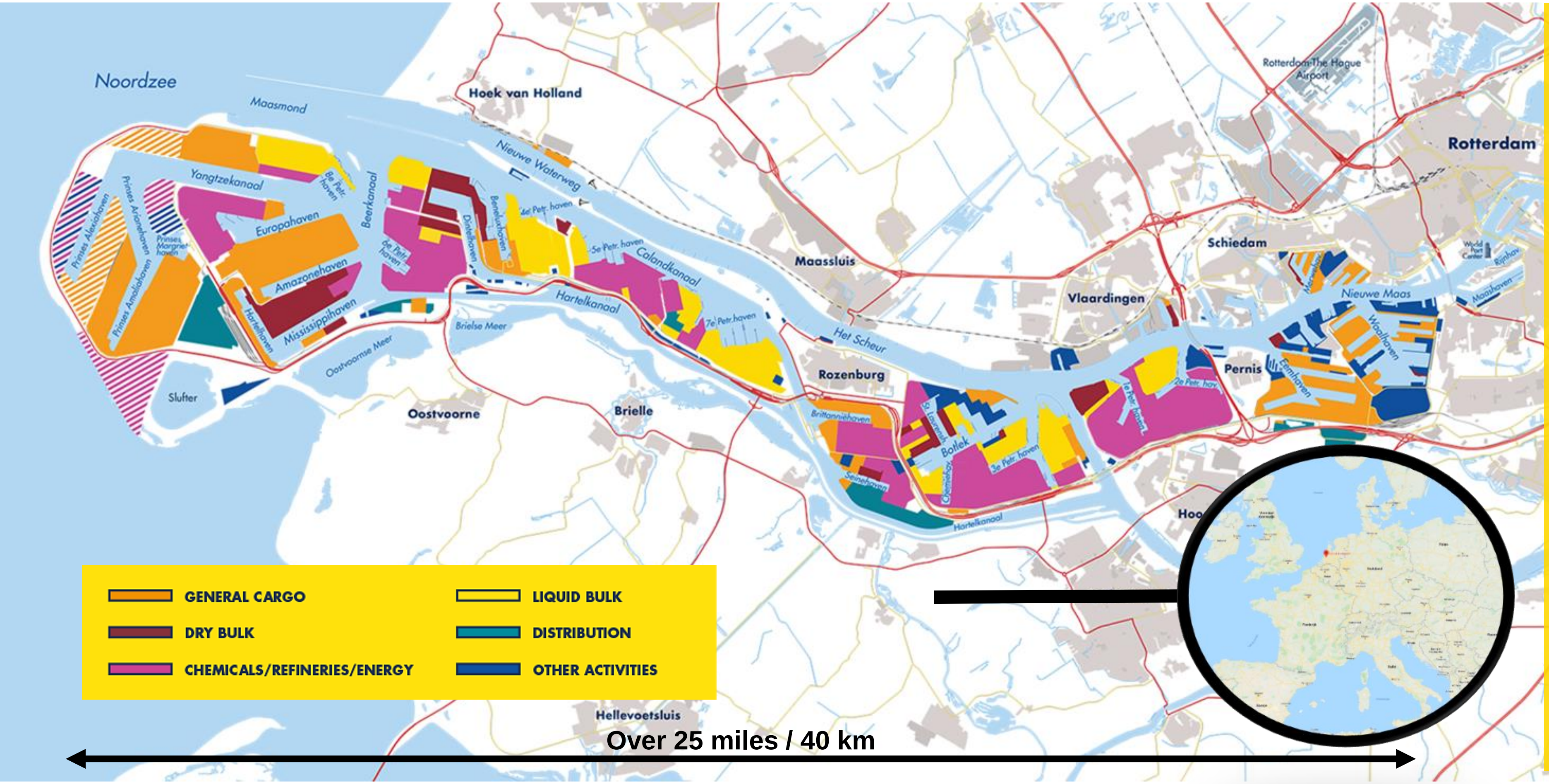
HYDROGEN IN THE PORT OF ROTTERDAM

Wouter Demenint
Business Manager Hydrogen Supply Chains Port of Rotterdam

Port of
Rotterdam

PORT AND INDUSTRIAL AREA



Port of Rotterdam

- Largest port in Europe, 10th port worldwide
- Total employment 385,000 people*
- Total added value € 45,6 billion (6.2% GNP)*
- Visits (2018):
  - 29,476 sea-going vessels
  - 107,000 inland navigation
- 3.000 companies
- Throughput (2018): 469 mln tons
  - 45% Liquid bulk
  - 32% containers
  - 17% dry bulk
  - 6% Breakbulk

** source: Erasmus University*

Port of Rotterdam

CURRENT SITUATION IN ROTTERDAM

Position of Rotterdam in the current energy system (2018 figures)

- 8.800 petajoule (PJ), 14% of the energy consumption of Europe (more than 3x the Dutch energy consumption).
- For the production of steam, heat and electricity in the Port of Rotterdam, 430PJ of energy was used (29 Mton CO2 emissions / 20% of the total Dutch emissions).

