We show the world it is possible

Agenda

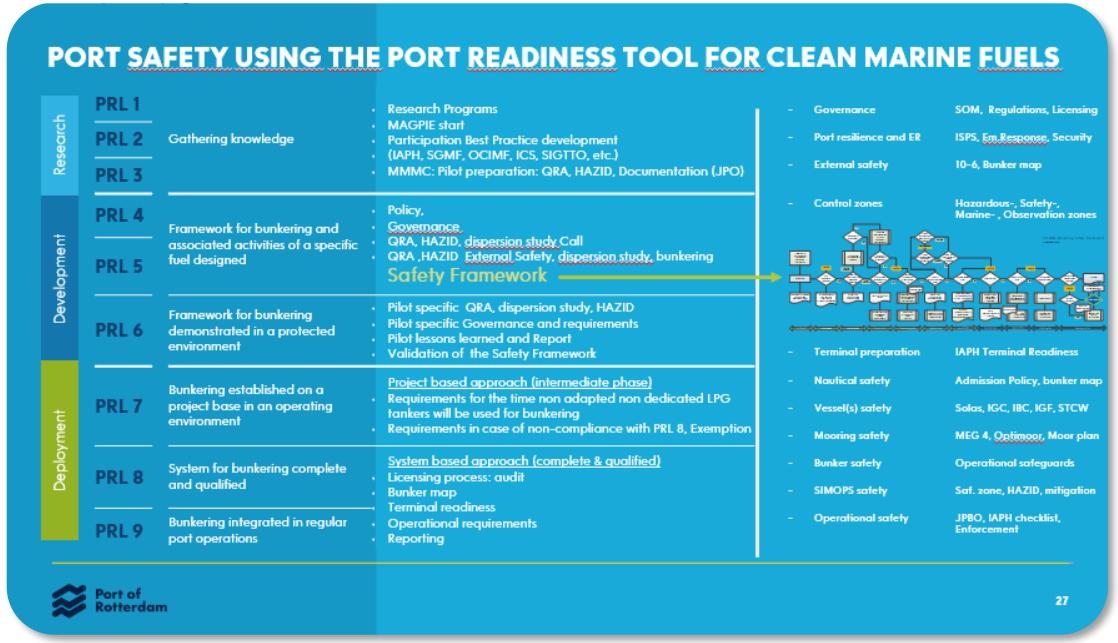
01 Background
02 The Ammonia Bunkering Demonstration Report

