E-fuels, Bio fuels and other options in the Maritime and Aviation Sectors

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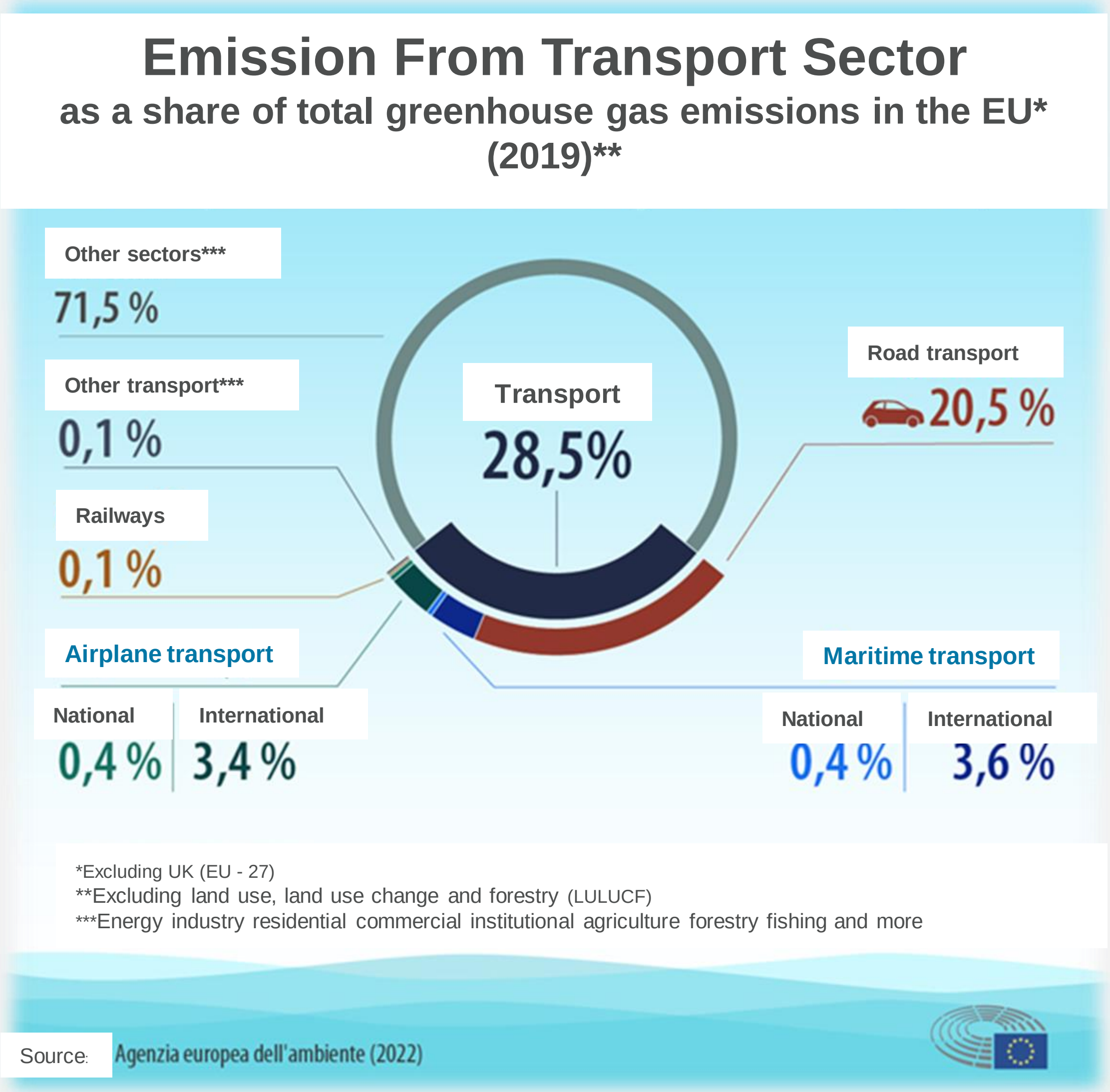
Emissions of the transport sector



Net Zero Maritime

Net zero Approach - Roadmap the Actions

Rules IMO ed EU
CO2 Emission targets
Net Zero 2050

Roadmap to net zero target!
Progressive actions to meet the targets
Efficiency, always to be done!
Technology, is ready or not?
CO2 CCUS?

