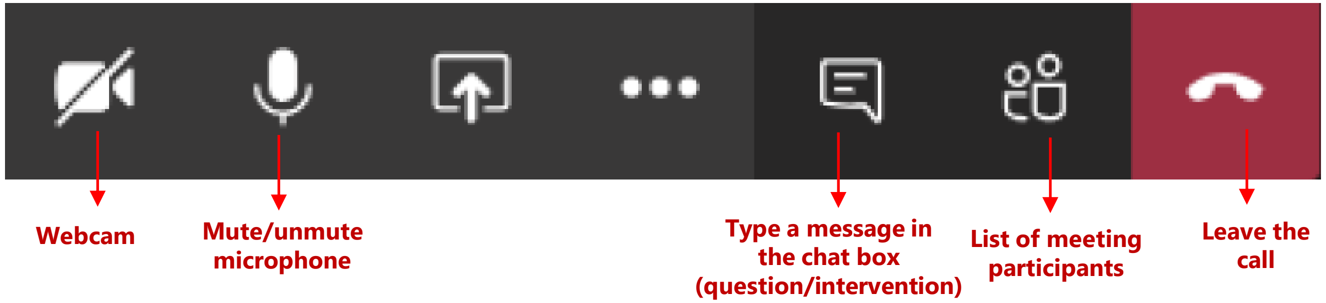
29/04/2020

ENTSOG 2050 Roadmap for Gas Grids

Workshop 3: Principles for EU Gas Qualities, handling of hydrogen and CO_2 transportation

Webinar

Housekeeping



General:

– Please **mute your microphone** during the whole workshop unless asked by Chair to provide verbal intervention.

– Please **do not use the webcam** function since this can affect the stability of call.

– Please do **not connect via multiple devices**, as this will overload the Microsoft Teams tool

– If you dialled into the meeting, please **press *6 to mute/unmute**

– For **technical assistance** please email our IT Manager at Bogdan.Gugescu@entsog.eu.

Posing questions/interventions:

- Use the **chat box** which is visible to all meeting attendees to **pose your questions/interventions**.
- The Chair will either:
  - **pose your question** himself to the presenter/audience or,
  - ask you to **verbally present** your question during the discussion.

Agenda

10:00 – 10:30 Welcome address and presentation of 'ENTSOG 2050 Roadmap for Gas Grids'

Hendrik Pollex, System Operation Director|ENTSOG

Keynote address

Gerald Linke, President | Marcogaz

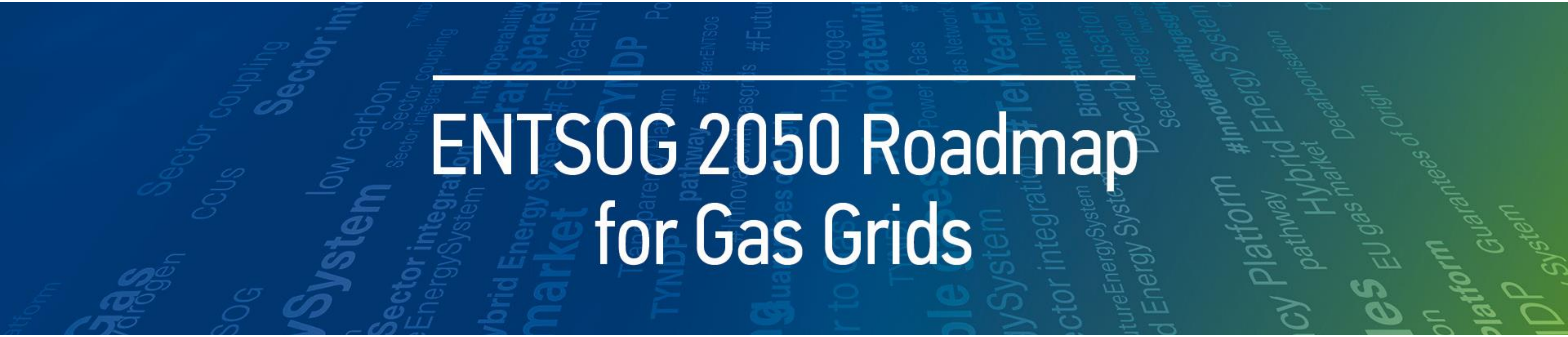
10:30 – 11:50 1st Session: Principles of EU Gas Qualities and handling of hydrogen

11:50 – 12:00 Break

12:00 – 13:20 2nd Session: CO2 transportation

13:20 – 13:30 Final concluding remarks and next steps

Hendrik Pollex, System Operation Director|ENTSOG



3rd Roadmap 2050 Workshop: Principles for EU Gas Qualities, handling of hydrogen and CO_2 transportation

Hendrik Pollex, ENTSOG System Operation Director

Webinar

Seven Recommendations to Decarbonise Gas Grids

Gas TSOs' propose enablers necessary to decarbonize the gas grids by 2050

Animated video on decarbonisation pathways

DISCUSS THE ROADMAP WITH US

Hendrik Pollex, ENTSOG System Operation Director

ENTSOG - European Network of Transmission System Operators for Gas
Avenue de Cortenbergh 100, 1000 Bruxelles

www.entsog.eu | info@entsog.eu

ENTSOG Workshop on Principles for EU Gas Quality, Handling of Hydrogen and CO_2 Transportation

Keynote address

Wednesday, 29 April 2020

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Gerald Linke
President

EC Mandate M/400 (2007)

1. Invitation to CEN to draw up standards for gas quality parameters for H-gas, that are **as wide as possible within reasonable costs**
2. Promotion of competition and security of supply, ….
   - minimising the negative effects on **efficiency and the environment** and
   - allowing the maximum number of **appliances** to be used without compromising safety.

- ➢ Direct relation to **Directive 2003/55/EC on the creation of a competitive single European gas market**, especially Art. 6: Interoperability of systems respecting objectivity and non-discrimination.
- ➢ Support of Gas Appliance Directive (90/396/EEC) now **Gas Appliance Regulation (REG 2016/426)**

CEN pre-normative approach

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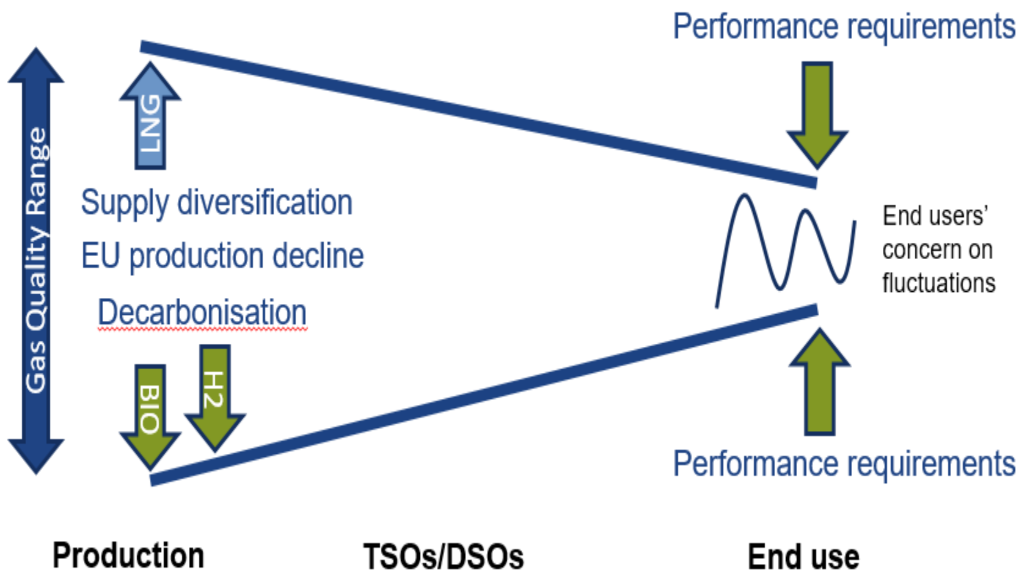
Differentiation between Wobbe Index range at entry and exit

- **Entry**
  Impacts security of supply, competitivity and decarbonisation

- **Exit**
  Impacts performance and fitness for purpose

- Consideration of impact of renewable and low-carbon gases on WI and GCV (acc. MF 10/2018)



Source: CEN SFGas GQS, MF 03/2019

Gas decarbonisation triggers gas quality changes

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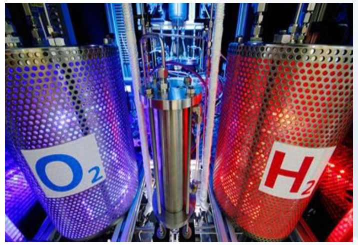

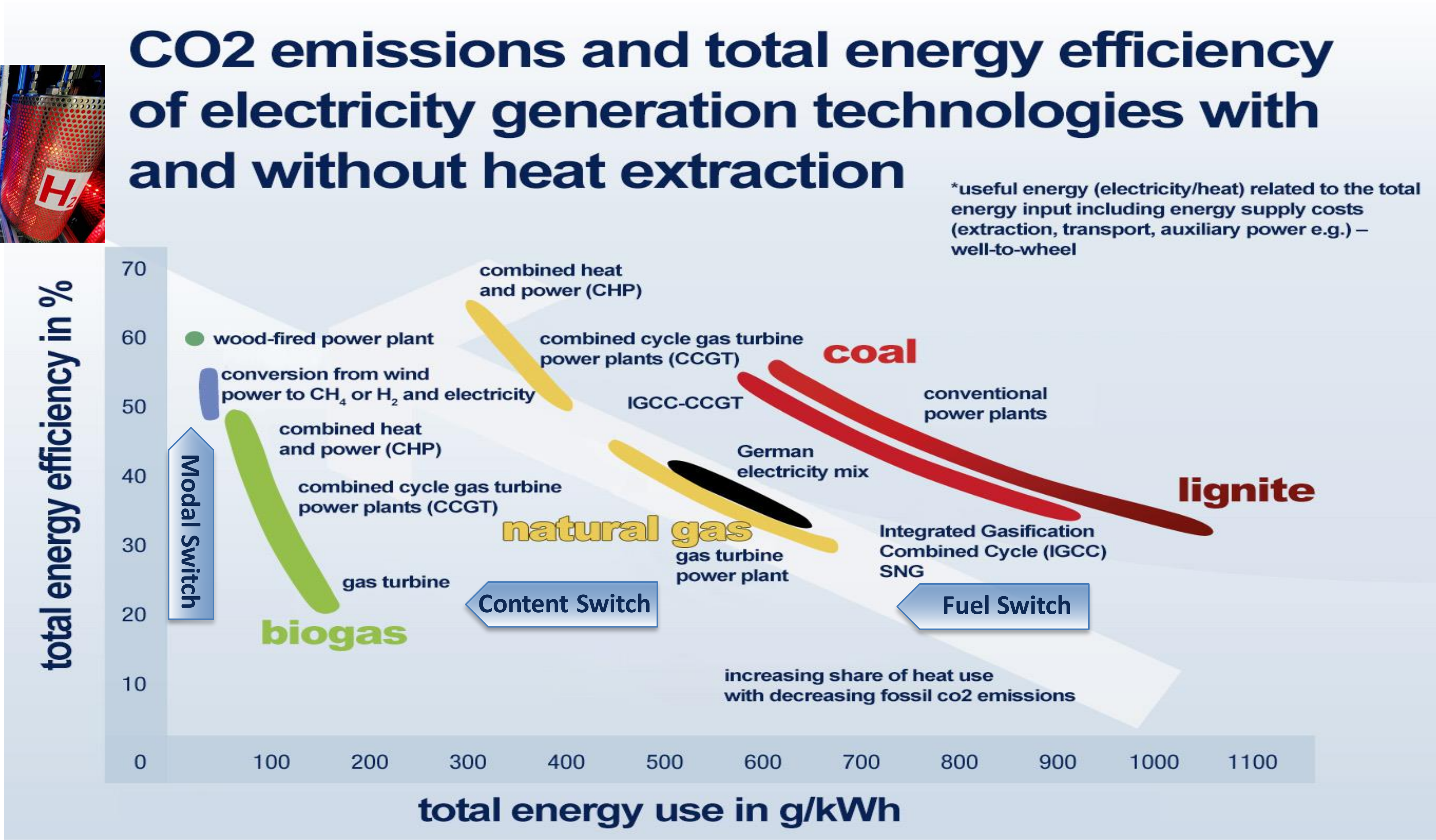

Serious studies predict the step-wise replacement of natural gas by hydrogen

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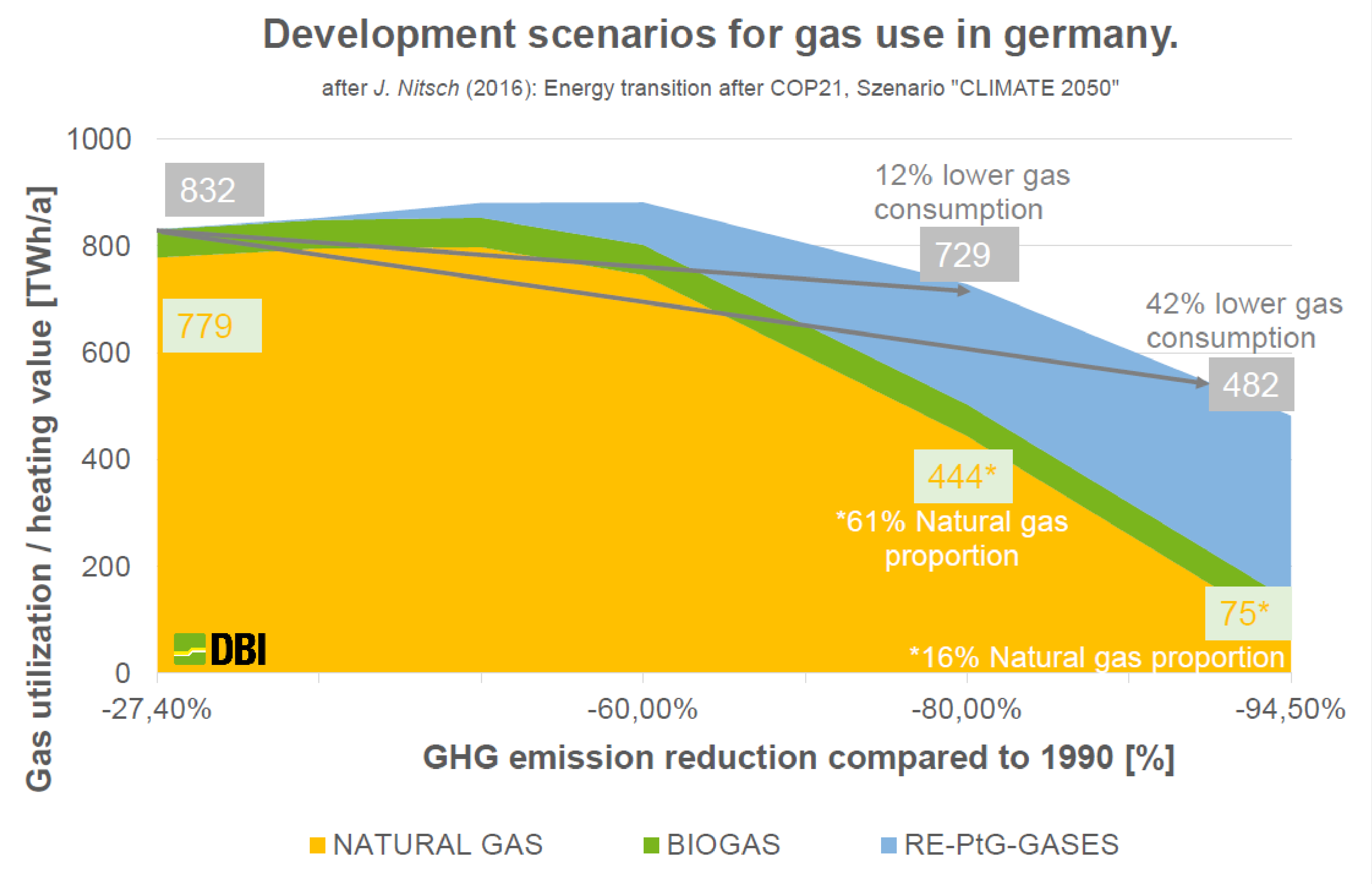

February 2020: First proposal for a German hydrogen grid published by FNB

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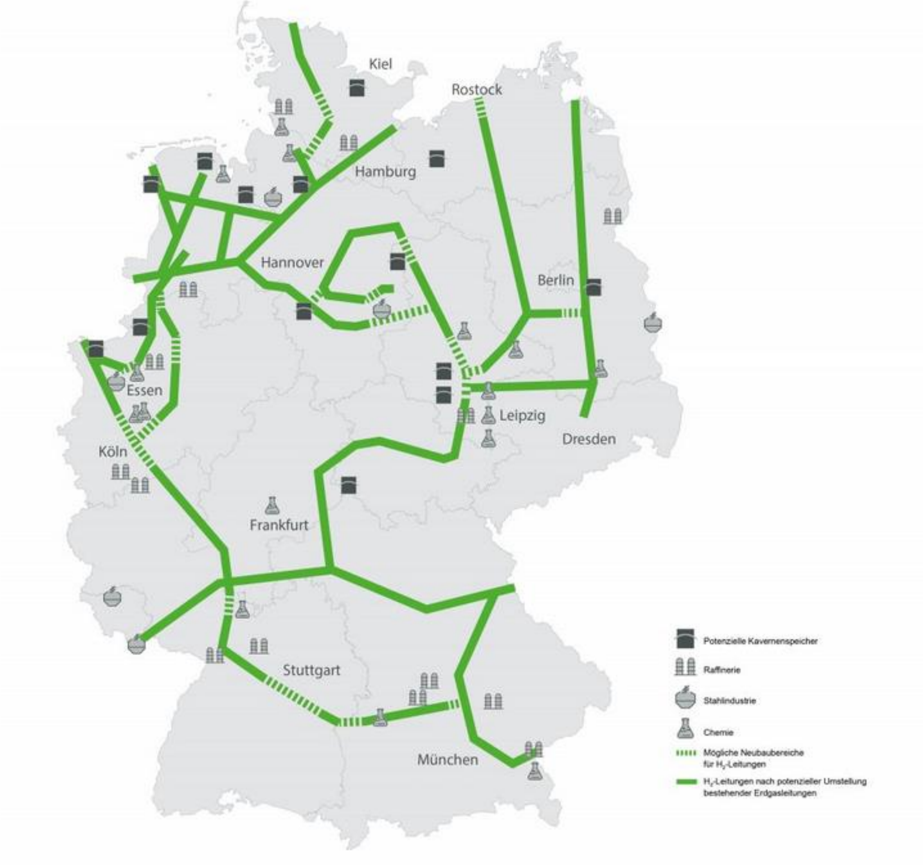
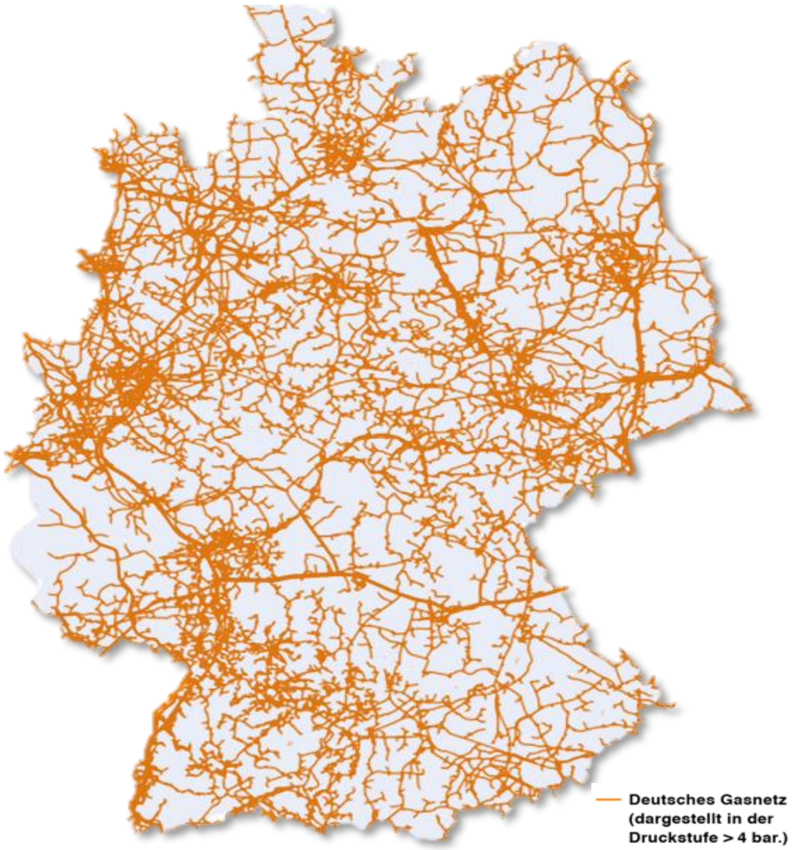
First published design of a German hydrogen grid



Disclaimer: Bei der Karte handelt es sich um eine schematische Darstellung, die hinsichtlich der eingezeichneten Speicher und Abnehmer keinen Anspruch auf Vollständigkeit erhebt.