03 The Ammonia Bunkering Pilot, lesson learned and recommendations
04 Concluding remarks
05 Q&A

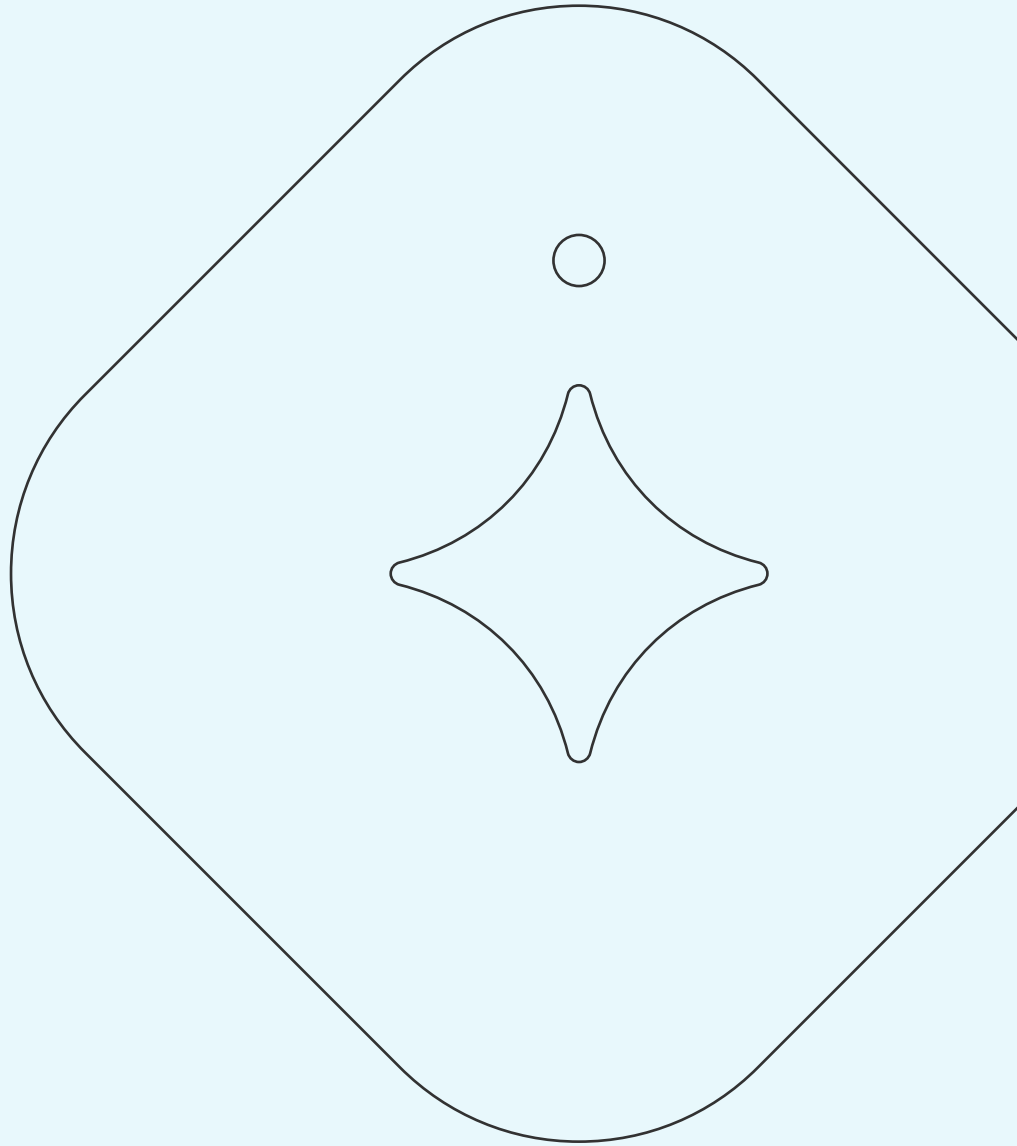
Background

European Commission

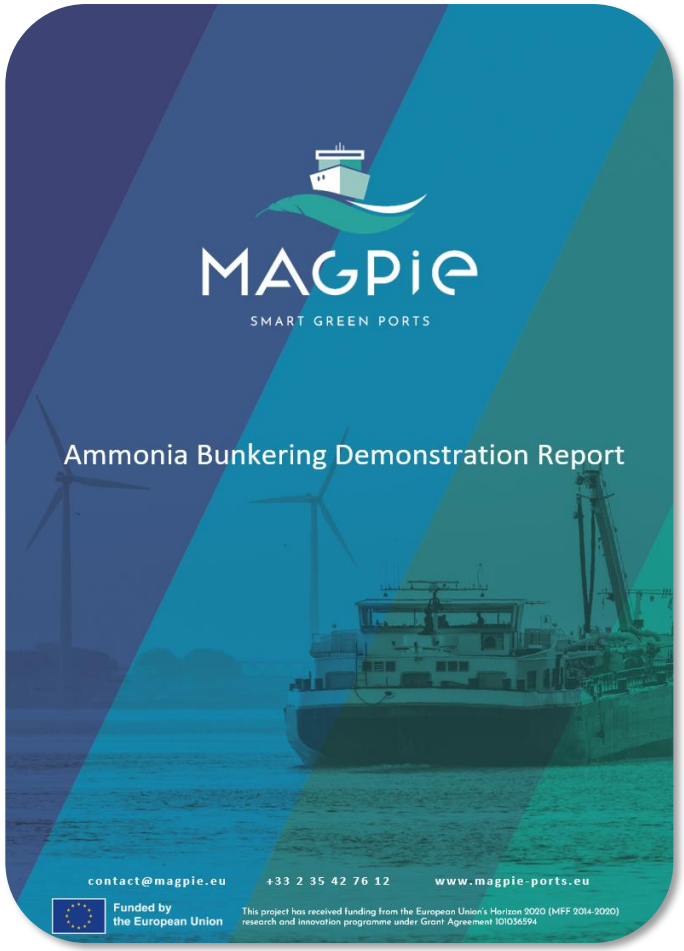
- Horizon 2020 call, Green Deal
- Doel: **Demonstrate** technical, operational, and procedural energy supply and digital solutions in a living lab environment to **stimulate green, smart and integrated multimodal transport** and **ensure roll-out** through the European Green Port of the Future Master Plan and dissemination and exploitation activities.
- Focus: **research & innovation**
- Partners: **45**
  - Lighthouse port: Rotterdam
  - Fellow ports: Sines (Portugal), Haropa (Frankrijk), Deltaport (Duitsland)
  - Overig: 9 kennisinstellingen, 4 belangenverenigingen, 32 commerciële partijen
- Subsidie: **EUR 25 mln**
- Selected Green Ports: MAGPIE / PIONEERS