Business Assurance
Vessel Fleet have to be always operative
Long range

Engine
30 years vessel lifetime
One – Fuel
Dual – Fuel
CO2 Capture
pre- combustion
Post combustion

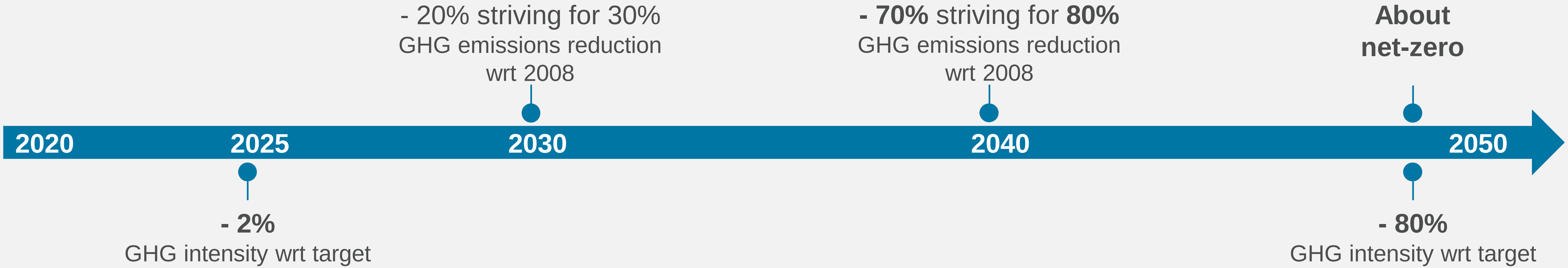
Green Fuels
Fuels must be as **equivalent** in terms of energy content per volume, mass, safety
Diesel, Natural Gas, Biofuel, Synthetic Fuel, Ammonia, Hydrogen…
Supply chain, fuel have to be available in quantity and in all geography, etc…
SAFETY on board and in bunkering

EXXI - CII - On Board RES
On Board RES can improve the overall performances

Regulatory framework

INTERNATIONAL

- **International Maritime Organization (IMO) - Strategy on reduction of GHG emissions from ships**
  Compliance with target carbon intensity requirements is needed: non compliance, no certificate, NO SAILING



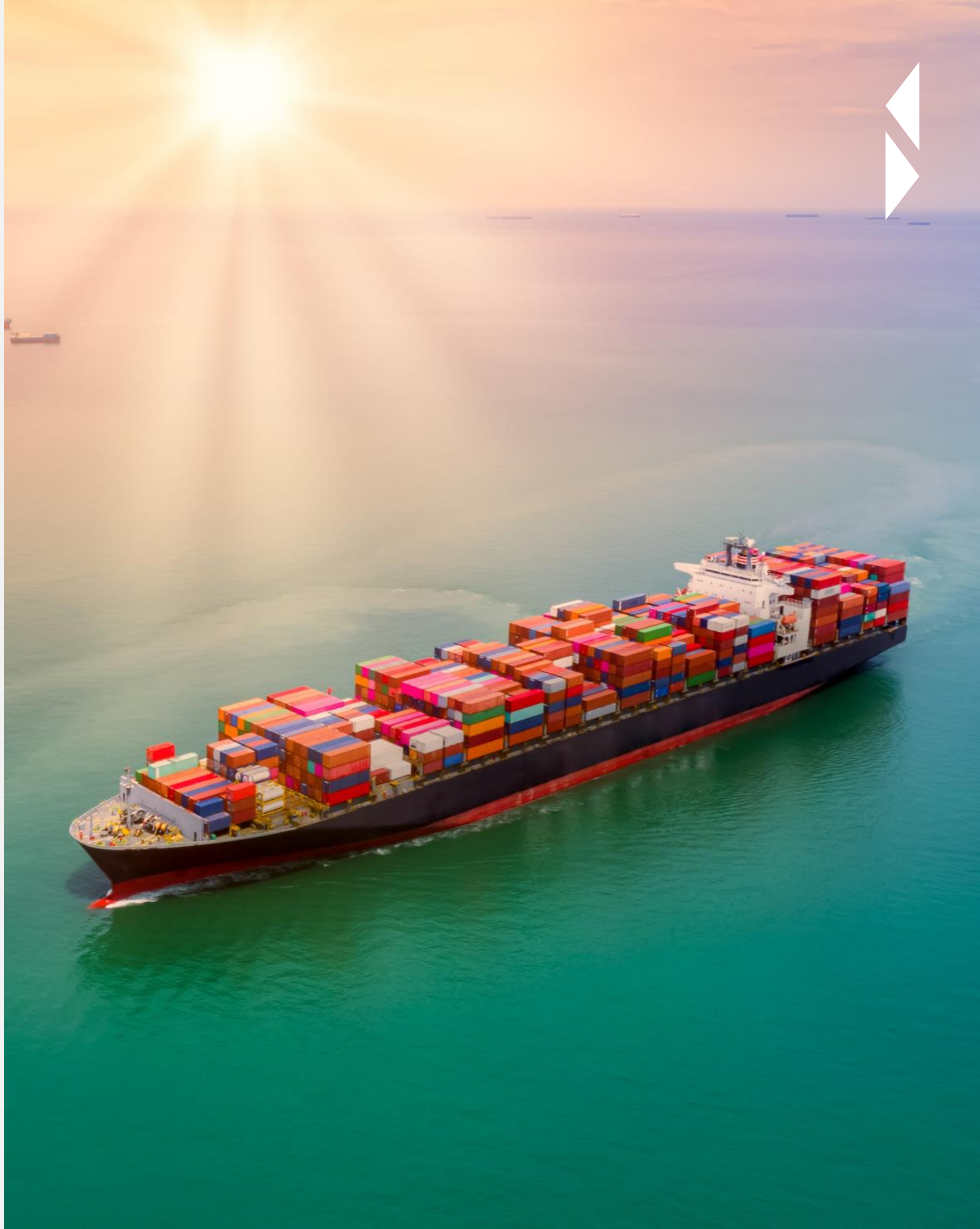
According to the IMO's Carbon Intensity Indicator (CII):

