

Overview of technically available promising zero-emission solutions for European inland navigation

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Roadmap and actions towards zero-emission Danube fleet
Joint Workshop by Danube Commission and EUSDR PA1a

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The Challenge



- Technically available?
 - Depends on the TRL threshold
 - Requires equipment and infrastructure
- Promising?
 - Save the planet or improve air quality
 - Business case depends on application and funding
- Zero-emission?
 - GHG and/or air pollutants?
 - Well-to-Wake / Tank-to-Wake / Tail-pipe
 - Zero zero? Net zero? Zero impact?

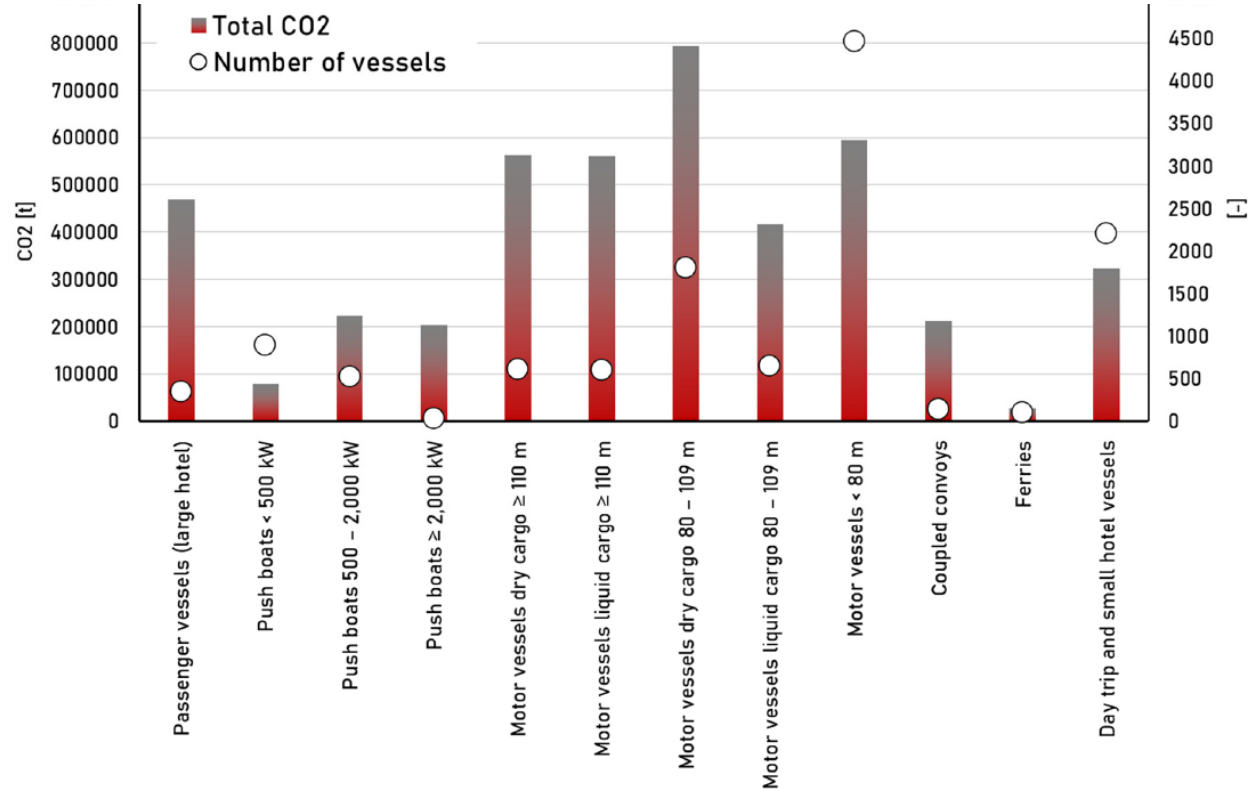
Zero-emission?



Well-to-Wake	Tail-pipe	Tank-to-Wake
Batteries with renewable energy (w/o production)	Batteries with renewable energy	Batteries
Green hydrogen (on site, FC)	Green hydrogen (FC)	H ₂ Fuel cell systems
Pink hydrogen (on site, FC)?	Pink hydrogen (FC)?	H ₂ in ICE
Small nuclear reactors	Small nuclear reactors	Ammonia (N ₂ O)
		Green Methanol (FC / ICE)
		HVO / FAME
		Green Methane
		Carbon Capture

Promising? Who for?

