



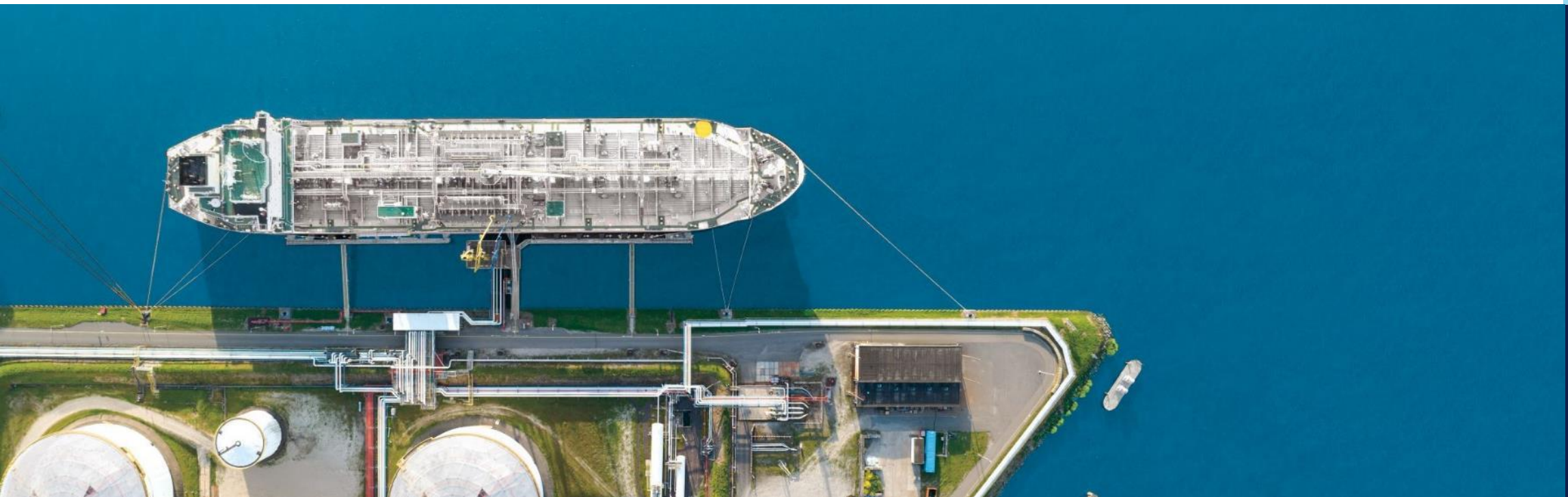
WHEN TRUST MATTERS

Maritime Forecast to 2050

Energy Transition Outlook 2022

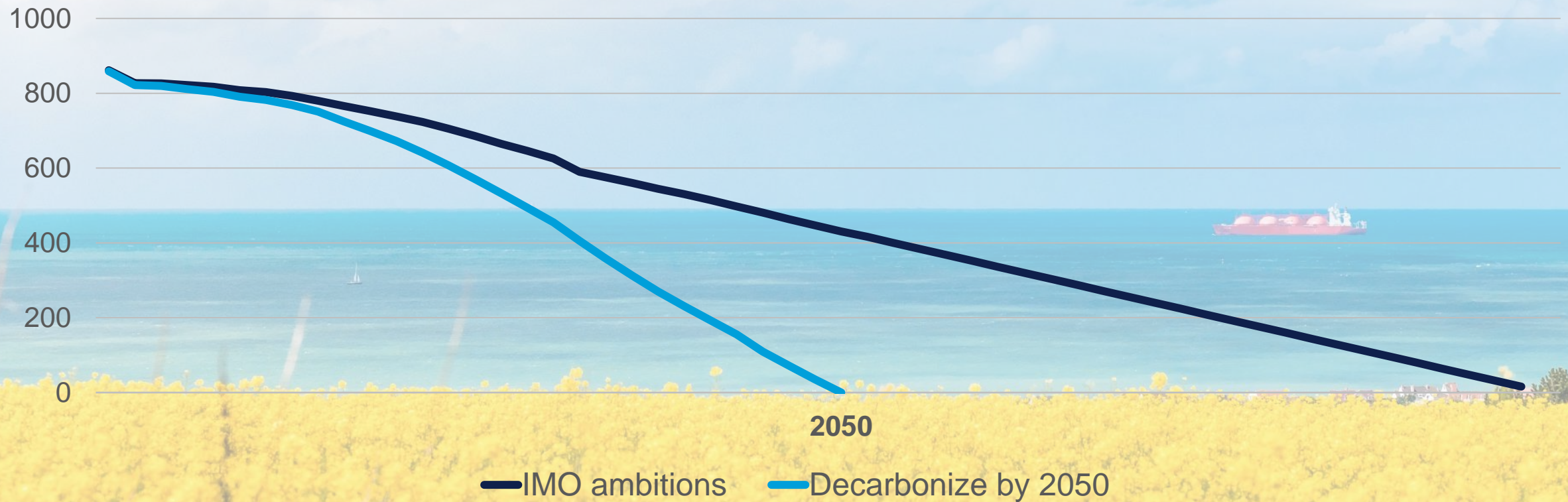
Jakub Walenkiewicz, Principal Market Analyst

24 October 2022



Shipping must decarbonize, but the pace of the transition is unclear

World fleet CO2 emissions (million tonnes)



Maritime Forecast to 2050 – key findings

The fuel transition in shipping is accelerating, and key fuel technologies needed will be available in 3-8 years

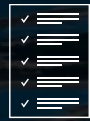
The fuel transition at sea hinges on developments on land, fuel availability and cost become key challenges

The transition will require large onboard investments, but even greater onshore investments

The future fuel mix is highly dependent on fuel price and policy ambitions

Shipowners need transition plans reflecting the uncertain future, and fuel-flexible solutions providing robustness and reducing carbon-risk

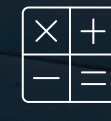
Maritime Forecast report explores the future fuel mix and implications for decisions made today



Drivers
regulations



Onboard
technology



Fuel availability
and cost

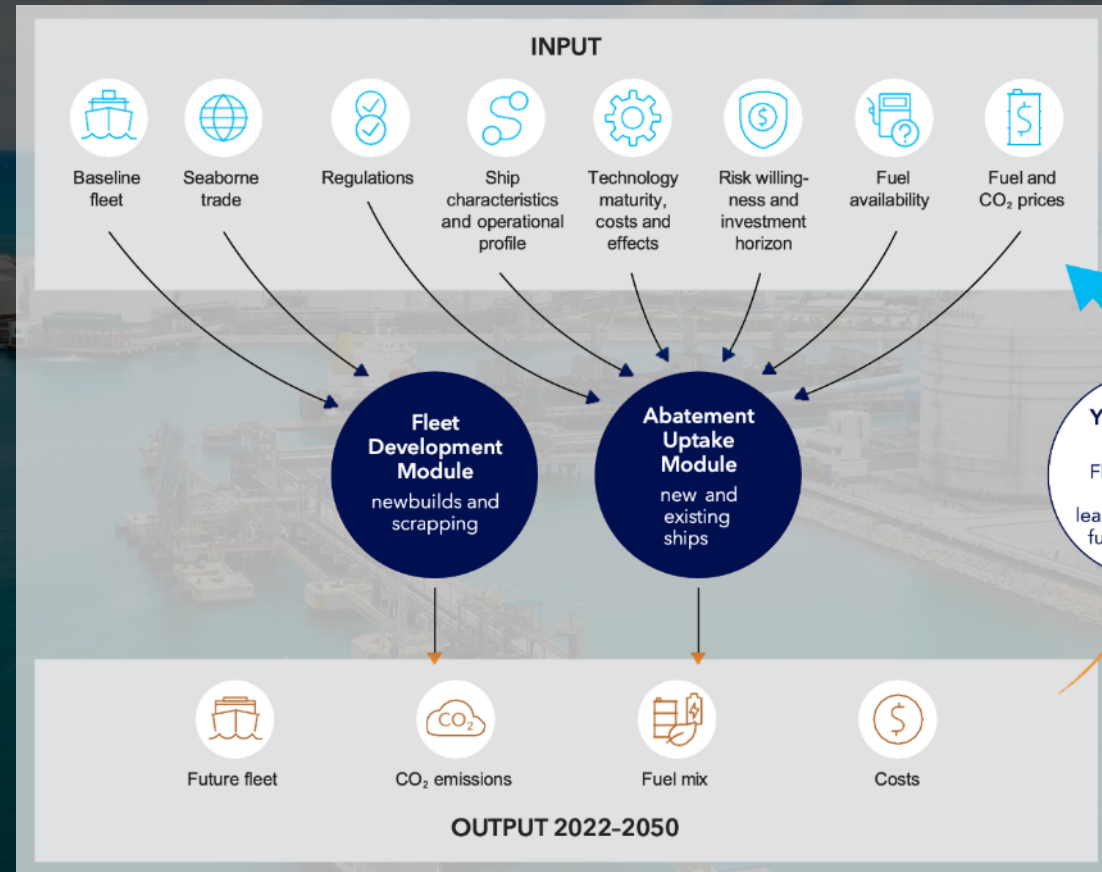


Fuel uptake
scenarios



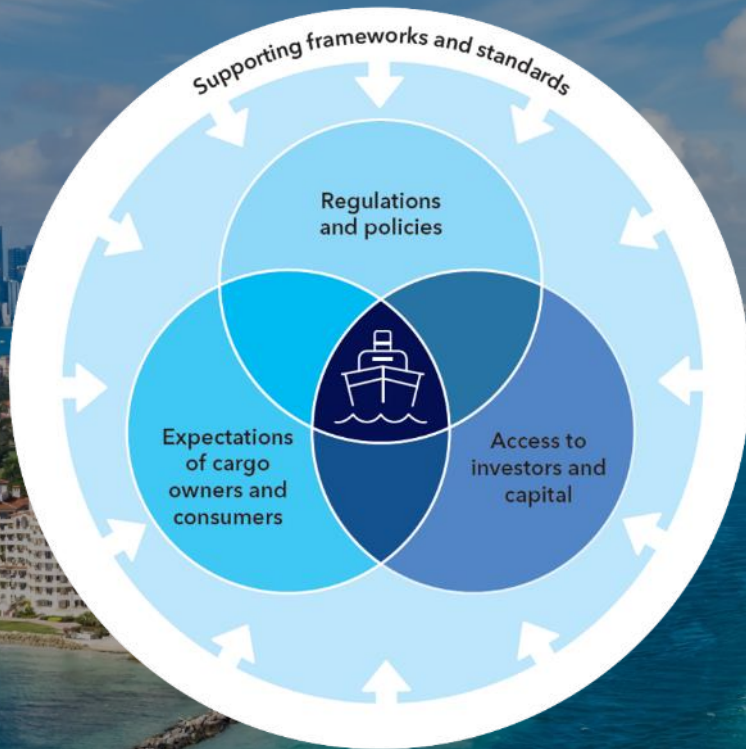
Decision-making
support

DNV's GHG Pathway Model enables understanding of the complex landscape



Emerging frameworks and standards enable regulators, cargo owners and investors to drive decarbonization