Current German NG grid



DVGW case studies in Germany

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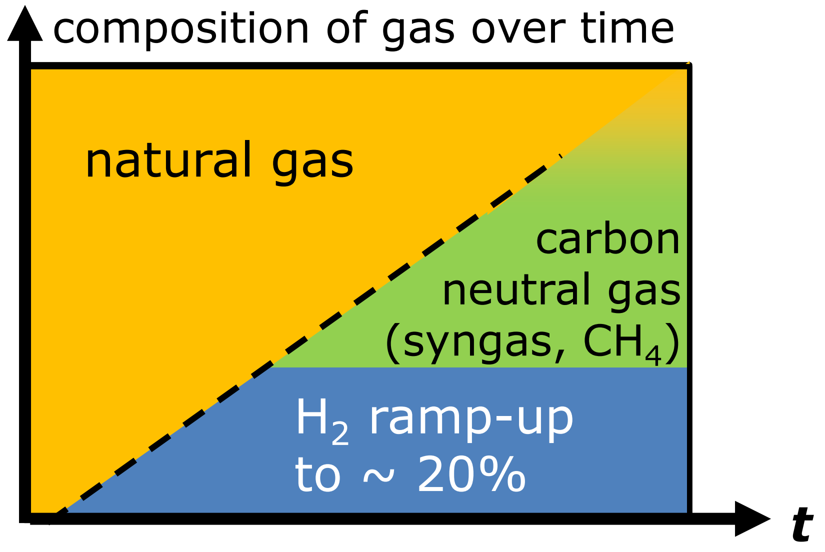
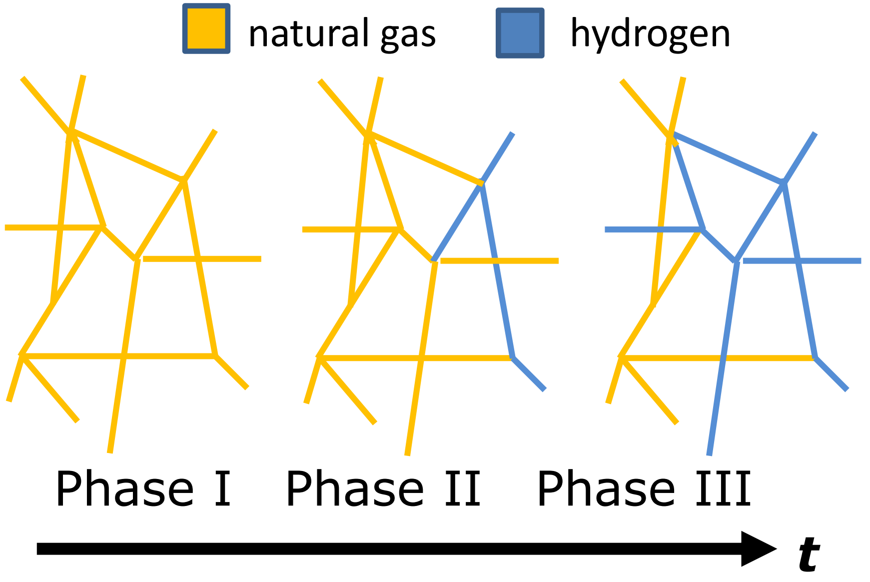
Different approaches have been studied or are under investigation

Model A: Increasing H_2 & syngas content and replacement of fossil origin



Model B: Temporary co-existing of natural gas and H_2 grids



Result of assessment of Model A:

German gas standards will aim for 20% hydrogen and > 20% carbon-neutral gas by 2030

Result of assessment of Model B:

DVGW R&D project "ROADMAP2050" will deliver a regional infrastructure transition plan for Germany

Effect on appliances can be predicted by studying the Wobbe index

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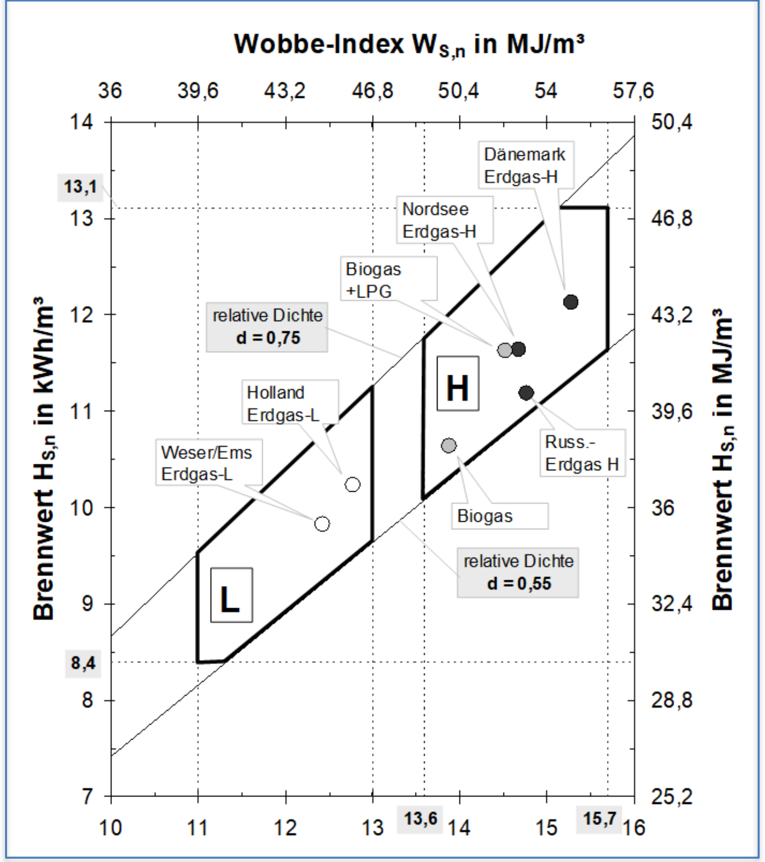
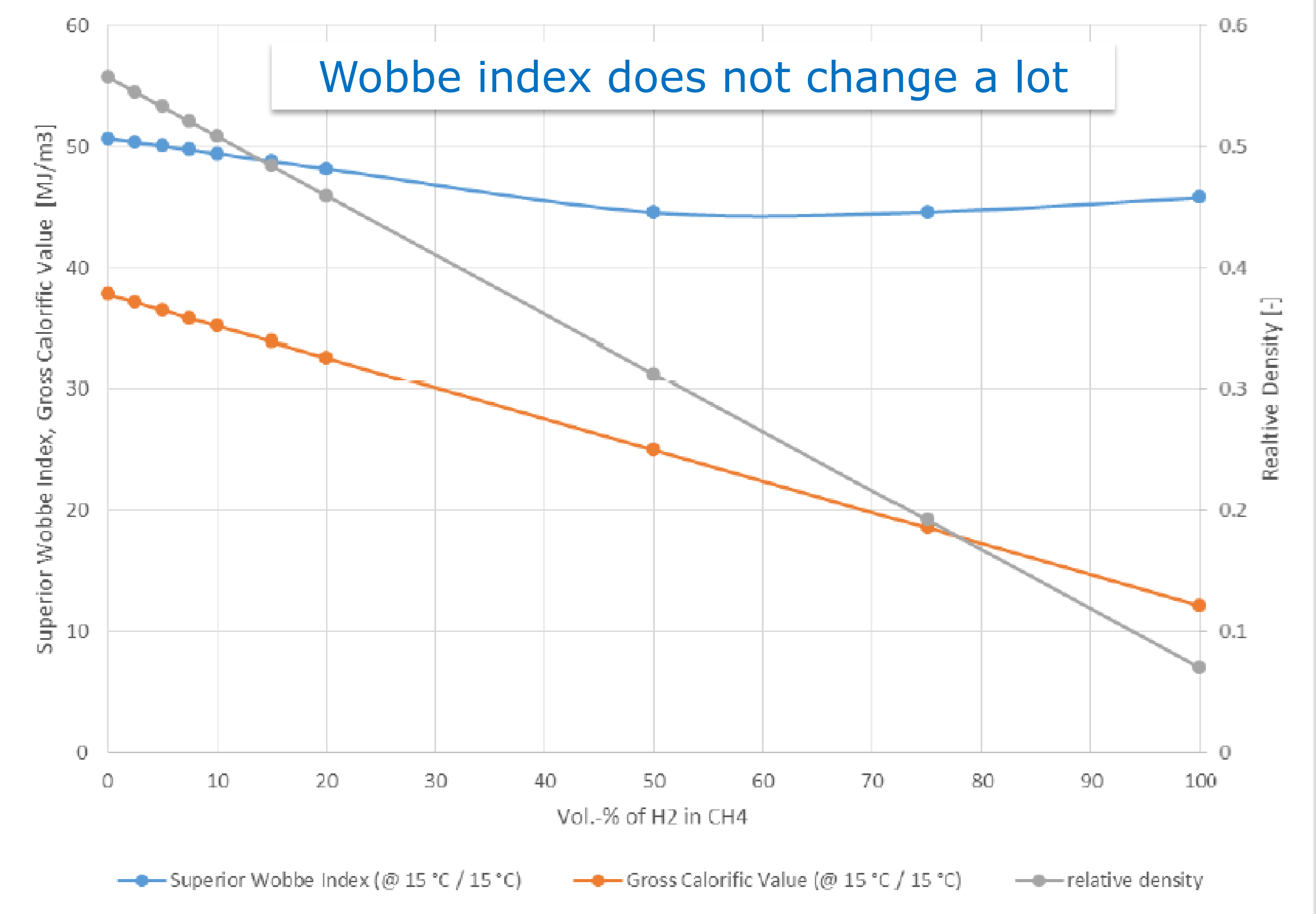
Gas parameter range according to DVGW G 260





As the power of a burner depends on the WI, it can be expected that appliances tolerate hydrogen admixtures

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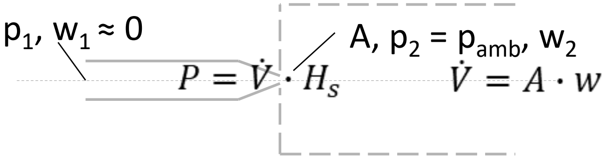
Some physics

Nozzel or burner tip



Power:

$$= A \cdot w \cdot H_s$$

$$= A \cdot \sqrt{\frac{2\Delta p}{\rho}} \cdot H_s$$

$$= \underbrace{A \cdot \sqrt{\frac{2\Delta p}{\rho_{Luft}}}}_{= \text{const}} \cdot \boxed{\frac{H_s}{\sqrt{d}}}$$

$$\frac{p_1}{\rho_1} + \frac{\cancel{w_1^2}^{\,0}}{2} = \frac{p_2}{\rho_2} + \frac{w_2^2}{2}$$

Bernoulli equation

$$w = w_2 = \sqrt{\frac{2\Delta p}{\rho}}$$

simplification: no friction and incompressible ($\rho_1 = \rho_2$)

$$d = \frac{\rho}{\rho_{Luft}}$$

Some tests

0% H_2

10% H_2

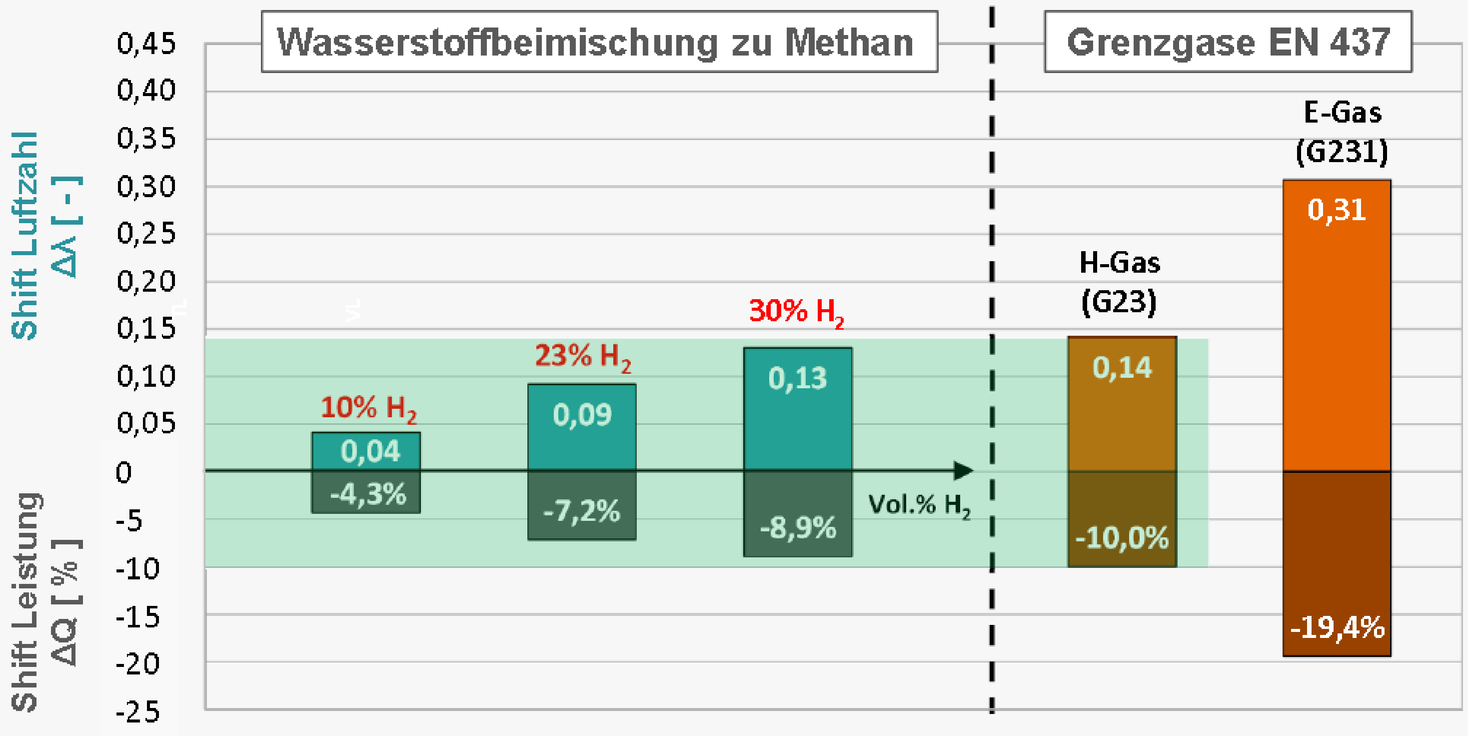
20% H_2

Source: M.J. Kippers, J.C. De Laat, R.J.M. Hermkens Kiwa Gas Technology, Apeldoorn, J.J. Overdiep, GasTerra, A. van der Molen, W.C. van Erp, Stedin, A. Van der Meer, Joulz: ***Pilot Project on Hydrogen Injection in Natural Gas on Island of Ameland in the Netherlands***; Poster Präsentation im Rahmen der IGRC, Seoul 2011

Recent tests from Viessmann with CBs under 30% H_2: *"No disadvantages to be expected"*

Eignung aktueller Gas-Brennwertgeräte für **H_2 bis 30 %**

Ergebnisse: Luftzahl und Leistung (Bsp: Vitodens 100, B1HC)



Fazit für 30 % H_2

- ❑ H_2 beeinflusst Luftzahl und Leistung
  - ⇒ **Luftzahl : + 0,13**
  - ⇒ **Leistung : - 9 %**
- ❑ Zum Vergleich: Einfluss Gasbeschaffenheit im H-Gas ähnlich (grün unterlegt)
- ❑ **Es sind keine essentiellen Nachteile zu erwarten**

Admixture of hydrogen to typical natural gases in Germany

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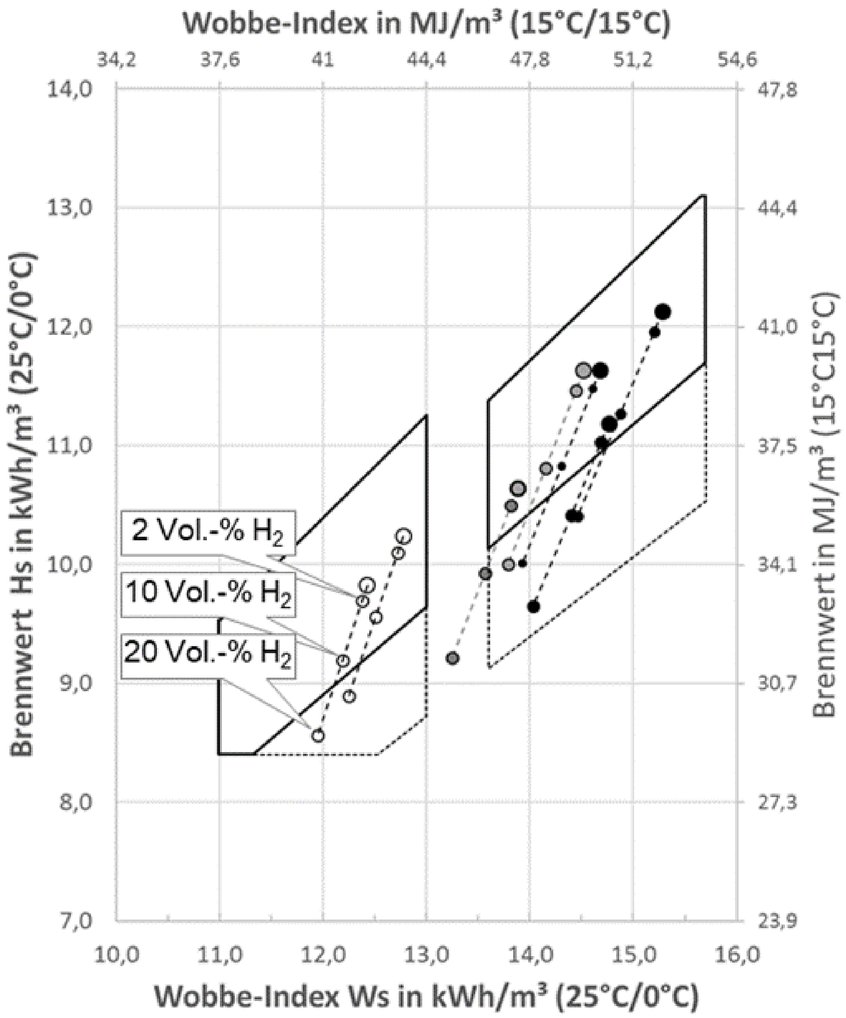

- Admixture up to 10 % Vol. has been successfully field tested in several European countries, including Germany.
- Admixture up to 20 % Vol. field tests currently in progress in France and Germany.
- Small field test up to 30 % Vol. in progress in Southwest of Germany.

But:

- Appliance industry sees 20 % as maximum - above that, new appliances need to be developed.
- Where gas is used as chemical feedstock (approx. 10 % in Germany) hydrogen is generally not wanted – indication for the need of separate hydrogen grids as well. The chemical industry in Germany has been operating two of these for many years.

Technical regulation for gas including hydrogen

- ISO 14687:2019 gives a choice ("grades") of hydrogen qualities, depending on the application.
- CEN-CENELEC/JTC 6 is developing European standards for "Hydrogen in energy systems".
- Draft CEN/TR in consultation by CEN/TC 234 "Gas infrastructure" regarding effects of incremental injection of hydrogen (at 2, 5, 10, 20 and 100 %) into gas grids (TSO and DSO level) - publication due end 2020.
- CEN/TC 234 standardisation of techniques of injecting hydrogen into gas grids based on national codes of practice.
- DVGW code of practice G 260 on gas quality under review: hydrogen may be injected without maximum fixed; depends on each infrastructure and on clients supplied; and new gas family for "pure" hydrogen grids (98 % and above).

