Contractual questions of hydrogen value chains

26. October 2023 | Dr. Christian von Halen | Cologne
thyssenkrupp Steel Europe AG

Agenda

Transformation at thyssenkrupp Steel Europe AG – current infrastructure and market situation

- Deductions for hydrogen purchase contracts and tendering process

Who we are

Germany's largest flat steel manufacturer

~ 10.5 m metric tons
crude steel p.a.

~ 13.2 bn €
sales in 2020/21

~ 26,300
employees

Automotive sector

Special vehicles

General industry

Power generation & turbines

thyssenkrupp

Consumer goods

Transformers & charging infrastructure

Structural elements

Packaging (e.g. cans and closures)

tkH$_2$Steel

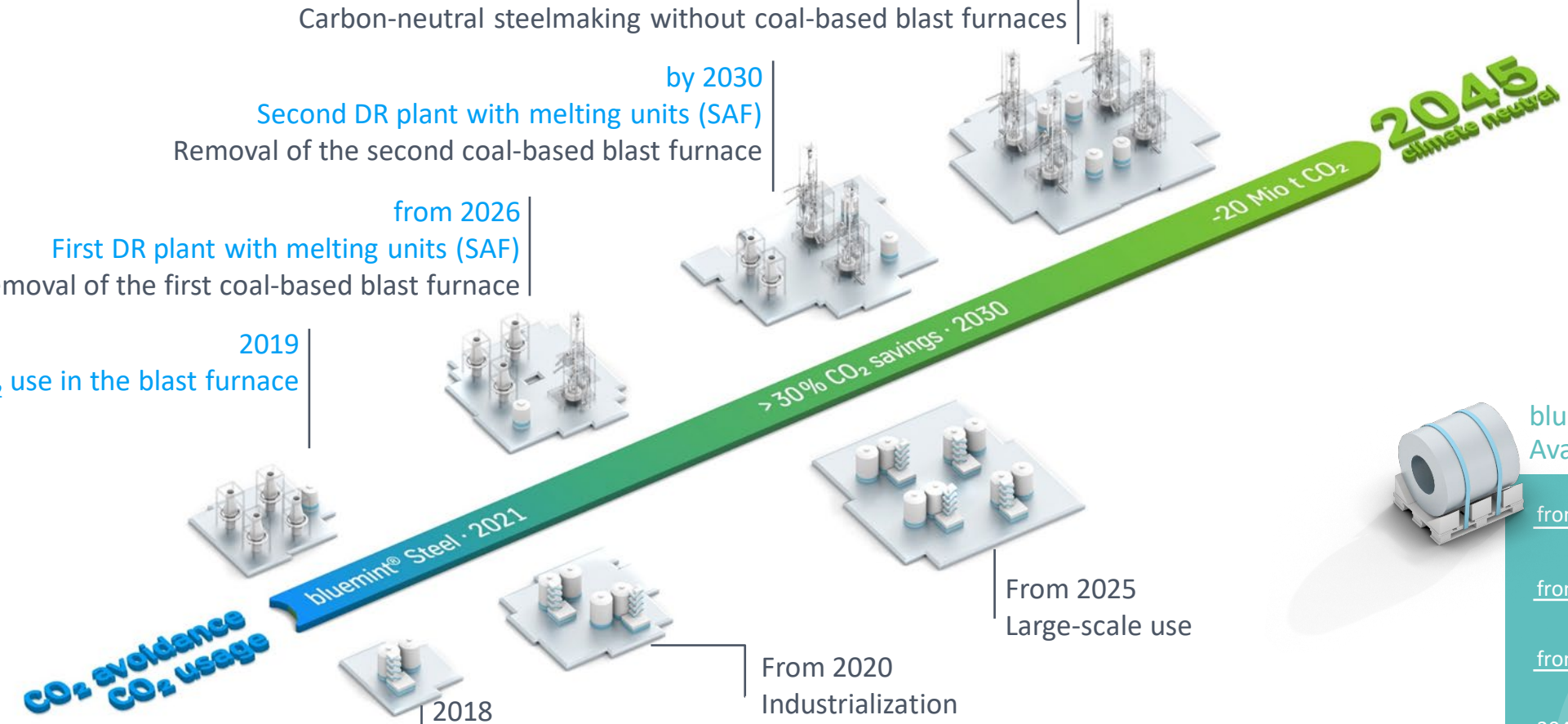
With hydrogen to carbon-neutral steel

before 2045
Full implementation of the transformation
Carbon-neutral steelmaking without coal-based blast furnaces

by 2030
Second DR plant with melting units (SAF)
Removal of the second coal-based blast furnace

from 2026
First DR plant with melting units (SAF)
Removal of the first coal-based blast furnace