By 2030, 5% of fuel will have to be carbon-neutral



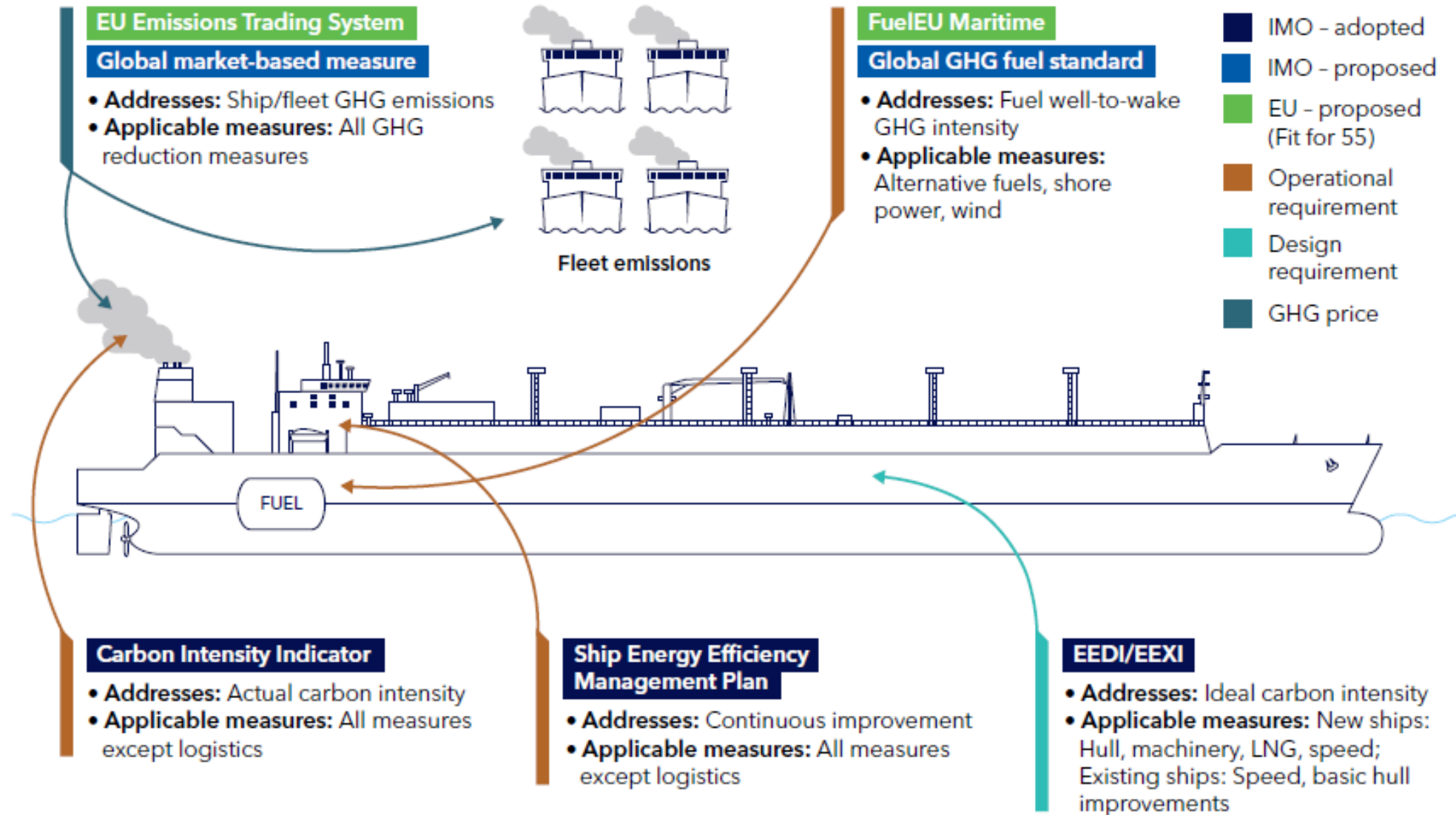
IMO's ambitions will be reviewed and could be strengthened to decarbonize shipping by 2050

Lifecycle GHG emissions standards are being developed to ensure fuel sustainability

Major cargo owners expect low- and zero-emission shipping services to be in place this decade

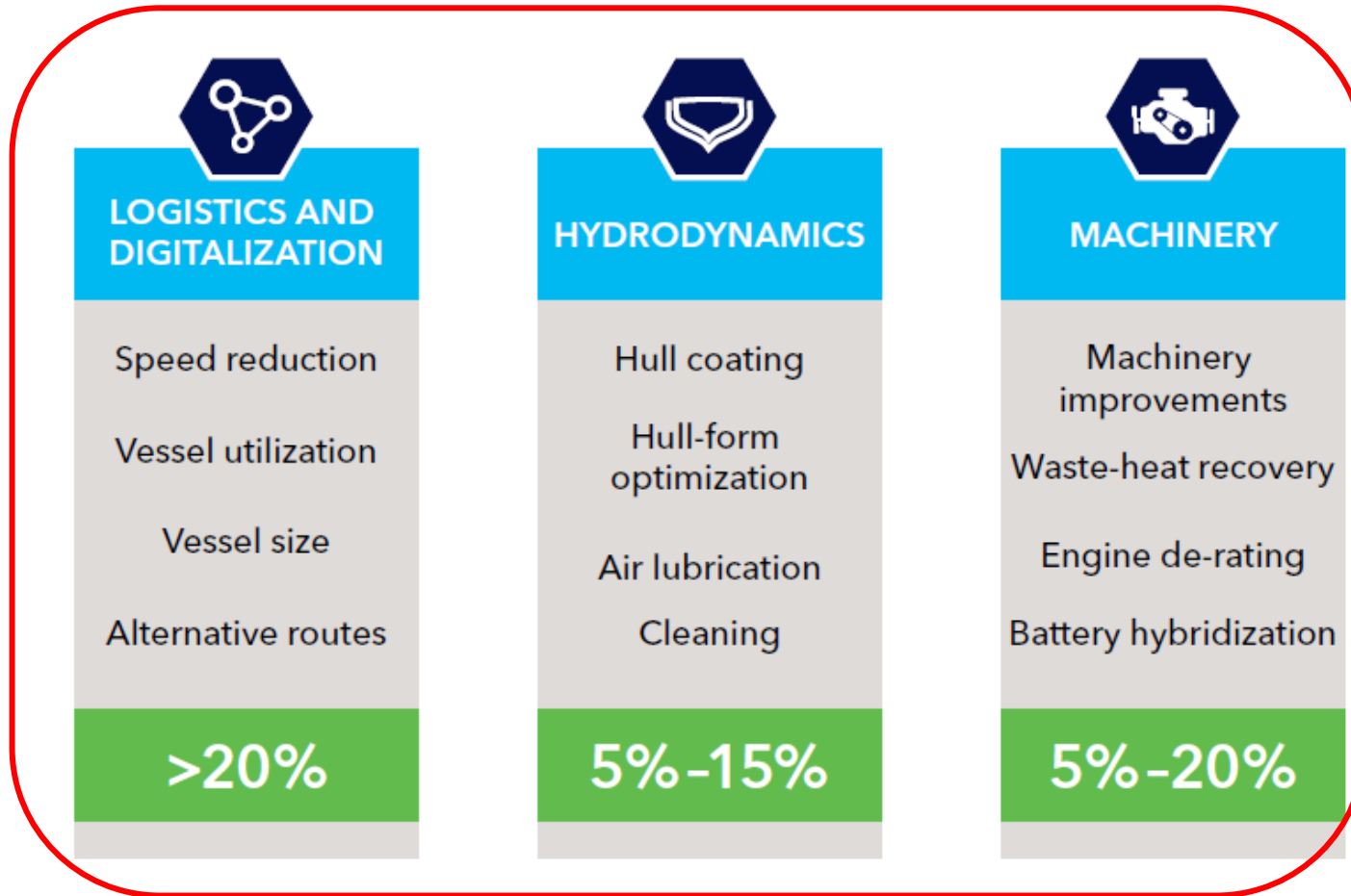
Access to capital depends increasingly on environmental credentials

The pressure is on to build and run compliant, low emission vessels

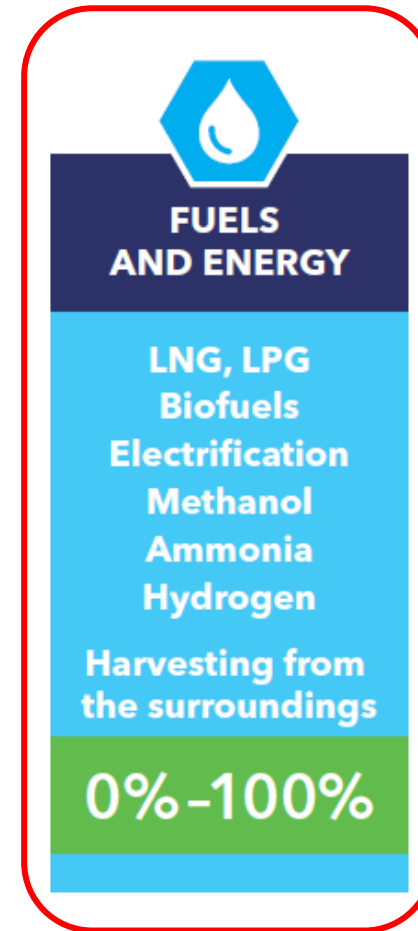


What are our options?

