WORKING TOGETHER ON THE BEST POSSIBLE PORT.
MAKE IT HAPPEN.

Wilco van der Lans

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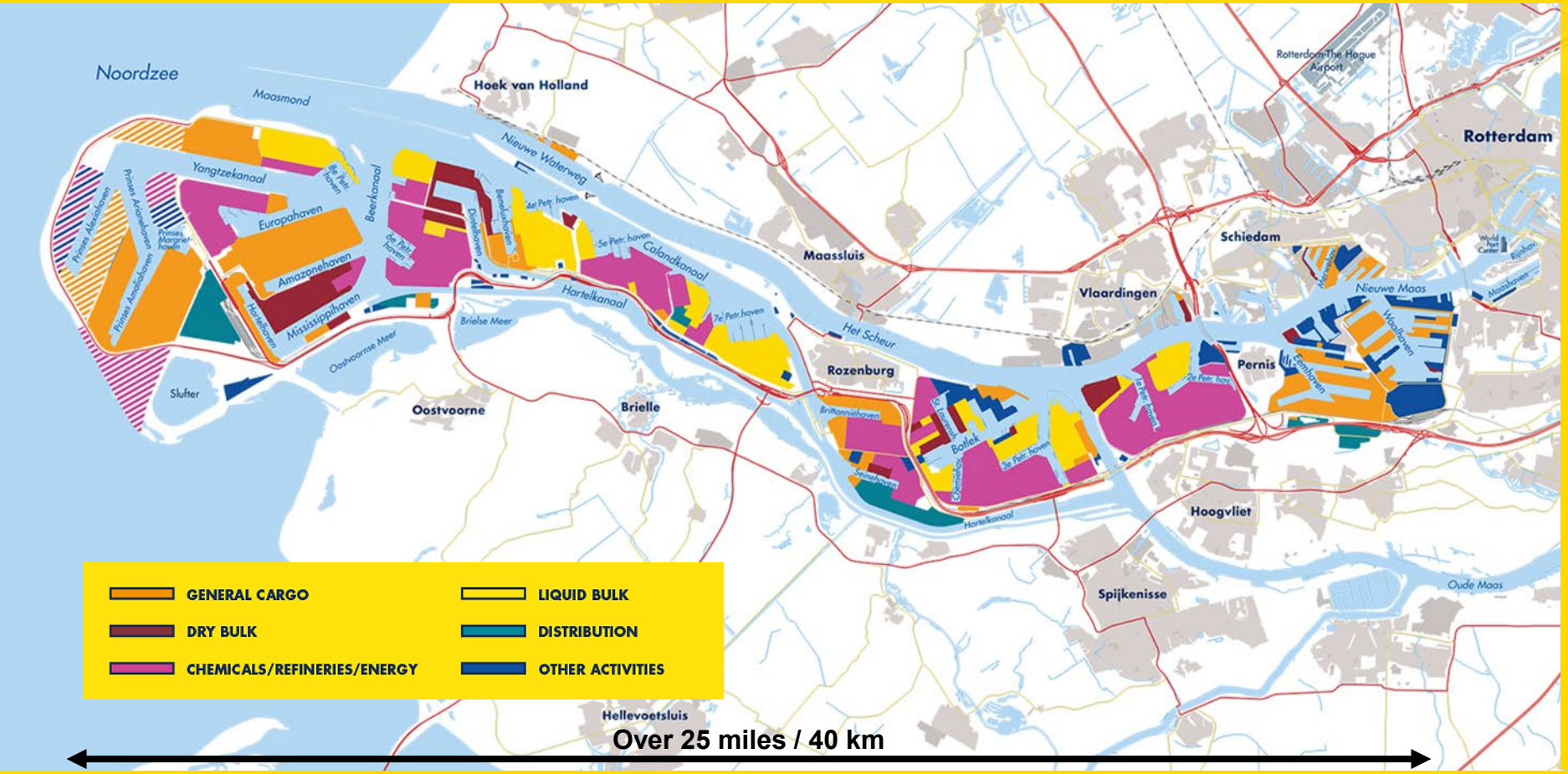
Port of Rotterdam

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

Position and Ambition Port of Rotterdam (PoR)

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

- 8.800 petajoule (PJ) per seagoing vessel (more than 3x the Dutch energy consumption & 13% of the energy consumption of Europa).
- For the production of steam, heat and electricity in the Port of Rotterdam & Moerdijk, 430 PJ of energy was used (29 Mton CO_2 emissions / 16% of the total Dutch emissions).