Version 2020-03-30
Subject to 1st circulation to CEN/TC 234 and CEN/TC 234 consultation

CEN/TC 234

Date: 2020-03

TC 234 WI 00234080

CEN/TC 234

Secretariat: DIN

Gas infrastructure — Consequences of hydrogen in the gas infrastructure and identification of related standardisation need in the scope of CEN/TC 234

Gasinfrastruktur — Auswirkungen von Wasserstoff in der Gasinfrastruktur und Identifikation des zugehörigen Normungsbedarfs im Zuständigkeitsbereich des CEN/TC 234

Élément introductif — Élément central — Élément complémentaire

Hydrogen-readiness of natural gas systems

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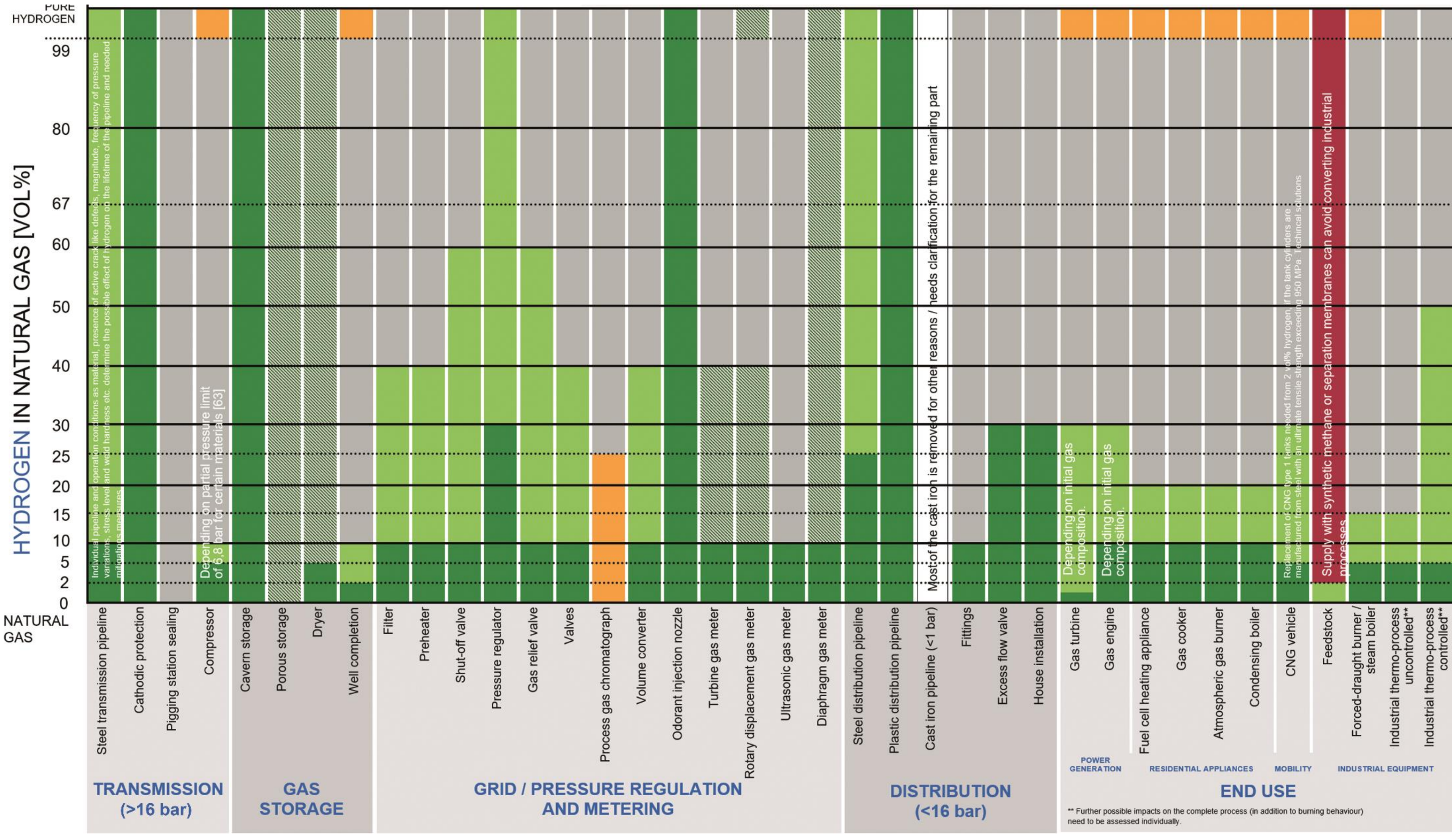

Legend used in infographic

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- **Assessment based on information from R&D projects, codes & standards, manufacturers and MARCOGAZ members' expertise**

Dark green	No significant issues in available studies*.
Light green	Mostly positive results from available studies*. Modifications/ other measures may be needed.
Orange	Technically feasible, signifcant modifications/ other measures or replacement expected.
Red	Currently not technically feasible.
Grey	Insufficient information on impact of hydrogen, R&D required.
Hatched green	Conflicting references were found, R&D/ clarification required.

***According to the list of references**

- **Any decision to inject hydrogen into a gas grid (system) is subject to a case by case investigation depending also on the NG quality and local regulatory approval**

Where does hydrogen come from and at what cost?

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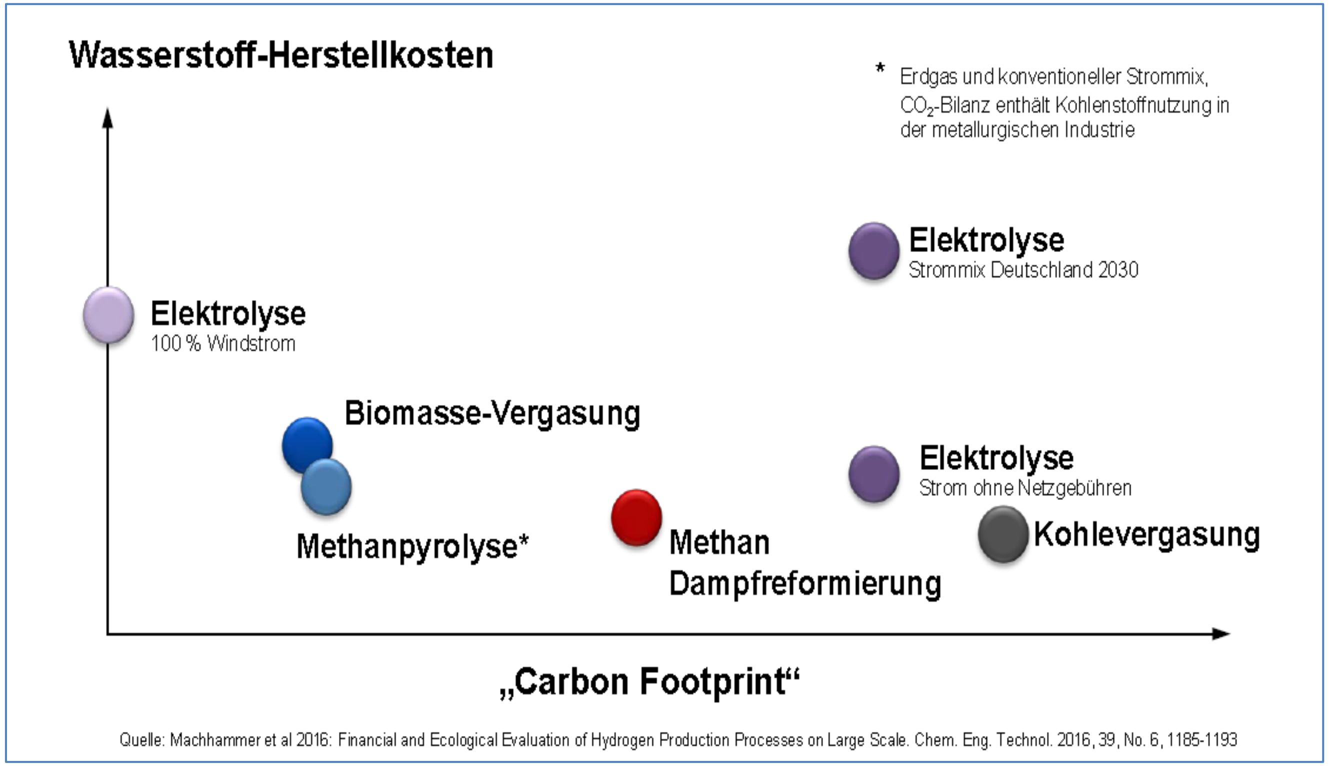
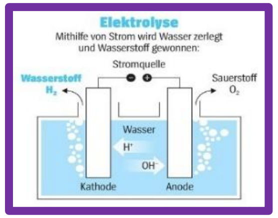
Green H_2 from green power produced through electrolysis

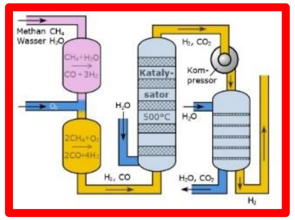
Green H_2 from green gas produced via steam reforming

Blue H_2 produced from natural gas via pyrolysis (no CO_2 in the process!)

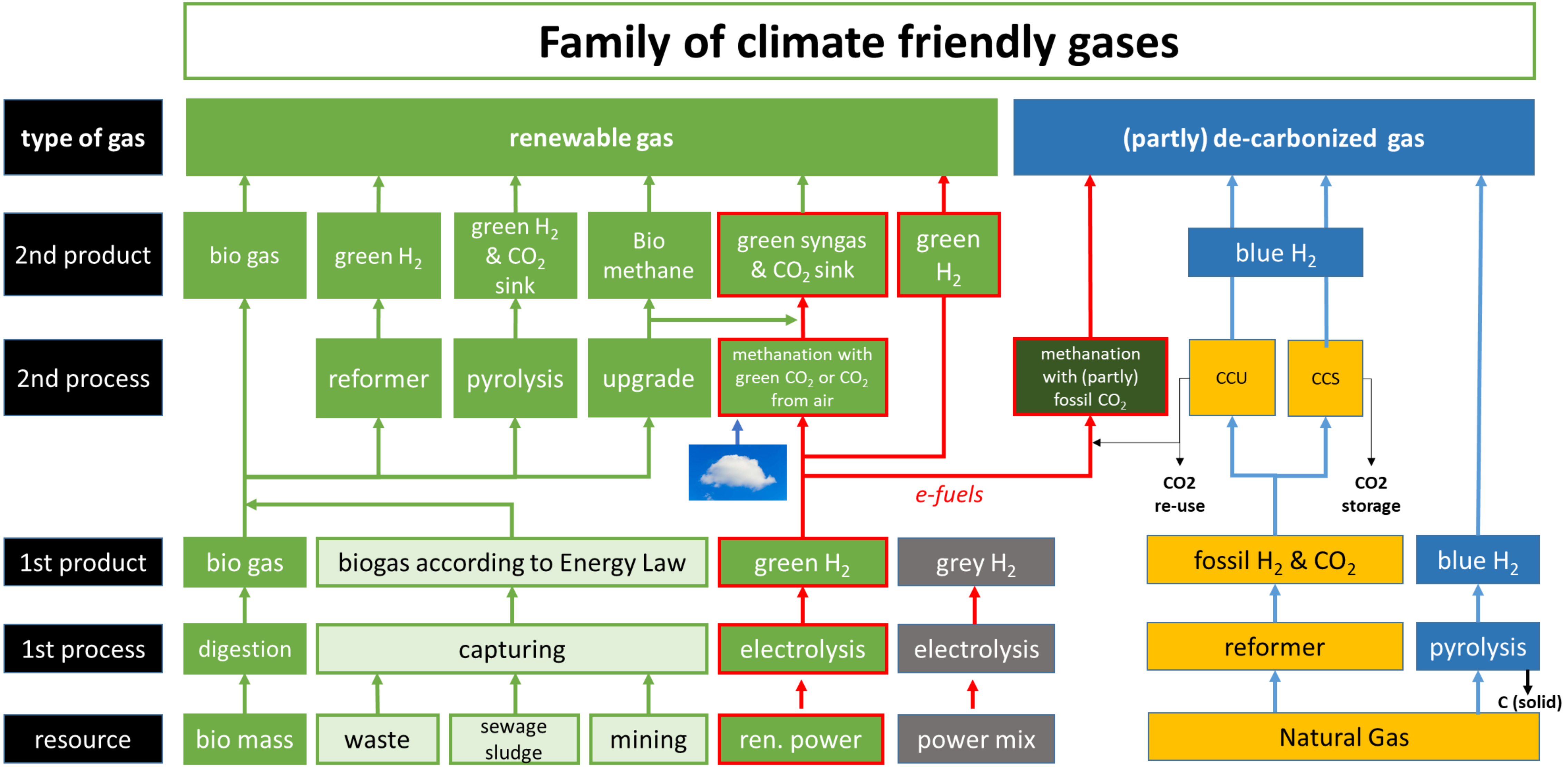
Blue H_2 produced from natural gas and using CCS or CCU







Where does hydrogen come from?



ISO standard available for CO_2 transportation

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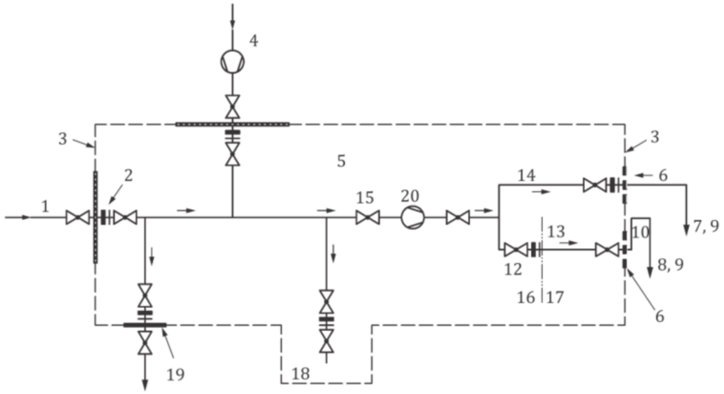
ISO 27913:2016 - Carbon dioxide capture, transportation and geological storage — Pipeline transportation systems

Additional requirements and recommendations not covered in existing pipeline standards for the transportation of CO_2 streams from the capture site to the storage facility where it is primarily stored in a geological formation or used for other purposes (eg EOR or CO_2 use).

ISO 27913:2016 applies to:

- rigid metallic pipelines;
- pipeline systems;
- onshore and offshore pipelines for transportation of CO_2 streams;
- conversion of existing pipelines for transportation of CO_2 streams;
- pipeline transportation of CO_2 streams for storage or utilisation; and
- transportation of CO_2 in gaseous and dense phases.



Key

1 source of CO_2 from capture, e.g. from power plant, industry; see ISO/TR 27912 (capture)
2 isolating joint
3 boundary limit
4 other source of CO_2
5 ISO 27913 (transportation system inside)
6 boundary to storage facility
7 onshore storage facility
8 offshore storage facility
9 EOR
10 riser (out of transport scope)
11 subsea valve (inside transport scope)
12 beach valve
13 offshore pipeline
14 onshore pipeline
15 valve
16 landfall
17 open water/sea
18 third party transport system
19 export to other uses than 7, 8 and 9
20 intermediate compression or pumping

Figure 1 — Schematic illustration of the system boundaries of this document

Thank you for your attention

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Gerald Linke
Marcogaz President

CEO of German Gas & Water Association (DVGW)

