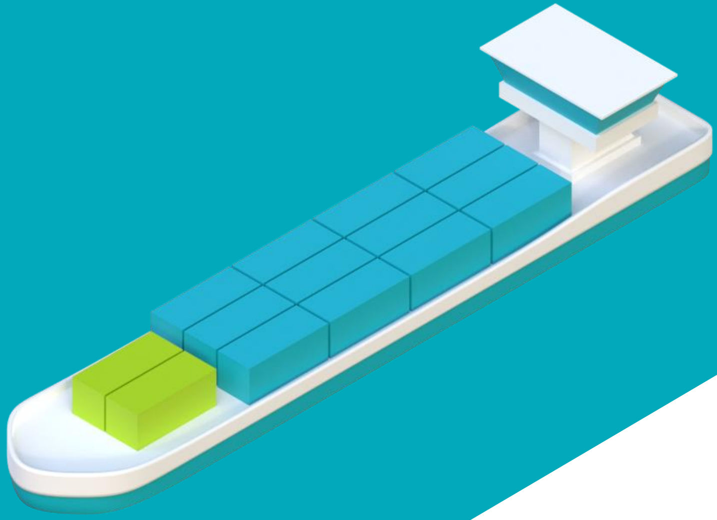
Towards a Zero Emission Shipping sector!



Innovation Fund InfoDay

ECSA, DG CLIMA, CINEA, CLIA, ESPO, Waterborne Platform, Sea Europe and Feport

WaterstofNet

Rabobank

provincie Zuid-Holland

Port of Rotterdam

The EU Targets for transportation/ shipping

Condor H_2

- By 2030: zero-emission vessels will become ready for market
- By 2050: 90% reduction in the transport sector's emissions

"Air and waterborne transport have **greater decarbonisation challenges** in the next decades, due to current **lack of market ready zero-emission technologies, long development and life cycles** of aircraft and **vessels**, the required significant investments in refuelling equipment and infrastructure, and international competition in these sectors. EU international emissions from navigation and aviation have grown by more than 50% since 1990......These modes must have priority access to additional renewable and low-carbon liquid and gaseous fuels, since there is a lack of suitable alternative powertrains in the short term."

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The Inland Shipping sector

Numbers of ships and age

TABLE 1: **SIZE OF FLEETS** (NUMBER OF INLAND VESSELS) **PER MACRO-REGION AND VESSEL TYPE IN EUROPE**

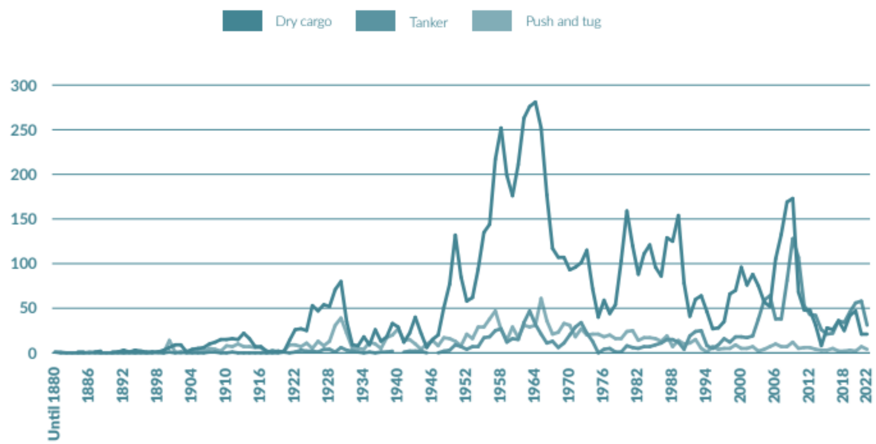
	Dry cargo vessels	Liquid cargo vessels	Push and tug boats	Total
RHINE FLEET	7,283	1,435	1,268	9,987
DANUBE FLEET *	2,652	204	642	3,498
TOTAL NUMBER OF VESSELS (RHINE AND DANUBE)	9,935	1,639	1,910	13,484
OTHER COUNTRIES **	951 (dry and liquid cargo combined)		266	1,217
Total	12,525 (dry and liquid cargo combined)		2,176	14,701

Sources: 1) Rhine countries: VNF (France), CBS/Rijkswaterstaat (Netherlands), ITB (Belgium), German Waterways and Shipping Administration (WSV), national fleet register of Luxembourg, Swiss Waterway Administration. 2) Danube countries: Danube Commission. 3) Other countries: Eurostat [iww_eq_loadcap], [iww_eq_age], Ministry of Transport of the Czech Republic, Statistics Poland, Statistics Lithuania. For push and tugs: Eurostat [iww_eq_age].

