



Building a sustainable, low-carbon society

Hydrogen: a solution to decarbonize transport in the maritime industry

A world leader in gases, technologies, and services for...



INDUSTRY

**Sustainable solutions
for a wide range of industrial
processes of our customers:**
energy, metals, food,
chemicals, automotive,
pharmaceuticals, etc.



HEALTH

**Patients at home
Hospitals
Specialty ingredients**

©Adrien Daste

Key Figures Air Liquide 2023



~67,800
EMPLOYEES



PRESENT IN
72 COUNTRIES



MORE THAN
4 MILLION
CUSTOMERS &
PATIENTS



REVENUE
€27.6bn



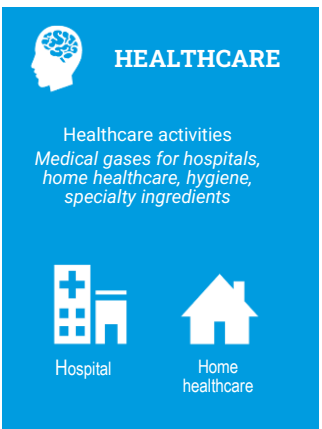
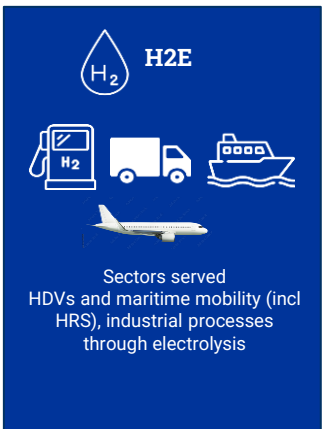
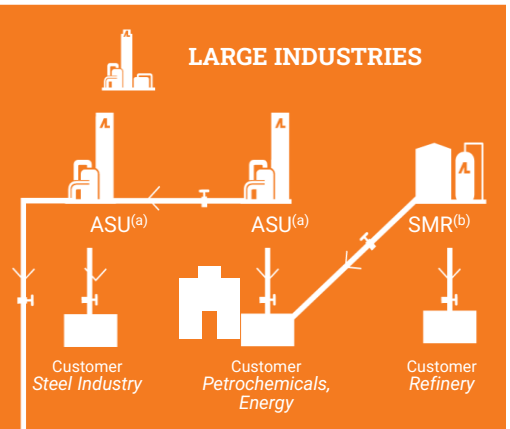
NET PROFIT
(GROUP SHARE)
€3.1bn



INVESTMENT
DECISIONS
~€4.3bn

All Air Liquide business lines are active in the Benelux

Hydrogen to Industry and mobility



We have solutions and make it h

60

YEARS OF EXPERTISE

>1,000

EMPLOYEES IN HYDROGEN

€2.2bn

ANNUAL SALES

1.2 Mt

ANNUAL PRODUCTION

~250

STATIONS DELIVERED

~2,000

KM OF PIPELINES

12 FARES.
1.25 MILES TRAVELED.
0 GRAM OF CO₂.

POWERED BY HYDROGEN, THIS CAB EMITS 0 GRAM OF CO₂ AS IT TRAVELS AND ONLY PRODUCES WATER.

As a molecule of the future that can replace fossil fuels, hydrogen helps reduce the CO₂ emissions of road transport. With its refueling time of less than 5 minutes and its impressive range, it is ideally suited for the short and medium distances that require frequent refueling. The distribution of our hydrogen stations, Air Liquide drives an all-in technical and industrial approach to develop and multiply that benefits the planet.

Air Liquide

312 STOPS.
1.25 MILES TRAVELED.
0 GRAM OF CO₂.

POWERED BY HYDROGEN, THIS BUS EMITS 0 GRAM OF CO₂ AS IT TRAVELS AND ONLY PRODUCES WATER.

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Air Liquide

500 PASSENGERS.
170 NAUTICAL MILES TRAVELED.
AND 0 GRAM OF CO₂ TOMORROW.

TOMORROW, THIS HYDROGEN-POWERED FERRY WILL EMIT 0 GRAM OF CO₂ AS IT TRAVELS AND ONLY PRODUCES WATER.

