Updated PGS-12 code: Preparing for increased ammonia imports to the Netherlands

WEBINAR

Mark Stoelinga
Business Manager
Port of Rotterdam

Gert Jan de Geus
Managing Director
OCI Global

Tamme Mekkes
Business Development Director
chane

AMMONIA ENERGY ASSOCIATION

Tuesday, July 30, 2024
4PM-5PM CEST (10 AM EDT)

House rules

Any questions for the speakers can be asked in the Q&A section. The questions will be answered by text by the speakers, or will be discussed in the panel.

The webinar recording of this webinar will be shared with all registrants after the webinar.

An article about the webinar will be posted on AmmoniaEnergy.org

Ammonia storage terminals

- Ammonia has been stored and handled for over a decade
- About 18-20 Mt-NH_3 is shipped annually via ports (10% of total ammonia production)
- Procedures for ammonia storage and handling have been updated continuously to ensure safe operations

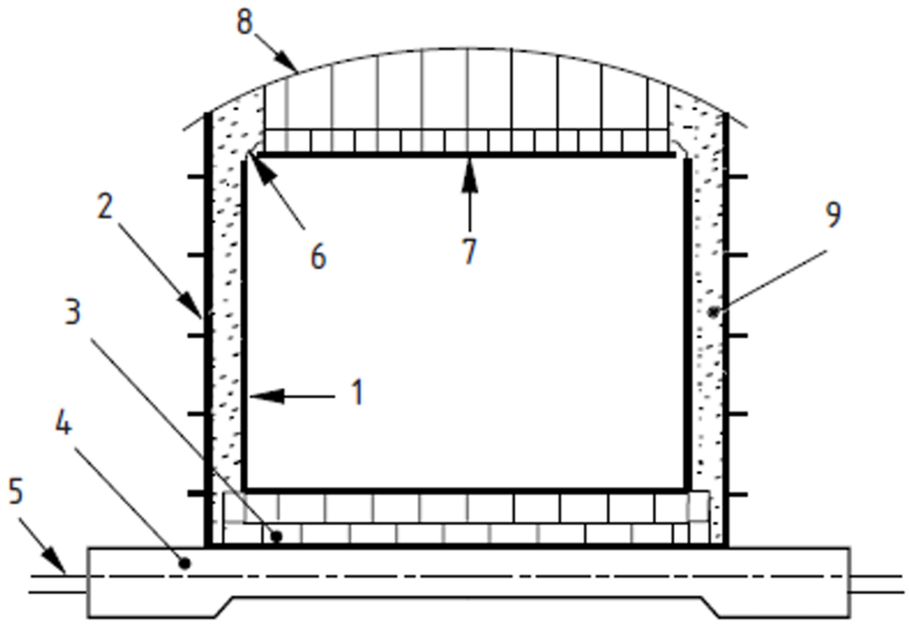
Ammonia Storage Terminals List. Ammonia Energy Association.

Ammonia storage terminals

- **Full containment**: Current industry standard for ammonia standard
- **Double integrity**: If primary liquid containment (first tank) fails, a secondary containment (second tank) will contain liquid. Vapor seal is gas-tight. Tank-in-tank design with insulation on outside of outer tank.

Relevant codes and materials:

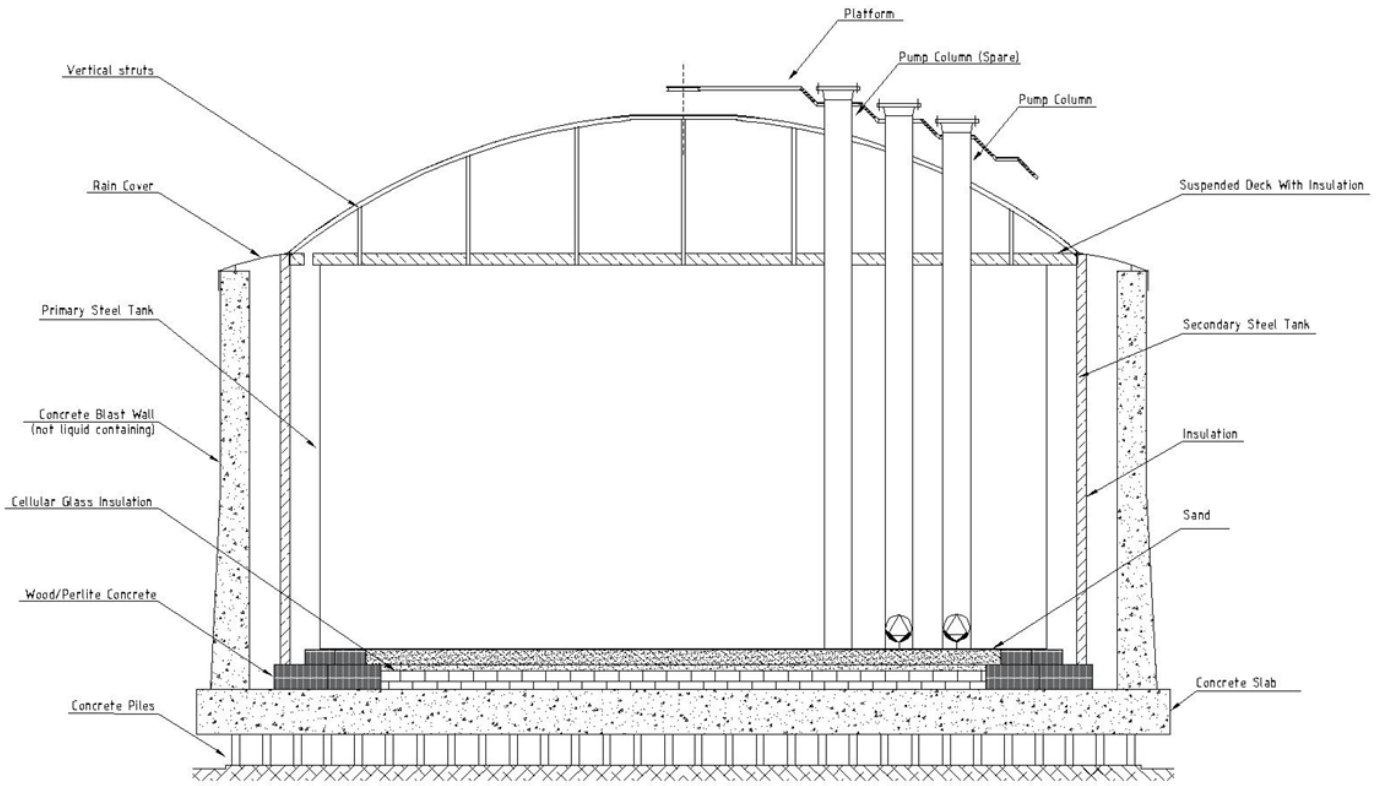
- Europäische Norm (EU): EN14620
- American Petroleum Institute (USA): API620/625
- Publicatiereeks Gevaarlijke Stoffen (the Netherlands): PSG-12
- Materials: P275NL, ASTM A516