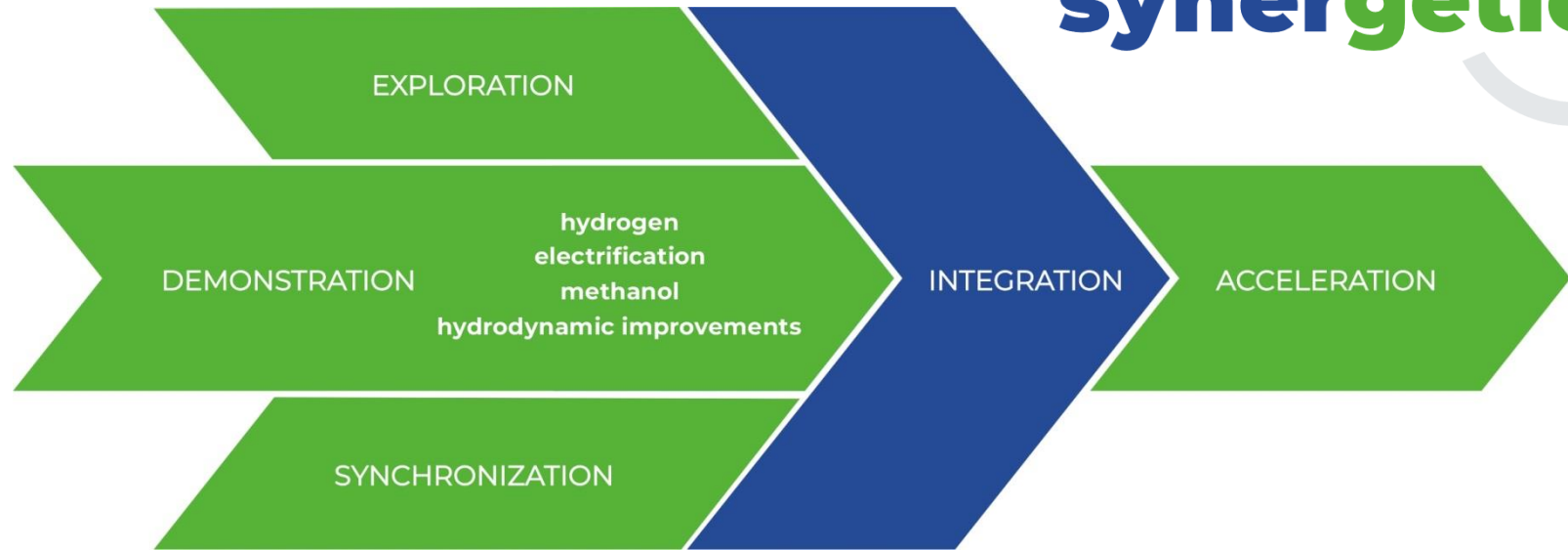
2015 (European Inland Fleet)		
CO ₂	NO _x	PM
[t]	[t]	[t]
4 281 650	47 307	2 386



Technical available?

Synergies for Green Transformation of inland and coastal shipping

www.synergetics-project.eu



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Selected SYNERGETICS outputs



- [D1.1 Relevant identified technical solutions](#)
- [T2.1 Pilot database 2.0](#)
- T4.2 Fact Sheets (Sneak Preview of WIP)