- **Today** only **37%** of ships belongs to the acceptable range without further measures
- **Starting from 2025**, **more than 73% of ships will be seaworthy**

What Fuel for Trade

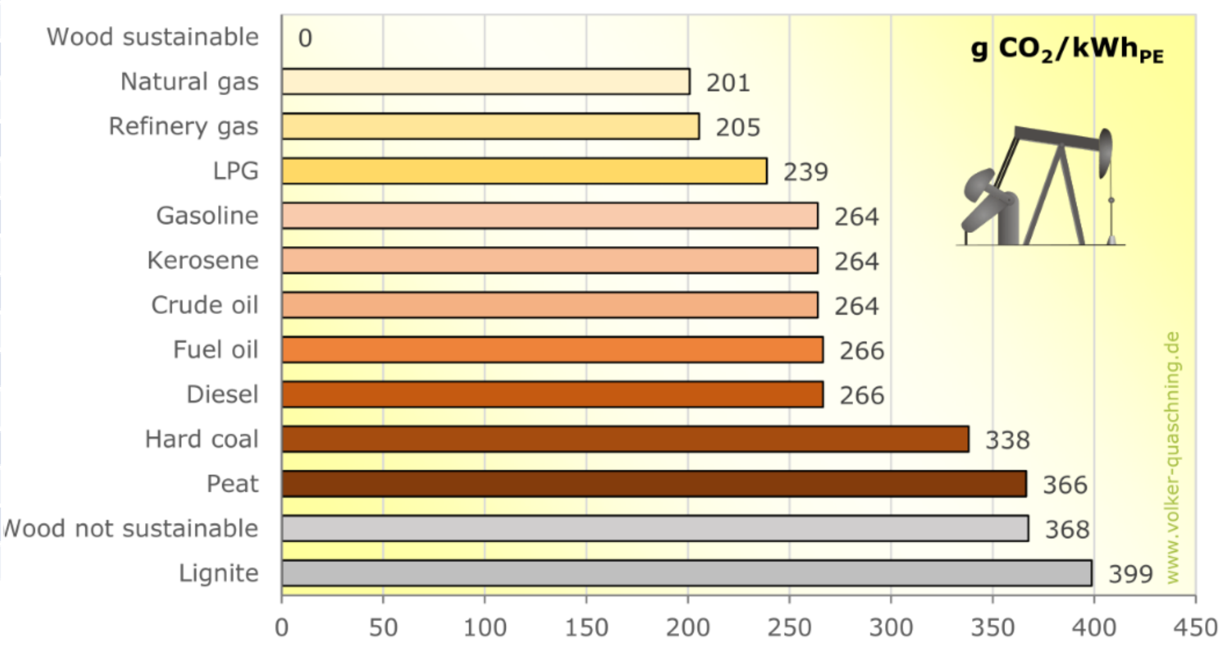
Maritime Trading features

- **Large capacity at lower cost**
- **National and international**
- **Versatile transport**. any type of cargo.
- **Competition**. Maritime transport is governed by the principle of free competition
  - ***Vessels can’t stop ….***
  - ***Long travel distances (no intermediate bunkering)***
  - ***No price increase for bunker***
  - ***No reduction of payload on board because of bunker storage***



The EU WtW approach - Fuel Classification

Fuel Class	Pathway name and Feedstock
Fossil	HFO
	LSFO
	ULSFO
	VLSFO
	LFO
	MDO/MGO
	LNG
	LPG
	Methane
	H2 (from natural gas / grey and blue)
	Methanol (from natural gas)
	Ethane
	NH_3
Liquid biofuels	Biodiesel - Main products / wastes / feedstock mix /rapeseed
	Biodiesel - Main products / wastes / Feedstock mix
	HVO - Main products / wastes / Feedstock mix
	Bio-LNG - Main products / wastes / Feedstock mix
	Bio-Methanol and Bio-Ethanol
Gas biofuels	Bio-H_2 - Main products / wastes / Feedstock mix
	Bio-Natural Gas
e- fuels	e-diesel - electricity mix (such as EU el. Mix or Nat el. Mix)
	e-methanol - electricity mix (such as EU el. Mix or Nat el. Mix)
	e-LNG - electricity mix (such as EU el. Mix or Nat el. Mix)
	e-H_2 - electricity mix (such as EU el. Mix or Nat el. Mix)
	e-NH_3 - electricity mix (such as EU el. Mix or Nat el. Mix)
Others	Electricity produced on purpose – such as EU electricity mix



