [EC 2023a] does not include any steps to increase biomethane production and that, given the levels of methane consumption and the existing infrastructure, the European Commission issued recommendations to Germany on 18 December 2023 to incorporate into the NECP more detailed measures to promote the sustainable production of biomethane (see Commission Recommendation of 18 December 2023, point 8, p. 7) [EC 2023b]. Furthermore, according to Article 4 of the amended Internal Gas Market Regulation, the expansion of the use of renewable gas and low-carbon gas, in particular hydrogen and biomethane, in the EU energy system should be supported and promoted.

Based on the aforementioned developments at German and European level compared to the assumptions made in the system development strategy, the transmission system operators point out that there could be deviations for the resulting transformation paths. Given the need to ensure security of supply and planning reliability, the transmission system operators are required to take this into account appropriately.

3.2.9 Baseline data and developments for methane at cross-border interconnection points

Capacity development at the cross-border interconnection points (IPs) is decided by the transmission system operators as part of their network modelling.

The currently allocated and marketed capacities serve as a reference value for this exercise. These capacities based on the "sufficient level" (see chapter 3.2.11) at cross-border IPs are shown as "baseline data" in the "2025 - SR" cycle in the Gas NDP Database. Depending on the assumed development of the energy system in the various scenarios, the resulting balances and the expected development of the cross-border IPs, these capacities are (only) considered proportionately for the Gas and Hydrogen Network Development Plan 2025 in the respective scenarios or modelling variants. The expected developments, particularly in connection with the development of hydrogen capacities, are continuously reviewed in discussions with the neighbouring European gas transmission system operators.

3.2.10 Incremental capacity

Regulation (EU) 2017/459 (NC CAM) has been in force since 2017. It provides for a European process for new capacities to be created in the methane network (incremental capacity). This instrument is intended to incorporate the shippers' capacity requirements into a sustainable development of the gas transmission infrastructure as part of a market-based process. At present, there are no capacity requests from the incremental capacity process to be taken into consideration in the Gas and Hydrogen Network Development Plan 2025.

The process, which has been in place since 2017, is conducted at least every two years after the start of the annual yearly capacity auction with a non-binding market survey on the demand for additional cross-market area capacities. The gas transmission system operators then publish their market assessment report (cf. Article 26 NC CAM). If the required capacities can be provided without expansion, the process ends. Otherwise, the transmission system operators publish a draft of their project proposal to create the requested transmission capacity, including a technical study (cf. Article 27 NC CAM). After a public consultation, they then revise the draft document and submit the project proposal to the BNetzA for approval. Depending on this approval, offer levels with new capacity to be created are offered in the next annual auction (cf. Article 28 NC CAM). An economic test is carried out after the bookings. In this test, the BNetzA checks whether a project for incremental capacity will actually be realised. To this end, incremental capacity must have been booked to an extent that covers an appropriate portion of the expected investment costs (cf. Art. 22 NC CAM). As part of the 2021-2023 incremental capacity cycle, incremental entry and exit capacities were offered in the annual auction on 3 July 2023 for the following market area borders.

Table 13: Overview of the new entry and exit capacities offered in the annual auction on 3 July 2023

No.	Entry/exit from … to…	Capacity product	New capacity to be created [MWh/h]*	Realisation of the project [yes/no]
1	Entry Belgium - Germany	FAC	16,800	no

* In the annual auction, 10 % or 20 % of the technical capacity must be withheld for short-term marketing in accordance with BNetzA resolution BK7-15-001 (KARLA 1.1). It was therefore not possible to offer the entire new capacity to be created in the 2023 annual auction.

Source: Gas transmission system operators

The economic test was not successful, and accordingly no project will go ahead. For this reason, the non-binding capacity requests have not been considered for the Scenario Framework 2025. The documents for the 2021-2023 incremental capacity cycle have been published on the FNB website at www.fnb-gas-capacity.de.

The annual auction on 3 July 2023 marked the start of the incremental capacity cycle 2023-2025. No relevant non-binding market demand indications have been submitted for this incremental capacity cycle. The cycle has therefore already ended for the German gas transmission system operators.

3.2.11 Sufficient amount of freely assignable entry and exit capacity

In accordance with section 9 (1) and (2) GasNZV, the transmission system operators determine the freely allocable technical entry and exit capacities ("FAZK) for the Trading Hub Europe market area. Paragraph 3 of section 9 GasNZV in conjunction with the BNetzA decision "BK7-23-043 – Determination on the recognition of instruments for capacity increase ANIKA" makes provisions in the event that the determination of the FZK does not lead to a sufficient result.

Operative part 2 of the ANIKA decision stipulates that the sufficient level of FZK must be derived from the current market-area-wide long-term capacity demand, which the transmission system operators determine as part of their network development planning procedure in accordance with section 17 GasNZV. Prior to the 2024 annual auction, the transmission system operators determined the sufficient level of FZK for H-gas on the basis of the findings of the Gas Network Development Plan 2022-2032, modelling variant LNGplus C and changes that have occurred in particular since the Gas Network Development Plan 2022-2032 was drawn up.

The long-term L-gas demand is determined only as part of the market area conversion due to the forthcoming termination of L-gas supplies. The use of capacity-increasing instruments is not planned.

In the Gas and Hydrogen Network Development Plan 2025, the following criteria are used to determine the future sufficient level of FZK for H-gas:

1. The expected development of the relationship between methane supply and demand (cf. section 17 (1) GasNZV) is derived from the scenarios in chapter 4 and will be evident from the long-term H-gas capacity balance to be drawn up. Capacity shortfalls that only occur for a few years will not lead to a long-term capacity demand.
2. The annual auctions on 3 July 2023 marked the start of the 2023-2025 incremental capacity cycle, which asked about the long-term binding capacity requirements of network users covered by the scope of Regulation (EU) 2017/459 NC-CAM (see section 17 (2) GasNZV). No relevant non-binding market demand was submitted for this incremental capacity cycle. The cycle has therefore already ended for the German gas transmission system operators. The request has no influence on the sufficient level of FZK.
3. The findings from load flow simulations in accordance with section 9 (2) sentence 1 GasNZV (see section 17 (3) GasNZV) and about existing or forecast congestion (see section 17 (4) GasNZV) in the network are generated by modelling the gas transmission network in the Gas and Hydrogen Network Development Plan 2025 and are included in the H-gas capacity balance. If the congestion is permanent and is not resolved by network expansion measures or by capacity production in accordance with KASPAR, load flow commitments or MBI, it can have a negative impact on the long-term supply of FZK.

4. The result of the annual auction for capacities in accordance with NC CAM (see section 17 (5) GasNZV) will be available in July 2024. While in previous years only firm incremental capacities were offered for one year in the annual auctions in accordance with the KAP+ procedure, firm technical capacities for at least five years will be offered in 2024 in accordance with the decision on the recognition of instruments to increase capacity (*Anerkennung von Instrumenten zur Kapazitätserhöhung* – ANIKA). The past auctions are therefore not meaningful for reviewing the long-term capacity requirements. If auction premiums for long-term capacities are achieved at entry or exit points in 2024, the Gas and Hydrogen Network Development Plan 2025 must examine whether these requirements trigger a long-term capacity demand or whether they can be satisfied by market-based instruments, relocations or similar.
5. The transmission system operators review findings from denial of network access in accordance with section 25 sentences 1 and 2 EnWG (cf. section 17 (6) GasNZV) on a regular basis as part of the Gas and Hydrogen Network Development Plan 2025.
6. The possibilities for increasing capacity through cooperation with neighbouring transmission or distribution system operators (cf. section 17 (7) GasNZV) are reviewed on a regular basis in the Gas and Hydrogen Network Development Plan 2025.
7. The market area merger took place in 2021 (see section 17 (8) GasNZV). No further mergers are planned.
8. The findings from the TYNDP 2025 for necessary capacities at cross-border IPs (cf. section 17 (9) GasNZV) will be taken into consideration for the long-term capacity demand after consultation with the foreign TSOs concerned and included in the H-gas capacity balance.
9. Existing and rejected capacity reservations pursuant to section 38 GasNZV and corresponding connection requests pursuant to section 39 GasNZV (cf. section 17 (10) GasNZV) are presented in chapter 3.2.1 .

The BNetzA expressly points out in paragraph 58 of its justification for the ANIKA decision that "due to the statutory decarbonisation target and the associated lower remaining useful lives of tangible assets in gas transportation, any newbuild projects in the methane network must be examined to determine whether they are compatible with the objectives of the EnWG". Therefore, the transmission system operators will examine as part of their Gas and Hydrogen Network Development Plan 2025 whether parts of the sufficient level of FZK or the long-term capacity requirements according to section 17 GasNZV can be provided by capacities restricted in their use. Adjusting the congestion zones for the MBI may also be an option.

3.3 Input variables for hydrogen network

Chapter 3.3.1 below presents the results of the first joint electricity and hydrogen market survey conducted by the electricity and gas transmission system operators in early 2024 for projects in connection with the hydrogen network. These include in particular reported entry and exit capacity projects, hydrogen storage facilities and power-to-gas plants (water electrolysis only). The Hydrogen Production and Demand – HPD (*"Wasserstoff Erzeugung und Bedarf – WEB")* market survey is used to record project-related demand for hydrogen for which a network connection request has already been submitted, demand has been registered or at least discussions have been held with the project developer. Chapter 3.3.2 provides information on hydrogen volume and capacity requirements that were provided by distribution system operators as part of their long-term forecasts, which go beyond the HPD survey conducted by the gas transmission system operators. The long-term forecast is therefore intended to allow the reporting of additional, prospective demand for which there may not yet be any concrete project agreements, e.g. due to outstanding or only recently started heat planning by municipalities. Chapter 3.3.3 presents the baseline data and possible developments for hydrogen at cross-border IPs, including "baseline capacities" for hydrogen at cross-border IPs to neighbouring European countries.

3.3.1 Results of market survey for hydrogen projects 2024 (including PtG plants)

This chapter presents the results of the first joint electricity and hydrogen market survey conducted by the electricity and hydrogen transmission system operators for hydrogen projects including power-to-gas plants (PtG). This survey was conducted from 7 February 2024 to 22 March 2024. The aim of the survey was to collect up-to-date information on projects already underway as well as future plans for hydrogen production (including PtG plants), storage and use as well as the electricity consumption by large-scale consumers (including large-scale battery storage), market participants and distribution system operators (DSOs).

A total of 1,731 project notifications (plus PtG plants) were received in the market survey for hydrogen projects (HPD survey) in the "2024" cycle. Following the 22 March 2024 deadline, the reports received for hydrogen were subjected to a plausibility check by the transmission system operators for quality assurance purposes. A hydrogen project can be considered for the further NDP process if all of the information required for a connection to the hydrogen transmission network has been submitted by the project owner and the gas transmission system operators have checked the information for plausibility. In this way, the gas transmission system operators identified a total of 131 hydrogen projects that could not be considered in the Scenario Framework for the Gas and Hydrogen Network Development Plan 2025, as they were neither fully recorded in a plausible way nor corrected by the project owners at the request of the gas transmission system operators. In addition, duplicate reports were not considered. This means that some 1,600 plausible hydrogen projects have currently been reported for the Scenario Framework 2025 (36 projects (w/o PtG plants) requiring entry capacities, 1,534 requiring exit capacities and 30 hydrogen storage projects). These results are presented in Annex 2.

In all, over 300 projects were reported to the electricity and gas transmission system operators as part of the PtG projects survey. Two of the reported PtG projects were identified as incorrect, as the reported electrical capacity was in the three-digit GW range. With regard to further plausibility checks and the use of the survey results, the transmission system operators are in continuous dialogue with the electricity transmission system operators in order to draw up a joint list of PtG plants.

The following two tables each show the total number of entry (including power-to-gas plants), exit and hydrogen storage projects reported – initially aggregated by federal state, with terminals and blue hydrogen etc. listed in the "Other" column.

Table 14: Reported projects by category and federal state

Federal state [number]	Exit	Entry		Storage facilities	Total
		Power-to-gas plants	Other		
Baden-Württemberg	145	14	1	---	**160**
Bavaria	282	27	4	4	**317**
Berlin	8	1	---	---	**9**
Brandenburg	41	28	1	2	**72**
Bremen	1	3	1	1	**6**
Hamburg	14	4	2	---	**20**
Hesse	151	5	---	1	**157**
Mecklenburg-Western Pomerania	9	32	4	---	**45**
Lower Saxony	106	54	10	11	**181**
North Rhine-Westphalia	473	50	7	5	**535**
Rhineland-Palatinate	66	7	---	---	**73**

Federal state [number]	Exit	Entry		Storage facilities	Total
		Power-to-gas plants	Other		
Saarland	17	4	---	---	**21**
Saxony	105	12	2	1	**120**
Saxony-Anhalt	29	29	2	3	**63**
Schleswig-Holstein	14	18	2	1	**35**
Thuringia	73	10	---	1	**84**
Total	**1,534**	**298**	**36**	**30**	**1,898**

Source: Gas transmission system operators based on the hydrogen and electricity market survey

In addition, all project reports are listed below, categorised according to their status.

Table 15: Reported projects by category and project status

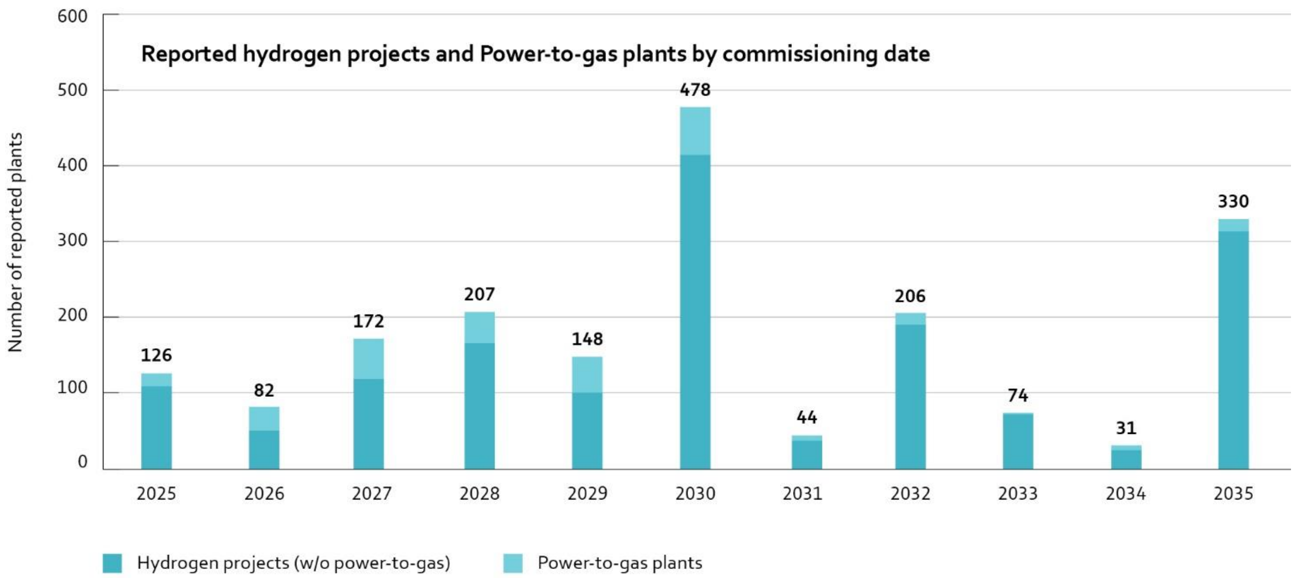
Project status [Number]	Exit	Entry		Storage facilities	Total
		Power-to-gas plants	Other		
Project idea	834	99	8	7	**948**
Basic evaluation / feasibility study	563	104	15	9	**691**
Basic design / regional planning procedure	58	49	6	7	**120**
Detailed design / approval procedure	37	32	6	5	**80**
Procurement / project preparation / assembly / construction	23	9	---	2	**34**
Commissioning / project completion / finalisation	19	5	1	---	**25**
Total	**1,534**	**298**	**36**	**30**	**1,898**
thereof FID	64	10	2	---	**76**

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The results for hydrogen are aggregated and categorised in the following maps, diagrams and tables for the years 2025 to 2035. They have also been anonymised so that no conclusions can be drawn about individual projects or project locations from the total of 1,898 project reports evaluated. Annex 2 to the Scenario Framework document also contains detailed tables, including information on the federal state for the respective project as a site allocation. Detailed information on individual project notifications is presented in Annex 2 in anonymised form.

The following figure shows the hydrogen and power-to-gas projects scheduled to be commissioned in each year. The highest number of projects is expected to be commissioned in 2030 (478 projects) and in 2035 (330 projects).

Figure 14: Reported hydrogen projects and Power-to-gas plants by commissioning date



Commissioning year [number of projects]	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total
Hydrogen projects (w/o PtG)	109	51	119	166	101	415	37	191	72	25	314	**1,600**
Power-to-gas plants	17	31	53	41	47	63	7	15	2	6	16	**298**
Total	**126**	**82**	**172**	**207**	**148**	**478**	**44**	**206**	**74**	**31**	**330**	**1,898**

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The results of the market survey are analysed as a whole according to the categories of entry capacity, exit capacity or hydrogen storage. In addition, individual sectors are also analysed in terms of exit capacity and their regional distribution across districts or federal states and project status. All data was recorded in relation to the gross calorific value of hydrogen (3.54 kWh/m³).

The following table shows an overview of the reported projects for entry and exit capacity (including power-to-gas plants).

Table 16: Project notifications for hydrogen and power-to-gas plants by entry and exit capacities and volumes

Total (gross calorific value)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
H2 entry capacity (incl. PtG) [GWh/h]	0.2	1.0	4.7	10.3	21.3	38.1	45.5	71.2	73.9	77.6	94.0
H2 exit capacity [GWh/h]	0.9	2.5	4.2	9.2	17.9	42.6	50.5	71.2	89.8	97.7	162.3
H2 entry volume per year (incl. PtG) [TWh]	0.7	5.7	23.0	59.5	126.9	233.1	283.3	314.7	330.1	350.5	449.2
H2 exit volume per year [TWh]	4.4	8.1	16.0	43.7	72.0	146.1	176.2	245.4	293.0	321.6	535.0

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The following table shows the hydrogen entry capacities and volumes through import terminals and production plants using various processes, such as ammonia cracking, vapour reforming, plasmalysis or pyrolysis (w/o power-to-gas plants).

Table 17: Hydrogen entry capacities and volumes of import terminals and production facilities (w/o power-to-gas plants)

Entry (gross calorific value)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
H2 entry capacity [GWh/h]	---	0.1	0.3	2.6	5.8	10.6	12.6	13.2	13.8	14.8	21.4
H2 entry volume per year [TWh]	---	1.3	2.3	20.5	45.9	82.6	101.1	105.6	110.5	117.2	171.3

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The following table shows the hydrogen entry capacities and volumes of the PtG plants as well as the total electrical capacity and electrical energy demand of the power-to-gas plants.

Table 18: Evaluation of data for the reported power-to-gas plants

Power-to-gas plants (gross calorific value)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Electrical capacity [GW_e]	0.5	2.3	8.8	17.7	32.6	52.2	61.6	70.3	73.4	77.8	92.2
Electrical energy demand per year [TWh]	1.5	6.6	37.0	79.7	152.3	256.1	309.7	344.6	345.8	390.0	454.7
H2 entry capacity [GWh/h]	0.2	0.9	4.4	7.7	15.5	27.4	32.9	57.9	60.1	62.8	72.6
H2 entry volume per year [TWh]	0.7	4.4	20.7	39.0	80.9	150.5	182.1	209.1	219.6	233.3	277.9

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The following table shows the hydrogen exit capacities and volumes for the years 2025 to 2035 as well as any associated reduction in methane exit capacity and volume. Around 66 % of the hydrogen project reports included information on methane capacity and volume reductions.

