Biofuels and Ammonia studies: Overview of Cost Analysis

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Studies on Alternative Fuels/Power for Shipping

Ammonia and Biofuels

Overview of Cost Analysis

EMSA Alternative Fuels Workshop
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Agenda

1. Method and input TCO analysis
2. Analysis results
3. Discussion
4. Retrofitting
5. Closing the cost gap

Overview cost analysis

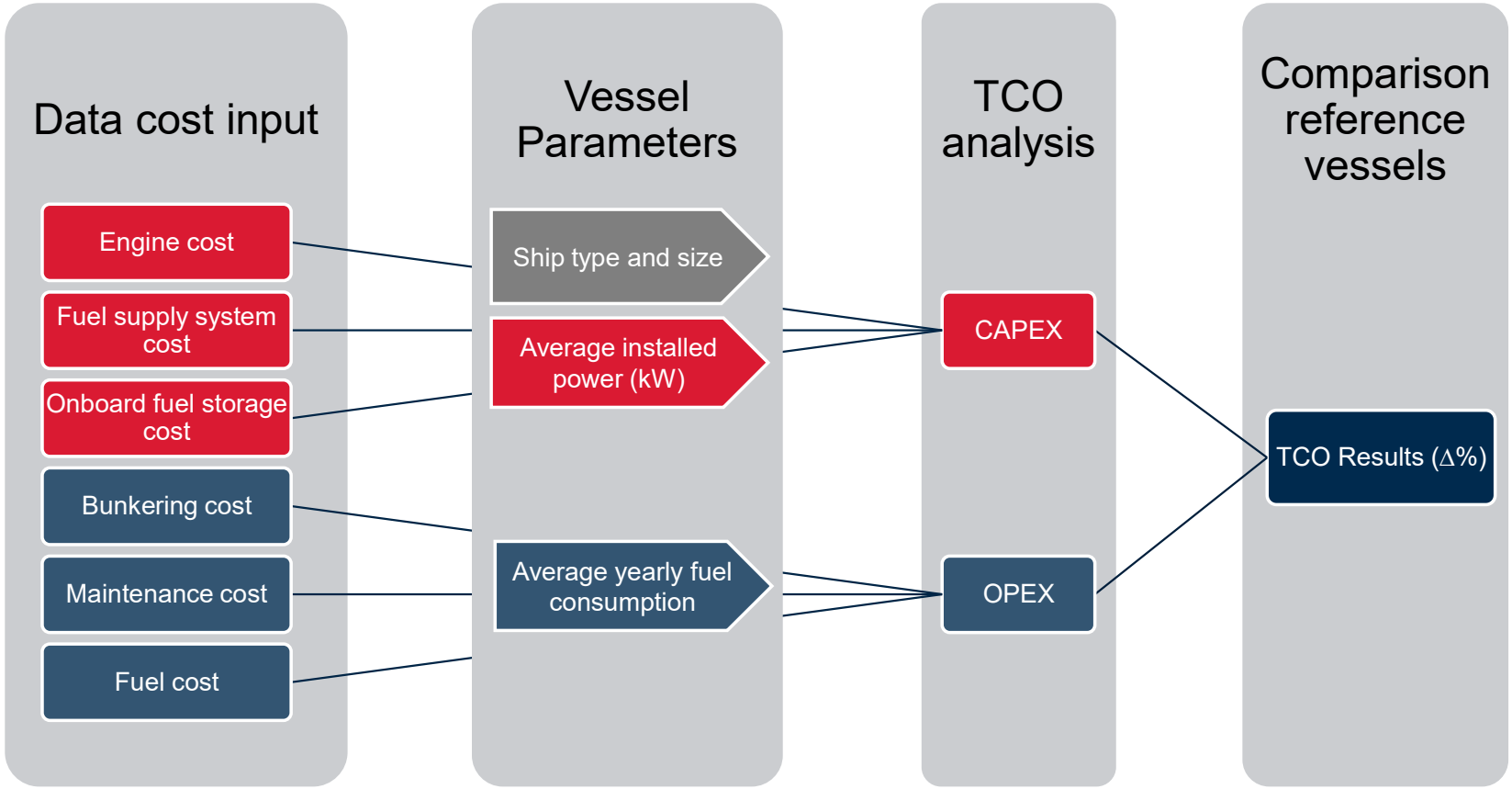
Retrofit TCO

- Approximation for certain vessel types
- Based on past industry retrofit cases

Newbuilding TCO

- Based on newbuilding cost data
- Cost modelling for several common vessel types