2019
Trialling H_2 use in the blast furnace



From 2025
Large-scale use

From 2020
Industrialization

2018
World premiere of Carbon2Chem®
The pilot plant uses metallurgical gases to produce chemical precursors in a continuous process

bluemint® Steel
Available quantity p.a.

from 2022 – 2025	50 – 500 kt/a
from 2026	3 m t/a[1]
from 2030	5 mt/a[1]
2045	11.5 m t/a

1. Quantity after plant ramp-up

Core of the transformation

Switch from blast furnaces and coking coal to DR plants and green hydrogen

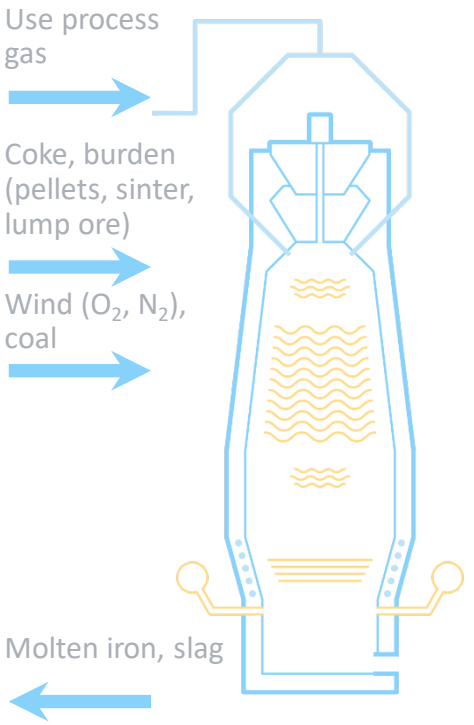
Use of hydrogen in direct reduction (DR) plants, in combination with innovative melting units.

Process innovation with clear ecological and economic advantages.

- **Innovation**
  Engineering of the melting unit in combination with a DR plant
- **Ecological benefit**
  Hydrogen and green electricity substitute coal and eliminate CO_2
- **Process advantage**
  Use of more favorable input materials and refractory materials, use of process heat
- Electric furnace iron is used like hot metal, therefore all products can continue to be produced

Classic blast furnace

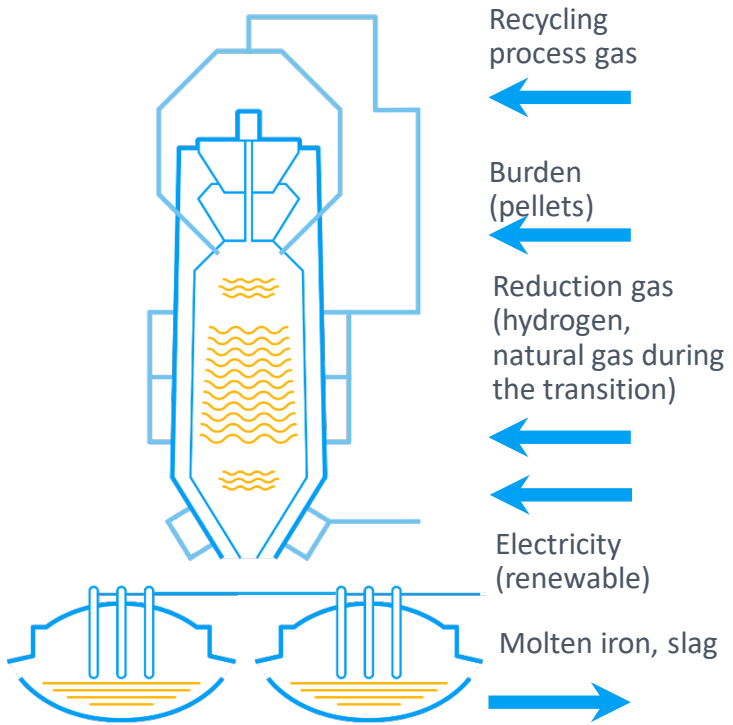
Carbon as a reducing agent and energy carrier