Sources: Umweltbundesamt and Fachbuch Regenerative Energiesysteme

Weight and volume matter in the maritime sector

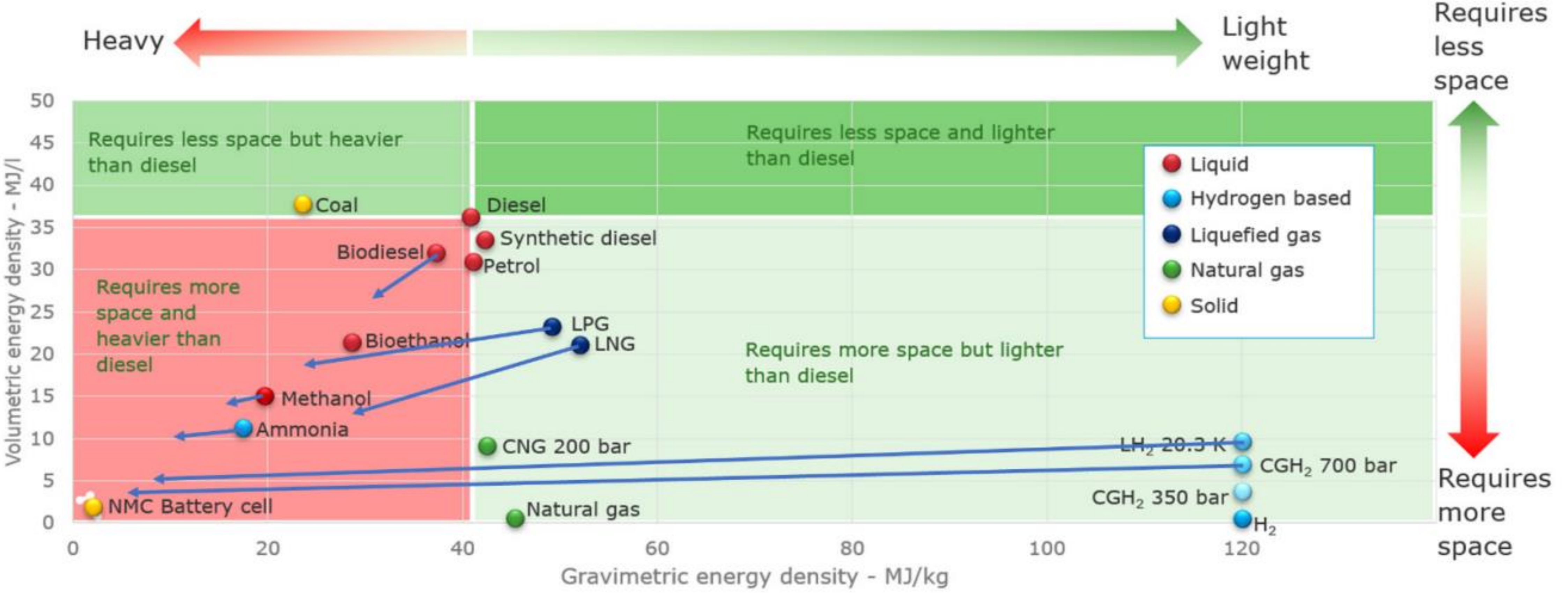


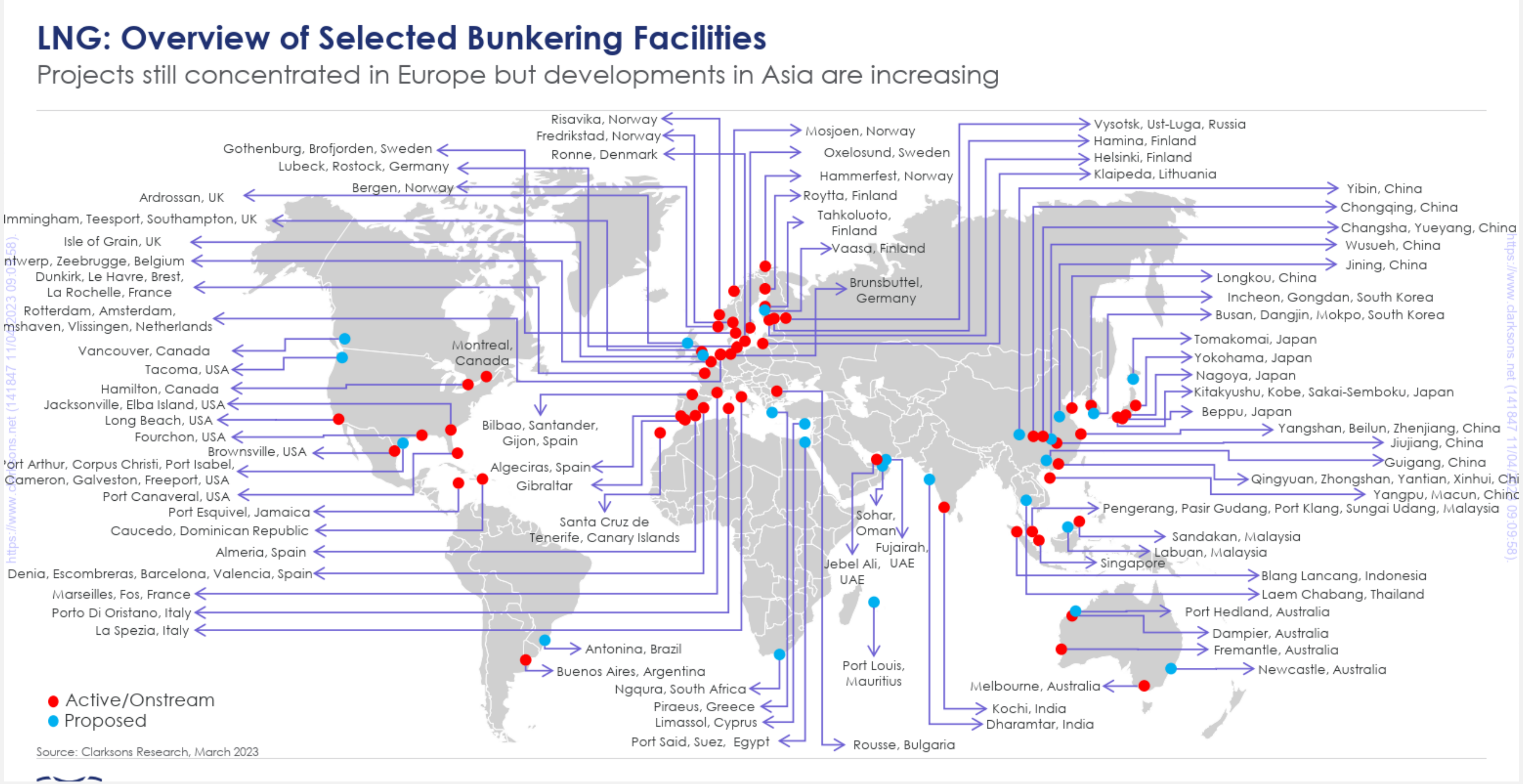
Figure 6-1: Energy densities for different energy carriers (inspired by /49/ /72/ and /73/). The arrows represent the impact on density when taking into account the storage systems for the different types of fuel (indicative values only).