** Data for 2017*

*** Other countries = Poland, Czech Republic, Italy, Finland, Lithuania*

FIGURE 12: **COMMISSIONING YEARS FOR THE RHINE FLEET OVER TIME** (NUMBER OF INLAND VESSELS)



Sources: IVR, CCNR analysis
Note that 121 dry cargo vessels and 15 push and tug vessels have an unknown year of construction. Furthermore, 235 additional tanker vessels, 1,750 dry cargo vessels and 500 push and tug vessels are recorded in the IVR database as being registered in countries other than Rhine countries.

[CCNR_annual_report_EN_2023_WEB-1.pdf (inland-navigation-market.org)]

The Inland Shipping sector

Rate of yearly fleet renewal

TABLE 1: **SIZE OF FLEETS** (NUMBER OF INLAND VESSELS) **PER MACRO-REGION AND VESSEL TYPE IN EUROPE**

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** Data for 2017*
*** Other countries = Poland, Czech Republic, Italy, Finland, Lithuania*

TABLE 3: **NEWLY BUILT DRY CARGO VESSELS ACCORDING TO LOADING CAPACITY**

	0 < 1,000 t	1,000 - 2,000 t	2,000 - 3,000 t	3,000 - 4,000 t	> 4,000 t	
2017	5	6	7	16	2	36
2018	4	4	8	6	3	25
2019	4	7	12	13	6	42
2020	17	7	8	14	1	47
2021	5	0	3	11	2	21
2022	1	5	8	7	0	21

Source: IVR
Note that in 2022, for five newly built vessels the deadweight was partly estimated due to initially missing values. Estimations were also made in the previous years.

TABLE 5: **NEWLY BUILT TANKER VESSELS ACCORDING TO LOADING CAPACITY**

	0 < 1,000 t	1,000 - 2,000 t	2,000 - 3,000 t	3,000 - 4,000 t	> 4,000 t		Total:
2017	1	14	14	2	5	36	72
2018	2	13	12	4	3	34	59
2019	1	16	16	3	10	46	88
2020	0	10	23	9	14	54	91
2021	0	14	19	13	12	58	79
2021	0	4	24	1	2	31	52

Sources: IVR, CCNR analysis
Note that in 2022 for four newly built vessels, the deadweight was partly estimated due to an initially missing value. Estimations were also made in the previous years.

Average: 73,5

[CCNR_annual_report_EN_2023_WEB-1.pdf (inland-navigation-market.org)]

The Inland Shipping sector

Transition to zero-emission

If:

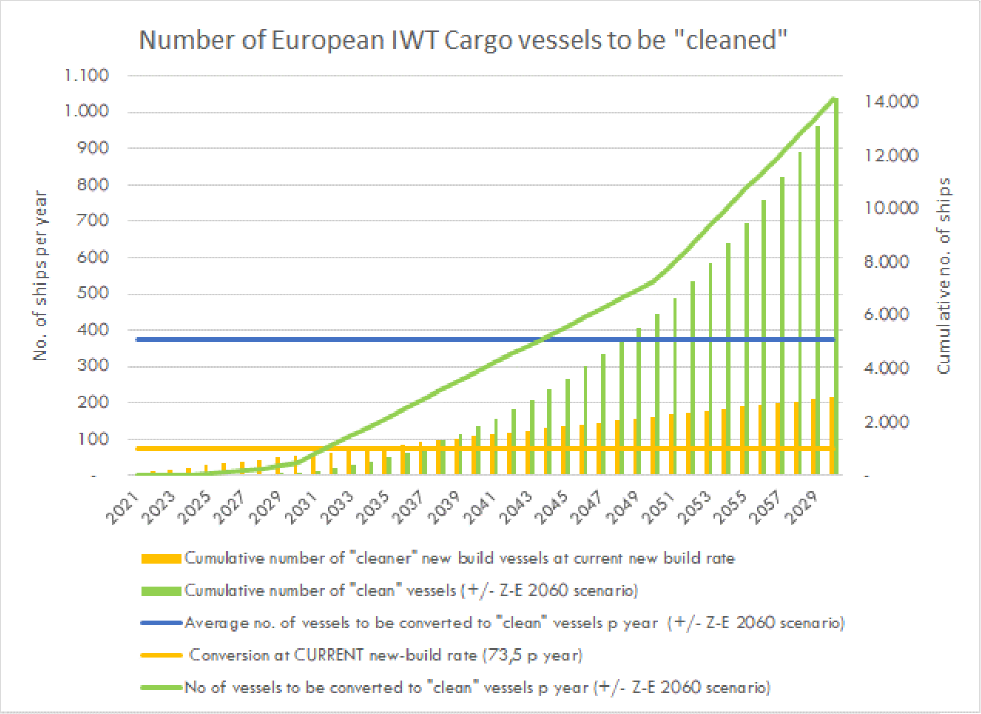
1. we would keep the current renewal rate

and

2. From now on ALL new ships would be built Zero-Emission

.........it would take over 150 years to make the inland shipping fleet zero-emission!

A serious breakthrough is required if we really want this sector to become zero-emission!