Example of a full containment ammonia storage tank design

Ammonia storage terminals in the Netherlands

- Increased imports of ammonia to the Netherlands foreseen
- **Rotterdam**: 1 existing terminal (OCI), 4 new ammonia terminals announced
- Requires up-to-date design codes about how an ammonia terminal should be constructed
- **PGS-12 Code updated via the "Polder Model"**: Industry, government institutions and permitting authorities working together. Acceptance is key.



Example of an ammonia storage tank design in accordance with PSG-12 (courtesy Proton Ventures)

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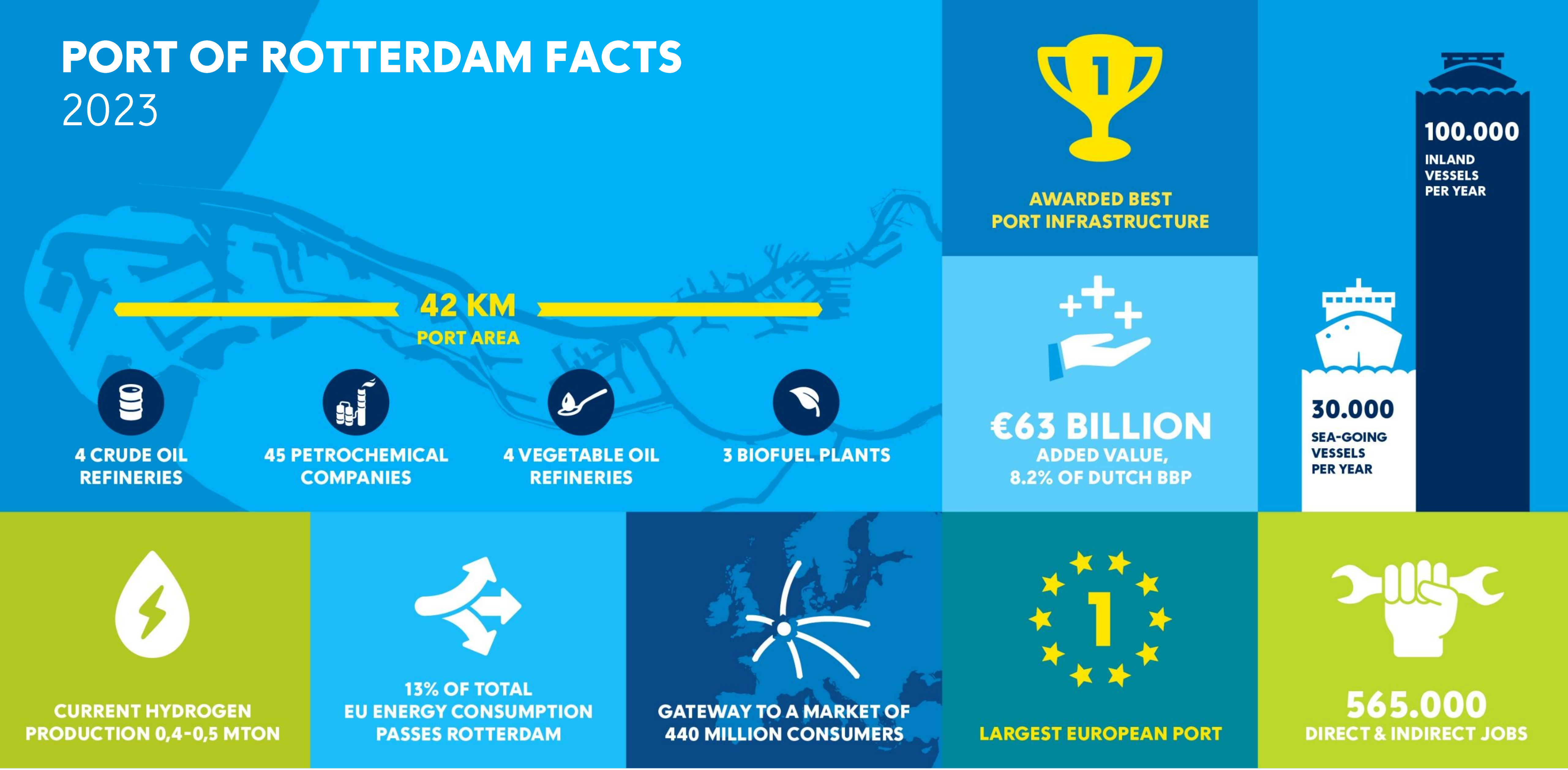
ROTTERDAM EUROPE'S HYDROGEN HUB AEA