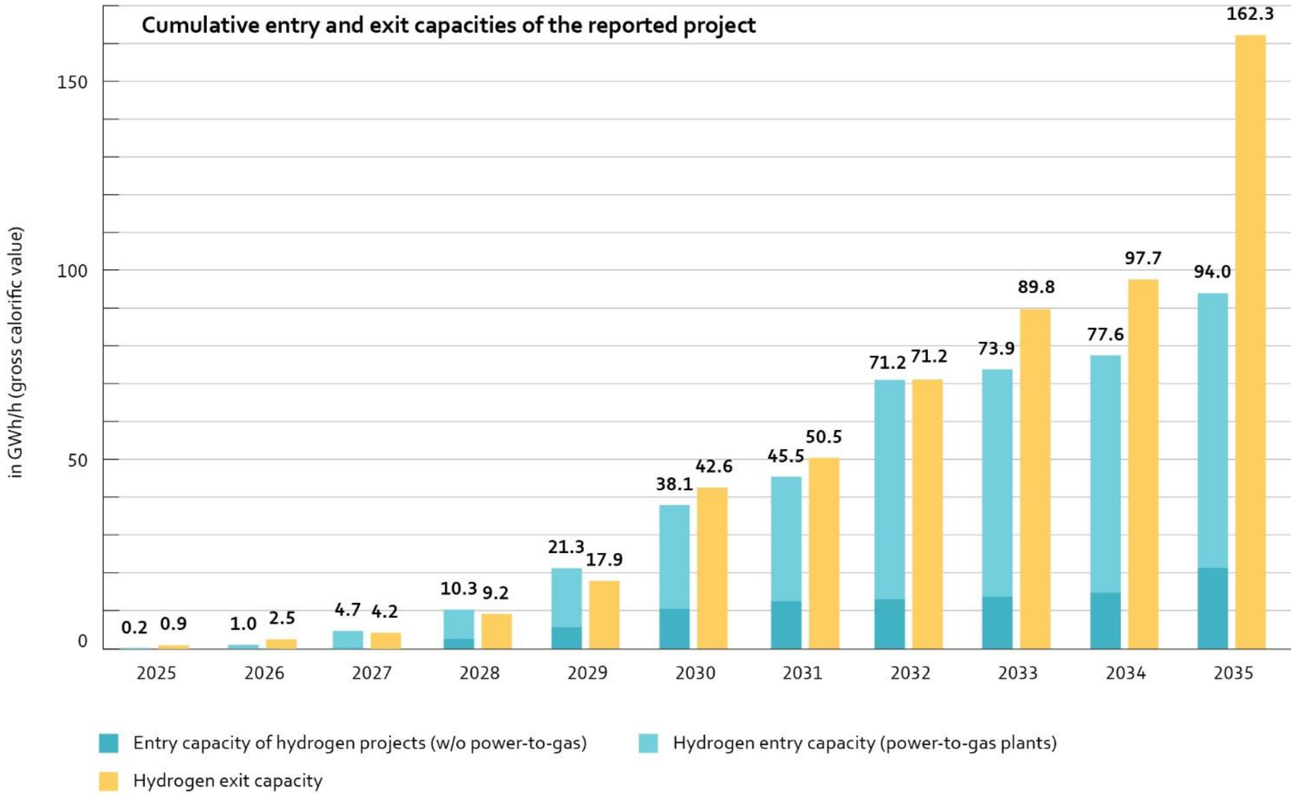
Table 19: Hydrogen exit capacities and volumes for the years 2025 to 2035

Total exit (gross calorific value)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
H2 exit capacity [GWh/h]	0.9	2.5	4.2	9.2	17.9	42.6	50.5	71.2	89.8	97.7	162.3
CH4 exit capacity reduction [GWh/h]	0.5	0.7	1.9	3.6	4.5	19.7	21.0	29.7	34.6	37.9	70.1
H2 export volume per year [TWh]	4.4	8.1	16.0	43.7	72.0	146.1	176.2	245.4	293.0	321.6	535.0
CH4 exit volume reduction per year [TWh]	2.1	3.0	8.5	14.7	19.3	49.2	55.6	86.4	102.7	112.7	180.6

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The following figure summarises the reported entry and exit capacities.

Figure 15: Cumulative entry and exit capacities of the reported projects



Cumulated entry and exit capacity	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
H2 entry capacity [GWh/h]	0.2	1.0	4.7	10.3	21.3	38.1	45.5	71.2	73.9	77.6	94.0
of which hydrogen projects (w/o PtG)	---	0.1	0.3	2.6	5.8	10.6	12.6	13.2	13.8	14.8	21.4
of which power-to-gas plants	0.2	0.9	4.4	7.7	15.5	27.4	32.9	57.9	60.1	62.8	72.6
H2 exit capacity [GWh/h]	0.9	2.5	4.2	9.2	17.9	42.6	50.5	71.2	89.8	97.7	162.3

Source: Gas transmission system operators based on the hydrogen and electricity market survey

Based on the additional information provided with the reported projects, the hydrogen exit capacities and volumes as well as the reported reduction in methane exit capacities and volumes can be broken down into the four sectors of industry, transport, power plants and tertiary sector, whereby it was possible for a project to be assigned to several sectors by the project reporters. The power plants and industry sectors in particular account for the majority of the exit capacities and volumes (over 90 %).

The four tables below show the breakdown by sector: industry, transport, power plants, and trade, commerce & services.

The following table shows the hydrogen exit capacities and volumes for the industrial sector.

Table 20: Hydrogen exit capacities and volumes for the industrial sector

Exit capacities & volumes for industrial sector (gcv)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hydrogen exit capacity [GWh/h]	0.8	2.3	3.5	7.6	11.5	20.9	23.6	28.6	34.1	36.3	48.8
Hydrogen exit volume per year [TWh]	4.0	7.5	14.5	38.5	56.3	94.8	113.4	139.6	160.9	178.5	242.2
Reduced methane exit capacity [GWh/h]	0.3	0.5	1.4	2.7	3.6	8.8	9.6	11.4	12.8	13.7	19.2
Reduced methane exit volume per year [TWh]	1.3	2.2	7.1	12.1	16.5	32.3	36.5	44.8	50.8	55.1	76.3

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The industrial sector accounts for around 25 % of the total hydrogen exit capacity. In terms of total exit volumes, the reported hydrogen demand is around 35 % of total consumption.

The following table shows the hydrogen exit capacities and volumes for the transport sector.

Table 21: Hydrogen exit capacities and volumes for the transport sector

Exit capacities & volumes for transport sector (gcv)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hydrogen exit capacity [GWh/h]	0.0	0.0	0.1	0.3	4.0	4.1	4.1	4.2	4.2	4.3	4.9
Hydrogen exit volume per year [TWh]	0.1	0.2	0.5	0.7	12.5	12.7	12.8	12.9	13.0	13.1	15.5
Reduced methane exit capacity [GWh/h]	0.0	0.0	0.0	0.1	0.5	0.5	0.5	0.5	0.5	0.5	0.7
Reduced methane exit volume per year [TWh]	0.0	0.0	0.0	0.2	2.6	2.6	2.6	2.6	2.7	2.7	3.4

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The transport sector's share of the total hydrogen exit capacity is around 2 % to 3 %. In terms of total exit volumes, the reported hydrogen demand is around 2 % to 3 % of total consumption.

The following table shows the hydrogen exit capacities and volumes for the trade, commerce & services sector.

Table 22: Hydrogen exit capacities and volumes for the trade, commerce & services sector

Exit capacities & volumes for trade, commerce & services sector (gcv)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hydrogen exit capacity [GWh/h]	0.0	0.1	0.2	0.6	1.7	2.9	3.2	3.5	3.8	3.8	4.9
Hydrogen exit volume per year [TWh]	0.2	0.3	1.0	2.4	7.5	10.7	12.5	13.7	14.6	14.6	17.7
Reduced methane exit capacity [GWh/h]	0.0	0.1	0.1	0.4	0.8	1.6	1.6	1.7	2.0	2.0	2.8
Reduced methane exit volume per year [TWh]	0.1	0.3	0.5	1.0	3.3	4.8	4.8	5.3	6.2	6.2	8.1

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The trade, commerce & services sector's share of the total hydrogen exit capacity in 2035 is around 2 % to 3 %. In terms of total exit volumes, the reported hydrogen demand is around 2 % to 3 % of total consumption.

The following table shows the hydrogen exit capacities and volumes for the power plant sector.

Table 23: Hydrogen exit capacities and volumes for the power plant sector

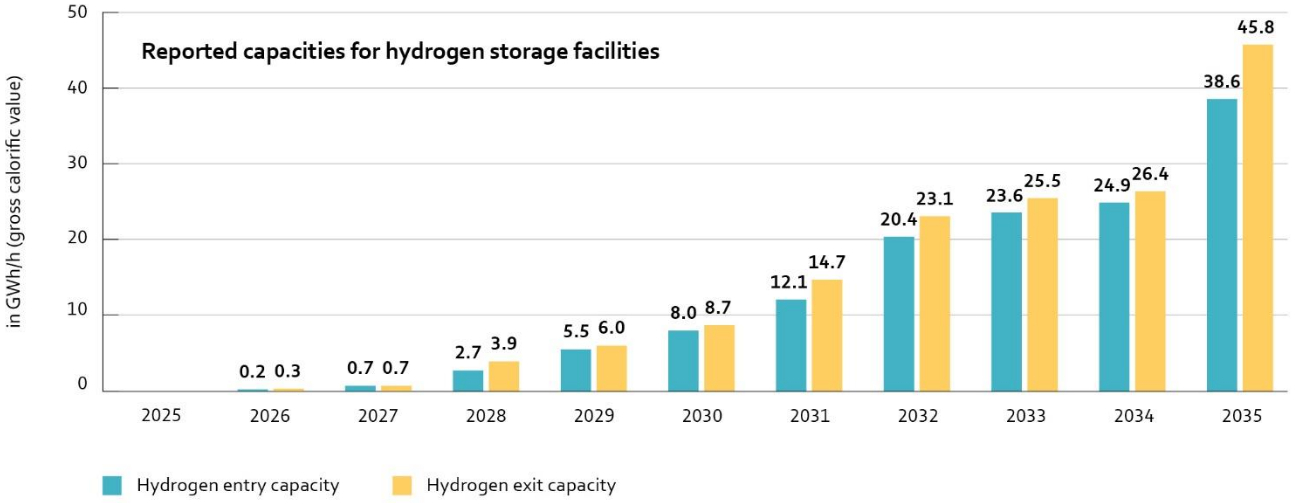
Exit capacities & volumes for power plant sector (gcv)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hydrogen exit capacity [GWh/h]	0.2	0.5	0.9	2.0	4.3	20.5	25.9	42.0	57.0	63.1	118.0
Hydrogen exit volume per year [TWh]	0.6	2.0	2.8	8.0	12.9	54.0	67.3	111.2	143.8	156.6	320.2
Reduced methane exit capacity [GWh/h]	0.2	0.3	0.8	1.3	1.6	12.4	13.3	20.5	24.4	27.1	55.7
Reduced methane exit volume per year [TWh]	1.0	1.7	2.4	4.8	6.3	25.0	29.0	52.4	64.7	71.3	123.5

Source: Gas transmission system operators based on the hydrogen and electricity market survey

The power plant sector's share of the total hydrogen exit capacity in 2035 is around 70 %. In terms of total exit volumes, the reported hydrogen demand is around 60 % of total consumption. These are plants used for producing electricity or heat as well as combined heat and power plants (CHP plants). This means that the CHP plants that are particularly relevant for the energy transition have also been included. They account for 242 of the 413 power plant notifications with a hydrogen exit capacity of 40 % to around 50 % of the total capacity of the power plants in each of the years up to 2035.

The following tables and figures show the total entry and exit capacities and the working gas volumes (WGV) of the future hydrogen storage projects reported as an annual development for the years 2025 to 2035.

Figure 16: Reported capacities for hydrogen storage facilities

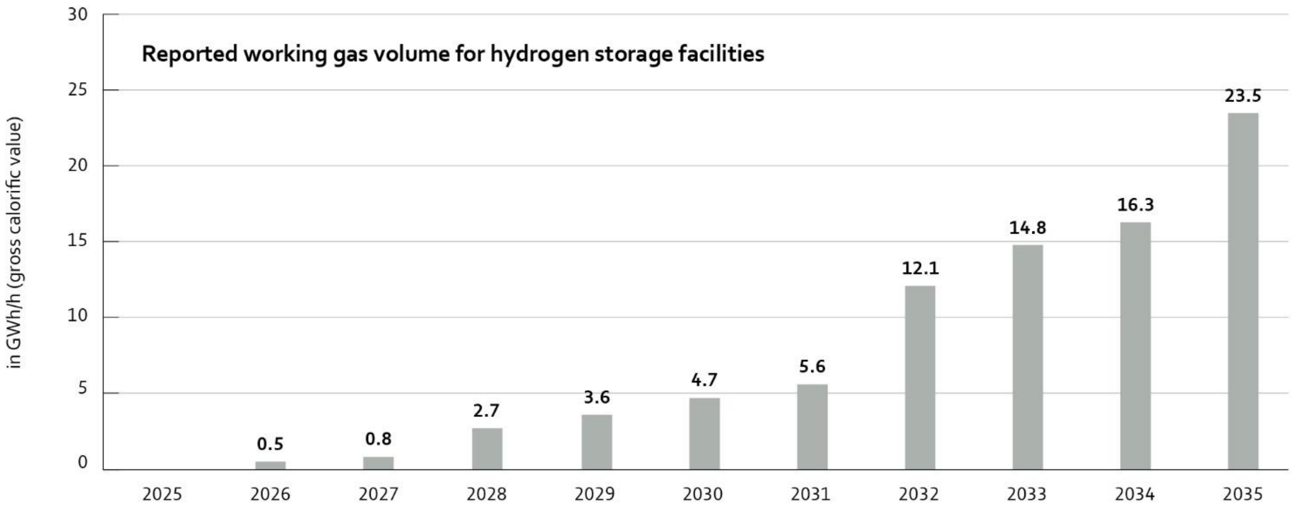


H2 storage capacities (gcv)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Hydrogen entry capacity [GWh/h]*	---	0.2	0.7	2.7	5.5	8.0	12.1	20.4	23.6	24.9	38.6
Hydrogen exit capacity [GWh/h]*	---	0.3	0.7	3.9	6.0	8.7	14.7	23.1	25.5	26.4	45.8

* "Hydrogen entry capacity" corresponds to withdrawal from storage into the hydrogen pipeline system and "Hydrogen exit capacity" corresponds to injection from the hydrogen pipeline system into storage

Source: Gas transmission system operators based on the hydrogen and electricity market survey

Figure 17: Reported working gas volume for hydrogen storage facilities

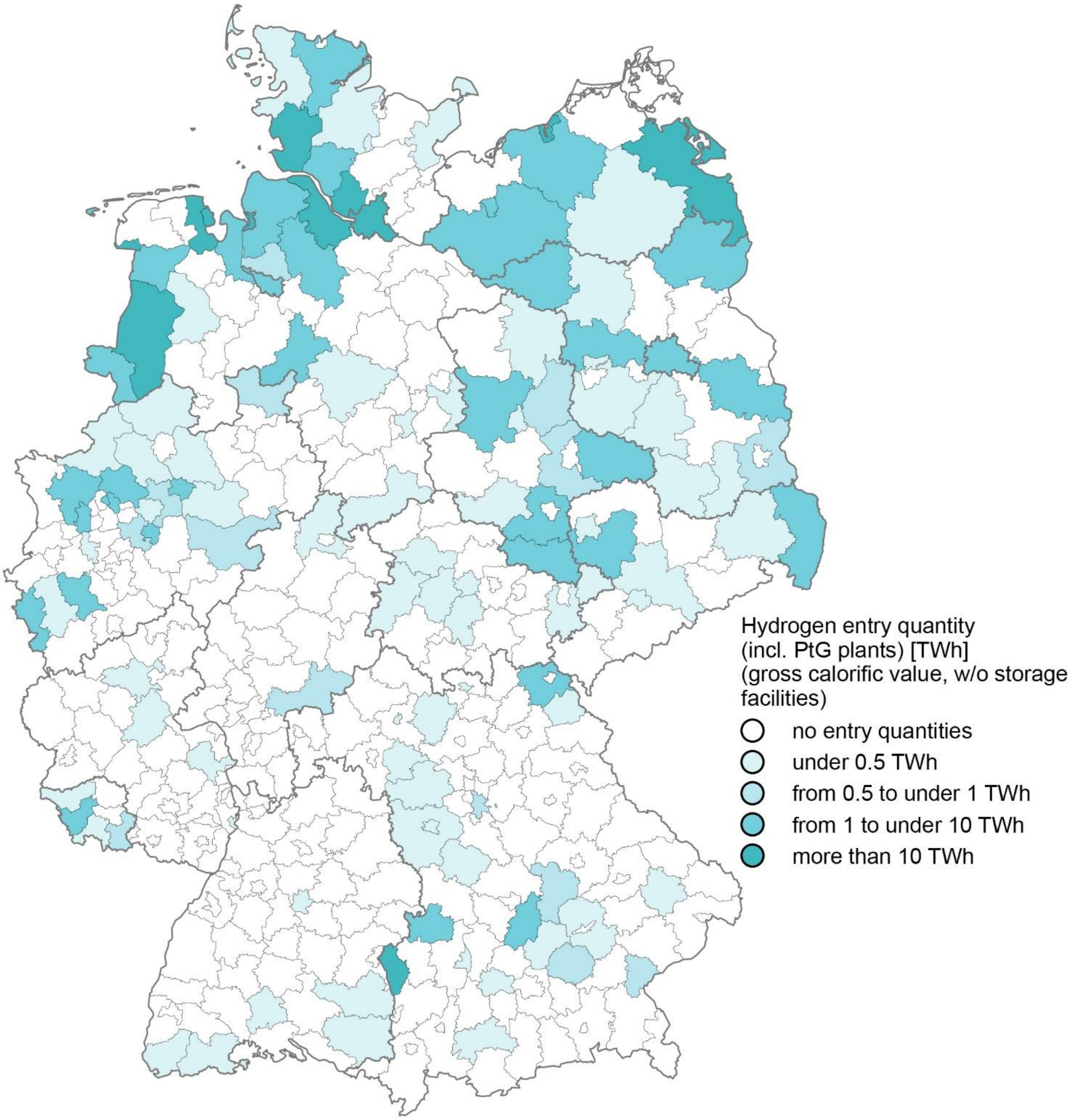


Working gas volume of hydrogen storage facilities (gcv)	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
H2 working gas volume [TWh]	---	0.5	0.8	2.7	3.6	4.7	5.6	12.1	14.8	16.3	23.5

Source: Gas transmission system operators based on the hydrogen and electricity market survey

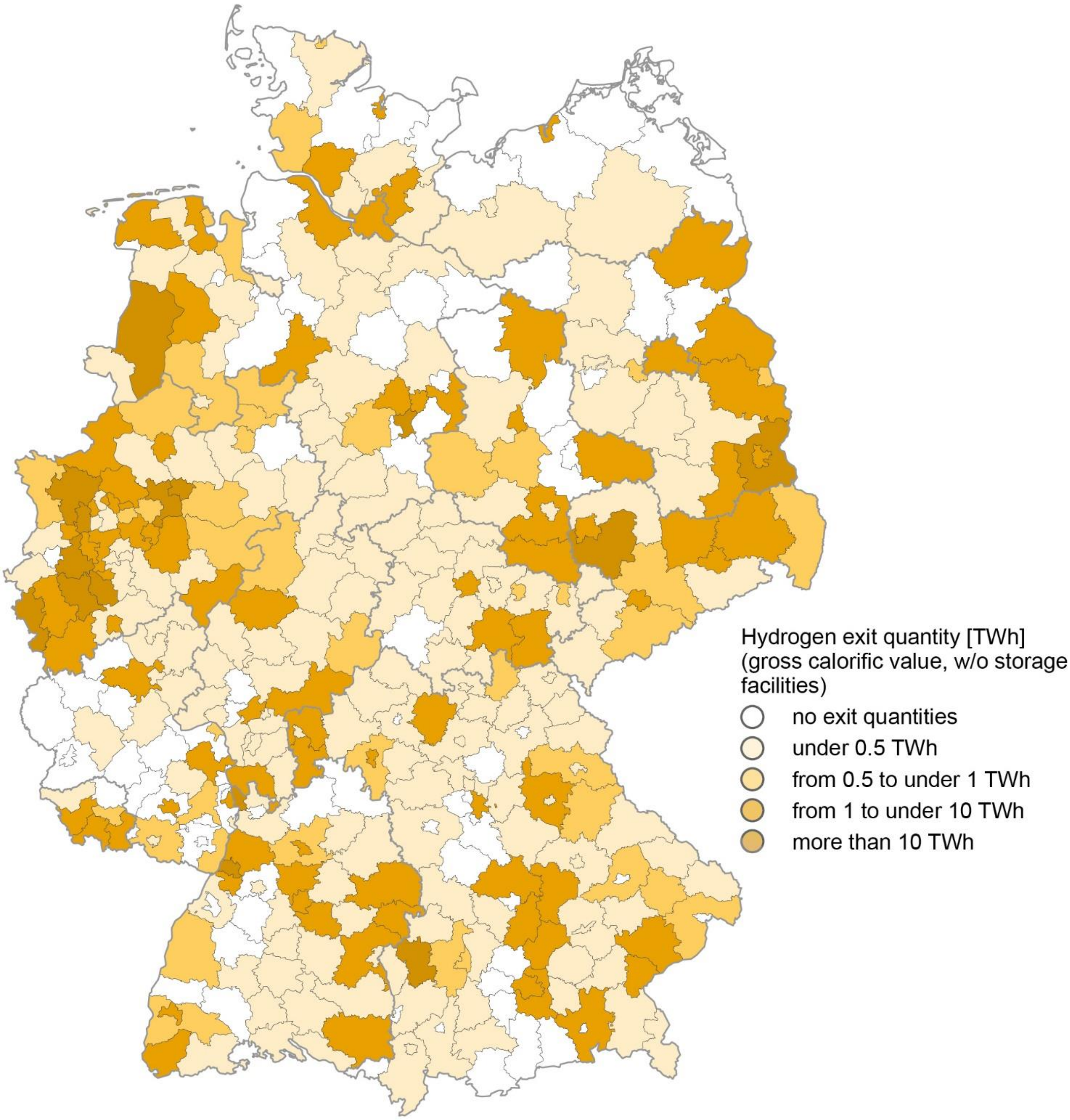
The map below shows all projects reported in the market survey for hydrogen and power-to-gas plants at district level. The following figures thus show the regional distribution of the reported hydrogen projects for 2035 (reported entry and exit volumes as well as working gas volumes of the storage facilities).

