WHEN TRUST MATTERS

Biofuels in shipping

1. Drivers for decarbonization
2. Why biofuels?
3. Current marine market and use

IEA Bioenergy TCP ExCo96 Workshop

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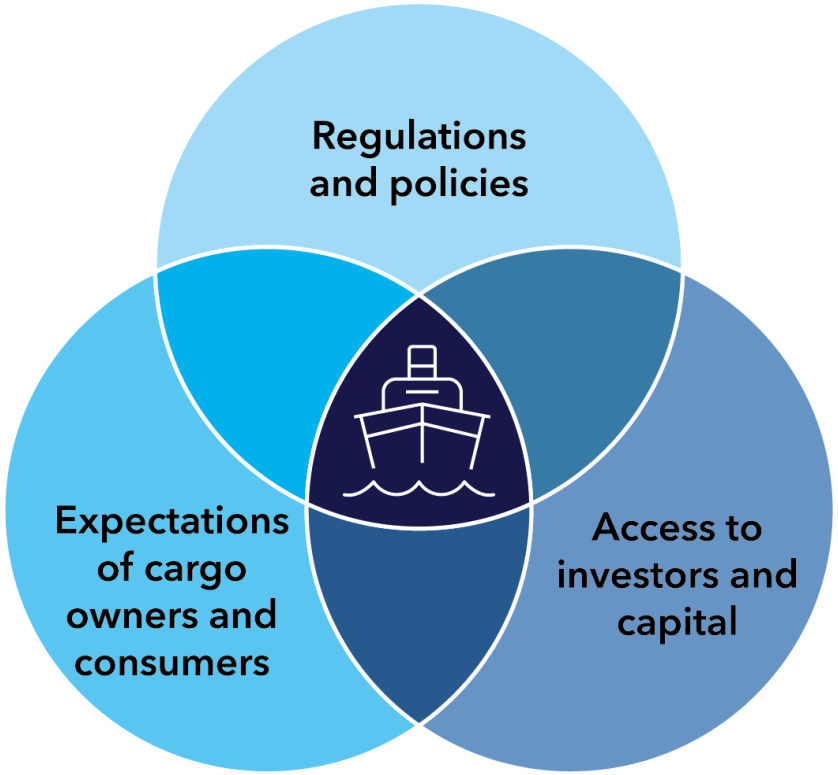
Key drivers for decarbonization in shipping



Regulations and policies	IMO INTERNATIONAL MARITIME ORGANIZATION; EU
Access to investors and capital	Climate Bonds Initiative; THE EU TAXONOMY; POSEIDON PRINCIPLES; ICMA International Capital Market Association
Expectation of cargo owners and consumers	SEA CARGO CHARTER; IKEA; amazon; DELL; equinor; Ørsted; Nike

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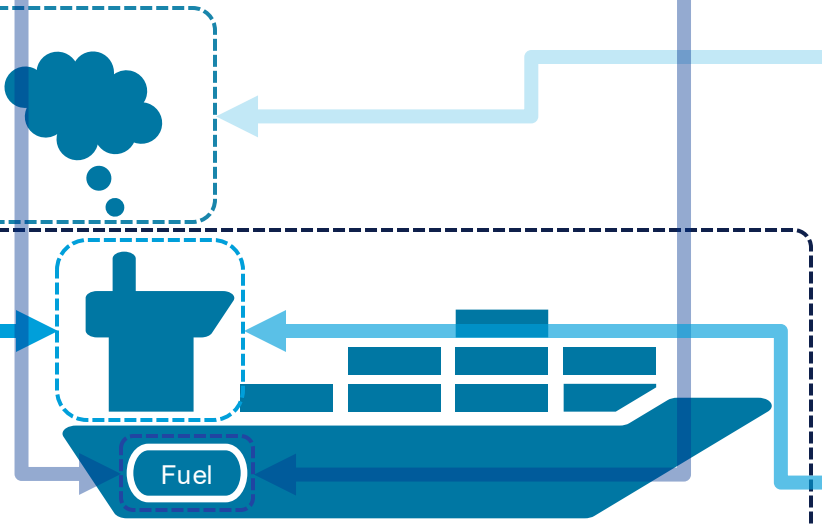
The regulatory framework to reduce GHG emissions

