

Gas Network Development Plan 2020-2030

Modelling results for green gas variant

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Agenda

- Basic approach
- Natural gas modelling
- Hydrogen modelling
- Modelling results
- Outlook

Background

- Integrating **green gases (hydrogen, synthetic methane)** into the existing infrastructure will make a substantial contribution to carbon emission reductions in a quick and cost-effective way.
- From the transmission system operators' point of view, the **conversion of the current gas infrastructure** to green gases in general and hydrogen in particular will require the close involvement of all market participants.
- For this reason, the gas transmission system operators conducted a **market partner survey for green gas projects** from 21 March 2019 to 12 July 2019 as part of their work to prepare the scenario framework.
- In its confirmation of the scenario framework, the Federal Network Agency obliges the transmission system operators to take into account the planned green gas projects identified by the market partner survey in a separate modelling variant (green gas variant) for the years 2025 and 2030.

Basic approach

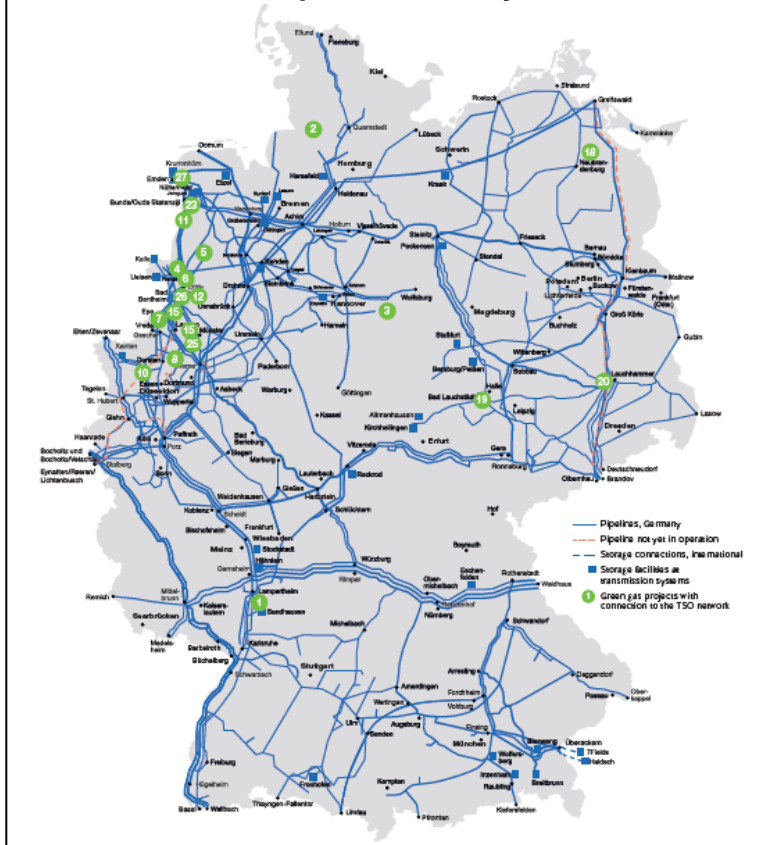
Modelling approach for green gas variant

- Identification of a **potential hydrogen network** (basis: green gas projects according to market partner survey and visionary hydrogen network).
- **Natural gas modelling:** Identification of pipelines that can be converted from natural gas to hydrogen (additional model for blending hydrogen into natural gas networks).
- **Hydrogen modelling:** Modelling of hydrogen transmission in a separate hydrogen network comprising the identified (and converted) natural gas pipelines as well as new pipelines required.
- For projects where the use of converted hydrogen pipelines is not an option and the construction of new hydrogen pipelines does not appear sensible, modelling will involve the **admixture** of pure hydrogen or synthetic methane into the natural gas network.

Potential hydrogen network

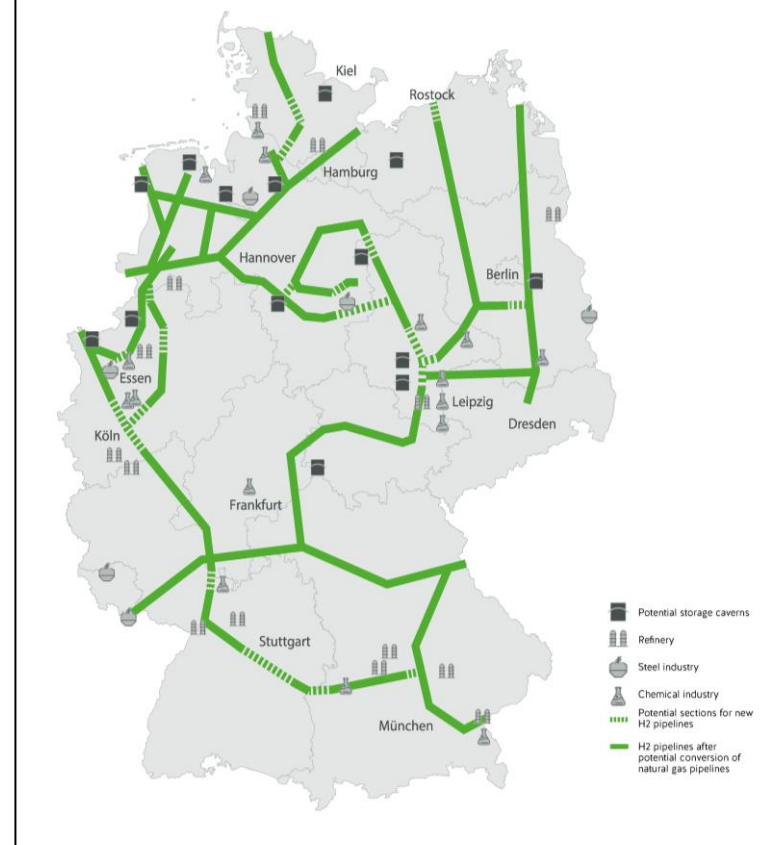
Approach

Results of market partner survey



Source: Transmission system operators, Fig. 37/ Fig. 46 NDP Gas 2020-2030

Visionary hydrogen network



► Comparison of visionary hydrogen network with projects acc. to market partner survey