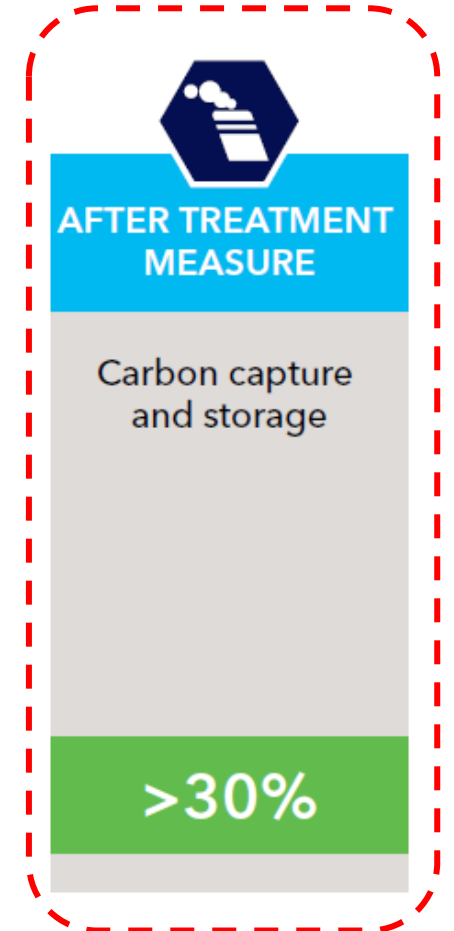
Reduce energy consumption



Low-carbon energy



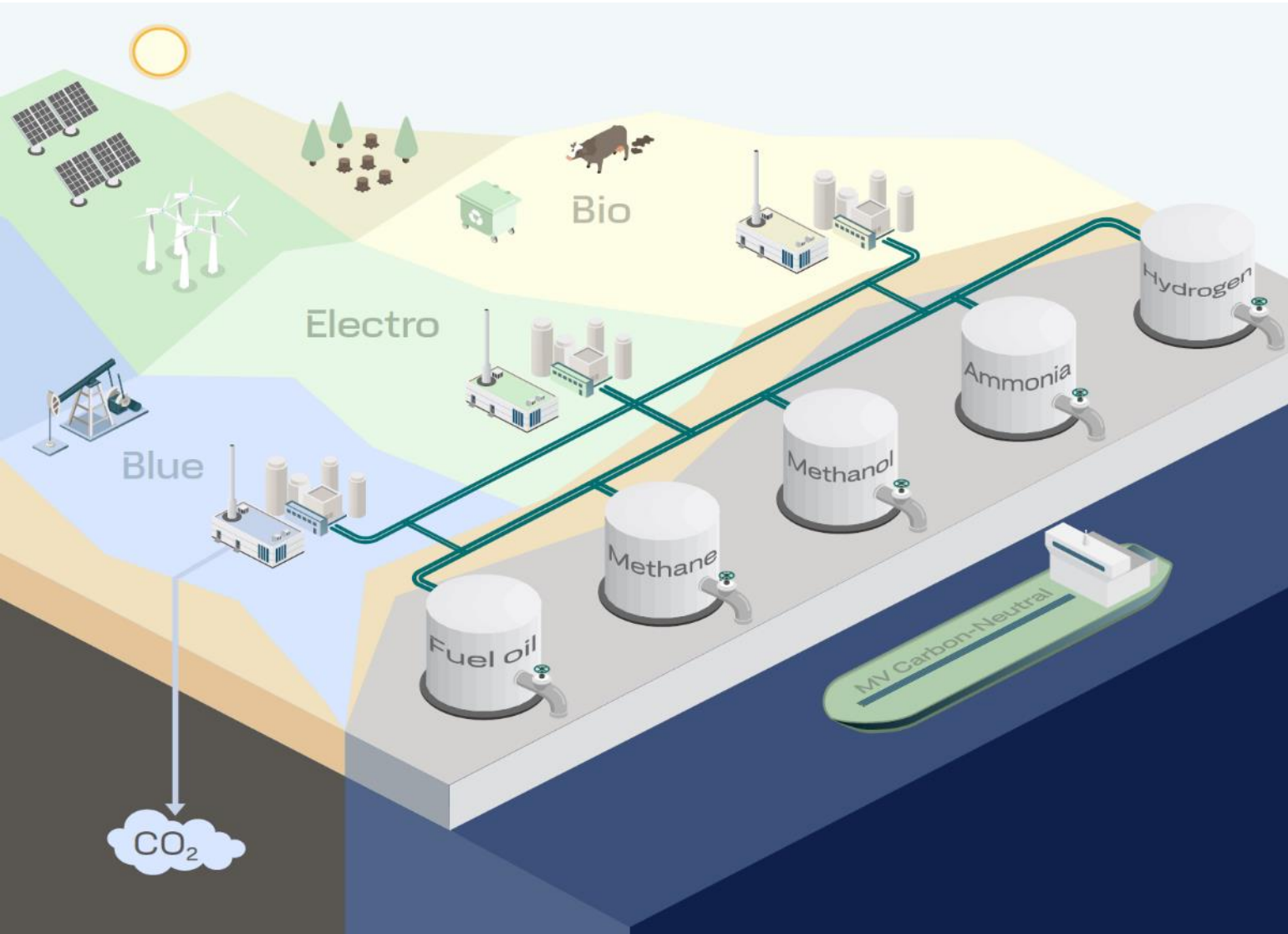
Clean up exhaust



Key fuel technologies will be available in 3-8 years



Shipping needs to switch to carbon-neutral energy supply chains



Sustainable biomass for biofuels

Renewable electricity for electrofuels

Sustainable carbon for carbon-based electrofuels

Large scale CCS

The energy converters, fuel options and transitions allowed in DNV's GHG Pathway Model

FUEL CELL AND FUEL SYSTEM ENGINE						Blue ammonia	Blue hydrogen	
		e-MGO	e-LNG		e-methanol	e-ammonia	e-hydrogen	Electricity from grid
		bio-MGO	bio-LNG		bio-methanol			
	HFO	VLSFO/MGO	LNG	LPG				
MF ICE	⚙️	✅	⚙️	⚙️	⚙️	⚙️		
MF ICE with scrubber	✅	✅	⚙️	⚙️	⚙️	⚙️		
DF LNG ICE		✅	✅		⚙️	⚙️		
DF LPG ICE		✅		✅	⚙️	⚙️		
DF methanol ICE		✅			✅			
DF ammonia ICE		✅				✅		
DF hydrogen ICE		✅					✅	
Hydrogen FC							✅	
Ammonia FC						✅		
Battery EM								✅

24 Key: Dual fuel (DF); electric motor (EM); fuel cell (FC); internal combustion engine (ICE); liquefied natural gas (LNG); liquefied petroleum gas (LPG); mono fuel (MF)



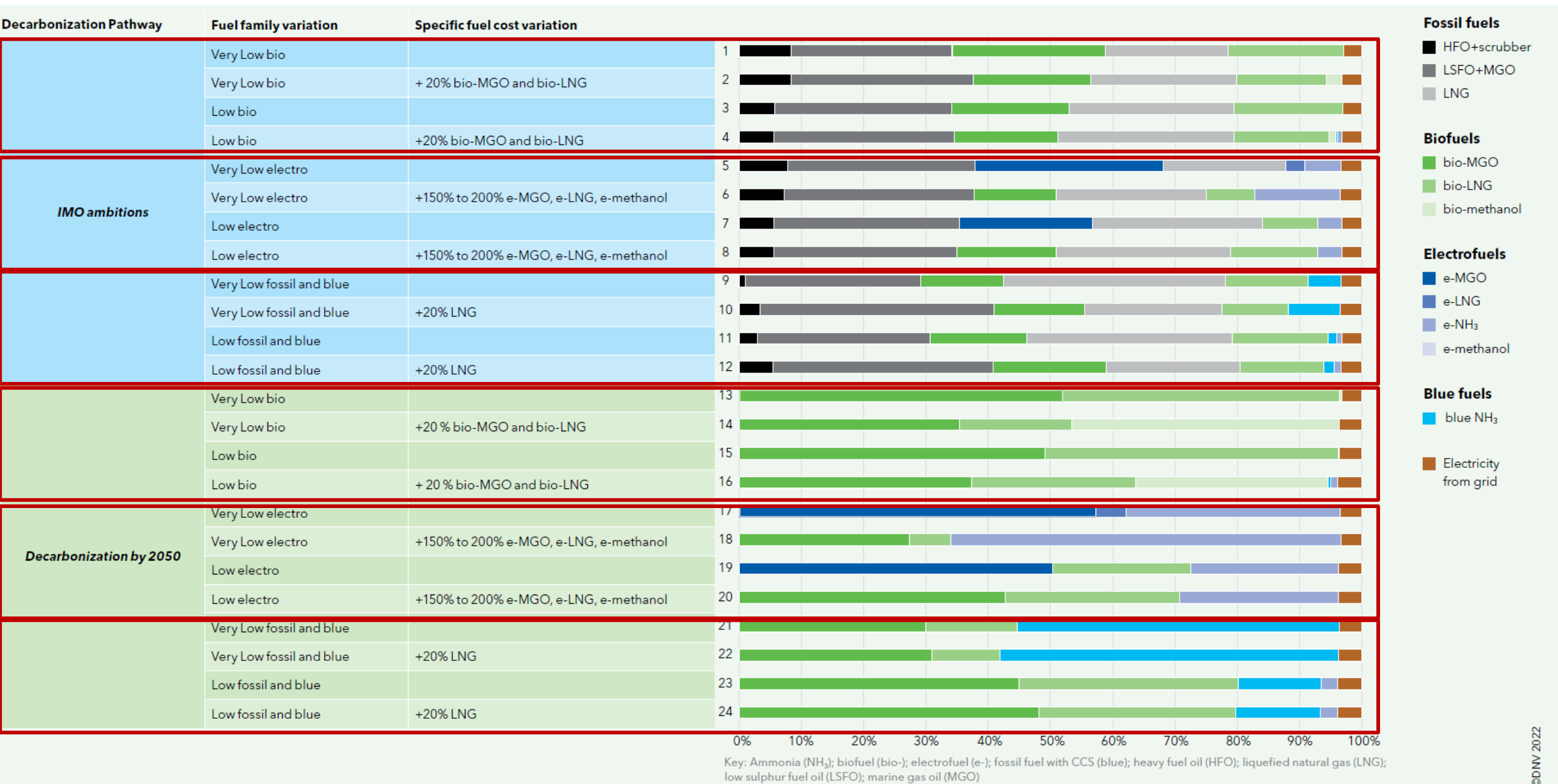
Drop-in



Retrofit

©DNV 2022

DNV presents 24 decarbonization scenarios exploring the future fuel-mix



To decarbonize shipping we must collaborate to increase the availability of all carbon-neutral fuels