1. Method TCO analysis newbuilds

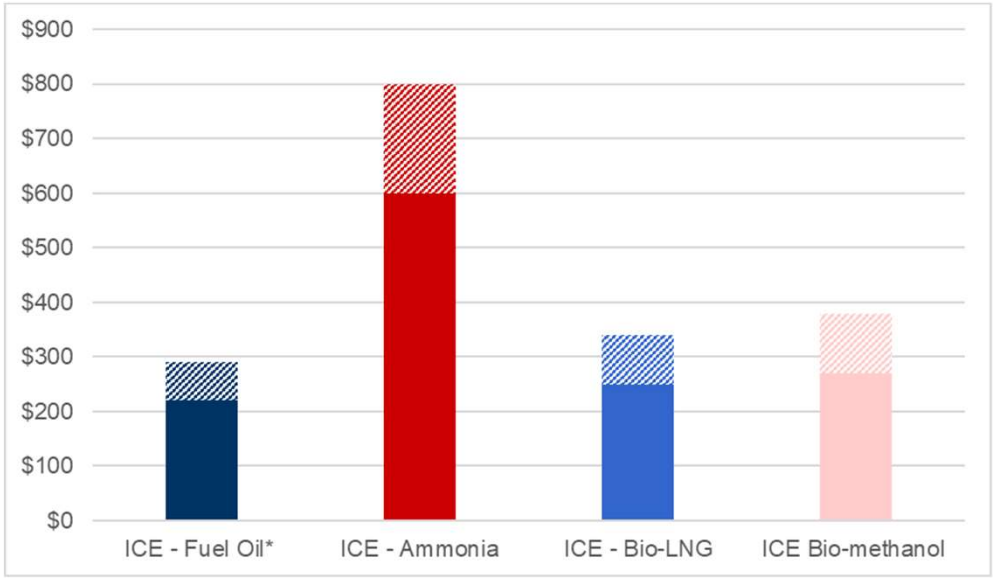


1. Method TCO analysis newbuilt vessels

- Main economic assumptions and CAPEX inputs

Parameter	Value	Unit
Vessel Operating Lifetime	25	years
Discount rate (WACC)	7,5	%

Fuel type	Engine cost per kW	Storage cost per kW
Fuel Oil*	220 - 290 USD	70 USD
Ammonia	600 - 800 USD	250 USD
Bio-methane	250 - 340 USD	110 - 250 USD
Bio-methanol	270 - 380 USD	70 - 110 USD



* Fuel oil include the fuel types: ULSFO, VLSFO, HFO, MGO, FAME, FT-Diesel

1. Method TCO analysis newbuilt vessels

Fuel cost is the main component of the TCO model for alternative fuels

- Modelling included low and high fuel price estimation
- Cost trends given by previously available studies
- No carbon pricing incorporated (ETS)
- Based on projected production costs
  - Fossil fuels in line with EU projections
  - Energy and feedstock input price
- Competition for biomass may drive market prices

DB0

Fuel type	2020	2030		2050	
	Mid value	Low	High	Low	High
VLSFO	$ 6.60	$ 12,00	$ 36,00	$ 20,00	$ 59,00
Bio-methanol	$ 41.60	$ 33,00	$ 33,00	$ 26,00	$ 27,00
HVO/FAME/FT	$ 16.80	$ 17,00	$ 30,00	$ 18,00	$ 33,00
Biomethane (bio-LNG)	$ 23.20	$ 32,00	$ 32,00	$ 53,00	$ 53,00
Green Ammonia	$ 62.00	$ 44,00	$ 51,75	$ 33,00	$ 44,00
Blue Ammonia	$ 32.00	$ 26,00	$ 32,00	$ 32,00	$ 39,00

Sources: IRENA, IEA, FuelEU Maritime, EC EU ETS IA

Slide 7

DB0 Julius, can you please add some references here ?
Daniel Barcarolo, 2022-10-08T07:20:49.779

DB0 0 We also need to put something here on what is driving the costs
Daniel Barcarolo, 2022-10-08T07:25:50.840