Mark Stoelinga, juli 2024

Port of Rotterdam

PORT OF ROTTERDAM FACTS
2023



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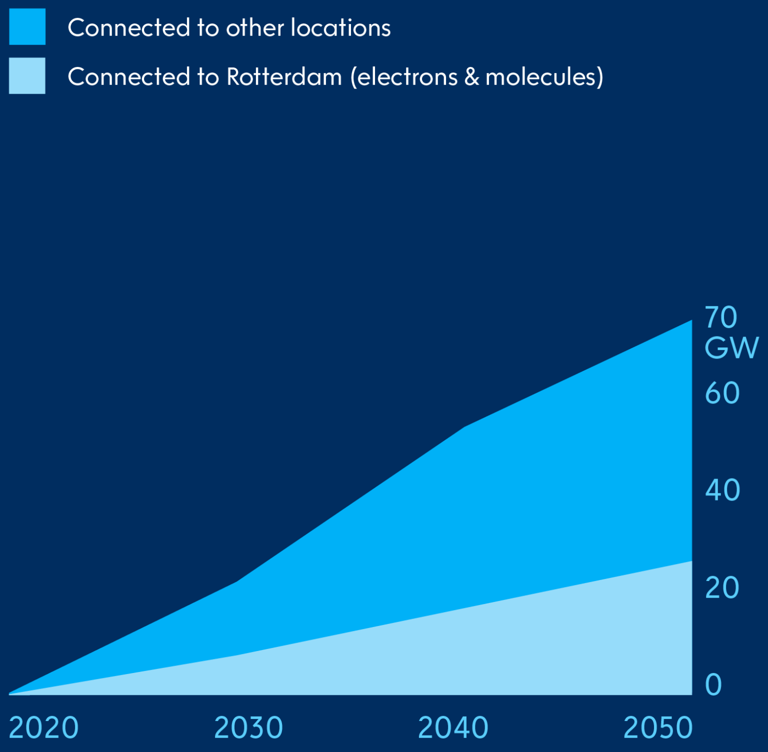
ROTTERDAM: EUROPE'S HYDROGEN HUB

CO_2-reduction through offshore wind, hydrogen and its derivatives

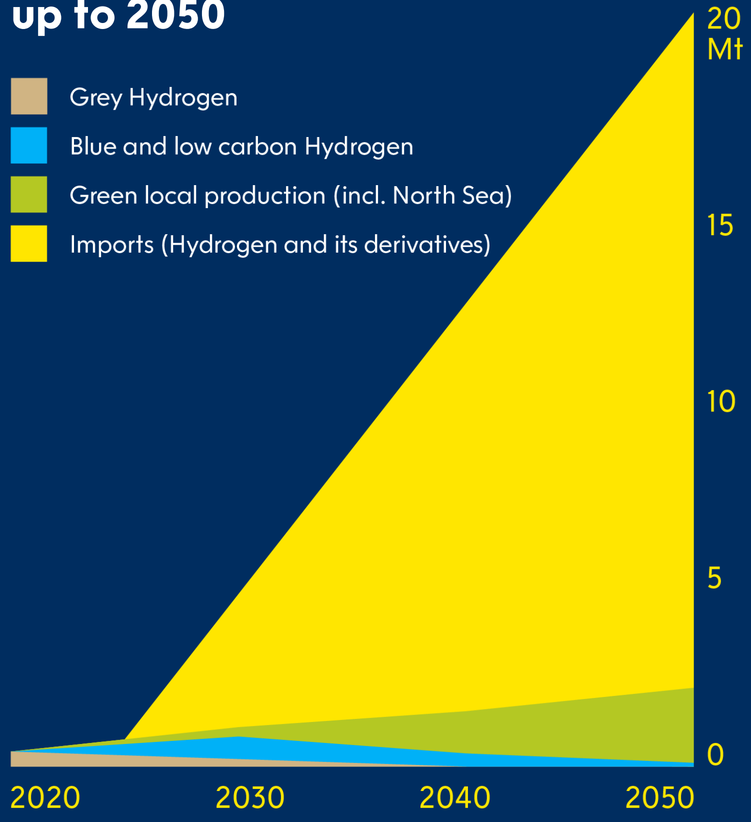
13% of total energy consumption EU goes via Rotterdam, Europe's largest energy port.

NL offshore renewable energy up to 2050

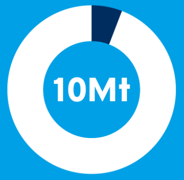


Source: Min. EZK, Kamerbrief windenergie op zee 20302050 (2022)

Hydrogen in Rotterdam up to 2050

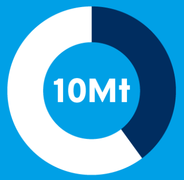


Rotterdam plays a huge role in fulfilling EU ambitions 2030 (RePowerEU)



EU green hydrogen production

0.6 Mtpa Rotterdam green & low carbon hydrogen production



EU hydrogen import

4.0 Mtpa Rotterdam green hydrogen import

Rule of thumb:

50 TWh ENERGY → **10 GW** ELECTROLYSIS → **1 MTON** HYDROGEN (H_2) → **10 MTON** CO_2-REDUCTION

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PRIORITIES

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IMPORTS ARE ESSENTIAL FOR EUROPE, AS IT USES MORE ENERGY THAN IT CAN PRODUCE

High potential areas for green hydrogen export

PROGRESS AND PLANNING

- Expected import Hydrogen and its derivatives in Rotterdam:
  4 Mtpa in 2030, 18 Mtpa in 2050
- Huge potential for production in many areas worldwide
- Imports Rotterdam are expected to start around 2025
- 9 terminals have announced plans for import facilities
- Rotterdam is preparing itself for Ammonia, Methanol and LOHC, Liquid Hydrogen
- Multiple MoU's in place

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PORT OF ROTTERDAM IS READY TO RECEIVE ALL TYPES OF CARRIERS

Green ammonia
One existing terminal.
4 new ammonia terminals announced.

LOHC
Conversion of 2 existing terminals, first pilot in 2023.

LH2
2 Feasibility studies for new terminal completed.
Possible before 2030.

Green methanol
Multiple existing terminals.
Already a European methanol hub.

Powders
Other technologies are also being explored (e.g. NaBH2).

Cracking facilities in study.

13 HYDROGEN TERMINAL PROJECTS ANNOUNCED

More initatives expected

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WHAT IS NECESSARY ?