Fuel Cells



Methanol-ICE

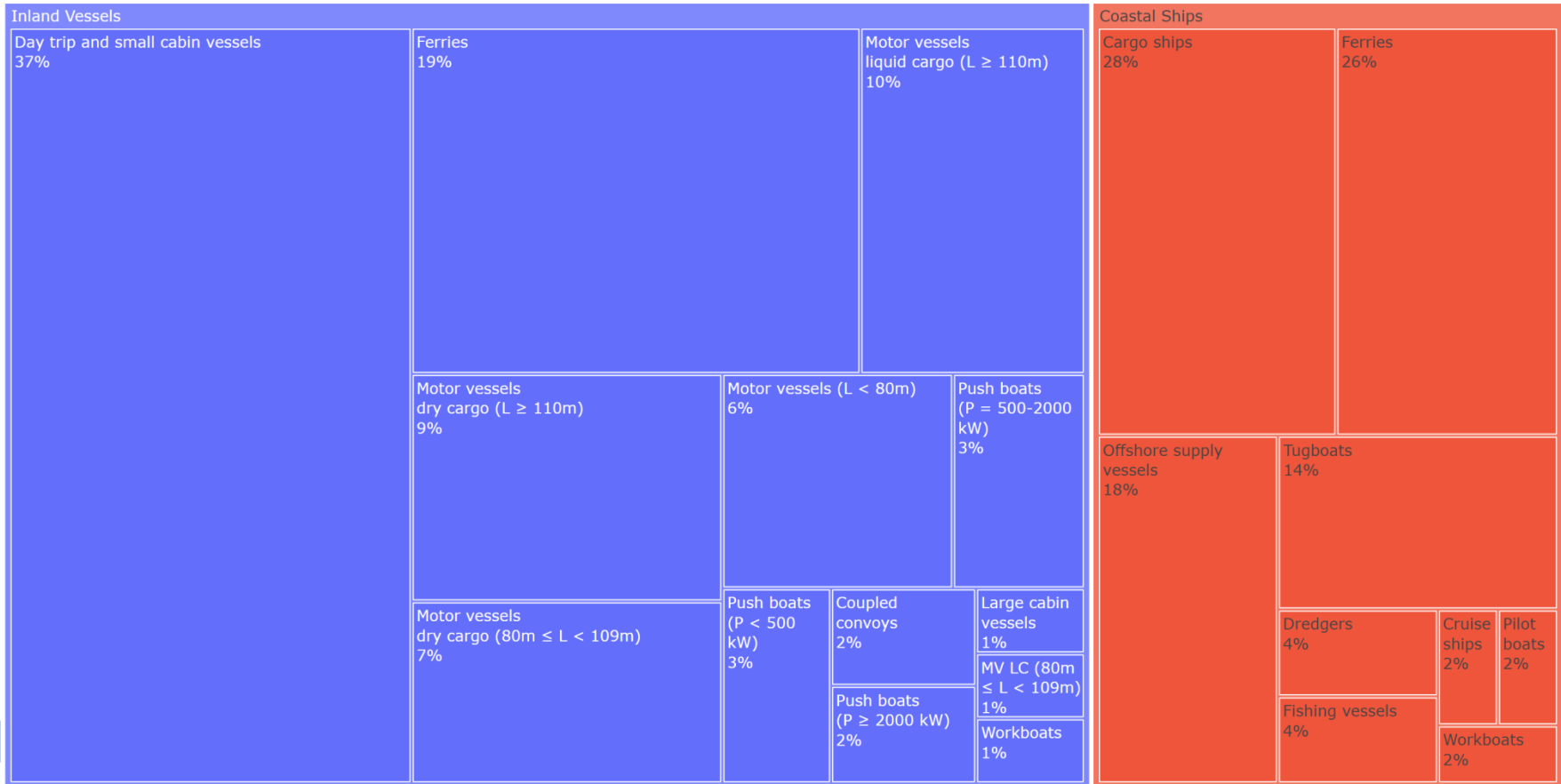


Electrification

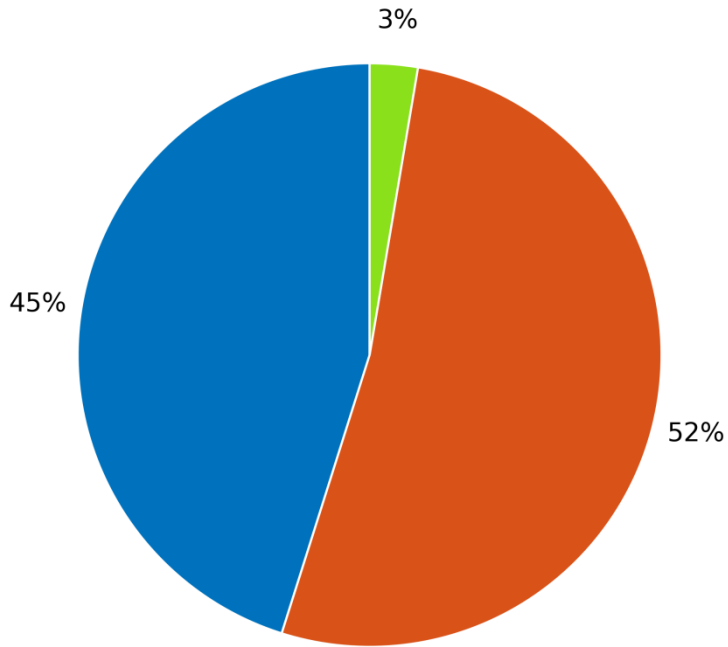


- The database comprises 115 inland vessels and 50 coastal pilots.
- Pilots performed in the period 2008–2026.
- Identification of trends in greening of ships:
 - Types of inland vessels (fleet families) used in pilot projects
 - Retrofit vs. newbuild
 - Innovative greening technologies (electrification, alternative fuels, energy-efficiency)
 - Evolution over time, etc.
- Analysis of the observed trends.