Current hydrogen market in Rotterdam

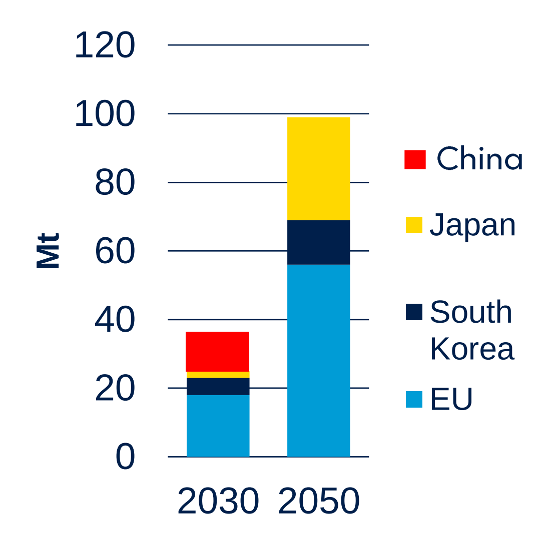
- Current hydrogen demand per year in Rotterdam is ~450 kton, mainly used for oil refinery
- In the Port of Rotterdam 2 hydrogen grids exist from Air Products (local network) and Air Liquide (international network)

Pipeline network of Air Liquide, hydrogen in RED

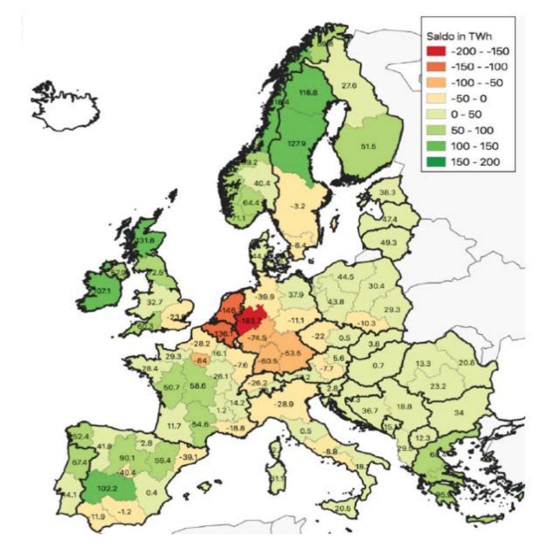
A HUGE NEW MARKET IS DEVELOPING

ROTTERDAM DEMAND 4.6 MTPA BY 2030

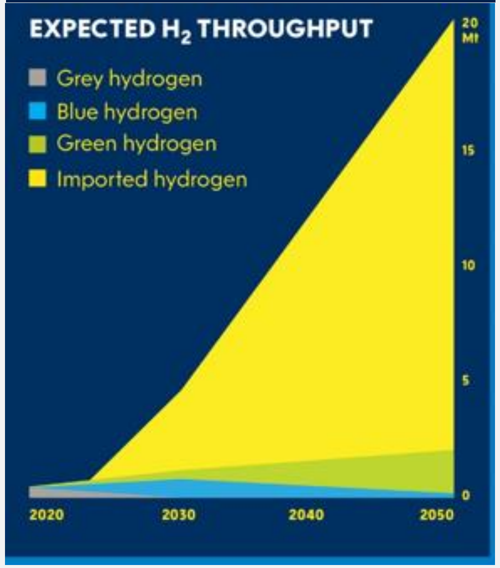
Global hydrogen demand



European demand



Port of Rotterdam



Today - 2030

The first green and blue hydrogen proof of concept projects are being developed. Major scaling commencing 2027. Europe aims for development of 40GW renewable in- and 40GW outside Europe. First demand is also created in Korea, Japan and the US.

2030 - 2050

Rapid scale-up due to regulatory incentives (ETS, carbon border adjustments, more clear regulation of hydrogen trading and transport, timed to emerging EU backbone) aimed at achieving the next climate target.