Fast and reliable permitting
(incl. nitrogen regulations)

A robust H_2 certification scheme for imports

Stimulation of demand and closing the financial gap with CO_2-emitting alternatives
(like contracts for difference)

Parallel development of public and private H_2 infrastructure

Financing run-up risks
(especially for infrastructure)

Societal acceptance of new energy carriers

IT'S HAPPENING!

Offshore wind landfall

Pipes for Hynetwork

Start Construction Hynetwork

Electrolyser Projects

GREEN HYDROGEN PRODUCTION STARTS AT DEDICATED SITES FOR ELECTROLYSIS

Ambition Rotterdam
2030: 2.5GW (onshore)
2050: 20GW (onshore & offshore)

Conversion park 1

PROJECT (COMPANY)	CAPACITY	PLANNED FID	OPERATIONAL
H2-Fifty (bp&HyCC)	250MW	2024	2027
Holland Hydrogen I (Shell)	200MW	2022 ✓	2025
CurtHyl (Air Liquide)	200MW	2024	2027
Confidential	200MW	2025	2028

Conversion park 2

PROJECT (COMPANY)	CAPACITY	PLANNED FID	OPERATIONAL
IJmuiden Ver GW-scale project	1000MW	2025	2029

Local developments

PROJECT (COMPANY)	CAPACITY	PLANNED FID	OPERATIONAL
H2Maasvlakte (Uniper)	500MW	2025-2026	2029-2030
Eneco Electrolyser (Eneco)	800MW	2025	2029

Port of Rotterdam

OCI & OCI Terminal Europoort B.V.

Introduction to OCI

Powering a cleaner future sooner

We are a **game-changing global leader in nitrogen, methanol and hydrogen**, driving forward the **decarbonization of the energy-intensive industries** that shape, feed and fuel the world. Through our cleaner products and practical solutions, we are making our **transport cleaner, products greener and our harvests better**

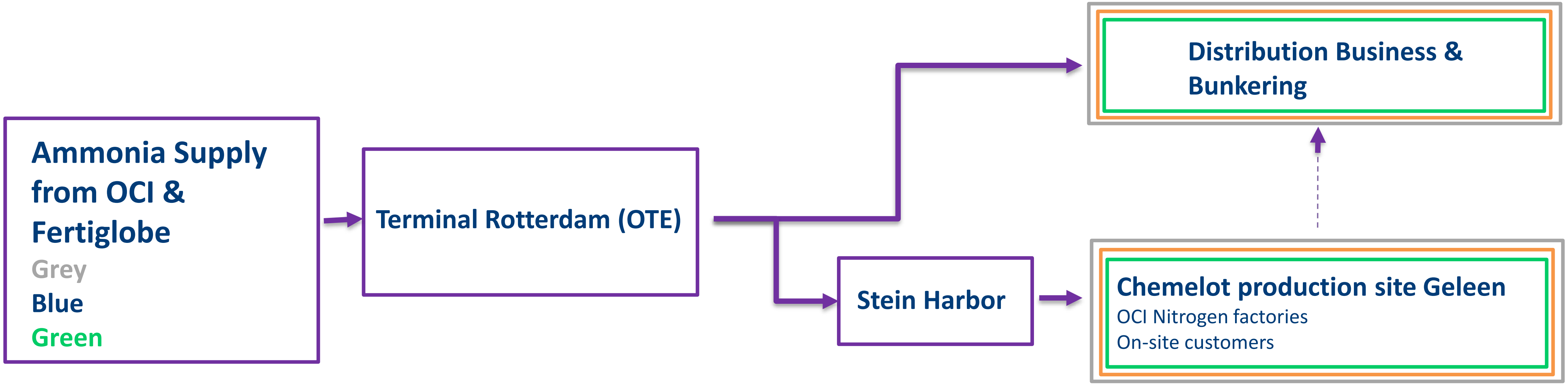
OCI NV is a global firm active in the production and sales of Ammonia , Fertilizers , Methanol and Melamine.
OCI Terminal Europoort (OTE) is our ammonia import terminal in Rotterdam serving our Ammonia Distribution Business and our production in Europe.

OCI

Ammonia imports : the way to the future!

Goals of Import Maximization:

- Unleash synergy of the global portfolio of OCI
- To decarbonize OCI's products by importing Blue ammonia and Green ammonia produced at other OC/Fertiglobes facilities.
- Grow Ammonia as bunkering fuel



Jetty 1 – Import of Cargoes up to 25,000 MT

- Cold ammonia - import only
- Max. draft: 13 meter
- Max. mooring length: 260 meter
- Max ship size: 80,000 DWT
- Shared use with ETT

OCI

Cold Ammonia storage

- Atmospheric storage at -33 ^{o}C
- 2 Storage tanks of 15,000 MT each
- Redundant cooling system
- Inside renovation completed 2017
- Outside renovation completed 2022

OCI

Jetty 2 – Barges & Coasters up to 2500 mt

- Export of warm Ammonia
- Export of Aquous Ammonia (AA)
- Max. draft 7 meter
- Max. mooring lenght 100 meter
- Max ship size 8,000 DWT
- Shared use with ETT