Hydrogen is a molecule of the future that can replace fossil fuels and help reduce the CO₂ emissions of air transport. From the production to the distribution of hydrogen stations, Air Liquide drives an all-in technical and industrial approach to develop and multiply that benefits the planet.

Air Liquide

150 PACKAGES DELIVERED.
42 MILES TRAVELED.
0 GRAM OF CO₂.

POWERED BY HYDROGEN, THIS DELIVERY TRUCK EMITS 0 GRAM OF CO₂ AS IT TRAVELS AND ONLY PRODUCES WATER.

As a molecule of the future that can replace fossil fuels, hydrogen helps reduce the CO₂ emissions of road transport. With its refueling time of less than 5 minutes and its impressive range, it is ideally suited for the short and medium distances that require frequent refueling. The distribution of our hydrogen stations, Air Liquide drives an all-in technical and industrial approach to develop and multiply that benefits the planet.

Air Liquide

40 TONS.
370 MILES TRAVELED.
0 GRAM OF CO₂.

POWERED BY HYDROGEN, THIS TRUCK EMITS 0 GRAM OF CO₂ AS IT TRAVELS AND ONLY PRODUCES WATER.

As a molecule of the future that can replace fossil fuels, hydrogen helps reduce the CO₂ emissions of road transport. With its refueling time of 12 minutes and its impressive range, it is ideally suited for the short and medium distances that require frequent refueling. The distribution of our hydrogen stations, Air Liquide drives an all-in technical and industrial approach to develop and multiply that benefits the planet.

Air Liquide

A 92-MINUTE FLIGHT.
517 MILES TRAVELED.
AND 0 GRAM OF CO₂ TOMORROW.

TOMORROW, THIS HYDROGEN-POWERED PLANE WILL EMIT 0 GRAM OF CO₂ AS IT TRAVELS.

Hydrogen is a molecule of the future that can replace fossil fuels and help reduce the CO₂ emissions of air transport. From the production to the distribution of hydrogen stations, Air Liquide drives an all-in technical and industrial approach to develop and multiply that benefits the planet.

Air Liquide

Conclusion: Air Liquide thinks BIG and has a very strong ambition in hydrogen. We are ready to go!

By 2030^(a)