Zero-emission sailing is already possible, the second 100% H2 barge will be launched on

Comparison of Inland Shipping, Shortsea & Deepsea, which effect the path to Zero-Emission

Inland Shipping:

- +/- 15,000 EU ships
- Short routes with lowest propulsion capacity required.
- Lower energy requirements, battery solutions can cover part of the fleet.
- Always “near shore” and therefore more options for re-”fuelling”.
- Part of the fleet has fixed routes
- Zero-Emission solutions **technically available** for almost all ships and routes
- More “family businesses” just owning one ship
- Ship is often the “home” of shipowners/ captain, financed with mortgage
- Inland shipping is “a way of living”, especially for older generations

Shortsea Shipping:

- +/- 3000 EU ships
- Medium distance routes, medium propulsion capacity required.
- Medium energy needs makes energy storage more challenging
- Due to the trade the ship should be able to carry out a one-way route with a full “tank” which can be combined other efficiency solutions. Currently still challenging
- Zero-Emission solutions **technically available for selected ships** and routes
- Fewer “family businesses” just owning one ship, more companies own a considerable number of ships
- Typically, companies have more equity capital
- More “business like” approach

Deepsea Shipping:

- About 23,400 “EU28 controlled” ships
- Long routes, very high propulsion capacity required
- High energy needs, makes energy storage very challenging
- Real Zero-Emission solutions **not available yet,** though a lot can be achieved with efficiency measures
- Most companies own a fleet of ships.
- Typically, large 2nd party equity financing, very commercial approach

Comparison of Inland Shipping, Shortsea & Deepsea, which effect the path to Zero-Emission

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Inland Shipping:

- +/- 15,000 EU ships
- Short routes with lowest propulsion capacity required.
- Lower energy requirements, battery

mortgage

- Inland shipping is "a way of living", especially for older generations

Shortsea Shipping:

- +/- 3000 EU ships
- Medium distance routes, medium propulsion capacity required.
- Medium energy needs makes energy

considerable number of ships

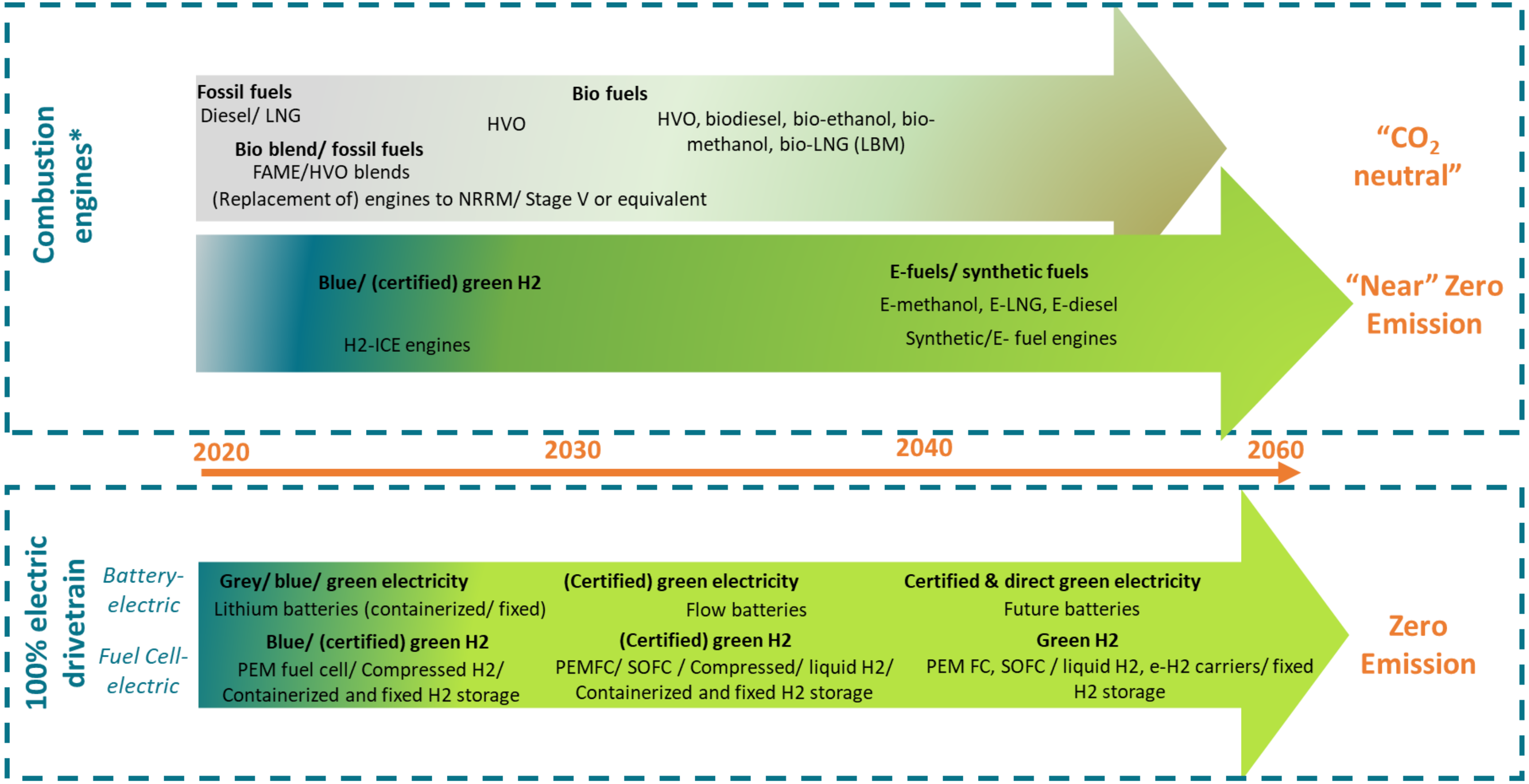
- Typically, companies have more equity capital
- More "business like" approach