OCI

Railcar / truck loading

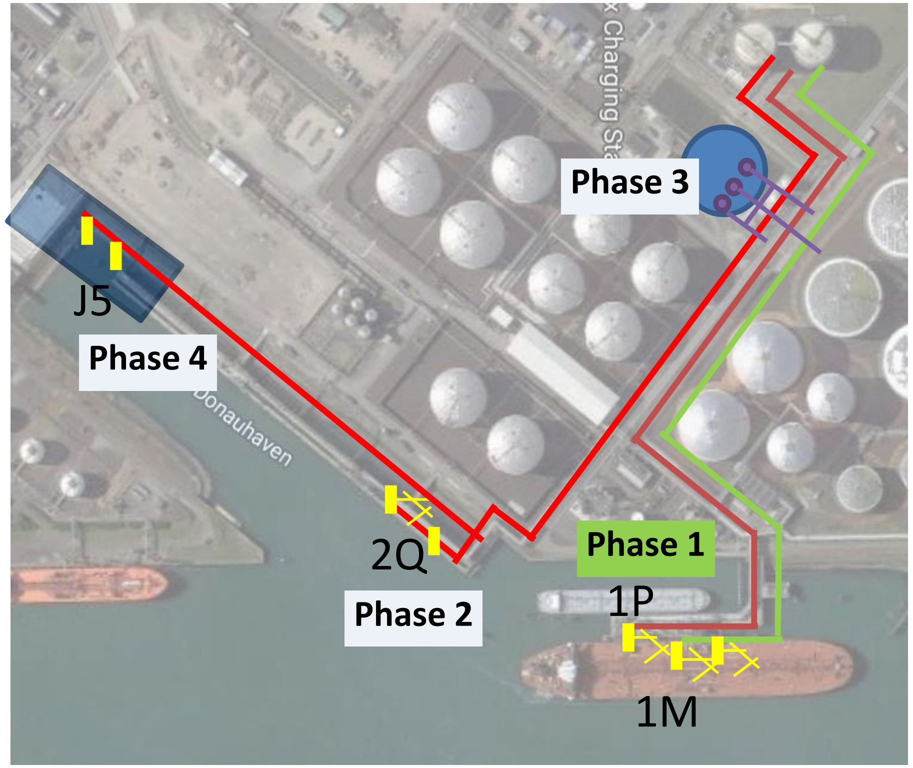
- Export of warm Ammonia (Railcar + Truck)
- Rail infrastructure shared with ETT
- Most modern fleet of RTC’s in Europe

OCI

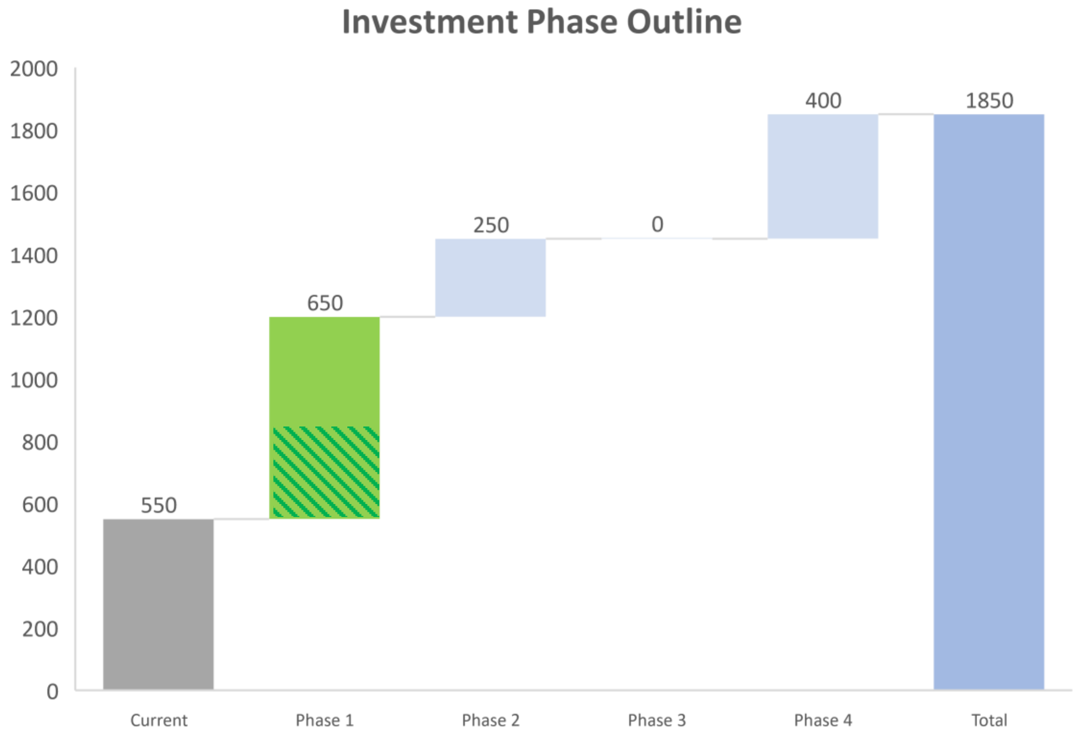
Future developments

Investment phases – complete expansion scope

Phase 1 - 4



Phase	Headline additions
Phase 1	Jetty 1P additions, increased line capacity
Phase 2	Jetty 2Q increased loading (incl. cold)
Phase 3	Tank 1003 (60kt)
Phase 4	Jetty 5 addition (barges)



Scope Phase 1:

- New loading arms Jetty 1M, Jetty 1P and Jetty 2Q
- New 20” line from existing storage tanks to Jetty 1

Permit (based on new PGS 12) granted for all 4 Phases !

OCI

Chane NH3 in Rotterdam, NL

Current State of Developments

AEA Webinar 30 July 2024

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Tamme Mekkes

Business Development Director

Responsibilities

- Commercial Growth CAPEX Projects
- Terminal GHG Reduction Projects
- Energy Transition and International Business

Contact Details

- Rotterdam Head Office, Netherlands
- +31 6 835 89 425
- tamme.mekkes@chane.eu

Example Projects

- Tripling capacity to remain Europe's largest toll distiller for Sustainable Aviation Fuels
- Expanding leading position in biofuels and feedstock storage with several 100k cbms
- Realising a residual heat and steam connection to decarbonise a terminal

Background

- Chief Commercial Officer – Attero Waste Management
- Associate Partner – OC&C Strategy Consultants
- MSc Business Administration – University of Twente
- MSc Applied Physics – University of Twente