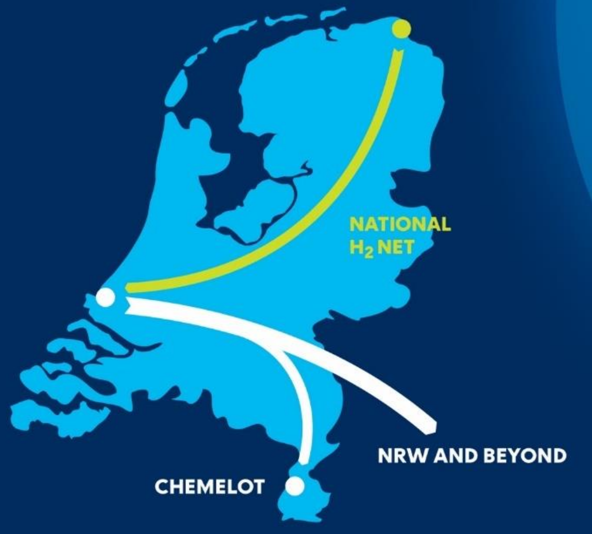
2050 - onwards

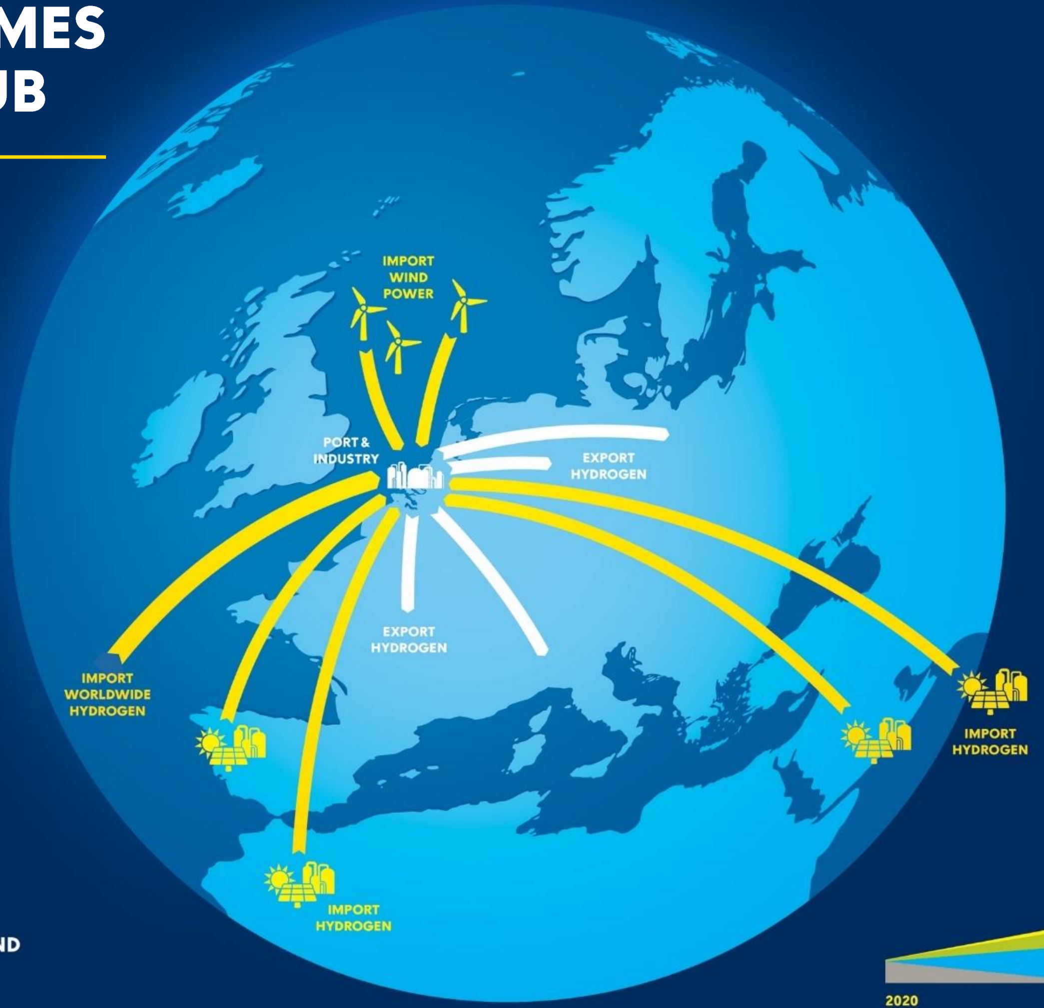
Hydrogen will be an intrinsic part of our integrated energy system.