Not adopted

IMO NZF	Operational requirement with financial penalty Well-to-wake GHG intensity	2029 or later
CII	Operational requirement Actual carbon intensity	2023
EEXI	Design requirement for existing ships Ideal carbon intensity	2023
SEEMP III	Management requirement Continuous carbon intensity improvement	2023
DCS SEEMP II	Reporting of actual fuel consumption and CO_2 emissions	2019
SEEMP I	Management requirement Continuous energy efficiency improvement	2013
EEDI	Design requirements for new ships Ideal carbon intensity	2013

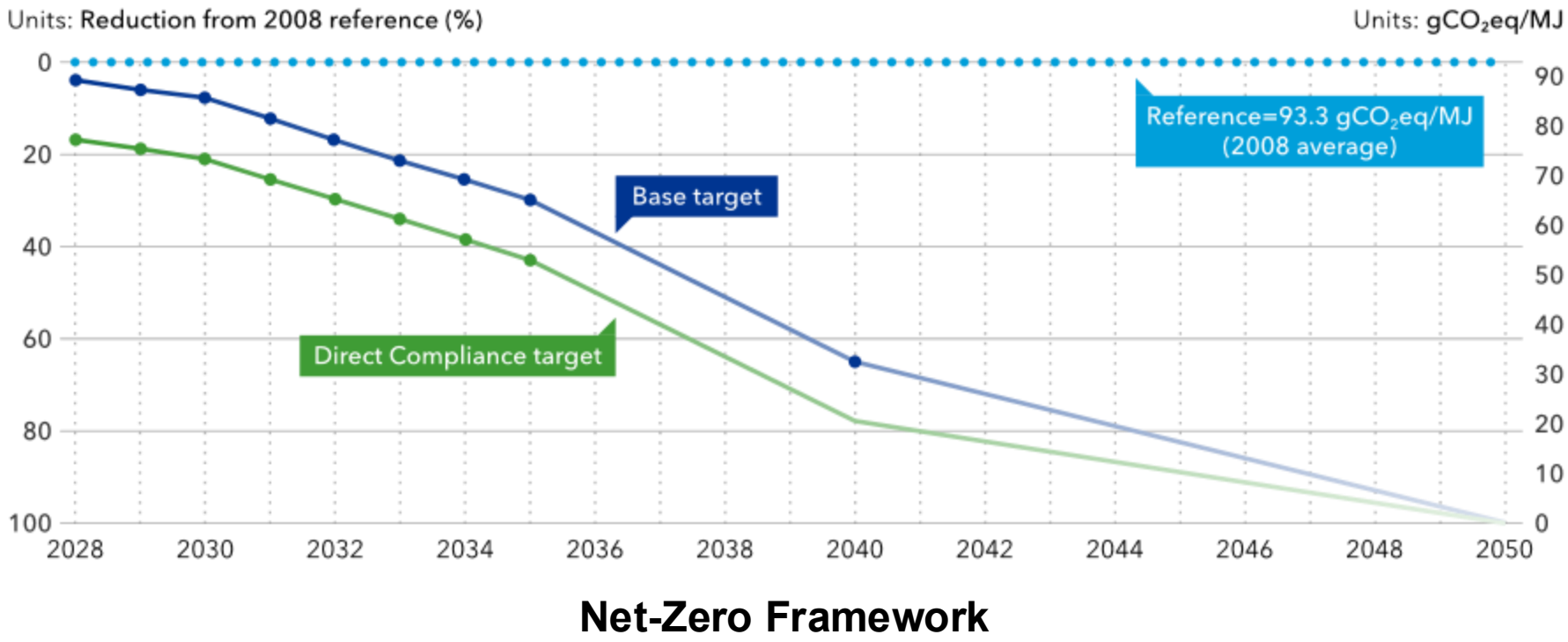


2025	Operational requirement with financial penalty Well-to-wake GHG intensity	**FuelEU Maritime**
2024	Emission cap-and-trade Sets a price on CO_2 emissions	**EU ETS**
2018	Reporting of actual fuel consumption and CO_2 emissions	**EU MRV**