Types of inland and coastal ships

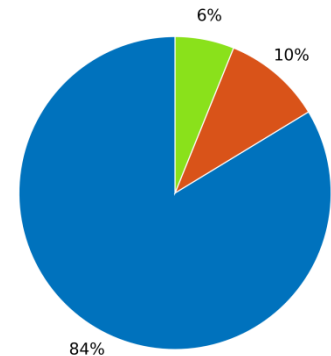


Innovative technologies



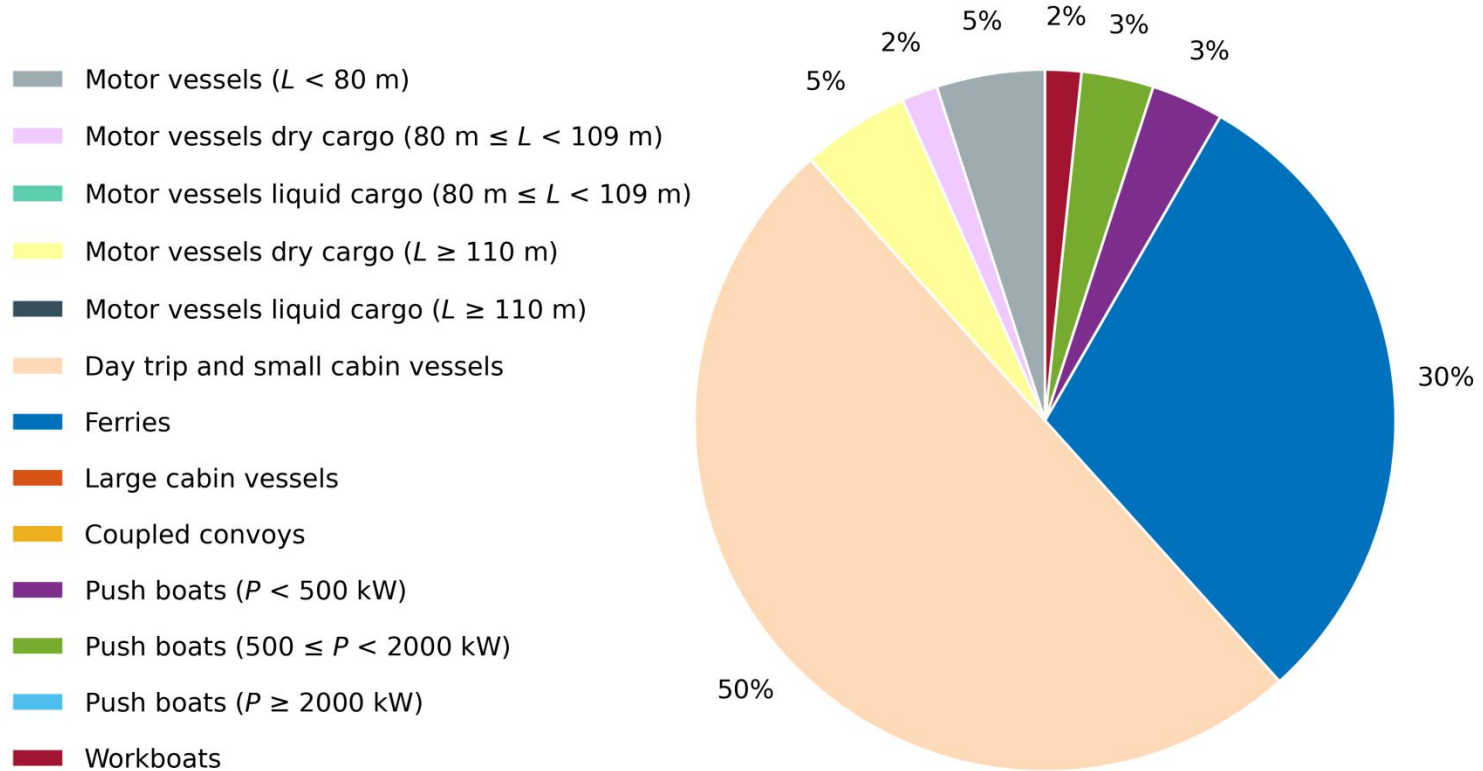
Alternative fuels Electrification Energy-efficiency

(Coastal)