Natural gas modelling

Approach

Identification of suitable natural gas pipelines for hydrogen transportation

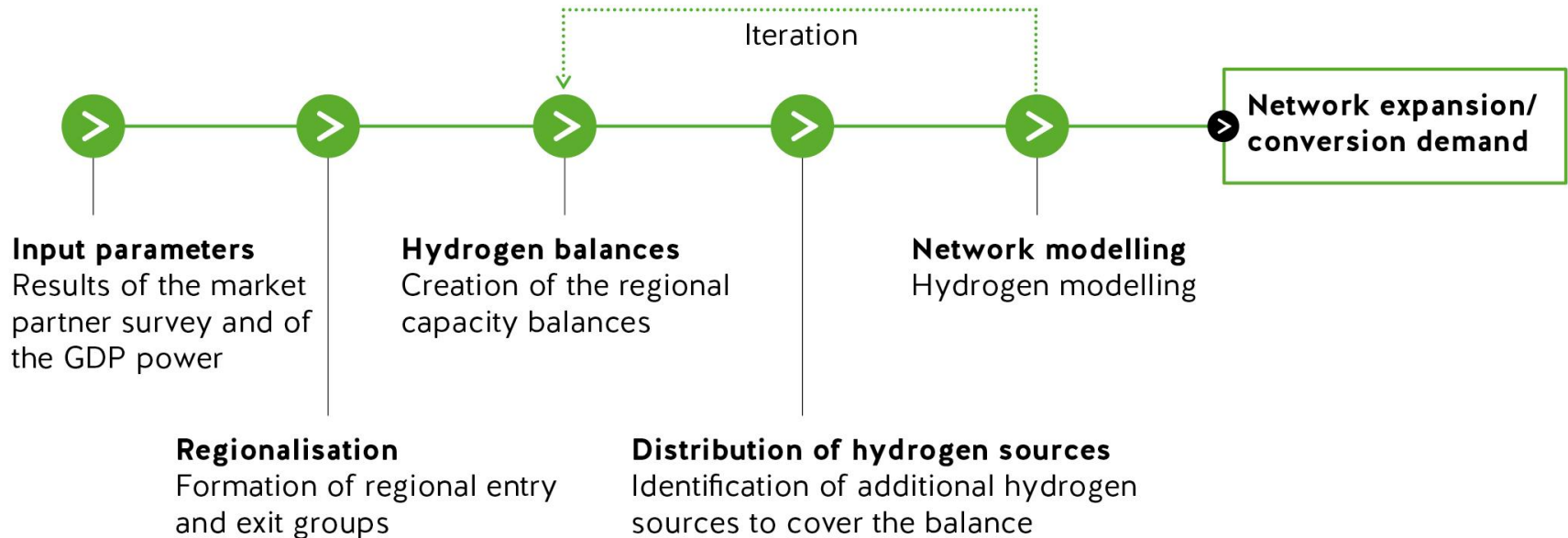
- Natural gas modelling involves examining which pipelines can be made available for hydrogen modelling.
- The review also looks at the construction of new natural gas pipelines to avoid major hydrogen network expansion measures.

Review of options for hydrogen blending into natural gas network

- For projects that cannot be connected to the identified hydrogen network (distance too great, new pipeline not economically viable), blending or methanisation is being looked into.
- A maximum blending rate of 2 % is assumed for modelling purposes to avoid significant investments on both the network infrastructure and the consumer side.

