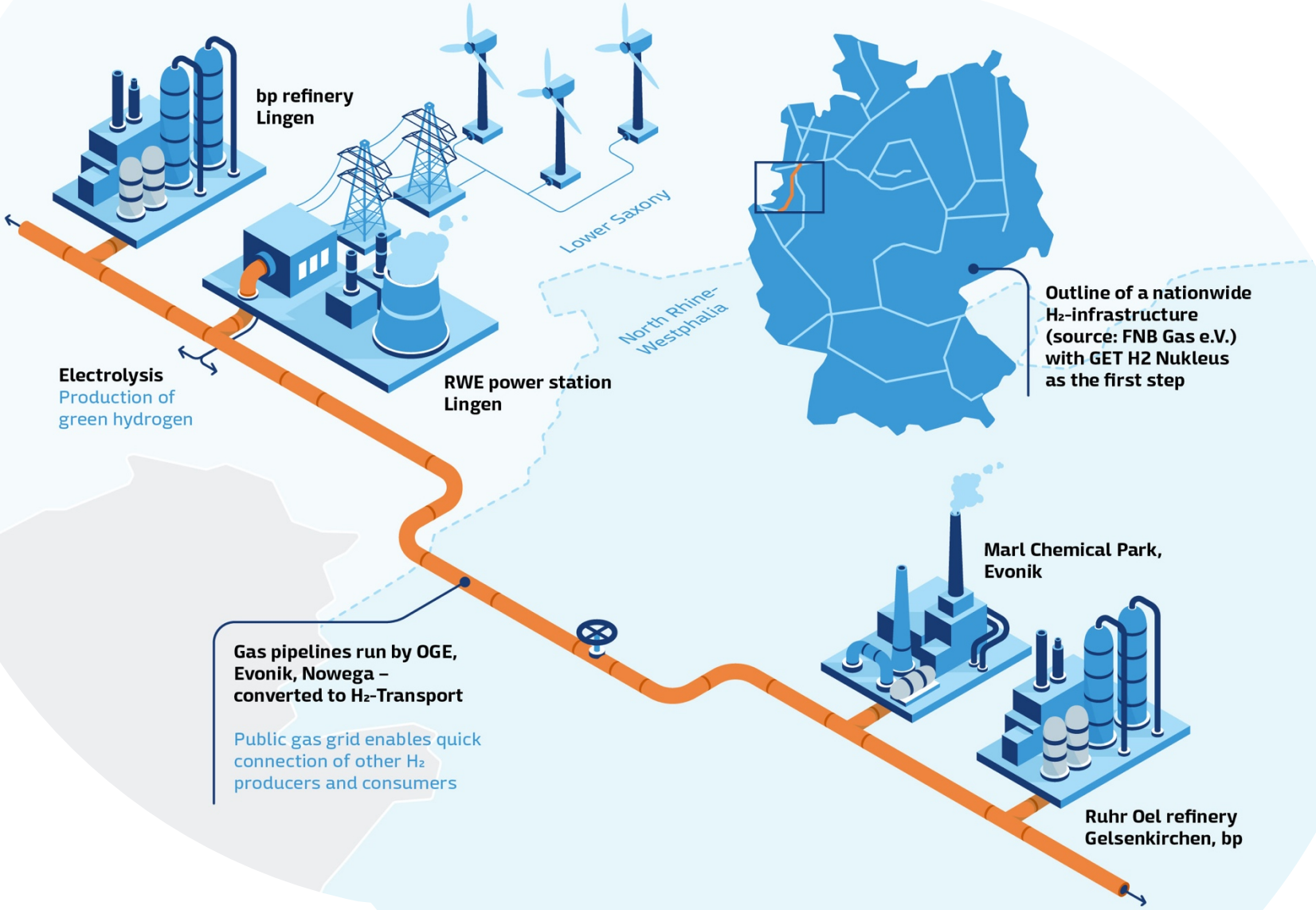
GETH2 Nukleus

Kickoff for the H_2 Economy in Germany

GET H2 Nukleus

The first dedicated H_2 infrastructure with non-discriminatory access



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Reflection of the entire H_2 value chain

1. Production of green hydrogen at the RWE power plant site in Lingen using an electrolyzer **with a capacity of** at least 100 MW.

2. Conversion of existing gas pipelines of Evonik, Nowega and OGE to the **transport of 100% hydrogen**, additionally partial new construction of Evonik.

