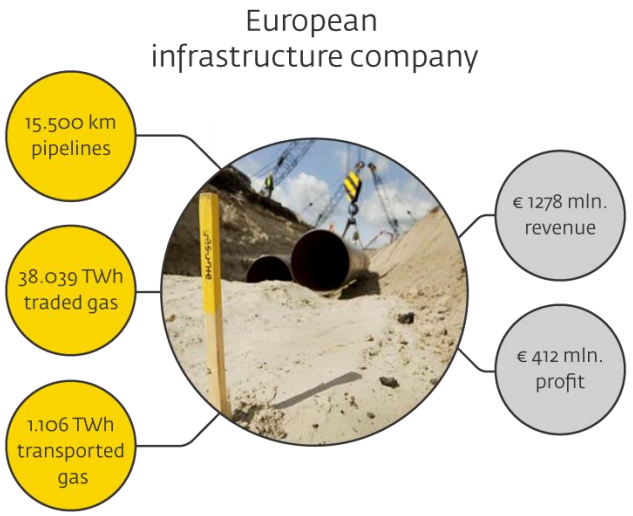
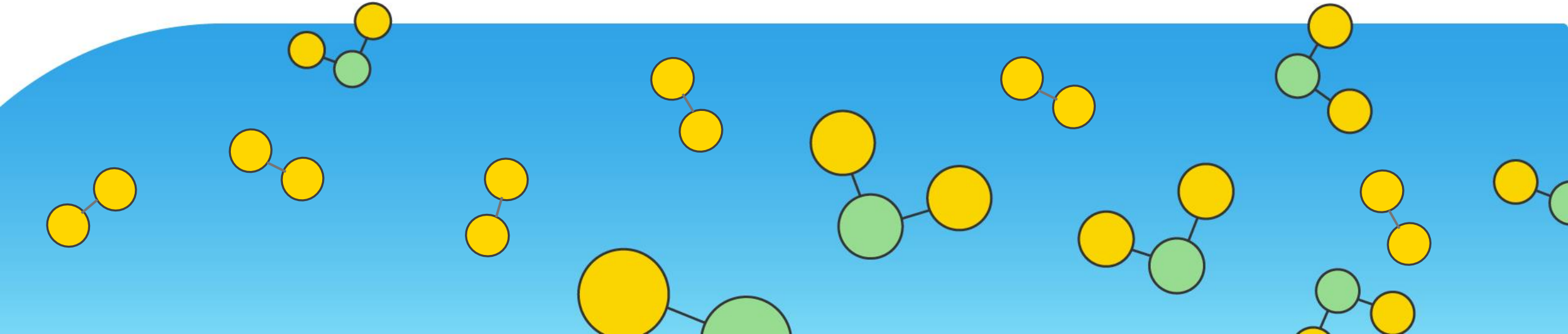
gasunie
crossing borders in energy