Deepsea Shipping:

- About 23,400 "EU28 controlled" ships
- Long routes, very high propulsion capacity required
- High energy needs, makes energy storage

Zero Emission projects in Inland Shipping are required to prepare towards Zero-Emission in Shortsea and those learnings can help to move to zero-emission Deepsea shipping!

How to move to Shipping to zero-emission?



*High-capacity **shore power connections** can support the zero-emission transition*

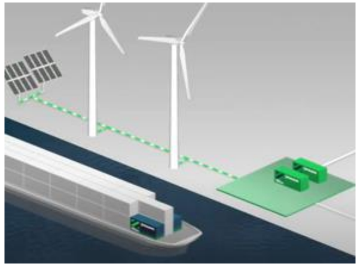
**combustion drivetrain or combustion engine feeding electric motor – figure based on EICB-format*

Zero Emission Services
A new energy concept for inland shipping

Swappable energycontainers

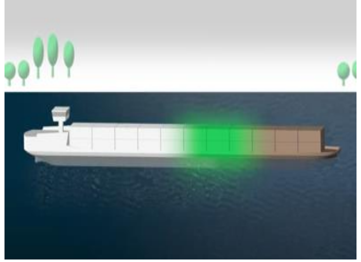
ZESpacks are future-proof, now with Lithium-ion batteries, ready to use other e-carriers to be changed with renewable energy.

Charging infrastructure



ZESpack Charging stations are connected to the grid and can support the grid loading/ balancing.

Pay per use paymentsystem



Shipowners pay for the use, no technology lock-in and lower investments for shipowners.

Battery container swapping and fixed infrastructure

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Why battery container swapping vs fixed batteries on ships?

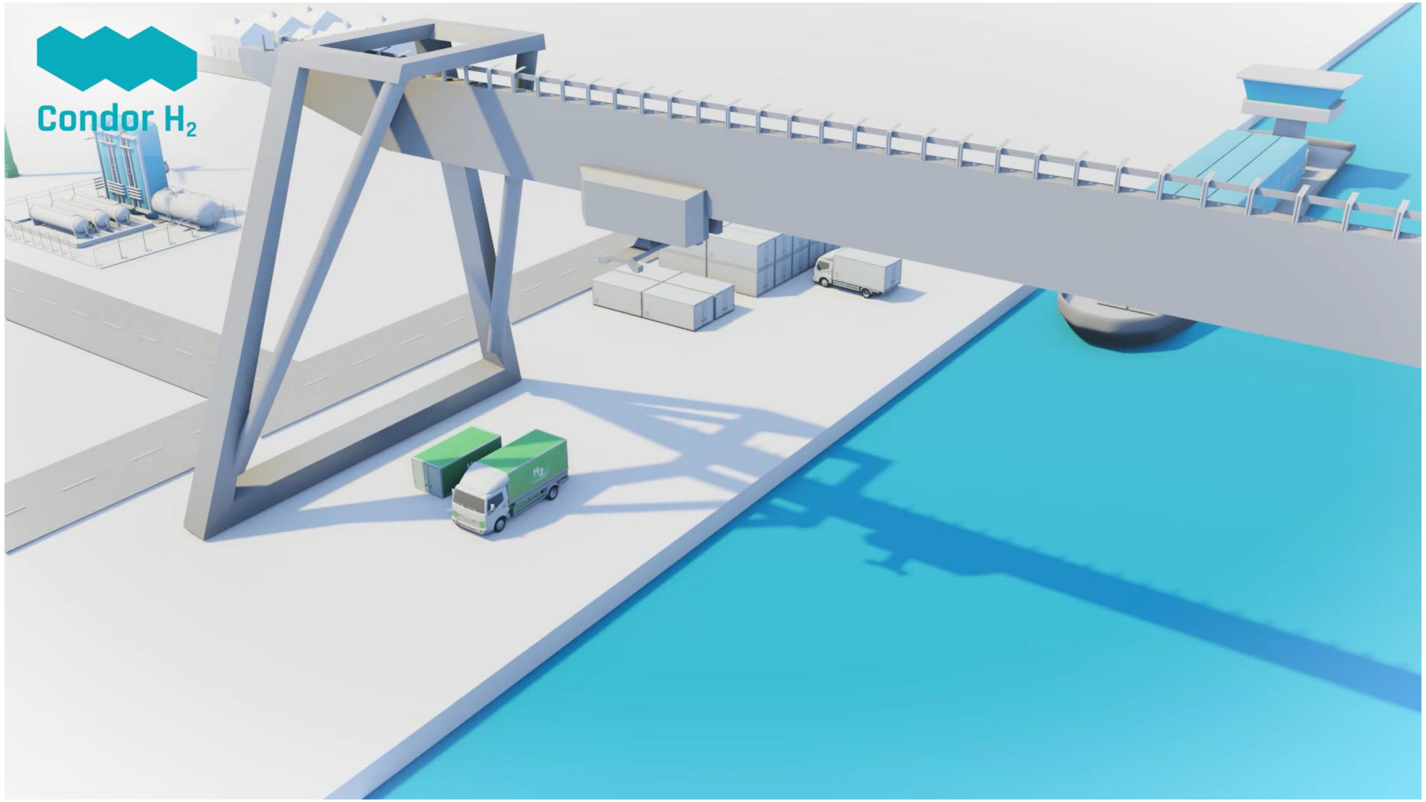
1. Charging a 1MW battery takes about 3 hours, most ships cannot wait for fixed battery to be loaded
2. Current state of the art can supply 3 MWh of energy in a 20ft container (= 90 km on calm water)
3. Short distance inland routes are often fixed and therefore easy to plan
4. Battery swapping allows for a “pay per use” concept, removing the largest investments from the shipowners
5. The battery containers have a triple potential “earning model”: grid balancing, electricity price dips and selling energy to shipowner.