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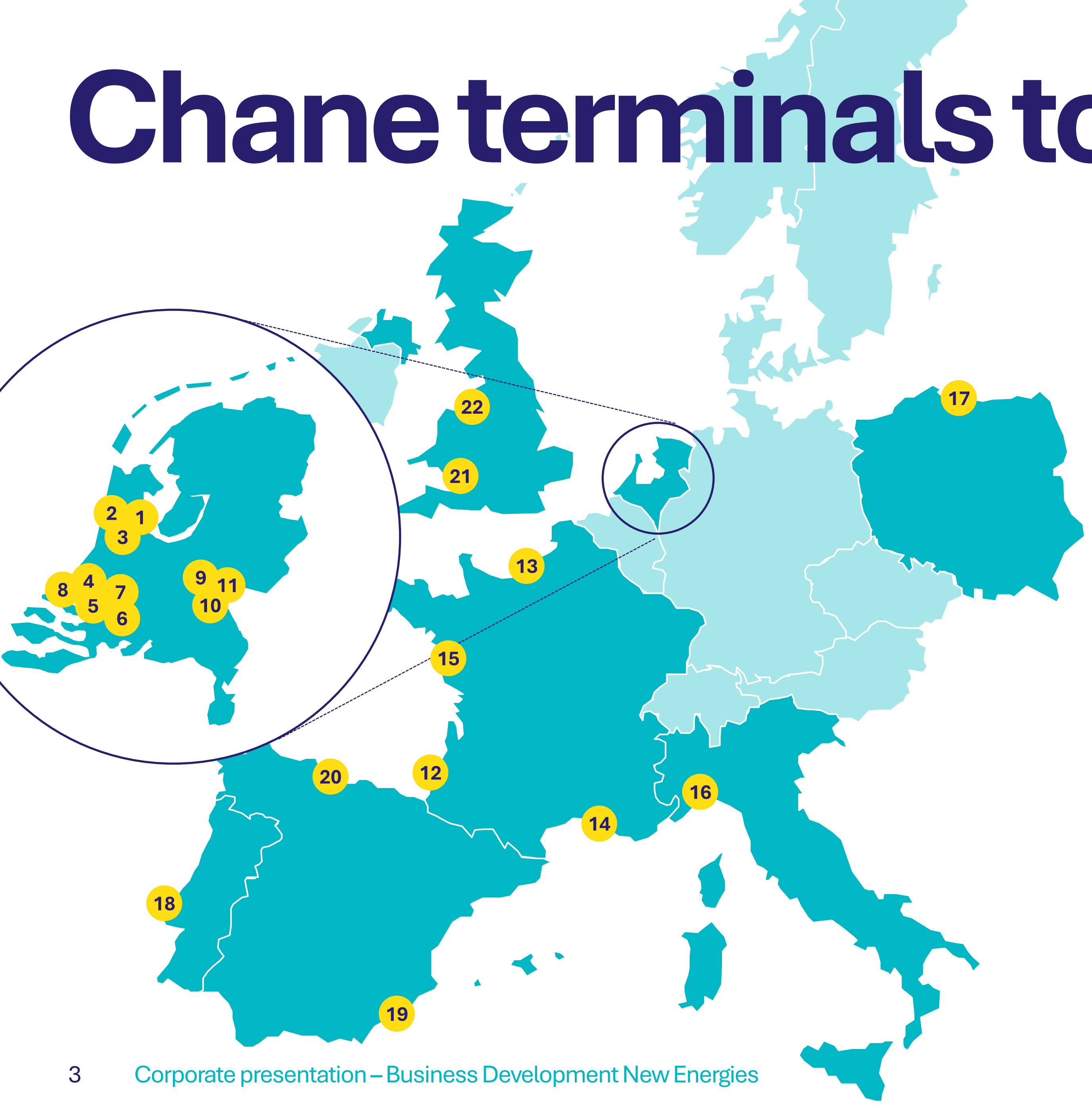
Chane terminals today



1. **Chane Terminal Amsterdam** 119,000 cbm
2. **Chane Terminal Westerhoofd** 74,000 cbm
3. **Chane Terminal Zaandam** 56,000 cbm
4. **Chane Terminal Botlek** 1,600,000 cbm
5. **Chane Terminal Geulhaven** 150,000 cbm
6. **Chane Terminal Nieuwe Maas** 1,400,000 cbm
7. **Chane Terminal Pernis** 675,000 cbm
8. **Chane Terminal Welplaat** 110,000 cbm
9. **Chane Terminal Dodewaard** 20,000 cbm
10. **Chane Terminal Nijmegen** 80,000 cbm
11. **Chane Terminal Oostkanaalhaven** 80,000 cbm
12. **Chane Terminal Bayonne** 125,000 cbm
13. **Chane Terminal Le Havre** 460,000 cbm
14. **Chane Terminal Marseille** 107,000 cbm
15. **Chane Terminal Nantes** 25,000 cbm
16. **Chane Terminal Vado Ligure** 158,000 cbm
17. **Chane Terminal Gdynia** 32,000 cbm
18. **Chane Terminal Lisbon** 170,000 cbm
19. **Chane Terminal Cartagena** 26,000 cbm
20. **Chane Terminal Santander** 86,000 cbm
21. **Chane Terminal Avonmouth** 25,000 cbm
22. **Chane Terminal Liverpool** 22,000 cbm

Strategic Design Considerations

- Safety first (e.g. PGS12)
- Independent tank terminal
- Land available at brownfield location
- Fully zoned, NOx space, and permittable
- Built as per customers' demands
- High throughput, ideally ammonia pipeline out
- Financial shareholder willing and able to invest
- Increase the support for NH_3 in energy transition
- We will be operational when you will be operational

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Chane Rotterdam footprint

Chane operates 3.9 million cbm of storage capacity in Rotterdam, spread over 5 different terminals