3. Transport of hydrogen via this **infrastructure** to the Evonik chemical park in Marl and BP refineries in Lingen and Gelsenkirchen.

4. Use of the green hydrogen in the existing production processes and as a result **significant reduction of CO_2 emissions**.

bp

EVONIK Leading Beyond Chemistry

Wir transportieren Gas. nowega

OGE

RWE

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Key facts

H_2 demand*

- bp refinery Lingen: up to 50,000 m³/h
- Marl Chemical Park, Evonik: up to 50,000 m³/h
- Ruhr Oel refinery Gelsenkirchen, bp: up to 80,000 m³/h

Existing gas pipelines

- Converted for transport of 100% H_2
- Total length of 130 km
- Connections to gas storage facility Epe and existing private H_2 grid in Marl are possible

H_2 generation

- RWE Lingen: 100 MW electrolyzer, initially 22,000 m³/h (~10 scfm), capacity increase possible with raising customer demand
- Temporary backup from existing H_2 production possible to stabilize the system (~80,000 m³/h / 38 scfm)

Target date

- Ready to operate in 2023

* according to Network Development Plan Scenario 2020

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Necessary political support for the establishment of green hydrogen*

Build-up of green hydrogen generation capacities	Expansion and conversion of the transport and storage infrastructure	Incentives for the use of green hydrogen
• **Lower electricity levys: Either EEG levy exemption or adjustment Special Equalisation Scheme (BesAR) for electrolysers who use green electricity** ***→ NWS Measure #1:*** *„In particular, we are working towards exempting the production of green hydrogen from the EEG surcharge."*	• **Consistent consideration of hydrogen in EnWG and GasNZV**	• **Rapid implementation of RED II into national law** ***→ NWS Measure #5:*** *„… swift and ambitious transposition … H_2 used for the production of fuel … electrolysing capacity 2 GW … financial support …"*
• Compensation for first mover disadvantages: Incentive programme for investments in first large-scale electrolyzer projects, which initially bear high learning costs.	• Further development of the existing regulatory framework for natural gas to allow its application to H_2 • Create the possibility for operators of transmission networks and gas storage facilities to convert the infrastructure from natural gas to hydrogen • Supplement to the NEP Gas for the transparent development of the hydrogen infrastructure ***→ NWS Measures #20 & #21***	• Pragmatic criteria for the purchase of renewable electricity to guarantee the "green" nature of the hydrogen ***→ NWS Measure #30*** • Harmonized introduction of tradable Guarantees of Origin for hydrogen at EU level, which can be counted towards CO_2 reduction targets ***→ NWS Measure #30***

* With reference to Germany's National Hydrogen Strategy (NWS)

EEG surcharge exemption for electrolyzers indispensable

Green electricity for electrolyzers not financed via Renewable Energies Act

Current legal situation :

1. EEG-supported electricity **loses its renewable properties by law when fed into the grid** – Ensuring that EEG electricity can only be credited to the expansion target of the EEG (avoiding double counting).
2. Thus, guarantees of origin for the green property of the electricity used may only be issued by RE plants that have not been supported by the EEG or other financing instruments.*
3. The Renewable Energy Sources Directive (RED II) stipulates that **only "additional" electricity not previously promoted, e.g. through the EEG**, may be credited to the renewable energy targets of the transport sector in the case of hydrogen production.

If electrolyzers have to pay the EEG levy, they would thus finance the expansion of renewables twice over:

1. via the EEG surcharge **and**
2. via the financing of RE plants not supported by the EEG from which they obtain the required RE electricity.

Additionally, electrolyzers make an important contribution to the grid integration of renewable electricity:

- They can stabilize the system by using network services (control power, disconnectable loads, "connectable loads")
- They enable the storage of RE production peaks, which inevitably occur as the proportion of RE in the system increases