Linke@DVGW.de

1st Session: Principles of EU Gas Qualities and handling of hydrogen

1st Session Agenda

10:30 – 10:35 Introduction by Chair

Antonio Gómez, *Coordinator of Innovation and New Energies | Enagás*

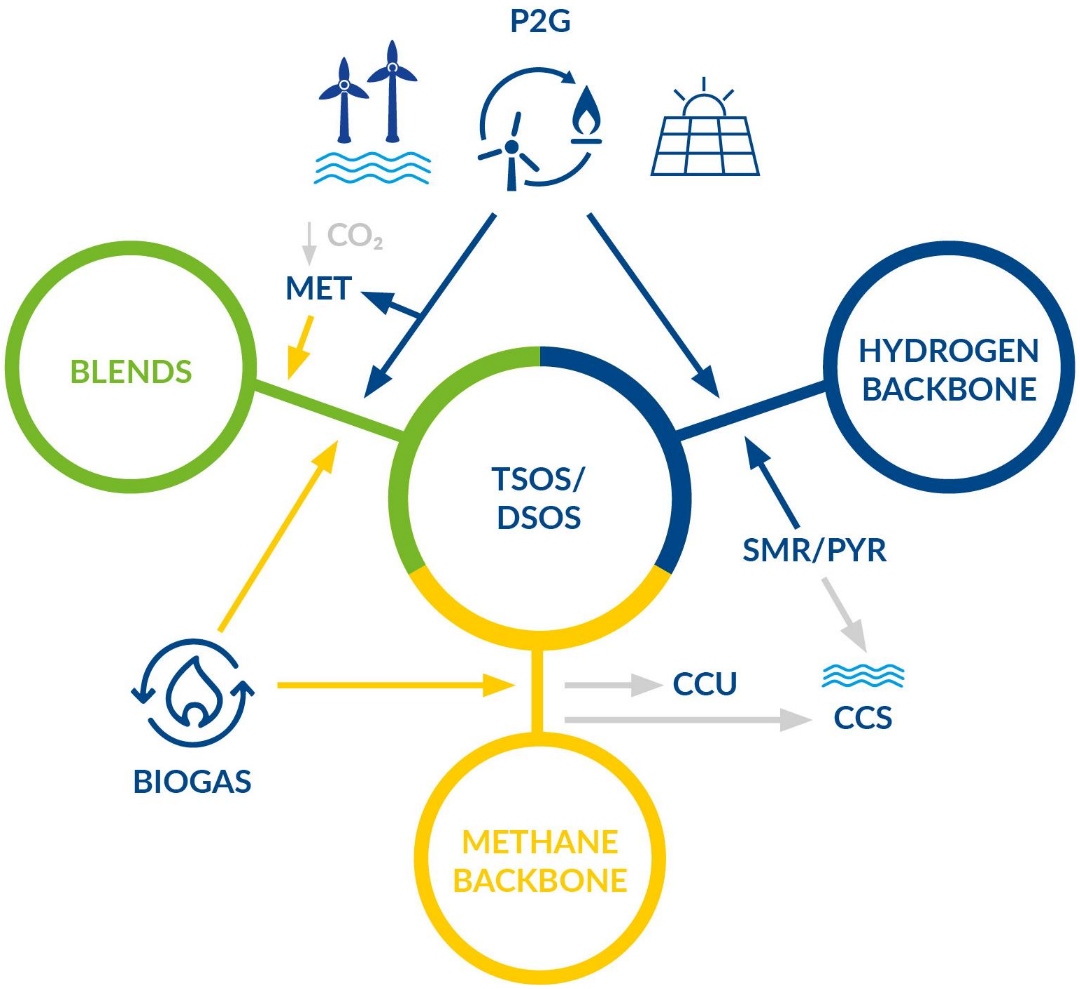
10:35 – 11:00 Presentations and Q&A

Anthony Mazzenga, *Head of Renewable Gases | GRTGaz*

Piet Nienhuis, *Senior Adviser in Energy transition & infrastructure | Gasunie*

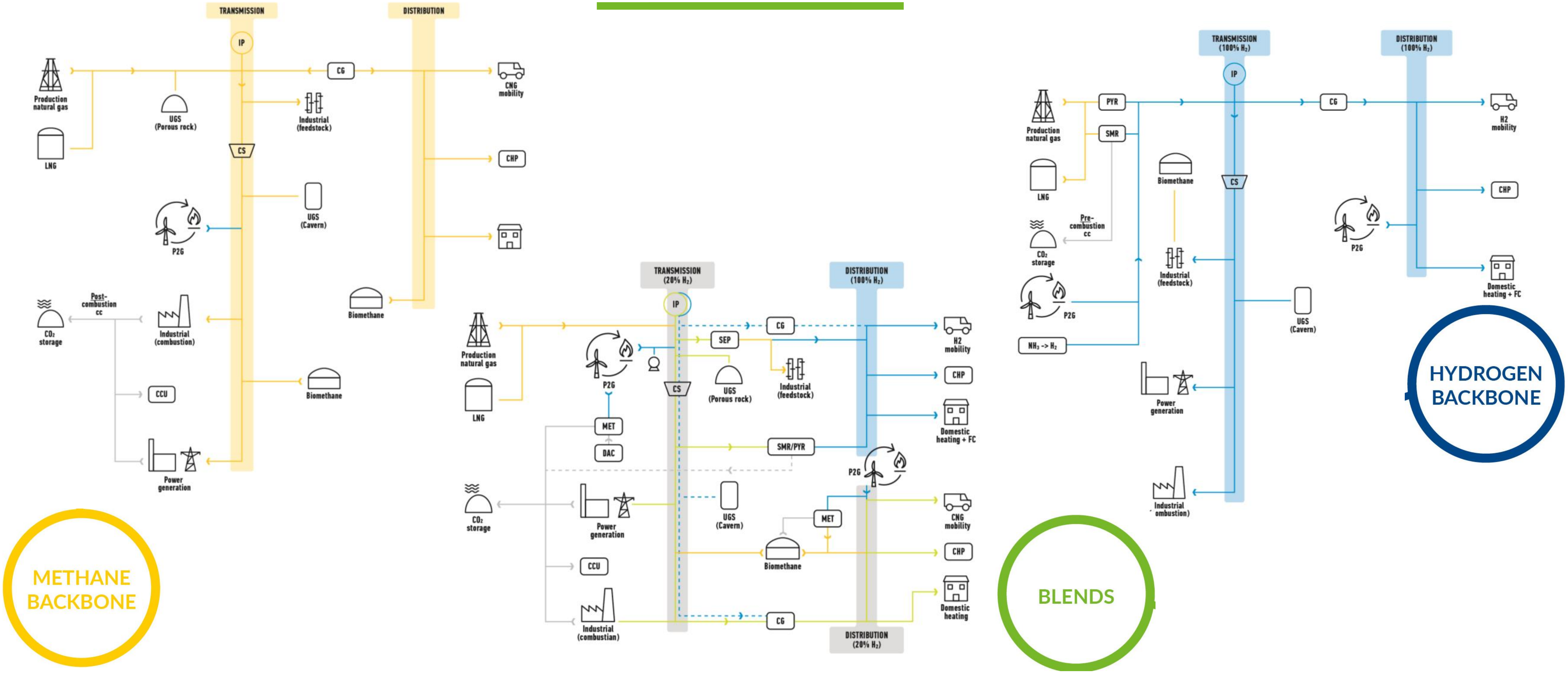
11:10 – 11:50 Discussion

Grid configurations for new gases



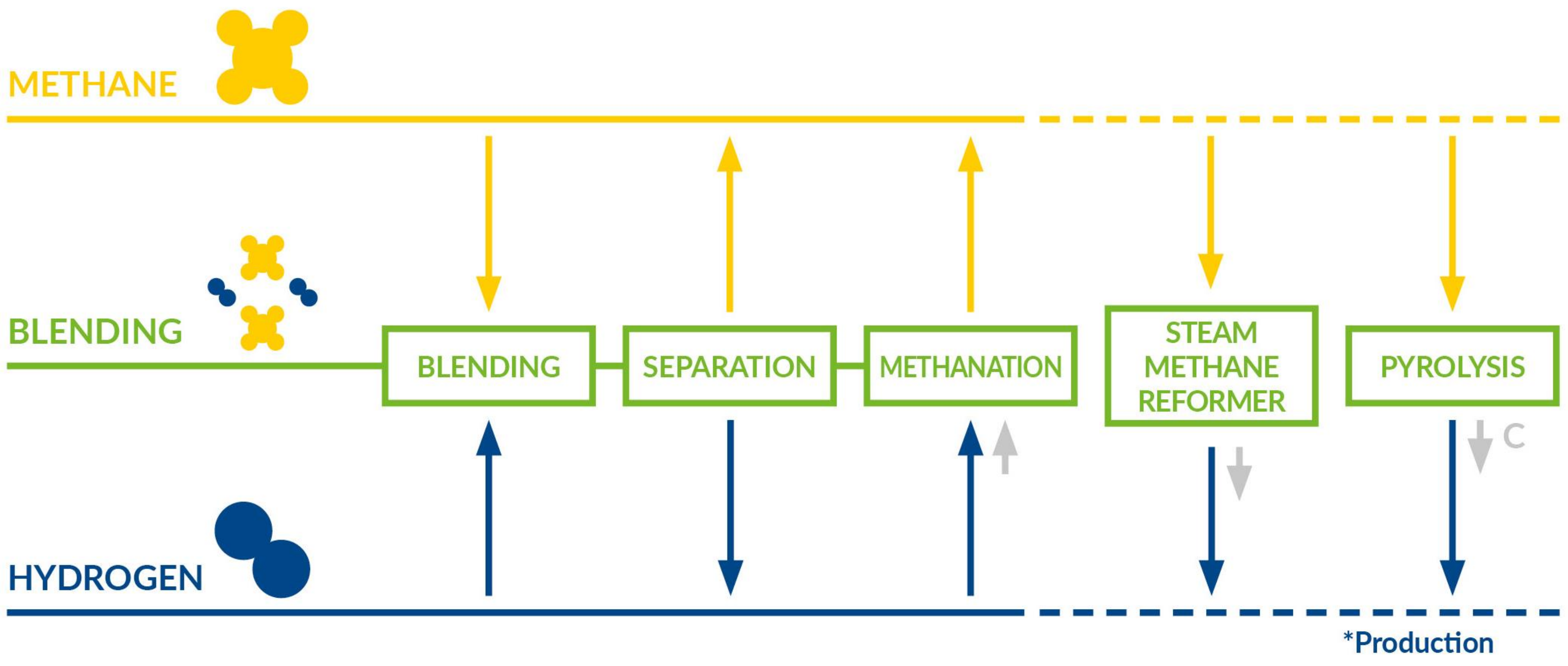
Pathways materialise differently and co-exist - depending on local/regional framework

Grid configurations for new gases



The topography of the gas network towards a zero-carbon gas grid will evolve over time, as a result of the MS and EU regulatory decisions, and cost/efficiency considerations

European Gas Quality & Hydrogen Handling



TSOs aim to actively participate in managing interfaces between electricity and gas and between gases

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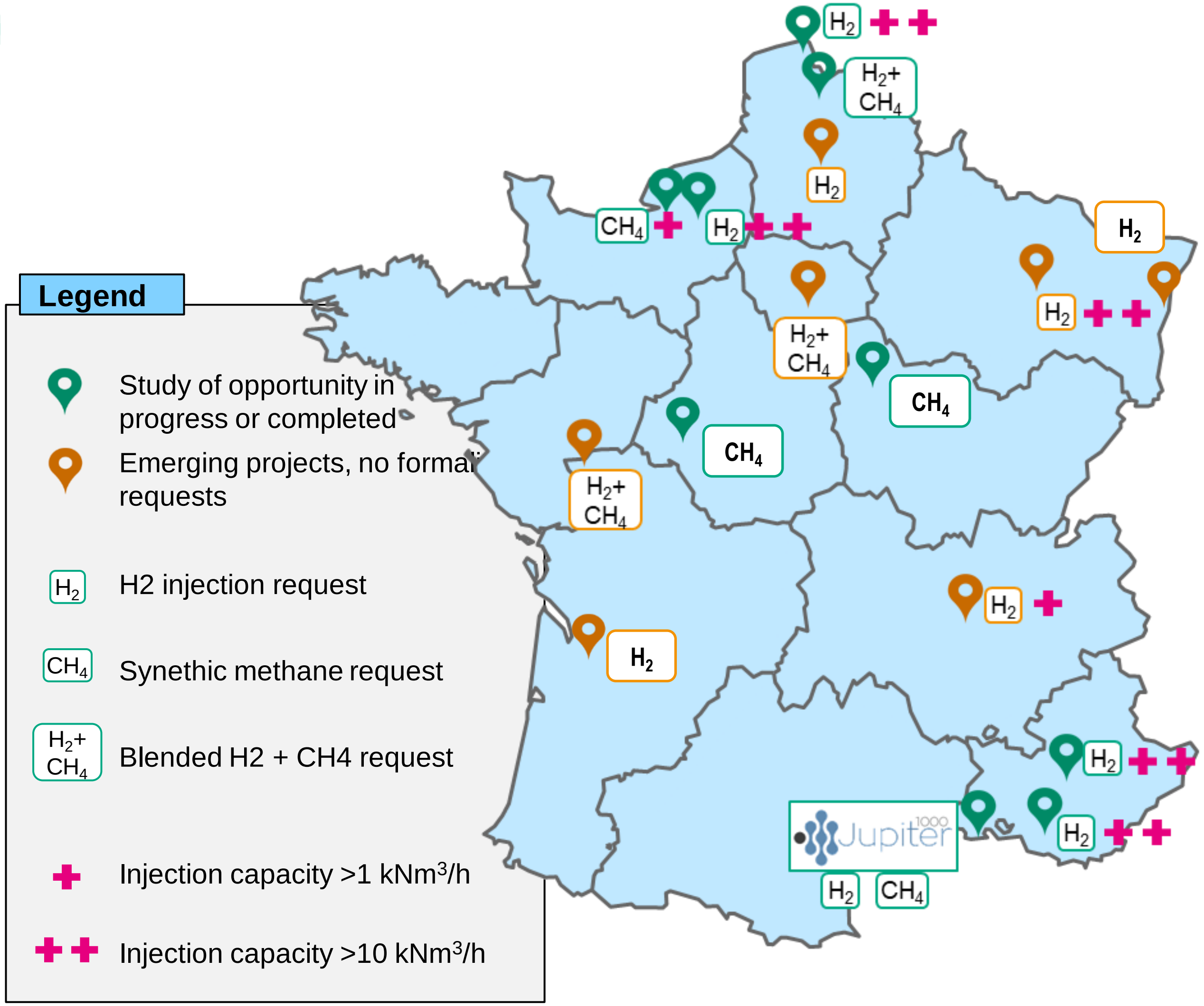
Considerations on H_2 injection in gas infrastructures

Anthony Mazzenga

29th April 2020

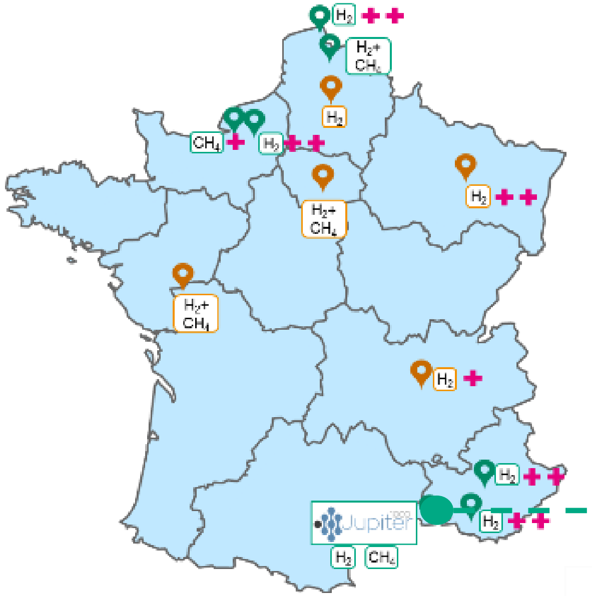
H2 & Syngas injection already under examination by French gas operators

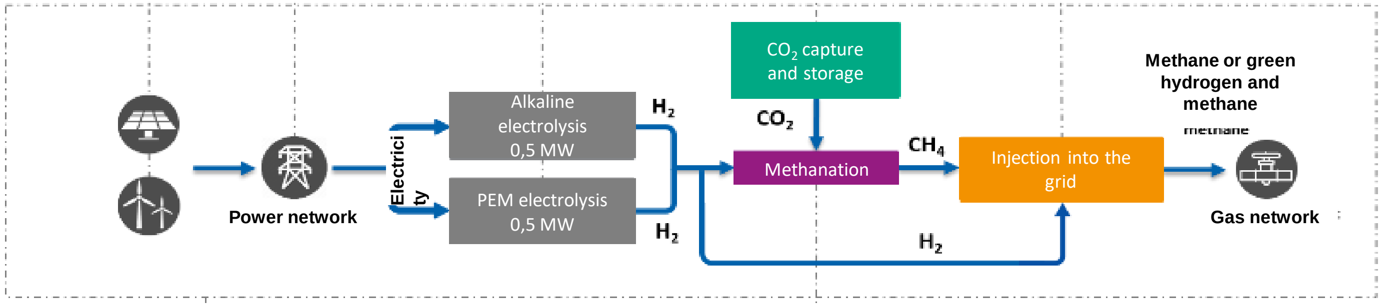


Applications for the connection of projects of different nature, from synthetic gas to pure hydrogen

- **Power-to-gas** from 1 to 200 MW (total injection or surplus)
- **H_2 byproduct** (chlorine industry)
- **Pyrogasification** (biomass, wood waste or RDF) CH_4/H_2 blend or pure H_2

1MW industrial pilot of H_2 injection Led by GRTgaz





*Proton Exchange Membrane

H_2 injection started end of February 2020, for 3 years

Report by the French gas industry, led by GRTgaz, within the framework of France's Hydrogen Plan

Coordinated report from the French gas operators:

- **TSOs** – GRTgaz & Teréga (representativeness: 100%)
- **DSOs** – GRDF, R-GDS, REGAS & SPEGNN association (100%)
- **SSOs** – Geométhane, Storengy, & Teréga (100%)
- **LSOs** – Elengy (75%)

Report publicly disclosed: **download link**

1 — Injection of blended H2 into existing pipelines

2 — H2 network

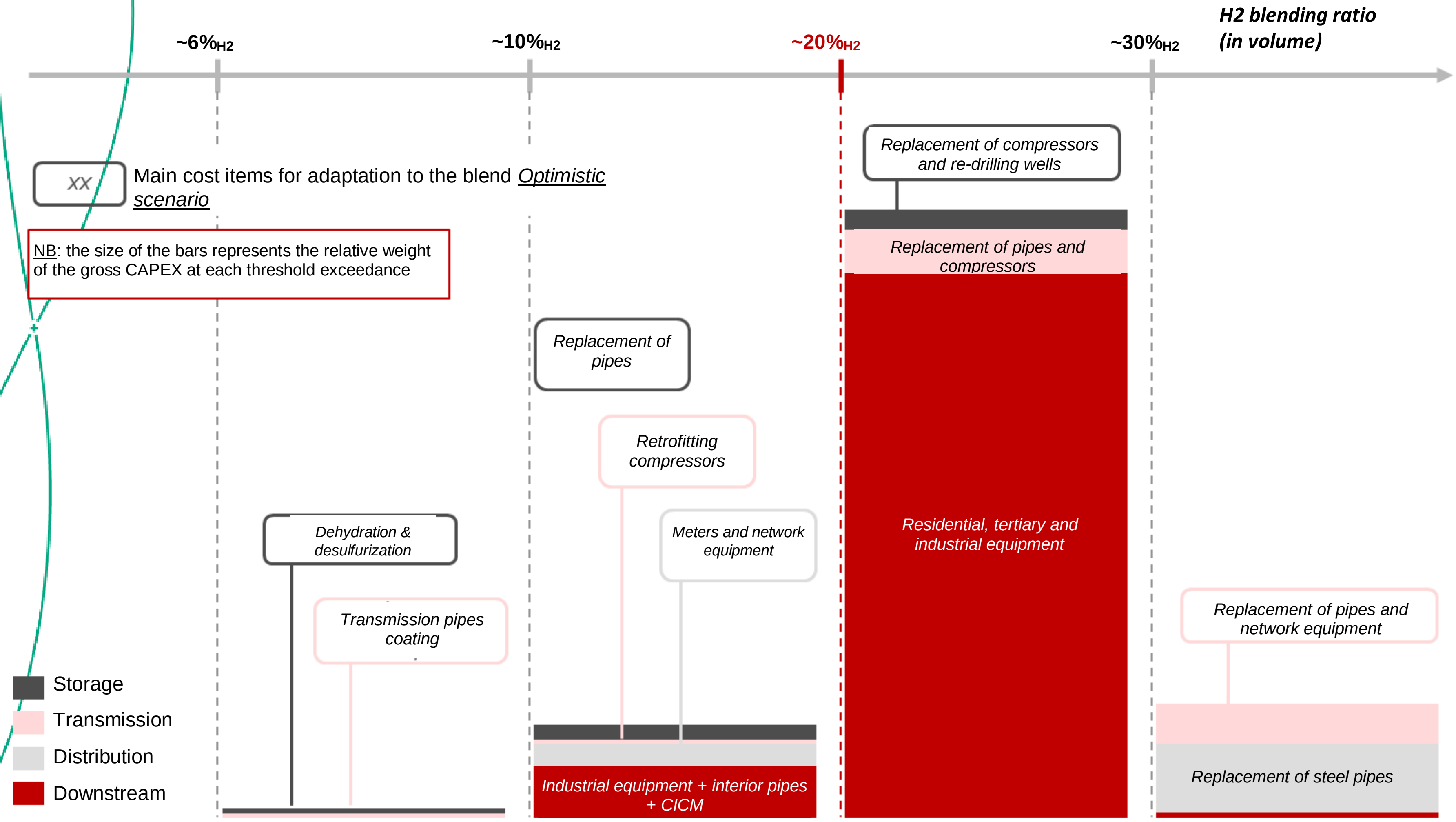
- Conversion of all or part of the existing natural gas network to 100% H2
- AND/OR
- Construction of a dedicated H2 network

3 — Methanation

Complementary routes, consistent with a differentiated development of H_2, dependent on **Mode of production , Concerned area & Dynamic of projects deployment**

Main barriers related to blending: limited adaptation costs up to 20%, unreasonable beyond

Summary of adaptation costs (CAPEX) at different hydrogen levels [adaptation costs relative to the volume of equipment concerned]



Results of modeling:

From € 1 to 8 / MWh by 2050 to integrate hydrogen by infrastructure adaptation depending on the scenarios studied(1)

(1) H_2 production: 10 to 40 TWh/year with various profile Adaptation costs in €/MWh related to final gas consumption Gas final consumption: 195 to 295 TWh/year

Note: the operating costs of H2/CH4 separation upstream of NGV stations or groundwater aquifiers take effect from 1%H2

Source: E-CUBE Strategy Consultants analysis, Gas operators WG

NB: the graphic view above is maximising as it represents the financial volumes corresponding to the cost of adapting 100% of the fleet at a given time, with no anticipation effect (gradual replacement of equipment by other compatible equipment over time)

Benefits of blending: overall energy system optimization at low costs

Upstream

Existing gas networks

Downstream

Integrate all low-carbon & renewable gases production
-> accept syngas injection - blend of CH_4 and limited % of H_2

Waste & biomass gasification

Optimize business model of H_2 projects for industry or mobility
-> offer a highly available outlet whatever the local H_2 needs are

H_2 for industry & mobility

Optimize planning and gas & power networks investments
-> offer alternative solution to integrate growing renewable electricity capacities

Sector coupling

Limited adaptation costs

All gas end uses decarbonization without equipment conversion

No adaptation costs
Apart from protection of some sensitive customers

Conclusions and recommendations

1. **Possibility of integrating a significant volume of hydrogen into the 2050 gas mix with limited adaptation costs**

2. **Need to mobilize blending, methanation and 100% H_2 clusters,** green field or by conversion of existing gas networks

3. **Maximum acceptable blending rate**
   - **6% feasible at short term in most networks**, except for area with sensitive gas infrastructures or end-user equipment
   - **Recommendation to set an EU wide target of 10% by 2030 and 20% beyond** in order to anticipate equipment adaptation, particularly at end-user level

GRTgaz

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grtgaz.com

crossing borders in energy

Groningen, 29 April 2020

Developing a hydrogen infrastructure in the Netherlands

Presentation on the ENTSOG workshop

“Principles for EU Gas Qualities, handling of Hydrogen and CO_2 Transportation”