The IMO postponed adoption of the first ever global pricing of GHG emissions – 10–15 BUSD per year

IMO Net-Zero Framework:

- Technical GHG requirement
- Pricing if emissions per unit energy above limit
- IMO to receive 10–15 BUSD year



Net-Zero Framework

Note: the decision to adjourn the adoption of IMO NZF by one year could result in changes to the regulations, including aspects such as timeline

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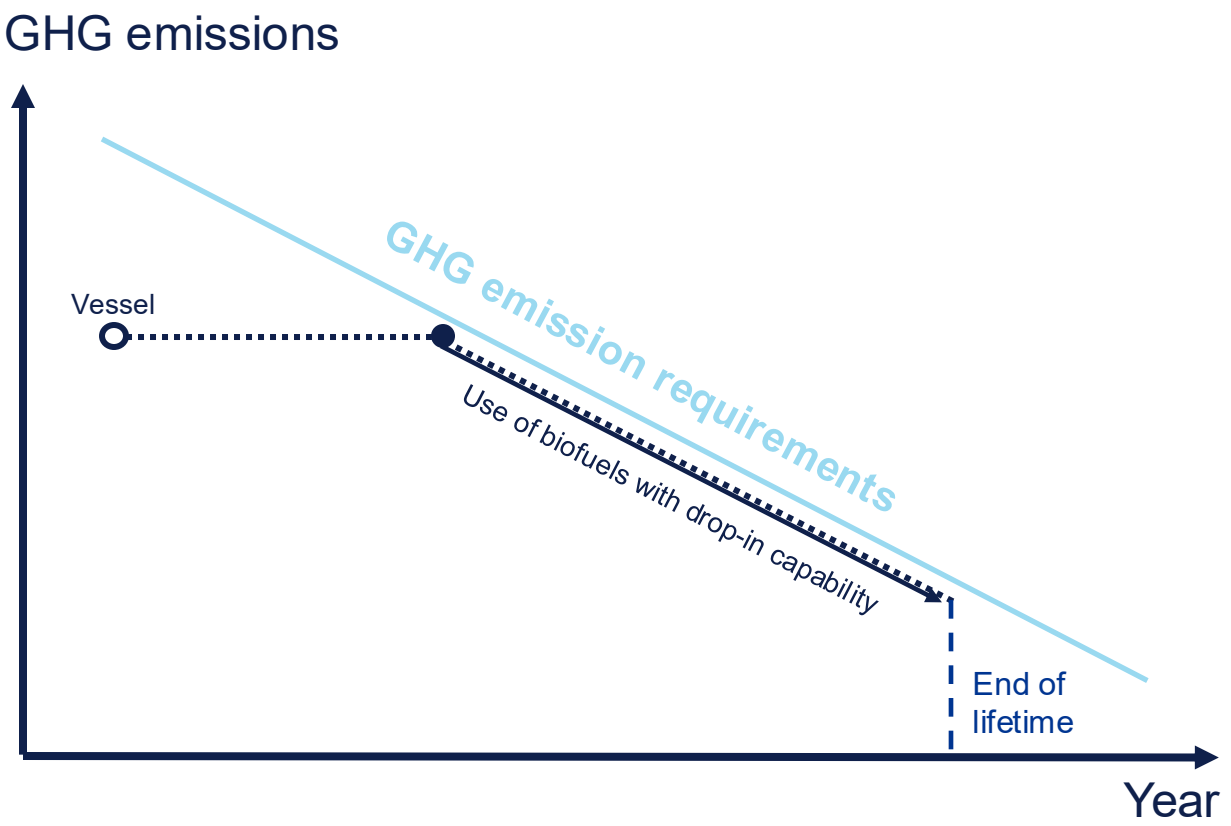
Why biofuels?