Need for infrastructure:

- Charging locations are required in key sea and inland ports, at terminals with container lifting equipment
- High-capacity grid connection availability is crucial
- Ports can facilitate, but the companies on the shore-side need to co-invest and make space available. An attractive business case is required and still needs to be supported with subsidies until scale is achieved.
- For most ships high-capacity shore connections can help charging the fixed batteries while waiting

Sailing electric on batteries is the most energy-efficient way of sailing!

The current H_2 solution for inland/ near-shore shipping:



H2 tanktainer swapping and infrastructure

Condor H_2

Why "tanktainer swapping" versus fixed tanks on ships and direct "filling"?

1. Fixt filling of high quantities of H2 to floating equipment is not approved yet for safety reasons.
2. Filling a 20ft tank with about 400kg of compressed H2 at 300bar still takes about 4-6 hours. Many ships do not have the time to wait.
3. A fixed filling station would need to be linked to a H2 pipeline. The number of H2 pipelines is still limited, and current pipelines have grey H2 (higher emissions than diesel and needs to be filtered for PEM fuel cell).
4. Investment in a fixed filling station at a terminal is costly per location, especially if it involves connection to a pipeline, companies are not willing to invest until scale is achieved.
5. Besides a few key locations (hubs in large ports) the required locations are not known yet.
6. Swapping a tanktainer is allowed at almost all terminals with a "dangerous goods permit", this provides operational flexibility.
7. Swapping tanks and trucking them to H2 suppliers allows the system to grow flexibly when the number of H2 supplier filling locations is slowly increasing.

Need for infrastructure:

- Some terminals may need to add dedicated equipment to be able to handle the H2 tanktainers safely and offer a high services level.
- For many ships high-capacity shore connections can help charging the fixed batteries to reduce H2 usage!
- When higher numbers of ships are sailing and pipelines with green H2 are ready, creating in-port infrastructure will significantly reduce the total cost! (see BuCa slides)

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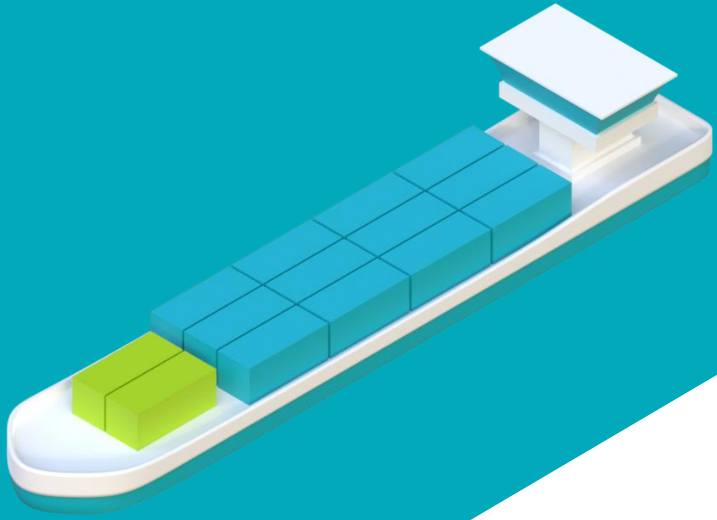
Hydrogen shipping