Piet Nienhuis

gasunie
crossing borders in energy

Groningen, 29 April 2020

Dutch H_2 backbone connects sustainable supply & demand

Project description

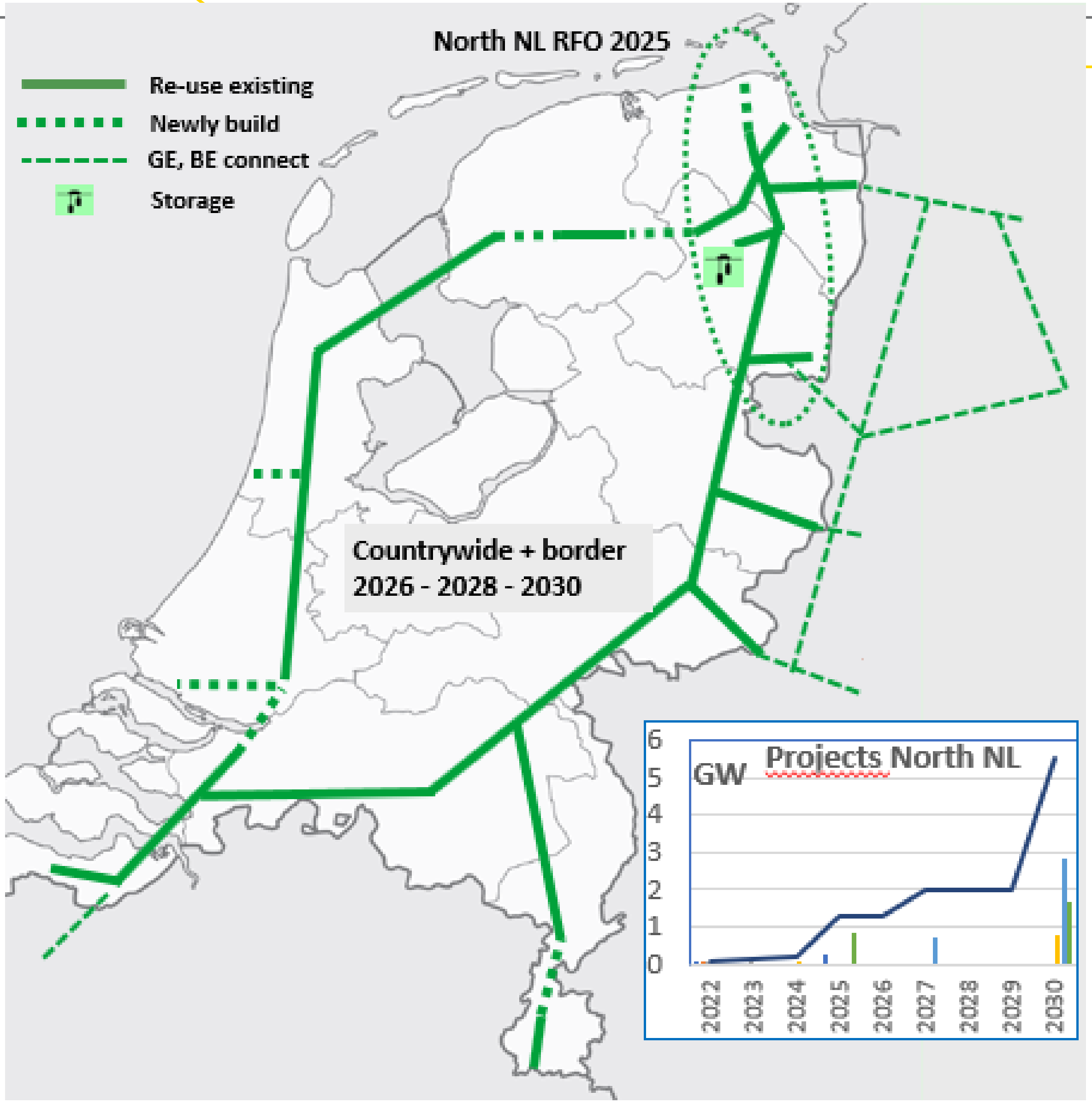
The aim is to develop a H_2 transport network, including storage facilities, that will supply green H_2 to the market in the Netherlands and in surrounding countries. This network is to be the basis of a liquid green H_2 market in NW Europe.

Current status

First phase, in the north of the Netherlands, is expected to be operational in 2025. This includes cross border connection to Germany. From 2026 – 2028 to connect all industrial regions in the Netherlands and cross border GE+BE regions by 2030.

Relevance

The development of H_2 transport infrastructure offers the opportunity to contribute significantly to a cost efficient energy transition in NW Europe by using existing natural gas infrastructure



Already operational

gasunie
crossing borders in energy

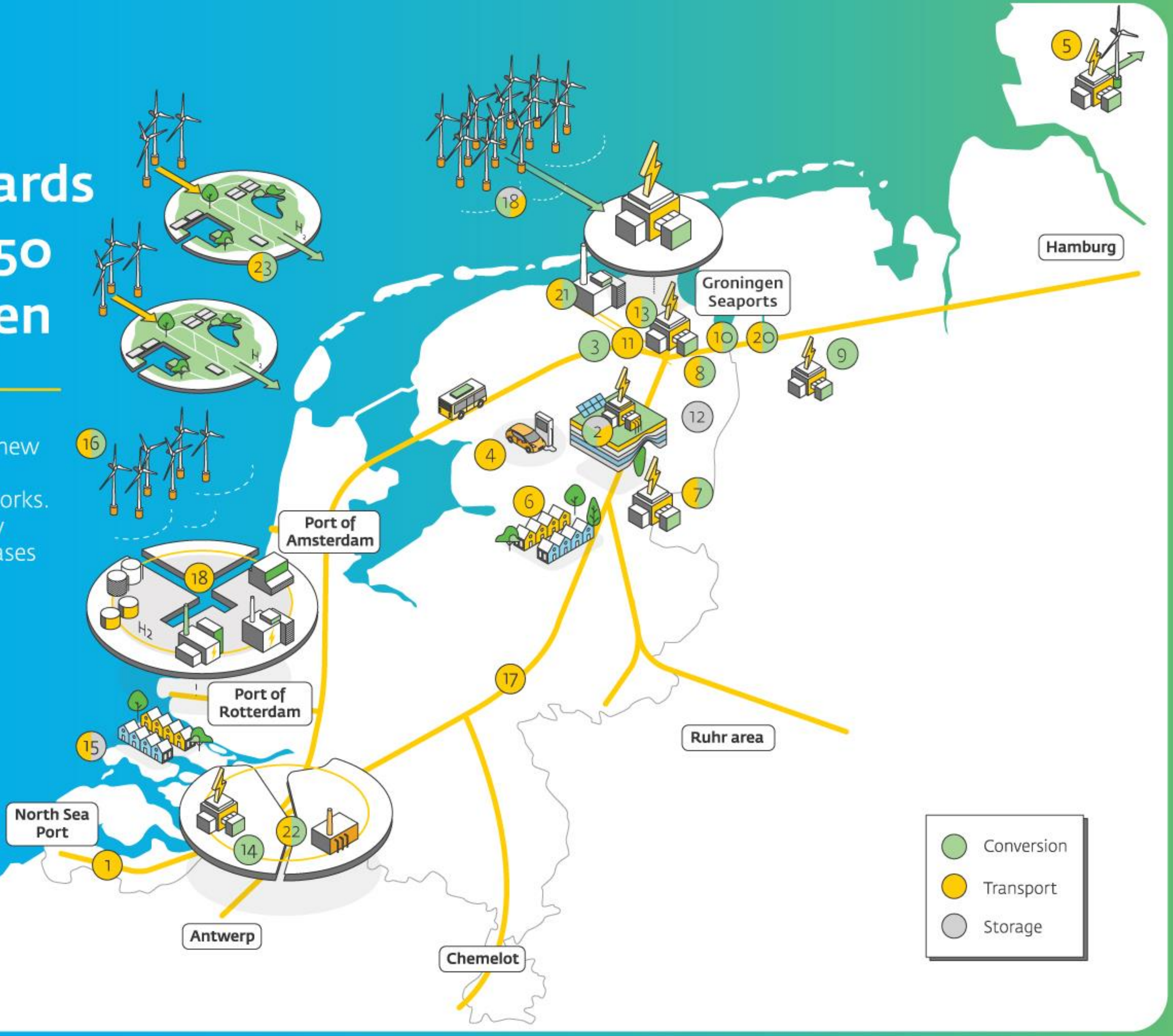
Moving towards 2030 and 2050 with hydrogen

The energy transition requires new forms of infrastructure and intelligent use of existing networks. Gasunie wants to invest in new infrastructure for renewable gases such as hydrogen.

2016 Paris Agreement:
Global warming set at a max. 2°C. This requires CO_2-reduction in the Netherlands of:

- **40-50% in 2030**
- **85-100% in 2050**

Hydrogen as a fuel and as a raw material can help to achieve CO_2-reduction targets.



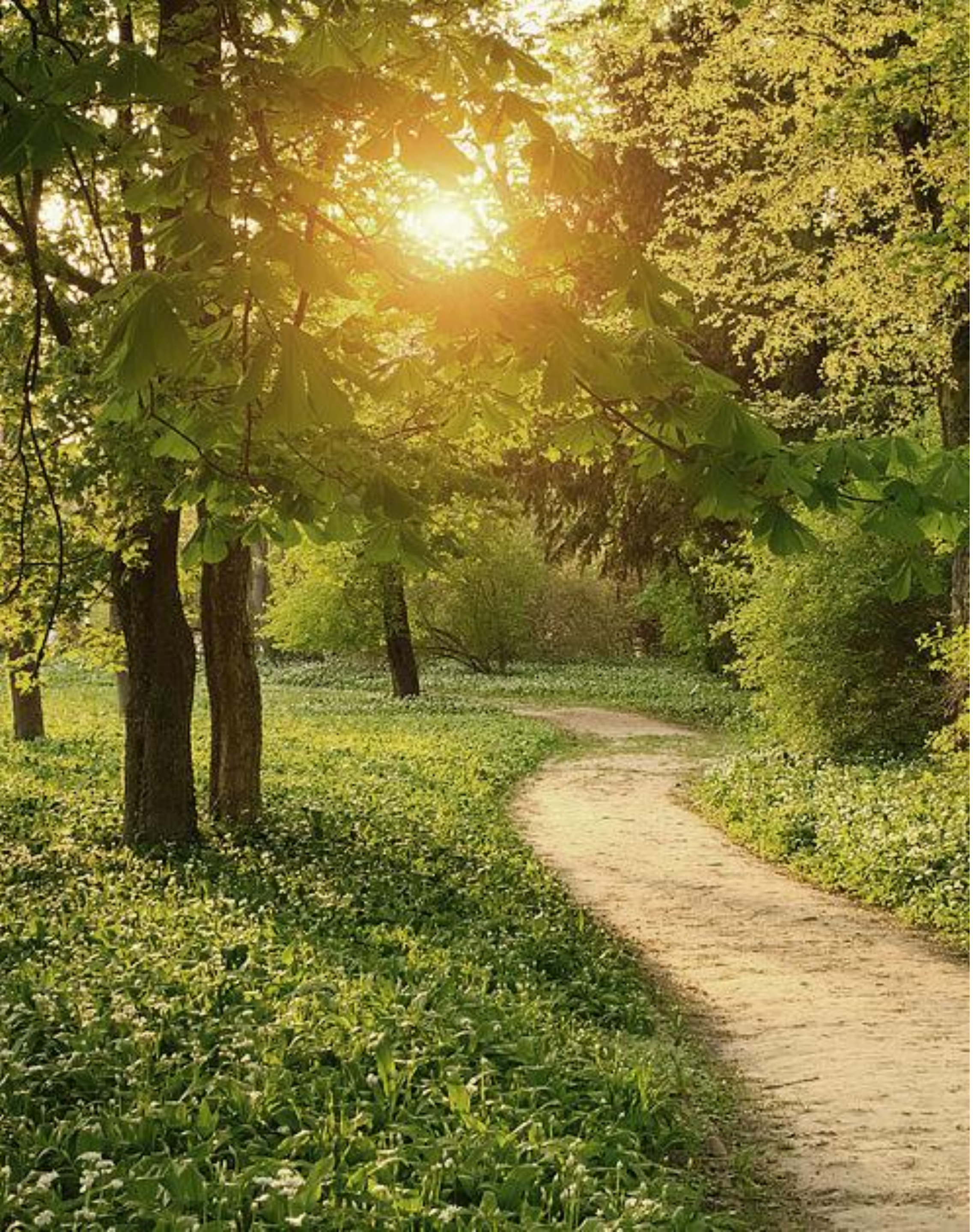
- 2017: 1 Hydrogen pipeline
- 2018: 2 HyStock
- 2019: 3 Hydrohub
- 2020: 4 Hydrogen re-fuelling stations and buses; 5 H_2-projekt Haurup
- 2021: 6 Hydrogen district Hoogeveen; 7 GZI Next
- 2022: 8 Djewels
- 2023: 9 Element 1; 10 HyNetherlands
- 2024: 11 Northern H2 infra
- 2025: 12 Hydrogen storage; 13 H2M
- 2026: 14 CUST; 15 Hydrogen district Stad aan 't Haringvliet; 16 North Sea Wind Farm; 17 Backbone
- 2027: 18 NorthH_2; 19 H-vision
- 2028: 20 HyNetherlands
- 2029: 21 H2M phase 2
- 2030: 22 CUST; 23 North Sea Wind Power Hub

https://www.theworldofhydrogen.com/gasunie/infrastructure/

Q & A

Anthony Mazzenga, Head of Renewable Gases | GRTGaz

Piet Nienhuis, Senior Adviser in Energy transition & infrastructure | Gasunie



DISCUSSION

Discussion points (until 11:50)

What are the benefits of blending H_2 in the natural gas grid?

How far should we go with the blending route? Is there a tipping point?

What is needed to secure the gas quality stability and predictability for the End-users?

How can end-users be supported in their adaptation process?

How do we maintain a high level of security of supply in a gas system with dual gas types and fluctuating gas quality?

What technologies are needed to accommodate the transition to a carbon-neutral energy system?

How do we facilitate the development of these new technologies?

BREAK

2nd session: CO_2 transportation starts 12:00 CET

2^{nd} Session: CO_2 transportation

2nd Session Agenda

12:00 – 12:05 Introduction by Chair

Hendrik Pollex, *Director of System Operation | ENTSOG*

12:05 – 12:30 Presentations and Q&A

Dan Sadler , *Project Manager LCS (Low Carbon Solutions) | Equinor*

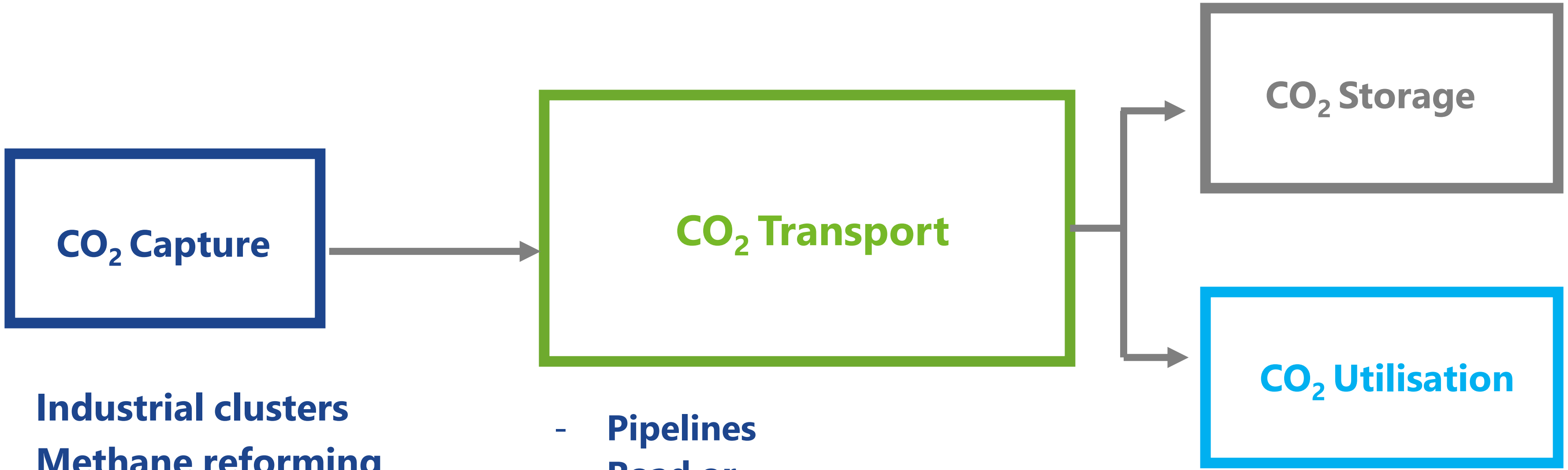
Thijs de Vries, *Senior Business Developer | Gasunie*

Brian Murphy, *European Affairs Manager | Ervia*

Kees Bouwens, *Regulatory & Policy Advisor | IOGP*

12:30 – 13:20 Discussion

Principles for CO_2 transportation



CO_2 Capture:

- Industrial clusters
- Methane reforming
- Gas fired power
- Cement
- Steel
- Other

CO_2 Transport:

- Pipelines
- Road or maritime

CO_2 Storage:

- Offshore
- Onshore

CO_2 Utilisation:

- Circular economy
- Synthetic gas
- Food & beverage
- Construction
- Other

Efficient and sustainable approach to decarbonisation will include CCUS requiring CO_2 transport systems

ENTSOG Online Workshop - Principles for EU Gas Qualities, handling of Hydrogen and CO_2 Transportation

April 29th, 2020

Dan Sadler

equinor

Equinor in a nutshell

A broad energy company

We're Equinor, a broad energy company with a proud history. We are 21,000 committed colleagues developing oil, gas, wind and solar energy in more than 30 countries worldwide. We're the largest operator in Norway, one of the world's largest offshore operators, and a growing force in renewables.

Driven by our dedication to safety, equality and sustainability and our Nordic urge to explore beyond the horizon, we're shaping the future of energy.