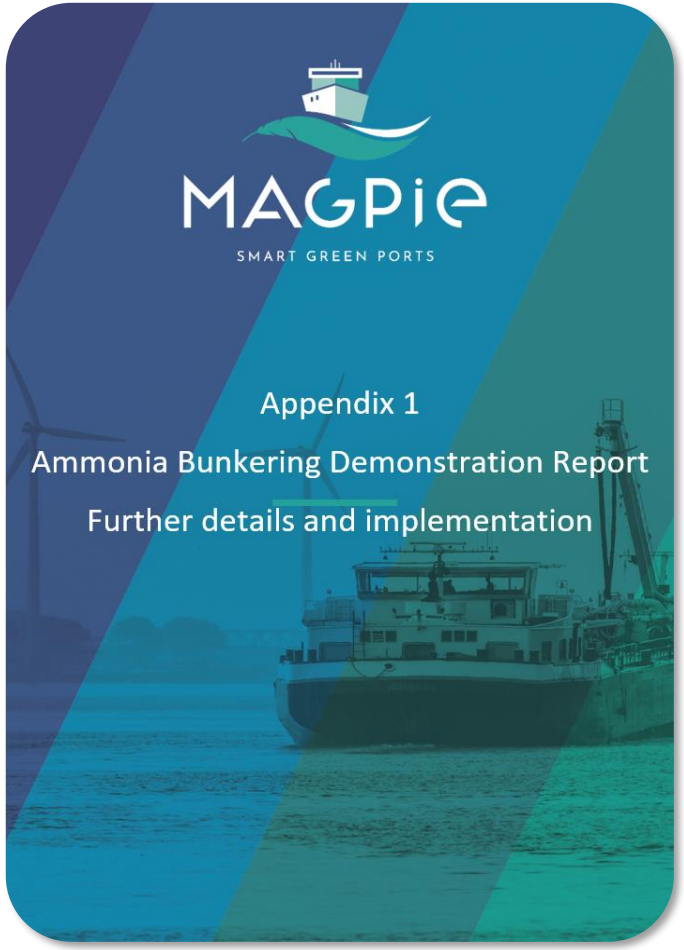


The Ammonia Bunkering Demonstration Report



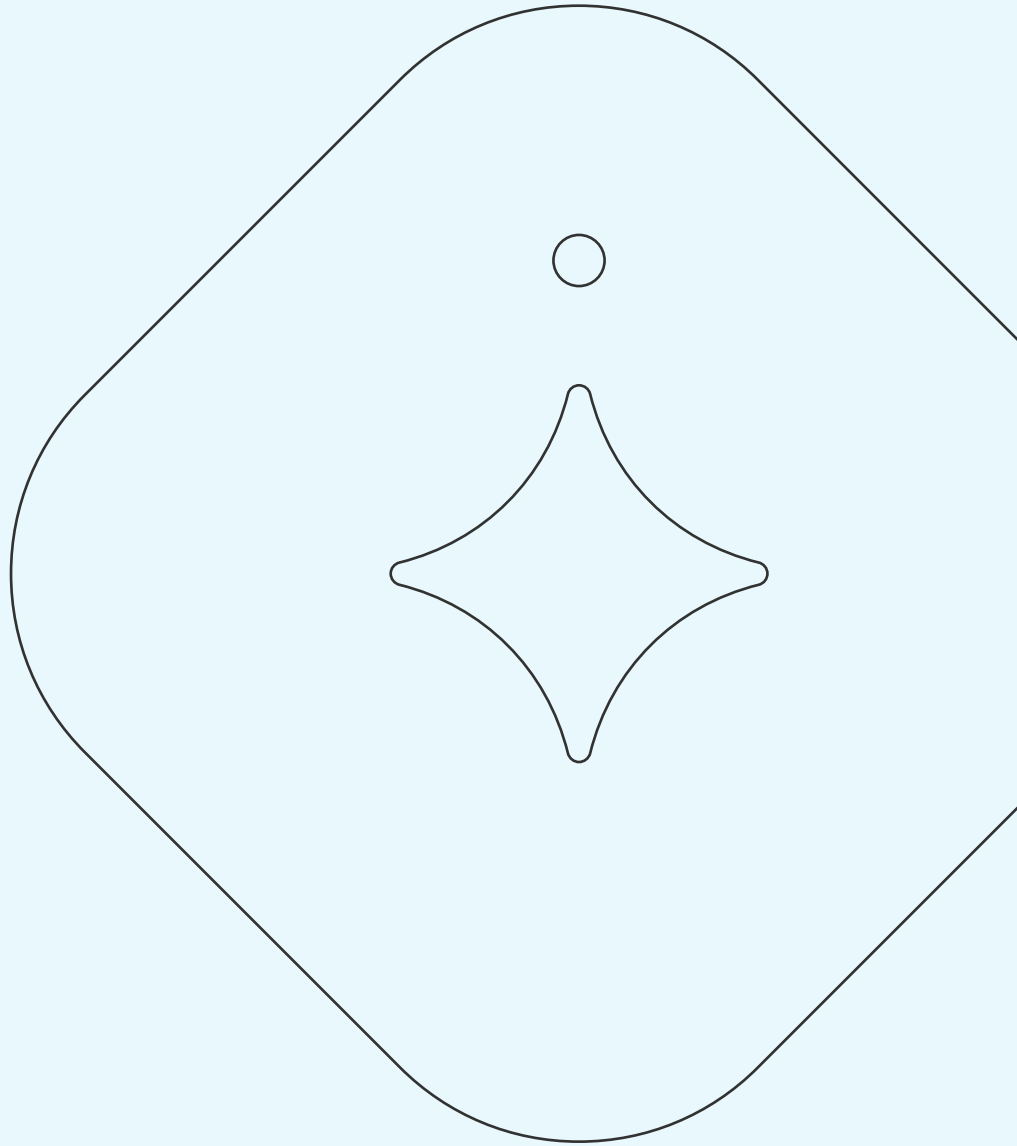
Ammonia Bunkering Demonstration Report launched this May





Download the report on **www.magpie-ports.eu/**

The bunkering pilot, lesson learned and recommendations



Video: Port of Rotterdam takes next step with successful ammonia bunkering pilot

Click here to watch on YouTube

AMMONIA BUNKER PILOT

Pilot successfully executed on the 12th of April with several partners as part of the EU funded MAGPIE project.

Requirements:

- Transfer of cold ammonia at -33 °C
- Transfer outside working hours
- Use & validation of international standards

Statistics:

- ~500 tonnes / ~800 m3 NH3 transferred
- 2.5 hours of transfer time

Important: Take community stakeholders along in the development to build a long-term sustainable environment

OCI

James Fisher Fendercare

Lifting Global Trade. APM TERMINALS