Figure 18: Regional distribution of entry volumes in 2035



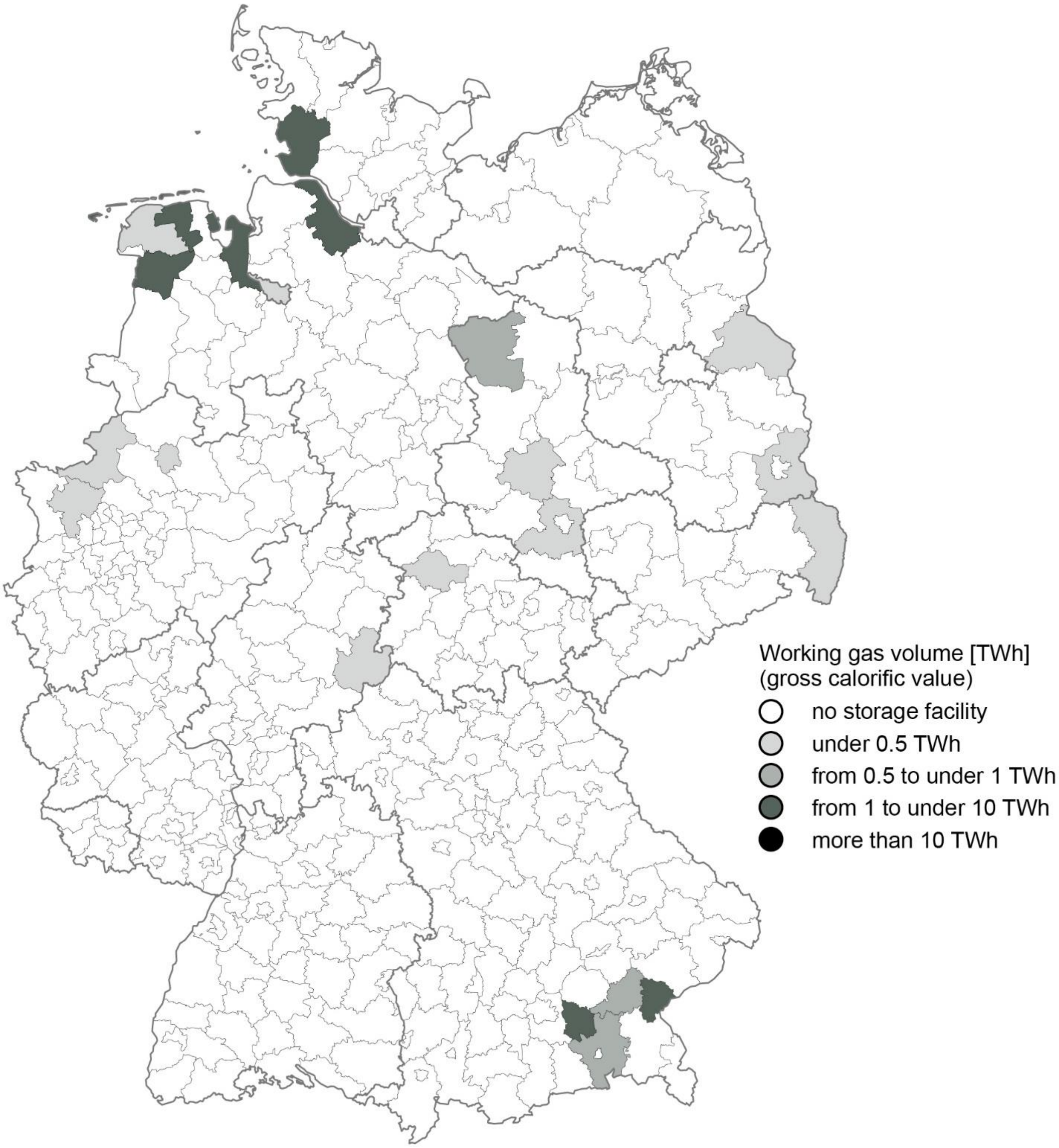
Source: Gas transmission system operators based on the hydrogen and electricity market survey

Figure 19: Regional distribution of exit volumes in 2035



Source: Gas transmission system operators based on the hydrogen and electricity market survey

Figure 20: Regional distribution of the reported working gas volumes of storage facilities in 2035



Source: Gas transmission system operators based on the hydrogen and electricity market survey

The gas transmission system operators are very grateful to the project owners for participating in the Germany-wide electricity and hydrogen infrastructure survey and for continuing to provide information on their hydrogen projects. The joint market survey by the electricity and gas transmission system operators has shown a continued high level of interest from the market in the development of a hydrogen economy and the associated pipeline-based infrastructure required.

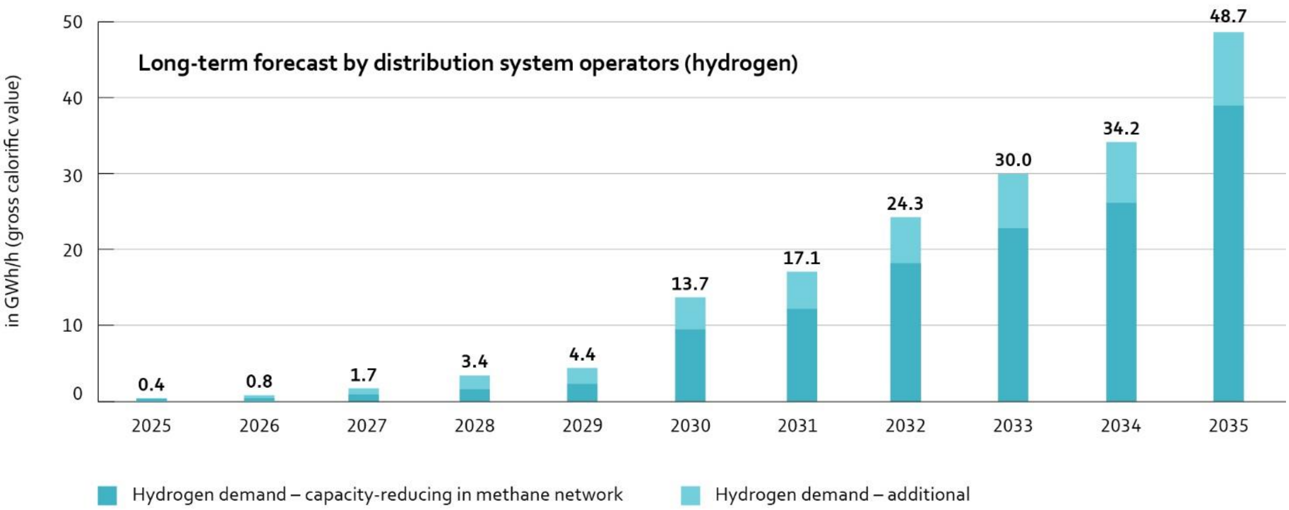
3.3.2 Long-term forecast of hydrogen capacity requirements by distribution system operators

In order to be able to include the distribution system operators' most recent hydrogen capacity requirements into their network development planning process even before the revised Cooperation Agreement (KoV) comes into force, the gas transmission system operators conducted a survey on hydrogen capacity and volume requirements predicted for 2025-2035, including their impact on methane capacity requirements.

The distribution system operators were asked to specify their long-term requirements over and above the demand already reported as part of the gas transmission system operators' market survey for hydrogen projects (HPD survey). This earlier market survey in early 2024 was used to collect information on hydrogen projects for which a connection request has already been submitted, demand has been registered or at least discussions have been held with the project developer. By contrast, the latest survey is to encourage distribution system operators to report longer-term additional, prospective requirements for which there may not yet be any concrete project agreements. The aim here is to give distribution system operators the opportunity to have their strategic transformation plans, including the demand identified in the relevant gas network area transformation plans, incorporated into the Scenario Framework 2025.

The following diagram shows the results of the long-term hydrogen capacity survey conducted by the gas transmission system operators in the first quarter of 2024.

Figure 21: Long-term forecast by distribution system operators (hydrogen)



Long-term hydrogen forecasts	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Total long-term forecast [GWh/h]*	0.4	0.8	1.7	3.4	4.4	13.7	17.1	24.3	30.0	34.2	48.7
of which methane capacity-reducing H2 demand [GWh/h]	0.3	0.4	0.9	1.6	2.3	9.5	12.2	18.2	22.8	26.2	39.0
of which additional H2 demand [GWh/h]*	0.1	0.4	0.8	1.8	2.1	4.2	4.9	6.1	7.2	8.0	9.7

Source: Gas transmission system operators

The reported hydrogen capacity demand increases steeply during the period under review from 2025 (0.4 GWh/h) to 2035 (around 49 GWh/h). This significant increase affects all gas transmission system operators equally. The long-term hydrogen forecasts (capacity) are shown in Annex 4.

Figure 21 also shows that the majority of the reported long-term hydrogen forecasts reduce the distribution system operators' methane demand. This reduction was already factored into the long-term forecasts for methane (cf. chapter 3.2.5).

The hydrogen volumes reported by the distribution system operators develop exponentially in line with the hydrogen capacities from around 1.4 TWh in 2025 to around 133.3 TWh in 2035. The long-term hydrogen forecasts (volume) are shown in Annex 4.

3.3.3 Baseline data and developments for hydrogen at cross-border IPs

The specific development of hydrogen capacities at cross-border interconnection points (IPs) is determined by the German gas transmission system operators (TSOs) as part of their modelling work. For this purpose, the transmission system operators identify "baseline capacities" for the possible development at the cross-border IPs for the years 2037 and 2045. These figures (Table 24) result from discussions with the neighbouring TSOs. For comparison, the table shows the cross-border IP assumptions for the hydrogen core network for the year 2032. The specific approach in the various scenarios/modelling variants is determined by the transmission system operators as part of their modelling of the Gas and Hydrogen Network Development Plan 2025.

Table 24: "Baseline capacities" for hydrogen at cross-border IPs

Country	Cross-border IP	Core network capacity 2032	Baseline IP capacity 2037	Baseline IP capacity 2045	Baseline IP capacity 2037	Baseline IP capacity 2045
		Entry [GWh/h]			Exit [GWh/h]	
Denmark	Bornholm-Lubmin	10.0	10.0	10.0	---	---
	Ellund	4.3	12.0	24.0	1.5	2.0
Norway/ UK	AquaDuctus (Offshore)	5.0	10.0	20.0	---	---
	Dornum/ Emden	---	---	10	---	---
The Netherlands	Oude Statenzijl/ Bunde	4.0	4.0	4.0	4.0	4.0
	Vlieghuis	1.3	1.3	1.3	---	---
	Elten	3.2	3.2	3.2	3.2	3.2
	Vreden	3.2	3.2	3.2	3.2	3.2
Belgium	Eynatten	3.8	6.5	6.5	---	---
France	Medelsheim	8.0	8.0	8.0	---	---
	Fribourg	0.5	0.5	0.5	---	---
	Leidingen	0.2	0.2	0.2	---	---
Switzerland	Wallbach	---	3.9	9.5	---	---
Austria	Überackern	6.25	6.25	6.25	6.25	6.25
Czech Republic	Waidhaus-Deutschneudorf (Transit)	6.0	6.4	6.4	6.6	6.6

Country	Cross-border IP	Core network capacity 2032	Baseline IP capacity 2037	Baseline IP capacity 2045	Baseline IP capacity 2037	Baseline IP capacity 2045
		Entry [GWh/h]			Exit [GWh/h]	
	Waidhaus (Import/Export)	6.0	6.4	12.0	6.6	6.6
	Deutschneudorf (Import/Export)	6.0	6.4	6.4	6.6	6.6
Poland	Oder-Spree	2.0	8.3	8.3	4.2	4.2
	Uckermark	0.8	0.8	0.8	0.8	0.8

Source: Gas transmission system operators

The development of hydrogen capacities at cross-border IPs up to 2032 was described in the application for the hydrogen core network (Appendix 1: 'Explanations of cross-border interconnection points in the hydrogen core network' page 55ff) [FNB Gas 2024]. In addition to the assumed IP capacities (the capacity type is determined as part of the modelling), Table 24 also shows further developments for the hydrogen core network for the years 2037 and 2045. Apart from entry capacities, the table also shows exit capacities. The extensions and changes compared to the hydrogen core network are as follows.

Denmark

Ellund entry and exit capacities in 2037/2045

The estimate for Denmark's long-term hydrogen export potential as agreed with Energinet is based on the current forecast by the Danish Energy Agency (DEA) [DEA 2023], which shows an increase for a later period compared to the 2022 [DEA 2022] numbers. The DEA forecast covers a period up to 2050. In order to be able to take account of Denmark's full expansion potential for the planning period up to 2045, a slightly accelerated expansion of hydrogen production in Denmark has been assumed for the base capacities in the Gas and Hydrogen Network Development Plan 2025. The projected capacity for 2037 roughly corresponds to the capacity of the first expansion stage envisaged for the Danish hydrogen network.

Denmark is aiming to establish its own hydrogen-based economy, particularly for the production of hydrogen derivatives. To secure the supply of hydrogen to this industry in Denmark, there are plans to provide exit capacity towards Denmark at Ellund.

Bornholm-Lubmin entry capacities in 2037/2045

The planned entry capacity for hydrogen from Denmark to Germany at the Baltic Sea offshore cross-border IP point was agreed between the technical experts at Energinet and GASCADE during the coordination process. The PCI projects under consideration, 'Interconnector Bornholm-Lubmin' (HYD-N-854/HYD-N-800) and 'Flow' (HYD-N-796), serve to establish a European hydrogen network for hydrogen transmission from Denmark to Germany.

Energinet has calculated an export capacity of 240 GWh per day for the Danish upstream hydrogen project 'Interconnector Bornholm-Lubmin'. A capacity of 240 GWh per day has also been agreed with the German partners for the cross-border IP. As a result, a total entry capacity of 10 GWh/h has been assumed for Lubmin starting in 2032.

In addition to the PCI project 'Interconnector Bornholm-Lubmin', Gasgrid Finland Oy (Finland) and Nordion Energi AB (Sweden) have also submitted an application for the PCI project 'Baltic Sea Hydrogen Collector' (PRJ-G-277). This PCI project is intended to transport hydrogen from Finland and Sweden to Germany. The project participants have agreed to co-operate in order to avoid duplicating infrastructure. One result could be to integrate the 'Bornholm-Lubmin Interconnector' into the 'Baltic Sea Hydrogen Collector' between Bornholm and Lubmin, especially if the hydrogen potential on Bornholm is not fully realised by 2032. The entry capacity of 10 GWh/h assumed for Denmark should therefore be understood as entry capacity from the Baltic Sea region (Denmark, Sweden and Finland).

Norway/UK

AquaDuctus (offshore) entry capacities in 2037/2045

Applications for both IPCEI and PCI were submitted for the transmission route from Norway to Germany. The various applied projects ('CHE Pipeline', 'H2T Project' and 'AquaDuctus') aim to establish a European hydrogen network for the transmission of hydrogen from Norway to Germany.

For the upstream Norwegian hydrogen transmission projects 'CHE-pipeline' (HYD-N-1249) and 'H2T project' (HYD-N-884, HYD-N-1339), Equinor and Gassco have stated a total capacity of 820 GWh per day for their PCI applications. A capacity of 480 GWh per day has been calculated for the 'AquaDuctus' project, which is intended to connect the Norwegian PCIs.

Due to its IPCEI status, 'AquaDuctus' has been included as an offshore pipeline connecting for offshore hydrogen production in the German EEZ while allowing the import of hydrogen from the countries bordering the North Sea (Norway, the United Kingdom, the Netherlands, or Denmark). In addition to the 5 GWh/h of import capacity assumed in the core network for 2032, the expansion of 'AquaDuctus' can provide a capacity of 10 GWh/h in 2037 and 20 GWh/h in 2045 for hydrogen from the North Sea. Additional compression can efficiently increase the import capacity to as much as 30 GWh/h.

Dornum/Emden entry capacities in 2045

The estimated entry capacity for hydrogen from Norway to Germany at the cross-border IPs Dornum/Emden in 2045 should be seen as an alternative or supplement to the import capacity increase via the offshore system to Wilhelmshaven ('AquaDuctus'). As part of the feasibility study conducted with the Norwegian export consortium (led by Gassco and Dena), a long-term expansion target of 20 GWh/h has been agreed for hydrogen exports from Norway to Germany. The existing offshore export system via the Dornum/Emden import stations can be used for long-term hydrogen transport, providing an alternative to future expansions in Norway (including an increase in compressor capacity) and Germany. The offshore system to Wilhelmshaven is designed for a capacity of 20 GWh/h. However, splitting it into two pipeline strings would significantly reduce the required compressor capacity. A capacity of 10 GWh/h has therefore been included for 2045 usingthe existing methane infrastructure.

Netherlands

Oude Statenzijl/Bunde exit capacities in 2037/2045

The planned exit capacity for hydrogen from Germany to the Netherlands at the Oude Statenzijl/Bunde cross-border IP was agreed in further discussions between Hynetwork Services and GUD. In order to promote the continued expansion of a European hydrogen network, the transmission capacities at the cross-border IPs to the Netherlands have been included as bidirectional load flows. For the Oude Statenzijl/Bunde cross-border IP, it is therefore planned to examine a potential exit capacity of up to 4 GWh/h in 2037 and 2045.

Elten exit capacities in 2037/2045

The Elten cross-border IP will be designed to allow reverse flow. The exit capacities shown in Table 24 represent the expected technical exit capacity of the network interconnection.

Vreden exit capacities in 2037/2045

The Vreden cross-border IP will be designed to allow reverse flow. The exit capacities shown in Table 24 represent the expected technical exit capacity of the network interconnection.

Belgium

Eynatten entry capacities in 2037/2045

The estimated entry capacity for hydrogen from Belgium to Germany was agreed between the technical experts at Fluxys Belgium and Open Grid Europe as part of the applications related to the 6th list of Projects of Common European Interest (PCI). The confirmed 'Belgian Hydrogen Backbone' and 'H2ercules' projects serve to establish a European hydrogen network for the transmission of hydrogen from the Belgian network to Germany within the meaning of Section 28q (4) (4) (b) of the German Energy Industry Act (EnWG).

For the upstream 'Belgian Hydrogen Backbone' transmission project (HYD-N-1311), Fluxys Belgium has calculated a capacity of 91.2 GWh per day for the PCI application. For the Eynatten cross-border IP, a capacity of 91.2 GWh per day has been agreed with the German partners for the 'H2ercules Network West' project (HYD-N-1038), which is directly connected to the cross-border IP. The confirmed PCI 'H2ercules' is part of the German hydrogen core network. For this reason, an entry capacity of 3.8 GWh/h has been estimated for Eynatten for 2032. According to Fluxys Belgium, up to 9 GWh/h can be provided in Belgium in the long term based on the conversion of existing pipelines and the development of the methane market. An average entry capacity of 6.5 GWh/h has therefore been assumed for 2037 and 2045.

Switzerland

Wallbach entry capacities in 2037/2045

A connection from Italy via Switzerland to Germany will be available only after 2032 and has therefore not been included in the application for the hydrogen core network which is based on the reference year 2032. In 2045, an import corridor expansion will be completed on the German side, which will be the final expansion stage for the time being, and the first complete pipeline connection will be created in 2037, so that the capacities will be available as indicated. The capacities linked to the expansion stages were agreed and confirmed by the participating network operators along the route (project numbers H2T-N-740 and H2T-N-1286) for the preparation of the TYNDP 2024, for which data was provided at the beginning of 2024. Based on recent findings, the timeframe has been adjusted in the Scenario Framework, as the projects can now be implemented earlier than assumed in the TYNDP 2024.

Austria

Überackern exit and entry capacities in 2037/2045

The bidirectional hydrogen capacity of 6.25 GWh/h between Austria and Germany was agreed between Gas Connect Austria (GCA) and bayernets as part of the applications related to the 6th list of Projects of Common European Interest (PCI). The hydrogen will be transferred at the Überackern cross-border IP between the neighbouring PCI projects 'HyPipe Bavaria - The Hydrogen Hub' of bayernets and 'H2-Backbone WAG + Penta West' of GCA.

As part of the consultation on the draft application for the 2032 hydrogen core network, Gas Connect Austria and the Austrian regulatory authority Energie-Control Austria each submitted a statement. These two statements underline the importance of Germany as a hub for hydrogen transmission across Europe. Hydrogen that is fed into the hydrogen pipeline system at terminals in northern Germany or at cross-border IPs or PtG sites should also be available for transfer into Austria at southern cross-border IPs such as Überackern. This would open up the possibility of onward transmission towards Italy, for which the 'SoutH2Corridor' project could provide the necessary capacities.

With its PCI list published in April 2024, which includes the projects 'HyPipe Bavaria - The Hydrogen Hub' and 'H2 Backbone WAG + Penta West' in a corridor between Italy, Austria and Germany, the EU Commission has signalled its support for a future bidirectional exchange of hydrogen.