DR plant with melting unit

Hydrogen as reducing agent in DR plant

Green electricity as an energy carrier in the melting unit



thyssenkrupp Steel Europe takes responsibility and has set itself clear targets

Our goal by the year 2030[1]

>30 %

Reduction in CO_2 emissions (-6 m metric tons)

Our goal by 2045 at the latest

-100 %

CO_2 emissions (-20 m metric tons)

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

CDP
DISCLOSURE INSIGHT ACTION

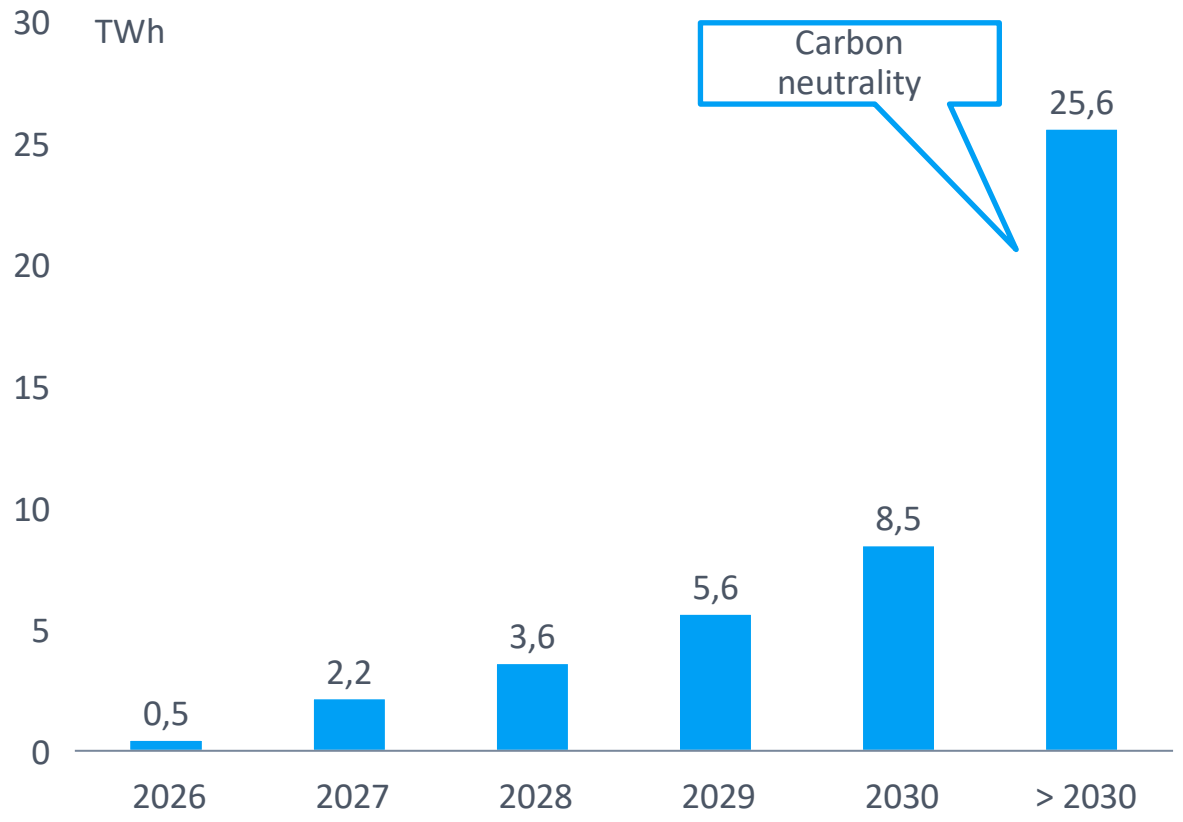
Responsible Steel standards & certification

Stiftung KlimaWirtschaft

1. -30% CO_2 emissions in 2030 refers to Scope 1 and Scope 2 emissions (reference year 2018)

The transformation to carbon neutrality requires large quantities of hydrogen

Hydrogen requirement of thyssenkrupp Steel Europe



Source: tkSE, National Hydrogen Strategy 2020

In the long term, we are relying on green hydrogen, but for the transition we need all technologies