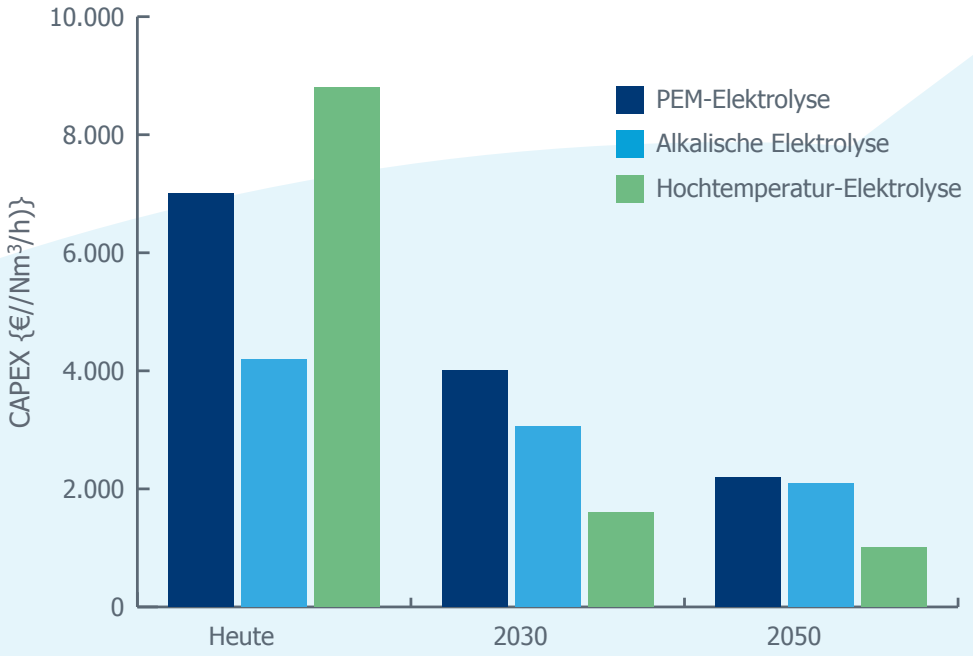
* E.g. from plants that will be dropped from the EEG support after 20 years or from plants that are built without EEG support

Solve first mover disadvantage:
Support program for first installations necessary

Learning curves and economies of scale by increasing production capacity lead to reduced technology costs by:

- Increase of the degree of automation
- Standardization of the product and the production steps
- Increasing competition between international vendors

Reduced technology costs and general technology developments have an **impact on the production costs** of green hydrogen.



Already today, economies of scale allow considerable CAPEX reductions in electrolysers.

Source: Fraunhofer ISE (2019), Wasserstoff an der Schwelle zur großskaligen Industrialisierung

Conclusion

Cost disadvantages for first investors in electrolyzers over the entire life cycle of the electrolyzer - advantages for investors, who enter the market later and push down the market price for hydrogen

Necessary step: Risk equalisation through support for first movers, e.g. via Contract for Differences

Hydrogen offtake: Green hydrogen in refineries

1 Refineries are already among the **world's largest consumers of hydrogen**. Grey hydrogen, which releases CO_2 during its production, has so far been used.

2 The **use of green hydrogen is possible in the short term** – and thus a significant reduction in CO_2 emissions. An **economic gap** currently prevents this.

3 Nevertheless, no one is **as close to the economics** of using green hydrogen on an industrial scale as refineries. They are therefore **crucial for financing the system ramp-up of the hydrogen economy**.

4 The **profitability gap can be closed** by legal adjustments.

5 The refineries are therefore predestined to **drive forward the development of technology** and to develop the **transport infrastructure for the market as a whole** during the market upturn.