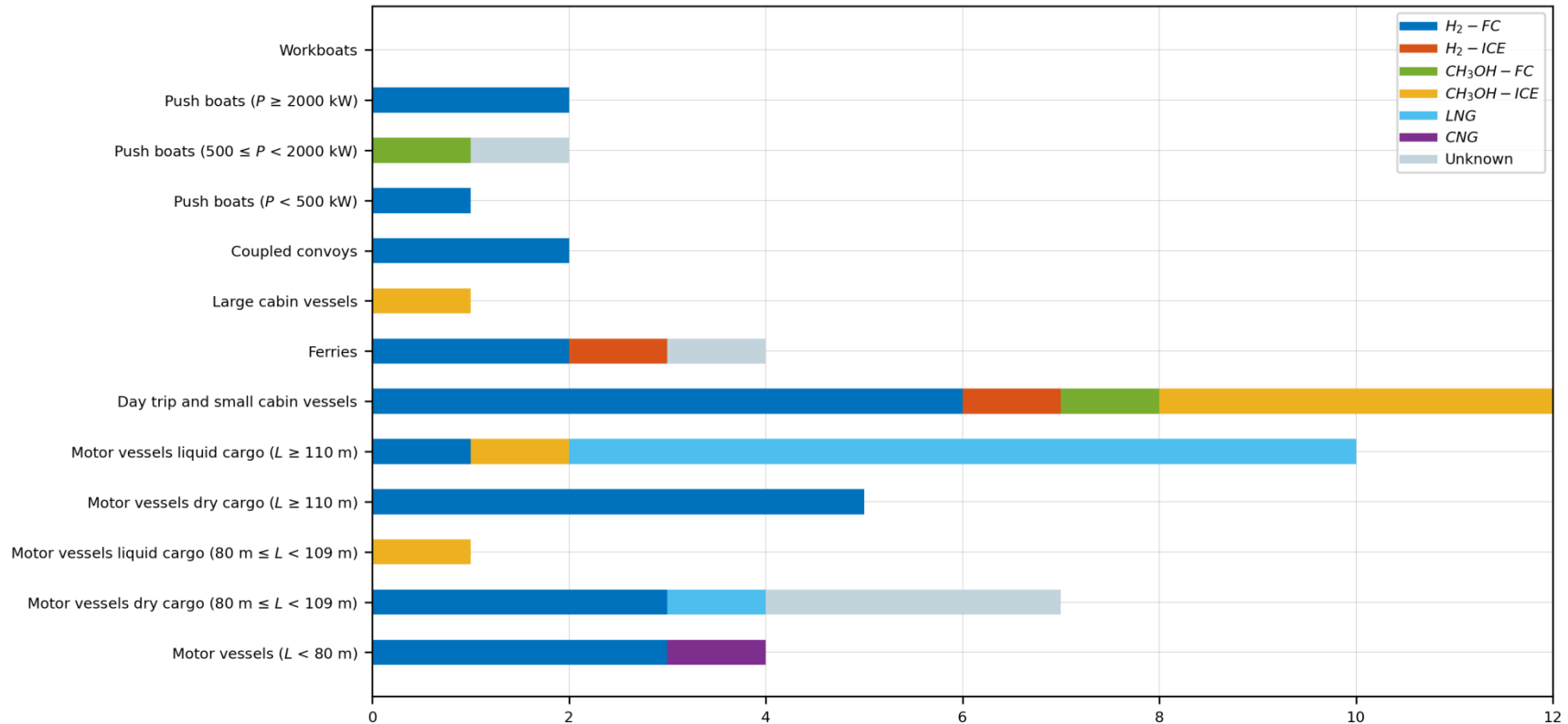


Alternative fuels Electrification Energy-efficiency

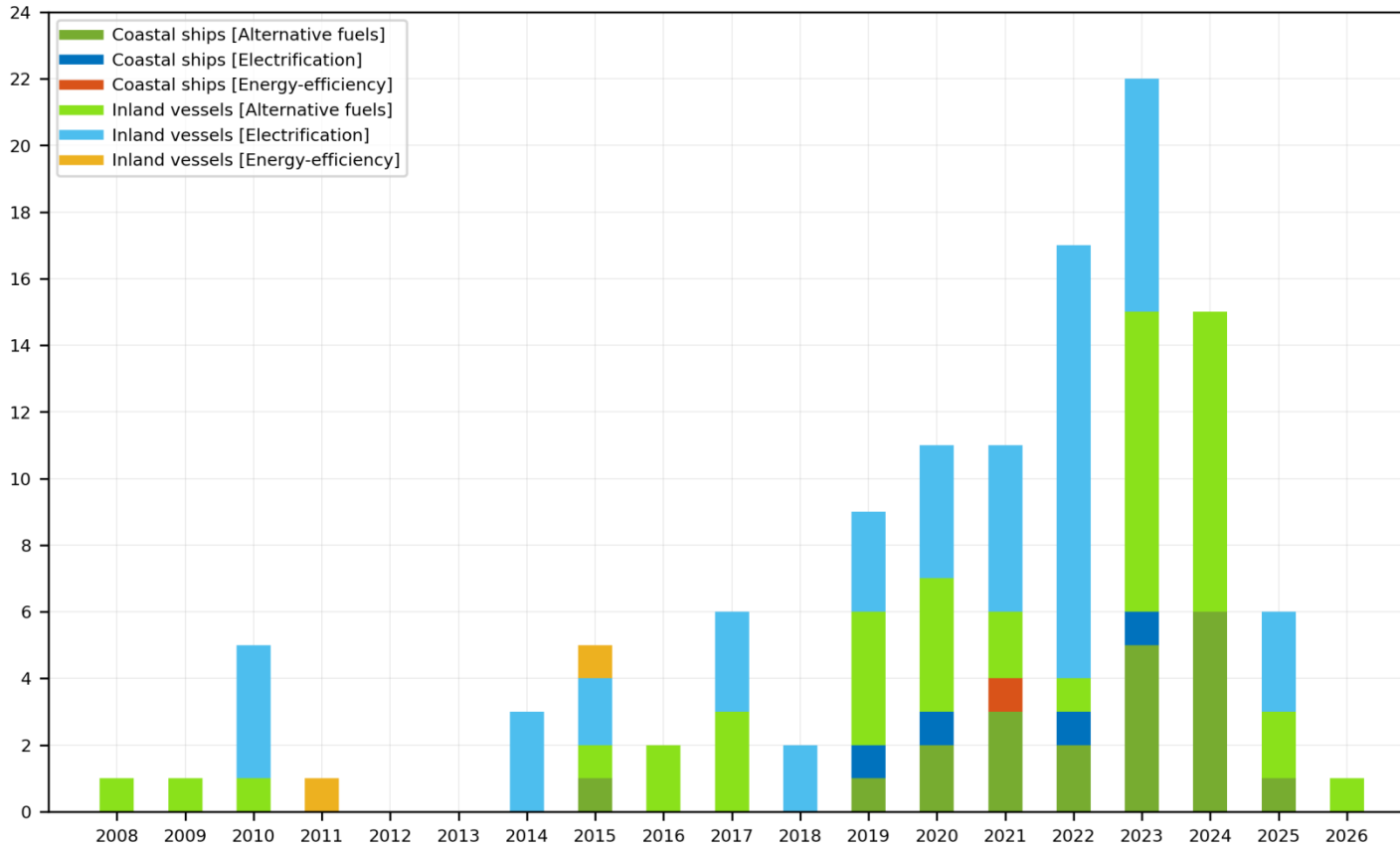
Electrification by fleet family



Alternative fuels by fleet family