Hydrogen modelling

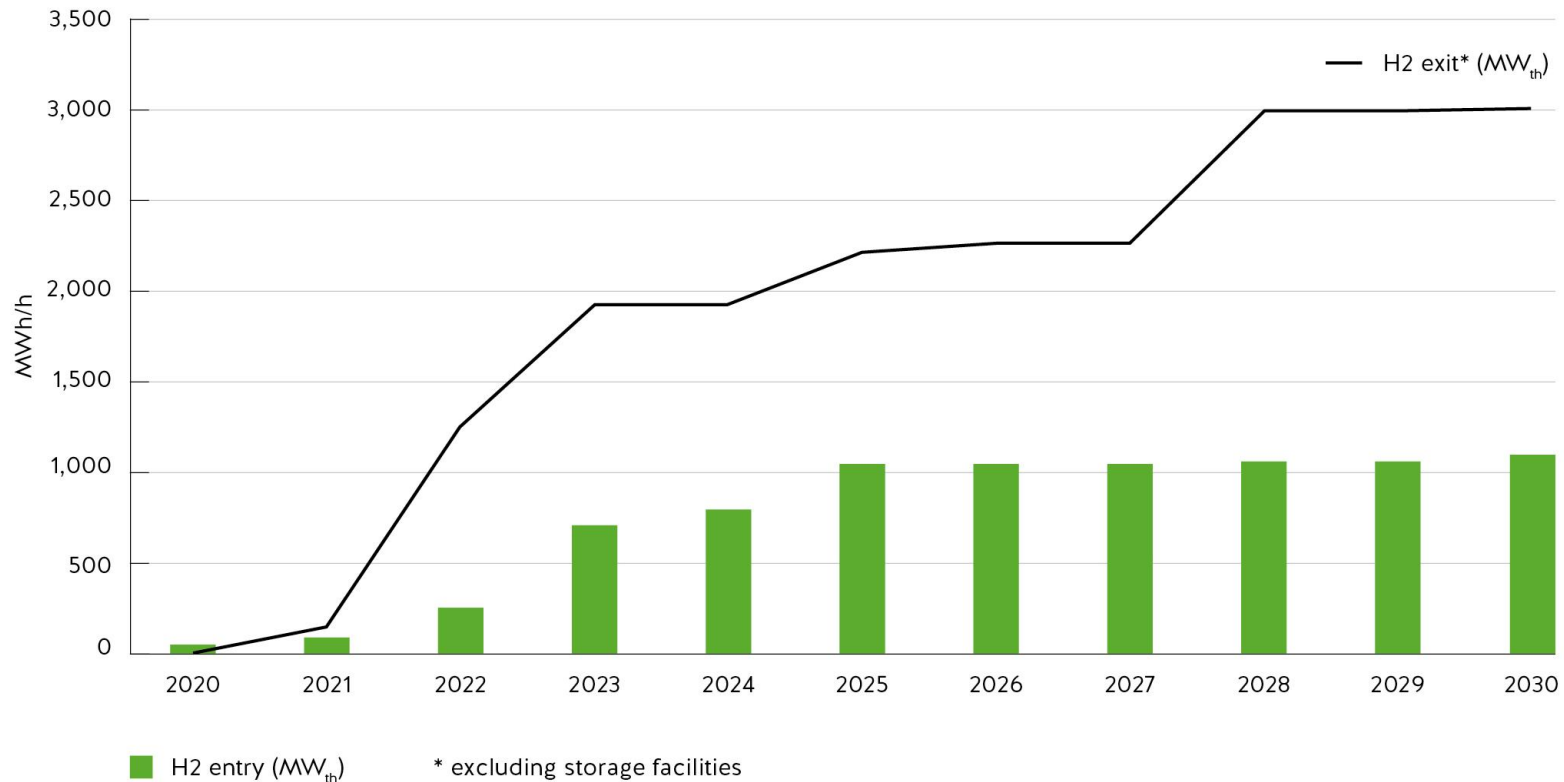
Approach



Source: Transmission system operators, Fig. 38 NDP Gas 2020-2030

Hydrogen modelling

Results market of partner survey



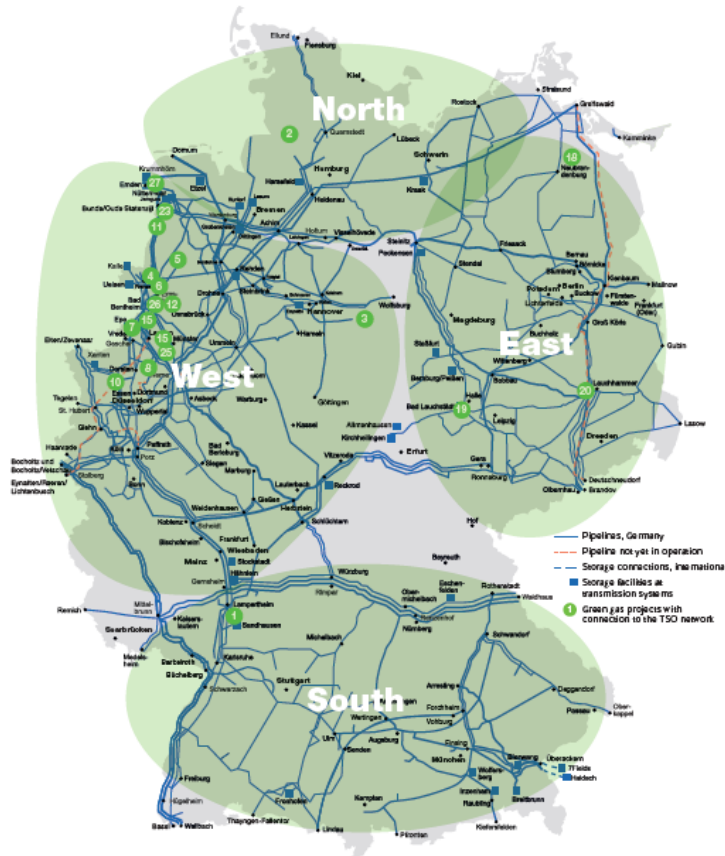
Source: Transmission system operators, Fig. 39 NDP Gas 2020-2030

- ▶ Additional hydrogen demand: 1,166 MW_{th} (2025) and 1,906 MW_{th} (2030).
- ▶ Additional demand to be met from other hydrogen sources.

Hydrogen modelling

Regional view

Overview of regions



Source: Transmission system operators, Fig. 40 NDP Gas 2020-2030

Northern region

- One project for feeding green gas into network (HySynGas/ARGE), no demand reported
- No hydrogen infrastructure available; admixture/methanisation will therefore be necessary

Eastern region

- Development of a local hydrogen network involving the conversion of a natural gas pipeline (Bad Lauchstädt Energy Park project)

Southern region

- The demand identified for a project in Ludwigshafen (BASF) cannot be met demand until 2030
- One project in Bavaria (anonymous)

Western region

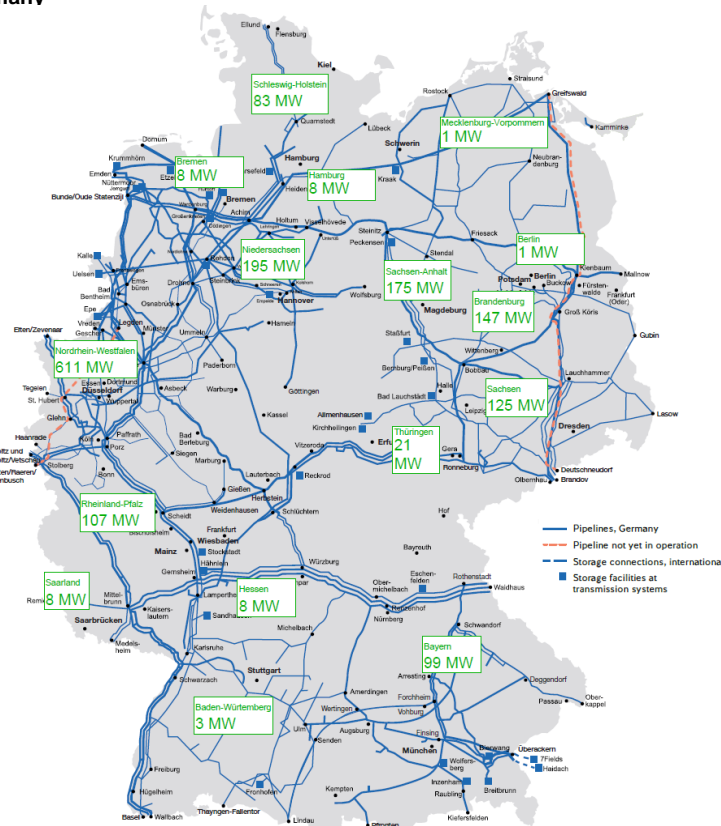
- Focus region of market partner surveys
- Formation of a balancing area necessary

► Summary of reported projects in geographical proximity.