Three main regulatory factors influencing profitability

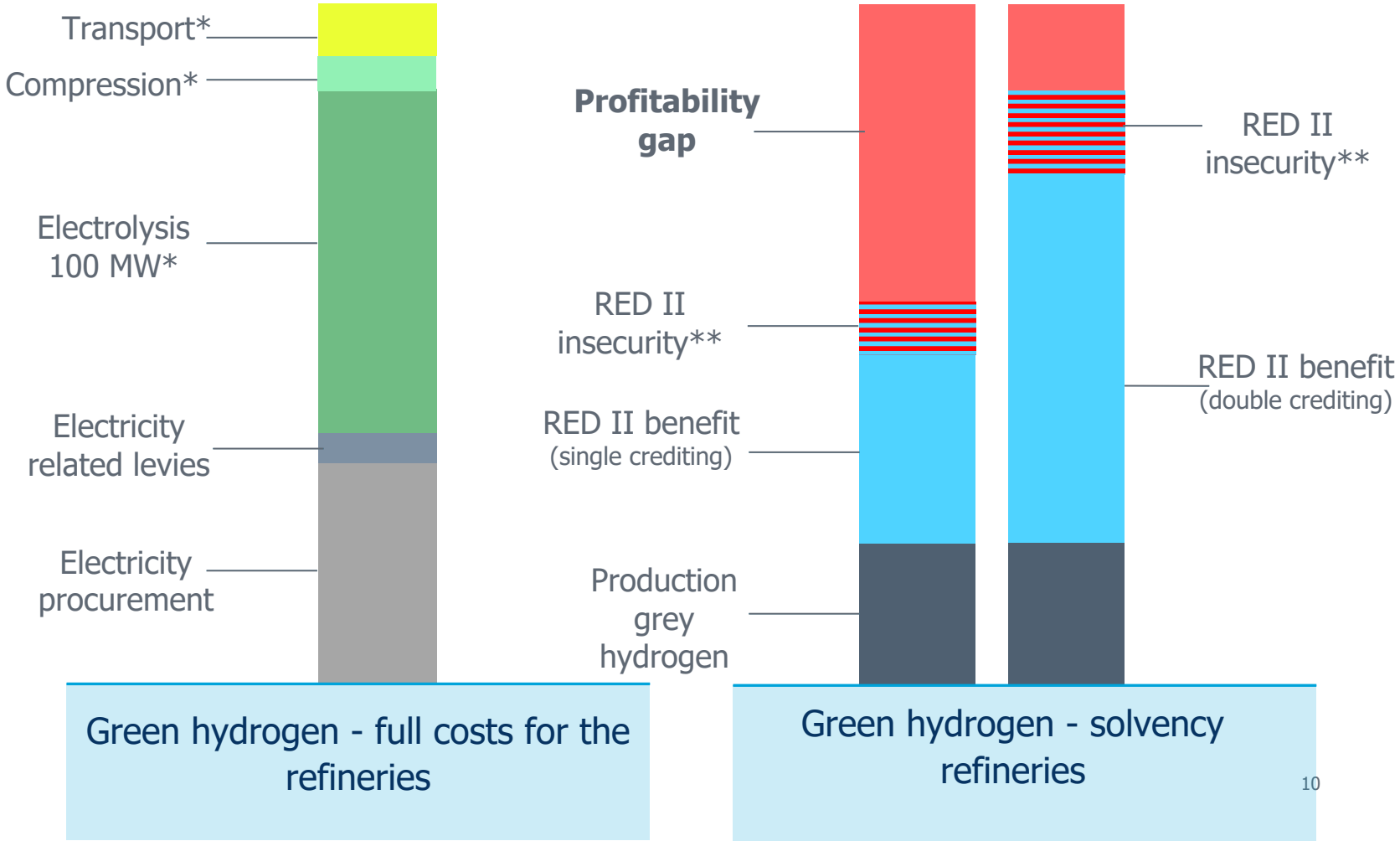
Hydrogen production		Hydrogen transport		Hydrogen offtake	
Electricity taxes und levies		Changes in EnWG and GasNZV		National implementation RED II	
Befreiung	BesAR	Application of cost regulation and uniform transmission charges for hydrogen and natural gas (including biogas levy)	Independent hydrogen charge, payment by first customers	Eligibility of green hydrogen[4]	
6,99 €/MWh[1]	2,37 €/MWh[2]	approx. 4 €/kWh/h/a	approx. 70 €/kWh/h/a[3]	Single	Double

[1] Exemption from the EEG levy, other levies and charges (CHP levy, offshore levy, §19 electricity NEV levy, charge for disconnectable loads) continue to apply.
[2] Existing special equalisation scheme (BesAR) EEG for electricity cost intensity > 20%; only for plants in selected economic sectors; in the case of BesAR new applications, full EEG levy payment for 1-2 years during the BesAR approval process; no reduction for the first 1 GWh/a. BesAR approval has an effect by reducing the CHP levy and offshore levy.
[3] Nowega estimate on the basis of numerous individual premises; the main influencing factor here is the low capacity utilisation of the hydrogen network of only approx. 25%.
[4] Depending on the national implementation of RED II. The value of imputability has not yet been defined because it depends, for example, on the level of ambition, availability and costs of other RED II fulfilment options. Furthermore, it needs to be clarified whether 100% of the green hydrogen used is chargeable or only the portion that is ultimately contained in the fuel sold (approx. ¾); here it was assumed that 100% is chargeable.