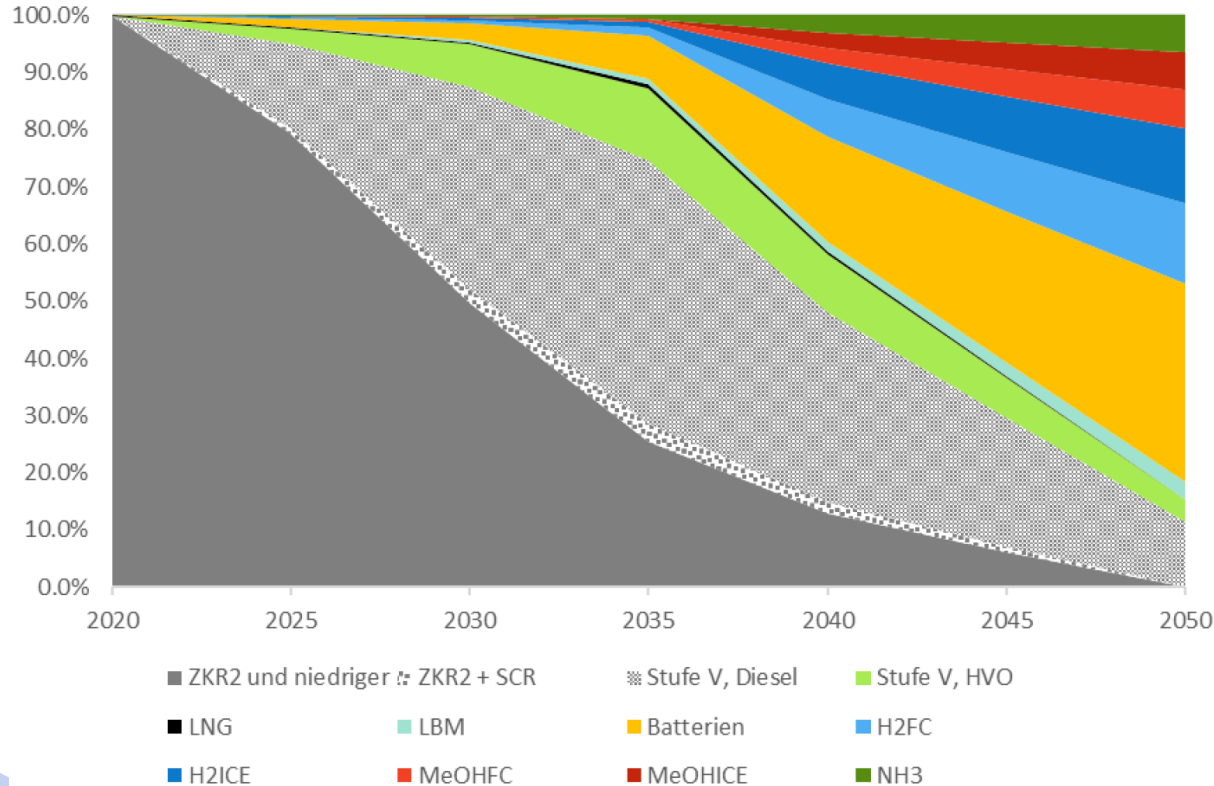


Evolution of greening pilots



Evolution of technologies until 2050

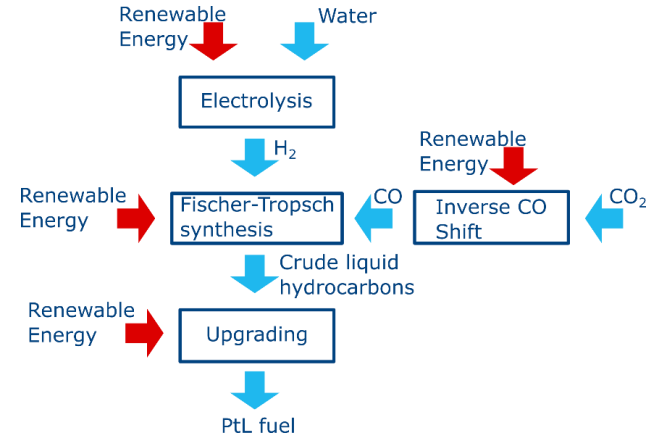