Sustainable biomass



High availability

bio-MGO
bio-LNG
bio-methanol

Low availability

CCS

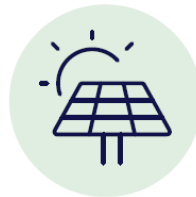


High availability

blue NH₃
blue H₂, compressed
blue H₂, liquefied

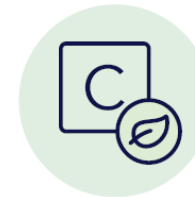
Low availability

Renewable electricity



High availability

Sustainable carbon



Low availability

High availability

e-MGO
e-LNG
e-methanol

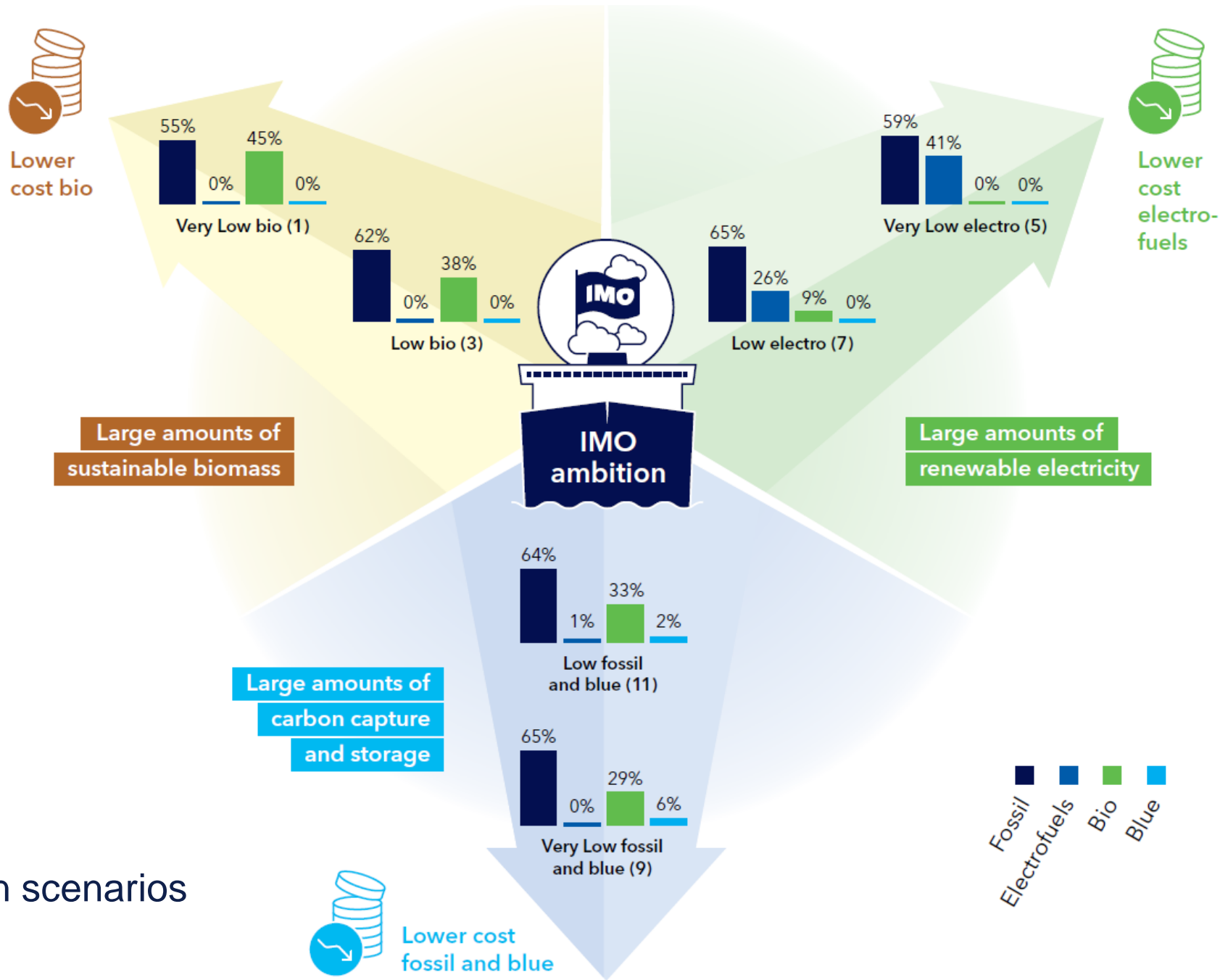
Low availability

e-NH₃
e-H₂, compressed
e-H₂, liquefied

Key: ammonia (NH₃); biofuel (bio-); carbon capture and storage (CCS); electrofuel (e-); fossil fuel with CCS (blue); hydrogen (H₂); liquefied natural gas (LNG); marine gas oil (MGO)