Economically insufficient

Framework conditions:

- Full exemption from EEG levies, but further levies and taxes are due
- **Full costs for transport and compression** of the green hydrogen must be **borne by the project**
- **Single or double crediting** of green hydrogen **within the RED II** core requirement for economic efficiency

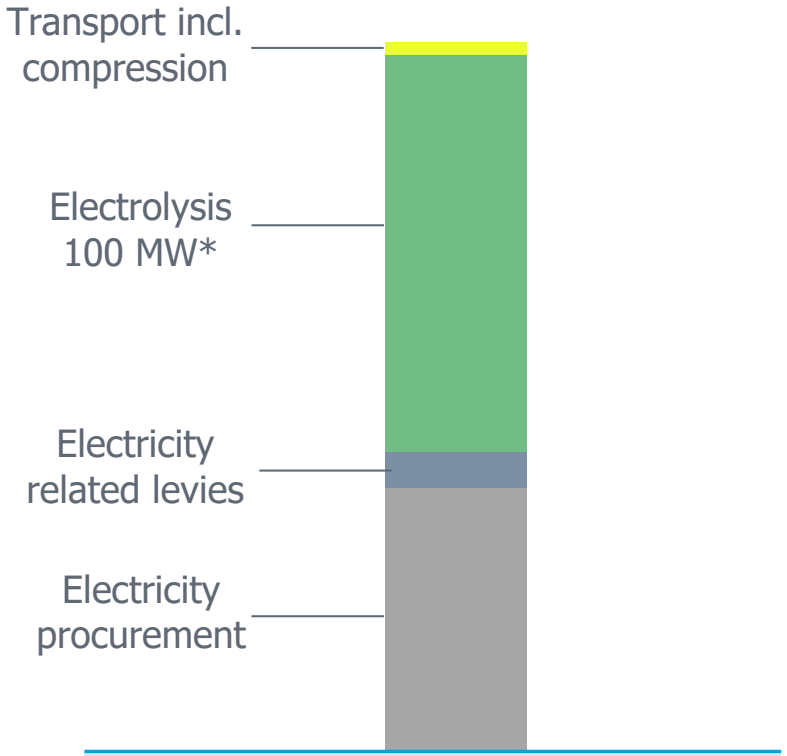


* CAPEX funding necessary to compensate for first mover disadvantage and RED II insecurity
** Amount of RED II benefit still unclear, as it depends on national implementation and the costs of other compliance options

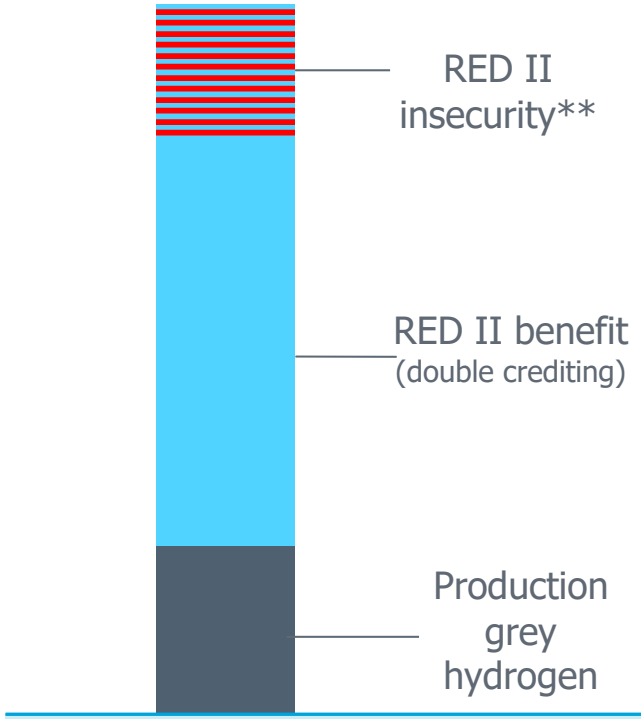
Business case achievable

Framework conditions:

- Full exemption from EEG levies, but further levies and taxes are due
- Application of **uniform charges for transport costs** and use of the **biogas levy for compressor costs**
- **Double crediting** of green hydrogen **within RED II** may be sufficient to achieve economic viability



Green hydrogen - full costs for the refineries



Green hydrogen - solvency refineries

* CAPEX funding necessary to compensate for first mover disadvantage and RED II insecurity
** Amount of RED II benefit still unclear, as it depends on national implementation and the costs of other compliance options

Key economic parameters

Regulatory factors:

- Largest influence: Creditability of green hydrogen to RED II
- Second largest impact: national implementation with multiplier for green hydrogen
- Third largest influence: Level of the ancillary electricity costs
- Fourth largest influence: Network costs - of which the highest influence: Network utilisation

→ Required funding depends on the structure of the regular funding programme influencing factors.