Source: DNV

Supply chain

GNL & bio GNL

An infrastructure for storage has been developing in the last decade



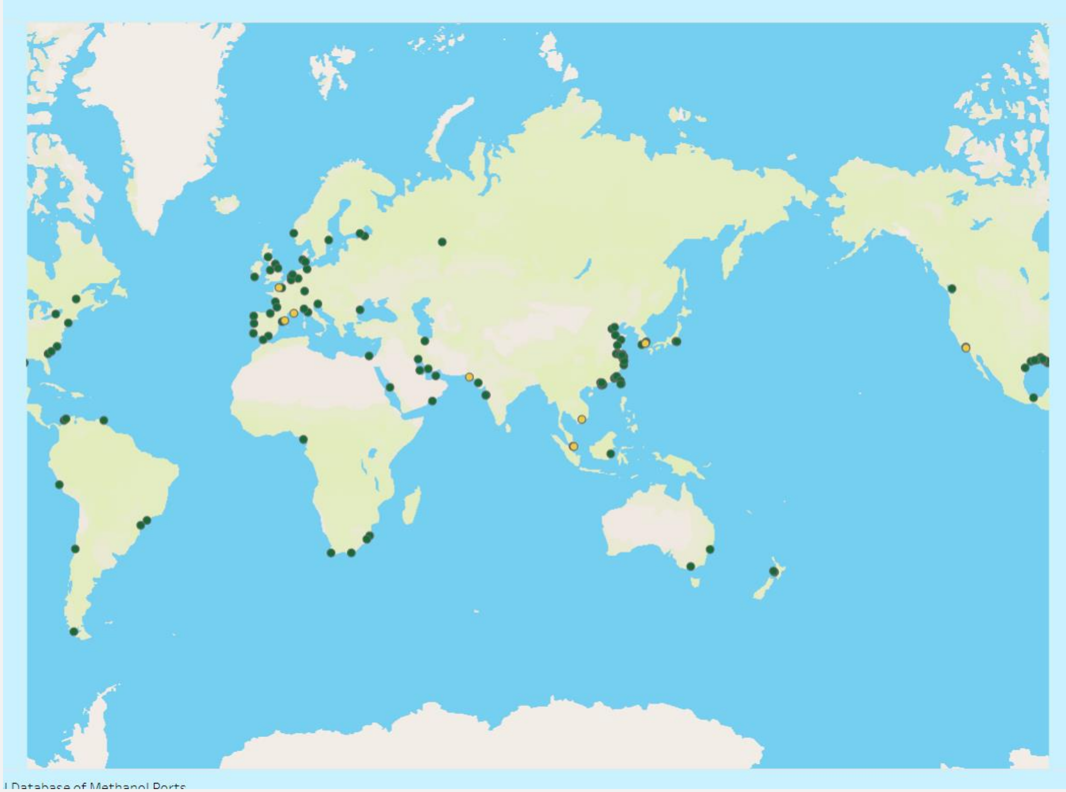
Projects are mainly in Europe but new developments are expected in Asia

Supply chain

METHANOL & AMMONIA

The existing infrastructure is not enough for bunkering

Ports with available methanol storage capacity



Source: Methanol Istitute https://www.methanol.org/

Figure 11 Ammonia shipping infrastructure, including a heat map of liquid ammonia carriers, as well as the ammonia loading and unloading facilities

Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply any endorsement or acceptance by IRENA.