Absorbance of CO_2 from atmosphere by biomass feedstock during growth

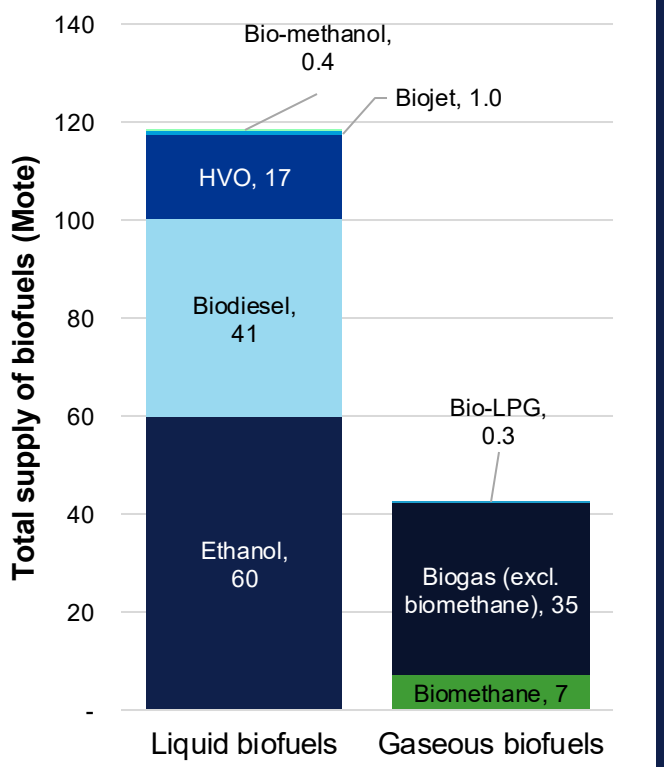
Carbon cycle

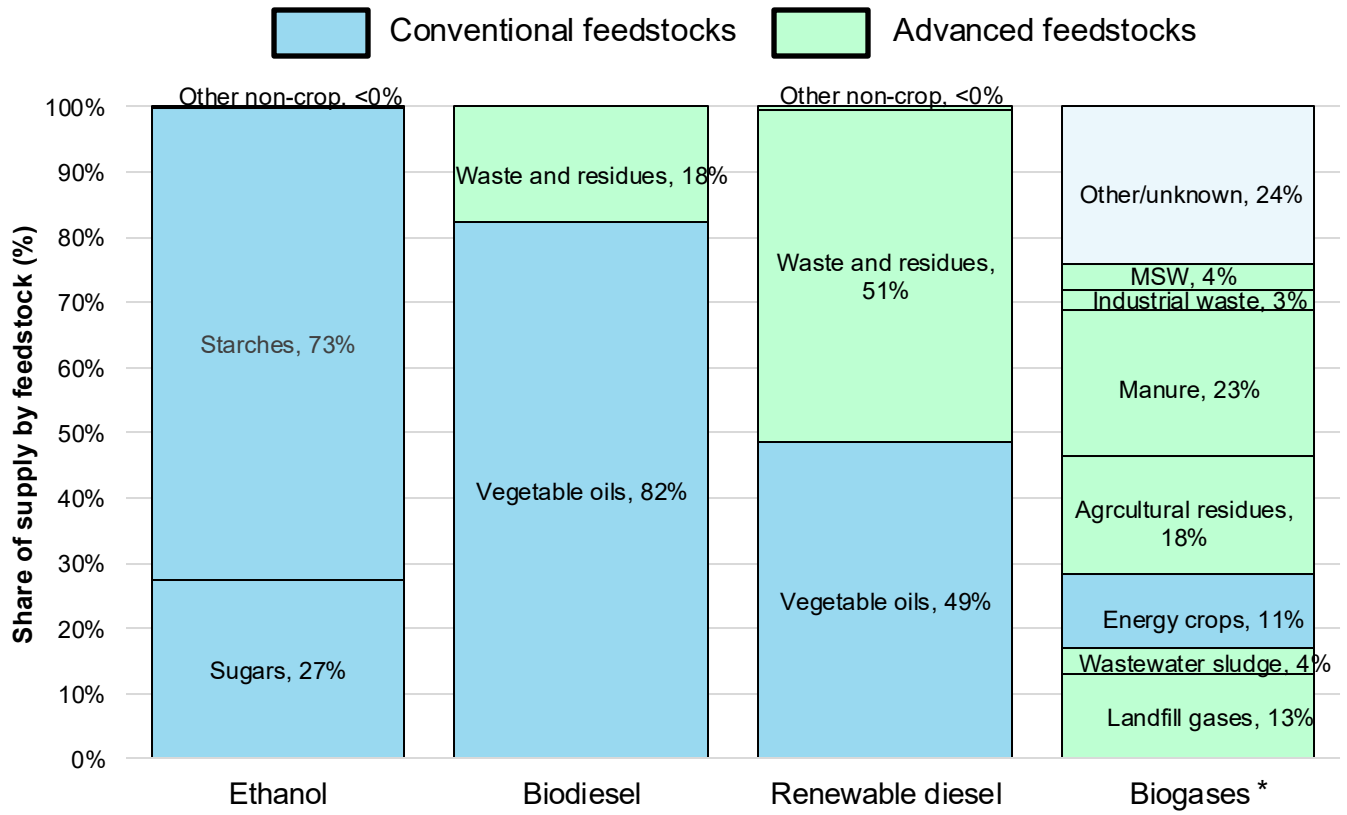
(simplified)