A RH_2INE zero-emission shipping project

Innovation Fund InfoDay

ECSA, DG CLIMA, CINEA, CLIA, ESPO, Waterborne Platform, Sea Europe and Feport



WaterstofNet

Rabobank

provincie Zuid-Holland

Port of Rotterdam

Rhine Hydrogen Integration Network of Excellence
RH_2INE -Participating regions and countries

Condor H_2

Selection of compressed- H2- FC-electric IWT projects- partly funded

	Project name	Vessel name	Vessel owner	Sailing Location	(Target) sai…		…e
1	SWIM	H2-Watertaxi	Watertaxi	Netherlands			…ew
2		Elektra	Imperial logistics	Germany			…n boat, new
3	ZEM ports, and other	H2 Barge 1 (Maas)	Future Proof Shipping	Neth…			110m dry cargo, retrofit
4	FCH- JU Flagships	FPS Waal	Future Proof Shipping			…el Cell	110m dry cargo, retrofit
5		Ab Initio	STC			C-H2, small Fuel Cell	Training vessel, small FC
6	WEVA	MS Antonie	Lenten BV			C-H2, Fuel Cell	135m dry cargo, new
7	FCH- JU Flagships	Zulu06	…		…/2024	C-H2, Fuel Cell	Tanker, New
8	German subsidy	new			Q4/2024	Hybrid, C-H2, Fuel Cell, ZES batteries	135m dry cargo, containers
9	RH2IWER			…erlands- Germany	Q4/2024	C-H2, Fuel Cell	135m dry cargo, retrofit
10	RH2IWER			Netherlands- Belgium	2025	C-H2, Fuel Cell	135m tanker, retrofit
11	R…			Belgium- Netherlands	2025	C-H2, Fuel Cell	110m dry cargo, new
12			…Fluvial de Transport	France	2025	C-H2, Fuel Cell	135m tanker, new
13			xxx				
14	R…		Future Proof Shipping	Netherlands- Germany	2026	C-H2, Fuel Cell	110m dry cargo, retrofit
15	MA…	…w	HTS	Netherlands	2025	Battery- C-H2, FC	110m dry cargo, retrofit
16	Germ…	new	RHENUS	Germany	2025?	Hybrid, C-H2, Fuel Cell, generators	Dry cargo
17		?	Tercofin	Belgium	?	C-H2	??

Plenty of demonstrators on its way!

How to make it scalable for the shipping sector?

Mission, vision & goal statements

Vision

Zero-emission shipping on hydrogen will be competitive before 2035. This is required to achieve near-zero emission inland shipping sector by 2050.

Mission

Condor H2 accelerates the transition to zero-emission shipping in inland and near-shore shipping with 5 to 10 years, by advancing collaboration between all essential parties across the value chain.

Goal

Remove major hurdles inland shipowners encounter when switching to hydrogen-electric ships before 2030 to achieve operational, technical and financial feasibility of zero-emission H2 ships before 2035.

How will we do this? by:

1.

Introducing **modular, standardised & scalable** solutions, electrification as "no-regret"

2.

Facilitating necessary **regulations** and **policies**

3.

Reducing and facilitating the necessary **investments for shipowners**

4.

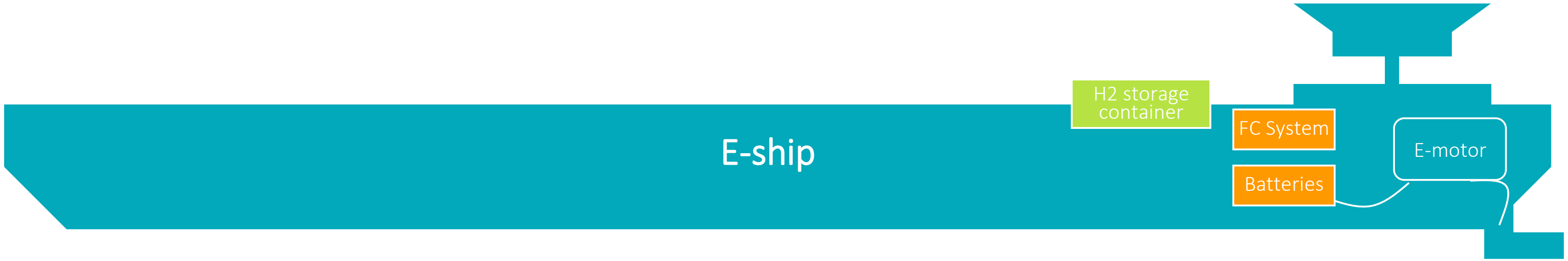
Facilitating an **open & flexible** hydrogen supply market for shipping

5.