Green H2 is our priority …

- Best CO2-footprint
- Obtained by electrolysis with electricity from renewable sources
- Only available in large quantities in the long term

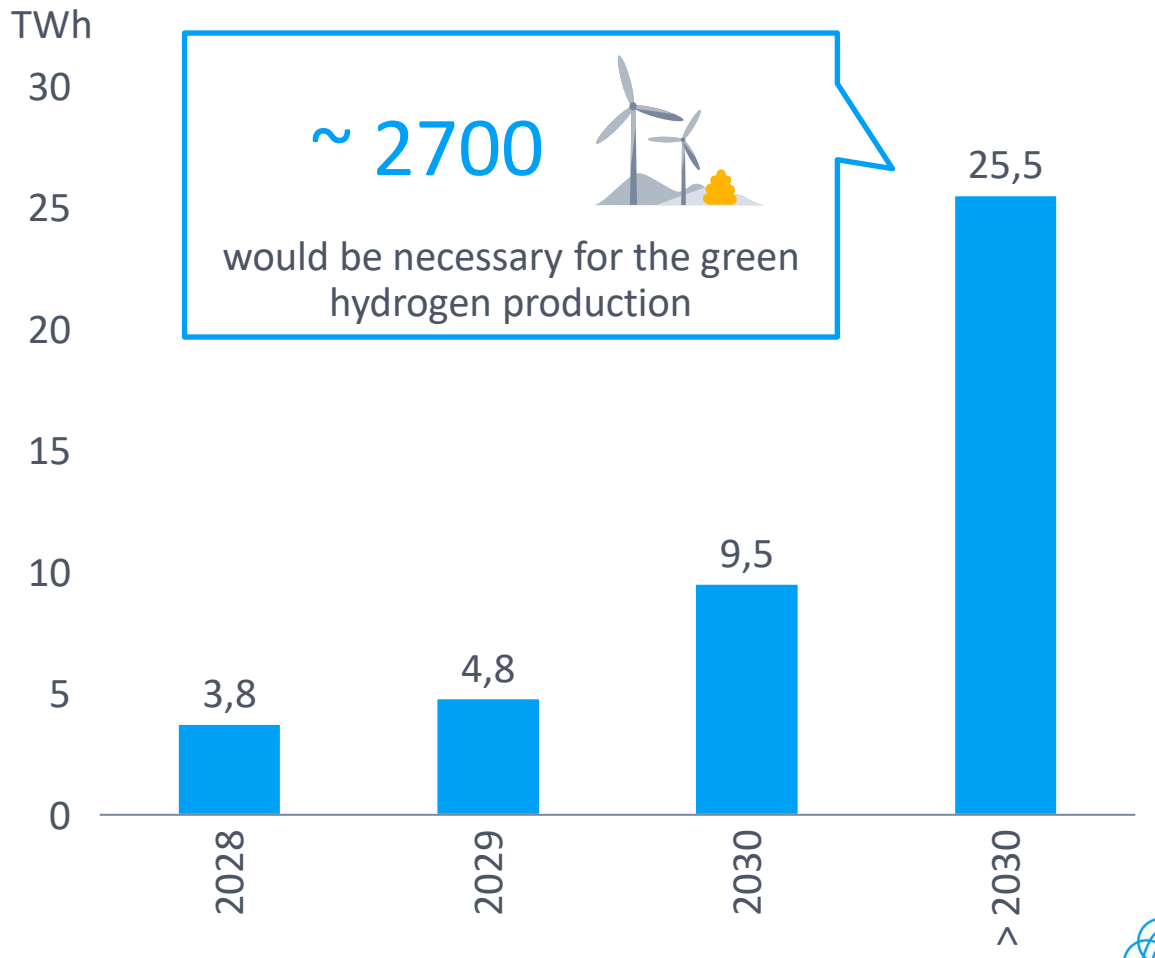
H_2

… but blue H2 will be a important bridge technology

- Obtained from natural gas via reformation
- Storage of CO2 via CCS/CCOS
- Nearly climate neutral
- Available in the medium term in