Trammo

VICTROL

Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping

MAGPIE SMART GREEN PORTS

Co-funded by the European Union

Port of Rotterdam

PROJECTED PORT READINESS FOR BUNKERING

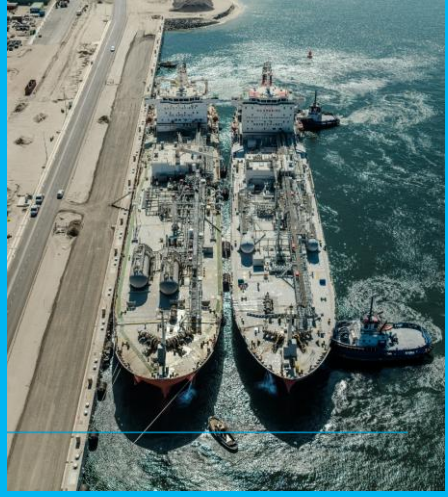
Port Readiness Level (PRL) for marine fuel

Research	**PRL 1**	Fuel relevance assessed
	PRL 2	Interest of port stakeholders determined
	PRL 3	Sufficient information gathered
Development	**PRL 4**	Policy for bunkering specific fuel decided, roadmap developed
	PRL 5	Framework for bunkering and associated activities of a specific fuel designed
	PRL 6	Framework for bunkering specific fuel demonstrated in a protected environment
Deployment	**PRL 7**	Bunkering of specific fuel established on a project base in an operating environment
	PRL 8	System for bunkering of specific fuel complete and qualified
	PRL 9	Bunkering of specific fuel integrated in regular port operations