2. Analysis results

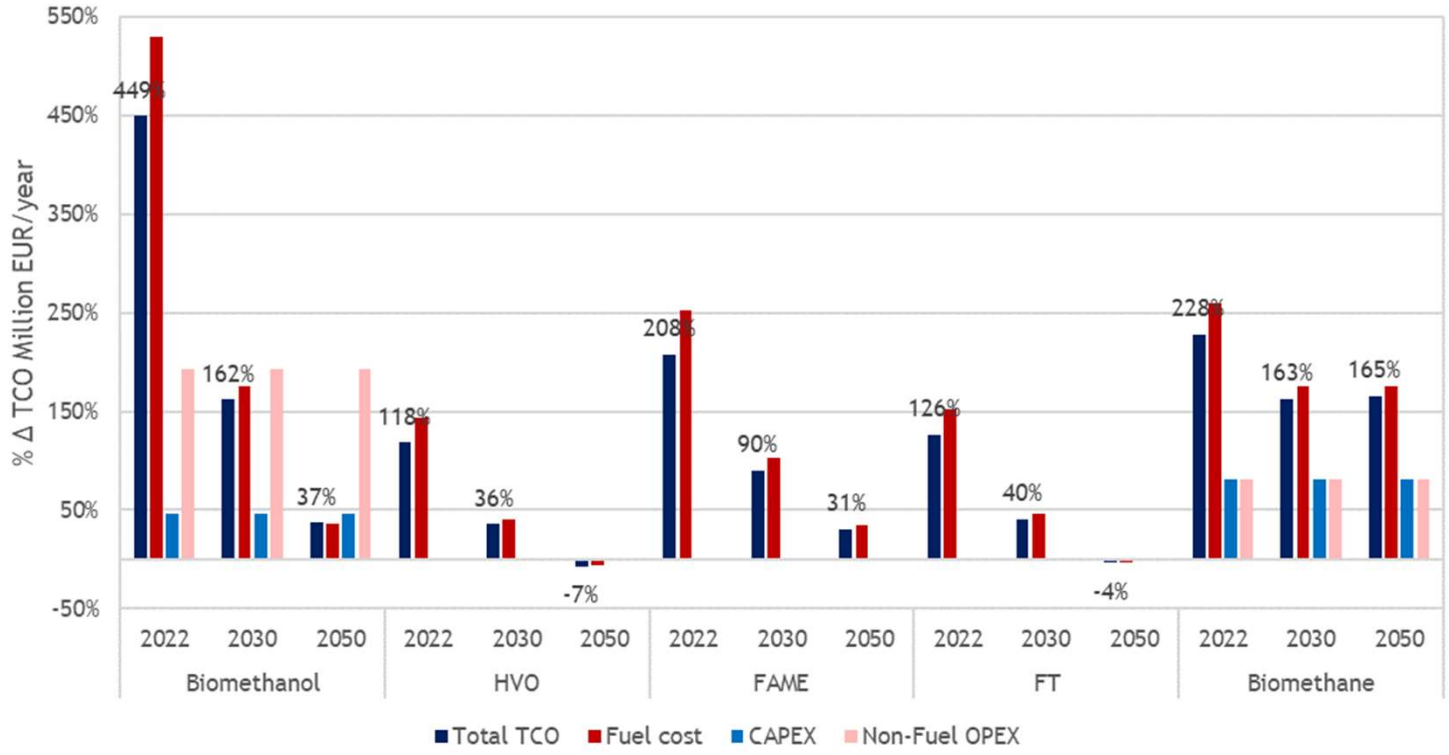
- Yearly TCO for common vessel types: bulkers, containerships, tankers
- Detailed view on TCO for mid-sized bulkers (40kDWT) and container ships (20kTEU)
- Cases including increased bunkering vs increased fuel storage (descrease of cargo volume)

- Comparison of TCO alternative fuelled vessel and per cost component
  - CAPEX for alt fuels significantly higher
  - Fuel cost several times higher