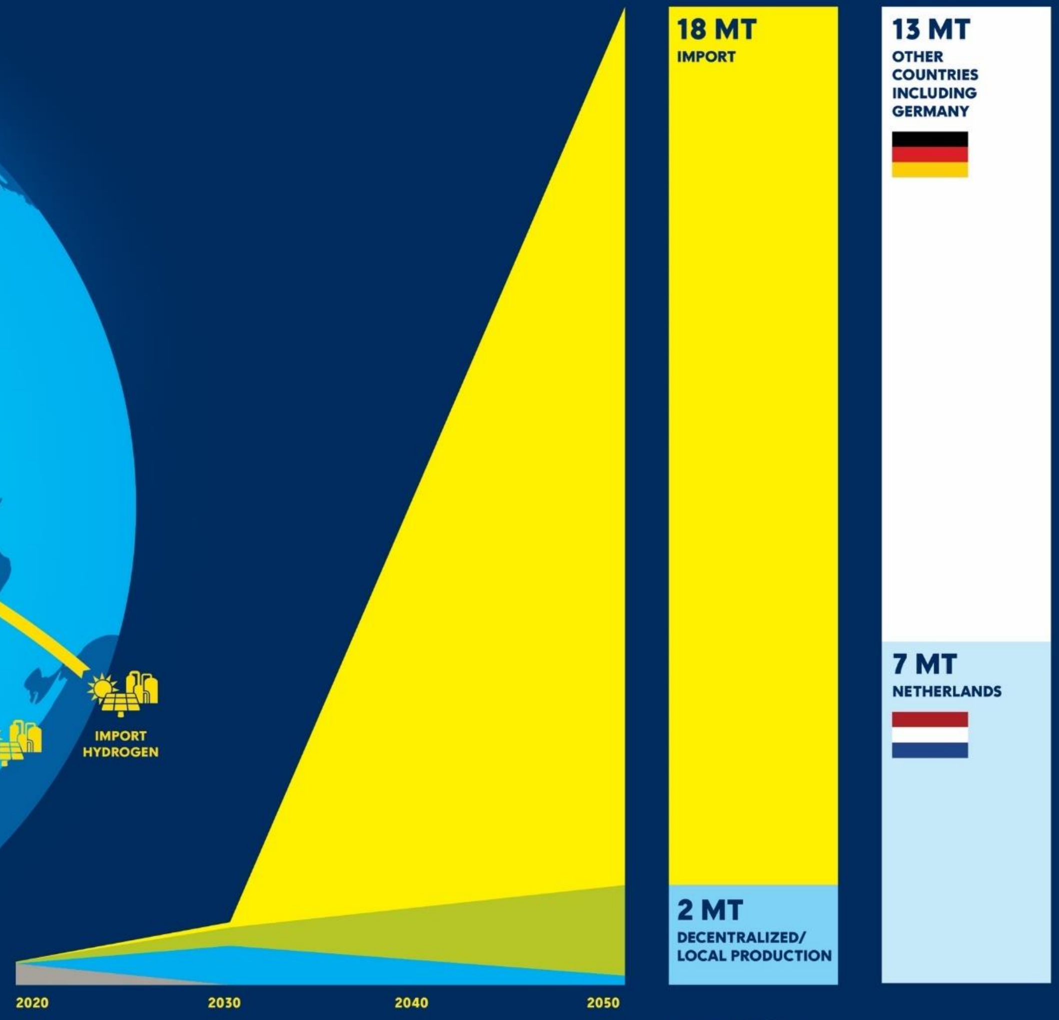
Source: Wuppertal and PoR whitepaper

Port of Rotterdam

ROTTERDAM BECOMES KEY HYDROGEN HUB







Connection with national H_2 grid, Chemelot and North Rhine–Westphalia (NRW).

Strong growth in hydrogen flow through Rotterdam due to imports.

Grey hydrogen
Blue hydrogen
Green hydrogen
Imported hydrogen

Green & Blue hydrogen made with 20-25GW offshore wind.

Estimated use of 20 MT hydrogen by country.

Hydrogen vision: https://bit.ly/32M6Wrl

Port of Rotterdam

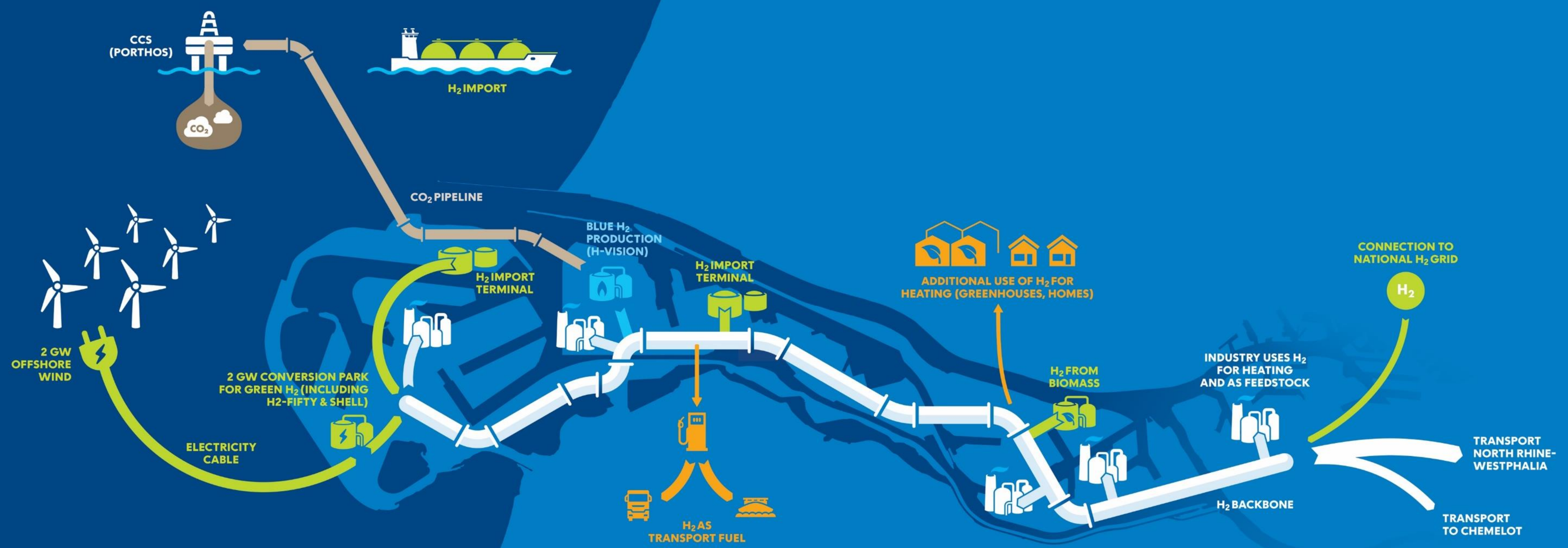
LOCAL PRODUCTION & IMPORTS VIA ROTTERDAM:

4,6 MTON HYDROGEN IS FEASIBLE IN 2030 TOGETHER WITH INTERNATIONAL PARTNERS

AD PORTS GROUP
CEPSA
ProChile
OCI
Koole Terminals
AustriaEnergy
RRP Rotterdam-Rijn Pijpleiding
Horisont energi
Port of Cromarty Firth
Fisterra energy
APS
H2energy
La Nueva Energía
duisport excellence in logistics
Linde
aramco
RHINE
PORT Baie-Comeau
Net Zero Technology Centre Technology Driving Transition
Port Saint John Canada
Air Liquide
GES
Northland Power
Port of A Coruña
A Coruña Green Port
ENGIE
Algeciras Port
PROTON VENTURES
Pouw
RWE
Air Products
Maasvlakte Olie Terminal
CHARIOT Transitional Energy
Rotterdam The Hague Airport
Rotterdam The Hague Innovation Airport
chemelot
sasol
TRAFIGURA
Source
tarafert
ptc
Vopak
aes Brasil
thyssenkrupp
vtti
EMPRESAS GASCO
South Australia
Eneco
gasunie crossing borders in energy
essent
NOBIAN
e.on
covestro
Aker Clean Hydrogen
HES International
Ministerio de Industria, Energía y Minería
HyNewGen
HYCHICO
STAHL. DAS SIND WIR. HKM
nceda
bp
HyCC
pecem
uniper
westenergie
steag

City of Rotterdam
provincie Zuid-Holland
Port of Rotterdam

HYDROGEN ECONOMY IN ROTTERDAM INFRASTRUCTURE 2020-2030



The locations ***depicted*** are approximate.