Port of Rotterdam

AMBITION FOR AMMONIA: READY FOR NEW FUELS

When the market is ready



PROGNOSED START
FIRST BUNKERINGS

New Fuels

3	4	5	6	7	8
Sufficient information gathered	Policy decided	Framework designed	Framework demonstrated	Project basis	System complete & qualified

2023 2024 2025 2026 2027 2028 2029 2030

Port of Rotterdam

PORT BUNKERING SAFETY FRAMEWORK

Port of Rotterdam

SUMMARY OF THE WORK DONE

To reach due diligence in governance and safety for the ammonia bunkering

Due diligence in safety is if all 11 topics of the safety framework are fulfilled for a specifc bunker operation.
The required level of safety for the license to operate is achieved.

Research (PRL 1-3)
Participation in international research programs and development of best practice and tools and stakeholder interests assessed.

Development (PRL 4-6)
Specific PoR safety requirements for ammonia bunkering in the Port Bye Laws considered, stakeholder support and Safety Framework studies performed.

Deployment (PRL 7-9)
License to operate safely

Milestones over time

PRL 4 PRL 5 PRL 6

27-2-22 Port of Rotterdam signed MAGPIE consorium agreement

05-10-22 Maersk, Mc-Kinney Moller Center for Zero Carbon Shipping signed by MAGPIE

03-11-23 QRA Final Report from Haskoning DHV Nederland B.V. (TNO management)

30-01-24 QRA Final Report from Peutz (TNO management)

10-12-24 Report from DNV including (draft) ammonia bunker map (independent-ly) of MAGPIE

20-02-25 Port of Rotterdam Trial Specific Dispersion Study

Maart 25 Port of Rotterdam Trial specific HAZID/ HAZOP facilitated by DNV

12-04-25 Physical STS transfer of ammonia in port of Rotterdam (the trial)

May-June 25 Lessons learned and Validation workshops

Sept. 25 Ammonia bunkering preliminary lessons sharing workshop

Feb. 26 MAGPIE Demo 4 Final Report Issued

2022 2023 2024 2025 2026

Port of Rotterdam

LESSONS LEARNED

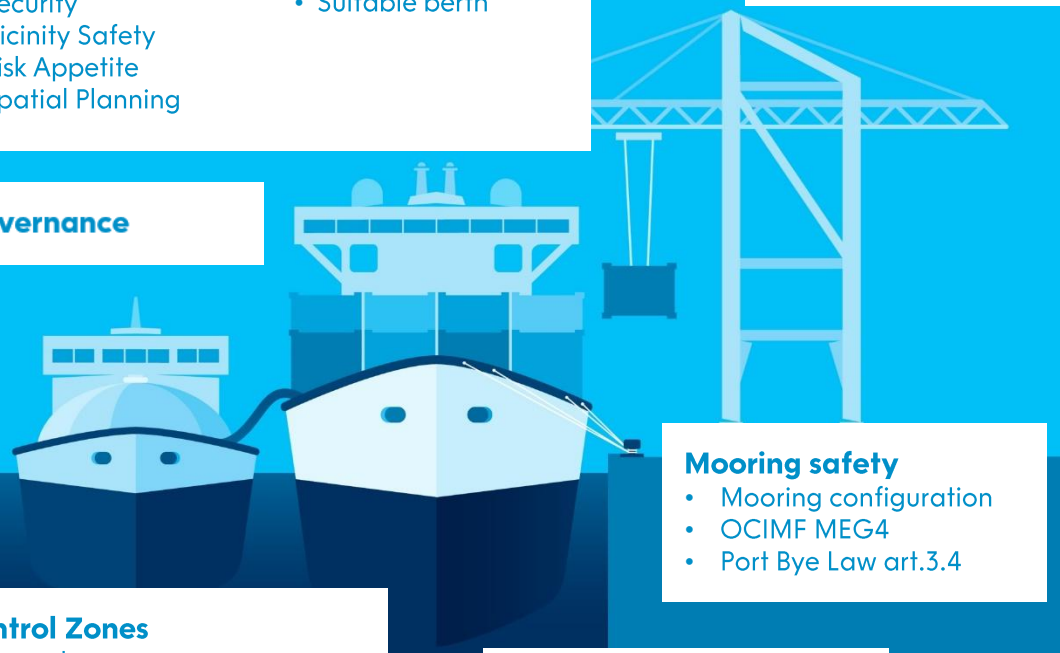
Ammonia bunker map:

External safety (QRA)
+ Incident response capability
+ Security
+ Vicinity Safety
+ Risk Appetite
+ Spatial Planning

Nautical safety
- Collision Risk study
- Reachable berth
- Suitable berth

Terminal readiness
Ammonia Ready Terminal based upon the IAPH Terminal Ready Methodology.

Governance



Mooring safety
- Mooring configuration
- OCIMF MEG4
- Port Bye Law art.3.4

Control Zones
- Hazardous zones
- Safety Zones – Dispersion study
- Monitoring Zones
- Marine Safety Zones
- Security Zones

Simultaneous Operations
SIMOPS safety must be assured Supplementary provisions art. 4

Port of Rotterdam

Additional port of Rotterdam restrictions

Mandatory equipment

Processes and operational plans

- Governance
- External Safety
- Vessel Safety
- Bunker Safety
- SIMOPS
- Mooring Safety
- Control zones
- Operational safety
- Terminal readiness
- Port Resilience
- Nautical Safety

LESSONS LEARNED

Port of Rotterdam additional restrictions

Governance

External Safety

Vessel Safety

Port of Rotterdam additional safety restrictions

- Cold bunkering (not pressurized)
- Large transfer rate bunkering with two lines (>1000m3/h)
- Zero Emission (After Release Mitigation System)
- Only emission by disconnecting (max 25 ppm)
- Spill containment (Knock out facility)
- No discharge of NH3 polluted water in the harbor water (contaminated water containment system)
- External supervisor operations PRL 7

Port of Rotterdam

PORT READINESS – NEXT STEPS

Pilot execution (pilot set up, level 6)

Ammonia bunkering pilot to develop and test the procedures. Preparation for the pilot includes **multiple safety studies and assessments.**

Executed 12th of April 2025
MAGPIE report published

Project base (intermediary solutions, level 7)

While the procedures and guidelines are available, but no dedicated solutions are ready, bunkering can be done **on project basis with an intermediary solution.**