~€8bn

INVESTMENT DECISION

Before 2035

>3x

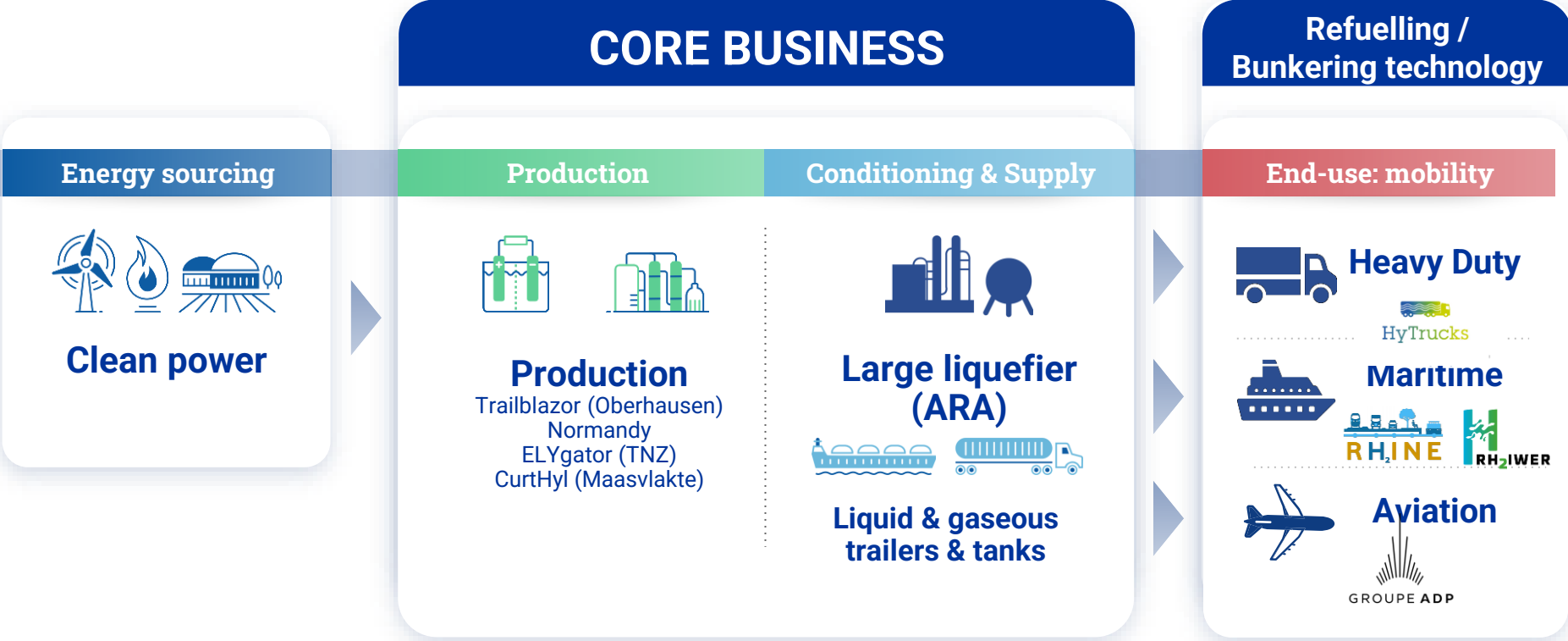
SALES

3 GW

ELECTROLYSIS

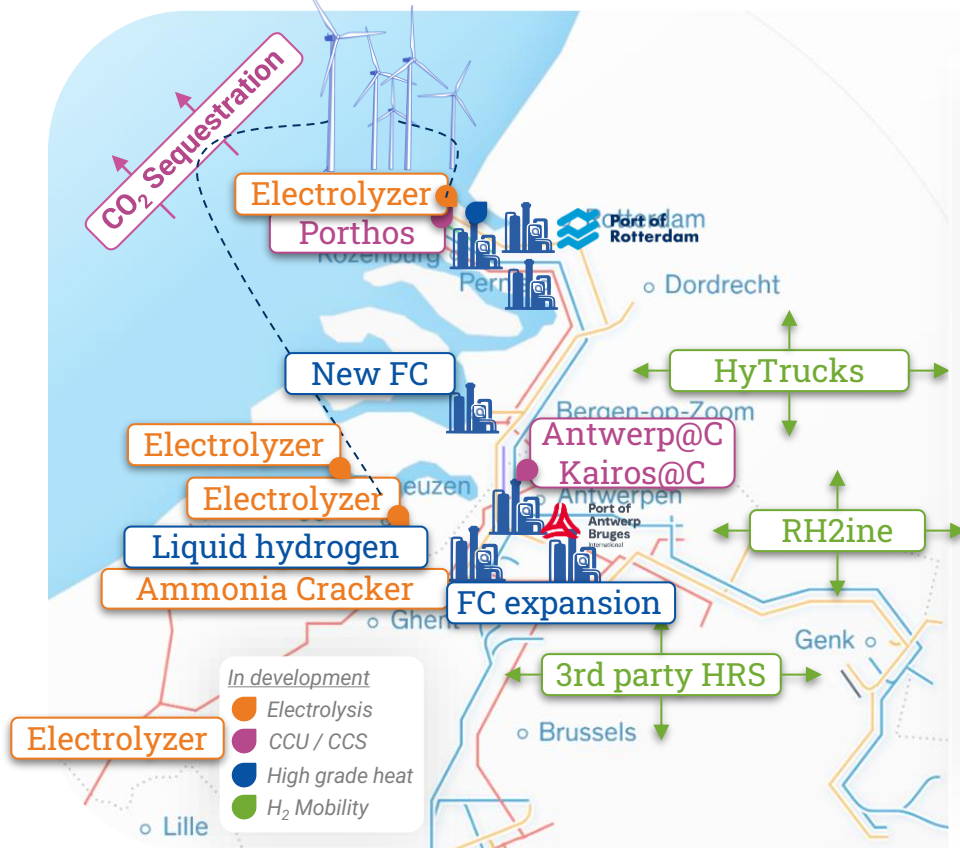


Air Liquide's hydrogen expertise



The Benelux, an example of Air Liquide's hydrogen strategy.....