Port of Rotterdam

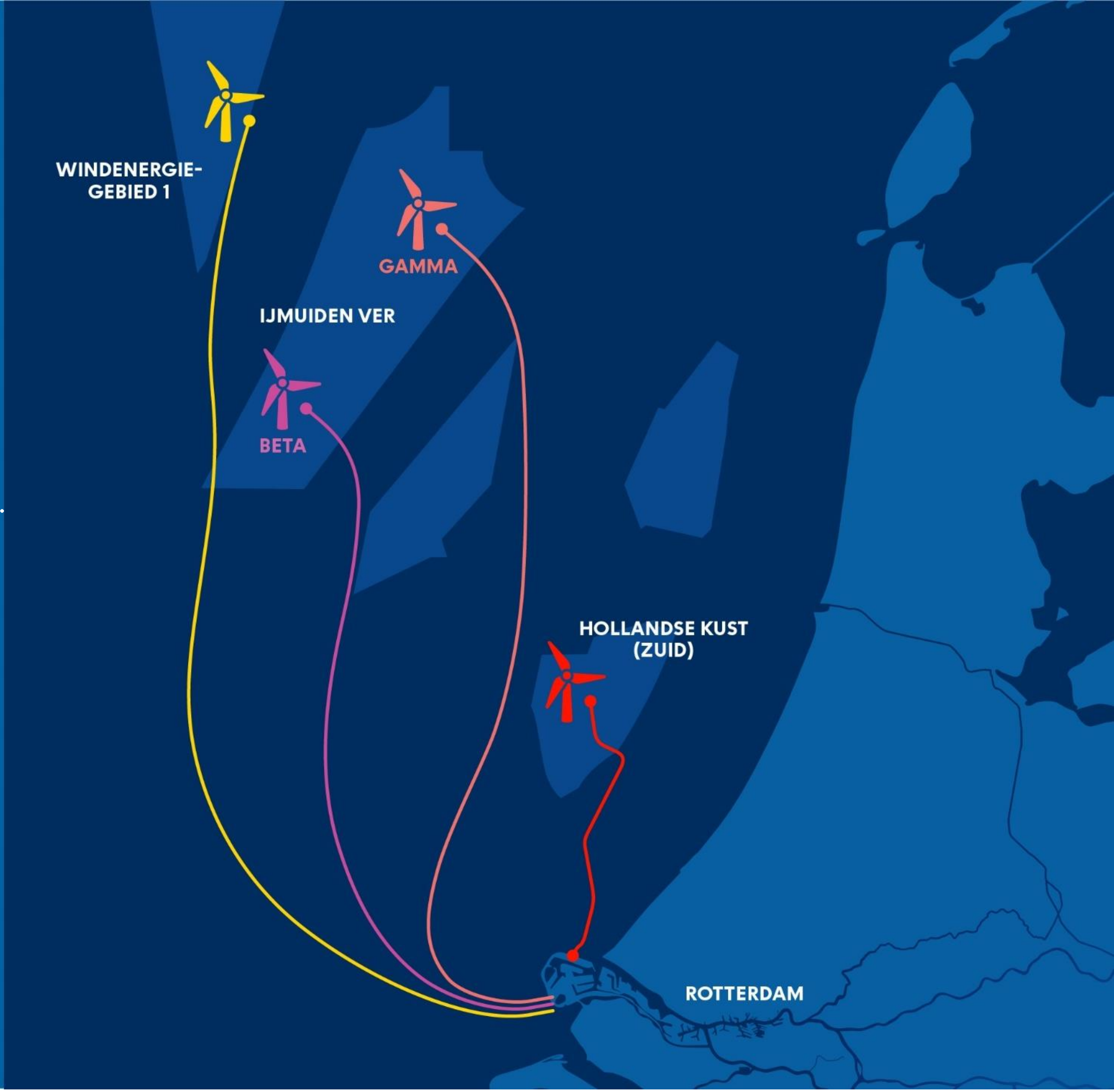
7.4 GW WINDFARMS NORTH SEA CONNECTED TO ROTTERDAM

7.4 GW = 35% of all windpower projects in Dutch part of the North Sea.

These projects are to be realized *before* 2030.

Consultation with the government about projects after 2030 has started.

WINDFARMS	CAPACITY	OPERATIONAL
Hollandse Kust Zuid	1,4 GW	2023
IJmuiden Ver Beta	2 GW	2029
IJmuiden Ver Gamma	2 GW	Before 2030
Windenergiegebied 1	2 GW	Before 2030
Total	**7,4 GW (H2: 2-2,5)**	



Port of Rotterdam

A DEDICATED SITE FOR ELECTROLYSIS

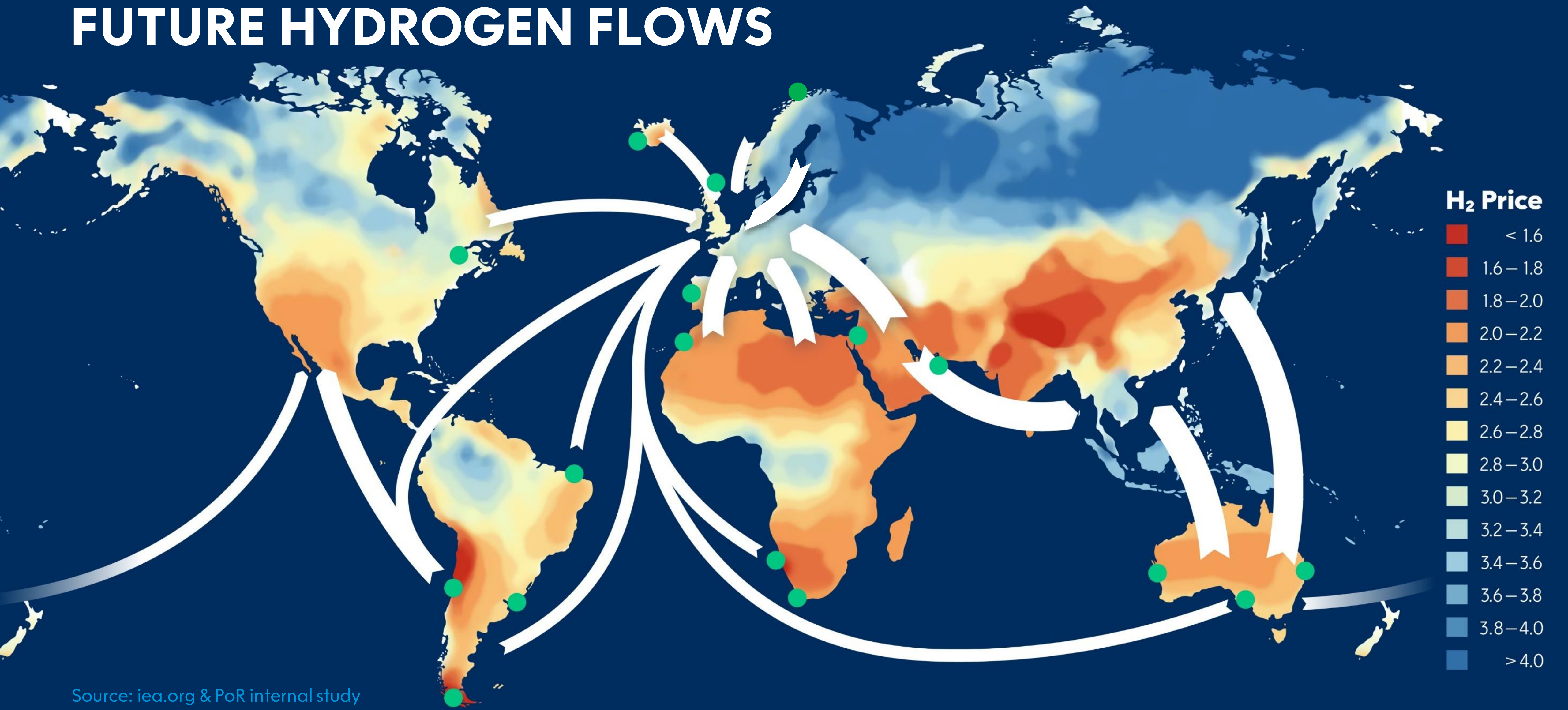
H-vision
Production of low-carbon hydrogen, mainly from refinery gases, combined with CCS, to decarbonize high temperature processes. First plant in 2027.