2. Analysis results - TCO Biofuel fuelled vessel

Bio-fuels

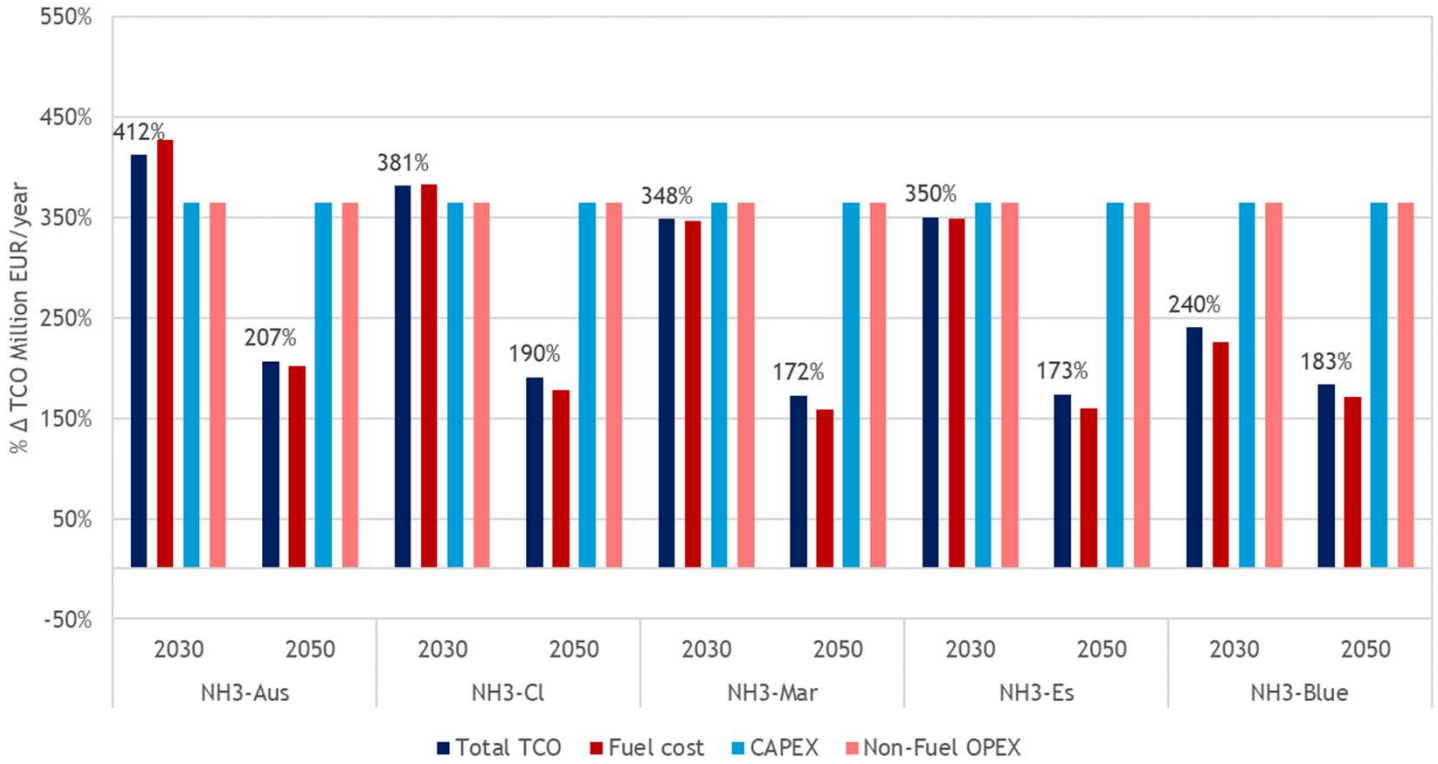
Bulk carrier 35,000-59,999 dwt – TCO difference to VLSFO vessel



2. Analysis results - TCO Ammonia fuelled vessel

NH_3

Bulk carrier 35,000-59,999 dwt – TCO difference to VLSFO vessel



3. Discussion results

Uptake of Biofuels

- Drop-in cost-effective reduction
- No major technical modifications
- Biomass availability and competition

Uptake of Ammonia

- Zero-carbon taill pipe emissions
- Major costly technical modifications
- Green energy production and transportation of NH3

4. Fuel - Retrofits

Retrofit consideration and challenged are many:

- Retrofit is always more expensive than a newbuild, increase CAPEX needs to be considered
- The ship is not origianlly designed for the alternative fuel, challenged on space and loss of cargo.
  - Shorter range and thereby smaller tanks can be selected
  - Ships design can have been prepared for a later retrofit.
- Shorther lifetime of the ship compared to a newbuild, shorther pay-back time.
- Retrofit is associated with a higher risk as it is a tailor-made design made to an old ship.
- Retrofit engines are expected not fully optimized, auxiliary systems are not calibrated.

Type of vessel	Fuel type conversion	Additional cost to newbuilt CAPEX	Indicative ship conversion cost* (million USD)	Indicative ship conversion cost* (million EUR)
Medium-sized Containership	Fuel oil to biomethanol	~13-17%	19.0 – 25.0	16.6 – 21.8
Medium-sized Containership	Fuel oil to biomethane	~15-20%	22.0 – 30.0	19.2 – 26.2