Facilitate the creation of a market neutral **tanktainer pool**

6.

Supporting construction & retrofit of **50 ships** by 2030, inland and short-sea



Condor H2- full Project Scope

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Current focus

Supportive

Project management

WP1: Project building, stakeholder management & communication

- Project funding strategy & proposal writing
- Stakeholder management
- Communication & Dissemination
- Policy strategy and coordination
- Legal structures/ entities

WP2: Finance

- Economic impact, ToC & SCBA (MKBA), incl scenario's
- Funding plan, state aid
- Business cases of companies & ships
- Investment & financing plans assessment & support

WP3: Human capital

- Training & Education

WP4: H2 supply & logistics

- H2 supply network
- Storage regulation & standardisation
- Facilitate creation of H2 storage pool
- H_2 logistics, incl. data & digitalisation
- Contracting/ maintenance/ after sales services
- **Regulation & Standardisation**

WP5: On-board H2 technology

- Standardisation in
  - Fuel cell systems
  - Battery systems
  - H_2 distribution system
  - System integration & control
- Data & digitalisation/ maintenance
- **Regulation & Standardisation**

WP6: E-ship design

- Electrification
- Modular design, retrofit blueprints
- Preparation of vessels for H_2 technology

Inland Vessels:
Cargo/ push boats
(New / Retrofit)

Shortsea Vessels:
Cargo/ Ro-Ro
(New / Retrofit)

- **Regulation & Standardisation**

WP7: Market premium

- Emission reduction certification,
- Z-E Insetting
- Market development

Logistics Service providers

Cargo owners

Current Condor H2 consortium partners

Condor H₂

Group	Party
Bank/ investor	Rabobank
	KBC
Shipping	BCTN
	DFDS
	Future Proof Shipping
	HTS Maritiem
	NPRC
	Theo Pouw B.V.
	Verenigde Tankrederij
	Samskip
H2 suppliers	Air Liquide
	Air Products
	BP
	Engie
	EOLY/Virya/ VoltH2
	Inovyn
	Linde
	Roger Energy
	Shell
E-ship design/ build	Concordia Damen
	Holland Shipyards
	ERIKS
Fuel Cells	Ballard
	Nedstack
	Zepp Solutions

Group	Party
H2 tanktainers/ logistics	Argo Anleg
	Blue H Engineering
	Hexagon
	Cryovat
	H2storage BV
	Umoe
	VITRITE Middelburg
H2 logistics/ trade	Rotterdam Shortsea Terminal (RST)
	Schenk Tanktransport
	FinCo
Ports	Port of Antwerpen Brugge
	(Port) Nijmegen
	Port of Rotterdam
	Port of Amsterdam
	Port of Duisburg
	Northseaports
Other stakeholders	De Vlaamse Waterweg
	Provincie Zuid Holland
	Provincie Noord Holland
	Waterstofnet
	EICB
	STC
	Marin
	Maritime Academy Harlingen
	TNO
Total no. of parties	51

Budgeting full scope- 50 ships

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Hours

Project management &
work in WPs to remove hurdles
EUR 9M

CAPEX

Block 1: Tanktainers

H_2 storage tanktainer pool
- CAPEX- H_2 tank tanks
  - 20ft IWT
  - 40ft shortsea

+/-EUR 209M

Block 2: Energy conversion

H_2 On-board technology
- CAPEX on-board tech
  - Fuel Cells
  - Batteries
  - Integration

+/-EUR 88M

Block 3: Ship preparation

On-board fixed H_2-Electric
- Electric drive train
- Fixed H_2 technology
- Integration

+/-EUR 123M

+/- EUR 420M for 50 ships

Contribution market parties (contracts & Z-E premium)

Business case high level assumptions

1. Route Rotterdam – Duisburg
2. 110 meter, 200 TEU
3. Additional investments of the ship (H2-FC- electric) EUR 5 mln.
4. Tanktainers operated in a centralized pool
5. Additional OPEX costs for shipowner/ agent:
    1. Swapping, filling and rental costs tanktainers
    2. Hydrogen
    3. Maintenance
    4. Price of hydrogen reduces from €12 /kg to €5 /kg in 20 years, MGO/ Diesel price slowly increases