Ambition (2050)

- Transforming the position of an energy port into a sustainable energy hub for NW Europe
- 95% of CO_2 emission reduction in the port (Assumption: over 50% of energy saving is possible by 2050, results in 190 PJ of energy consumption in 2050). This requires 2,5 – 6,4 GW electrolysis capacity with full operating hours.
- Import terminal for Renewable Fuels

Port of Rotterdam

Energy Transition: Towards a new energy and circular material system

Committed to the Paris Agreement

- 2030: 49% reduction of CO_2
- 2050: Climate neutral

Wuppertal pathways (2016):

- Goal: develop pathways for the Port of Rotterdam to 98% CO_2 reduction
- Together with all relevant stakeholders

Climate action program, Three steps towards a sustainable industry cluster (2018)

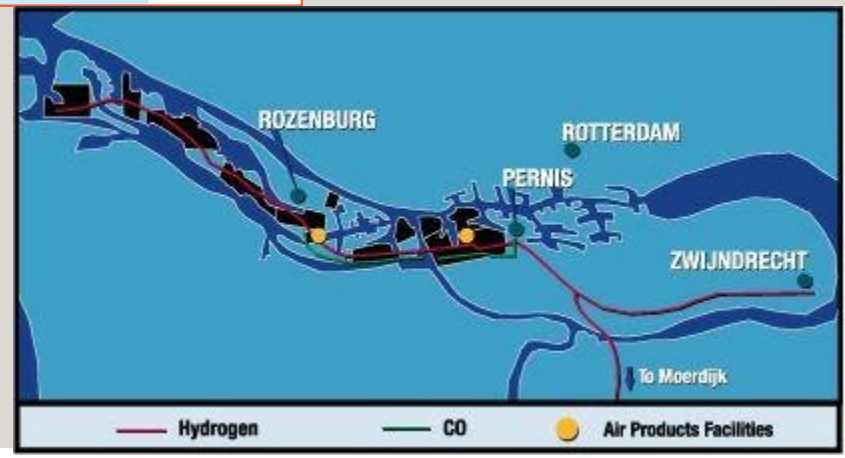
- H2 as a pillar of the port energy transition strategy
- Others: CCS, renewables, electrification, alternative fuels, biobased economy, circular economy, etc.

Port of Rotterdam

Current hydrogen situation in Rotterdam

- Current hydrogen demand per year in Rotterdam is 300 - 400 kt (36-48 PJ $_{LHV}$), mainly used for oil refinery
- Main suppliers are Air Liquide and Air Products with world scale SMR-plants, own production on refineries and the chlorine plant of Nouryon
- SMR-plants are being connected to CCUS network (Porthos)
- In the Port of Rotterdam 2 hydrogen grids exist from Air Products (regional network) and Air Liquide (international network)

Pipeline network of Air Liquide & Air Products, hydrogen in RED



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Local/regional Hydrogen Development a stepwise approach

Production

- *Blue Hydrogen*: H-vision, a project exploring local production of blue hydrogen (made from natural gas and decarbonized with CCS). This hydrogen can be used to provide local industries with high-temperature heat and for electricity generation.
- *Green Hydrogen*: Several initiatives in large scale electrolysis. Largest development is collaboration between Port of Rotterdam, Nouryon and BP: 250 MW (impact: 40 kton/a green H_2, avoiding 360 kton CO_2/a)