Combustion of biofuel releases CO_2 into atmosphere



In 2024, global supply of liquid and gaseous biofuels amounted to about 160 Mtoe



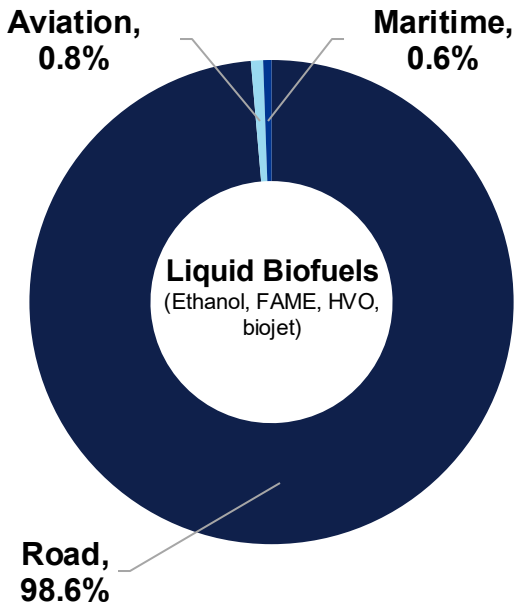


*includes all biogases, including biomethane

Sources:
IEA (2025a), Renewables 2024 – Analysis and forecast to 2030. International Energy Agency.
IEA (2025b), Outlook for biogas and biomethane – Prospects for organic growth. International Energy Agency
IEA (2025c), Renewable Energy Progress Tracker, https://www.iea.org/data-and-statistics/data-tools/renewable-energy-progress-tracker#overview
GENA Solutions (2025). Renewable Methanol Update (October 2025), Retrieved from Renewable Methanol: https://www.genasolutions.com/analysis_and_insights/58
Argus Media (2022). Argus White Paper: BioLPG: Supply boost. Argus Media.

Today, the share of total biofuels supply consumed by ships is very small, but growing

End-use of liquid biofuels by sector (2024)