Focus on key basins to pursue a sustainable development



A favourable ecosystem

- Strong **renewable energy** potential from sea
- Major European **industrial & transportation hub**
- Strong **national & EU support**

Large Air Liquide footprint

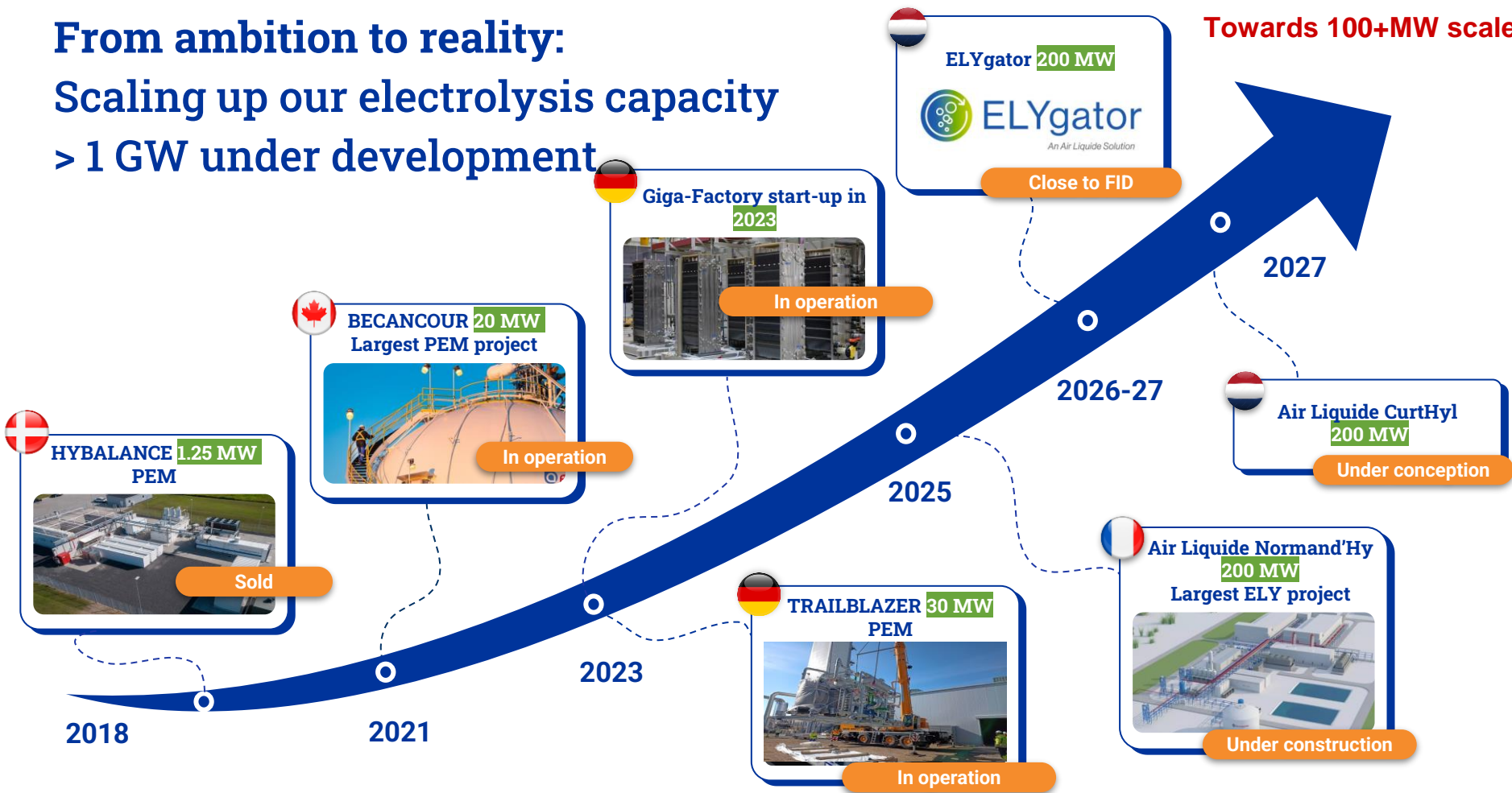
- 7 world scale H₂ production units today
- >900km H₂ Pipeline in the BNL
- >60 customer industrial sites supplied
- **Large scale filling capacities available**