Czech Republic

Entry and exit capacities and transit capacities at Waidhaus and Deutschneudorf in 2037/2045

The planned entry capacity for hydrogen from the Czech Republic to Germany at Waidhaus was agreed between the technical experts at GRTgaz Deutschland, Net4gas and Open Grid Europe as part of the applications related to the 6th list of Projects of Common European Interest (PCI). The confirmed projects 'Central European Hydrogen Corridor' and 'H2ercules' serve to establish a European hydrogen network for hydrogen transmission from Ukraine via Slovakia and the Czech Republic and from North Africa via Italy, Austria, Slovakia and the Czech Republic to Germany. The hydrogen corridor was confirmed as a PCI by the EU Commission on November 28, 2023 under section 9.1.6 (German part) and point 10.2.1 (Czech part) in the Union list.

For the upstream Czech hydrogen transmission project 'Central European Hydrogen Corridor (CZ part)' (HYD-N-990), Net4gas has calculated a capacity of 144 GWh per day at the Waidhaus cross-border IP. This capacity was agreed with the German partners for the 'H2ercules Network South' (HYD-N-1052) project, which is directly connected to the cross-border IP. The confirmed PCI 'H2ercules' is part of the German hydrogen core network. For this reason, an entry capacity of 6 GWh/h has been assumed in the core network at Waidhaus for 2032. Capacity expansion options in the Czech Republic are expected to increase hydrogen transmission capacities to 6.4 GWh/h in 2037 and to 12 GWh/h in 2045.

The planned capacity for hydrogen from Germany to the Czech Republic at Deutschneudorf and the return transfer from the Czech Republic to Germany at Waidhaus was agreed between Net4Gas, GASCADE and Open Grid Europe as part of the applications relating to the 6th list of Projects of Common European Interest (PCI). The proposed 'Flow East', 'Czech German Hydrogen Interconnector (CGHI)' and 'H2ercules South' projects serve to establish a European hydrogen network for hydrogen, initially from Denmark and in later years from Sweden and Finland to Germany. The PCI projects also offer the technical option of feeding hydrogen from the Czech Republic into the German hydrogen network at Deutschneudorf.

For the Czech hydrogen transmission project 'CGHI', Net4Gas has calculated a capacity of 144 GWh per day for the PCI application. A capacity of 144 GWh per day has therefore been assumed at Deutschneudorf, as the capacity is limited by the 'CGHI' PCI for which the application was submitted. Therefore, an exit capacity of 6 GWh/h has been included for Deutschneudorf. Capacity expansion options in the Czech Republic are expected to increase hydrogen transmission capacities to 6.4 GWh/h in 2037 and 2045.

Poland

Oder-Spree entry and exit capacities in 2037/2045

The European gas transmission system operators Gasgrid Finland (Finland), Elering (Estonia), Conexus Baltic Grid (Latvia), Amber Grid (Lithuania), GAZ-SYSTEM (Poland) and ONTRAS want to develop the cross-border hydrogen infrastructure from Finland through Estonia, Latvia, Lithuania, and Poland to Germany, the 'Nordic-Baltic Hydrogen Corridor (NBHC)'. The aim of the project is to create a link between the production regions for green energy in North-East Europe and the most important centres of consumption in Central Europe. The NBHC is to be completed by 2030.

When the PCI list was published at the beginning of April 2024, this project was granted PCI status. In the BEMIP HYDROGEN region defined by the EU Commission, the project has been assigned the number 11.2. GAZ-SYSTEM and ONTRAS have agreed a bidirectional cross-border IP at Eisenhüttenstadt for the project and defined an entry capacity as well as an exit capacity. Once the final expansion is complete, approx. 8.3 GWh/h of entry capacity to Germany and approx. 4.2 GWh/h of exit capacity to Poland will be available.

Uckermark entry and exit capacities in 2037/2045

GASCADE has teamed up with the Polish gas transmission system operator GAZ-SYSTEM and a German renewable energy project developer to establish a cross-border IP in the Uckermark region. The joint project is being funded by the European Union as part of the CEF programme.

The cross-border IP will connect the Polish hydrogen network in the West Pomerania region with the German hydrogen core network. As potential industrial customers for hydrogen are located in both Poland and Germany, the cross-border IP is expected to be a bidirectional IP. Based on the dimensions of the overall project, an entry and exit capacity of 0.8 GWh/h has been agreed.

4 Scenarios and modelling variants

4 Scenarios and modelling variants

This chapter 4 contains an overview of the development of gas demand in Germany based on various energy scenarios (cf. chapter 4.1) along with an explanation of the scenarios selected by the transmission system operators (cf. chapter 4.2). The modelling variants derived from these scenarios for the Gas and Hydrogen Network Development Plan 2025 are explained in chapter 4.3 .

Coordination between gas and electricity transmission system operators for the Scenario Framework

The EnWG provides for two separate processes for the preparation of the network development plans for electricity as well as gas and hydrogen (cf. section 12a, section 12b and sections 15a ff. EnWG). As part of the amendment to the EnWG, the processes for the Scenario Framework 2025 for electricity as well as gas and hydrogen were synchronised. The gas and electricity transmission system operators must submit their respective draft Scenario Frameworks to the BNetzA.

There was already some coordination between the gas and electricity transmission system operators as part of the previous network development plans. This related in particular to gas power plants (existing, newbuild and system-relevant power plants). This coordination has been extended since 2023; thus the gas and electricity transmission system operators have established a regular dialogue. Overall, coordination between the network development planning processes for gas, hydrogen and electricity has been significantly extended.

As part of these consultations, a joint Germany-wide survey of infrastructure requirements for the electricity and hydrogen networks was carried out in the first quarter of 2024, in which the gas and electricity transmission system operators recorded projects affecting hydrogen capacity requirements (entry and exit), power-to-gas plants and large consumers of electricity. This market survey forms a common basis for the network operators' planning work. As part of this market survey, the gas transmission system operators provided the electricity transmission system operators with the locations of the currently planned compressors and their capacity requirements.

There are many similarities between the gas and electricity transmission system operators' scenarios. For example, the scenarios generally assume climate neutrality by 2045. In addition, both the electricity and gas transmission system operators have scenarios focussing on electricity and scenarios focussing on hydrogen. The scenario parameters relevant for network planning differ in terms of the requirements for electricity, methane and hydrogen network planning, which is why not all of the framework figures in the scenarios are the same.

The gas transmission system operators would welcome a joint power plant list. This could feature the existing power plants on the BNetzA's power plant list, the requests submitted to the gas transmission system operators pursuant to sections 38/39 GasNZV, the requests submitted to the electricity transmission system operators in accordance with the KraftNAV and the project reports from hydrogen power plants submitted as part of the hydrogen market survey. In addition, specific information, e.g. on power plant capacity, which the electricity transmission system operators have available, could be used.

Once the list has been drawn up, the power plants would be assigned to the individual methane and hydrogen modelling variants by the transmission system operators in consultation with the BNetzA and the electricity transmission system operators.

The transmission system operators propose a similar procedure for the coordination of a joint PtG list. These lists should be drawn up by the end of October 2024 if possible and then confirmed by the BNetzA.

The gas and electricity transmission system operators will continue with and extend their cooperation and coordination. The German government's system development strategy will be an important basis for the next network development plan cycle.

4.1 Overview of existing gas demand studies

On 12 May 2021, the German government decided to introduce tougher climate targets. By 2030, Germany's greenhouse gas emissions are to be reduced by 65 % (previously 55 %) compared to 1990, with greenhouse gas neutrality to be achieved by 2045. Reducing greenhouse gas emissions, expanding renewable energies and increasing energy efficiency are key objectives of both German and European energy and climate policy. The energy and climate policy framework provides an important basis for the large number of energy and gas demand scenarios.

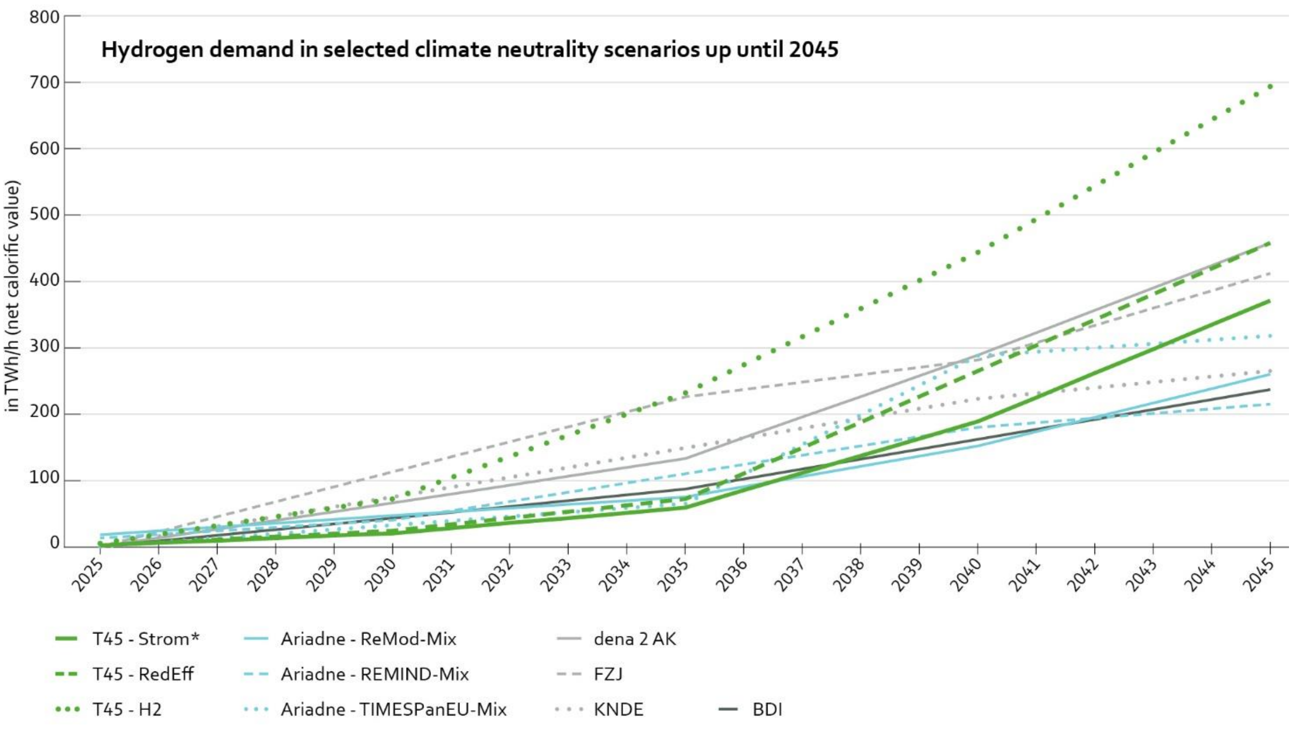
On behalf of the gas transmission system operators, Prognos AG has analysed recognised studies and publications on the future development of methane and hydrogen demand as well as methane and hydrogen volumes in Germany, which can be used for the Scenario Framework 2025. The scenarios were selected on the basis of the German government's climate and energy policy goals of achieving greenhouse gas neutrality by 2045 and thus meeting the requirements of the national Climate Protection Act.

The following energy studies and demand scenarios were included in the comparison:

- Long-term scenarios of the Federal Ministry for Economic Affairs and Climate Action (BMWK) from November 2022 and February 2024, including the scenarios "T45-Strom*", "T45 H2" and "T45 RedEff" (reduced efficiency) [BMWK 2024],
- dena pilot study "Towards Climate Neutrality", with its "dena 2-AK" scenario [dena 2021],
- Agora Energiewende et. al. "Towards a Climate-Neutral Germany 2045", with its "KNDE" scenario [Agora 2021],
- Jülich Research Centre "Strategies for a greenhouse gas-neutral energy supply by 2045", with its "FZJ" scenario [FZJ 2022],
- Ariadne projects "Germany on the road to climate neutrality in 2045 – Scenarios and paths in a model comparison", including the scenarios "Ariadne-REMIND-Mix", "Ariadne-ReMod-Mix" and "Ariadne-TimesPanEU-Mix" [Ariadne 2021],
- BDI Climate Pathways 2.0, with the "BDI" scenario [BDI 2021].

The following figure shows an overview of the development of hydrogen demand in the selected climate neutrality scenarios up until 2045.

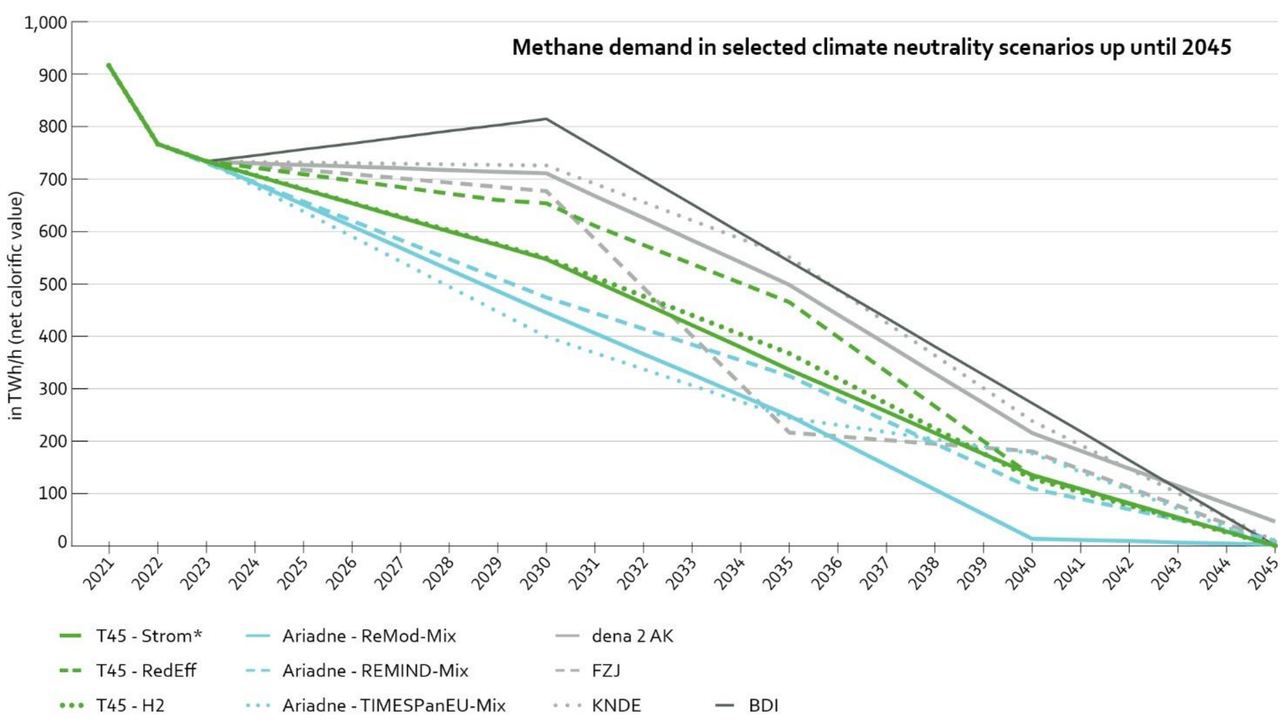
Figure 22: Hydrogen demand in selected climate neutrality scenarios up until 2045



Source: Gas transmission system operators based on [BMWK 2024], [dena 2021], [Agora 2021], [FZJ 2022], [Ariadne 2022]

The following figure shows an overview of the development of methane demand in the selected climate neutrality scenarios up to the year 2045.

Figure 23: Methane demand in selected climate neutrality scenarios up until 2045



Source: Gas transmission system operators based on [BMWK 2024], [dena 2021], [Agora 2021], [FZJ 2022], [Ariadne 2022]

4.2 Description of the scenarios

Following the amendment of the Energy Industry Act, the transmission system operators are obliged under section 15b EnWG to create a Scenario Framework with at least three scenarios that cover the range of probable developments under the German government's climate and energy policy goals for the next ten and a maximum of 15 years. Three further scenarios must include the year 2045 with the same proviso. The gas transmission system operators are free to model additional scenarios over and above the minimum scenarios, provided they are able to do so within the statutory deadlines. Furthermore, the Scenario Framework must take appropriate account of the specifications of the system development strategy[2] (*Systementwicklungsstrategie – SES*). Accordingly, there are three long-term BMWK scenarios in particular that form the basis for this Scenario Framework 2025, thus ensuring compliance with the requirements of the EnWG. The SES was initially published by the BMWK in an interim report in 2023 and is to be submitted to the German Bundestag by the German government every four years from 2027.

The Long-Term Scenario Consortium has announced that it is currently planning to publish further scenarios from July 2024 (focussing in particular on delayed network expansion projects). However, these publications will be too late for inclusion in the Scenario Framework Document 2025. The extent to which these scenarios can be incorporated in the Gas and Hydrogen Network Development Plan 2025 as part of the approval of the Scenario Framework by the BNetzA will need to be examined.

In selecting the long-term scenarios, the gas transmission system operators aim, among other things, to show the widest possible range of hydrogen ramp-up developments, particularly with respect to the year 2045. This allows the modelling process to comprehensively examine the effects on the transmission infrastructure of increased use of electricity combined with low hydrogen demand compared to moderate to intensive use of hydrogen. The long-term scenarios T45 Electricity*, T45 RedEff and T45 H2 are analysed for this purpose.

For the modelling year 2037, however, the scenarios differ only insignificantly in terms of methane demand development. The transmission system operators have therefore added a demand-orientated scenario for this period. This approach also provides a more diversified view of the decline in demand for methane and the transmission system operators fulfil their primary task of ensuring security of supply in a special way.

The selected scenarios are explained in more detail in the following chapters.

4.2.1 Scenario 1: Focus on electricity

This scenario is based on the long-term scenario T45 Electricity*, which is characterised by the highest degree of electrification in all sectors. This is achieved, for example, by a far-reaching switch to heat pumps in the heating sector, electrification of most of the transport sector and industrial processes also predominantly running on electricity.

In this scenario, hydrogen is used in particular for industrial high-temperature processes and in industries that are difficult to electrify and as a material. In contrast, hydrogen plays no role in the building and transport sectors, as these sectors are predominantly electrified. This high degree of electrification affords a special role to hydrogen power plants which serve as a back-up to maintain network stability in the electricity system, particularly when little or no renewable energy is available.

The following table shows the development of hydrogen demand in the T45 Electricity* scenario for the individual sectors.

[2] The BMWK's system development strategy process serves to develop a cross-sectoral vision and a robust strategy for transforming the energy system towards climate neutrality. Further information can be found at: https://www.bmwk.de/Redaktion/DE/Dossier/ses.html.

Table 25: Development of hydrogen demand in the T45 Electricity scenario* by sector

Hydrogen demand by sector	2030	2037	2045
	[TWh, net calorific value]		
Private households as well as trade, commerce & services	0	0	0
Industry, incl. non-energy consumption	15	75	289
Transport	0	0	0
Transformation sector	1	36	83
Total	**16**	**111**	**371**

Source: Gas transmission system operators based on [BMWK 2024], the numbers have been partially interpolated

Due to extensive electrification and the increasing use of hydrogen, demand for methane is set to gradually decline in all sectors. There are no plans to use methane to any significant extent in 2045. The following table shows the development of methane demand in the T45 Electricity* scenario for each of the sectors.

Table 26: Development of methane demand in the T45 Electricity scenario* by sector

Methane demand by sector	2025	2030	2037	2045
	[TWh, net calorific value]			
Private households as well as trade, commerce & services	321	221	95	0
Industry, incl. non-energy consumption	204	185	116	0
Transport	11	15	7	0
Transformation sector	208	143	63	0
Total	**744**	**564**	**280**	**0**

Source: Gas transmission system operators based on [BMWK 2024], the numbers have been partially interpolated

4.2.2 Scenario 2: Focus on hydrogen

This scenario is based on the long-term scenario T45 H2, which is characterised by a substantial use of hydrogen that is achieved in particular through extensive use of hydrogen in various industrial sectors and industrial high-temperature processes. In the heating and transport sectors, however, hydrogen plays a subordinate role compared to the use of electricity, as most buildings are switched to heat pumps and the transport sector is predominantly electrified.

Despite the intensive use of hydrogen, the demand for electricity is also high in this scenario, as the heating, transport and industrial sectors are also increasingly electrified in parallel.

In this scenario, hydrogen power plants again serve as a back-up to maintain network stability in the electricity system. The following table shows the development of hydrogen demand in the T45 H2 scenario for the individual sectors.

Table 27: Development of hydrogen demand in the T45 H2 scenario by sector

Hydrogen demand by sector	2030	2037	2045
	[TWh, net calorific value]		
Private households as well as trade, commerce & services	32	67	107
Industry, incl. non-energy consumption	26	191	437
Transport	8	39	111
Transformation sector	6	21	39
Total	**72**	**317**	**694**

Source: Gas transmission system operators based on [BMWK 2024], the numbers have been partially interpolated

Due to extensive electrification and the intensive use of hydrogen, the demand for methane is gradually declining in all sectors. There are no plans to use methane to any significant extent by 2045. The following table shows the development of methane demand in the T45 H2 scenario for each of the sectors.