Investment costs:

- Electrolysis system approx. 120 Mio. €
- Compressor system approx. 20 Mio. €
- Transport system upgrading approx. 60 million € - of which approx. 30 million for the transport network and approx. 30 million for industrial customers

Uniform charges for hydrogen and natural gas
Investment security and non-discrimination for Germany

Investment security during hydrogen ramp-up

- Avoidance of prohibitively expensive fees for first movers
- Stable charges: Avoidance of tariff leaps due to new connections and the merging of networks

Non-discriminatory equality of all green gas customers

- Status quo: transport charges for natural gas also apply to green hydrogen (100% + blending) Objective: technology-open and non-discriminatory extension of this scheme for hydrogen of any origin
- Non-discriminatory equality of all green gas customers regardless of regional availability and application

Uniform tariffs ensure stable natural gas prices in the long term

- In perspective, the roles are being swapped
- Initially, natural gas will support the hydrogen ramp-up through uniform charges, and in the long term, hydrogen will compensate for the decline in natural gas volumes

The whole of Germany benefits from a hydrogen network – therefore the costs should be spread over many shoulders

- The development of a hydrogen network is a contribution to the energy turnaround – we need first movers in the industry to get started
- The heating and mobility sectors will also benefit from the infrastructure – it is appropriate to bear the costs on a broad basis

Hydrogen transport in Germany
Safe alternative

Experience of the project partners

- Safe operation of 230 km grid with 100% hydrogen (privately operated between Marl-Cologne) for 70 years
- 2019 commissioning of H_2 network (Godorf, Wesseling, Kalscheuren) by converting existing lines
- Existing H_2 pipelines are identical in construction to the majority of the pipelines used for other gases

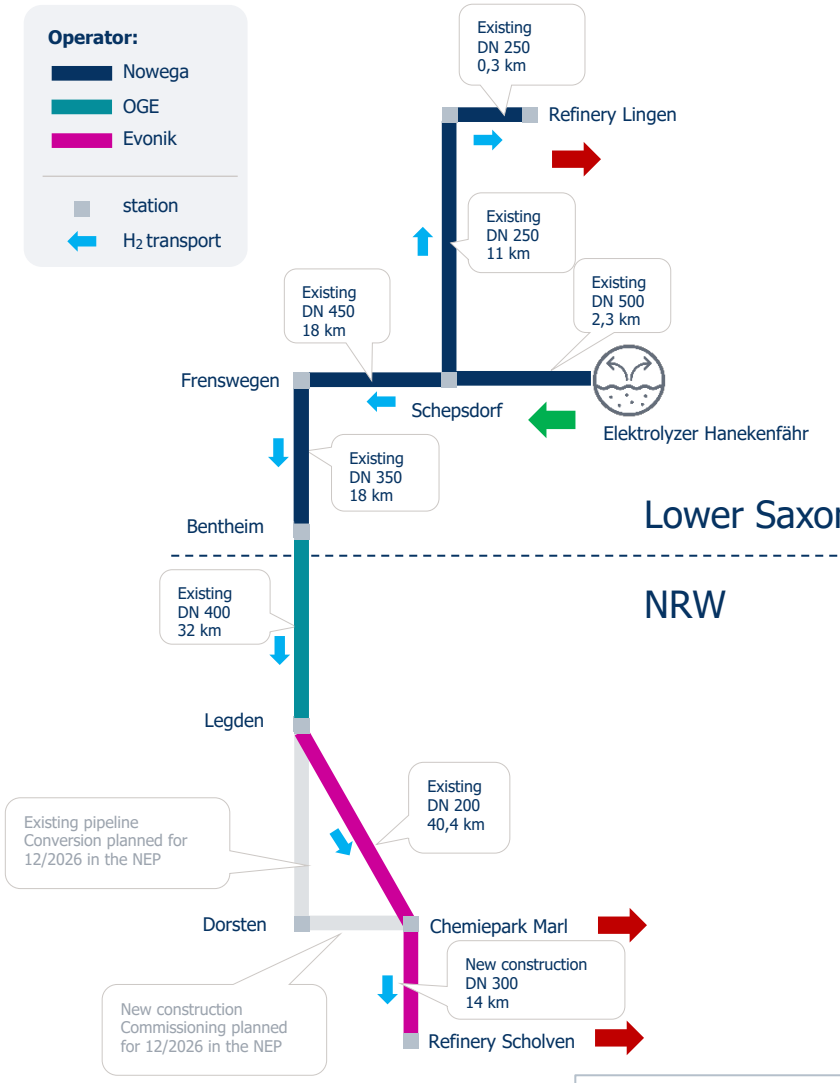
Scientific basis

- Studien zur Eignung der Leitungen im Gas-Fernleitungsnetz für die Umstellung auf Wasserstoff liegen vor