Air Liquide very involved in flagship projects



From ambition to reality: Scaling up our electrolysis capacity > 1 GW under development

Towards 100+MW scale



Air Liquide, a world leader in liquid hydrogen

Decades of expertise

First steps in liquid hydrogen

- Space industry
- Large Science projects (ITER, CERN...)
- Many liquefier references
- Turbo-Brayton technology for LNG



1960'

30 tonnes per day
Nevada

Air Liquide's largest liquid hydrogen production facility for the mobility market



2022

90 tonnes per day

South Korea



2025

115 tonnes per day

Under design

>700

liquid H2 tanks for Ariane with a 0 failure rate

800

ratio volume GH2/LH2

5

liquefaction centers

Mastery of the entire LH2 value chain



Our hydrogen mobility partnership strategy

→ *You can't do it alone*



Accelerating hydrogen road mobility

Partnerships with retailers in



Partnerships with automotive players



Activating hydrogen aviation, maritime and rail

Partnerships with industry leaders
First commercial projects



A leader in the hydrogen ecosystem

Advocacy: Hydrogen Council
Financing: First dedicated hydrogen infrastructure fund
Market activation through startups & innovative business models



Air Liquide



The World Leader in hydrogen mobility

Decarbonisation of the Maritime and Inland Water Transport (IWT) Why?



- > **90% of goods traded are shipped over water**
- > **on average 1500 kg of goods per person worldwide (150 kg CO₂/y/person)**
- > **total of 3% of CO₂ emission comes from maritime sector, and this is expected to grow (17% by 2050 if no action)**
- > **Maritime target (IMO): 0 emission by 2050 (TBC 2023)**
- > **need to start now as vessel lifetime is 25y (barges up to +40y with propulsion replacement every 10-15y)**

Regulation for CO2 emissions in shipping in Europe









- **FuelEU Maritime:** Reduces GHG intensity of fuels by 2% in 2025, 60% in 2030, 80% in 2050.
- **EU ETS: Includes maritime transport from 2024,** requiring shipping companies to purchase EU ETS allowances for CO2 emissions.
- **Onshore Power Supply (OPS):** Mandates use of OPS or zero-emission technologies in EU ports from 2030.

IMO Regulations for CO2 Reduction in Shipping



- **Goal:** Net-zero GHG emissions by or around 2050
 - Indicative checkpoints: 20% reduction by 2030, 70% reduction by 2040
- **Current Measures:** EEXI, CII
- **Developing Measures:** Basket of measures (technical, operational, market-based)

Hydrogen : a long-term winner for short and mid sea. What about IWT?

	 Biodiesel (HVO)	 LNG (fossil and bio)	 Ammonia (E- and blue-)	 Hydrogen (green- & blue-)	 E-methanol	 Battery Electric
Short sea			Not suitable	2nd to battery, but better due to high autonomy	High energy loss vs. H2 and battery	Cheapest option, no energy loss, but limited autonomy
Mid sea	Solution in short-run. Availability and CO2 content problems in long run	Solution in short-run. Availability and CO2 content problems in long run	Not suitable	Zero-emissions T-t-W. Requires liquid H2	CCS required for truly zero emission T-t-W	Capacity limit
Deep sea			Carbon-neutral, scalable	Very large tanks needed, difficult to manage	CO2 availability problematic in long-run	Capacity limit