Development of Gasunie's hydrogen network Part II

P2X Conference - 15, 16 June 2022 - Copenhagen

Harry Smit, Gasunie



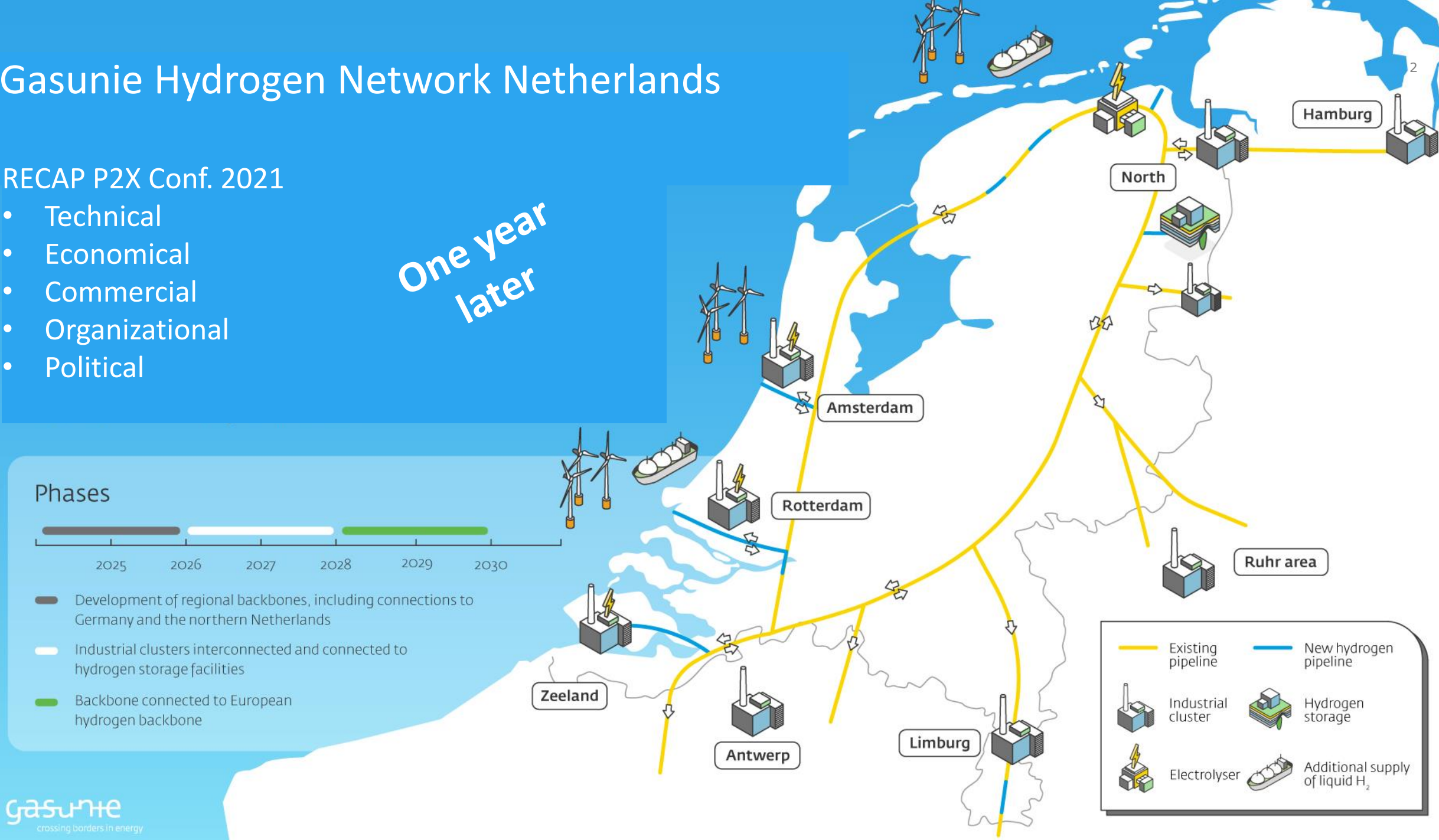


Gasunie Hydrogen Network Netherlands

RECAP P2X Conf. 2021

- Technical
- Economical
- Commercial
- Organizational
- Political

One year later



gasunie
crossing borders in energy

gasunie
crossing borders in energy

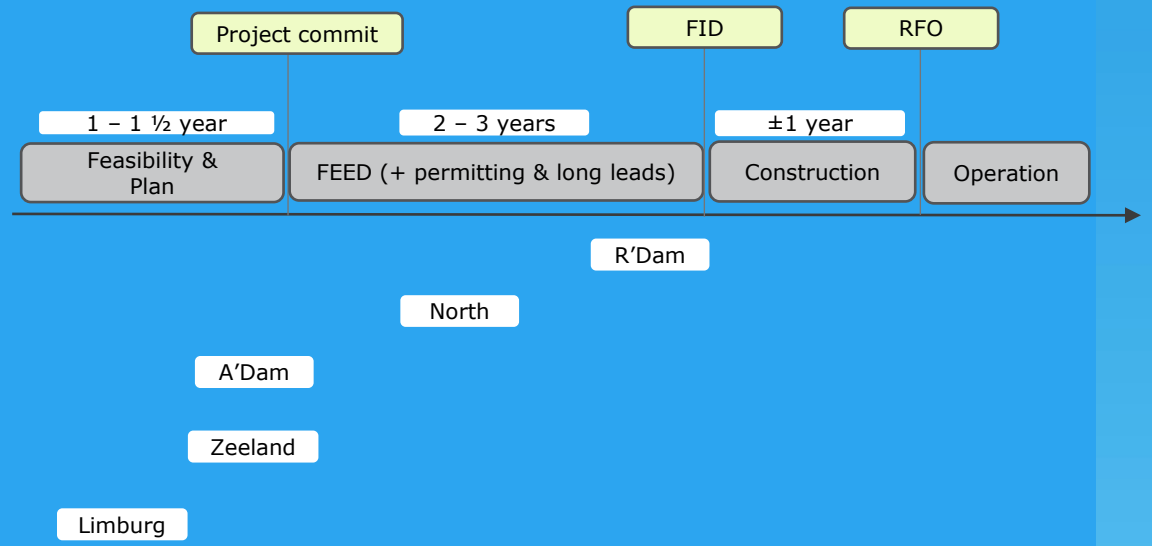
Gasunie hydrogen network

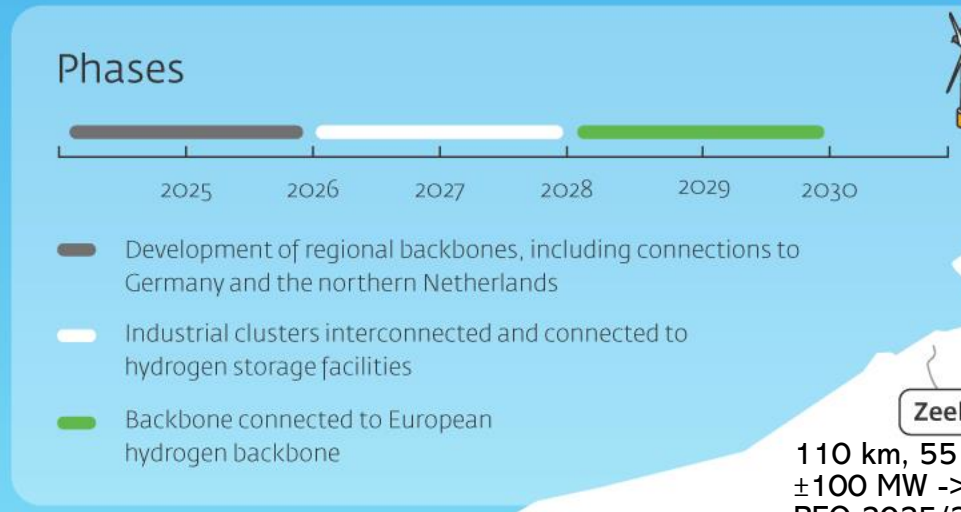
Network development since last year's P2X meeting. Aiming for 1st FIDs in 24/25

1.	Regional NL	Local pipelines connect first supply projects and industry demand
2.	National NL	A national network is established by connecting 5 industry regions
3.	NW EU	Cross border connections towards industry in Germany and Belgium
4.	H2 specs & flexibility	Play a key role in developing a market oriented and operable network securing delivery
5.	Hyperlink	Gasunie's hydrogen network in Northern Germany
6.	Offshore	Future offshore hydrogen production to be connected via offshore lines

Connecting regions, stretching cross border & offshore, incorporate flexibility & quality

Start-up: Regional network development





North

50-150 km, 100 km refit
±100 MW -> 5+ GW
RFO 2025
Chemicals, MeOH, power
Supply > demand
Cross border IP

Amsterdam

30 km, 10 km refit
±50 MW -> GW scale
RFO 2026
Steel & Power
Demand > supply

Rotterdam

30 - 75 km new
±100 MW -> GW+ scale
RFO 2024
Refining, chemicals
Supply & demand

Regional infra
Total pipeline length 350 km
Initial throughput ± 400 MW
Ultimate throughput 10-15 GW