(meeting the Mannheim Declaration ambitions)



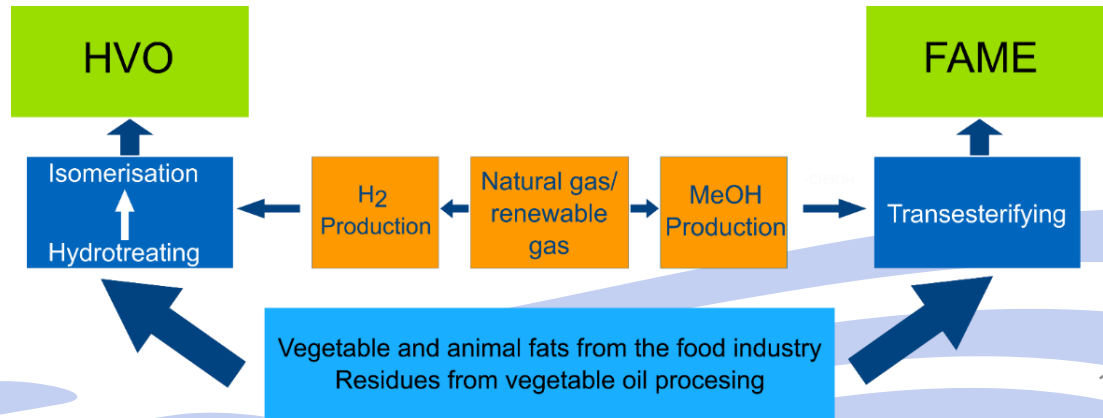
GTL, BTL, XTL und HVO

- Drop-in-Fuels
- Gas-to-Liquid (GTL),
- Biomass-to-Liquid (BTL)
- Hydrotreated-Vegetable-Oil (HVO)