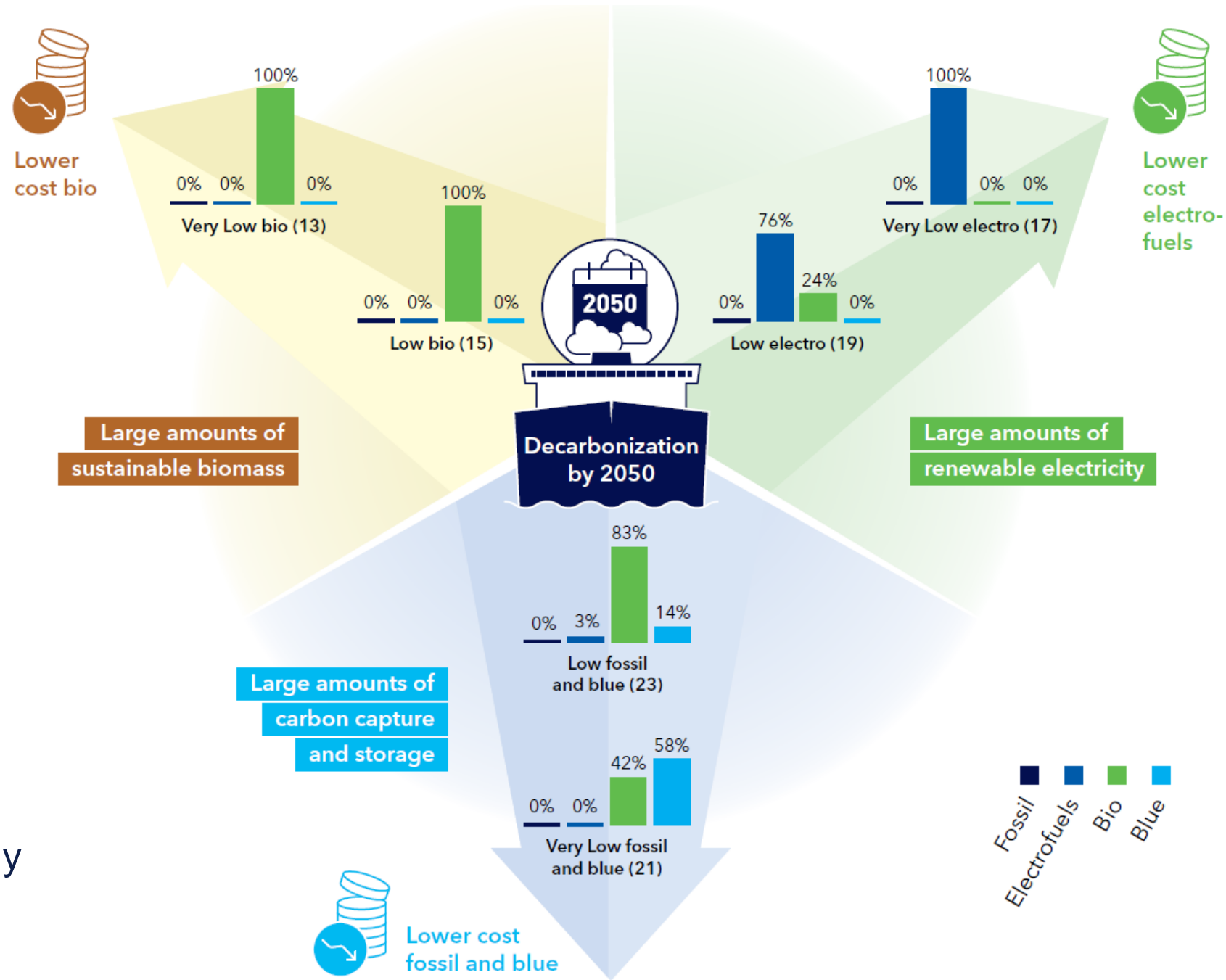
The 2050 energy mix

IMO ambitions family variation scenarios



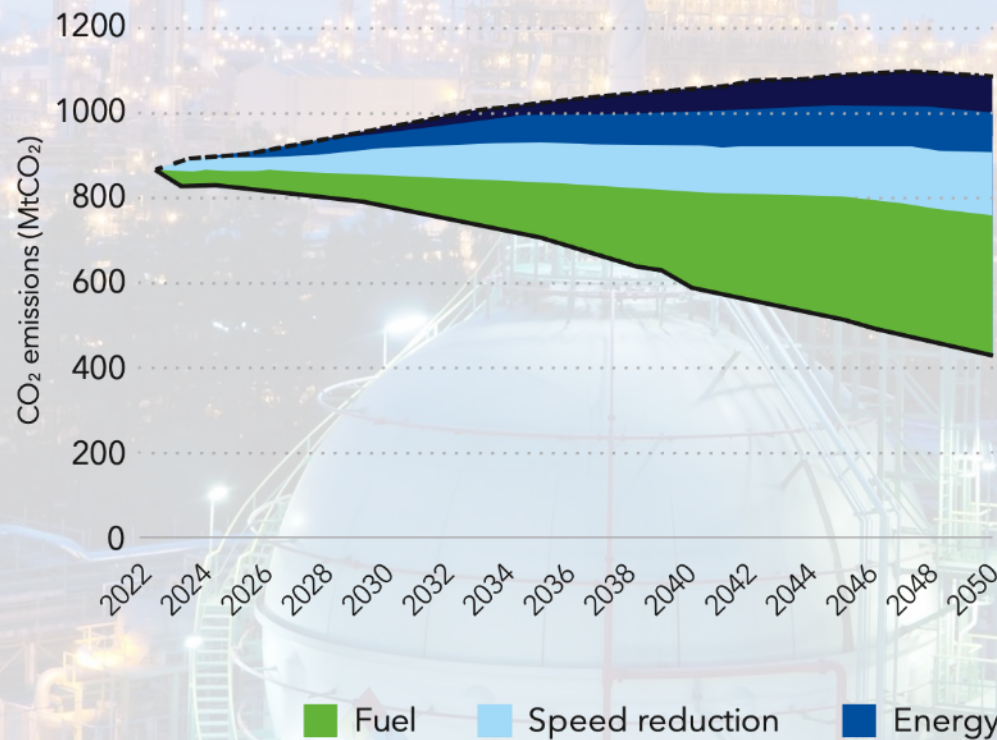
The 2050 energy mix

Decarbonization by 2050 family variation scenarios

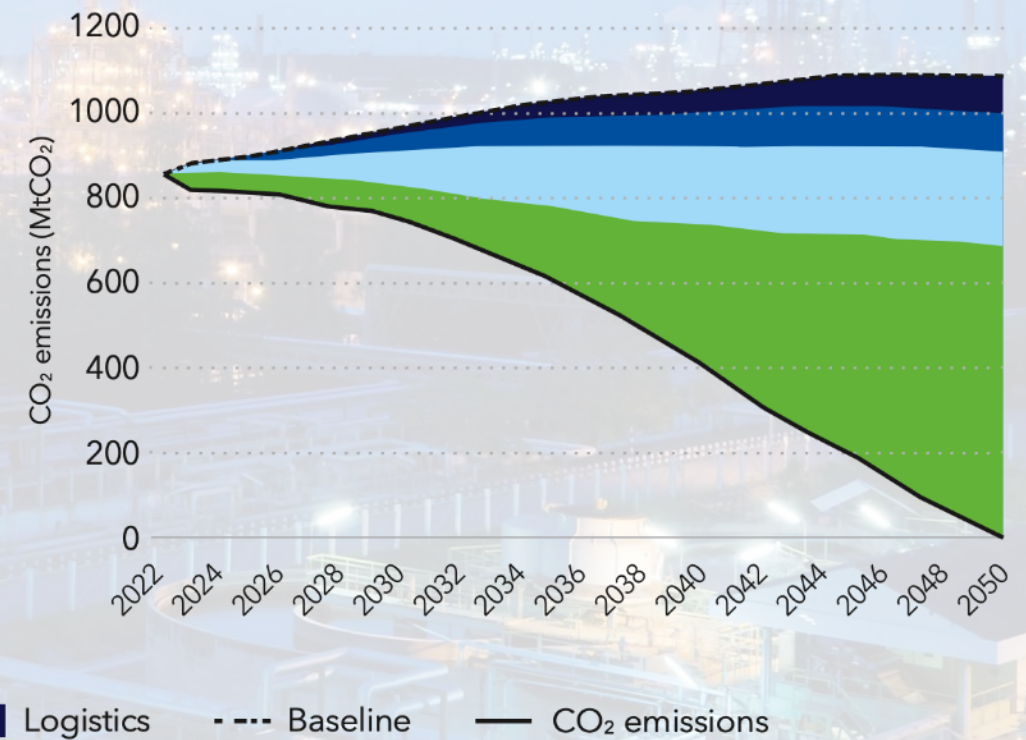


Energy efficiency is important, but carbon-neutral fuels are needed to decarbonize the world fleet

IMO ambitions scenario 7

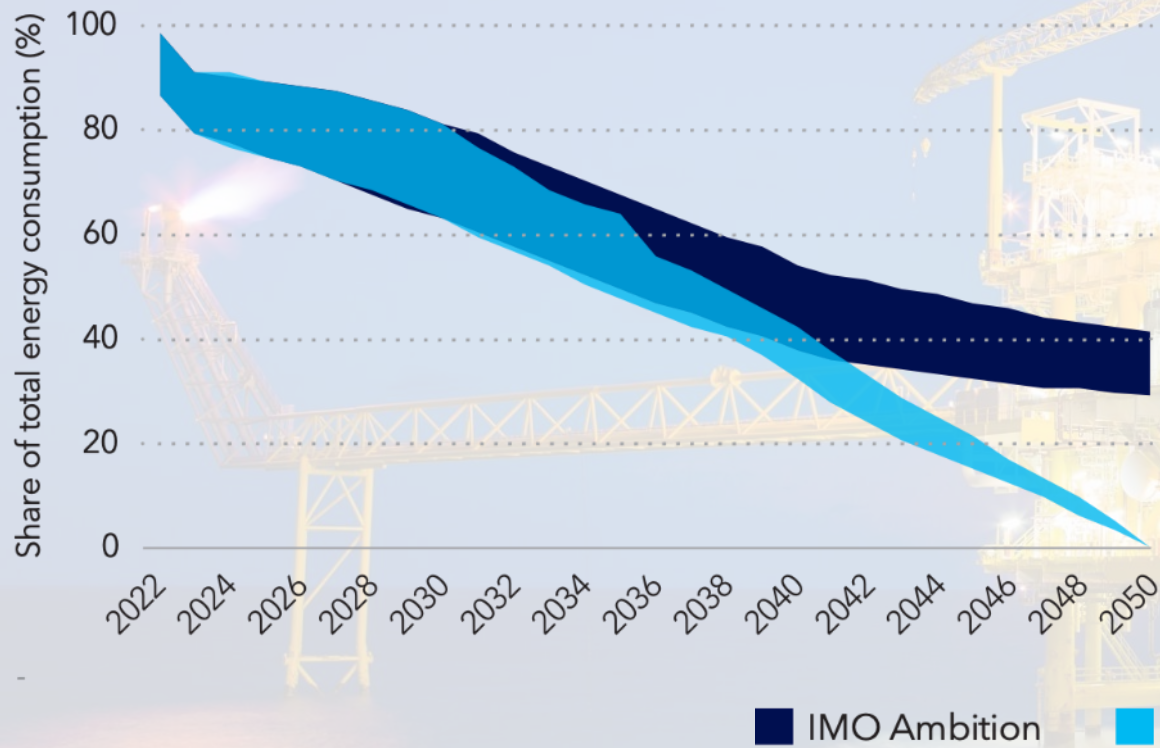


Decarbonization by 2050 scenario 19

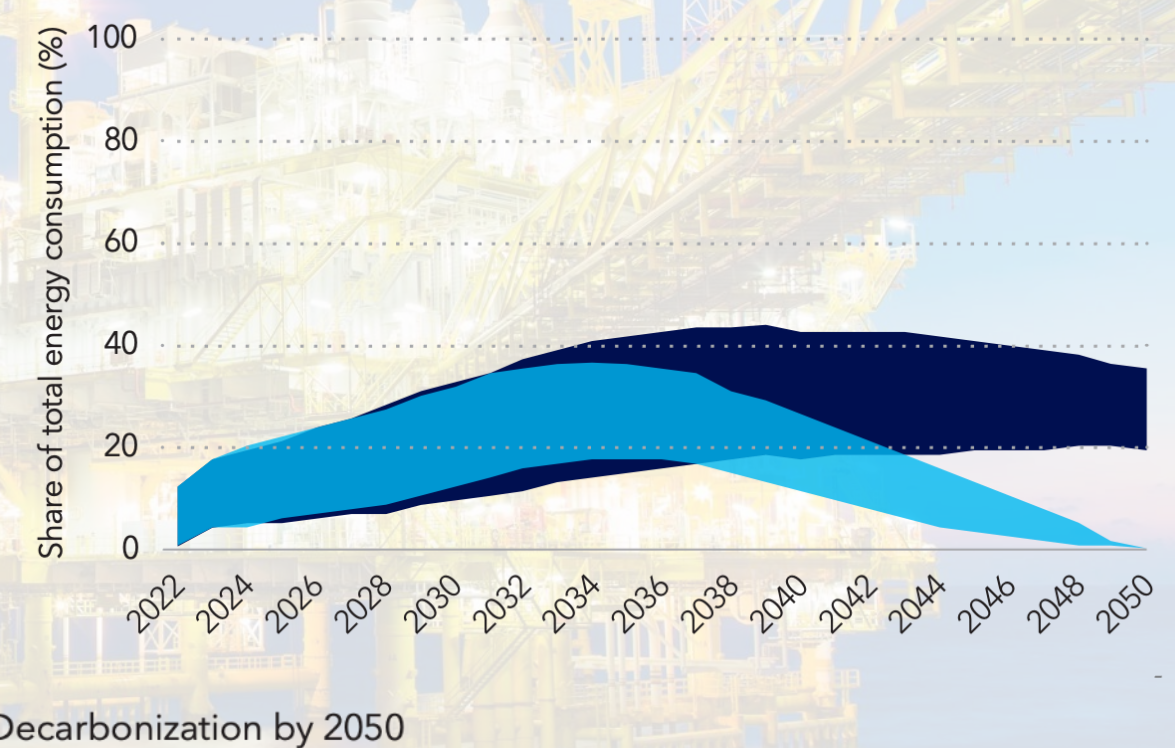


Fossil fuel use in shipping will decrease or be eliminated

Fuel oil (LSFO/MGO/HFO)