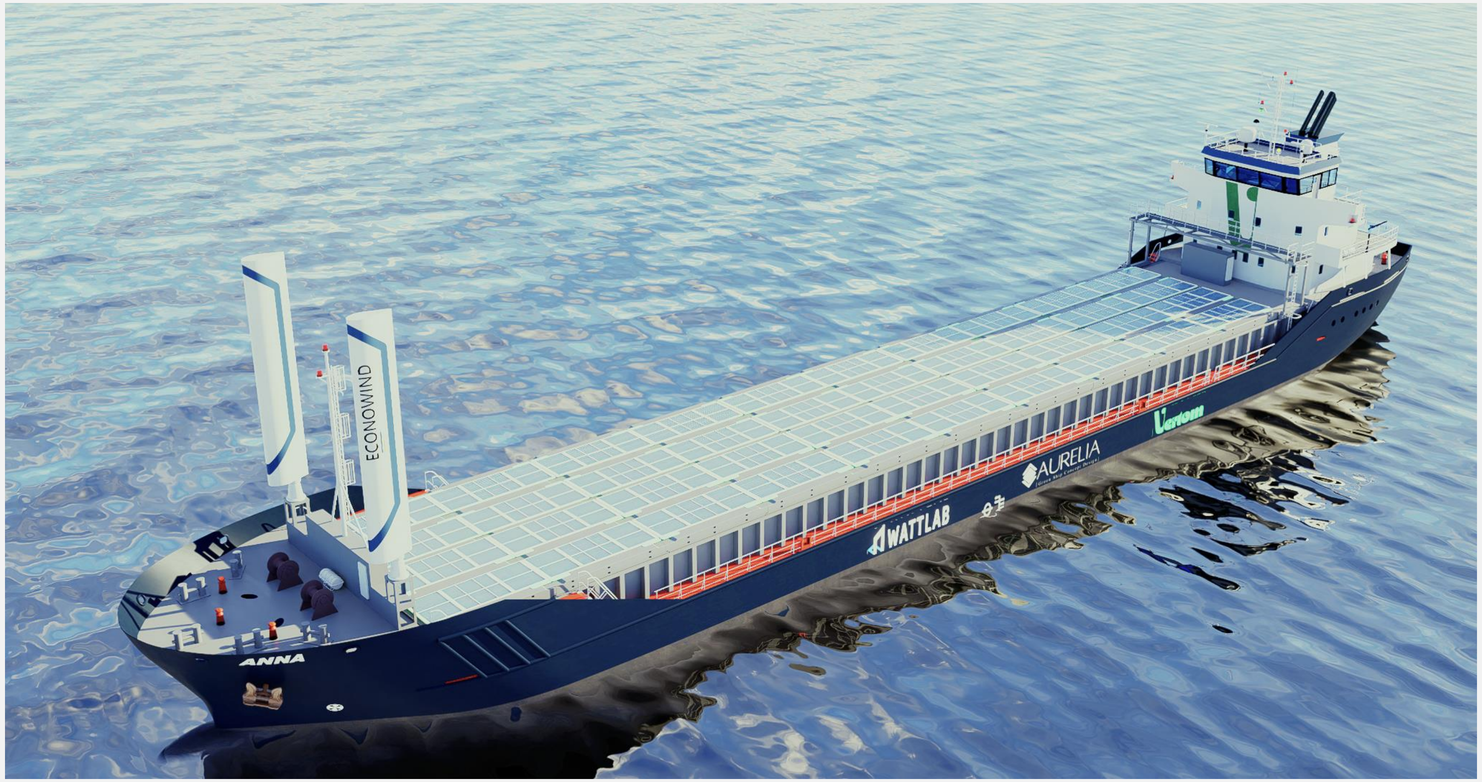
Reproduced from Royal Society (2020).