H_2

Hydrogen demand of thyssenkrupp Steel Europe



State aid / competitive tendering process for hydrogen

Press release | 20 July 2023 | Brussels

State aid: Commission approves German €550 million direct grant and conditional payment mechanism of up to €1.45 billion to support ThyssenKrupp Steel Europe in decarbonising its steel production and accelerating renewable hydrogen uptake

Supported by:

Federal Ministry for Economic Affairs and Climate Action

Gefördert durch:

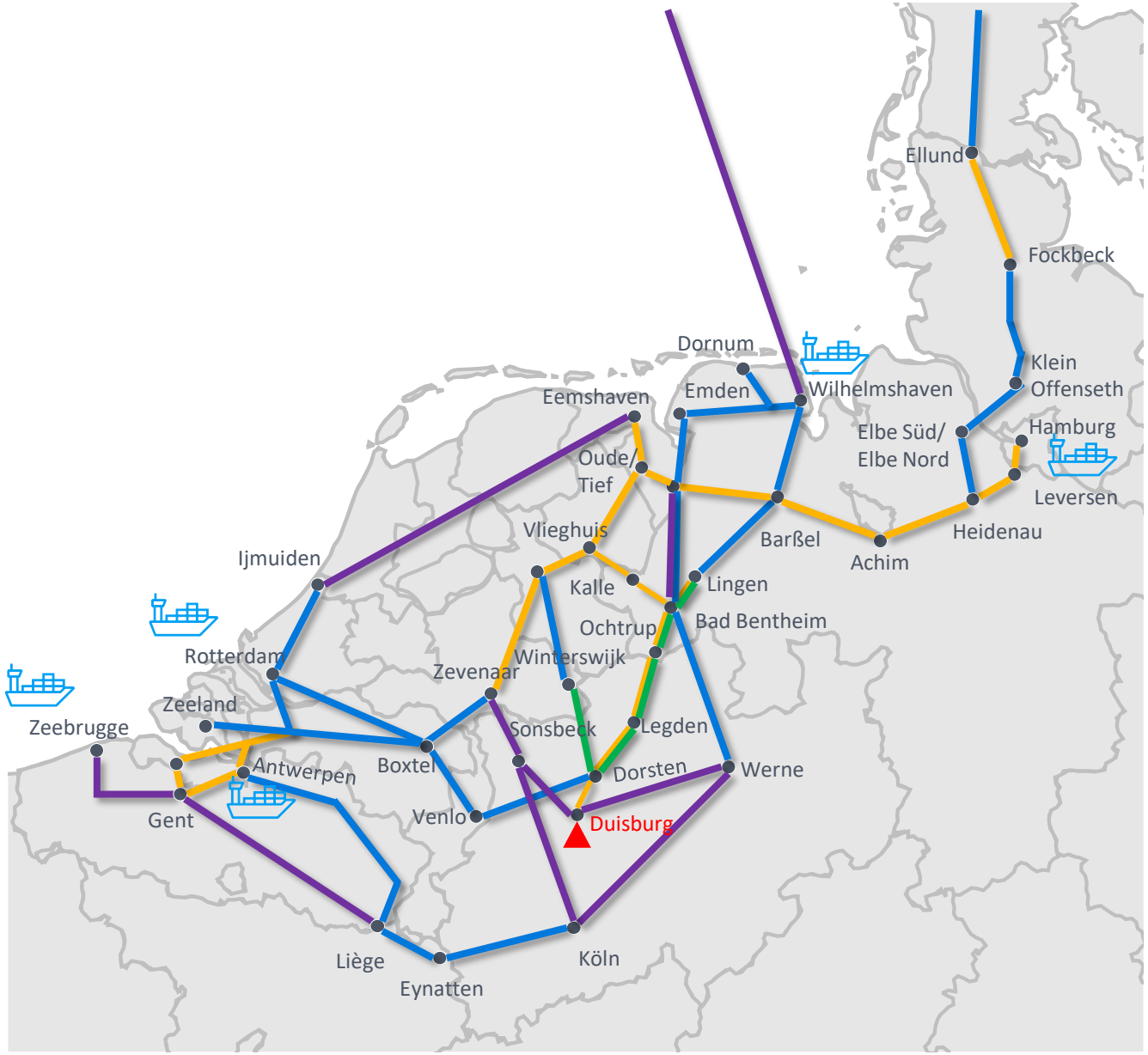
Ministerium für Wirtschaft, Industrie, Klimaschutz und Energie des Landes Nordrhein-Westfalen

on the basis of a decision by the German Bundestag

- Direct grant for direct reduction plant and two melting units to replace existing blast furnice
  - natural gas to be gradually phased out and to use hydorgen
    - huge hydrogen demand.
- Conditional payment mechanism covering additional costs of procuring and using renewable hydrogen instead of low-carbon hydrogen