Benefits of hydrogen as a fuel

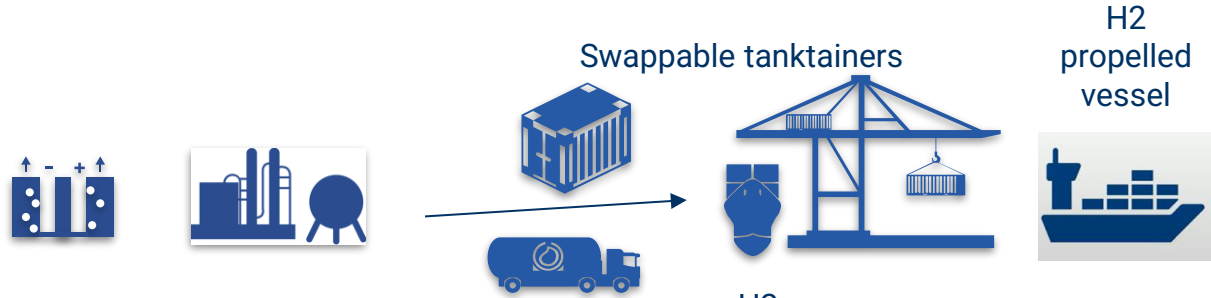
- Truly zero-emission
- Cost-competitive with other synthetic fuels
- Demonstrated technology
- Available already today with LH2/GH2 in containers, trailers and road tankers

Hydrogen bunkering in maritime and inland shipping.

Solutions:

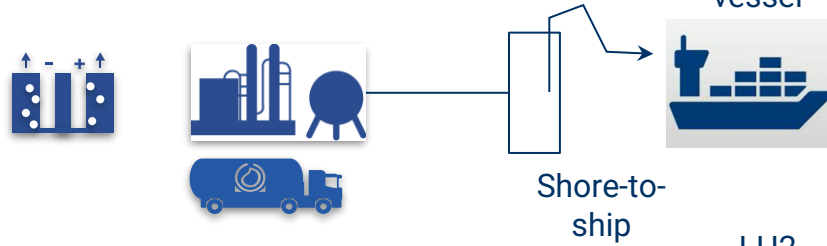
Option 1:

Swappable containers



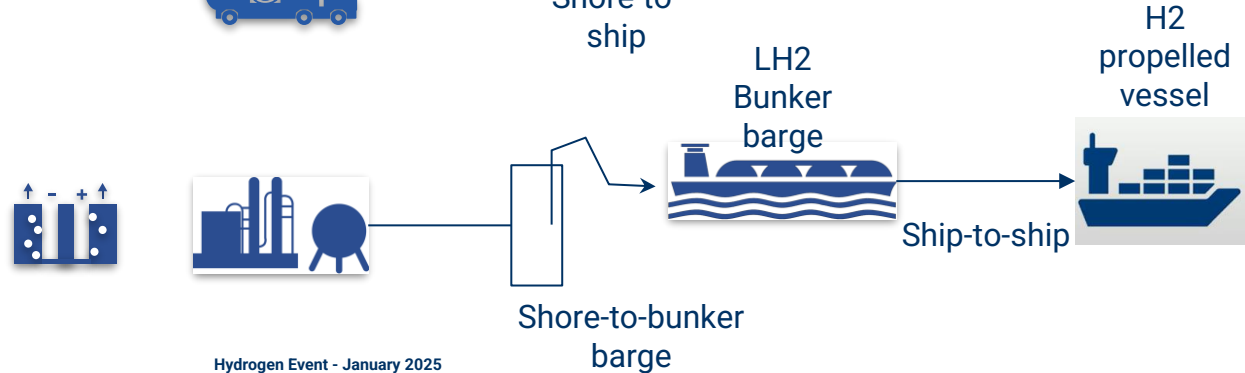
Option 2:

Shore-to-ship, w/o intermediate buffer



Option 3:

Refueling barge, ship-to-ship



Swappable containers 2kt/y of CO2

Avoided for each vessel



- Retrofit, 200 TEU
- 3x 275 kW FC (Nedstack)
- GH2 40ft container 300b
- 500-1000 kg every 2d (150 km?)
- AL: development of containers / fuel tank, supply GH2 to quay, LT supply agreement , more barges following

H2 Barge 1 & H2 Barge 2

Future Proof Shipping

Scaling up hydrogen-powered inland navigation



- Air Liquide and Future Proof Shipping (FPS), a provider of zero-emission shipping solutions, have successfully commissioned two hydrogen-powered container ships to sail on the Rhine-Delta.
- **World premiere !** This concrete implementation paves the way for the acceleration of the decarbonisation of inland waterways
- The solution can be **easily replicated** to other ships, trains and other applications.