Table 28: Development of methane demand in the T45 H2 scenario by sector

Methane demand by sector	2025	2030	2037	2045
	[TWh, net calorific value]			
Private households as well as trade, commerce & services	301	202	79	1
Industry, incl. non-energy consumption	212	178	92	1
Transport	13	59	69	9
Transformation sector	117	109	31	0
Total	**644**	**549**	**271**	**11**

Source: Gas transmission system operators based on [BMWK 2024], the numbers have been partially interpolated

4.2.3 Scenario 3: Focus on reduced efficiency

This scenario is based on the long-term scenario T45 RedEff which, in turn, is based on the long-term scenario T45 Electricity, but assumes a lower degree of efficiency improvement. One of the consequences is that the overall energy demand is the highest compared to the other two scenarios due to the lower efficiency gains.

The development of gas demand is therefore very similar to Scenario 1: Focus on electricity (see chapter 4.2.1). There are differences with regard to the development of hydrogen demand for the transformation sector: Due to the higher electricity demand, back-up hydrogen power plants are required to an even greater extent in order to maintain network stability in the electricity system. The following table shows the development of hydrogen demand in the T45 RedEff scenario for the individual sectors.

Table 29: Development of hydrogen demand in the T45 RedEff scenario by sector

Hydrogen demand by sector	2030	2037	2045
	[TWh, net calorific value]		
Private households as well as trade, commerce & services	0	0	0
Industry, incl. non-energy consumption	15	81	315
Transport	0	0	0
Transformation sector	9	69	143
Total	**24**	**150**	**458**

Source: Gas transmission system operators based on [BMWK 2024], the numbers have been partially interpolated

Due to extensive electrification and the increasing use of hydrogen, the demand for methane is gradually decreasing in all sectors. There are no plans to use methane to any significant extent by 2045. The following table shows the development of methane demand in the T45 RedEff scenario for each of the sectors.

Table 30: Development of methane demand in the T45 RedEff scenario by sector

Methane demand by sector	2025	2030	2037	2045
	[TWh, net calorific value]			
Private households as well as trade, commerce & services	295	211	82	1
Industry, incl. non-energy consumption	213	184	115	2
Transport	15	50	28	5
Transformation sector	211	203	106	0
Total	**734**	**648**	**332**	**8**

Source: Gas transmission system operators based on [BMWK 2024], the numbers have been partially interpolated

4.2.4 Scenario 4: Focus on security of supply

The comparison between the development of the long-term scenarios analysed and the reported demand shows a great deal of uncertainty with regard to the development of demand, particularly for methane. What's more, the German government's planned power plant strategy envisages the construction of further power generating capacity in the shape of "H2-ready" gas power plants.

The transmission system operators have therefore added a demand-oriented scenario to fulfil their primary task of ensuring security of supply, particularly with regard to methane.

This scenario is based on the distribution system operators' long-term forecasts for methane from the first quarter of 2024. At the time, they were also asked to provide a long-term forecast for hydrogen for the first time (see section 3.3.2). Together with the market survey for hydrogen projects (HPD survey) (cf. chapter 3.3.1), it forms the basis for the demand-orientated analysis of hydrogen capacity requirements in this scenario.

As described in chapter 3.2.1 the transmission system operators have received a large number of capacity reservations and expansion claims pursuant to sections 38/39 GasNZV. In their opinion, this underlines the need for additional demand-oriented methane modelling in order to determine the impact of these requests on the methane infrastructure.

For Scenario 4: Focus on security of supply, the gas transmission system operators propose methane modelling for the years 2030 and 2037. For the modelling year 2030, the scenario includes the distribution system operators' long-term forecasts, the requirements of industrial customers as well as capacity reservations and expansion claims pursuant to sections 38/39 GasNZV. The transmission system operators thus address both the issue of security of supply and the requirements pursuant to sections 38/39 GasNZV. With regard to compliance with the climate protection targets, the transmission system operators will model this scenario for the year 2037 with a reduced capacity approach. The detailed procedure is explained in chapter 4.3.2.4 .

4.2.5 Limits of the scenarios

The system development strategy, the long-term scenarios and the mission statement derived therefrom (including the anchor points) define a corridor for the development of the energy system. The scenarios are not a forecast but rather show possible development paths for achieving the climate policy goals in a simplified way and thus open up a solution space. Network planning should remain open to detailed developments that lie on the edge or outside of the funnel described.

4.3 Modelling variants

This Scenario Framework 2025 provides the basis for the Gas and Hydrogen Network Development Plan 2025. The following chapter describes the modelling variants proposed by the transmission system operators in derivation of the scenarios described above (cf. chapter 4.3.1) and explains the procedure and the input variables (cf. chapter 4.3.2).

4.3.1 Overview of the modelling variants

Following the amendment of the EnWG, the transmission system operators had to come up with a new system for developing modelling variants that no longer rely primarily on demand-based parameters but focus more on energy scenario-based modelling. An explanation of the scenarios on which the modelling variants for the Gas and Hydrogen Network Development Plan 2025 are based has already been provided in chapter 4.2 .

The link between scenarios and the proposed modelling variants for hydrogen and methane is explained below, with the specific capacity figures presented in the description of the modelling variants.

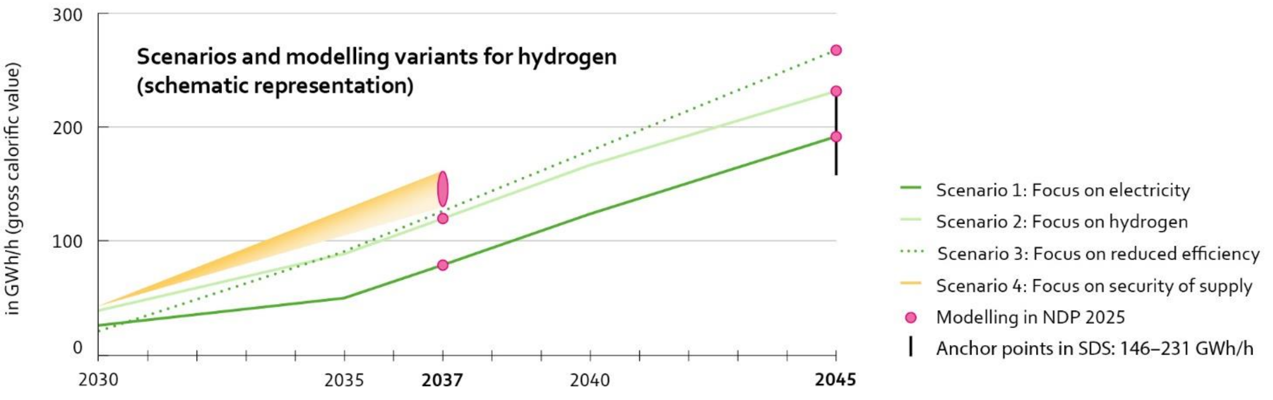
Hydrogen

Figure 24 shows the development of capacity in Scenario 1: Focus on electricity, Scenario 2: Focus on hydrogen, Scenario 3: Reduced efficiency as well as the potential development of the hydrogen ramp-up based on the demand reported as part of the market survey in Scenario 4. For the demand-oriented modelling variant (Scenario 4: Focus on security of supply), the gas transmission system operators are looking to determine, as part of their modelling work, how much capacity is taken into consideration (see chapter 4.3.2.2).

The gas transmission system operators propose modelling one variant each for hydrogen for the year 2037 based on Scenario 1: Focus on electricity and on Scenario 2: Focus on hydrogen. As Scenario 3: Focus on reduced efficiency differs only slightly from Scenario 2: Focus on hydrogen, the gas transmission system operators propose modelling the demand-oriented Scenario 4 instead of Scenario 3 in order to investigate a broader development.

For the year 2045, the gas transmission system operators propose modelling scenarios 1 to 3, as there are no demand indications for hydrogen for this point in time. Moreover, with this approach, the gas transmission system operators fulfil the requirement under section 15b (3) EnWG to give due regard to the stipulations of the system development strategy, as the capacity development shown for the period up to 2045 corresponds to the range of the so-called anchor points for the hydrogen ramp-up from the system development strategy.

Figure 24: Scenarios and modelling variants for hydrogen (schematic representation)



Source: Gas transmission system operators

Methane

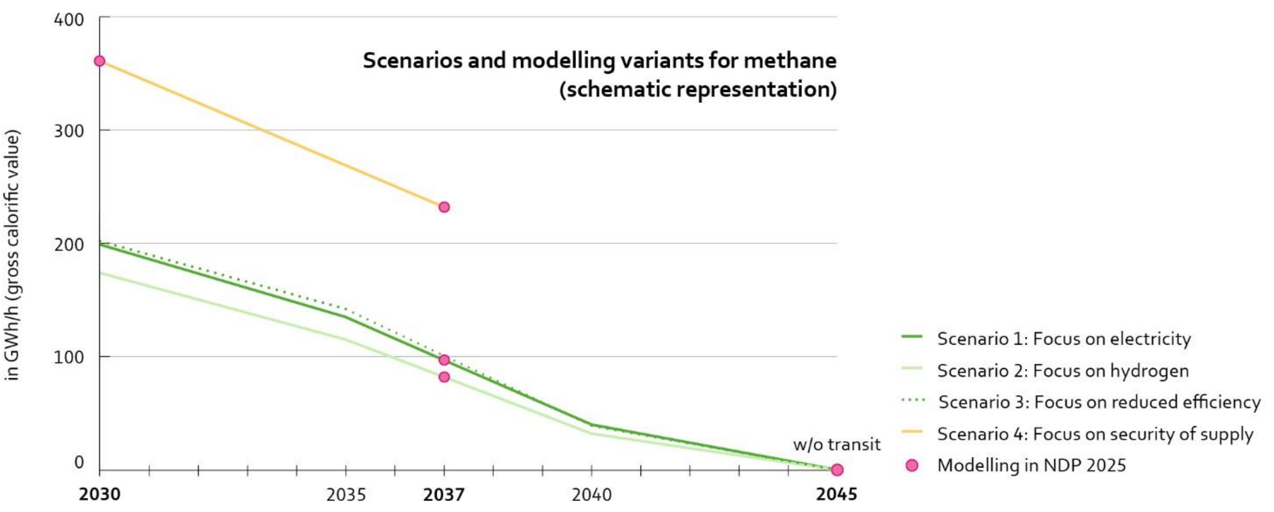
Figure 25 shows the capacity development in Scenario 1: Focus on electricity, in Scenario 2: Focus on hydrogen, in Scenario 3: Reduced efficiency, and in the demand-orientated Scenario 4: Focus on security of supply.

The gas transmission system operators propose that the modelling variants for methane in 2037 should also be calculated on the basis of Scenario 1: Focus on electricity and Scenario 2: Focus on hydrogen, as this will ensure consistency with the associated modelling variants for hydrogen. Scenario 4: Focus on security of supply is also proposed here as the third variant.

For the year 2045, the gas transmission system operators propose modelling scenarios 1 to 3, which is consistent with the procedure for hydrogen modelling.

For the year 2030, the gas transmission system operators propose additional methane modelling.

Figure 25: Scenarios and modelling variants for methane (schematic representation)



Source: Gas transmission system operators

Overview of modelling variants for hydrogen and methane

The following Table 31 shows the modelling variants that result from the above considerations regarding the scenarios and the demand-based parameters, and which the gas transmission system operators consider to be meaningful.

Table 31: Modelling variants for the Gas and Hydrogen Network Development Plan 2025

No.	Scenario	Energy source	Modelling		
			2030	2037	2045
1	Focus on electricity	Methane	---	x	x
		Hydrogen	---	x	x
2	Focus on hydrogen	Methane	---	x	x
		Hydrogen	---	x	x
3	Focus on reduced efficiency	Methane	---	---	x
		Hydrogen	---	---	x
4	Focus on security of supply (demand-orientated)	Methane	x	x	---
		Hydrogen	---	x	---

Source: Gas transmission system operators

In addition to the "pure" modelling for methane and hydrogen, iterative modelling is required to determine natural gas-reinforcing measures. As part of this modelling, the gas transmission system operators will examine which pipelines can be converted from methane to hydrogen in accordance with section 113 b EnWG and which natural gas-reinforcing measures are necessary in the methane network. The basis on which the modelling will be carried out will be determined as part of modelling work in consultation with the BNetzA. Carrying out the iterative modelling to determine natural gas-reinforcing measures as part of the Gas and Hydrogen Network Development Plan 2025 represents a major time challenge.

4.3.2 Procedure for determining the modelling variants

The individual scenario and demand parameters must be prepared for the proposed modelling variants. The procedure is described in this chapter.

Generally, it is important to distinguish between the procedures for modelling variants based on the scenarios and the procedures for modelling variants based on the demand reports. In addition, the transmission system operators propose a different approach for methane and hydrogen. The following chapter first describes the procedure for the scenario-based and demand-based modelling variants for hydrogen. In a second step, the procedure for the scenario-based and demand-based modelling variants for methane is presented.

4.3.2.1 Scenario-based modelling variants for hydrogen

Chapter 4.2 already explained that the transmission system operators regard the long-term scenarios T45 Electricity*, T45 H2 and T45 RedEff as the essential basis for scenario-based modelling for 2037 and 2045, the years under review.

The parameters for the hydrogen demand in the underlying scenarios were partially made available to the gas transmission system operators by the LFS consortium and are shown in the following tables.

Table 32: Hydrogen capacity demand in the T45 Electricity scenario*

Hydrogen demand by sector	2030	2037	2045
	[GWh/h, gross calorific value]		
Private households as well as trade, commerce & services	0	0	0
Industry, incl. non-energy consumption	3	16	60
Transport	0	0	0
Transformation sector/power plants	23	64	132
Total	**26**	**79**	**192**

Source: Gas transmission system operators based on [BMWK 2024], values partly interpolated and calculated in-house

Table 33: Hydrogen capacity demand in the T45 H2 scenario

Hydrogen demand by sector	2030	2037	2045
	[GWh/h, gross calorific value]		
Private households as well as trade, commerce & services	15	32	50
Industry, incl. non-energy consumption	5	40	91
Transport	1	5	15
Transformation sector/power plants	18	44	76
Total	**39**	**120**	**232**

Source: Gas transmission system operators based on [BMWK 2024], values partly interpolated and self-calculated

Table 34: Hydrogen capacity demand in the T45 RedEff scenario

Hydrogen demand by sector	2030	2037	2045
	[GWh/h, gross calorific value]		
Private households as well as trade, commerce & services	0	0	0
Industry, incl. non-energy consumption	3	17	66
Transport	0	0	0
Transformation sector/power plants	18	108	202
Total	**21**	**125**	**268**

Source: Gas transmission system operators based on [BMWK 2024], values partly interpolated and self-calculated

The following steps are then performed to prepare the data for the scenario-based modelling variants for hydrogen:

(1) Regionalise the total capacity from the scenarios using the projects reported in the hydrogen production and demand (HPD) market survey (selection based on criteria)

(2) Determine the exit capacities at cross-border IPs

(3) Determine the storage facilities used (WGV, entry and exit capacity)

(4) Regionalise the entry capacity (IPs, terminals and other entry points, PtG)

(1) Regionalise the total capacity from the scenarios using the projects reported in the hydrogen production and demand (HPD) market survey (selection based on criteria)

The gas transmission system operators carry out the regionalisation based on the data collected from the market survey for hydrogen (see description of hydrogen market survey in chapter 3.3.1) while also drawing on the distribution system operators' long-term hydrogen forecasts (cf. chapter 3.3.2). This approach makes it possible to precisely allocate the hydrogen requirements of the scenarios to specific locations within the modelling framework.

The aim is to back up the total capacity per sector from the long-term scenarios with specific projects from the market survey and the distribution system operators' long-term forecasts for hydrogen. As the demands in the market survey exceed those from the long-term scenarios, it is necessary to apply certain criteria for the modelling year 2037 for Scenario 1: Focus on electricity and Scenario 2: Focus on hydrogen. These are described below.

Due to the different demand and sectoral developments in the scenarios, different criteria are used in some cases for project selection. For example, in 2037, hydrogen is only used in industry and for electricity generation in Scenario 1: Focus on electricity, while Scenario 2: Focus on hydrogen also envisages its use in private households, trade/commerce/services and the transport sector.

The procedure is applied in the same way for the years 2037 and 2045, the only difference being that no further reduction is required for 2045, as hydrogen demand exceeds the reported needs from the market survey for hydrogen. For this reason, the same procedure is generally proposed for the regionalisation step as for 2037, but without a reduction in exit capacity as in 2037. However, this exit capacity is increased proportionately for the year 2045 in scenarios 1 to 3 in order to correspond to the capacity values from the long-term scenarios.

Industry

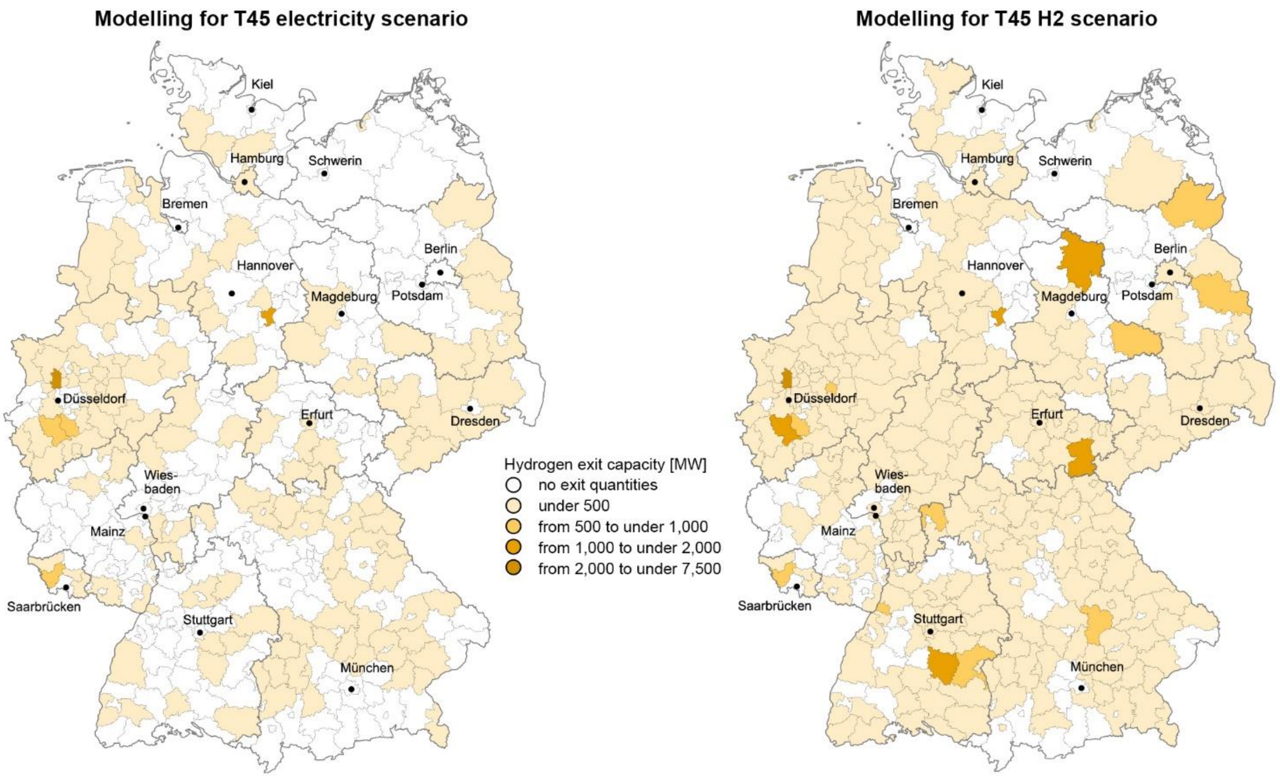
For the industrial sector, Scenario 1 considers the projects from the market survey for which a final investment decision has already been taken. In addition, the scenario only considers those projects that correspond to the industrial sectors of the hydrogen core network[3] and that were decisive for its creation. In T45 Electricity*, hydrogen is only used in sectors that cannot be electrified – comparable to the assumptions for the hydrogen core network. Finally, all further projects reported are distributed on a pro-rata basis until the total demand specified in the scenarios is met.

As the demand for hydrogen in Scenario 2 is significantly higher than in Scenario 1, it is necessary to adjust the criteria. Initially, those projects from the market survey that have a final investment decision are also taken into account. However, as a much broader use of hydrogen is envisaged in scenario T45 H2, it is not necessary to filter according to the industrial sectors based on the hydrogen core network. All other industrial projects are distributed in instalments until the specified total demand is covered.

The following figure shows an example of the result of the regionalisation for the industrial sector (T45 Electricity* scenario for the year 2037).

[3] The industrial sectors considered for the hydrogen core network are: iron and steel (production of crude steel from primary route, heating and annealing furnaces, steel rolling mills: continuous heating of flat/long steel, dis/continuous heat treatment of flat steel, forming technology: dis/continuous heating of forged components), chemicals (ammonia synthesis, basic chemicals: ethylene/olefins, methanol), refineries (desulphurisation, hydrocracking, e-kerosene, methanol), glass industry incl. glass fibre (continuous melting of container glass in large plants, continuous melting of flat glass), medium to large production facilities for ceramics, bricks and tiles.