Detailed technical regulations of the DVGW for H_2 pipelines (new construction and conversion)

- Proof of compatibility of the materials used in all components for operation with H_2 required
- Proof of sufficient dimensioning of pipelines for max. operating pressure and operating load change required
- Pipelines to be equipped with cathodic corrosion protection
- Participation of independent experts (e.g. TÜV) required to confirm compliance with the requirements
- After, continuous monitoring of the pipeline network (similcommissioningar to natural gas pipelines)

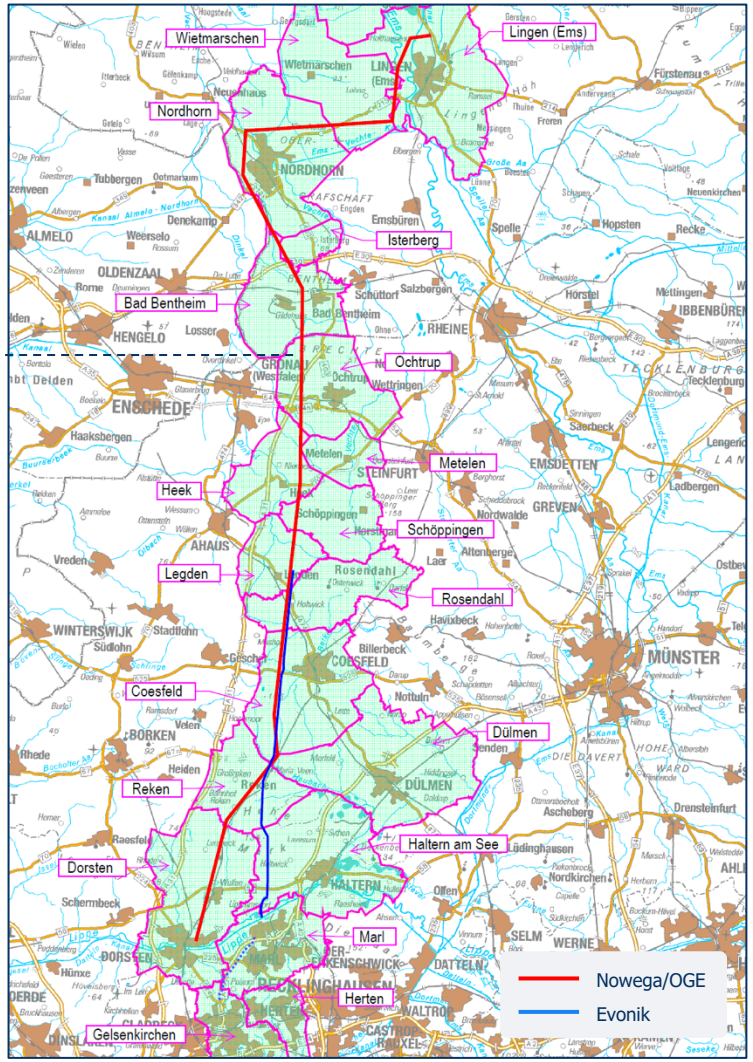
GET H2 Nukleus | Nukleus in detail



Lower Saxony

NRW

Up to DN 250 < 300 mm
From DN 300 > 300 mm



Numerous components have already been initiated

H_2 production und feed-in

- Site preparation and technical planning of the 100 MW electrolyzer in Lingen is underway.
- The feasibility study for the construction of the hydrogen feed-in station has been completed.
- The grid connection application for the feed-in of green hydrogen in Lingen has been submitted.

Authorisation

- The exchange of information with the approval authorities for the pipeline conversion, the new pipeline construction and the construction of the electrolyzer has started.

Pipeline conversion and construction

- Preparation of first measures for the conversion of existing natural gas pipelines to hydrogen will be undertaken.
- TÜV studies for the first of the pipelines to be converted are available.
- Construction of the connecting pipeline from Evonik's Chemical Park in Marl to bp's refinery in Gelsenkirchen-Scholven will begin in August 2020.
- The technical planning for the preparation of the bp Lingen grid connection point for the acceptance of the hydrogen has started.

The GET H2 initiative

GET H2 initiative

Platform of partners who support the goal of **building a nationwide H_2 infrastructure** and the implementation of the necessary regulatory changes.