Hydrogen modelling

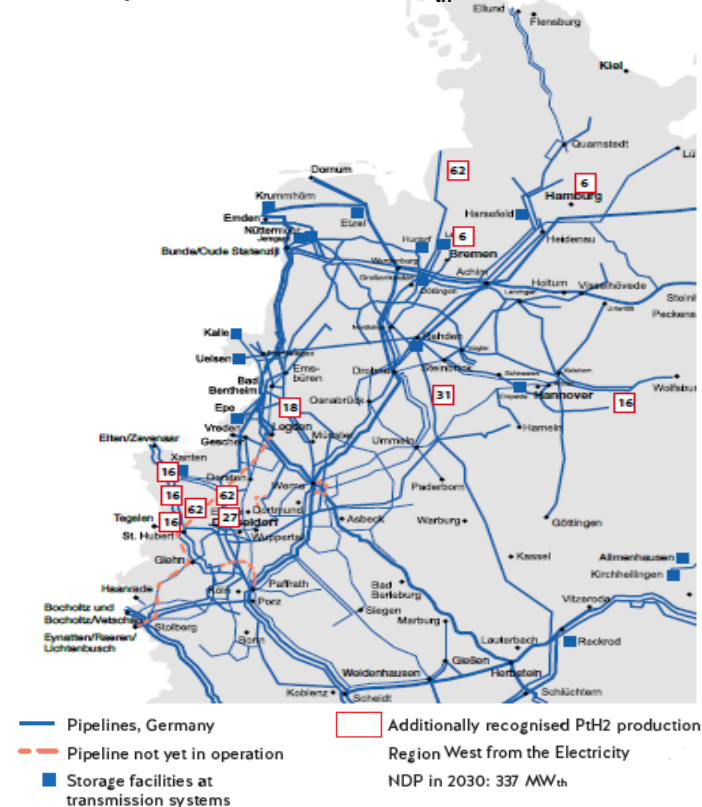
Electricity NDP taken into account

Electrolysis capacity acc. to Electricity NDP in 2030: 1.6 GW_e
 Germany



Source: Transmission system operators

Western region: Electrolysis capacities acc. to
 Electricity NDP in 2030: 0.337 GW_{th}



Source: Transmission system operators, Fig. 41 NDP Gas 2020-2030

► Electrolysis capacities of Electricity NDP taken into account for balancing needs.

Western region

Hydrogen balance incl. combination with the Electricity NDP

Year	Entry in total	Additional capacity, GDP power	Exit* in total	Additional demand
	MW_{th}			
2025	803	40	1,730	887
2030	890	337	2,751	1,523

* excluding storage facilities

Source: Transmission system operators, Tab. 41 NDP Gas 2020-2030

- Electricity NDP provides additional electrolysis capacities to meet hydrogen demand (after combination with the results of the market partner survey).
- Remaining hydrogen demand of 887 MW_{th} (2025) and 1,523 MW_{th} (2030) must be met from additional sources.

Western region

Distribution of hydrogen sources

The following potential hydrogen sources have been considered

Import of decarbonised hydrogen ("green" or "blue")

- TSOs see potential of up to 10 GW_{th} in the Netherlands, of which around 1 GW_{th} could be available for export to Germany by 2030
- Percentage distribution to meet additional demand: 70 %

Domestic production of "green" hydrogen from onshore wind farms whose renewable energy subsidies are expiring

- TSOs see potential of up to 10.8 GW_e
- Percentage distribution to meet additional demand: 20 %

Storage facilities

- Following consultations with Initiative Erdgasspeicher e.V. (INES), the TSOs see a potential of up to 500 MW_{th}
- Percentage distribution to meet additional demand: 10 %

Western region

Results of hydrogen source distribution

	Additional demand (MW _{th})	
	2025	2030
Importing of decarbonised hydrogen from the Netherlands	500	1,066
Domestic production of “green” hydrogen from onshore wind farms where the renewable energy sources subsidy has expired	235	305
Storage facilities	152	152
Total additional demand	887	1,523

Source: Transmission system operators, Tab. 42 NDP Gas 2020-2030

- Additional entry capacities agreed in advance with Gasunie Transport Services B.V. (GTS) and INES.
- In 2025, less than 70 % of the required capacity from the Netherlands will be available, therefore slight adjustments to distribution.

Western region

Hydrogen balance incl. additional feed-in sources

Year	Entry in total	Additional capacity, GDP power	Additional capacity, NL imports	Additional capacity, wind farms	Additional capacity, storage facilities	Exit* in total
	MW _{th}					
2025	803	40	500	235	152	1,730
2030	890	337	1,066	305	152	2,751