Figure 26: Scenario-based hydrogen modelling – regionalisation for industry in scenario T45 Electricity* and in scenario T45 H2 for the year 2037



Source: Gas transmission system operators

Transport/buildings/trade, commerce & services

The projects reported in the market survey are taken into consideration for the transport and building sector as well as the trade, commerce & services sector. As these capacities are lower than the capacities in the long-term scenarios, the distribution system operators' long-term hydrogen forecasts are also distributed on a pro-rata basis.

Power plants

Based on Annex 3 and the Gas NDP Database, the gas transmission system operators propose drawing up a consolidated power plant list together with the BNetzA and the electricity transmission system operators for inclusion of the power plants in the modelling variants. This list could be made up of existing power plants as per the BNetzA's power plant list, the requests pursuant to sections 38/39 GasNZV from the gas transmission system operators, the requests pursuant to KraftNAV from the electricity transmission system operators, and the hydrogen power plants reported as part of the hydrogen market survey. In addition, specific information, e.g. on power plant capacity, which is available from the electricity transmission system operators could be used.

The power plants would then be assigned to the individual methane and hydrogen modelling variants by the transmission system operators in coordination with the BNetzA and the electricity transmission system operators. To this end, the transmission system operators could use the information from the hydrogen market survey to identify the power plants that intend to switch to hydrogen in the future. If necessary, the gas transmission system operators will contact the power plant operators with a connection to the TSO network.

The gas transmission system operators propose that this list of power plants be drawn up by the end of October 2024 if possible and then approved by the BNetzA.

(2) Determine the exit capacities at cross-border IPs

The BMWK's long-term scenarios contain information on exports. No significant hydrogen exports are predicted here. On this basis, the transmission system operators will determine exit capacities for hydrogen in the modelling variants for the long-term scenarios.

The gas transmission system operators have been provided with data for the T45 Electricity* scenario. These values are used for all long-term scenarios. A hydrogen entry capacity of up to 6 GWh/h is assumed.

(3) Determine the storage facilities used (WGV, entry and exit capacity)

Under the system development strategy and according to the analysis of the long-term scenarios, hydrogen storage facilities represent a crucial infrastructure in the future energy system. Hydrogen is the energy carrier that provides flexibility and security of supply. Flexibility and supply security ultimately rely on usable storage facilities. The core functions (among other functions) of storage facilities are:

- Support for electrolysis plants: Electrolysis helps to use the available supply of renewable electricity generation – as close as possible to the point of generation. Storage facilities can temporarily absorb the supply of green hydrogen from an electrolysis plant on an intraday basis.
- The supply of green hydrogen varies significantly from season to season. Due to the higher availability of PV electricity in particular, the supply of green hydrogen is significantly higher in summer. Conversely, the demand for hydrogen is seasonally significantly higher in winter, depending on the scenarios. Storage facilities transfer the supply of hydrogen into the (increased) hydrogen demand periods.
- In times of reduced supply of renewable electricity (when there is no wind and no sunshine), hydrogen power plants supply the electricity needed. This requires considerable capacity to be provided by the storage facilities in particular.

In all long-term scenarios, hydrogen storage facilities are essential for the functioning of the energy system. The long-term scenarios reliably determine an H2 storage demand for each scenario and modelling year.

The storage demand is measured in terms of demand for working gas volume (WGV) to cover the seasonal swing of hydrogen supply and demand. Since the long-term scenarios only consider one climate year in the simulation and the models in the optimisation algorithm assume a "perfect forecast" (with the WGV used in an optimum way), the calculated demand for storage capacity should be understood as a lower limit.

The following table shows the working gas volume in the three long-term scenarios analysed and the relevant support years.

Table 35: Working gas volume in storage facilities in the different scenarios

Working gas volume in storage facilities	2037	2045
	[TWh, net calorific value]	
T45 Electricity* scenario	23	71
T45 H2 scenario	12	72
T45 RedEff scenario	No modelling	105

Source: Gas transmission system operators based on [BMWK 2024]

The anchor points of the system development strategy specify a range of 70 TWh to 100 TWh of working gas volume in hydrogen storage facilities in 2045. This range is well covered by the scenarios.

For the scenarios, it is assumed that the minimum working gas volume of the long-term scenarios can be built up in Germany for each support year.

Determination of entry and exit capacities

In the scenarios, the required working gas volume is the leading variable. A storage capacity cannot be utilised from the data of the long-term scenarios.

It must be possible to fill and empty storage facilities within a reasonable period of time. Typical times for emptying caverns range from 600 hours to 1,000 hours.

For the modelling of the scenarios, a period of 600 hours is assumed for filling and emptying, resulting in the following capacities.

Table 36: Injection and withdrawal capacities of storage facilities in the various scenarios

Working gas volume in storage facilities [based on 600 h]	2037	2045
	[GWh/h, gross calorific value]	
T45 Electricity* scenario	45	140
T45 H2 scenario	24	142
T45 RedEff scenario	No modelling	207

Source: Gas transmission system operators based on [BMWK 2024]

The assumptions are checked in the modelling while suitable assumptions are made for the load situations.

Regionalisation of storage capacities

For the modelling in 2037, the storage projects reported in the HPD market survey are scaled to the required working gas volume.

In 2045, the natural gas storage facilities that become available can be used in line with their geological suitability. In addition, the potential of geological salt deposits is to be used for providing additional regional storage caverns.

In 2022, DBI analysed transformation paths for gas storage facilities [BVEG/DVGW/INES 2022]. The study examined the technical requirements for storing hydrogen in salt caverns as well as porous rock storage facilities. It analysed both the repurposing of existing storage facilities as well as the leaching of new caverns specifically for hydrogen. The study also looked at how the need for around 70 TWh of working gas volume specified in the long-term scenarios (as of 2022) can be met.

4. Regionalisation of entry capacity (cross-border IPs, terminals and other entry points, PtG)

Cross-border IPs

The BMWK's long-term scenarios contain information on hydrogen imports. The breakdown of hydrogen demand between imports and domestic production involving electrolysis is specified for each long-term scenario. Based on this, the transmission system operators have determined entry capacities for hydrogen in their modelling variants for the long-term scenarios. A full load hour figure of 3,000 h was assumed for imports to estimate the necessary import capacity in the various modelling variants. The results are shown in the following table.

Table 37: Cross-border IP capacities in the different modelling variants

Hydrogen imports according to modelling variants	2037	2045
	[GWh/h, gross calorific value]	
T45 Electricity* scenario	9	85
T45 H2 scenario	56	166
T45 RedEff scenario	No modelling	129

Source: Gas transmission system operators on the basis of [BMWK 2024]

The specific development of hydrogen capacities at cross-border IPs is determined by the transmission system operators as part of their modelling work. The gas transmission system operators reserve the right to review the capacity at cross-border IPs according to the load cases, including considerations related tothe hydrogen core network. For this purpose, the transmission system operators have shown "baseline capacities" in Table 24 (cf. chapter 3.3.3) for potential capacity developments at cross-border IPs.

Terminals and other entry points for hydrogen

The long-term scenarios, which are focused on optimising total costs, use exclusively green hydrogen from electrolysis in future energy systems, which is either produced directly in Germany or imported via pipelines from across Europe. The import of hydrogen via terminals is not considered in the models, as the price in the models is higher than the price of hydrogen imported via pipelines. According to the gas transmission system operators, the supply of hydrogen is likely to develop in a much more differentiated way. In particular, they see a market for hydrogen that will provide very different price signals compared to a model based on production costs.

The German government is pursuing a diversified approach as part of its import strategy, e.g. sources of hydrogen are being sought worldwide via the H2Global initiative, usually in the form of ammonia imports. The system development strategy is clearly in favour of diversified planning of hydrogen sources, which includes terminals or sources of blue hydrogen. The gas transmission system operators will draw up diversified plans for import and generation infrastructure.

The transmission system operators will also consider established locations for the import and production of hydrogen in the scenario-based modelling variants.

As part of the modelling, they are also looking at the extent to which the sites can be efficiently designed as part of the network infrastructure to increase the resilience of the supply – possibly in competition with generation by power-to-gas plants or imports via pipeline.

Power-to-gas plants

Together with the electricity transmission system operators, the gas transmission system operators will agree a consolidated PtG list to take account of electrolysers in the modelling variants. Among other things, this will include projects reported as part of the joint market survey (cf. Annex 2 and section 3.4.1) and will also take existing plants into account. The gas transmission system operators propose that this PtG list be drawn up by the end of October 2024 if possible and then confirmed by the BNetzA.

The electrical electrolysis capacity shown in each of the scenarios serves as a target value (cf. Table 38). In order to achieve this target, the transmission system operators cluster the reported projects into the following three groups and fill these groups on a pro-rata basis, one after the other, until the target value is reached.

1. Group 1: Final investment decision (FID) has been taken and project is in progress:

An FID has been taken and the project has reached the status "Material and service procurement / construction preparation and start of construction / assembly / construction" or "Commissioning / project completion / finalisation"

2. Group 2: Project is underway (largely taken into account, partly in proportion to hydrogen production capacity):

   Project has reached the status "Material and service procurement / construction preparation and start of construction / assembly / construction" or "Commissioning / project completion / completion",

3. Group 3: All other reported projects.

Table 38: Electrolysis capacity of the scenarios

Electrolysis capacity [GW_e]	2037	2045
	[GW_e]	
T45 Electricity* scenario	38	68
T45 H2 scenario	68	110
T45 RedEff scenario	No modelling	61

Source: Gas transmission system operators based on [BMWK 2024]

The anchor points of the system development strategy show a range of 70 GW_e to 90 GW_e for the installed electrolysis capacity. Yet the gas transmission system operators go beyond the range of anchor points, as they believe it makes sense to have a resilient design for the future hydrogen network, even under a scenario with high domestic hydrogen production.

The gas transmission system operators are aware of the challenges of project development in the initial stages of the hydrogen market. However, given the time remaining until the modelling years under consideration, it should be possible to realise projects that are still at an early stage. In addition to prioritizing well-advanced projects, all projects are therefore included in the analysis. It is rather likely that, in addition to other measures such as subsidising and simplified authorisation procedures for the hydrogen core network, the measures envisaged as part of the network development plans and the distribution system operators' transformation plans will have a particularly positive effect on the commitment and project progress of power-to-gas plants.

All projects reported in the PtG list are included here, regardless of the planned network connection. The scenario therefore also includes projects that do not require a grid connection, e.g. because they are directly connected to a renewable energy generation plant, as well as those that are not planning to feed hydrogen into a future hydrogen network.

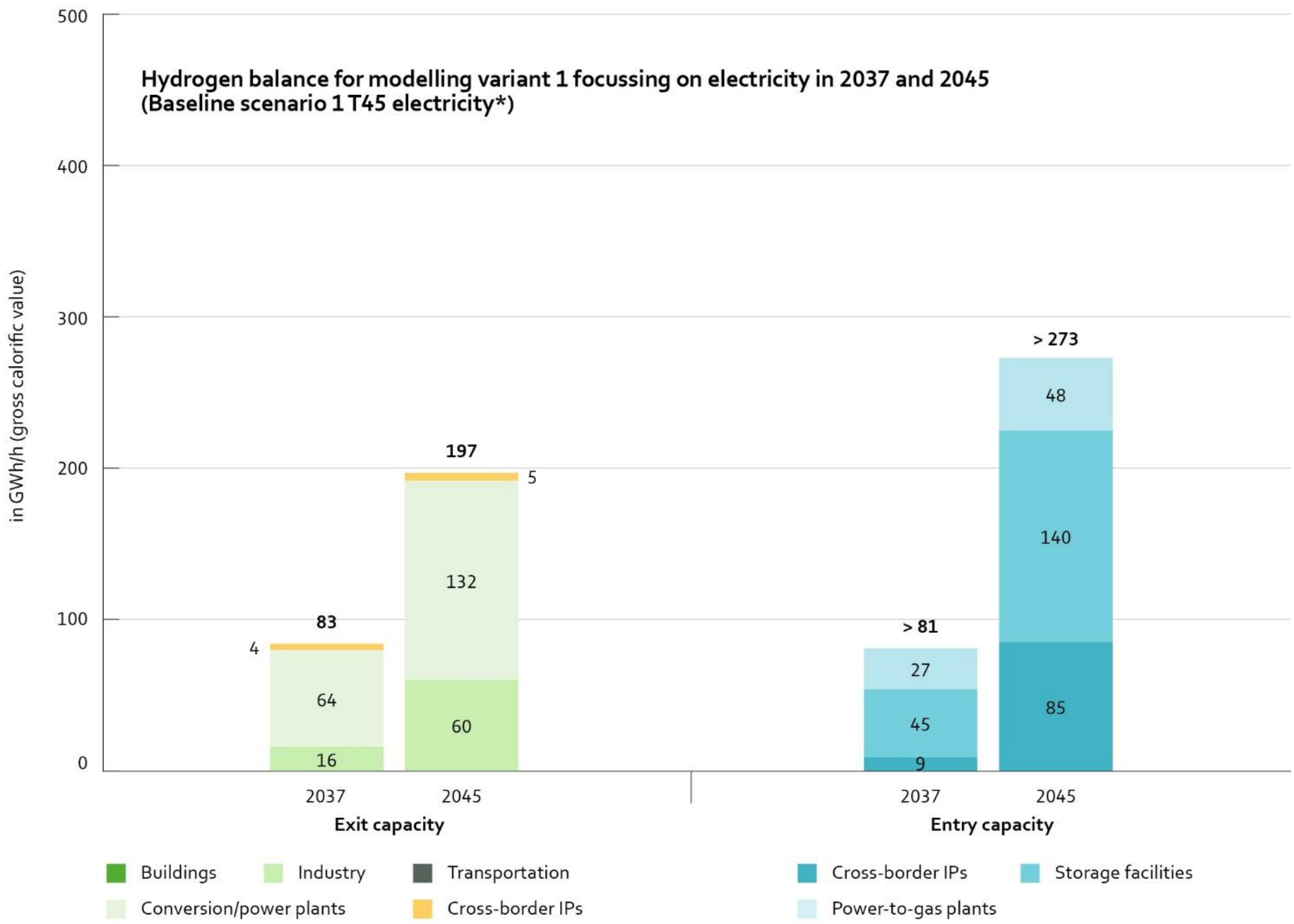
The remaining newbuild capacity in the Hydrogen Focus Scenario 2045 is achieved by scaling up the reported projects, as this allows planners to use their knowledge about the spatial distribution of power-to-gas plants.

In the modelling variant, the reported hydrogen entry capacity is used in line with the electrolysis capacity contained in the relevant scenario. For power-to-gas projects without a hydrogen entry point, no hydrogen injection is therefore assumed.

Fact sheets for the scenario-based hydrogen modelling variants

Based on the procedure described above, the following Germany-wide balancing values for hydrogen can be determined for the various modelling variants proposed.

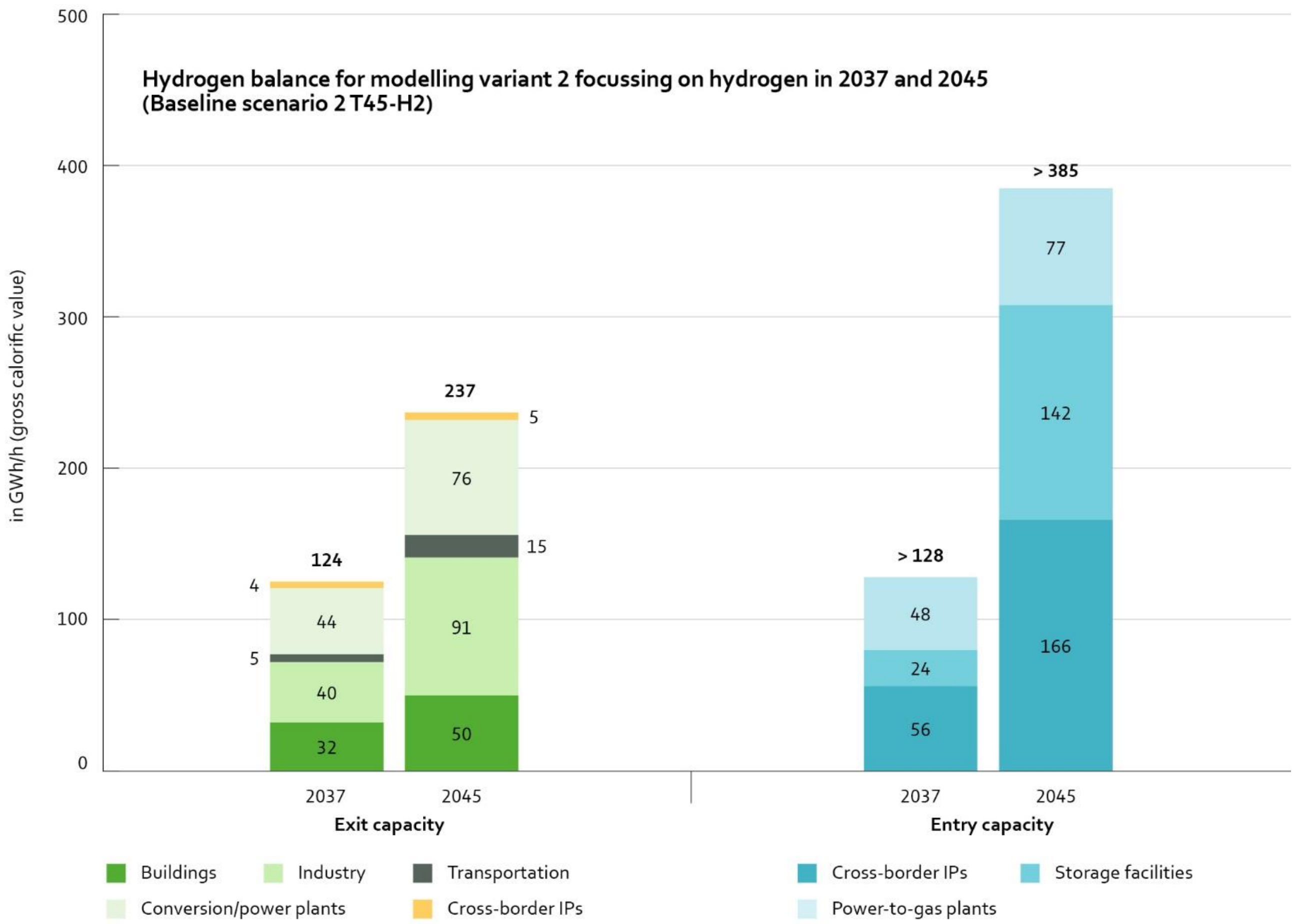
Figure 27: Hydrogen balance for modelling variant 1 focussing on electricity in 2037 and 2045 (Baseline scenario 1 T45 Electricity*)



Hydrogen: Modelling variant 1 focussing on electricity	2037	2045
	[GWh/h, gross calorific value]	
Buildings	0	0
Industry	16	60
Transport	0	0
Conversion/power plants	64	132
Cross-border IPs	4	5
Total exit capacity	**83**	**197**
Cross-border IPs	9	85
Storage facilities	45	140
Power-to-gas plants	27	48
Other (e.g. terminals)	optional	optional
Total entry capacity	**> 81**	**> 273**

Source: Gas transmission system operators

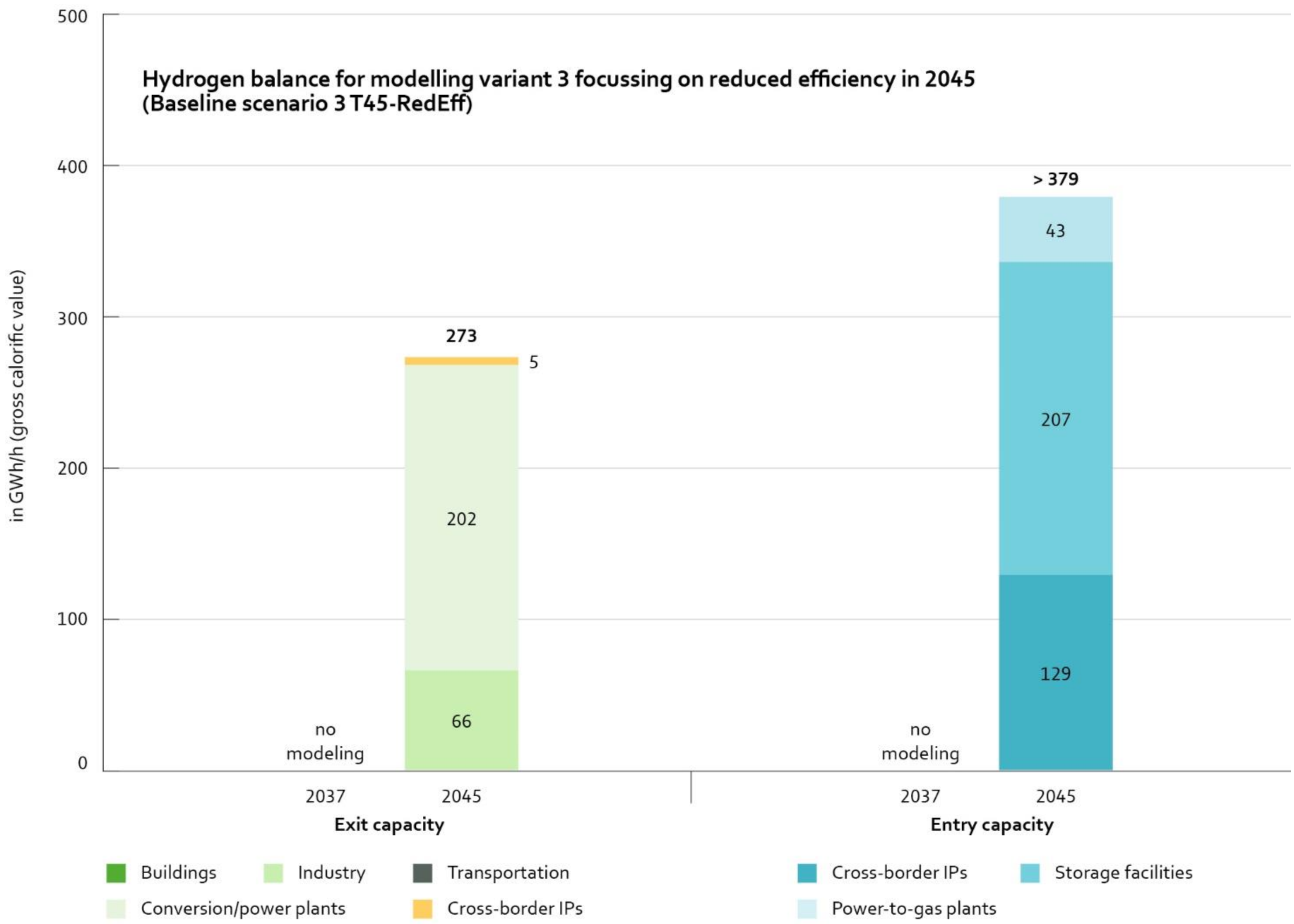
Figure 28: Hydrogen balance for modelling variant 2 focussing on hydrogen in 2037 and 2045 (Baseline scenario 2 T45 H2)