PROJECT/COMPANY	ELECTROLYSER CAPACITY	FID	OPERATIONAL
A. H2-Fifty (bp & HyCC)	250 MW	2023	2025
B. Holland Hydrogen 1 (Shell)	200 MW	Q2 2022	2024
C. Air Liquide & Vattenfall	200 MW	2023	2025
D. X	200 MW	2024	2026
Uniper	100-500 MW	2023	2025-2030

CONVERSION PARK

Port of Rotterdam

FUTURE HYDROGEN FLOWS



Source: iea.org & PoR internal study

BUILDING INTERNATIONAL SUPPLYCHAINS

A CASE IN POINT: PECÉM HYDROGEN EXPORT HUB

Excellent sun- and wind potential

Port of Rotterdam 30% shareholder in Operating company, local benefits and plans for export

PoR supporting H2 industrial hub development

Already 3 leases, 19 MOUs, 11 GW planned 2030

Port of Rotterdam

IN ROTTERDAM ALL CARRIERS EXPECTED

Port of Rotterdam will therefore be ready to receive all types of carriers:

1. Green Methanol - Multiple existing terminals. Already a regional Methanol hub
2. Green Ammonia - One existing terminal. 6 ammonia terminals announced
3. LOHC - Conversion of 2 existing terminals, first pilot in 2023
4. LH2 - 2 feasibility studies new terminals completed. Possible before 2030
5. NaBH2 - other technologies are also being explored

Additional new facilities will be needed:

- Cracking & dehydrogenation facilities
- Connection to H2 backbone and other hinterland transport modalities
- Barge and truck loading facilities




Port of Rotterdam

PUBLICLY ANNOUNCED IMPORT/PRODUCTION PROJECTS

AND MORE TO COME...

PRODUCTION

1. Connecting offshore wind energy
2. H2-Fifty
3. Shell - Holland Hydrogen I
4. AirLiquide
5. Conversiepark Maasvlakte
6. Uniper
7. Multiplhy
8. AVR e-thor
9. H-vision

IMPORT

1. Worldwide import of hydrogen
2. ACE Terminal
3. Global Energy Storage (GES)
4. VOPAK
5. Koole, Chiyoda, Mitsubishi, Port of Rotterdam
6. Airproducts, Gunvor
7. Koole, Horisonti
8. OCI
9. VTTI
10. Shell LH2