Zeeland

110 km, 55 km refit
±100 MW -> GW+ scale
RFO 2025/26
Refining, fertilizer, chemicals
Supply & demand
Cross border IP

Limburg

Short connection
Sizing to be assessed
RFO 2027
Fertilizer, chemicals
Demand > supply

gasunie
crossing borders in energy

Phase 1: Connect Rotterdam to Northern NL

- Aiming at Ready For Operation in 2026
- Connecting Rotterdam, Amsterdam with Northern NL & possibly Zeeland
- Enables transport Rotterdam -> Ruhr area via Vlieghuis (up to 1 GW)
- Enables transport Rotterdam -> Hamburg / Bremen / Hannover via Oude Statenzijl (> 2 GW)
- Process for cross border transport with neighbouring operators is ongoing

Actual progress will depend on supply & demand developments

gasunie
crossing borders in energy

Phase 2: Connect all industrial regions

- Aiming at Ready For Operation 2027/2028
- Connecting Zeeland and possibly Limburg
  - Actual progress depends on supply & demand developments
- Cross border routes to Germany and Belgium

Cross border alignment requires

- Common technical specifications and layout
- Common commercial & contractual approach
- Subsidy alignment / contracts for differences

Early European guidelines might need to be adopted / incorporated from the start

gasunie
crossing borders in energy

Phase 3: Fully closed network

- Ready For Operation ultimately 2030
- Connecting all Dutch industrial regions and cross border industrial regions in Belgium and Germany

- Total network length 1200 km
  - of which 200 km new pipelines
- Capacity 10 – 15 GW, no transport compression
  - Based on pressure range 50 – 30 bar(g)
- Further expansion might require additional pipelines and/or compression

gasunie
crossing borders in energy

Indicative quality specifications

- Quality requirements are **consulted by the Ministry of Ec. Affairs**
- Starting point 98% - accomodating blue and green H2
- International X-border alignment possibly via pentalateral forum
- Accepting potential impurities in the early stages
- To be finalized and published before the summer

Table 1: Indicative Quality Specification Hydrogen Network

Constituents	Unit	Min.	Max.
Hydrogen (H_2)	mol/mol %	98	
Total sum of hydrocarbons including CH_4 (CXHY)	mol/mol %		1,5
Oxygen (O_2)	µmol/mol (ppm)		10
Total sum of inerts (N_2, He, Ar)	mol/mol %		2,0
Carbon dioxide (CO_2)	µmol/mol (ppm)		20
Carbon monoxide (CO)	µmol/mol (ppm)		20
Total sulphur including H2S (S)	µmol/mol (ppm)		5
Formic acid (CH_3OOH)	µmol/mol (ppm)		10
Formaldehyde (CH_2O)	µmol/mol (ppm)		10
Ammonia (NH_3)	µmol/mol (ppm)		10
Halogenated compounds	µmol/mol (ppm)		0,05
Water dewpoint (H_2O)	ºC @ 70 bara		-8

Pressure specification

- Pressure entry 50 bar(g) , exit 30 bar(g)
- Design pressure of 66,2 bar(g) allowes for additional capacity through compression

gasunie
crossing borders in energy

Gasunie, April 2022

Storage & Flexibility requirement

- Fully intermittent supply (wind & sun) makes the network practically inoperable without additional flexible sources
- Gasunie / HyStock realizes cavern storage to fulfil this role
  - High flexibility needs (short response times, minimum downtime)
- Other sources (blue hydrogen, import terminals) might fulfil this role as well in the future
- Exact requirements and future possibilities to be further assessed