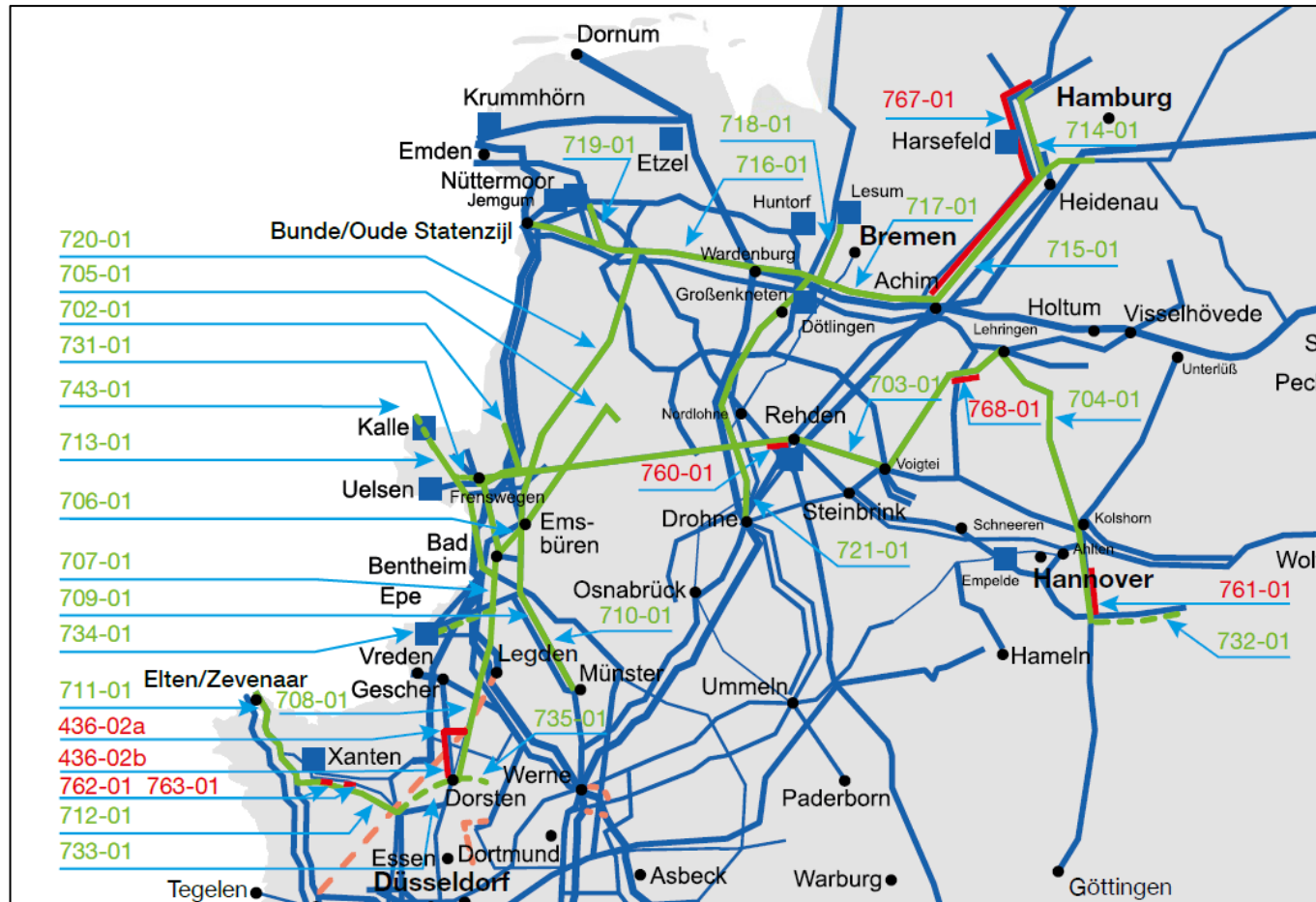
* excluding storage facilities

Source: Transmission system operators, Tab. 43 NDP Gas 2020-2030

- Hydrogen demand in western region is fully met by additional quantities fed into grid.
- In the model, the entry point for the capacity from the Netherlands in 2025 has been assumed to be the Vlieghuis area, in 2030 it is Elten.
- Other potential entry points from the Netherlands are Vreden and Oude/Statenzijl.

Modelling results

Overview of hydrogen network in western region (2030)



excluding GPCM stations, valve stations and other facilities

Source: Transmission system operators, Fig. 43 NDP Gas 2020-2030

Modelling results for western region

Hydrogen network in 2025 (1)

Vlieghuis-Kalle
 TSO tbd., COD*: 2025
 € 12.1m
 ID No. 743-01

Kalle-Ochtrup
 TG, COD: 2025
 € 9,8m
 ID No. 713-01

Frensdorfer Bruchgraben-Frenswegen
 TSO tbd., COD: 2025
 € 2.5m
 ID No. 731-01

Emsbüren-Bad Bentheim
 OGE, COD: 2026
 € 3.6m
 ID No. 706-01

Lingen-Bad Bentheim
 Nowega, COD: 2022
 € 9m
 ID No. 702-01

Bad Bentheim-Legden
 OGE/Nowega, COD: 2022
 € 6.6m
 ID No. 707-01

Bunde/Oude Statenzijl

702-01

731-01

743-01

713-01

706-01

707-01

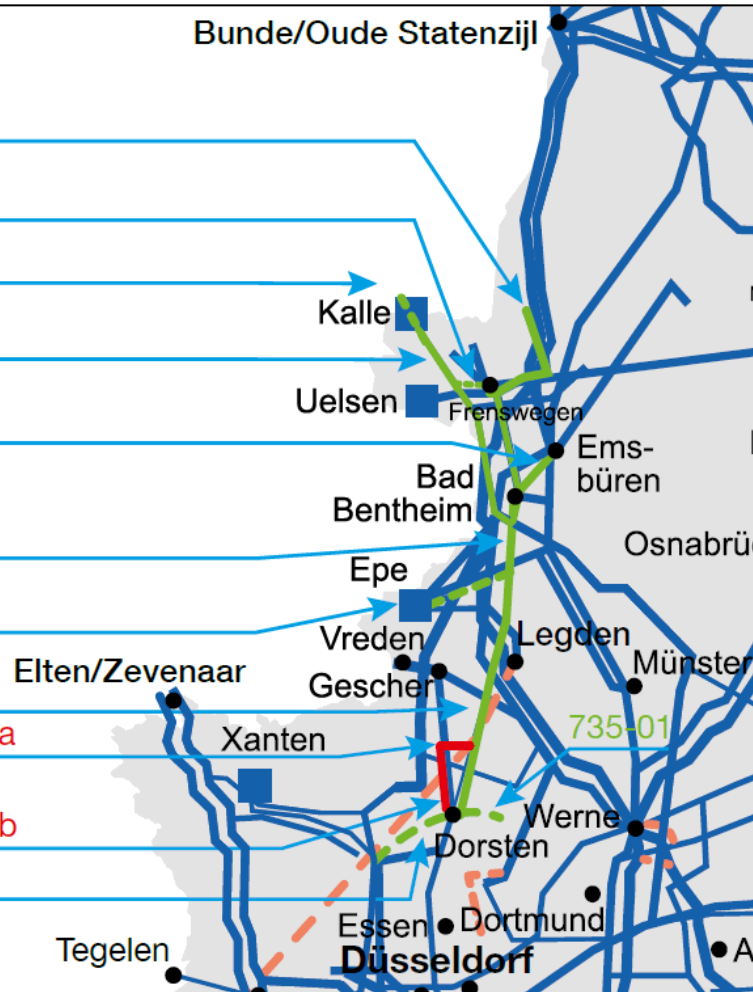
734-01

708-01

436-02a

436-02b

733-01



Epe-Ochtrup
 TSO tbd., COD: 2026
 € 14.9m
 ID No. 734-01

Legden-Dorsten
 OGE/Nowega, COD: 2026
 € 11.5m
 ID No. 708-01

Heiden Marbeck-H. Borken
 OGE, COD: 2026
 € 4m
 ID No. 436-02a

Heiden Borken-Dorsten
 OGE, COD: 2026
 € 25m
 ID No. 436-02b

Dorsten-Marl
 TSO tbd., COD: 2026
 € 11.9m
 ID No. 735-01

Dorsten-Hamborn
 TSO tbd., COD: 2026
 € 69.5m
 ID No. 733-01

*COD = commercial operating date

excluding GPCM stations, valve stations and other facilities

Source: Transmission system operators, Fig. 42 NDP Gas 2020-2030

Modelling results for western region

Hydrogen network in 2025 (2)