On Board RES
Wind Assisted Propulsion and Solar Panels AiP

Vertom front runner in evaluating combined technologies

MV ANNA Ship Features

- *5,097 T DWT General Cargo*
- *Wattlab PV Technology*
- *Batteries*
- *2x Econowind Ventofoils*



A possible roadmap

Short term	Medium term	Long term

LOW EMISSIONS FUELS:

- Efficency improvment
- Available in the market
- Use of the traditional logistic infrastructure and bunkering
- Use in the current operative engines in a pure form or in blending
- Hydrogenated Vegetable Oil (HVO) and biodiesel (FAME - Fatty Acid Methyl Esters): with diferent performances

GNL:

- The infrastructure is under development
- Fossil GNL guarantees a 25% emissions reduction while a Bio GNL would bring to about zero emissions

E-FUELS – AMMONIA – METHANOL

- E-fuels would use the the existing infrastrucutre but today are expensive and not availbale
- Ammonia and methanol would require the developlment of proper infrastructure and logistics

Net Zero Aviation

Aviation emission reduction options

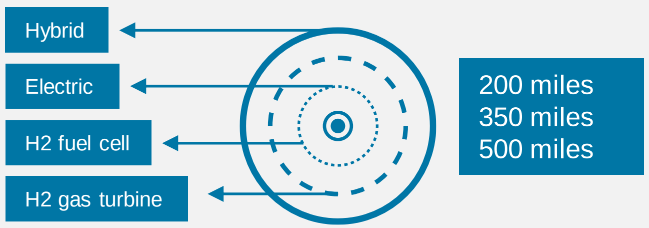
Aviation is considered a hard-to-decarbonise sector due to the long lifespan of the airplanes and the complexity involved.
EU commission target to is to achieve net zero by 2050

Decarbonisation option	Description	Sector perspective on decarbonisation impact before 2050	Applicability	Sentiment (before 2050 perspective)
Efficiency gains	Design and operations improvements to reduce fuel burn	55% 35% 10%	All flights	Important option but **impact diminishing over time**
Sustainable Aviation Fuels (SAF)	Fuels from sustainable resources to substitute fossil-based kerosene	78% 20% 2%	All flights	**Main decarbonisation option** in the next 30 years; ability to **use with existing aircraft**
Offsets	Investment in out-of-sector emission reductions or removal	50% 29% 21%	All flights	Important to bridge the timing gap as other options are scaled up
H_2 **Hydrogen**	Combustion of (low-emission) hydrogen and/or conversion to electricity through fuel cell	14% 32% 55%	Short- / medium-haul	Requires cryogenic storage and new airframe designs. **Long time** to develop, ensure safety, certify and deploy at scale
Battery	Electric propulsion with zero emissions if charged with green electricity	12% 14% 73%	Short-haul	Because of battery weight and size, only applicable on **very short-haul routes**
Behavioural change	Reduction of demand resulting from remote working and modal shift	15% 25% 60%	All flights	**Any behavioural change** likely to be outpaced by **overall population and economic growth**

Major impact | Moderate impact | Limited impact

Source: Deloitte - Shell, 2021: Decarbonising Aviation: Cleared For Take-off

Future aircrafts exploring new propulsion systems



H2 gas turbine

H2 /SAF/Jet fuel
2 gas turbines

35 – 50 seats
2040

H2 fuel cell

H2 fuel cells
2 electric motors

19 seats
2035

Electric

Full electric
1 electric m otor

9 seats
2035

Hybrid

Diesel engine +
2 electric motors

9 seats
2030

Conclusions

- Today, the maritime and aviation sectors heavily rely on fossil fuels. The decarbonization of these hard-to-abate mobility sectors is a challenging task. Achieving emissions target is possible through a **concerted effort involving all available solutions and technologies**. No single solution, whether it be fuel, engine type or supply chain, will be sufficient on its own.

- The decarbonization progress in the maritime and aviation sectors differs, with the **maritime industry being ahead**.

- **Biofuels represent an immediate decarbonization solution**. However, the limited production capacity and speculative factors affecting pricing pose limitations.

- **E-fuels generally have the potential to be valuable alternatives**, once available at a competitive cost.

- Both biofuels and e-fuels can be utilized in their pure form or blended with conventional fuels in existing engines, Additionally, they can **leverage the existing infrastructure**, including assets, storage facilities, bunkering systems, and engines. This adaptability ensures a smoother transition towards decarbonization.

- **Hydrogen and its derivatives** are expected to play a significant role in decarbonizing both the maritime and aviation sectors. However, the lack of **dedicated infrastructure** hinders the competitiveness of alternative fuels like **methanol, hydrogen, and ammonia**

- **Carbon Capture** can serve as a transition option for the maritime industry, it is not a viable solution for aviation.

Thank you for your attention

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