=> competitive tendering process to be organized

H_2 infrastructure to supply tkSE Duisburg up to 2030/2031



- By 2026 /2027 connection to Eeemshaven and Lingen via the Dutch H2 network and the German GetH2 network
- By 2028 connection to Rotterdam via Delta Rhine Corridor and via the Dutch H2 network and to Wilhelmshaven, Hamburg and Denmark via NWO/Hyperlink, H2ercules and GetH2
- By 2029 connection to Wilhelmshaven, Hamburg and Denmark via NWO/Hyperlink and a further connection to the Dutch H2 network via Winterswijk
- By 2030/31 a further connection to the Durch H2 network via L-gas pipeline Zevenaar and completion of the H2ercules connection from Belgium via Cologne to Duisburg and connection to Norway via Emden; commisioning of Eemshaven-Ijmuiden pipeline

Deductions for hydrogen purchase contracts and the tendering process

- first mover advantage / disadvantage?

Commercial / technical aspects

- transportaion (locally/regulated pipeline/shipment overseas)
- security of investment for supplier: contract duration and price
- volumes and flexibility (delivery profile)
- portfolio supplier / single source supplier
- delivery and offtake disturbances
- arbitrage Chance / H2-Hub
- compliance with funding requirements

Risk allocation / legal implementation

- separate transporation and grid agreements
- price index, price alignement, new price negotations during contract
- Take or Pay – planned und unplanned maintenance / sale of green energy / nomination process
- indeterminate obligation / „beschränkte Gattungsschuld“
- representation and warranties / force Majeure / liability
- no resale restrictions
- specification H2, including pressure requirements for line entry

Thank you

for your attention!

European wide tender process planned for our hydrogen procurement
– more details will follow soon –

engineering.tomorrow.together.

thyssenkrupp

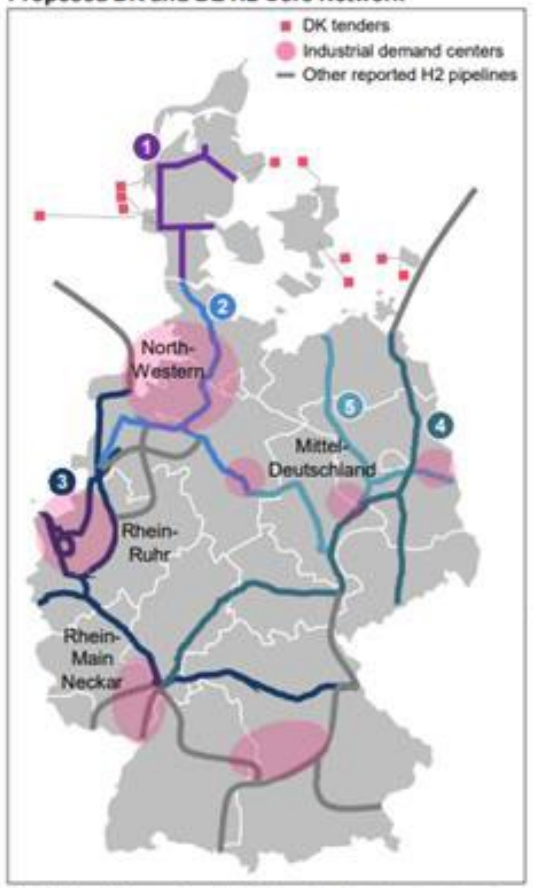
BACKUP

European H_2 infrastructure projects to supply tkSE Duisburg between 2028 and 2032

Infrastructure expected to be available to supply all demand centers in Germany

Danish and German hydrogen pipeline network to be developed by 2027 – 2032

Proposed DK and DE H2 Core Network[1]



5 projects are driving the development of Danish and German hydrogen backbone already by 2030