- Paraffinic Fuels, covered by EN15940
- Blends up to 100 %

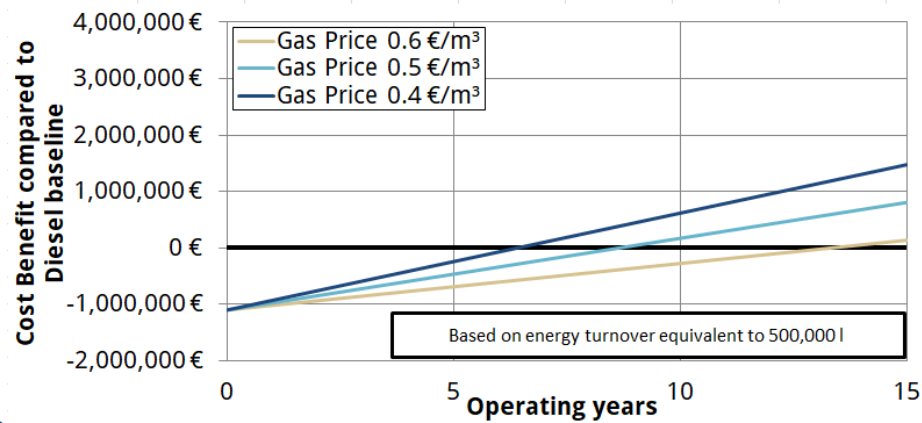


Availability

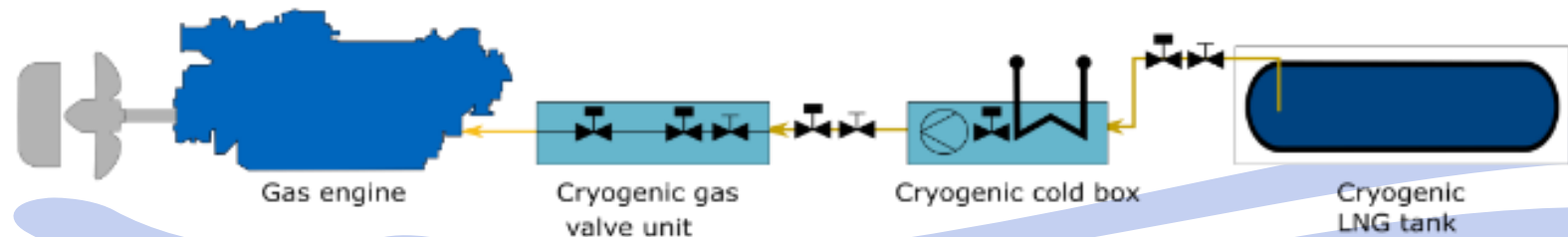


LNG / LBM / LMG

- Fossil methane (LNG) or from bio-mass (LBM) or from renewable energy (Power-to-Gas)
- LNG in cryogenic pressure tanks



Costs, methane slip, CO₂



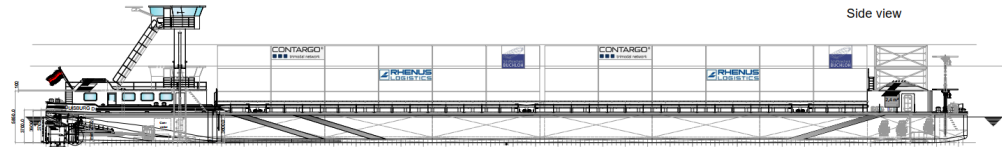
Batteries

- Pure battery power for short stretches on fixed routes
- Part of hybrids for peak-shaving and local zero-emission
- Swappable containers or fixed installation
- High efficiency, high utilisation required

High CAPEX, low energy density, life-cycle



SFK Kiel Ferries and Rhenus Mannheim
(see also upcoming PLATINA4Action D4.1)

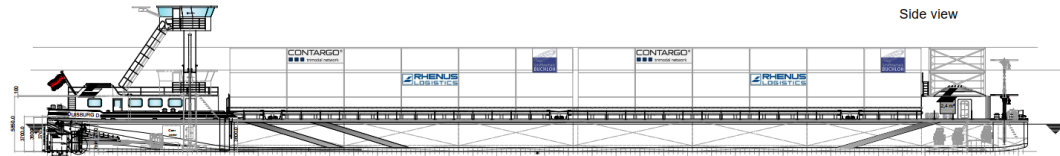


Hydrogen

- For moderate energy demands
- Fuel cells: still challenging, high CAPEX, high purity, good efficiency
- Combustion engines: mono or dual-fuel, more tolerant for impurities, no reference fuel in Directive (EU) 2016/1628
- Less production losses than e-fuels
- Challenging transport and handling

Costs and availability?


Rhenus Mannheim, H2 Barge 1/2, MTS
Letitia, Antonie, Hydroville...



Methanol

- From fossil sources, bio-mass or PTL
- Easier to handle than other alternative fuels
- Less toxic
- Combustion in Dual-Fuel engines or with ignition improver

Methatug, Stolt Ijssel, Enmar Engines...



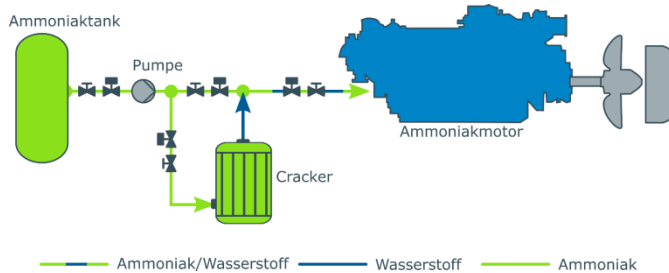
**no reference fuel in 2016/1628
costs / availability**



Ammonia

- Carbon free fuel / Hydrogen carrier
- Relatively cheap renewable production
- Simple liquefaction by pressure or temperature

high toxicity
no reference fuel; N₂O emissions; NH₃-slip



Conclusions



- The challenge is persistent
- Pilots and synergies
- Retrofitting
- Infrastructure does run ahead
- kWhs saved are the best
- Upcoming
 - SYNERGETICS Fact Sheets published end of the month
 - Danube Ports Days
 - SYNERGETICS Mid-term Conference (Brussels Nov. 5)
 - PLATINA4Action Stage Event (Brussels Nov. 6)
 - Ammonia study for PoS
 - PLATINA4Action D4.1 – Stock-taking of good practices
 - SYNERGETICS D1.2 on well-to-tank performance



synergetics

Thank you for your attention!



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Experiments, Fleet Modernisation and
Emissions

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