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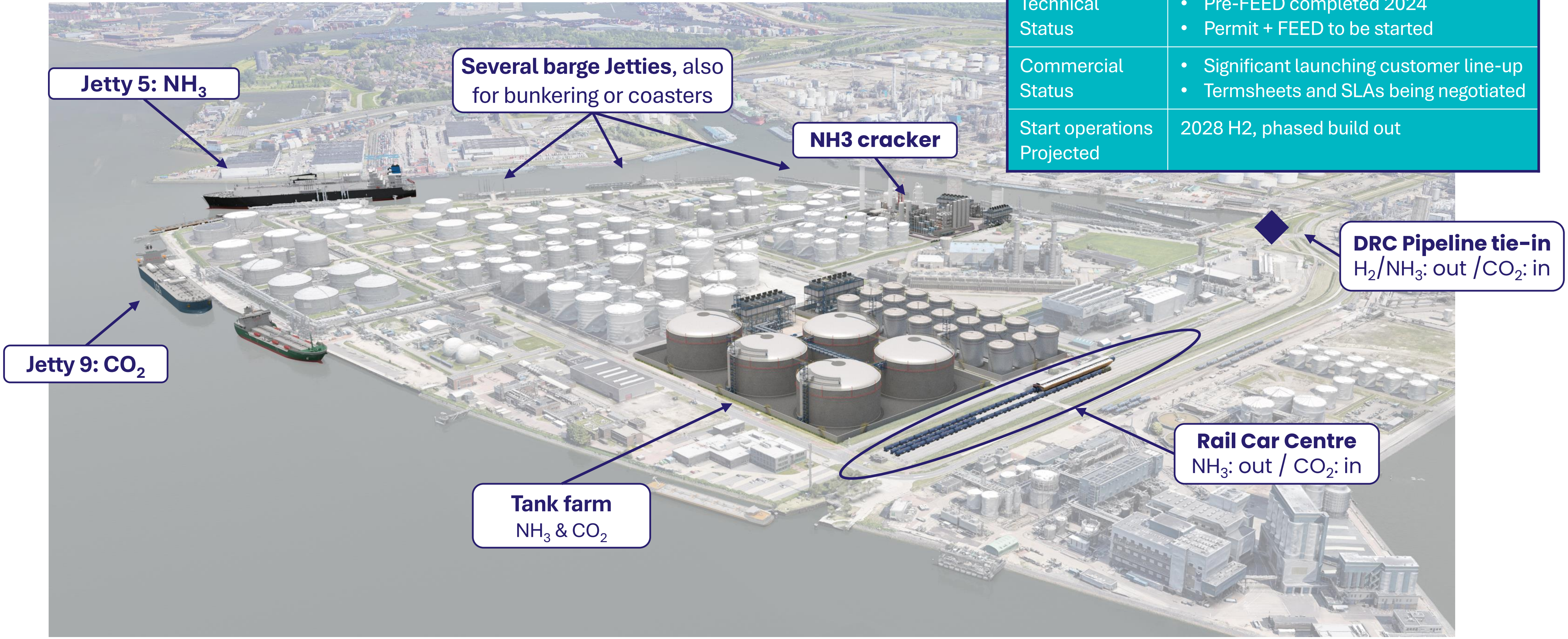
Rotterdam NH3 import hub

Currently negotiating termsheets with launching customers

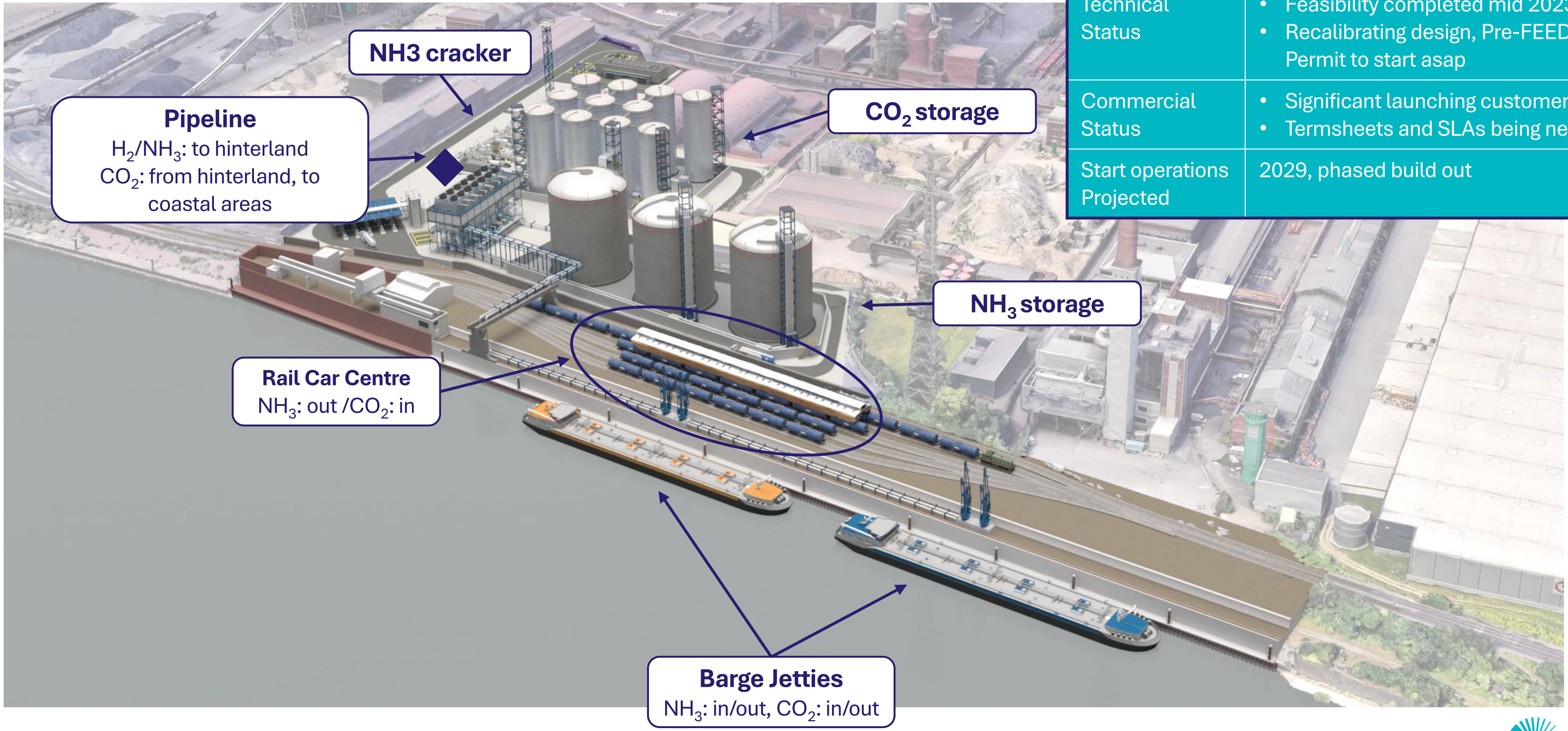
Modalities	Vessel, Barge, Pipeline, Rail, Truck
Technical Status	• Pre-FEED completed 2024 • Permit + FEED to be started
Commercial Status	• Significant launching customer line-up • Termsheets and SLAs being negotiated
Start operations Projected	2028 H2, phased build out