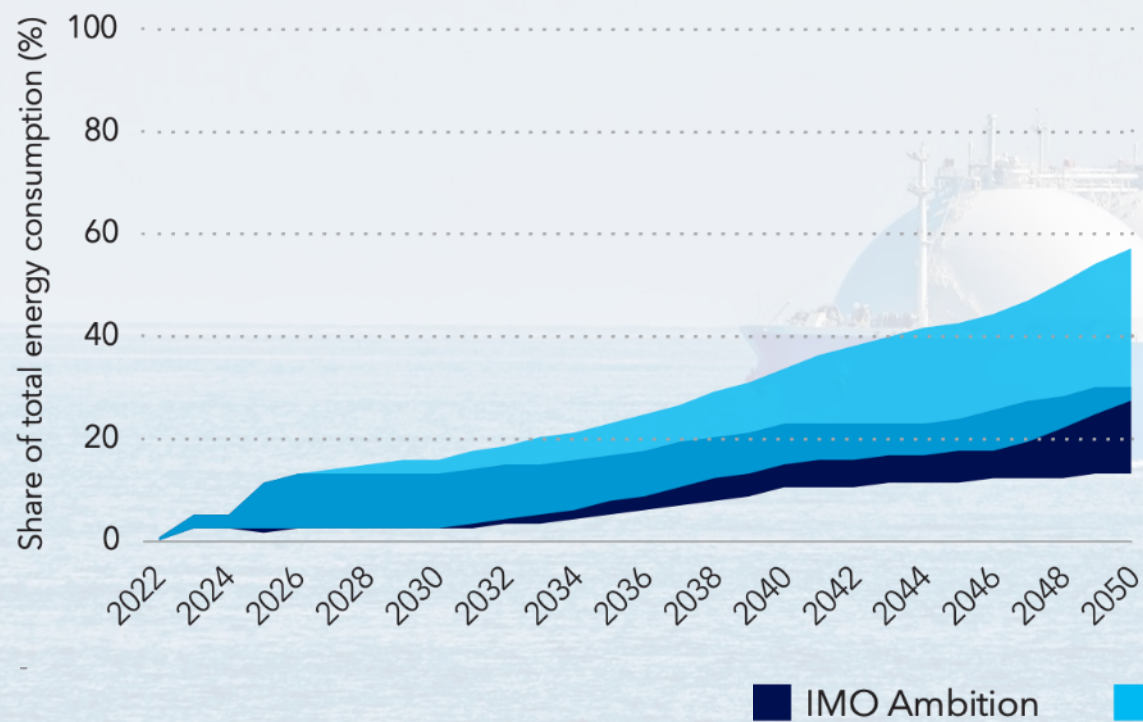
LNG (fossil)



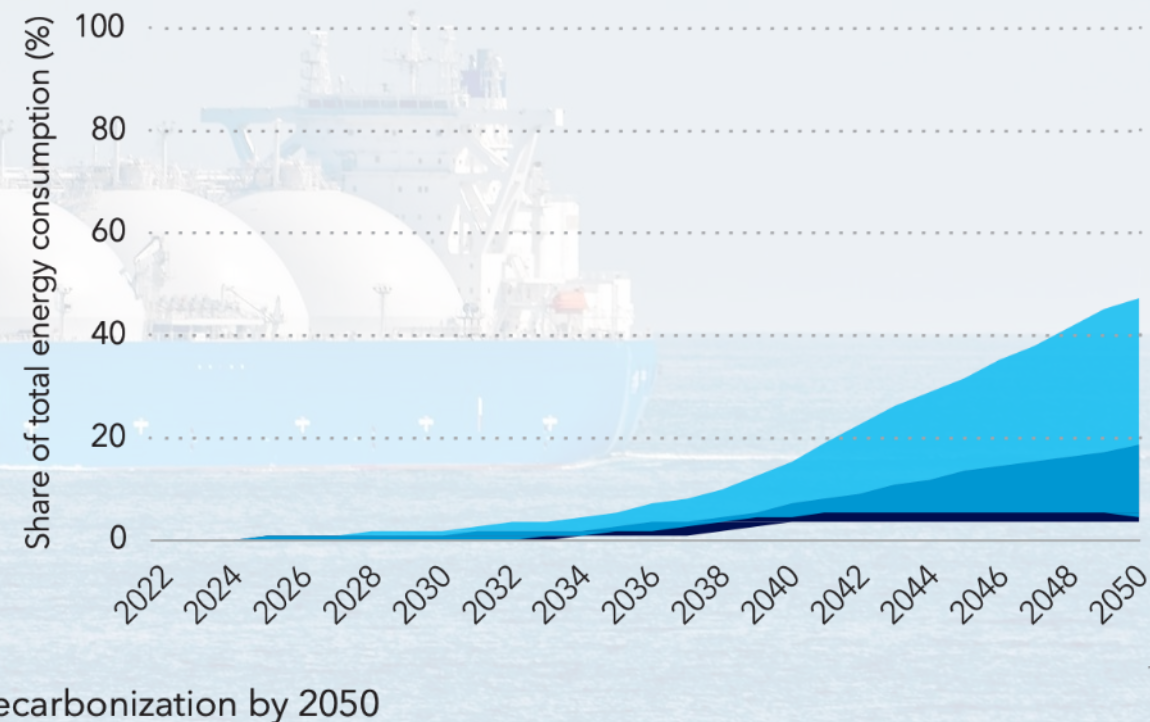
Hydrogen, compressed and liquified, is included in the model. Liquid organic hydrogen carrier, onboard CCS and nuclear are not included in the model.

Carbon-neutral LNG and MGO will largely replace fossil versions

MGO (carbon neutral)



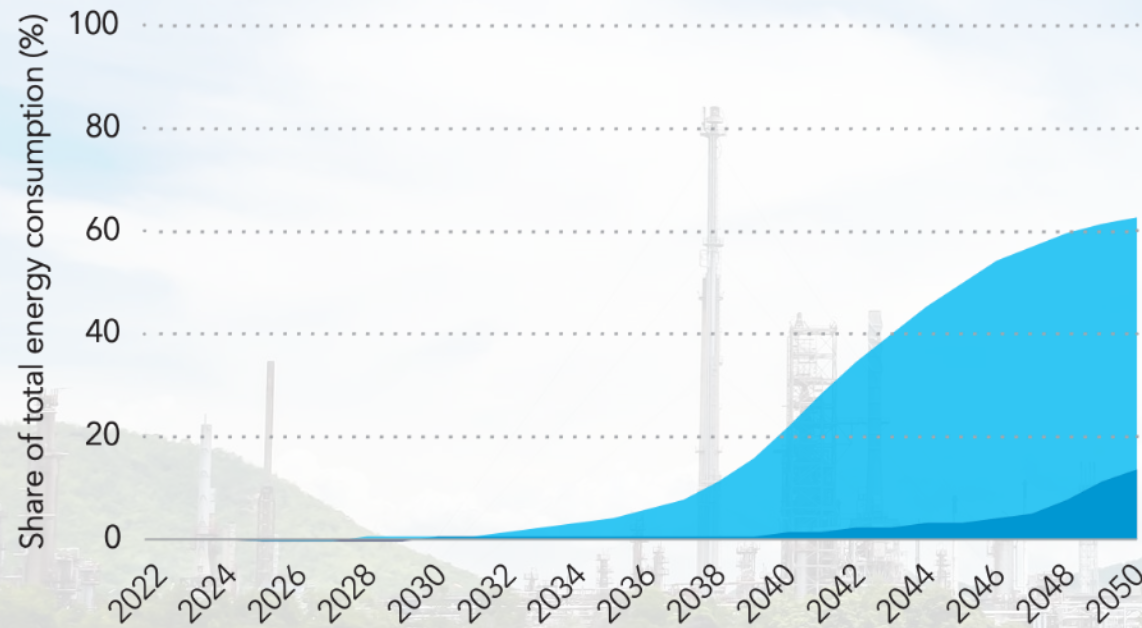
LNG (carbon neutral)



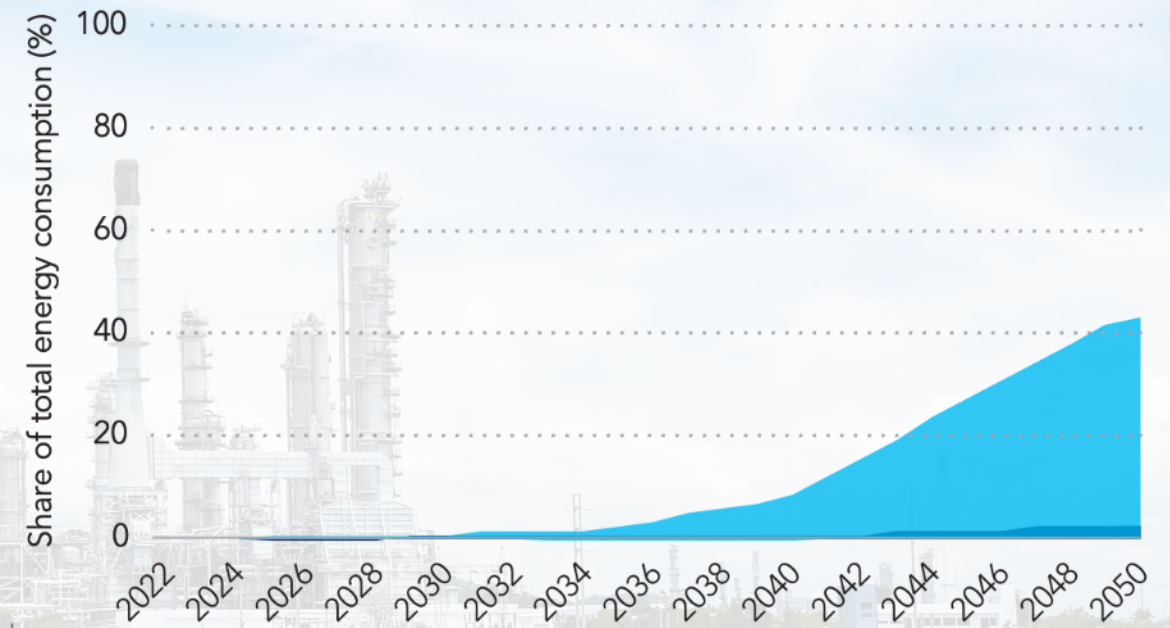
Hydrogen, compressed and liquified, is included in the model. Liquid organic hydrogen carrier, onboard CCS and nuclear are not included in the model.