Commercial & regulatory outlook

- Contractual arrangements under consultation
- Government funding is part of rollout plan, this includes an outlook on tariffs and future regulation
- Expected to be settled summer 2022

gasunie
crossing borders in energy

gasunie
crossing borders in energy

Further developments

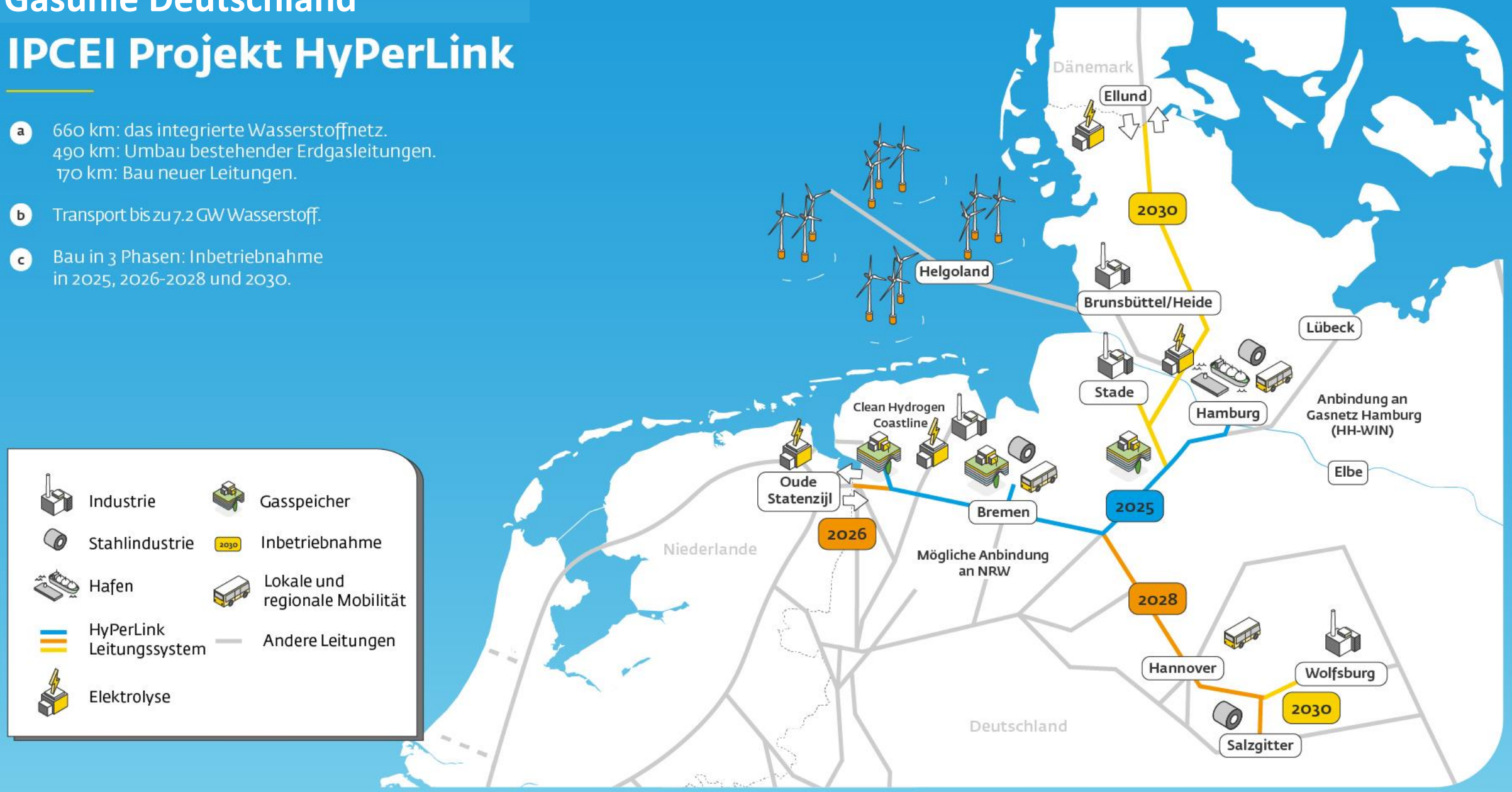
Gasunie Deutschland

IPCEI Projekt HyPerLink

a 660 km: das integrierte Wasserstoffnetz.
490 km: Umbau bestehender Erdgasleitungen.
170 km: Bau neuer Leitungen.

b Transport bis zu 7.2 GW Wasserstoff.

c Bau in 3 Phasen: Inbetriebnahme in 2025, 2026-2028 und 2030.