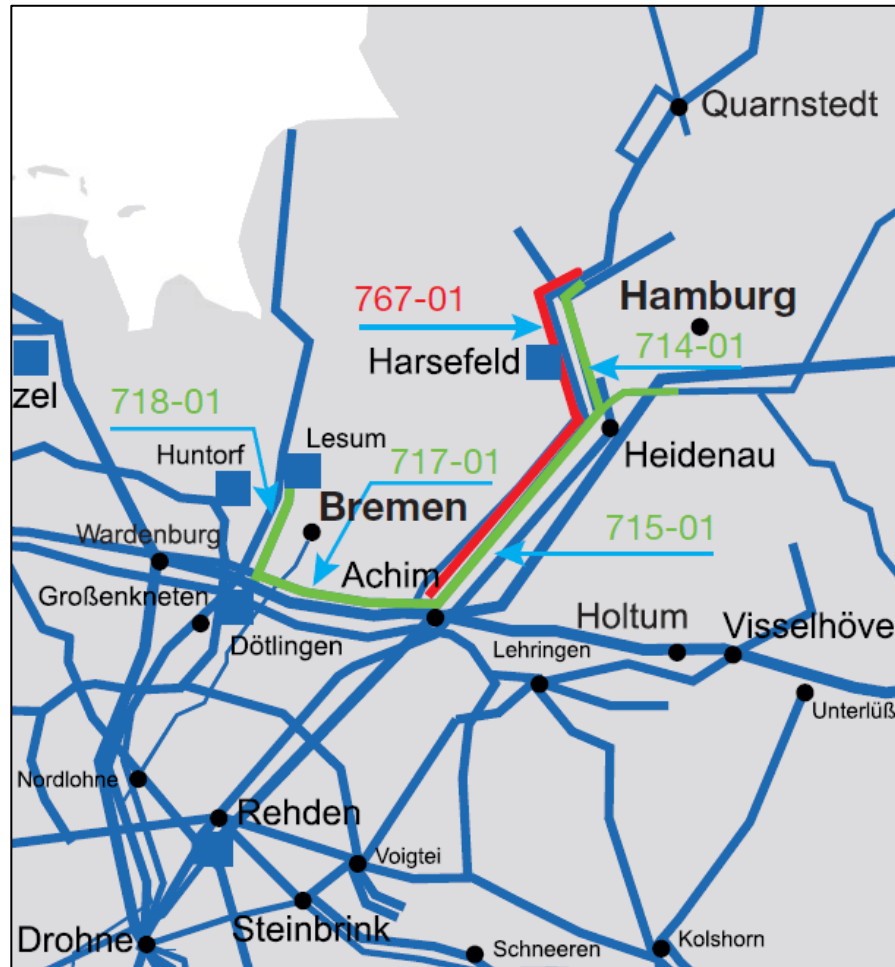
Ganderkesee-Bremen
 GUD, COD*: 2025
 € 3.5m
 ID No. 718-01

Ganderkesee-Achim
 GUD, COD: 2025
 € 8m
 ID No. 717-01

Elbe Süd-Heidenau
 GUD, COD: 2025
 € 8m
 ID No. 714-01

Eckel-Achim
 GUD, COD: 2025
 € 15m
 ID No. 715-01

Elbe Süd-Achim
 GUD, COD: 2025
 € 253m
 ID No. 767-01



*COD = commercial operating date

excluding GPCM stations, valve stations and other facilities

Source: Transmission system operators, Fig. 42 NDP Gas 2020-2030

Modelling results for western region

Hydrogen network in 2030 (1)

Vlieghuis-Kalle
 TSO tbd., COD*: 2025
 € 12.1m
 ID No. 743-01

Kalle-Ochtrup
 TG, COD: 2025
 € 9.8m
 ID No. 713-01

Frensdorfer Bruchgraben-Frenswegen
 TSO tbd., COD: 2025
 € 2.5m
 ID No. 731-01

Löningen-Emsbüren
 OGE, COD: 2030
 € 7.8m
 ID No. 705-01

Emsbüren-Bad Bentheim
 OGE, COD: 2026
 € 3.6m
 ID No. 706-01

Lingen-Bad Bentheim
 Nowega, COD: 2022
 € 9m
 ID No. 702-01

Bad Bentheim-Legden
 OGE/Nowega,
 COD: 2022
 € 6.6m
 ID No. 707-01

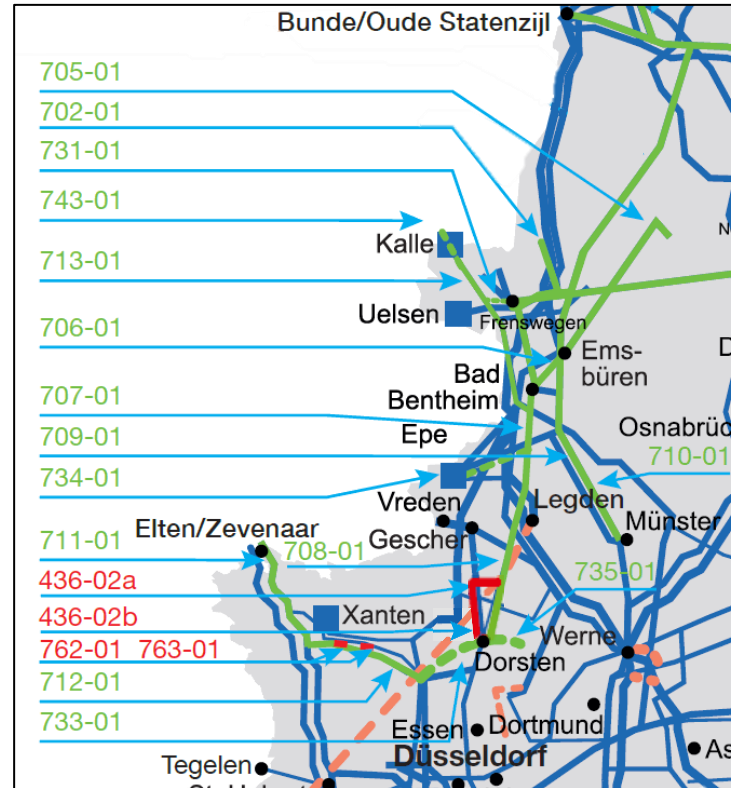
Epe-Ochtrup
 TSO tbd., COD: 2026
 € 14.9m
 ID No. 734-01