Ammonia and methanol need to have significantly lower cost than carbon-neutral MGO to compete

Ammonia (carbon neutral)



Methanol (carbon neutral)



IMO Ambition



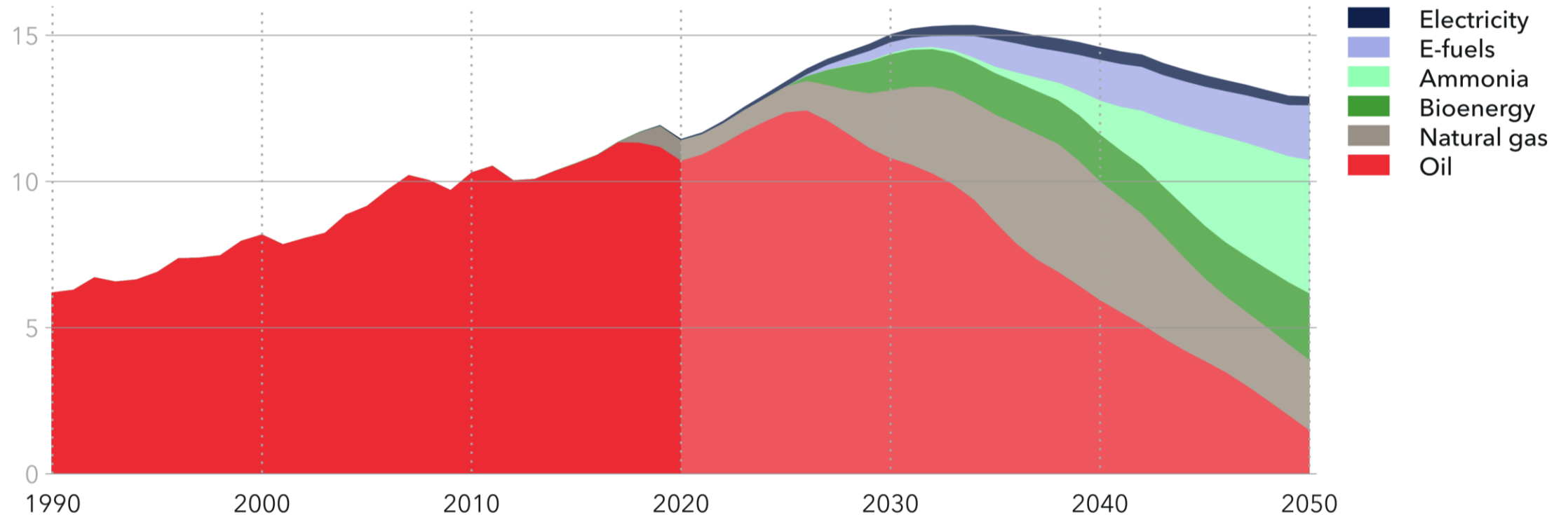
Decarbonization by 2050

Hydrogen, compressed and liquified, is included in the model. Liquid organic hydrogen carrier, onboard CCS and nuclear are not included in the model.

The maritime fuel mix will change dramatically

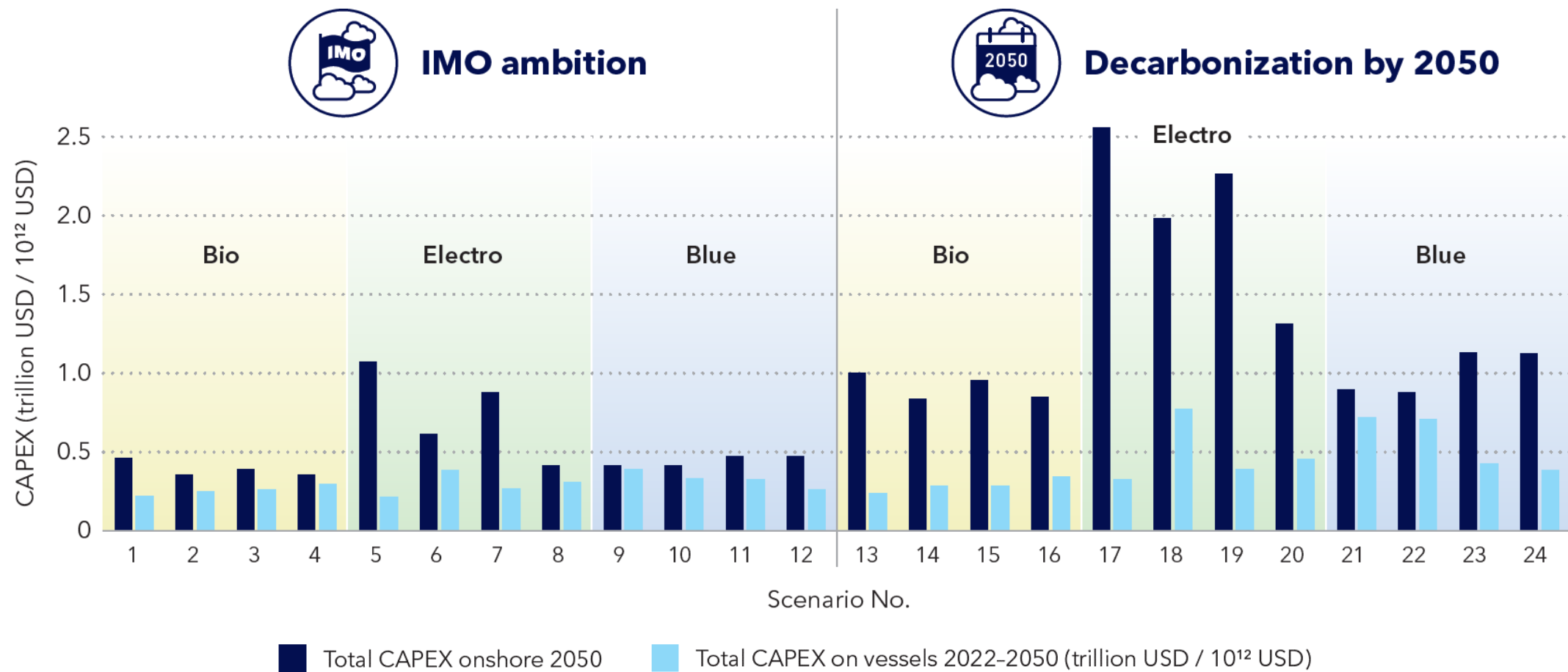
World maritime subsector energy demand by carrier

Units: EJ/yr



Natural gas includes LNG and LPG. Historical data source: IEA WEB (2022)

The transition entails large onboard investments, but even greater onshore investments



Maritime Forecast to 2050 – implications

The development of sustainable fuel-supply chains must be accelerated to achieve the transition, 5% carbon-neutral fuels are needed by 2030

It's required to have clear criteria for and increased production of sustainable biomass, renewable electricity, sustainable carbon and carbon storage

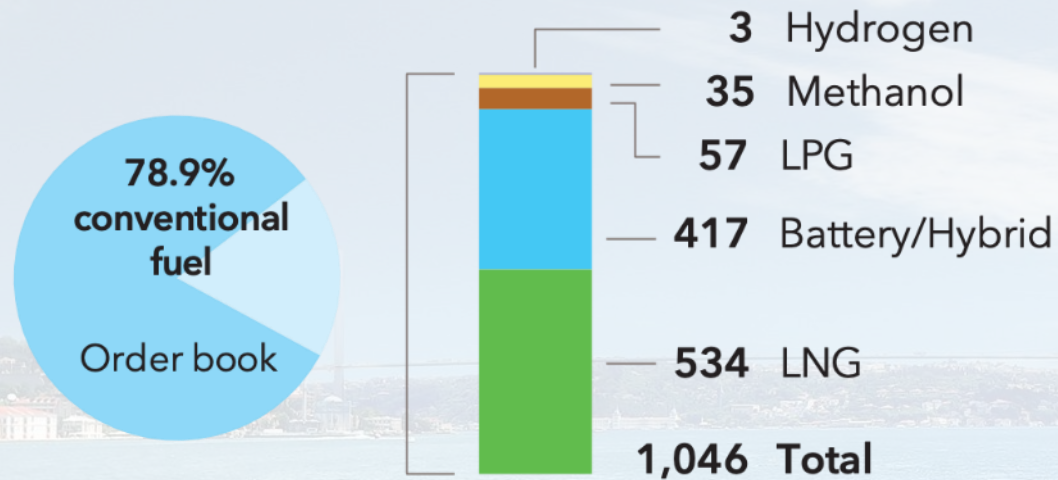
The transition entails large annual onboard investments of 8-28bn USD, but even greater onshore investments of 30-90bn USD.

Fuel flexibility and Fuel Ready solutions, combined with improved energy efficiency, provide business robustness and reduce carbon risk

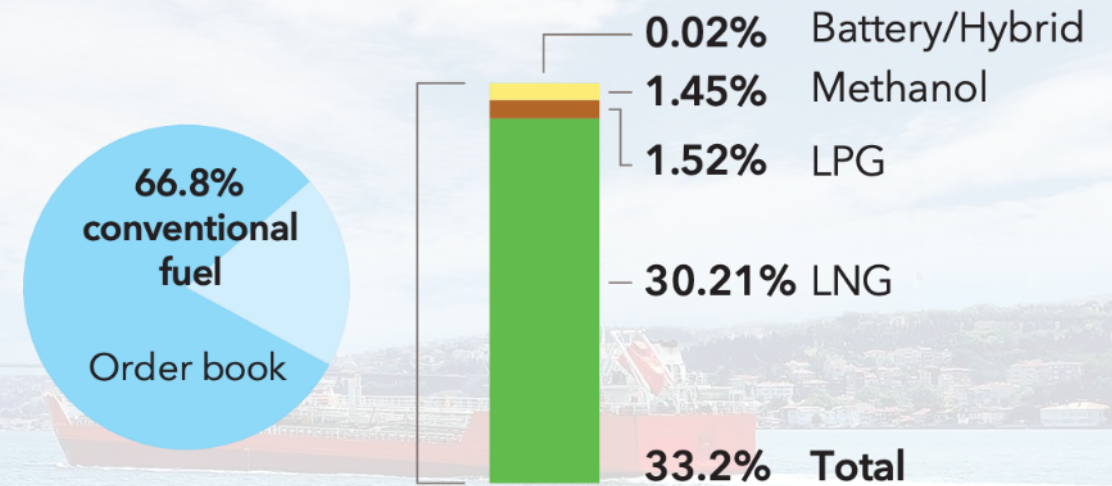
This requires collaboration across industries and authorities!