MOBILITY

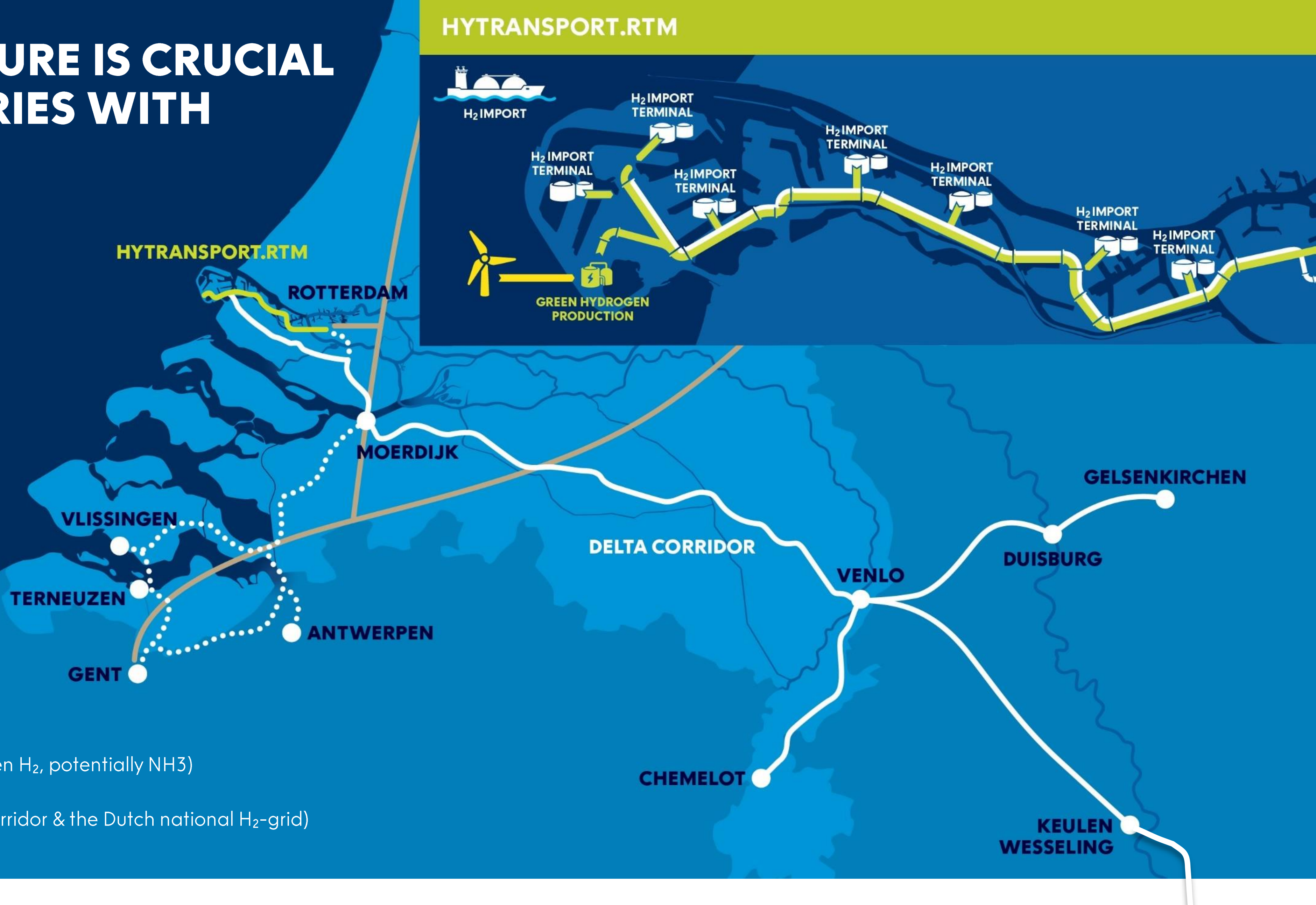
1. HyTrucks
2. Rh2ine
3. Green Energy Refuelling Station (GERS)
4. Hydrogen public bus transport Goerree Overflakkee - Hoekse Waard
5. Everfuel Refuelling Station Heinenoord
6. Rhine Hydrogen Integration Network of Excellence (RH2INE)

Port of Rotterdam

NEW INFRASTRUCTURE IS CRUCIAL TO SUPPLY INDUSTRIES WITH HYDROGEN

Right now, Rotterdam supplies a large part of NW-Europe's industries, including North Rhine-Westphalia, with fossil fuels and feedstock.

To supply these with the vast quantities of sustainable energy and feedstock needed to decarbonize, new infrastructure like the Delta Corridor has to be developed.



LEGEND
- Delta Corridor (LPG/propene, butane, CO2 en H_2, potentially NH3)
- Possible extension Delta Corridor
- HyTransPort.RTM (connected to the Delta Corridor & the Dutch national H_2-grid)
- Dutch national H_2-grid (HyWay27)

ONWARD TRANSPORT: MULTIMODAL DISTRIBUTION OF HYDROGEN

A DECADE OF CHANGE

2024

First Green ammonia imports start

Shell 200 MW electrolyser operational on conversion park

2025

H_2 backbone (HyTransPort.RTM) operational

H_2-Fifty 250 MW electrolyser operational (BP, HyCC)

Uniper 100 MW electrolyser operational (towards 500 MW in 2030)

2025

Road transport: 1000 H_2 powered trucks of which 500 in Rotterdam

LOHC import at industry scale

Pipelines to Chemelot and North Rhine – Westphalia operational (Delta Corridor)

2027

RH_2INE:

12 inland barges on H_2 operational

H-vision operational (blue H_2)

2028

LH_2 terminal operational

2 – 2,5 GW electrolysers operationeel

2030

2 – 4 Mt Hydrogen imports