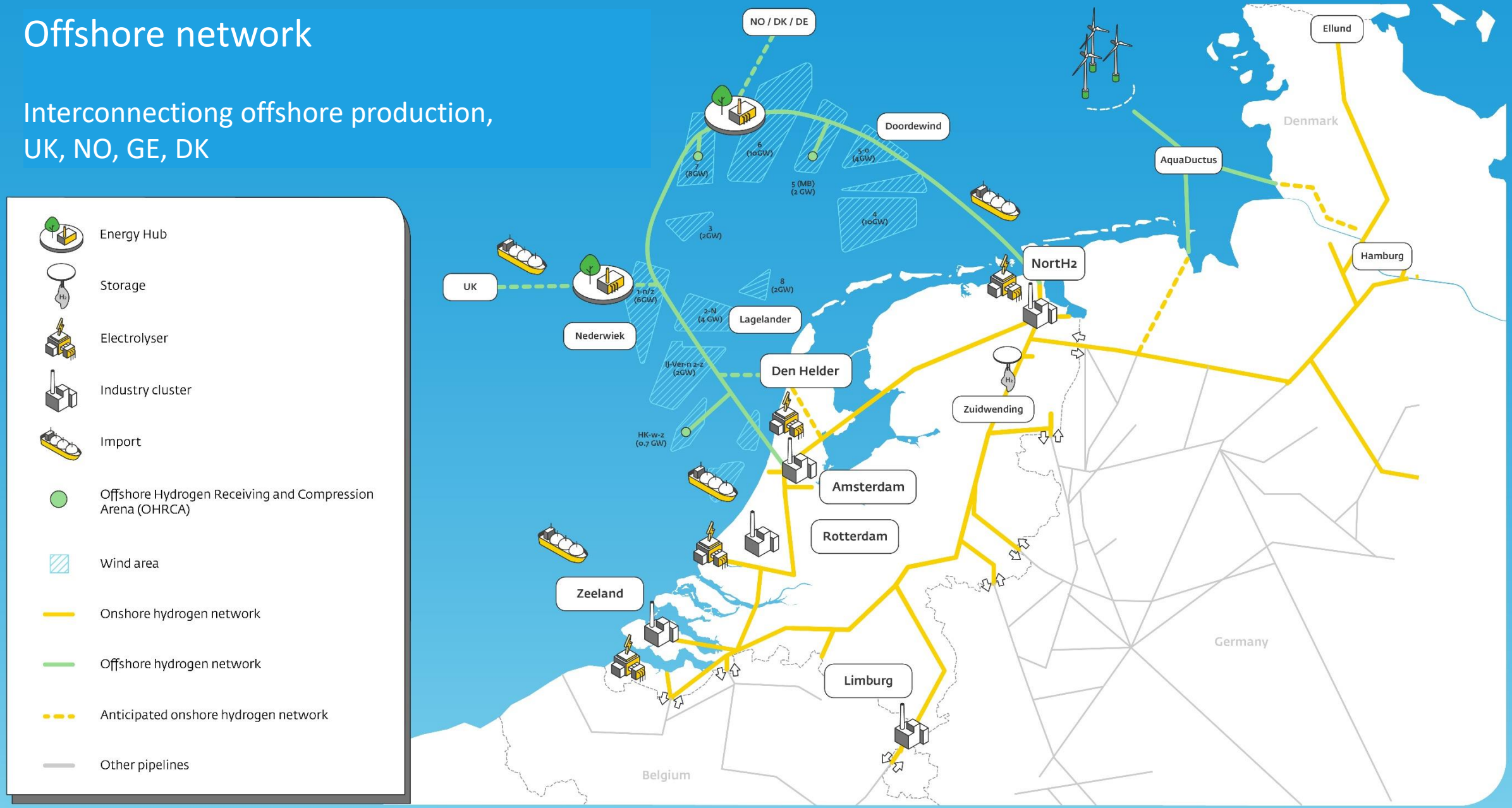


April 2022

gasunie
crossing borders in energy

Offshore network

Interconnectiong offshore production, UK, NO, GE, DK



May 2022


Thanks!