Support Partners

EVONIK Leading Beyond Chemistry
nowega – Wir transportieren Gas.
BASF We create chemistry
GASCADE
bp
uniper
OGE
Thyssengas
H2 GREEN POWER & LOGISTICS
RWE

Associated Partners

SALZGITTER FLACHSTAHL
EMERGY
Air Liquide
KEM
SIEMENS
Emsland – Zuhause bei den Machern.
gwi
ZBT
ALSTOM
dralon – a step ahead in acrylic fibers
JÜLICH Forschungszentrum
2G
Kraftanlagen München – A member of Bouygues Construction
Stadt COESFELD
ROSEN – empowered by technology
ENERTRAG – Eine Energie voraus
KREIS STEINFURT
Salzgewinnungsgesellschaft Westfalen
hydrogenious LOHC TECHNOLOGIES
SWO Netz GmbH
GMH GRUPPE
Deutsche Post DHL Group
Kerpen
creos
ITAD
WESTNETZ
TU Clausthal – Clausthal University of Technology
STADTWERKE LINGEN
Wirtschaftsbetriebe DUISBURG
Technische Universität Berlin – Energie und Ressourcen
engie
STADT LINGEN EMS

Flagship project: GET H2 Nukleus

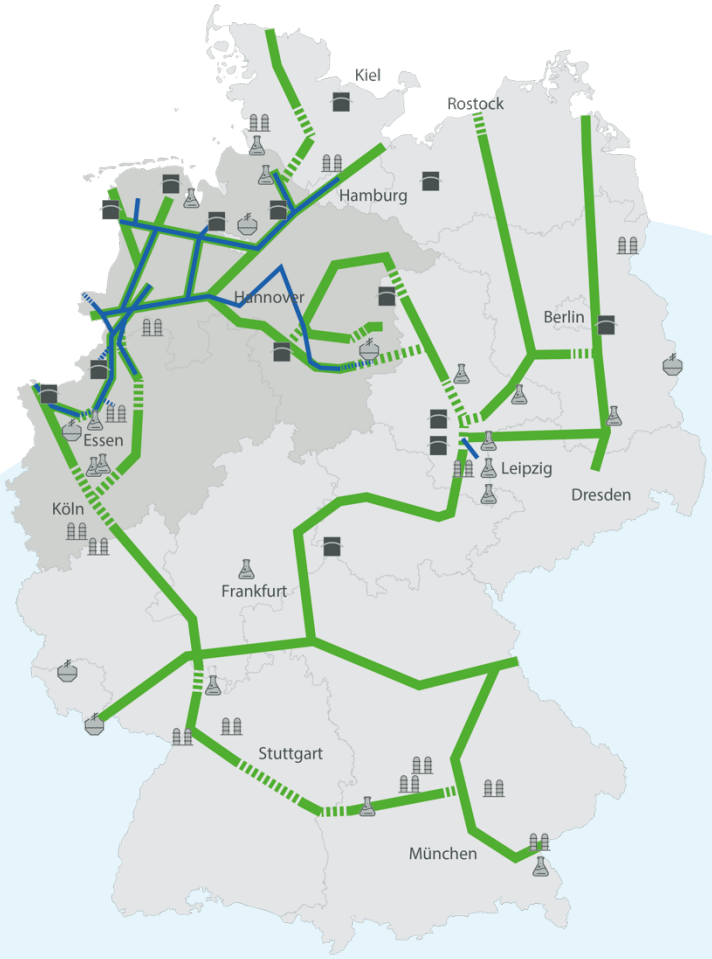
bp
EVONIK Leading Beyond Chemistry
nowega – Wir transportieren Gas.
OGE
RWE

Many of the GET H2 partners are also active in other national and international H_2 projects.

The GET H2 initiative …

- aims to initiate a hydrogen economy in order to considerably reduce GHG emissions,
- deems it necessary to establish a nation-wide (European), non-discriminatorily accessible hydrogen infrastructure as a basis,
- is convinced that this infrastructure can be established in a timely and cost-efficient manner by employing existing gas grid infrastructure,

- already comprises 40 project partners
- is based on a cooperation agreement
- considers itself to be an open network of companies/organizations
- supports projects of its partners that back the initiative and facilitate its development.



Sketch of a Germany-wide hydrogen infrastructure based on the existing natural gas network. Marked in blue: the "Start-up Network 2030" with the GET H2 Nukleus as one building block.

Source: FNB Gas e.V.