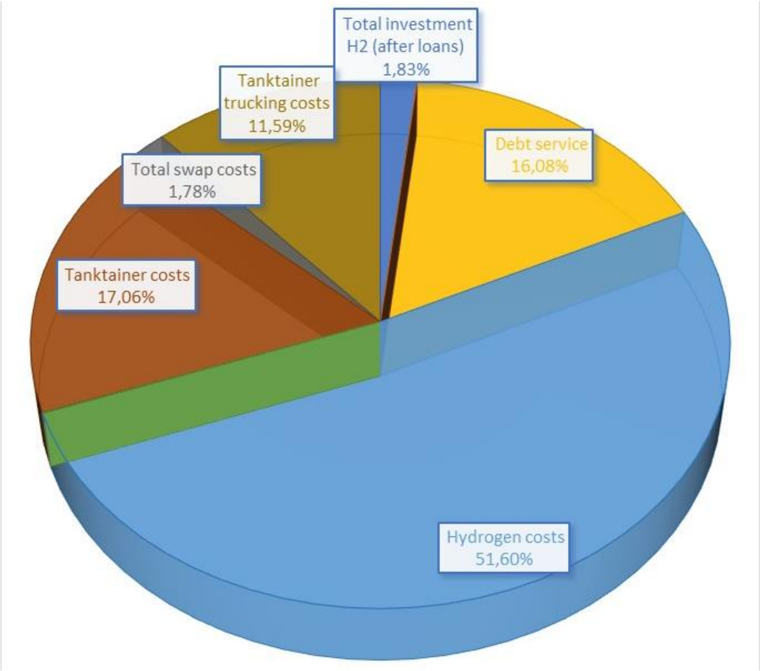
2 scenarios:

- zero subsidy
- 50% CAPEX subsidy on additional investments ships and on full tanktainer cost

Business case- high level indication of BuCa

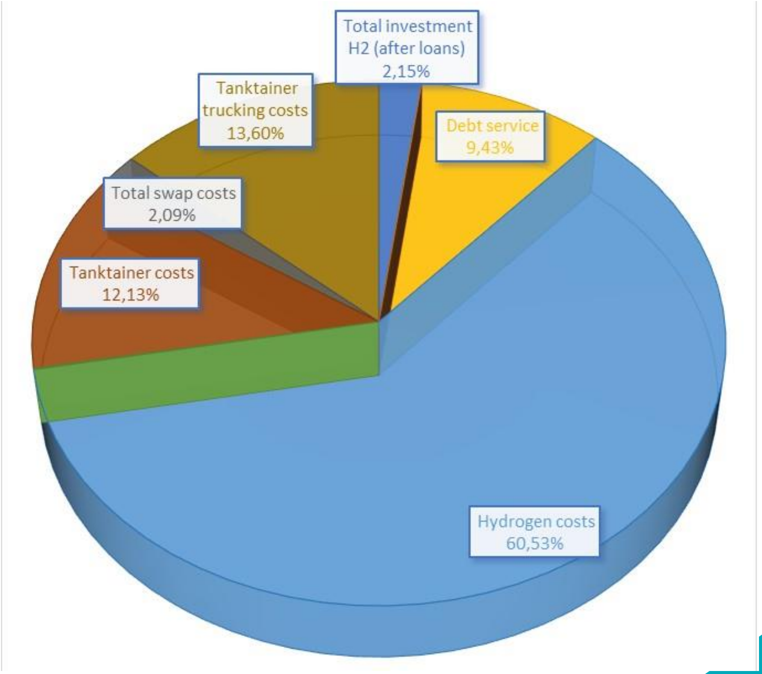
No subsidy scenario

Total additional cost over 20 years: €23,2 mln



50% CAPEX subsidy scenario

Total additional cost over 20 years: €16 mln
(Total subsidy amount p ship incl. tanktainers +/- €4,5mln)



Business case- high level indication of BuCa

50% CAPEX subsidy scenario

High level BuCa conclusions

1. Sailing zero-emission on Hydrogen is still 150- 250% more costly than fossil fuels (or biofuel)
2. A large part of the additional cost is related to the high price of hydrogen compared to the low costs of fossil/ biofuels (50-60%)
3. The cost of H2 storage and the related logistics also represents a large component (15-30%). This cost is specifically higher, because of avoided infrastructure costs, due to the swapping concept.
4. If a pool of tanks is not created, the related costs will increase by 10-15%
5. The cost gap will stay in place for **about 10-12 years**, after such a period and if regulation on emissions becomes stricter, sailing zero-emission on hydrogen can become competitive

What do Zero-Emission shipping initiatives need?

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Subsidies:

1. **CAPEX subsidies** should be high enough to allow initial investments (min. 50%), and based actual investment costs, not on depreciation during a project period
2. For the scale-up period, the **compensation for additional OPEX** is required, unless cargo owners will be forced to pay a premium
3. Technologies with higher TRL levels that still need scaling should be eligible, because innovation lies also in the specific application, it is hard to reach high numbers in the maritime sector and it takes long for costs to decrease.
4. To execute the upscaling efficiently, **project development and management funding** is required for a centralized project approach to jointly remove hurdles and avoid “re-inventing the wheel”.

Policy:

- Policies stimulating Zero-Emission shipping are crucial to support all value chain players
- Without fitting guiding policy zero-emission initiatives keep fighting an unfair battle against polluting solutions.

Condor H_2

Will you join us to accelerate zero-emission shipping?

Contact
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Condor H_2 project leader
marjon.castelijns@darel.nl