The fuel transition in shipping has started and is accelerating

Number of ships on order

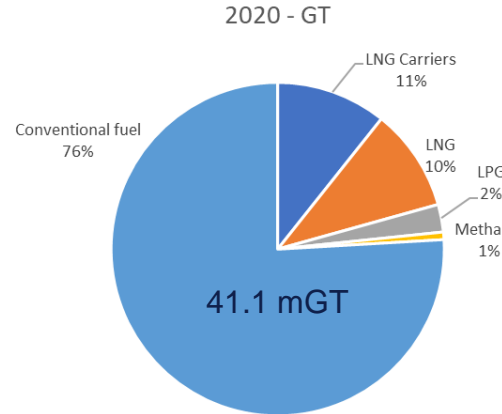
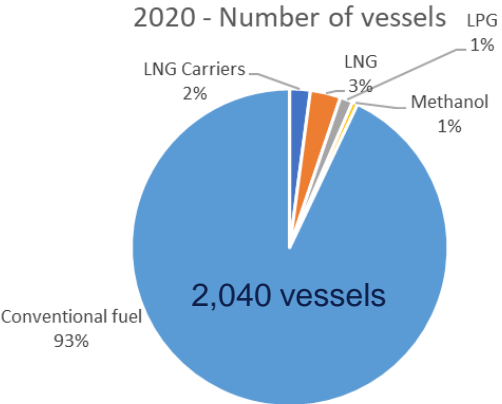


In % of gross tonnage

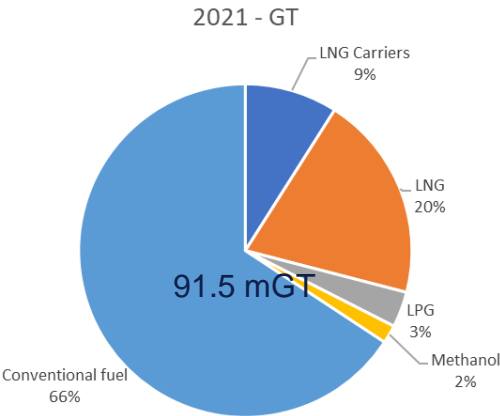
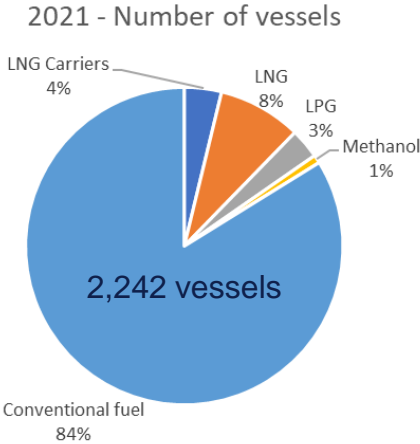


Newbuilding orders with alternative fuels

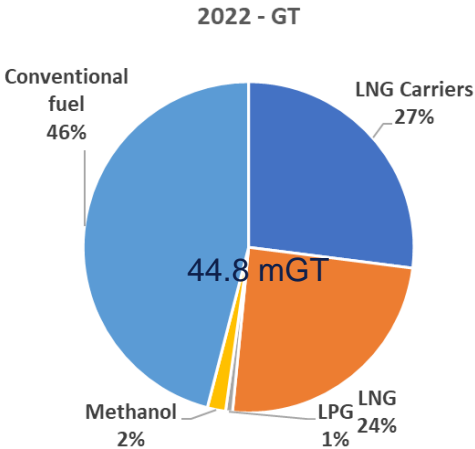
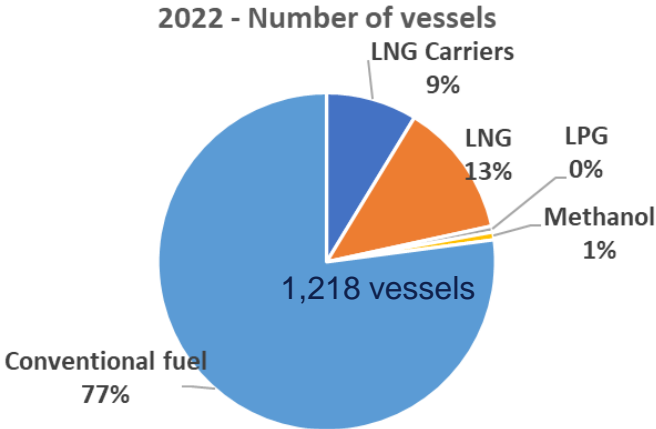
2020



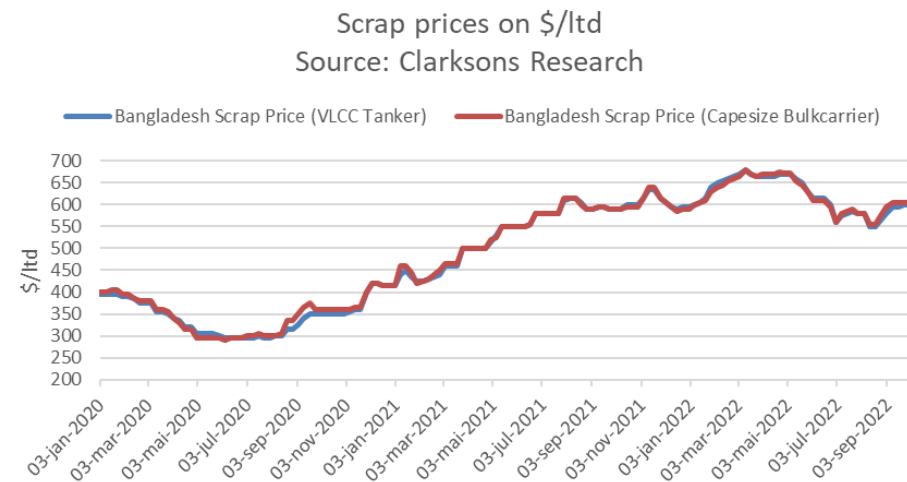
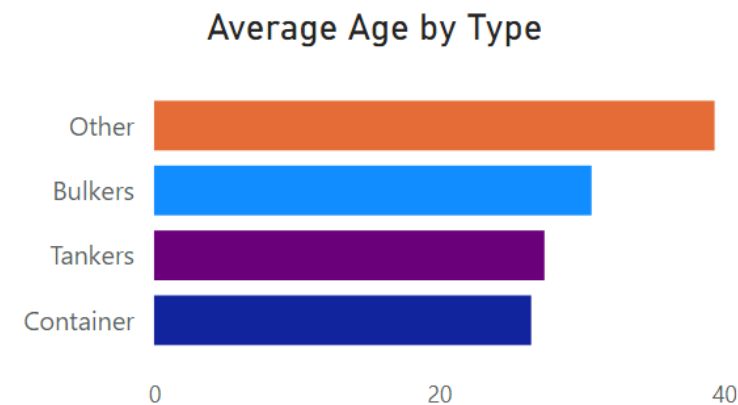
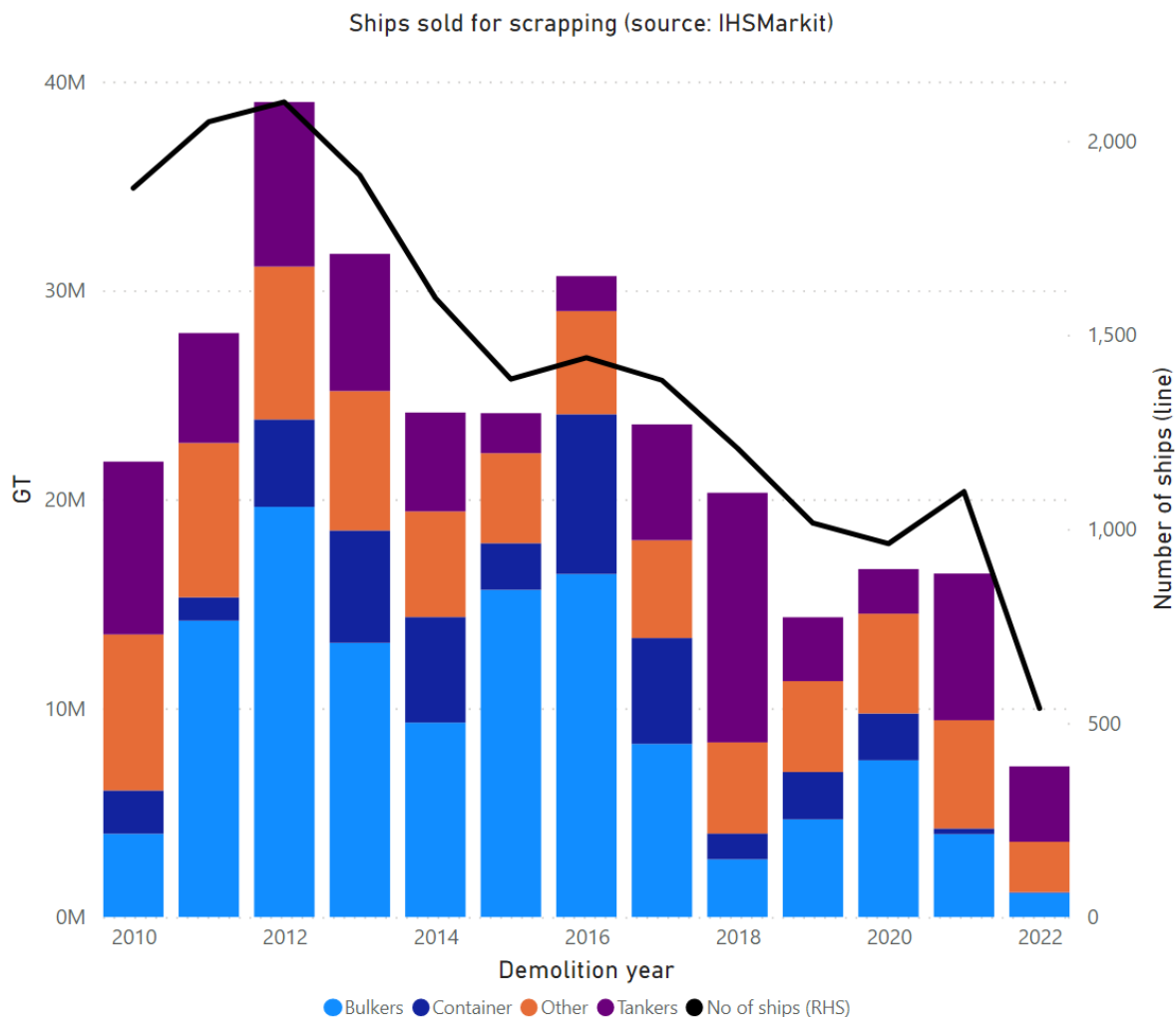
2021



2022



Tonnage sold for scrapping



2nd November 2022



TURN UNCERTAINTY INTO CONFIDENCE

ALTERNATIVE FUELS ONLINE CONFERENCE 2022

Collaboration to Carbon Zero