1 **DK West Backbone** Energinet 2028 – 2030	• DK West H2 Backbone (2028-2030) enabling connection to Germany • Energinet has completed feasibility study for backbone except connection to Aarhus / Kattegat II • Dimensioning of new pipelines likely to be 36", allowing for +10 GW capacity. • Based on non-binding capacity commitments in 2024, FID to be taken ultimo 2024. Binding commitments in Q1 2025
2 **Hyperlink Phase 1-3** Gasunie Deutschland, **2028**	• 610 km new and repurposed pipelines H_2 backbone connections to DK • CIP reference projects DK West (North Sea I, Vikinge Banke, Kattegat II)
3 **H2ercules** OGE & RWE, **2028 – 2030**	• 2000 km new and repurposed infrastructure to supply consumers in the south and west of Germany
4 **FLOW** GASCADE & ONTRAS, **2025 – 2028**	• 1100 km repurposed infrastructure connecting Baltic Sea with major demand centers, Berlin and Ludwigshafen • CIP reference projects DK East (Bornholm Energy Island)
5 **Doing H2 & Green Octopus** ONTRAS, **2030**	• 900 km new and repurposed infrastructure connecting Baltic Sea with major demand centers incl. Poland and western grid at Salzgitter

CIP Activities, Denmark

- CIP in close collaboration with Energinet and Ørsted on a DK market model for hydrogen – recommendations presented to and adopted by Energinet Q2 2023
- CIP and Ørsted have initiated a working group with 15 of the largest stakeholders to influence financing of H2 infrastructure. Recommendations to DK Government made public.
- Energinet expected to initiate broader H2 market model dialogue primo Q4 2023
- CIP to initiate PA effort for financing of H2-infrastructure Q3 2023

CIP Activities, Germany

- In May 2023, Germany amended the Energy Industry Act (EnWG), allowing the state to financially guarantee projects considered core hydrogen pipeline network(s) developed (COD) between 2027 and 2032.
- CIP in dialogue with main German gas TSOs incl. Gasunie, Gascade and OGE
- CIP's proposed market model for 'Danish' H2 has been presented to DE TSOs and may be presented to the FNB Gas association[2]

Notes: 1) Final H2 core network likely to be reduced in size, with revised version to be published medio September. Final network and financing model to be agreed ultimo 2023. 2) FNB Gas is the association of supra-regional gas transmission companies in Germany

CIP 13

Three key challenges for ensure the transition

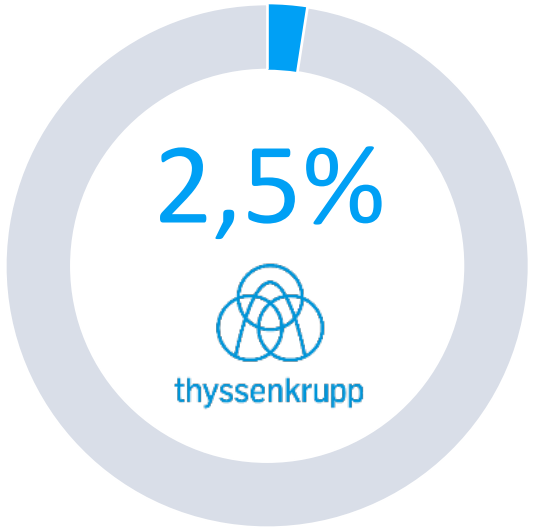
The rapid expansion of Europe-wide hydrogen backbone (from Spain to Norway) must be driven forward quickly

Production capacities and research expenditures for electrolyser must be increased rapidly - prices must drop rapidly

The ramp-up of the hydrogen economy involves great uncertainties. The state must play a strong safeguarding role in the ramp-up process

Germany's decarbonization targets cannot be achieved without the steel industry and tkSE

The tkSE currently contributes 2.5% to total German CO2 emissions ...



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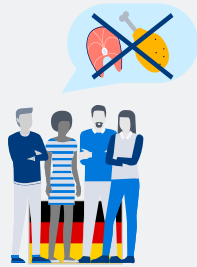
~ 20 Mt
CO_2-emissions

... comparable to

~ 75% of Denmark's CO2 emissions

~ 10x German domestic air traffic



CO2 savings when

~ 55% of the German population eats a vegetarian diet