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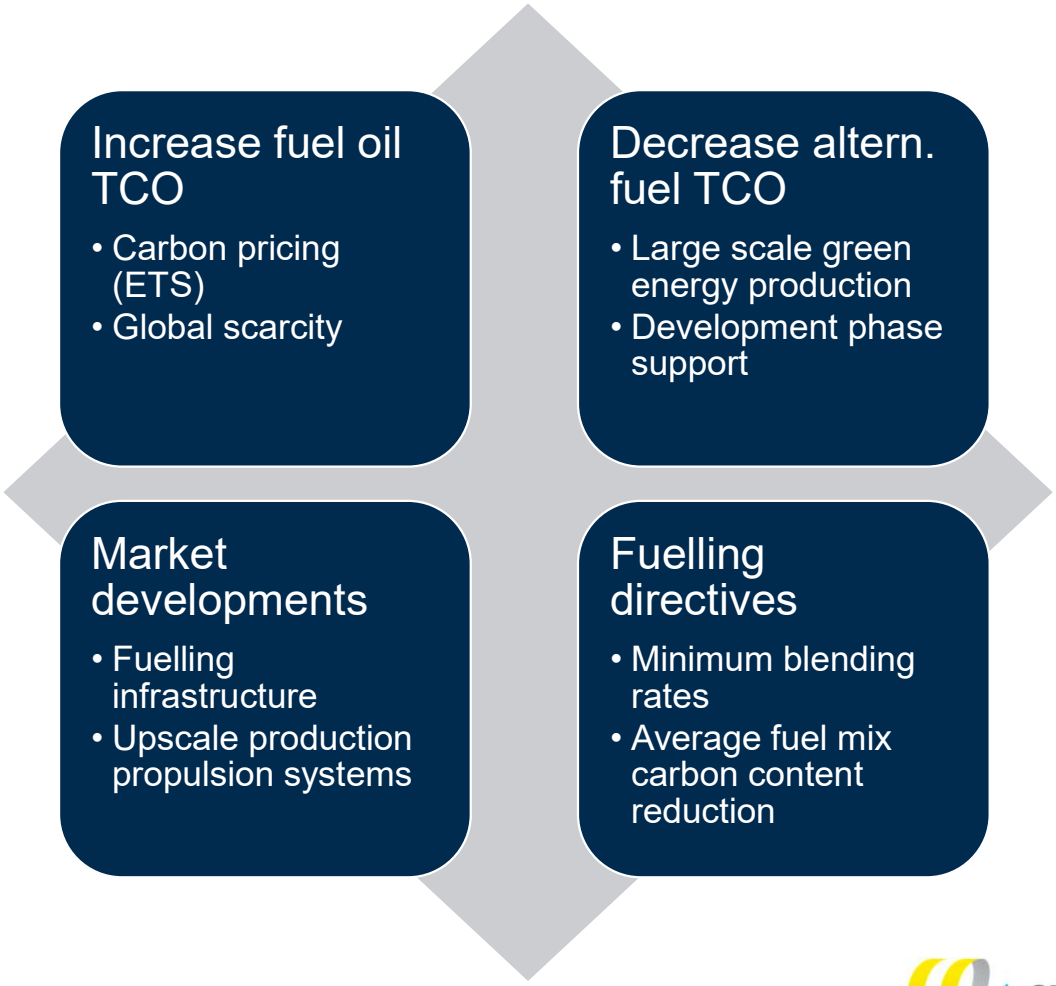
5. Closing the cost gap



Thank You

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Assumption details

Engine cost input

Ship category	Fuel type	Ship size	Engine cost per kW	Storage cost per kW
Small vessels	Fuel Oil*	All vessel types* with size up to 15,000 dwt	290 USD	70 USD
Large vessels	Fuel Oil*	All vessel types* with size above 15,000 dwt	230 USD	70 USD
Containerships	Fuel Oil*	All sizes containerships	220 USD	70 USD
Short-sea vessels	Ammonia	All vessel type with size up to 2,500 dwt	800 USD	250 USD
Deep-sea vessels	Ammonia	All vessel types with size above 2,500 dwt	600 USD	250 USD
Short sea vessels	Biomethane	All vessel type with size up to 15,000 dwt	340 USD	250 USD
Deep sea vessels	Biomethane	All vessel types with size above 15,000 dwt	290 USD	110 USD
Containerships	Biomethane	All sizes containerships	250 USD	110 USD
Short sea vessels	Bio-methanol	All vessel type with size up to 15,000 dwt	380 USD	110 USD
Deep sea vessels	Bio-methanol	All vessel types with size above 15,000 dwt	320 USD	70 USD
Containrships	Bio-methanol	All sizes containerships	270 USD	70 USD

* Fuel oil include the fuel types: ULSFO, VLSFO, HFO, MGO, FAME, FT-Diesel
[a] Storage sufficient for 30 days continuous sailing is assumed

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Assumption details

Volumetric Energy density alternative fuels & factor increased bunkering

Fuel type	MJ/L	Volumetric density % of VLSFO	Factor increased bunkering
VLSFO	36	100.0%	1.00
Bio-methanol	15	41.7%	2.40
HVO/FAME/FT	32	88.9%	1.13
Biomethane (bio-LNG)	13	36.1%	2.77
Ammonia	11	30.6%	3.27