Equinor produces around 2 million barrels of oil equivalent every day

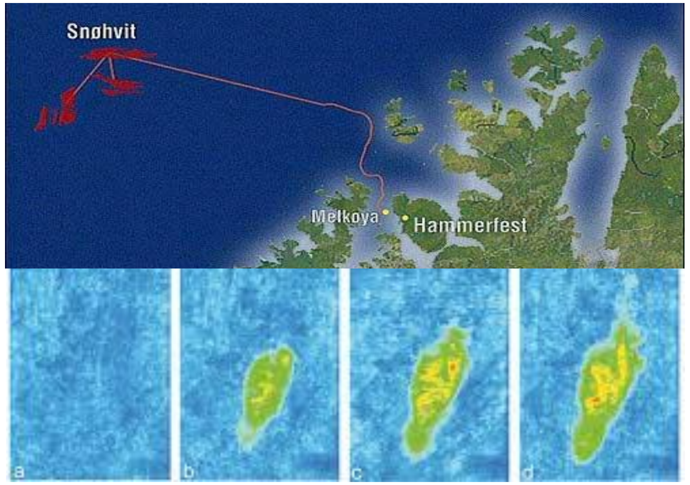
Providing renewable power to 1 million European homes

21,000 employees across more than 30 countries

Equinor Hydrogen and CCUS capabilities

Offshore CCS projects

- Sleipner CCS 1996 – 1 mtpa
- Snøhvit CCS 2008 – 0.7 mtpa



Technology Center Mongstad 2012

- 100,000 tpy post combustion capture technology center

Tjellbergodden Methanol – 1998

- 700 MW hydrogen production
- ATR and SMR technology

Open

Northern Lights 2023 – Making a national project an international light house

Capture

- Cement: Heidelberg 0.4 mtpa
- Waste Energy: Fortum: 0.3 mtpa

CO2 T&S (Equinor, Total and Shell)

- CO2 shipping
- CO2 storage 5 mtpa
- Drilling test undertaken

CO2 hub for Europe

- Seven MoU's signed in September
- 30-40 indicated similar interest
- Major influence on EU policy

equinor

Low Carbon Solutions portfolio
- building markets for CCS and clean hydrogen

CCS

2023

Northern Lights

- CCS for industry

Hydrogen

2025

HyDemo Norway

- Hydrogen for maritime

2026

Zero Carbon Humber

- Hydrogen for industry
- Chemicals
- Synthetic fuels
- BECCS
- Hydrogen power

2027/28

Clean Steel

- Hydrogen for industry (steel)

2027/28

H2 Magnum

- Hydrogen power
- Hydrogen for industry

Post-combustion

2026

Net Zero Teesside

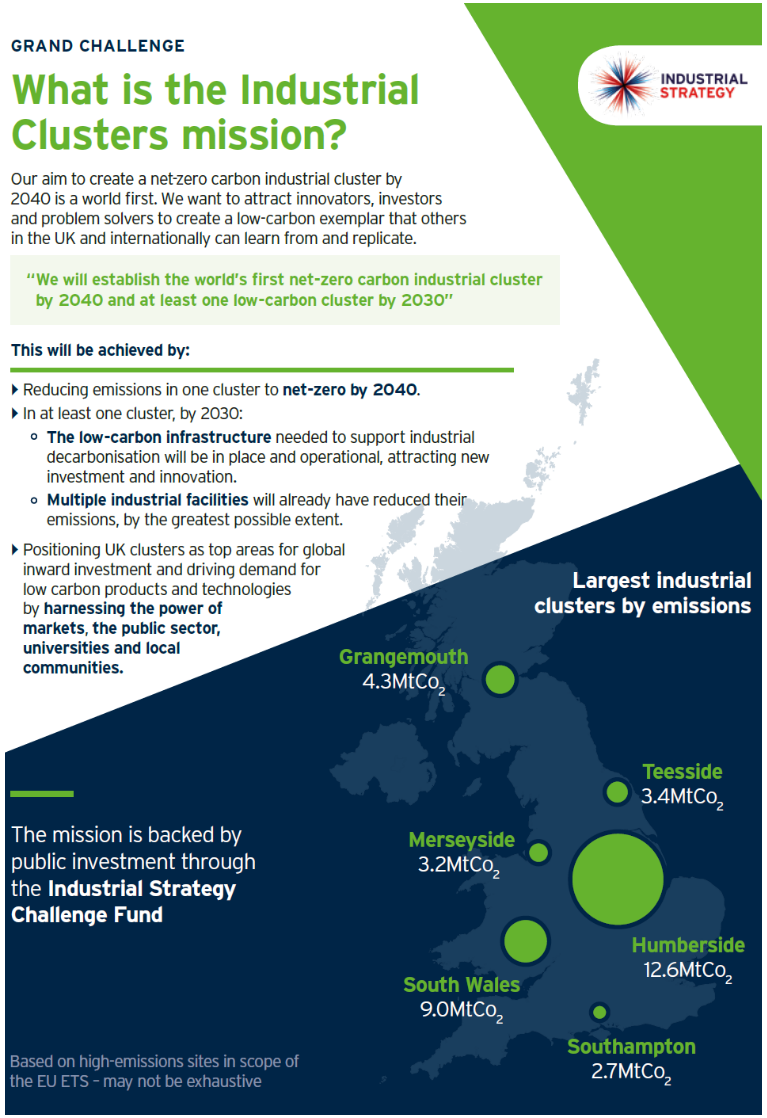
- Post-combustion CCS power generation
- CCS for industry
- BECCS
- Hydrogen production

Internal

UK Government Momentum – Where to start CO_2 T&S and H_2 production

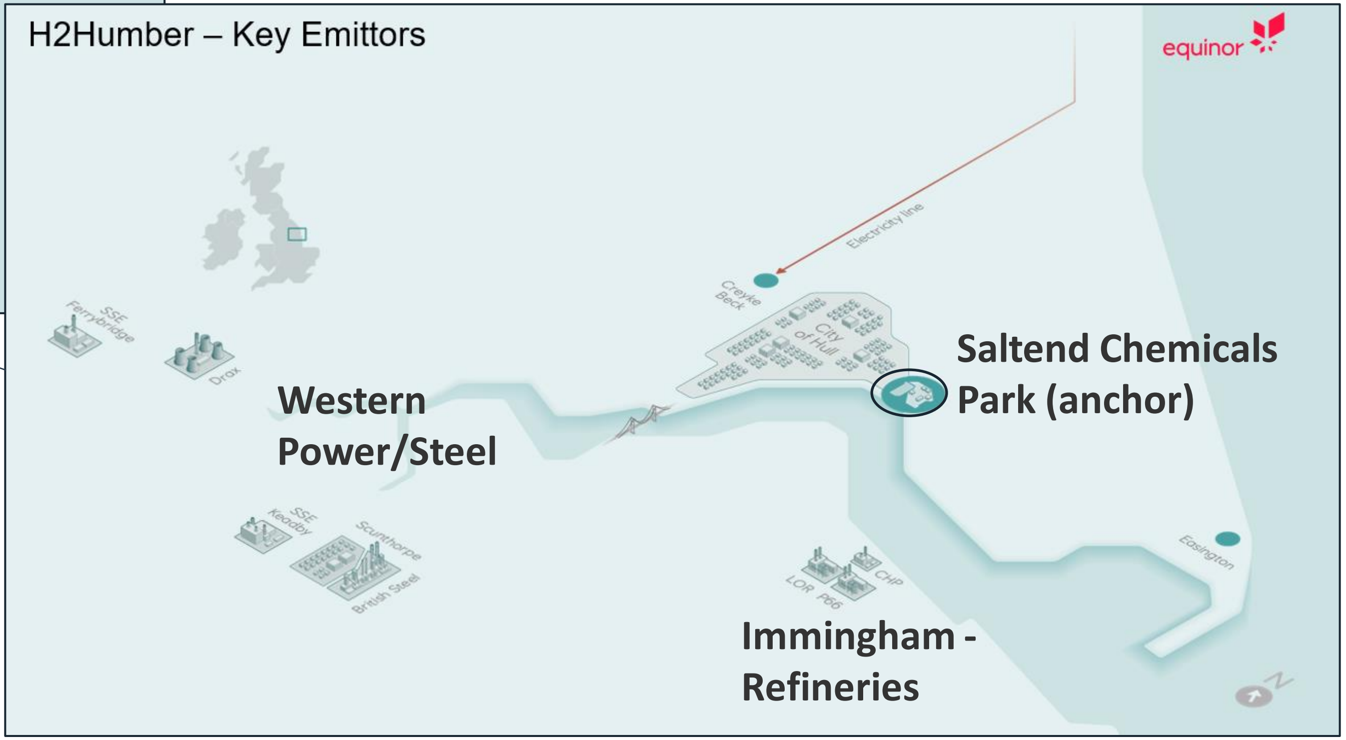
equinor

Where to Start?



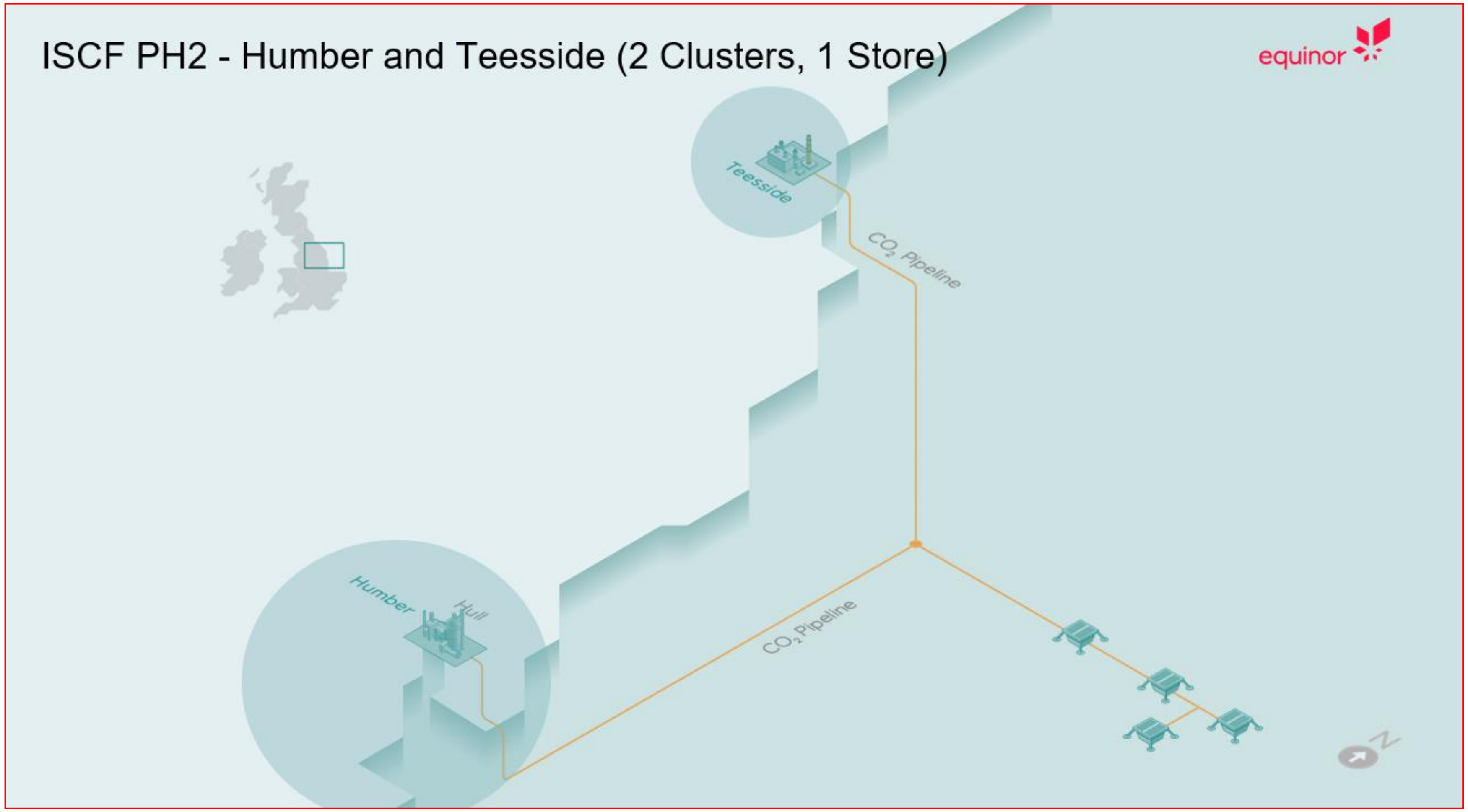
Anchoring a CO_2 T&S system

- Any industrial Cluster is likely to need three factor to meet 'net zero'
  - A strong fuel switching strategy (hydrogen)
  - Post combustion (where fuel switch is not possible)
  - BECCS to offset those remaining emissions.



- The Humber is the is the largest Industrial cluster in the UK.
- Humber has the full range of established industries.
- Humber has clear economies of scale justifying appropriate sizing of initial CO_2 T&S infrastructure

Achieving the Committee on Climate Changes (CCC) recommendations

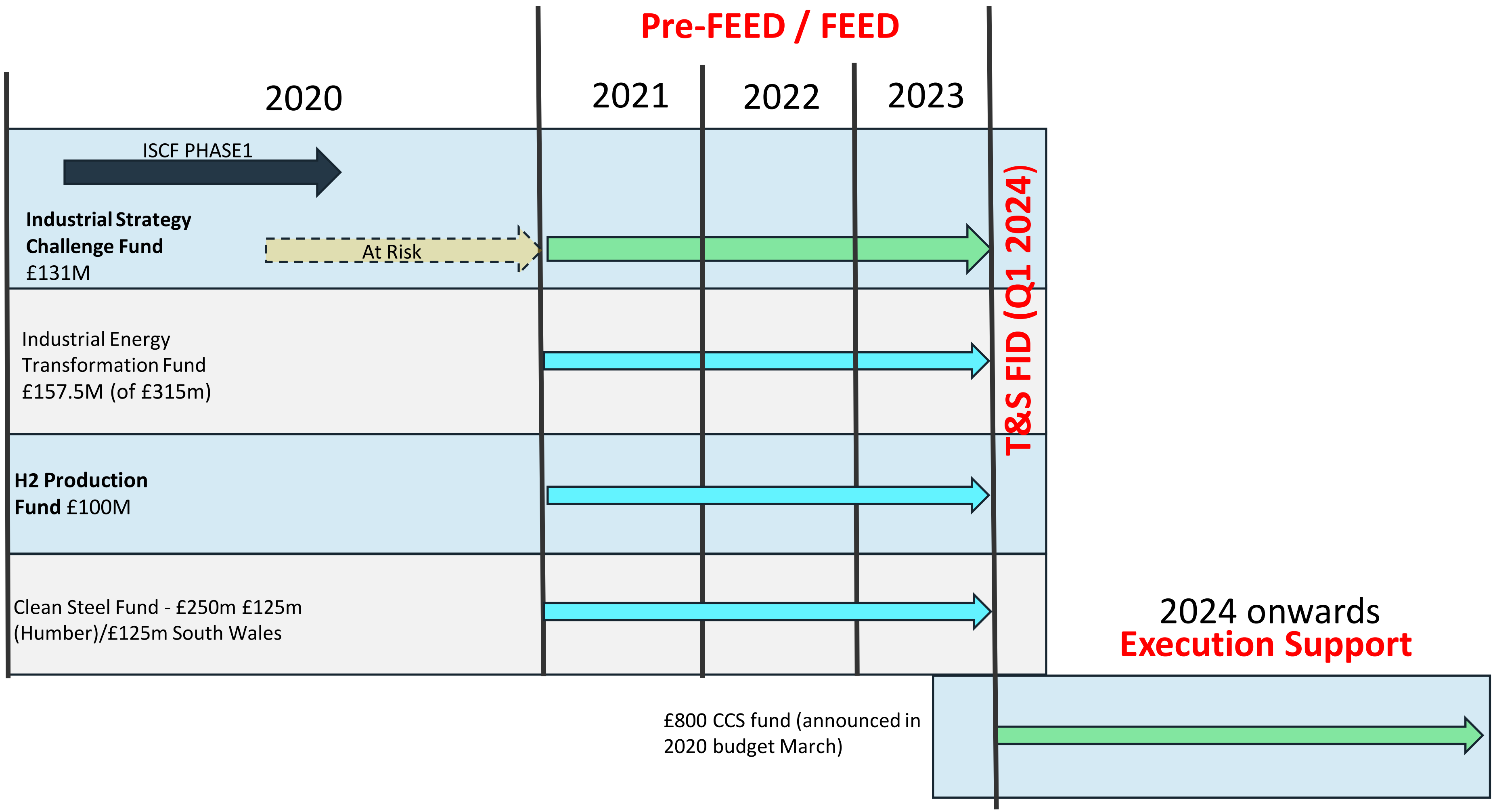


CCC 'Net Zero':
Carbon capture and storage (CCS) is essential. We (the CCC) previously recommended that the first CCS cluster should be operational by 2026, with two clusters, capturing at least $10MtCO_2$, operating by 2030. For a net-zero target it is very likely that more will be needed.

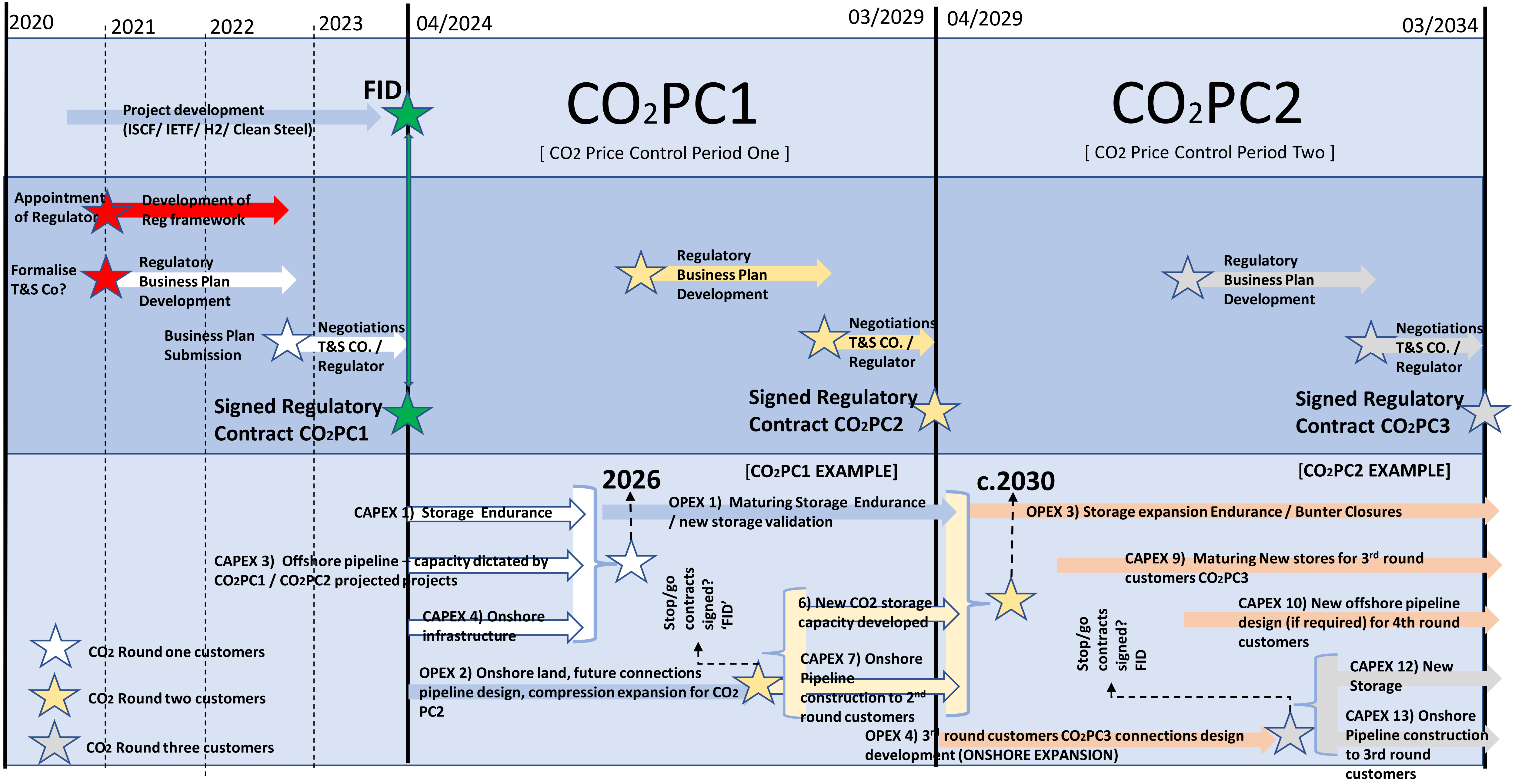
Humber and Teesside can achieve this with once store, Endurance. Humber can achieve these volumes alone!