Legden-Dorsten
 OGE/Nowega,
 COD: 2026
 € 11.5m
 ID No. 708-01

Heiden Marbeck-Heiden Borken
 OGE, COD: 2026
 € 4m
 ID No. 436-02a

Heiden Borken-Dorsten
 OGE, COD: 2026
 € 25m
 ID No. 436-02b

Dorsten-Marl
 TSO tbd., COD: 2026
 € 11.9m
 ID No. 735-01



Dorsten-Hamborn
 TSO tbd., COD: 2026
 € 69.5m
 ID No. 733-01

Sonsbeck-Hamborn
 OGE/TG, COD: 2030
 € 38.3m
 ID No. 712-01

Budberg-Eversael
 TG, COD: 2030
 € 2m
 ID No. 763-01

Wallach-Alpen
 TG, COD: 2030
 € 4m
 ID No. 762-01

Elten-Sonsbeck (NETG)
 OGE/TG, COD: 2030
 € 37.9m
 ID No. 711-01

Rheine-Wettringen
 OGE, COD: 2030
 € 8.2m
 ID No. 709-01

Wettringen-Albachten
 OGE, COD: 2030
 € 16.3m
 ID No. 710-01

excluding GPCM stations, valve stations and other facilities

Source: Transmission system operators, Fig. 43 NDP Gas 2020-2030

*COD = commercial operating date

Modelling results for western region

Hydrogen network in 2030 (2)

OSZ-Ganderkesee
 GUD, COD*: 2030
 € 18m
 ID No. 716-01

Ganderkesee-Achim
 GUD, COD: 2025
 € 8m
 ID No. 717-01

Folmhusen-Nüttermoor
 GUD, COD: 2030
 € 4m
 ID No. 719-01

Eckel-Achim
 GUD, COD: 2025
 € 15m
 ID No. 715-01

Barßel-Rheine
 GUD, COD: 2030
 € 22m
 ID No. 720-01

Elbe Süd-Heidenau
 GUD, COD: 2025
 € 8m
 ID No. 714-01

Ganderkesee-Bremen
 GUD, COD: 2025
 € 3.5m
 ID No. 718-01

Elbe Süd-Achim
 GUD, COD: 2025
 € 261m
 ID No. 767-01

Ganderkesee-Drohne
 GUD, COD: 2030
 € 16m
 ID No. 721-01

Messingen-Egenstedt
 Nowega, COD: 2030
 € 30m
 ID No. 703-01

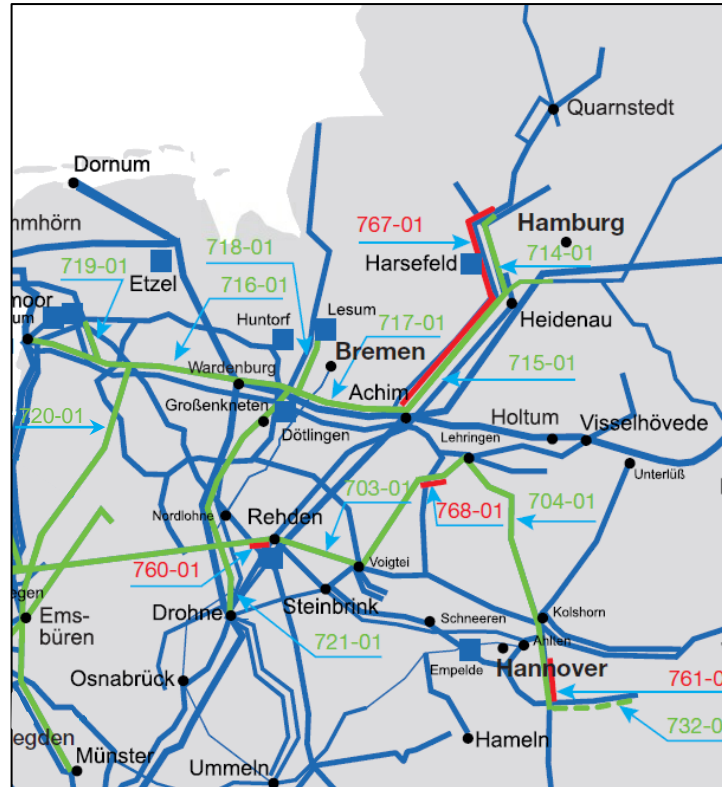
Rehden-Diepholz
 Nowega., COD: 2030
 € 11.8m
 ID No. 760-01

Mitte Weser-Kolshorn
 GUD/Nowega,
 COD: 2030
 € 19m
 ID No. 704-01

Hassel-Westen
 GUD, COD: 2030
 € 12m
 ID No. 768-01

Egenstedt-Clauen
 Nowega, COD: 2030
 € 22m
 ID No. 761-01

Egenstedt-Hallendorf
 TSO tbd., COD: 2030
 € 40m
 ID No. 732-01



excluding GPCM stations, valve stations and other facilities

Source: Transmission system operators, Fig. 43 NDP Gas 2020-2030

*COD = commercial operating date

Results of green gas variant

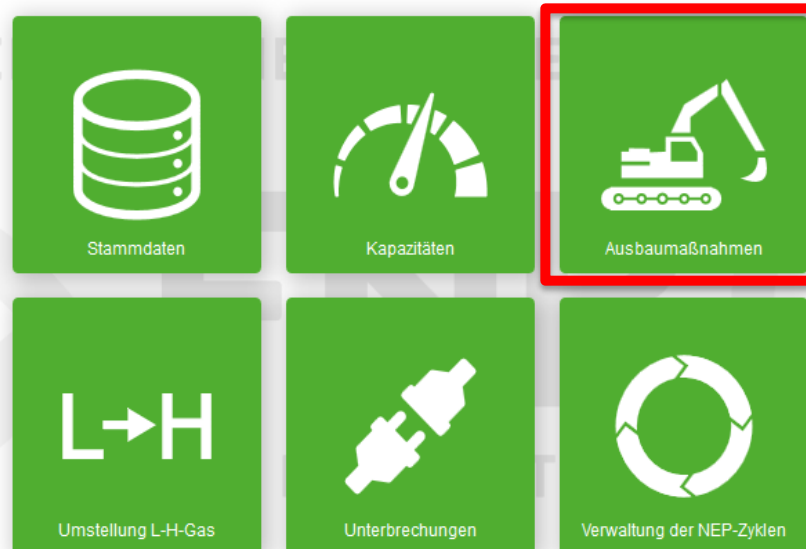
	Up to the end of 2025	Up to the end of 2030
Modelling result in addition to the base variant		
Compressor stations	0 MW	0 MW
Pipelines	471 km	1,294 km
– of which converted pipelines	389 km	1,142 km
– of which new hydrogen pipelines	63 km	94 km
– of which new H-gas pipelines	19 km	57 km
Additional costs in comparison with the base variant		
Conversion of natural gas pipelines	EUR 82 million	EUR 310 million
New construction measures, hydrogen modelling	EUR 128 million	EUR 220 million
New construction measures, natural gas modelling	EUR 84 million	EUR 132 million
Additional total costs	EUR 294 million	EUR 662 million

Source: Transmission system operators, Tab. 44 NDP Gas 2020-2030

- Additional investments (without connecting pipelines and without any compressors that may be required)
 - € 294m by the end of 2025, and
 - € 662m by the end of 2030
- Project implementation will depend on existing legal regulations for (natural) gas networks also becoming applicable to hydrogen networks.