Duisburg NH3 distribution hub

‘Last-mile’ rail and barge, and possible NH3 cracker into ‘Kernnetz’

Modalities	Barge, Rail, Pipeline, Truck
Technical Status	• Feasibility completed mid 2023 • Recalibrating design, Pre-FEED + Permit to start asap
Commercial Status	• Significant launching customer line-up • Termsheets and SLAs being negotiated
Start operations Projected	2029, phased build out



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Ammonia societal acceptance

Summary of findings from 60+ interviews with international governmental and industrial organizations

Key Message as starting point for increasing support for NH3 in accelerating the ET (1)

Reducing negative effects of fossil fuels

- About 80% of the world's total fuel usage is fossil (oil, gas, etc.). This form of energy is finite in the long term and has the drawback of releasing carbon dioxide and other greenhouse gases upon combustion. This has a negative effect on global warming and ultimately on human and environmental health.

International community aims at substantial reduction of CO2

- It's no wonder that NGOs exert significant pressure on governments to take action. The EU has already implemented various measures to reduce the negative impacts of fossil energy use. In the Paris agreements, national governments agreed to achieve a substantial reduction in CO2 emissions, partly by prioritizing renewable forms of energy in the long term.

Wind, water and solar will not be enough

- Wind, solar, and water are seen as the best alternatives for electrification. However, given the enormous energy needs of both industry and individual consumers, additional forms of energy will be necessary.

Molecule-based alternatives are a necessity to satisfy the energy needs

- Expectations surrounding molecular forms of energy are high. Hydrogen (H2) is widely seen as a suitable addition to the future energy mix to replace fossil fuels. Ammonia (NH3) can also be a good alternative, not only because it is an efficient carrier of H2 but also due to its applications as fuel for power plants and ships. A transition from fossil fuels to NH3 in these sectors would mean an unprecedented reduction in CO2 emissions worldwide, significantly improving air and sea quality. "The maritime sector consumes approximately 300 million tons of fossil fuel annually. This results in more than 1 gigaton of Greenhouse Gas emissions, equivalent to approximately 3% of all global GHG emissions" (ISPT report, 2024).

All molecule-based energy have their challenges

- Every energy source has its disadvantages. You wouldn't want wind turbines in your backyard, methanol can cause severe health issues, and hydrogen can explode. NH3 is toxic and, without adequate safety measures, can cause fatal accidents.

NH3 is potentially an accelerator of the ET

- The properties of NH3 such as its high energy density, makes it one of the more promising options for storing and transporting carbon free fuel efficiently. The promise of supply certainty will encourage off-takers to implement these products in their business processes and reach the ET goals in time.

Key Message as starting point for increasing support for NH3 in accelerating the ET (2)

NH3 has a negative connotation due to its toxic nature

- Safety is therefore an absolute necessity. The fertilizer industry has been using NH3 for over 100 years and has a good track record in this area. The same applies to companies like Air Products (Yara? OCI), which are also major users of NH3 and have been handling it responsibly for decades. Companies wishing to use NH3 are subject to strict scrutiny by safety services and environmental regulators.

High volumes of NH3 will be produced in a sustainable way

- The EU expects that the volumes of NH3 needed will increase enormously in the coming decades. This concerns sustainably produced NH3 using solar and wind energy in regions of the world where they are readily available. This sustainable and perpetually producible NH3 will be transported by ship, among other means, to European ports such as Rotterdam, where it will be stored in terminals specially designed for NH3 before being transported to end-users in the Netherlands and its Hinterland.

Delta Rhine Corridor avoiding train transports

- These end-users can either use NH3 as fuel or it can be cracked into H2. For H2, a pipeline (Delta Rhine Corridor: DRC) will be laid between Rotterdam and Duisburg with government subsidy. The government still needs to decide whether to permit the construction of a pipeline for NH3 transport. However, given the perceived risks of transporting ammonia by train through their municipalities by local authorities in Brabant and Limburg, opting for a pipeline seems inevitable in the long run.

Who will pay the ferryman?

- The question, of course, is who will pay for this? Several companies in our country and in Germany are willing to do so. However, governments at national and regional levels must first agree to a series of follow-up steps (including allowing the DRC to be made suitable for NH3).

Not investing in NH3 infra structure (or other molecule-based energy) will have negative consequences

- If, ultimately, this does not go ahead, it will be very difficult to achieve the Paris goals on time. Relying solely on H2 from electricity generated by wind farms in the Netherlands is not feasible (reliability of supply is insufficient and investors are withdrawing due to higher interest rates and lack of clarity about subsidies). The future energy mix will therefore need to be broadened with molecular supplements such as NH3.
- Inadequate supply security and affordable volumes of renewable energy will lead companies to postpone investments in this area and turn to better offers from abroad. This is bad for our competitive position and the business climate, and certainly also for our environment, given the widespread desire to achieve significant CO2 reduction volumes.

Develop joint messaging, together with all involved organizations

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Linking forward

Tamme Mekkes
Business Development Director
+31 6 835 89 425
tamme.mekkes@chane.eu

Irgen Iversen
Business Development Manager
+31 6 11 1 49 078
Irgen.Iversen@chane.eu

Sander van Kersbergen
Business Development Manager
+31 6 220 61 531
sander.van.kersbergen@chane.eu