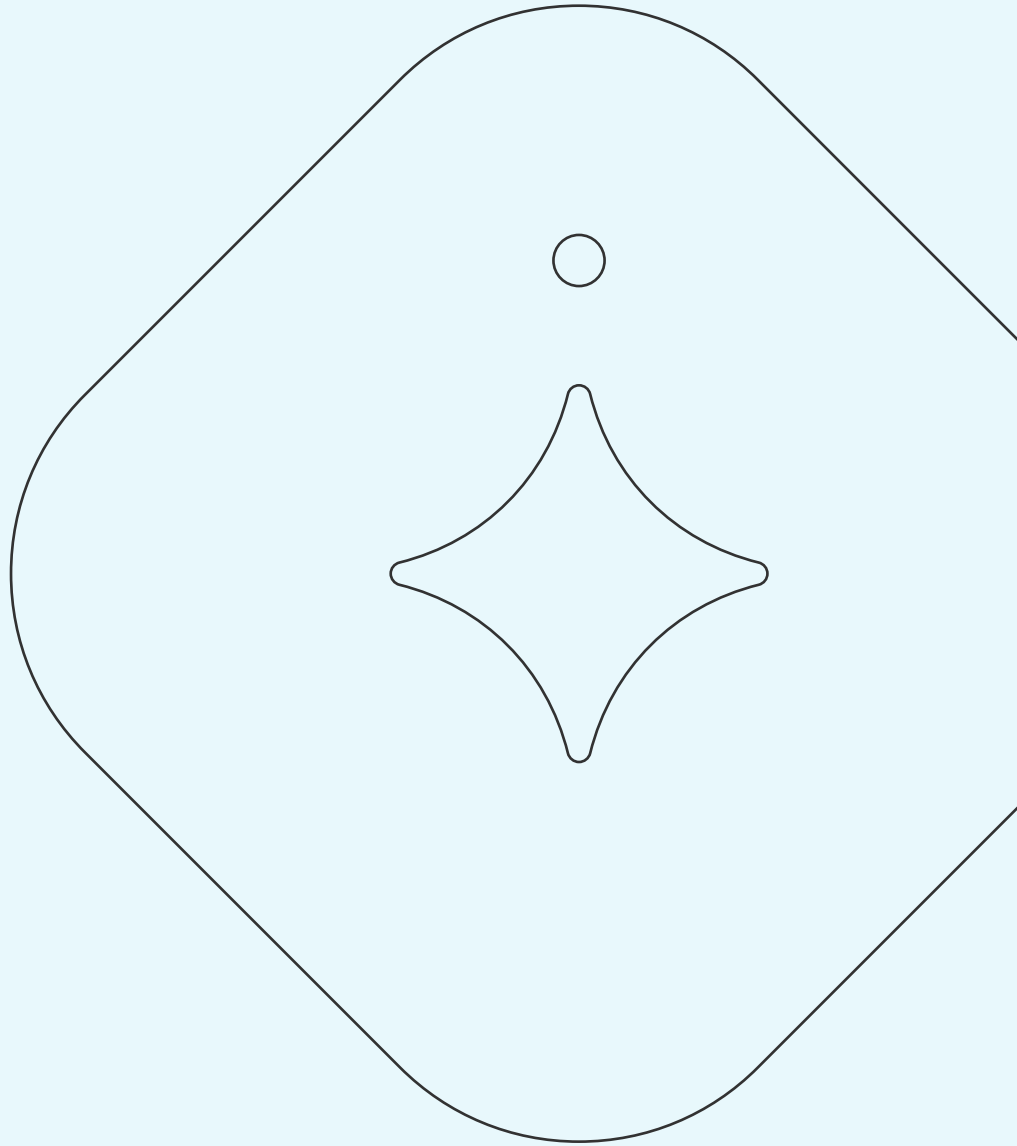
Possible in 2027

Complete & qualified (dedicated solutions, level 8/9)

Mature ecosystem with dedicated and licensed bunkering solutions, commercially available.

EU funding secured for bunkeroperator(s)

Concluding remarks

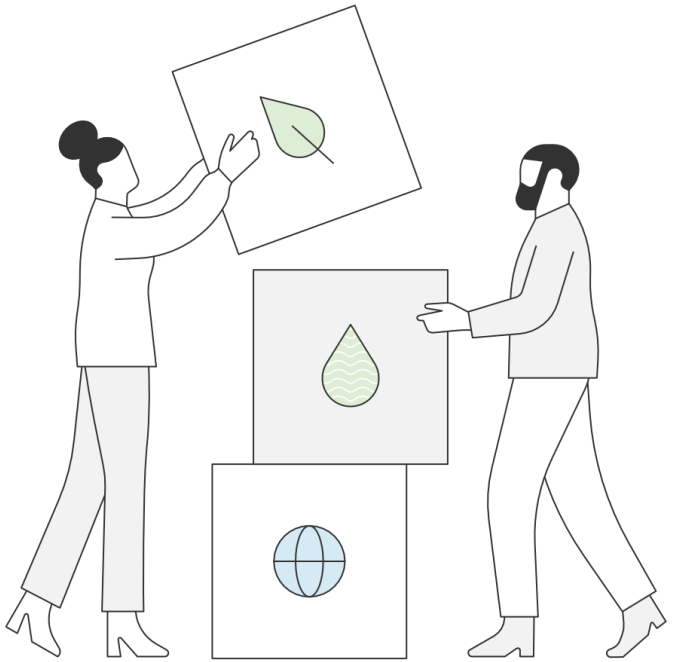


MAGPIE provides a blueprint for scaling ammonia bunkering globally

Test and validation of the Port of Rotterdam's port safety framework for ammonia as fuel.

The pilot demonstrated that the ship-to-ship transfer of ammonia within a port is feasible, it can be done safely & builds confidence

Multiple bunkering pilots have demonstrated ship-to-ship transfer of ammonia can be performed safely; learnings from all these pilots are needed to inform global port permitting and bunkering guidelines



Thank you for your attention – Q&A

Martin Eriksen

Head of Safety Leadership & Operations – Fleet Transition

Martin.Eriksen@zerocarbonshipping.com

Françoise van den Brink

Strategic Lead Energy Transition, Harbormaster Division, Port of Rotterdam

f.brink@portofrotterdam.com