Green gases in the NDP database

- www.nep-gas-datenbank.de



- Table of all expansion projects
- Project profiles

Green gases in the NDP database

Selection of cycle

NEP-Gas-Datenbank

Ausbaumaßnahmen

Suche

Beteiligter FNB: OGE

☐ Nur Ausbautorschläge der FNB ☐ Nur Startnetzmaßnahmen ☒ Nur aktuelle Version anzeigen

Ausgewählter NEP-Zyklus: 2020 - NEP Konsultation

Kürzel	Versionsnum...	Name	Länge	Nenndurchm...	Druckstufe DP	Verdichterszusammensetzung (...)	Anlagenleistu...	Maßnahmenart	OGE-Anteil d...	Ausbauvorse...	Startnetzmaß...	Netzausbau g...	Durchführende FNB	Termin bis
652	01	GDRM-Anlage Engelbostel und Verbindungsleitung	0,1 km	300 mm	70 bar		40.000 m³/h	GDRM-Anlage	1 Mio €	✓			OGE	12/2022
653	01	GDRM-Anlage Kleinenhammer und Verbindungsleitung	0,1 km	400 mm	16 bar		15.000 m³/h	GDRM-Anlage	1 Mio €	✓			OGE	12/2028
654	01	Armaturenstation Isenrohn Hennen						Armaturenstati...	1 Mio €	✓			OGE	12/2021
655	01	Armaturenstation Essen Dellwig und Verbindungsleit...	0,2 km	700 mm	70 bar			Armaturenstati...	2,2 Mio €	✓			OGE	12/2026
656	01	Armaturenstation Dulsburg Mündelheim und Verbind...	0,1 km	700 mm	70 bar			Armaturenstati...	0,8 Mio €	✓			OGE (78%) / Thyssengas (22%)	12/2026
705	01	Umstellung Leitungssystem Lönningen-Emsbüren	55 km	400 mm	70 bar			Leitung	7,1 Mio €	✓			OGE	12/2030
706	01	Umstellung Leitungssystem Emsbüren-Bad Bentheim	15 km	400 mm	70 bar			Leitung	3,4 Mio €	✓			OGE	12/2026
707	01	Umstellung Leitungssystem Bad Bentheim-Legden	31 km	400 mm	70 bar			Leitung	3,3 Mio €	✓			Nowega (50%) / OGE (50%)	12/2026
708	01	Umstellung Leitungssystem Legden-Dorsten	38 km	400 mm	70 bar			Leitung	5,4 Mio €	✓			Nowega (50%) / OGE (50%)	12/2026
709	01	Umstellung Leitungssystem Rheine-Wettringen	3,5 km	800 mm	70 bar			Leitung	7,4 Mio €	✓			OGE	12/2030
710	01	Umstellung Leitungssystem Wettringen-Albachten	43,2 km	800 mm	100 bar			Leitung	14,8 Mio €	✓			OGE	12/2030
711	01	Umstellung Leitungssystem Elten-Sonsbeck (NETG)	42,3 km	900 mm	70 bar			Leitung	17,2 Mio €	✓			OGE (50%) / Thyssengas (50%)	12/2030
712	01	Umstellung Leitungssystem Sonsbeck-Hamborn	34 km	500 mm	50 bar			Leitung	17,4 Mio €	✓			OGE (50%) / Thyssengas (50%)	12/2030
733	01	Neubau Leitung Dorsten-Hamborn	37 km	600 mm	70 bar			Leitung	65,5 Mio €	✓			OGE	12/2026
734	01	Neubau Leitung Epe-Ochtrup	10 km	300 mm	70 bar			Leitung	14 Mio €	✓			Nowega / OGE	12/2026
735	01	Neubau Leitung Dorsten-Marl	8 km	300 mm	70 bar			Leitung	11,2 Mio €	✓			Nowega / OGE	12/2026
736	01	GDRM-Anlage Elten und Verbindungsleitung	0,1 km	600 mm	100 bar		550.000 m³/h	GDRM-Anlage	5 Mio €	✓			OGE (50%) / Thyssengas (50%)	12/2030
737	01	GDRM-Anlage Sonsbeck und Verbindungsleitung	0,1 km	600 mm	100 bar		550.000 m³/h	GDRM-Anlage	5 Mio €	✓			OGE (50%) / Thyssengas (50%)	12/2030
738	01	GDRM-Anlage Hamborn und Verbindungsleitung	0,1 km	600 mm	100 bar		550.000 m³/h	GDRM-Anlage	5 Mio €	✓			OGE (50%) / Thyssengas (50%)	12/2030
739	01	GDRM-Anlage Dorsten und Verbindungsleitung	0,1 km	600 mm	100 bar		550.000 m³/h	GDRM-Anlage	10 Mio €	✓			Nowega / OGE	12/2026
740	01	GDRM-Anlage Bad Bentheim und Verbindungsleitung	0,1 km	300 mm	100 bar		130.000 m³/h	GDRM-Anlage	6 Mio €	✓			Nowega / OGE	12/2026
741	01	GDRM-Anlage Emsbüren und Verbindungsleitung	0,1 km	500 mm	100 bar		250.000 m³/h	GDRM-Anlage	7 Mio €	✓			OGE	12/2030
742	01	Armaturenstation Wettringen und Verbindungsleitung	0,3 km	800 mm	70 bar			Armaturenstati...	4,2 Mio €	✓			OGE	12/2030

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- Cycle: "2020 - NEP Konsultation"
- Can be exported as Excel file

Outlook on future network development plans

Green gases

- **Criteria** for including **green gas projects** in future network development plans have been put up for consultation
 - Transmission system operators are asking all market participants to comment
- **Capacity product for green gas projects** will depend on future market model and regulatory aspects
- Transmission system operators are continuing to develop their **visionary hydrogen network** on the basis of new findings

Integrated network planning

- Energy and climate policy objectives require **joint planning of energy infrastructure**
- More details to be clarified **together with the transmission system operators** and other stakeholders as part of the dena network study III

Thank You

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