Hydrogen: Modelling variant 2 focusing on hydrogen	**2037**	**2045**
	[GWh/h, gross calorific value]	
Buildings	32	50
Industry	40	91
Transport	5	15
Conversion/power plants	44	76
Cross-border IPs	4	5
Total exit capacity	**124**	**237**
Cross-border IPs	56	166
Storage facilities	24	142
Power-to-gas plants	48	77
Other (e.g. terminals)	optional	optional
Total entry capacity	**> 128**	**> 385**

Source: Gas transmission system operators

Figure 29: Hydrogen balance for modelling variant 3 focussing on reduced efficiency in 2045 (Baseline scenario 3 T45 RedEff)



Hydrogen: Modelling variant 3 focusing on reduced efficiency	2037	2045
	[GWh/h, gross calorific value]	
Buildings	---	0
Industry	---	66
Transport	---	0
Conversion/power plants	---	202
Cross-border IPs	---	5
Total exit capacity	---	**273**
Cross-border IPs	---	129
Storage facilities	---	207
Power-to-gas plants	----	43
Other (e.g. terminals)	---	optional
Total entry capacity	---	**> 379**

Source: Gas transmission system operators

4.3.2.2 Demand-oriented modelling variant for hydrogen 2037

Modelling of the demand-oriented modelling variant is based on the market survey for hydrogen and the distribution system operators' long-term hydrogen forecasts. These were originally surveyed up to the year 2035 and are constantly updated as a basis up to the year 2037.

The capacity requirements listed in the following table form the basis for the modelling variant in 2037.

Table 39: Hydrogen capacity demand in demand-orientated Scenario 4 for the year 2037

Total hydrogen demand range	2032	2037
	[GWh/h, gross calorific value]	
HPD market survey	---	up to 162
Hydrogen core network	87	---
H2 long-term forecasts	---	up to 49

Source: Gas transmission system operators

For this modelling variant, the gas transmission system operators intend to determine how much capacity should be taken into consideration as part of the modelling process. Given the limited options for implementing network expansions by 2037, the transmission system operators aim to fully utilize the potential of the hydrogen core network to accommodate as many market demand reports as possible. The modelling also analyses which additional measures the hydrogen core network can implement to accommodate further demand (review of development potential pursuant to section 28q EnWG (1)). Supplementary measures could be additional compressors, regional expansion via pipeline construction or the repurposing of further methane pipelines.

Overall, the capacity that can be taken into consideration in the demand-oriented scenario for the year 2037 will lie between the capacity shown in the hydrogen core network and the sum of the total demand for capacity identified by the hydrogen market survey and the long-term forecasts for hydrogen.

For the entry capacities in the demand-oriented modelling variant, the gas transmission system operators plan to also consider the assumptions made for the hydrogen core network at the cross-border IPs in addition to the results of the hydrogenmarket survey.

The gas transmission system operators will consider the following points of reference for determining the capacity to be taken into account:

- Final investment decision (FID) taken
- Funding application submitted/approved (PCI, IPCEI, living lab, other)
- Impact on network expansion and on the feasibility of network expansion measures by hydrogen transmission system operators
- Geographical location
- Project status
- Power plants (CHP, type of power plant and thermal capacity)
- Project delivery schedule, capacity reservation, capacity booking
- Network connection request submitted
- Project notification coordinated with the project developer

Given the process proposed, a current profile for the modelling variant is not yet available.

In view of the above criteria, projects with FID status (see **Fehler! Verweisquelle konnte nicht gefunden werden.**) and politically supported projects areassumed to be confirmed. Furthermore, the feasibility of the planned network expansion and its geographical location play a decisive role. The other criteria are of secondary importance.

The modelling to maximise transmission capacities is performed as part of an iterative process. Initial modelling is based on the reported demandsfrom the hydrogen market survey and the long-term hydrogen forecasts. Using the above parameters, the capacity is gradually reduced via further modelling calculations to a point where efficient network expansion can be achieved by 2037 to provide as much transmission capacity as possible.

4.3.2.3 Scenario-based modelling variants for methane

Similar to the scenario-based modelling variants for hydrogen, the capacity data derived from the long-term scenarios for the years 2037 and 2045 are also used as the main elements for scenario-based methane modelling. The approach described below relates primarily to the modelling for 2037. As demand for methane in Germany will reach almost zero by 2045 (transits are not included here, nor are the transport of biomethane or methane demand for the production of blue hydrogen), the transmission system operators concentrate on determining a potential remaining methane network for 2045. The capacity figures for the methane demand in the underlying scenarios were made available to the gas transmission system operators by the Long-Term Scenario Consortium and are shown in the following tables.

Table 40: Methane capacity demand in the T45 Electricity* scenario

Methane demand by sector	2025	2030	2037	2045
	[GWh/h, gross calorific value]			
Private households as well as trade, commerce & services	140	96	38	0
Industry, incl. non-energy consumption	40	36	23	0
Transport	1	2	1	0
Transformation sector/power plants	72	65	36	0
Total	**254**	**199**	**97**	**0**

Source: Gas transmission system operators based on [BMWK 2024], values partly interpolated and self-calculated

Table 41: Methane capacity demand in the T45 H2 scenario

Methane demand by sector	2025	2030	2037	2045
	[GWh/h, gross calorific value]			
Private households as well as trade, commerce & services	133	90	35	0
Industry, incl. non-energy consumption	41	35	18	0
Transport	2	7	9	0
Transformation sector/power plants	48	42	20	0
Total	**225**	**174**	**82**	**0**

Source: Gas transmission system operators based on [BMWK 2024], values partly interpolated and self-calculated

Table 42: Methane capacity demand in the T45 RedEff scenario

Methane demand by sector	2025	2030	2037	2045
	[GWh/h, gross calorific value]			
Private households as well as trade, commerce & services	131	93	36	0
Industry, incl. non-energy consumption	42	36	23	0
Transport	2	6	4	0
Transformation sector/power plants	74	66	38	0
Total	**248**	**202**	**101**	**0**

Source: Gas transmission system operators based on [BMWK 2024], values partly interpolated and self-calculated

The following steps are performed to prepare the data for the scenario-based modelling variants.

(1) Allocate sectoral capacity requirements to the gas transmission system operators' distribution structure

(2) Regionalise the total methane capacity according to the gas transmission system operators' distribution structure

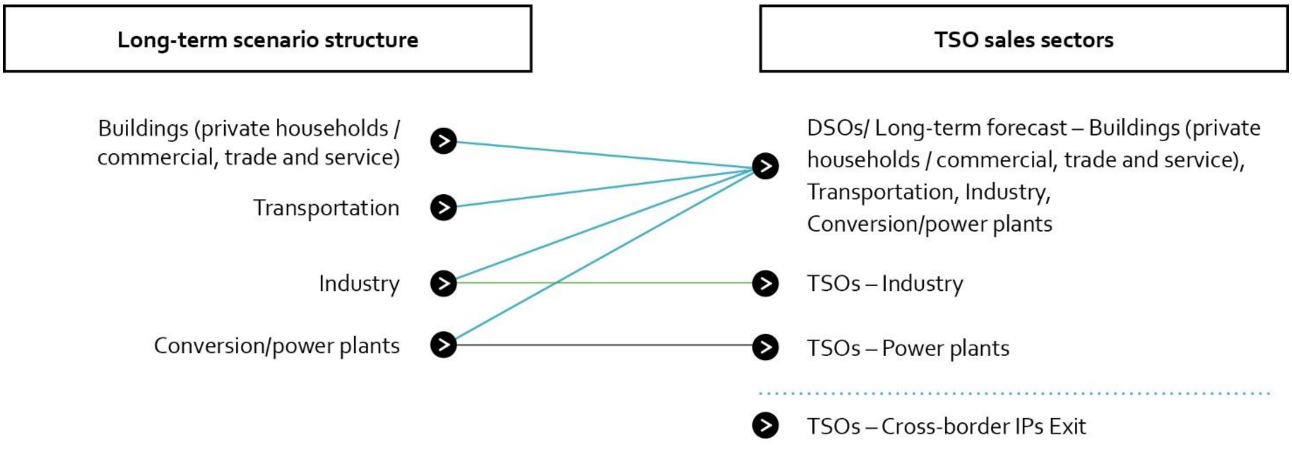
(3) Determine the exit capacities at cross-border IPs

(4) Determine the entry capacities (cross-border IPs, LNG, storage facilities, production).

(1) Allocate the sectoral capacity requirements to the gas transmission system operators' distribution structure

The data from the long-term capacity demand scenarios is not available in the structure previously used by the gas transmission system operators in preparation for the modelling. The data must therefore be prepared accordingly. The following figure shows this step schematically.

Figure 30: Breakdown of the total Germany-wide methane capacity from the scenarios into the previous structure of capacity demand



Source: Gas transmission system operators

In the long-term scenarios, a distinction is made between the capacity requirements in the private households, trade/commerce/services, transport, industry and transformation sectors. The latter essentially comprises power plants. The gas transmission system operators, on the other hand, differentiate in their capacity balances between the demand requirements of the distribution system operators and the direct requirements of the industrial and power plants on the gas transmission system operator's network. Other gas purchases by industry and power plants are handled via the distribution system operators' networks. These are part of the distribution system operators' long-term forecasts and are therefore allocated to them. In addition, the exit capacity demand at cross-border IPs is included in the total demand of the Network Development Plan structure.

(2) Regionalise the total methane capacity in accordance with the gas transmission system operators' distribution structure

The gas transmission system operators perform the regionalisation based on data from the distribution system operators' long-term forecasts and the demand from industry and power plants. The total capacity from the respective scenarios is divided proportionally between the distribution system operators' long-term forecasts and the demand from industry and power plants, or the values of the long-term forecasts are reduced such that the sum of long-term forecasts, industry and power plant demand corresponds to the capacity of the respective energy scenario. The main reason for this is that the network connection points of the DSOs, industrial consumers and power plants are already stored in the gas transmission system operators' network models and allow a more specific allocation of demand to specific exit points on the network than via the district data of the energy scenarios.

The capacity requirements of the distribution system operators and industry are reduced across the board depending on the scenario. Site-specific assumptions are made for the power plants. The gas transmission system operators propose that this list of power plants be drawn up by the end of October 2024 if possible and then approved by the BNetzA.

(3) Determine the exit capacities at cross-border IPs

The BMWK's long-term scenarios contain information on exports. Using this information, the transmission system operators will determine exit capacities for methane in their modelling variants for the long-term scenarios.

The gas transmission system operators have been provided with data for the T45 Electricity* scenario. These values are used for all long-term scenarios. A methane entry capacity of around 20 GWh/h in 2037 is assumed.

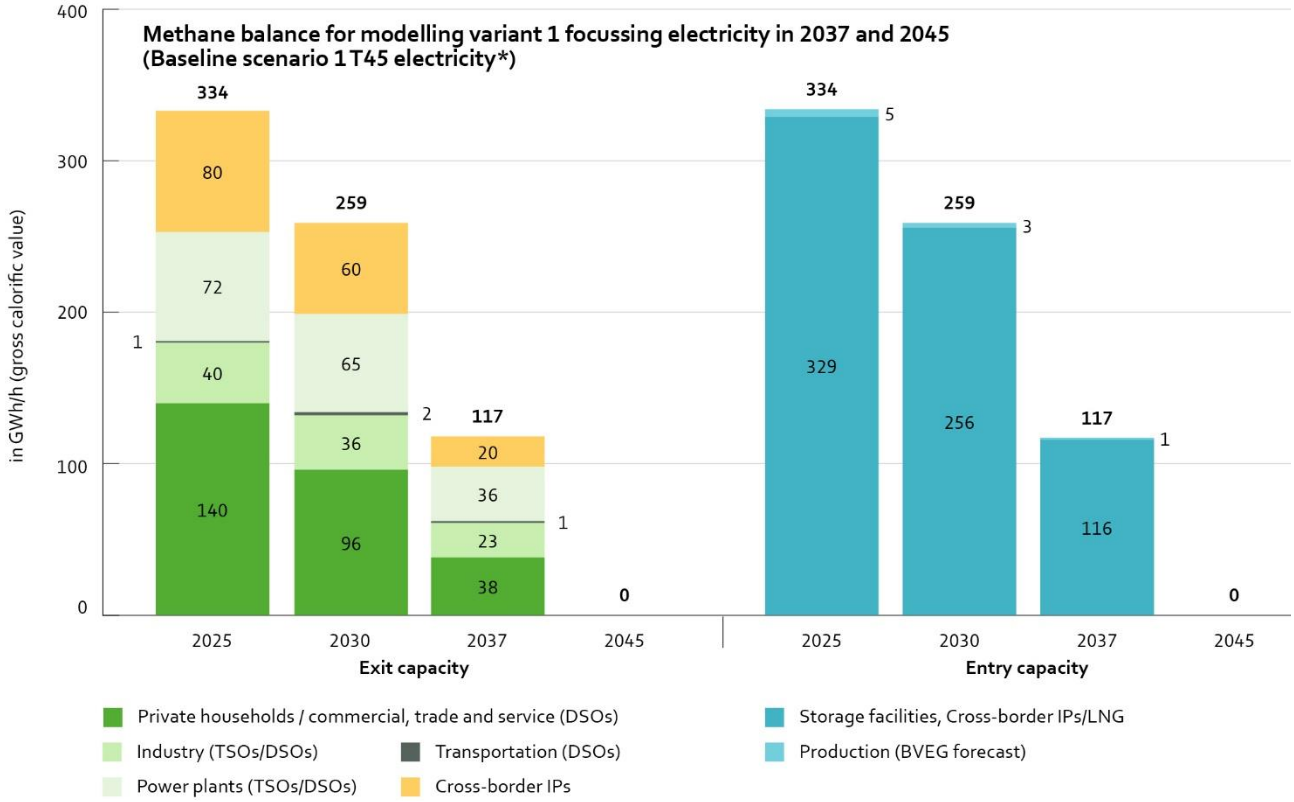
(4) Determine the entry capacities (cross-border IPs, LNG, storage facilities, production)

The exit capacity determined in the scenario is allocated to the various injection sources, cross-border IPs, storage facilities, LNG and production as part of the modelling. The BVEG forecast is used for the gas production data.

Fact sheets for the scenario-based methane modelling variants

Based on the procedure described above, the following Germany-wide balancing values for methane can be determined for the various modelling variants proposed.

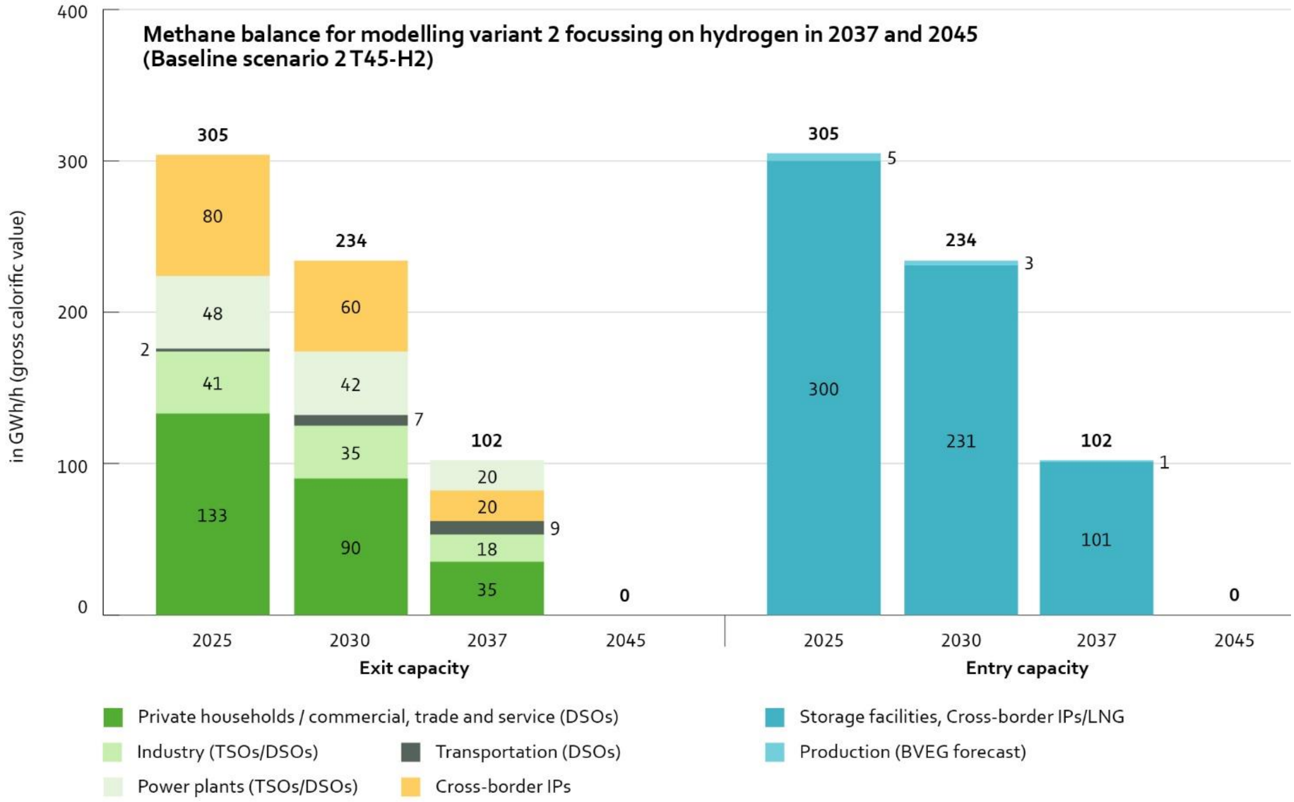
Figure 31: Methane balance for modelling variant 1 focussing on electricity in 2037 and 2045 (Baseline scenario 1 T45 Electricity*)



Methane: Modelling variant 1 focussing on electricity	2025	2030	2037	2045
	[GWh/h, gross calorific value]			
Exit capacities				
Private households as well as trade, commerce & services (DSOs)	140	96	38	0
Industry (TSOs and DSOs)	40	36	23	0
Transport (DSOs)	1	2	1	0
Power plants (TSOs and DSOs)	72	65	36	0
Cross-border IPs	80	60	20	0
Total exit capacity	334	259	**117**	**0**
Entry capacities				
Storage facilities, cross-border IPs and LNG	329	256	116	0
Production (BVEG forecast)	5	3	1	0
Total entry capacity	334	259	**117**	**0**