>150

H2-powered ships sailing on the Rhine by 2030

In the Rhine-Alpine corridor

450

H2 tons/week for the consortium

≈300.000
t/y of CO2

RH2ine Consortium and Short sea



Decarbonizing shipping industry in Europe

Rh2ine is a consortium of shipping companies, technology manufacturers and port authorities aiming to gradually **replace the diesel currently used for shipping with hydrogen.**

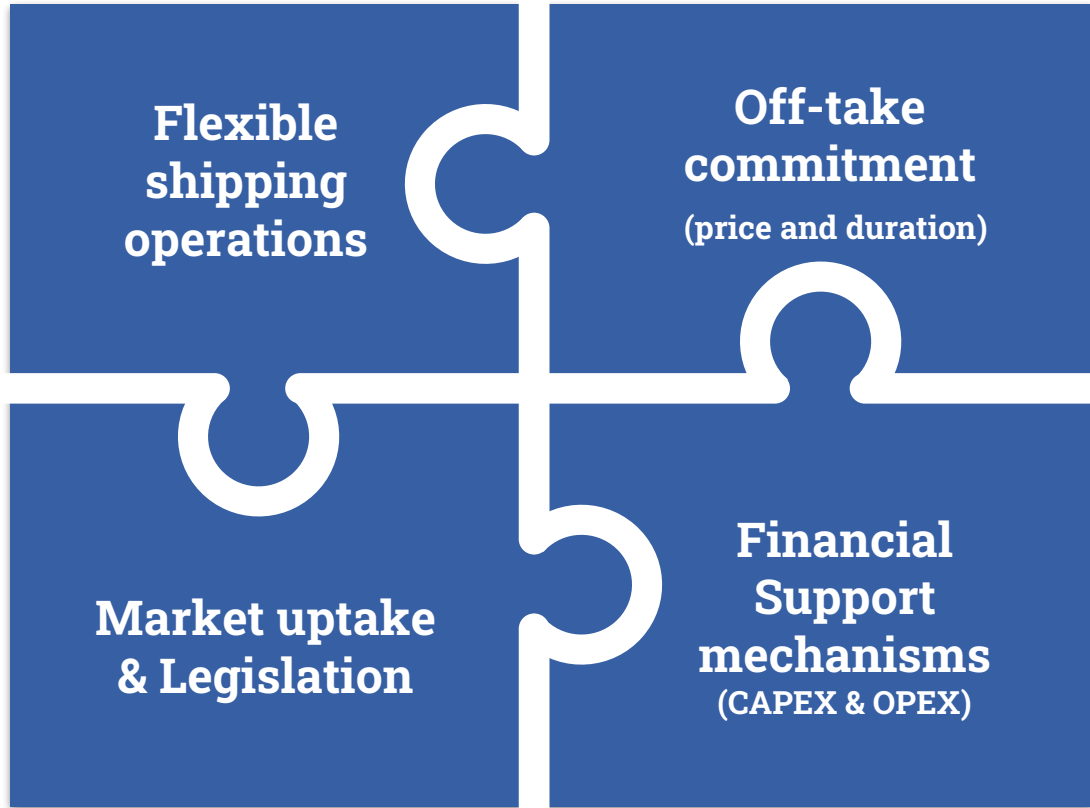
- **+20-years** heritage developing hydrogen as an energy source, particularly for the HD mobility market (IWT).
- Air Liquide is the **supplier of hydrogen and as the developer of the technology to allow refuelling or tank swapping** to optimise the refuelling process time.
- RH2INE develops **synergies between energy and transport networks in and around ports, along the full value chain** of H₂ production, distribution and use.



HD Port equipment



Key enablers to activate hydrogen fuel supply



AL ready to invest and looking for anchor customers



Thank you for your attention

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