Internal

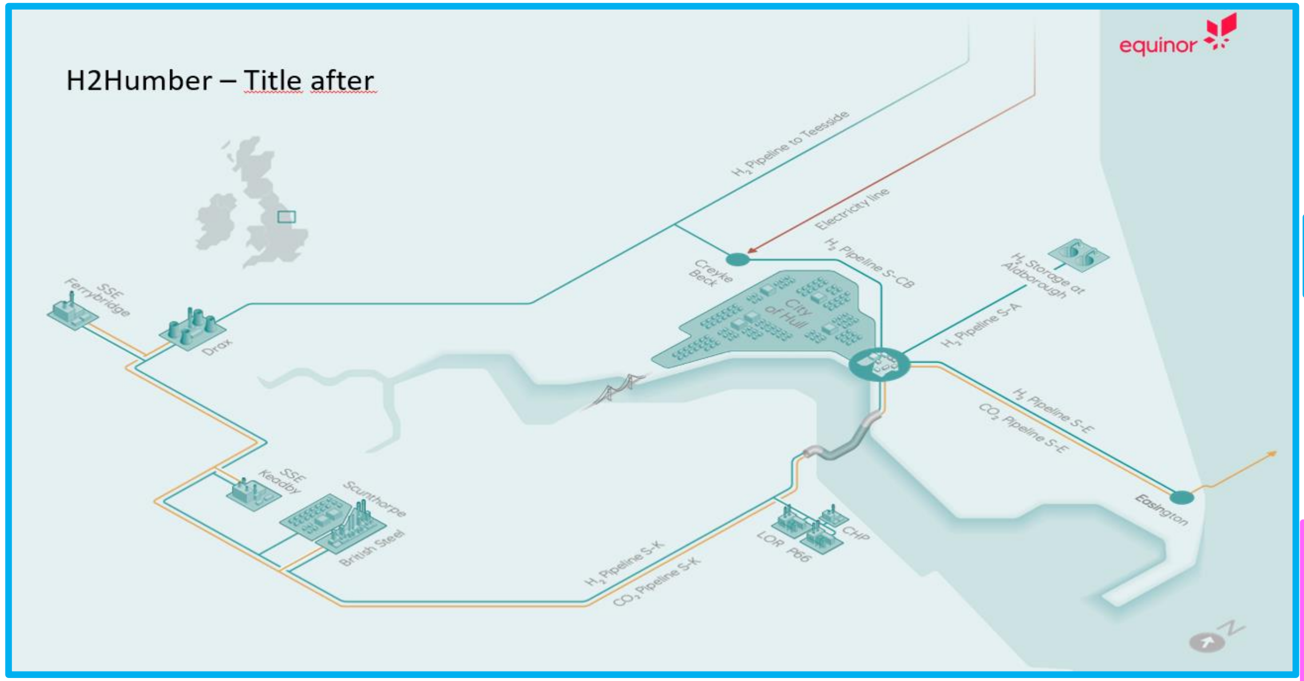
UK Funding – Supporting techno-economic development alongside business model development



CO_2 T&S Business models - Regulatory asset model

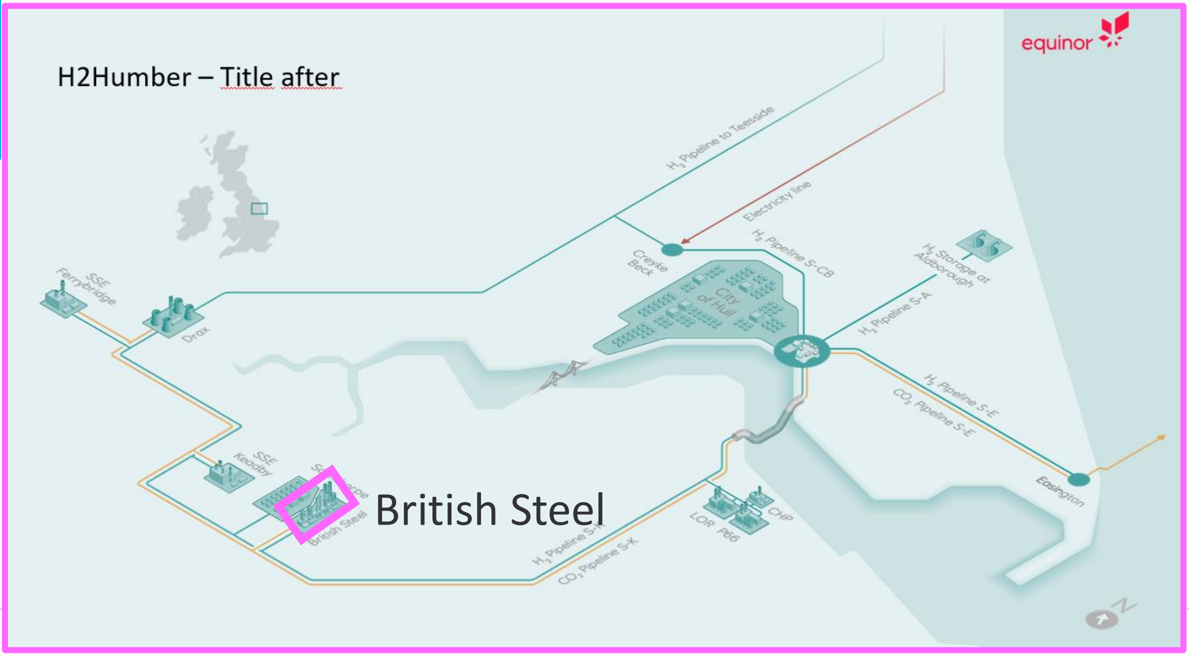


Roadmaps: Expansion and fuel switch strategy can be supported by government funds (to FID)

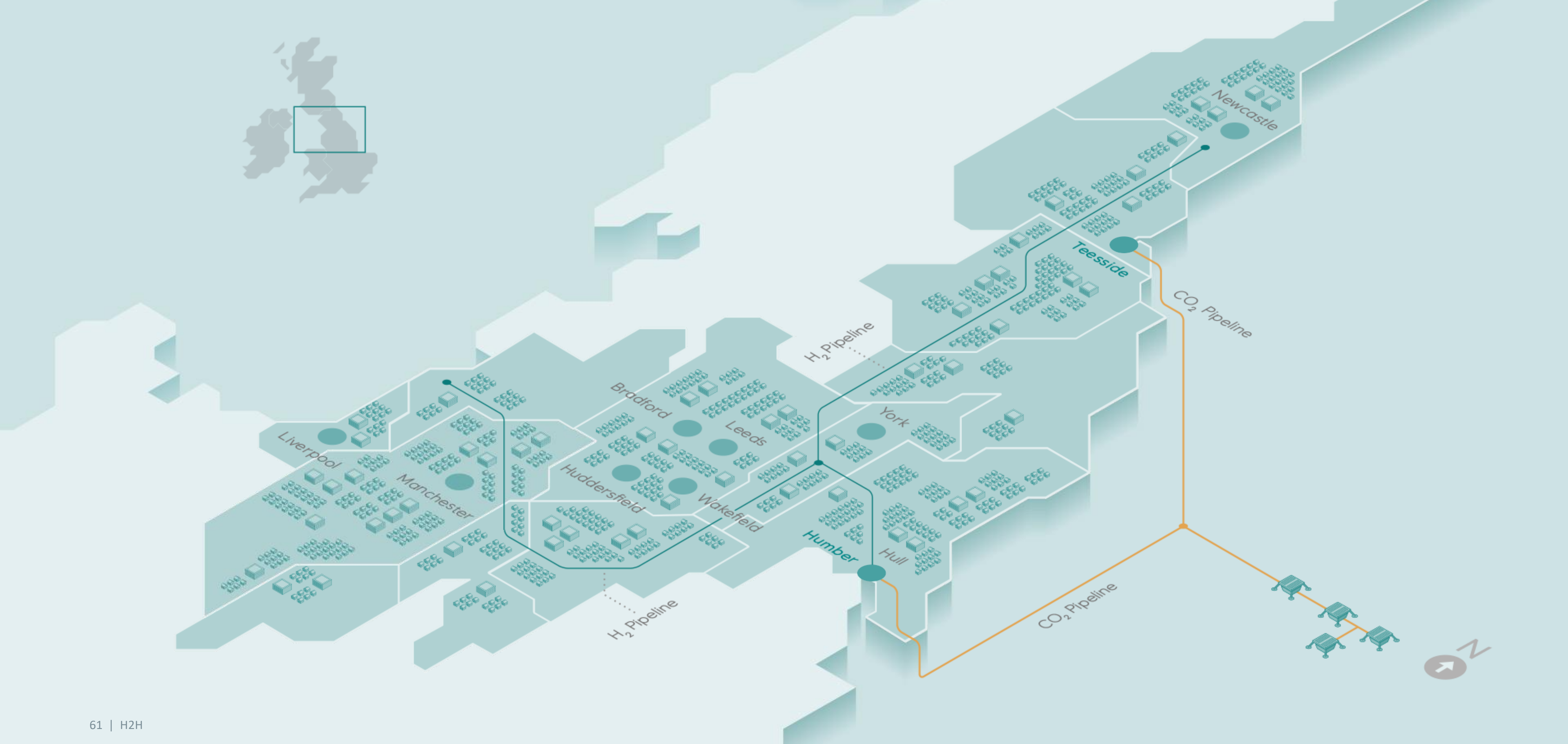


H2 production Fund £100m (2021)

Clean Steel Fund £250m (2021)



H21 North of England



gasunie
crossing borders in energy

29 april 2020

CCUS Developments in the Netherlands

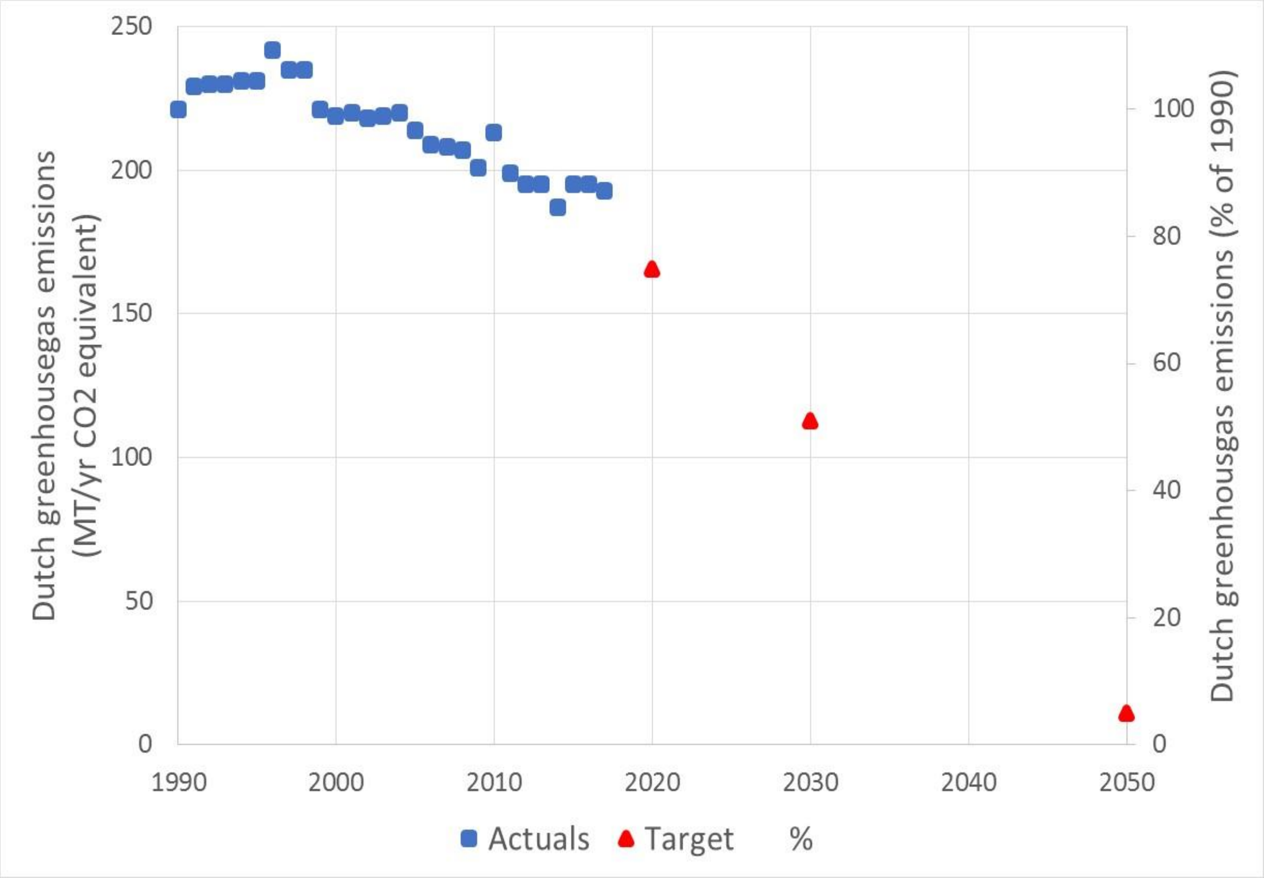
Presentation on the ENTSOG workshop

“Principles for EU Gas Qualities, handling of Hydrogen and CO_2 Transportation”

Thijs de Vries

CCS can help the energy transition

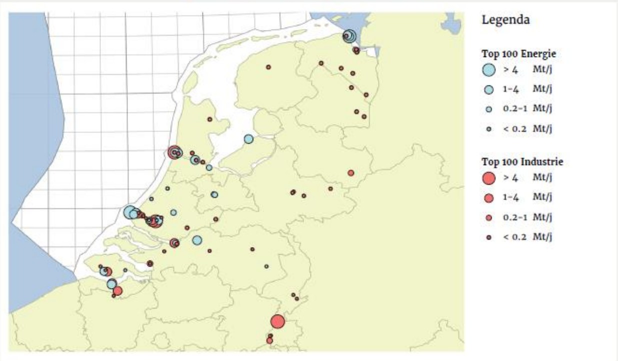
- Recent IPCC publication confirms the need for CCS.
- Industry in the Netherlands and Europe indicated that CCUS is a necessity to reach climate goals.
- CCS will be a temporary measure.
- CCS can play a role in the transition to a green hydrogen economy, via blue hydrogen.
- CCS can make negative emissions possible, via BECCS/BCCS or DAC.



CCUS in the Netherlands

- 2008-2010: CCS onshore stopped because of lack of political and societal support.
- Coalition agreement Government Rutte III: 18 Mton p/a in 2030.
- PBL climate agency: 7,2 Mton p/a CCS necessary for industry.
- Roadmap CCS: focus on industry and offshore storage. 2-4 start up projects.
- Climate Agreement: CCS necessary, 10,2 Mton p/a will be subsidized through SDE++
- Currently several projects under development.

ETS-locaties met meer dan 100.000 ton CO_2-uitstoot per jaar (blauw voor energie en rood voor industrie)



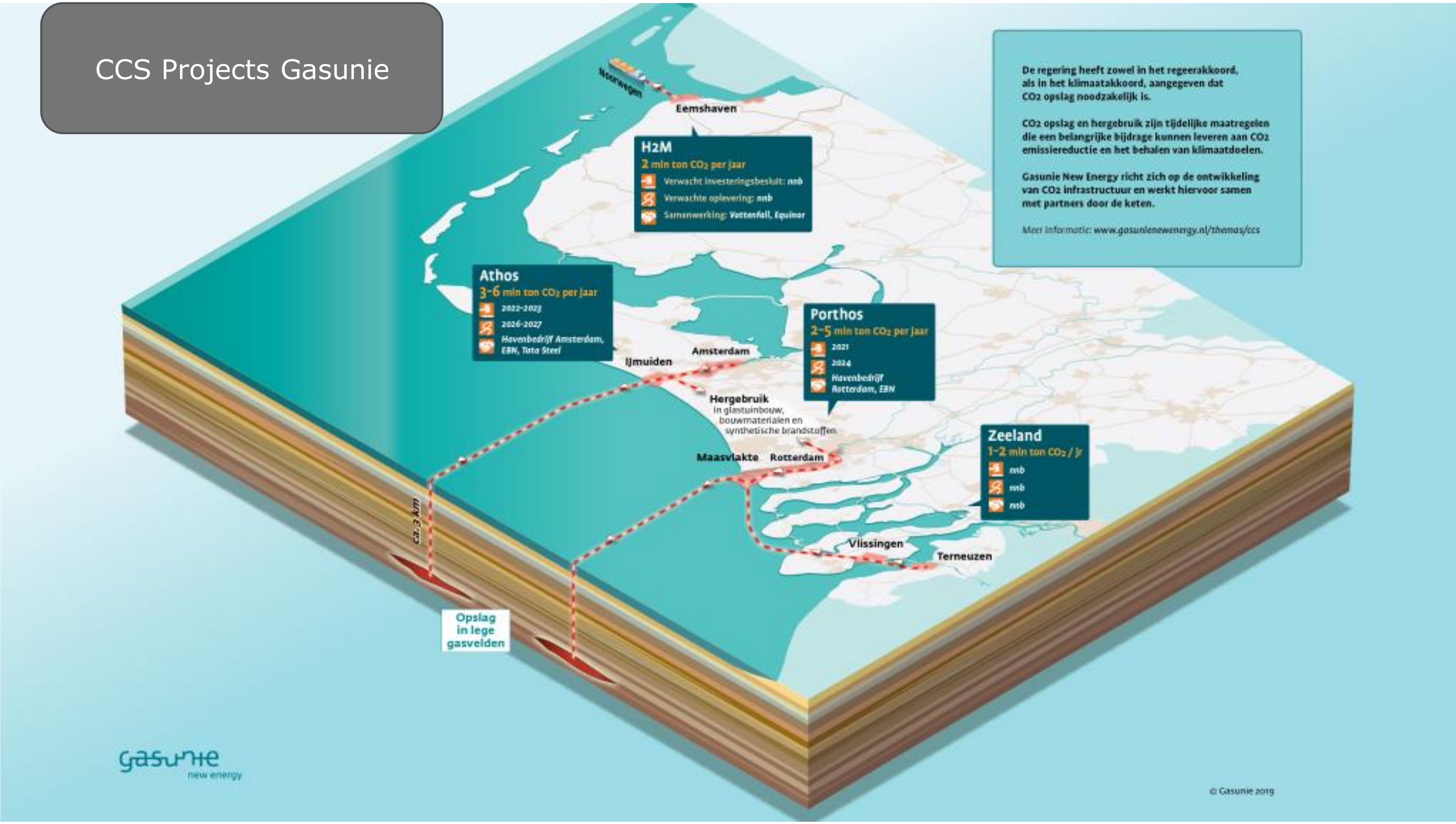
Verdeling van de grootste CO_2-emissiebronnen over verschillende regio's. Bron: [6]

Regio	Energie	Industrie
Rotterdam	13,8	10,6
Moerdijk	0	2,55
IJmuiden	9,3[1]	6,2
Eemshaven	10,5	0
Zeeland	1,42	8,0
Totaal	31,5[2]	27,4

[1] Het merendeel hiervan komt vrij bij de elektriciteitscentrales in IJmuiden die restgassen van Tata Steel gebruiken

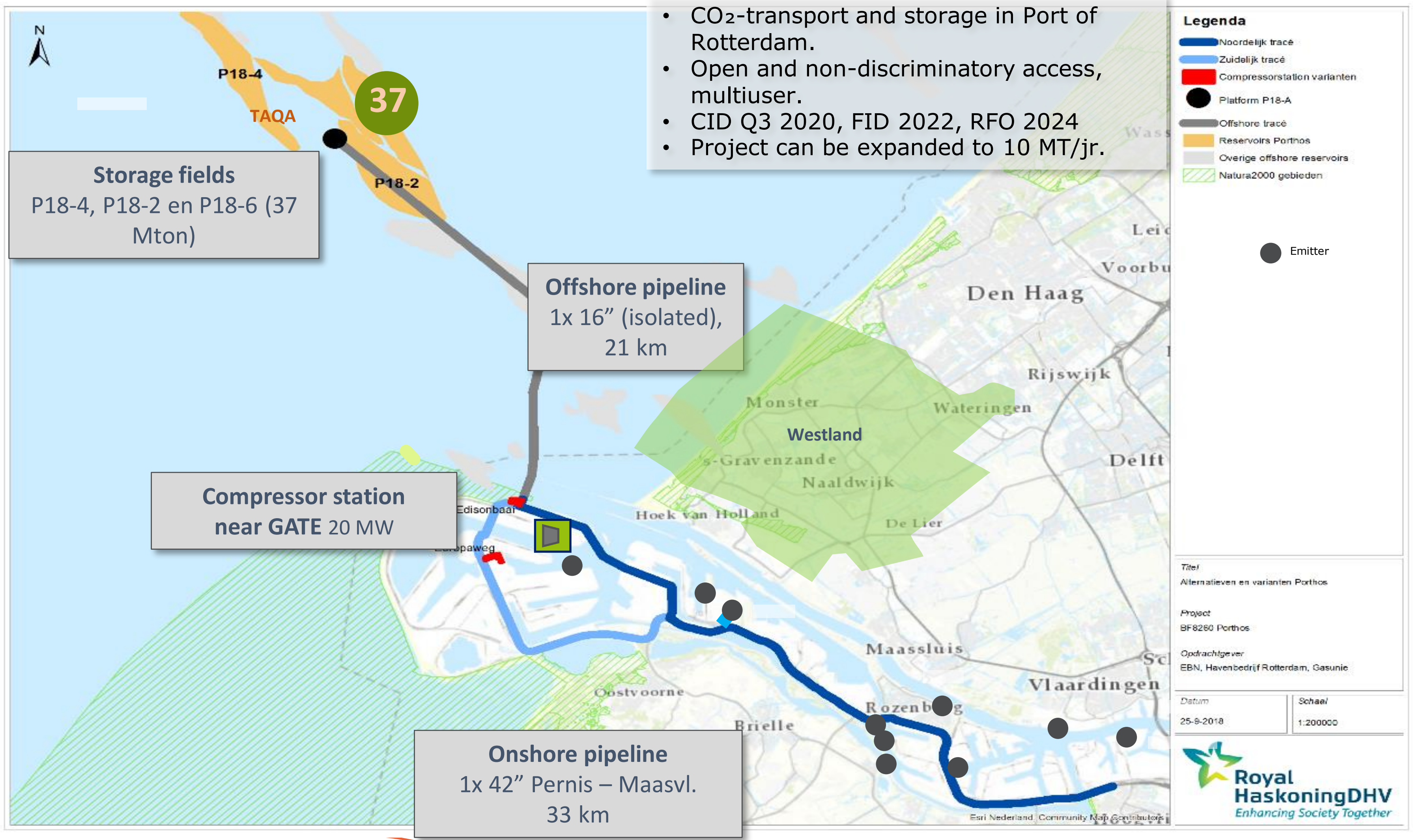
[2] Iets meer dan de helft hiervan kwam nog van kolencentrales in 2016