Consumption

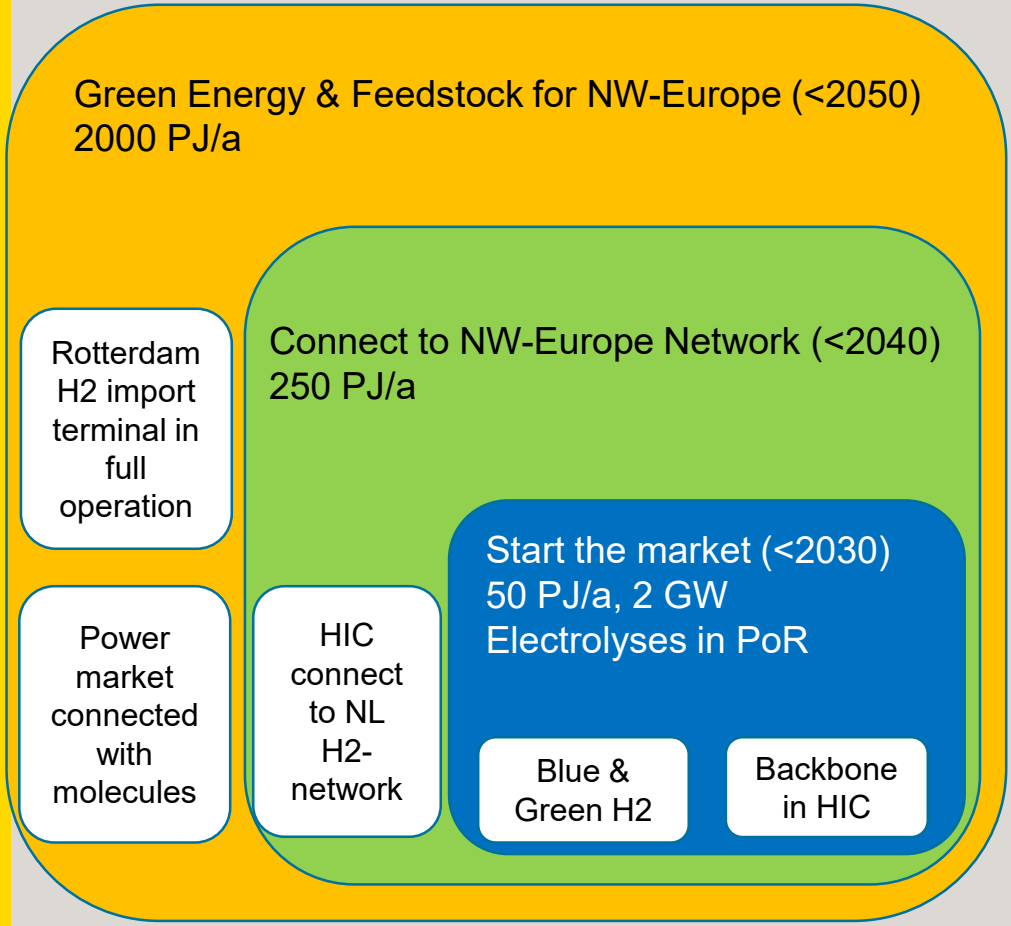
- Use as a resource in industries: feedstock (P-to-X) & high-temperature heat
- Emission free shipping and (heavy) road transportation (trucks)
- Use as a buffer for Power System (ProSumer)

Infrastructure

- 2GW conversion park (leading to efficient land-use and modest infrastructural investments for producers)
- Large scale open access hydrogen backbone (pipeline)
- Development of a bunkering showcase, together with several inland barges

Import/export

- Importing hydrogen will become necessary, because of a lack of regional potential to cost-effectively generate enough sustainable energy



Port of Rotterdam

POWER UP
YOUR IDEAS
MAKE IT HAPPEN

Wilco van der Lans
w.lans@portofrotterdam.com

LET'S CONNECT

Port of Rotterdam

Blue Hydrogen

H-Vision project: Collaboration for large scale production and usage of blue hydrogen (natural gas with CCS)

H-vision

16%
CO_2-emission reduction in Rotterdam

2,2 – 4,3 Mton
CO_2-emission reduction in 2026 – 2031 per year

3200 MW
700 kton H2 per year

Hub
Start Rotterdam as a Hydrogen hub

gasunie · Port of Rotterdam · Linde · TAQA · TNO · Deltalinqs · Vopak · OCI NITROGEN · ENGIE · equinor · bp · Air Liquide · Shell · GasTerra · uniper · ebn

Green Hydrogen

250 MW water electolyser connected to offshore windpower for the production of green hydrogen for BP's refinery

Potential to grow

350 kton
CO_2-emission reduction

250 MW
45 kton H2 per year

Part of 2GW conversion park development
Connect offshore wind farms with hydrogen production

Nouryon · Port of Rotterdam · bp