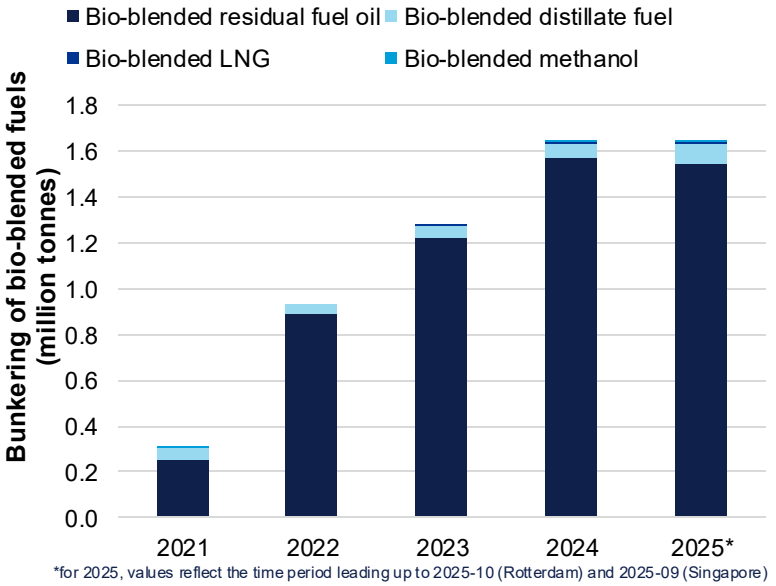
Uptake in shipping (2024)

~0.7 Mtoe

~0.2-0.3%
(of marine energy use)

Reported bunker sales (2021 – 2025*)

(Singapore and Rotterdam)



*for 2025, values reflect the time period leading up to 2025-10 (Rotterdam) and 2025-09 (Singapore)

Sources:
MPA Singapore (2025). MPA Singapore. Retrieved from Maritime Performance: https://www.mpa.gov.sg/who-we-are/newsroom-resources/research-and-statistics
Port of Rotterdam (2025). Port of Rotterdam. Retrieved from BUNKER SALES PORT OF ROTTERDAM 2021 - 2025: bunkersales-2021-2025.pdf
IEA (2025), Renewable Energy Progress Tracker, Renewable Energy Progress Tracker – Data Tools - IEA

Biofuel bunkering operations have taken place in more than 60 different ports since 2015

FAME and HVO are fundamentally different fuels with distinct properties

Comparison of selected fuel characteristics for pure FAME and HVO, using MGO as the baseline

(Baseline: MGO)	FAME	HVO
Energy content	Lower	Comparable
Cetane number	Comparable	Higher
Density	Comparable	Slightly lower
Viscosity	Slightly higher	Slightly lower
Material compatibility	Incompatible with certain materials*	Comparable
Flash point	Higher	Comparable
Lubricity	Good**	Poor
Cold flow properties* **	Poor	Good / Comparable
Storage stability	Poor	Good / Comparable

*Corrosive activity varies with quality indicators such as acidity; **FAME maintains good lubricity despite having a very low sulfur content; ***Cloud Point (CP), Pour Point (PP), and Cold Filter Plugging Point (CFPP)

Fatty Acid Methyl Ether (FAME):

- often referred to as biodiesel
- relatively good combustion and lubricity properties
- poses some challenges compared to standard oil fuels, particularly in terms of stability (degradation), corrosivity, and cold flow properties

Hydrotreated Vegetable Oil (HVO):

- often referred to as renewable diesel
- compared to MGO, HVO has a similar flashpoint, good cold temperature tolerance, robust stability and oxidation properties, and is generally comparable in terms of microbial growth or materials compatibility

Industry experience so far indicates that use of FAME and HVO generally proceed without significant problems (blends and pure products), provided that appropriate preparations and measures are taken

Sources: IEA (2025), Renewable Energy Progress Tracker, Renewable Energy Progress Tracker – Data Tools - IEA

Summary

1. GHG regulations will likely boost biofuel demand in shipping, but today the main push comes from cargo owners aiming to cut Scope 3 emissions

2. Global biofuel production reached ~160 Mtoe in 2024; GHG saving and sustainability criteria will impact the share of supply eligible for use in shipping

3. Biofuels accounted for 0.7 Mtoe or 0.2–0.3% of shipping's total energy consumption in 2024, bunker sales in Singapore and Rotterdam suggests rising use

4. Industry experience so far indicates that use of FAME and HVO generally proceed without significant problems (blends and pure products), provided that appropriate preparations and measures are taken

Thank you for listening

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