CCS Projects Gasunie

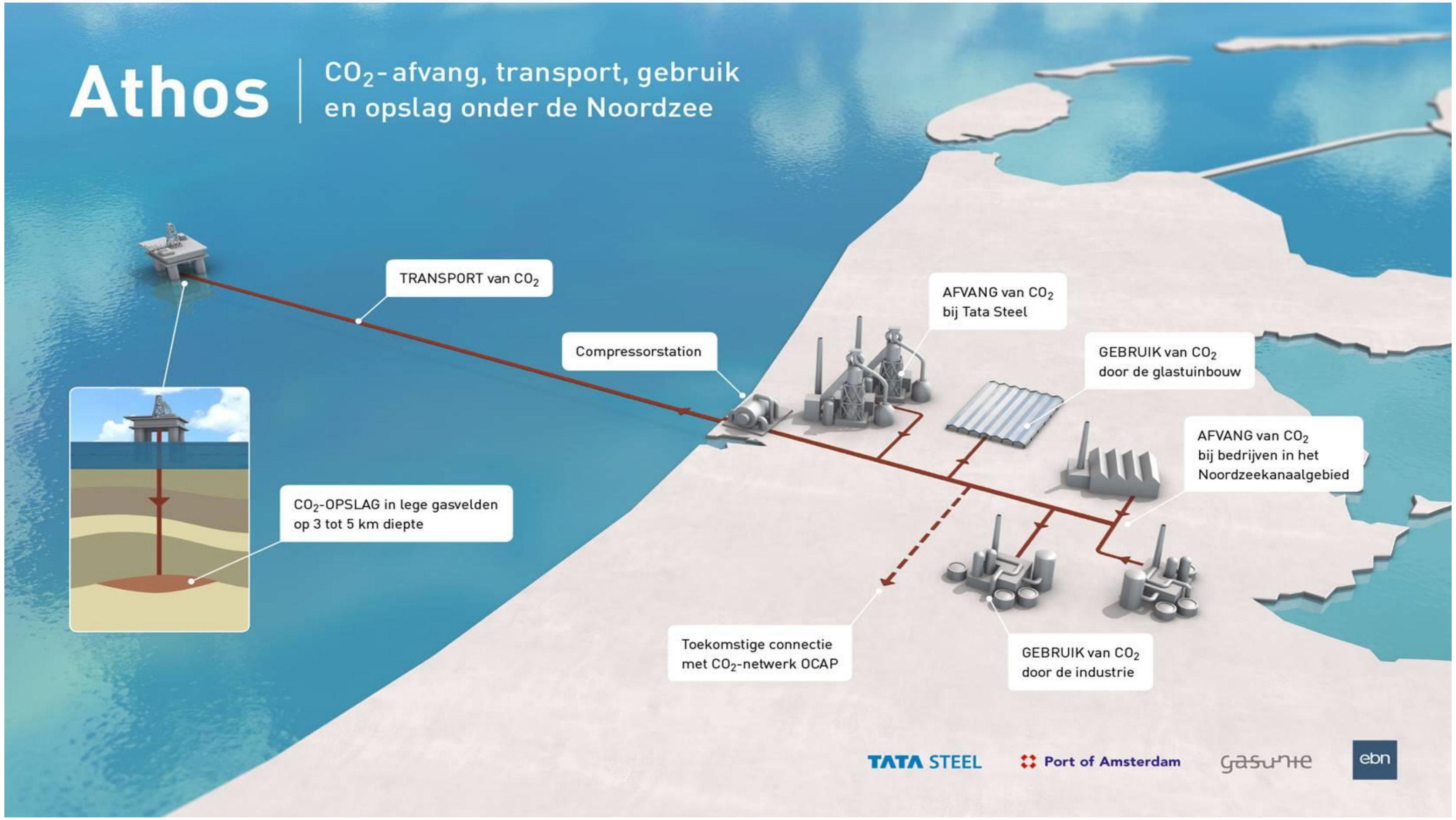


Porthos CCUS Rotterdam

- CO_2-transport and storage in Port of Rotterdam.
- Open and non-discriminatory access, multiuser.
- CID Q3 2020, FID 2022, RFO 2024
- Project can be expanded to 10 MT/jr.



Athos CCUS North Sea Channel Area



Vision 2050: The future of the gas network in Ireland

Brian Murphy

Ervia European Affairs Manager

ENTSOG Stakeholders Workshop 3

29th April 2020

A Net Zero Carbon Gas Network for Ireland

Introduction to Ervia

Pillars

Compressed Natural Gas (CNG)

CNG is natural gas stored under high pressure. Replacing diesel in HGVs and buses with CNG delivers immediate emission reductions, air quality improvement and noise reduction. There are over 24m CNG vehicles operational internationally

Renewable Gas

Renewable gas is net zero carbon, extremely versatile and fully compatible with existing gas network infrastructure. It is produced by anaerobic digestion from sustainable sources such as animal waste, grass, crop residues and food waste

Carbon Capture and Storage (CCS)

CCS captures emissions from natural gas power plants and large industry preventing emissions entering the atmosphere – the ‘abated’ natural gas is net zero carbon

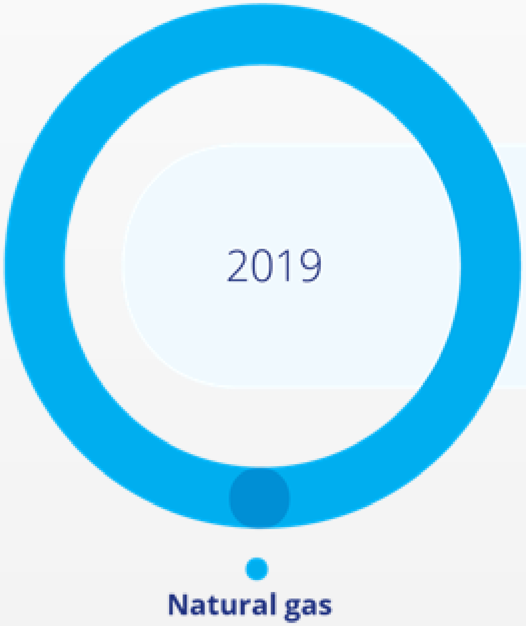
Hydrogen

Hydrogen produces zero CO2 emissions and can be blended with natural gas or used in its pure form. It is very flexible and can be used in transport, heat and power generation

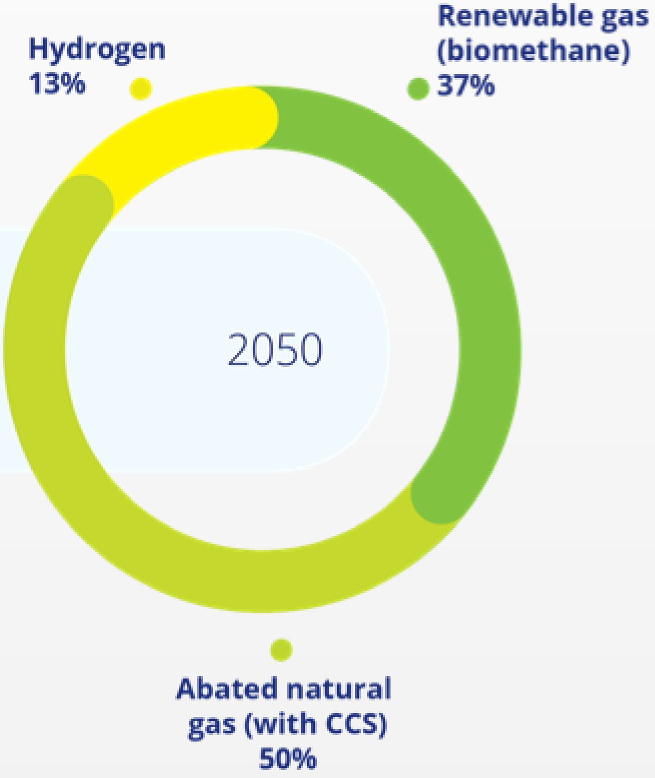
Emissions Savings: 18.7Mt pa

A net zero carbon gas network will deliver at least **18.7Mt/annum CO_2 emissions savings by 2050** (31% of Ireland's overall current emissions).

Electricity	Industry	Heat	Transport	Agriculture
8.2Mt	2.7Mt	2.6Mt	2.8Mt	2.4Mt



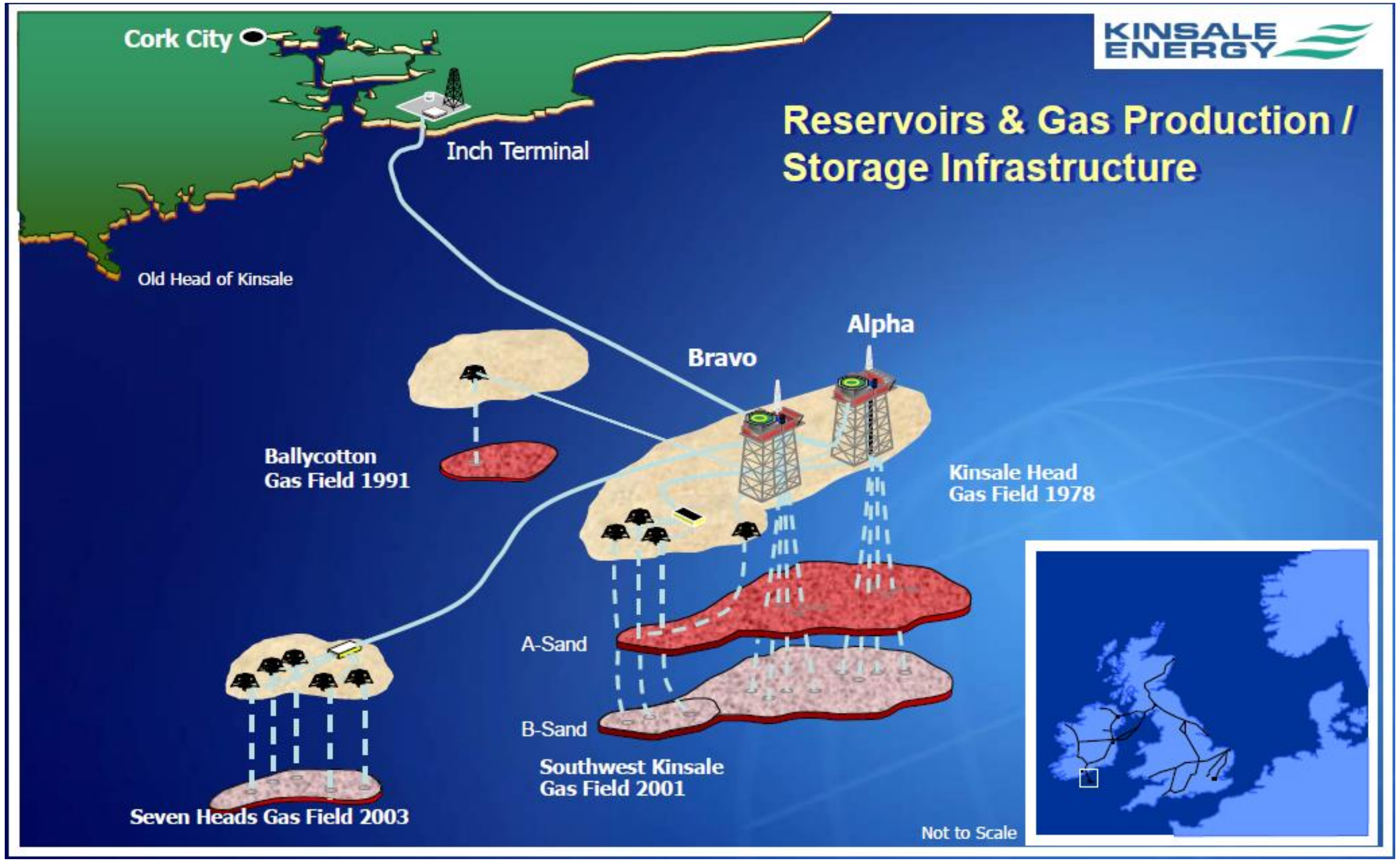
The gas network will provide a sustainable, secure and cost-effective decarbonisation pathway



Key drivers to deliver Ireland's carbon neutral gas network:

- CNG/Bio-CNG
- Renewable Gas (Biomethane)
- Abated natural gas (with CCS)
- Hydrogen

We're assessing the feasibility of storing CO_2 in Kinsale Head Gas Field

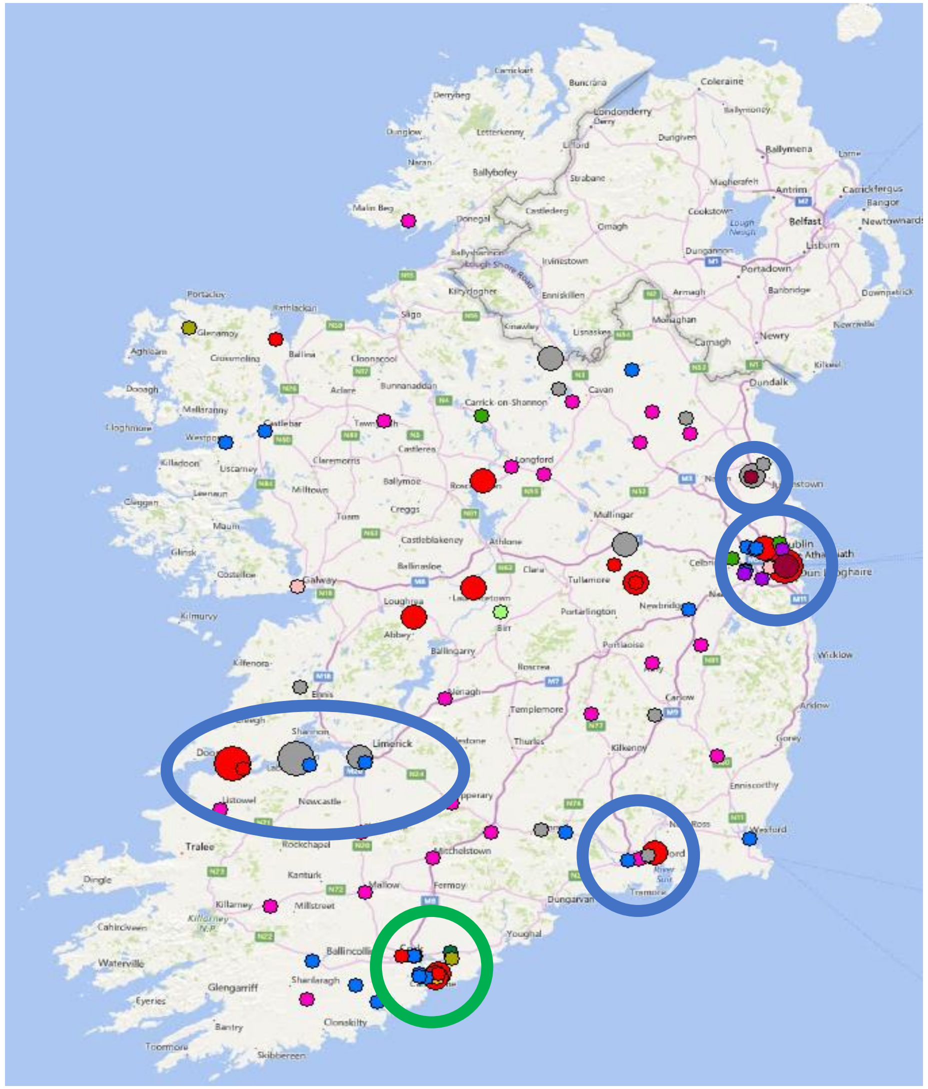


Proximity of power plants and refinery to where offshore pipe comes onshore

The 54km offshore gas pipeline comes ashore at Inch Terminal.

All key infrastructure for CCS is located within a few kms of each other.

Feasibility Study: CO2 Clusters with CCUS/Hydrogen Potential



- Potential for five CCS clusters.
- Existing emitters within potential clusters:
  - Gas fired power stations
  - Cement plants
  - Alumina production plant
  - Waste to energy facility
  - Oil refinery
  - Lime production
- Potential to produce emissions free hydrogen with CCS within clusters.

Potential EU Funding Sources

EUETS

CEF programme

HORIZON 2020

Innovation Fund Prequalification application due in 2020

Seeking projects which will deliver large scale emissions reductions

PCI Status Granted Oct 2019

Ervia to seek CEF support for Project Development Assistance for studies into the transport, compression, conditioning and storage of CO_2 (import/export)

Grant Funding also available for mature projects

Final Work Programme (2018-2020) has CCS opportunities

Horizon 2020 – Q3 2020

Creating a consortium for a geological storage pilot

OIL AND GAS CLIMATE INITIATIVE

Regulatory framework for CO_2 transport

Presented by Kees Bouwens

ENTSOG online workshop

29th April 2020

Introduction

IOGP has coordinated a report on CCUS for the 32nd Madrid Forum
which includes policy recommendations for CO_2 transport (link)

CCS Directive 2009/31/EC provides rules for TPA to CO_2 transport

Gas Directive 2009/73/EC provides common rules for the internal gas market

- Defines 'transmission' and 'distribution' as transport of natural gas
- Sets scope of activities for TSOs & DSOs
- Defines duties and powers of NRAs

Policy recommendation in the CCUS report:

"Enable gas infrastructure or other companies, where Member States so decide,
to transport CO_2 as a commercial or regulated activity (...)
overseen by NRAs with appropriate mandates"

International Association of Oil & Gas Producers

Elements of a regulatory framework for CO_2 transport

Expand the Gas Directive's definition of 'transmission' and 'distribution'

• Could work for biomethane and hydrogen blended with natural gas
  • these use the same system and
  • could be subject to common rules on capacity allocation, balancing and tariffs
	• Not straightforward for CO_2 transport
	  • this requires a separate system
	  • and tailored rules
	• Regulatory framework for CO_2 transport should be flexible to deal with local differences

Elements of a regulatory framework for CO_2 transport

When Member States designate TSOs, DSOs or other entities to carry out the function of CO_2 transport, they should address i.a. the following elements:

Framework elements	Considerations
• Access model: regulated or negotiated access	• May vary depending on desired level of competition
• Potential role for TSOs or DSOs	• Transport of new gases may offset declining natural gas volumes for TSOs/DSOs
• Cost allocation and funding mechanism	• Cost of CO_2 transport is small compared to capture and storage, but not if initial volumes carry all costs
• Allocation of risk and public support	• While CO_2 transport for CCUS may become a sound commercial activity, the start-up could be challenging • Public support could reduce initial costs or carry some of the risk (e.g. provide ship-or-pay guarantee)
• Cross-border coordination	• Allocation of public support and risk of unavailability of elements in the CCUS value chain
	• Framework for CO_2 transport should be coordinated with other elements in the CCUS value chain

International Association of Oil & Gas Producers

Q & A

Dan Sadler , Project Manager LCS (Low Carbon Solutions) | Equinor

Thijs de Vries, Senior Business Developer | Gasunie

Brian Murphy, European Affairs Manager | Ervia

Kees Bouwens, Regulatory & Policy Advisor | IOGP

DISCUSSION

Discussion points (until 13:20)

What financial instruments are needed to promote the scaling up of CCUS technologies?

Is the CO_2 price high enough to promote investments or is it seen as a risk?

Is the EU Emissions Trading System (ETS) directive enough to mitigate this risk?

Pipelines corrosion caused by hydrogen can be mitigated by reducing pressure, which is compensated by higher speed of hydrogen flow.

Can this approach be adapted for CO_2 transmission?

A cluster approach for the development of CCUS sharing transport and storage infrastructure and the reuse of existing oil and gas offshore assets can reduce costs of the activity.

What models can bring greater advantages for the developments of CCS?

What could be the role of TSOs in it?

Final concluding remarks and next steps

Hendrik Pollex, System Operation Director | ENTSOG, 13:20 – 13:30

Final Remarks & Next steps

Next steps:

- **Produce list of main take-aways from the workshop** - as input for the Smart Sector Integration Communication and for other regulatory contexts
- **Establish further engagement process with stakeholders** (bilateral/multilateral)

Thank you for your attention

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