Source: Gas transmission system operators

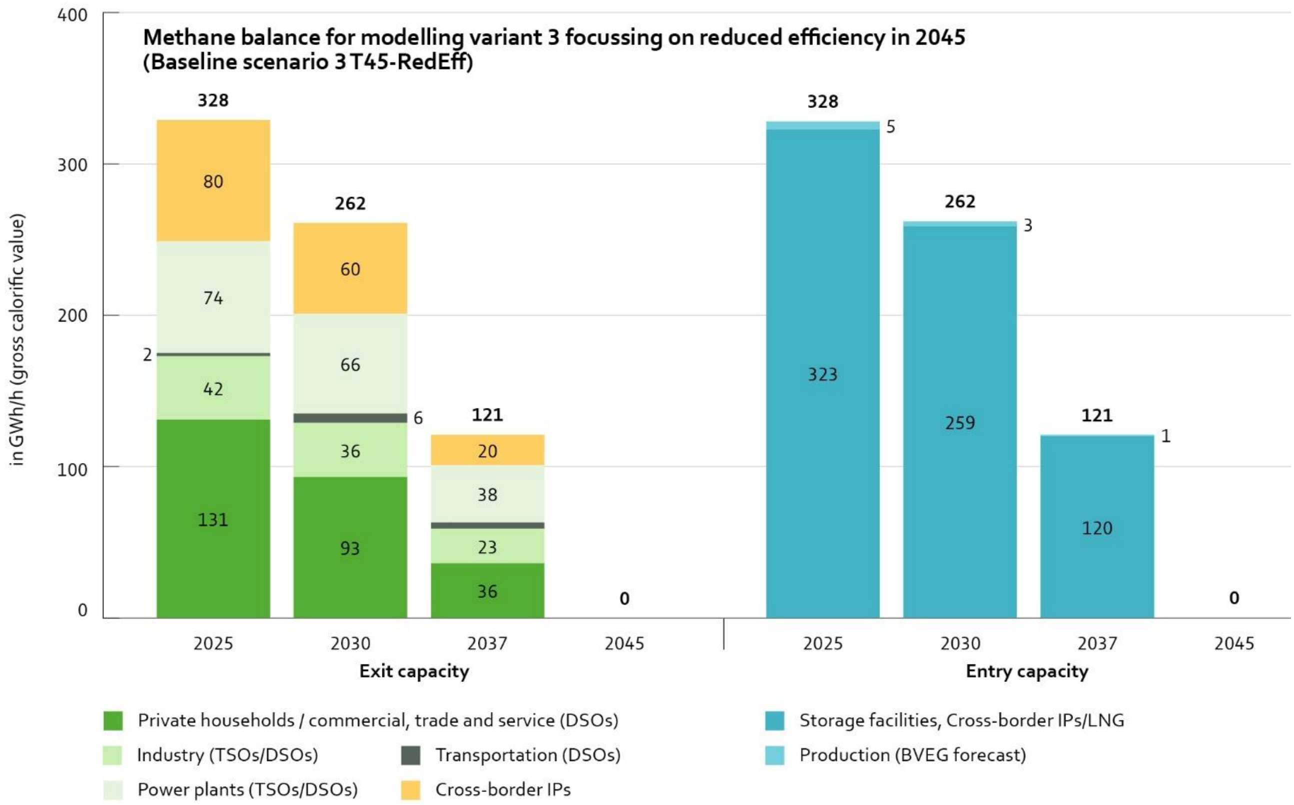
Figure 32: Methane balance for modelling variant 2 focussing on hydrogen in 2037 and 2045 (Baseline scenario 2 T45 H2)



Methane: Modelling variant 2 focussing on hydrogen	2025	2030	2037	2045
	[GWh/h, gross calorific value]			
Exit capacity				
Private households as well as trade, commerce & services (DSOs)	133	90	35	0
Industry (TSOs and DSOs)	41	35	18	0
Transport (DSOs)	2	7	9	0
Power plants (TSOs and DSOs)	48	42	20	0
Cross-border IPs	80	60	20	0
Total exit capacity	305	234	**102**	**0**
Entry capacities				
Storage facilities, cross-border IPs and LNG	300	231	101	0
Production (BVEG forecast)	5	3	1	0
Total entry capacity	305	234	**102**	**0**

Source: Gas transmission system operators

Figure 33: Methane balance for modelling variant 3 focussing on reduced efficiency in 2045 (Baseline scenario 3 T45 RedEff)



Methane: Modelling variant 3 focussing on reduced efficiency	2025	2030	2037	2045
	[GWh/h, gross calorific value]			
Exit capacities				
Private households as well as trade, commerce & services (DSOs)	131	93	36	0
Industry (TSOs and DSOs)	42	36	23	0
Transport (DSOs)	2	6	4	0
Power plants (TSOs and DSOs)	74	66	38	0
Cross-border IPs	80	60	20	0
Total exit capacity	328	262	121	**0**
Entry capacity				
Storage facilities, cross-border IPs and LNG	323	259	120	0
Production (BVEG forecast)	5	3	1	0
Total entry capacity	328	262	121	**0**

Source: Gas transmission system operators

It is evident that the three scenario-based scenarios for 2045 do not differ regarding methane. The gas transmission system operators consider it unnecessary to calculate all three scenarios for 2045. After the switch to hydrogen, there will be a methane network for potential transits or biomethane, which will be described by the gas transmission system operators.

4.3.2.4 Demand-oriented modelling variants for methane in 2030 and 2037

The demand-oriented modelling variants are based on the gas customers' demand reports to the transmission system operators. The individual requirements of the distribution system operators, industry and the power plants have already been presented in chapter 3 .

Methane 2030

As described in chapter 3, the gas transmission system operators have received demand reports, particularly from power plant projects and industry, showing an increasing methane demand for the year 2030. This demand development poses major challenges for the transmission system operators, as the additional exit capacity demand cannot be met by the entry infrastructure assumed in the LNGplus C modelling variant in the Gas Network Development Plan 2022-2032.

Against the background of the power plant strategy, the requesting power plants in particular require reliable gas infrastructure plans, which is why the transmission system operators propose a modelling exercise for the year 2030.

The modelling variant is intended as a basis for enabling the provision of the requested capacities in a timely manner.

Based on current knwoledge the additional capacities on the exit side are not matched by corresponding additional sources on the entry side. As part of the modelling, it will therefore be a central task of the gas transmission system operators to develop proposals for dealing with the under-supplied balancing. It would be conceivable to explore options on the entry side, such as additional entry capacities (gas transfer stations, LNG facilities and storage facilities), as well as on the exit side (including cluster approaches for power plants, assuming simultaneity effects, possibly capacity products).

The balancing rules in the market area ensure that there is no oversupply or undersupply to a market area (balanced balancing groups), regardless of available capacities.

Any expansion measures resulting from this modelling variant must be sustainable. The results of the modelling variant are evaluated together with the results of the modelling for the year 2037. Measures no longer required for methane by 2037 due to the reduced demand will only be of limited benefit if the measures have no subsequent use in the hydrogen system.

The steps required to prepare the demand reports for the modelling variant focussing on security of supply for methane 2030 are listed below:

(1) Prepare methane demand reports

(2) Determine the exit capacities at cross-border IPs

(3) Determine the entry capacities (cross-border IPs, LNG, storage facilities, production).

(1) Methane demand reports

A detailed description of the demand reported by distribution system operators, industry and power plant operators has already been provided in chapter 3.2 . In this scenario for 2030, the distribution system operators' long-term forecasts for methane from the first quarter of 2024 are used. Also included in this variant are the demand by the power plants and industry as well as capacity reservations and expansion claims pursuant to sections 38/39 GasNZV. The complete capacity requirements of the modelling variant for 2030 can be found in Table 43.

The gas transmission system operators will review non-binding industrial demand requests before the start of the modelling process. If an industrial customer has withdrawn its demand request, it will not be included in the modelling process for the Gas and Hydrogen Network Development Plan 2025.

(2) Determine the exit capacities at cross-border IPs

The exit capacities at cross-border IPs are based on the gas transmission system operators' capacity reports which were submitted to the BNetzA in accordance with the ANIKA specification (see Annex 1).

The gas transmission system operators will review the exit capacities at cross-border IPs in consultation with the BNetzA and based onther results of the consultation on the 2025 Scenario Framework.

(3) Determination of entry capacities (cross-border IPs, LNG, storage facilities, production)

The exit capacity determined in the scenario is allocated to the various injection sources, cross-border IPs, storage facilities, LNG and production as part of the modelling. The BVEG forecast is used for the gas production data.

The gas transmission system operators will review additional entry capacities at cross-border IPs. As the entry infrastructures in the LNGplus C modelling variant in the Gas Network Development Plan 2022-2032 were already exhausted in terms of capacity, this potential is limited in the Gas and Hydrogen Network Development Plan 2025. In particular, converted L-gas cross-border Ips are being considered.

The gas transmission system operators will continue to examine whether a higher entry capacity from storage facilities can be included in the modelling.

In addition, the gas transmission system operators welcome feedback from market participants regarding the demand-oriented modelling variant Methane 2030.

Methane 2037

The steps required to prepare the demand reports for the modelling variant focussing on security of supply for methane are listed below:

(1) Update the methane demand reports

(2) Determine the exit capacities at cross-border IPs

(3) Determine the entry capacities (cross-border IPs, LNG, storage facilities, production).

(1) Update the methane demand reports

The gas transmission system operators believe that the approach adopted in certain demand reports (e.g. update of internal orders for the next ten years) is not compatible with the climate protection targets. Furthermore, the current demand reports up to the year 2035 do not indicate that the necessary methane savings will be made to achieve the goal of climate neutrality by 2045. It can be assumed that the distribution system operators have indicated a conservative and wait-and-see path for the long-term forecast in their reports. All municipalities in Germany are obliged by law to draw up municipal heating plans. As part of this planning process, it is expected that methane demand will decrease as heat demand is increasingly met by additional heat pumps, district heating and improved efficiency.

The demand values requested were for the period up to 2035, and these form the basis for the modelling year 2037. This two-year time lag already makes it necessary to update distribution system operators' demand as described below.

Some parts of the distribution system operators' long-term forecasts already include very significant reductions in demand. On average, demand according to the long-term forecasts will fall by around 30 % in 2035 compared to 2024. However, the extent of the reduction in demand varies greatly between individual distribution system operators. While many reduce their demand by 30 % or more, most of them reduce their demand by less than 30 %, with a significant number of long-term forecasts even including a constant extrapolation of internal orders. For this modelling variant, the gas transmission system operators therefore propose to reduce the capacity only for those distribution system operators that have recorded less than the average 30 % reduction. For all these demand indications, the reduction in 2035 compared to 2024 is set uniformly at 30 %. Long-term forecasts that already show a reduction of 30 % or more are not updated. In this context, the gas transmission system operators are looking into the extent to which the long-term hydrogen forecasts, which were reported as substitutes for methane, can be considered in the demand-oriented hydrogen scenario for 2037.

In addition, the gas transmission system operators expect a partial substitution of methane demand by hydrogen or other energy sources, particularly for power plants and industrial users connected to the gas transmission network. This substitution, too, is not yet sufficiently recognisable in the previous demand reports. For these reasons, the transmission system operators have decided that it is justified to reduce the demand reports for the demand-oriented modelling variant for methane.

The methane demand for power plants is based on the existing capacities of the existing gas power plants and the additional connection requests pursuant to sections 38/39 GasNZV (cf. chapter 3.2.2 and 3.2.1.2). According to the German government's power plant strategy, conventional gas power plants are set to be gradually converted to hydrogen between 2035 and 2040. For the modelling year 2037, the transmission system operators therefore propose that a certain percentage of the power plant capacities be counted as hydrogen power plant capacities. One indicator here can be the hydrogen power plants reported in the market survey, which can replace conventional gas generation and thus reduce capacity in the methane network.

The transmission system operators have already identified power plant capacities from the market survey that are to be converted to hydrogen by 2037 (see Annex 2). This leaves the methane requirement for power plants on the gas transmission network at around 37 GW. Furthermore, the transmission system operators propose that a power plant list for the modelling variants be agreed with the BNetzA and the electricity transmission system operators by the end of October 2024 if possible and then approved by the BNetzA. This may result in further adjustments.

With regard to industry, the market survey also asked about the demand for hydrogen that would substitute methane demand and thus reduce capacity in the methane network. This is taken into account accordingly by the transmission system operators. As part of the HPD market survey, only a few industrial customers indicated that this methane substitution also reduces capacity (maximum reduction potential of 27 GWh/h), of which only around 2 GWh/h has been reported as reducing capacity to date. The transmission system operators will therefore examine this approach as part of the modelling process to see whether further capacity can be used from the remaining curtailment potential to reduce capacity demand.

(2) Determine the exit capacities at cross-border IPs

The IP exit capacities approach is based on the continuation of the gas transmission system operators' capacity reports, which were submitted to the BNetzA in accordance with the ANIKA specification. Since no precise information is currently available on the development of gas demand and requirements in neighbouring countries, it is assumed that exports to neighbouring countries will fall by roughly the same amount as demand in Germany in this modelling variant (decline of around 30 %). The exit capacities at cross-border IPs are therefore reduced proportionately in the order of magnitude of the gas demand development in Germany.

(3) Determine the entry capacities (cross-border IPs, LNG, storage facilities, production)

The exit capacity determined in the scenario is allocated to the various injection sources, cross-border IPs, storage facilities, LNG and production as part of the modelling. The BVEG forecast is used for the gas production data.

Methane capacity requirements in 2030 and 2037

The following table shows methane capacity requirements in the 2030 and 2037 modelling variants.

Table 43: Capacity demand of the methane modelling variants 2030 and 2037

Methane demand by sector	2030	2037
	[GWh/h, gross calorific value]	
Long-term forecasts by distribution system operators	241	158
Power plants on the TSO network	81	37
Industry on the TSO network	39	37
Total	**361**	**232**

Source: Gas transmission system operators

The gas transmission system operators have estimated the methane volume demand for this scenario based on the capacity demand as well a range of sectoral full load hours. In 2030, this is more than 700 TWh; in 2037 it will be between 450 TWh and 600 TWh (net calorific value).

Annexes

Annexes

Annex 1: Gas NDP Database

The gas transmission system operators have updated the Gas NDP Database for the Scenario Framework 2025 and are making it available to the public at http://www.nep-gas-datenbank.de.

The Gas NDP Database contains the following "baseline capacities" for the 2025 Scenario Framework cycle (name of the cycle in the Gas NDP Database: "2025 - SR"):

- Methane capacities: cross-border IPs, storage facilities (NAP-UGS), long-term forecast by the distribution system operators (NIP-IO), power plants (NAP-KW), LNG facilities (LNG), industry (NAP-IN), production, biomethane

The Gas NDP Database shows the capacities as of 1 January of the respective year. For example, for the year 2035, the capacities are shown as of 1 January 2035. The capacities shown in the Gas NDP Database are presented for the period 2025 to 2035, analogous to the survey period of the respective demand surveys of the gas transmission system operators. The IP capacities were entered in the Gas NDP Database on the basis of the ANIKA ruling.

The capacities shown in the Gas NDP Database reflect the gas transmission system operators' current state of knowledge and do not include any statement on future marketable capacities. The development of the hydrogen infrastructure based on the use of repurposed existing methane infrastructure will only be possible to a large extent if methane capacities are reduced. A reduction in methane capacities is therefore in the interest of a rapid and efficient development of a Europe-wide hydrogen network.

Annex 2: Results of the market survey for hydrogen projects, incl. power-to-gas plants

An overview of the projects reported as part of the hydrogen market survey and for PtG plants in the context of the gas TSOs' survey of major customers has been prepared in the form of an Excel file with two data sheets.

Annex 3: Gas power plant list

This annex contains an overview of the existing gas power plants according to the BNetzA power plant list. It also features the power plant requests pursuant to sections 38/39 GasNZV, which are taken into account in accordance with the defined criteria for the Scenario Framework 2025 and thus also for the Gas and Hydrogen Network Development Plan 2025. The system-relevant gas power plants are marked in this annex. In addition, it also provides information on the current power plant requests pursuant to sections 38/39 for which a conversion to hydrogen has already been reported as part of the Germany-wide survey of infrastructure requirements for the electricity and hydrogen network.

Annex 4: Long-term forecasts for hydrogen and methane-reducing project reports from distribution system operators

An overview of the long-term forecasts for hydrogen and methane reductions reported by the distribution system operators has been prepared in the form of an Excel file with two data sheets.

Glossary

Glossary

Gas transmission system operators and regulated operators of hydrogen transmission networks

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
ONTRAS	ONTRAS Gastransport GmbH
terranets	terranets bw GmbH
Thyssengas	Thyssengas GmbH

Other abbreviations and acronyms

ACER	European Union Agency for the Cooperation of Energy Regulators
ANIKA	Festlegungsverfahren zur Anerkennung von Instrumenten zur Kapazitätserhöhung - Determination procedure for recognising instruments to increase capacity
BDEW	Bundesverband der Energie- und Wasserwirtschaft e.V. - German Association of Energy and Water Industries e.V.
BEG	Baltic Energy Gate
BK	Beschlusskammer der Bundesnetzagentur - Ruling Chamber of the Federal Network Agency
BKartA	Bundeskartellamt - Federal Cartel Office
BMWK	Bundesministerium für Wirtschaft und Klimaschutz - Federal Ministry for Economic Affairs and Climate Action
BNetzA	Bundesnetzagentur - German Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railway
BVEG	Bundesverband Erdgas, Erdöl und Geoenergie e. V. - German Federal Association for Natural Gas, Petroleum and Geoenergy
CCGT	Combined-Cycle Gas Turbine
CEGH	Central European Gas Hub

CGHI	Czech German Hydrogen Interconnector
CH4	Methane
CHP	Combined heat and power plant
DBI	Unabhängige Unternehmensgruppe des DVGW e.V. - Independent group of companies of DVGW e.V.
DEA	Danish Energy Agency
dena	Deutsche Energie-Agentur - German Energy Agency GmbH
DSO	Distribution system operator
DVGW	Deutscher Verein des Gas- und Wasserfaches e.V. - German Technical and Scientific Association for Gas and Water
EEZ	Exclusive Economic Zone
Electricity TSO	Electricity transmission system operator
ENDK	Energinet.dk
ENTSOG	European Network of Transmission System Operators Gas
EnWG	Energiewirtschaftsgesetz - German Energy Industry Act
EU	European Union
EUGAL	Europäische Gas-Anbindungsleitung - European gas interconnector
fDZK	Feste dynamisch zuordenbare Kapazität - Firm dynamically allocable capacity
FID	Final investment decision
FNB Gas	Vereinigung der Fernleitungsnetzbetreiber Gas e.V. - Association of Gas Transmission System Operators Gas e.V.
FSRU	Floating Storage and Regasification Unit
FZK	Frei zuordenbare Kapazität - Freely allocable capacities
GasNZV	Verordnung über den Zugang zu Gasversorgungsnetzen/Gasnetzzugangsverordnung - German Gas Network Access Regulation
Gas TSO	Gas transmission system operator
GCA	Gas Connect Austria
gcv	Gross calorific value
GTP	Gasnetzgebietstransformationsplan - Gas network area transformation plan
GTS	Gasunie Transport Services B. V.
GW/GWh	Gigawatt/gigawatt hour
H2	Hydrogen
H-gas	Natural gas with a high gross calorific value (high calorific value)
HPD	Hydrogen Production and Demand
IO	Internal order

INES	Initiative Energien Speichern e. V. - association of German gas and hydrogen storage system operators
IP	(cross border) Interconnection Point
IPCEI	Important Projects of Common European Interest
KAP+	Genehmigung eines Überbuchungs- und Rückkaufsystems der Fernleitungsnetzbetreiber für das Angebot zusätzlicher Kapazitäten im deutschlandweiten Marktgebiet - Authorisation of an overbooking and buy-back system of the gas transmission system operator for the offer of additional capacities in the Germany-wide market area
KARLA	Festlegung in Sachen Kapazitätsregelungen und Auktionsverfahren im Gassektor - Determination of capacity regulations and auction procedures in the gas sector
KASPAR	Festlegung in Sachen Standardisierung von Kapazitätsprodukten im Gassektor (Kapazitätsproduktstandardisierung) - Determination of the standardisation of capacity products in the gas sector (capacity product standardisation)
KO.NEP	Koordinierungsstelle für Netzentwicklungsplanung Gas und Wasserstoff - Coordination Office for Integrated Network Development Planning Gas and Hydrogen at FNB Gas
KoV	Kooperationsvereinbarung - Cooperation agreement between the operators of gas supply networks located in Germany
KraftNAV	Verordnung zur Regelung des Netzanschlusses von Anlagen zur Erzeugung von elektrischer Energie - Power Plant Grid Connection Ordinance
kWh	Kilowatt hour
L-gas	Natural gas with a low calorific value
LFS	Langfristszenario – lang-terms scenario
LNG	Liquefied Natural Gas
m^3	Cubic metre; unless otherwise specified, this refers to a normal cubic metre
MBI	Market-based instruments
MW/MWh	Megawatt/megawatt hour
NBHC	Nordic-Baltic Hydrogen Corridor
NC CAM	Network Codes Capacity Allocation Mechanisms
NDP	Network Development Plan
NEL	Nordeuropäische Erdgas-Leitung - Northern European natural gas pipeline
NewCap	Model for determining the market-based instruments
NIP	Network Interconnection Point
Nm^3	Standard cubic metre
PCI	Project of Common Interest
PtG	Power-to-Gas
RedEff	Reduced Efficiency
SDS	System Development Strategy
SLP	Standard-Last-Profil - Standard load profile

SR	Szenario-Rahmen - Scenario Framework
TENP	Trans-Europe Natural gas Pipeline
THE	Trading Hub Europe
TSO	(Gas) Transmission System Operator
TWh	Terawatt hour
TYNDP	Ten-Year Network Development Plan (from ENTSOG)
UGS	Under Ground Storage
VIP	Virtual Interconnection Point
VTP	Virtual Trading Point
WGV	Working Gas Volume
WP	Heat pump
WPG	Wärmeplanungsgesetz - "Heat Planning Act", law for heat planning and the decarbonisation of heating networks

Literature

Literature

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