Net-zero transition pathways

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17 March 2021
UK & Brazil Partners in Energy

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Lloyd's Register

Sustainable shipping for a sustainable planet.

We need more concrete plans, more ambition from more

António Guterres,
U.N Secretary General

Ships currently at sea would have to reduce their emissions by more than 80%

Kitack Lim,
Secretary General, IMO

Our goal is to be the first climate neutral continent by 2050

Ursula von der Leyan,
European Commission President

Starting now is essential

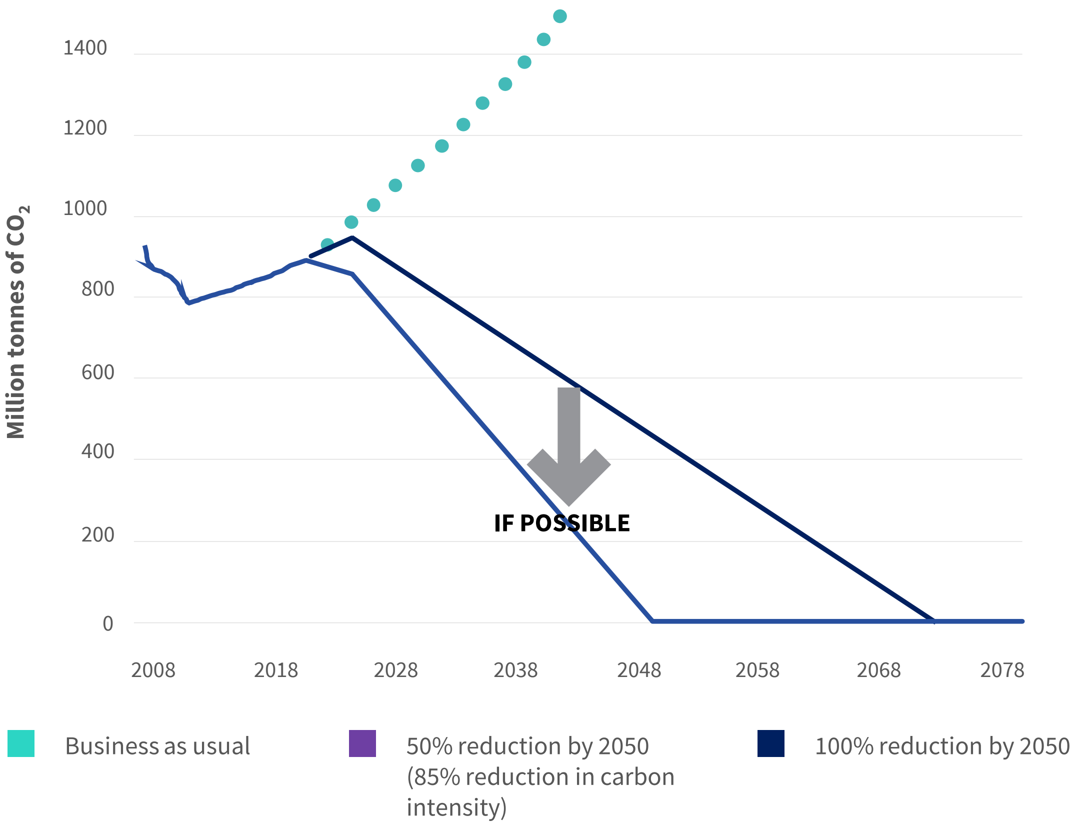
Soren Skou, Chief Executive,
A.P Moeller Maersk

Why are zero-carbon fuels needed for full decarbonisation?

To achieve an absolute reduction in GHG of at least 50% by 2050.

- Shipping emits around **2.3%** of global CO_2 emissions
- Unchecked increase to **10%** by mid-century
- Efficiency and renewables are not enough to reach the goal
- Zero-emission vessels need to be entering the fleet from 2030

Pathways for international shipping's CO_2 emissions



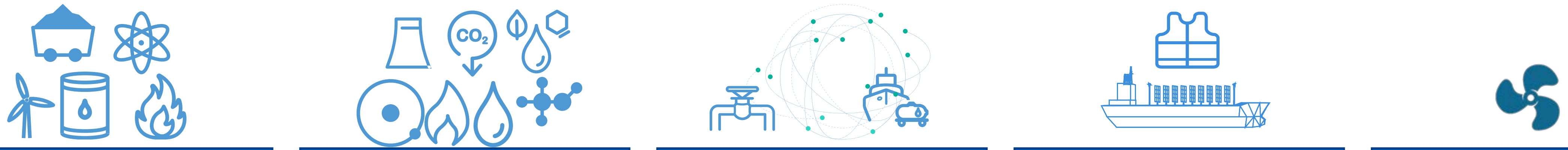
What do we mean by zero-carbon fuels?

Transition to zero emission vessels means phasing out fossil based fuels.

	Zero-carbon energy sources					
Energy source	Methanol	Hydrogen	Ammonia	Electricity	Diesel	LNG
Natural gas with CCS		NG-hydrogen	NG-ammonia			
Biomass	bio-methanol				bio-diesel	bio-LNG
Renewable electricity	e-methanol	e-hydrogen	e-ammonia	batteries	e-diesel	e-LNG

A transition involving a wider system

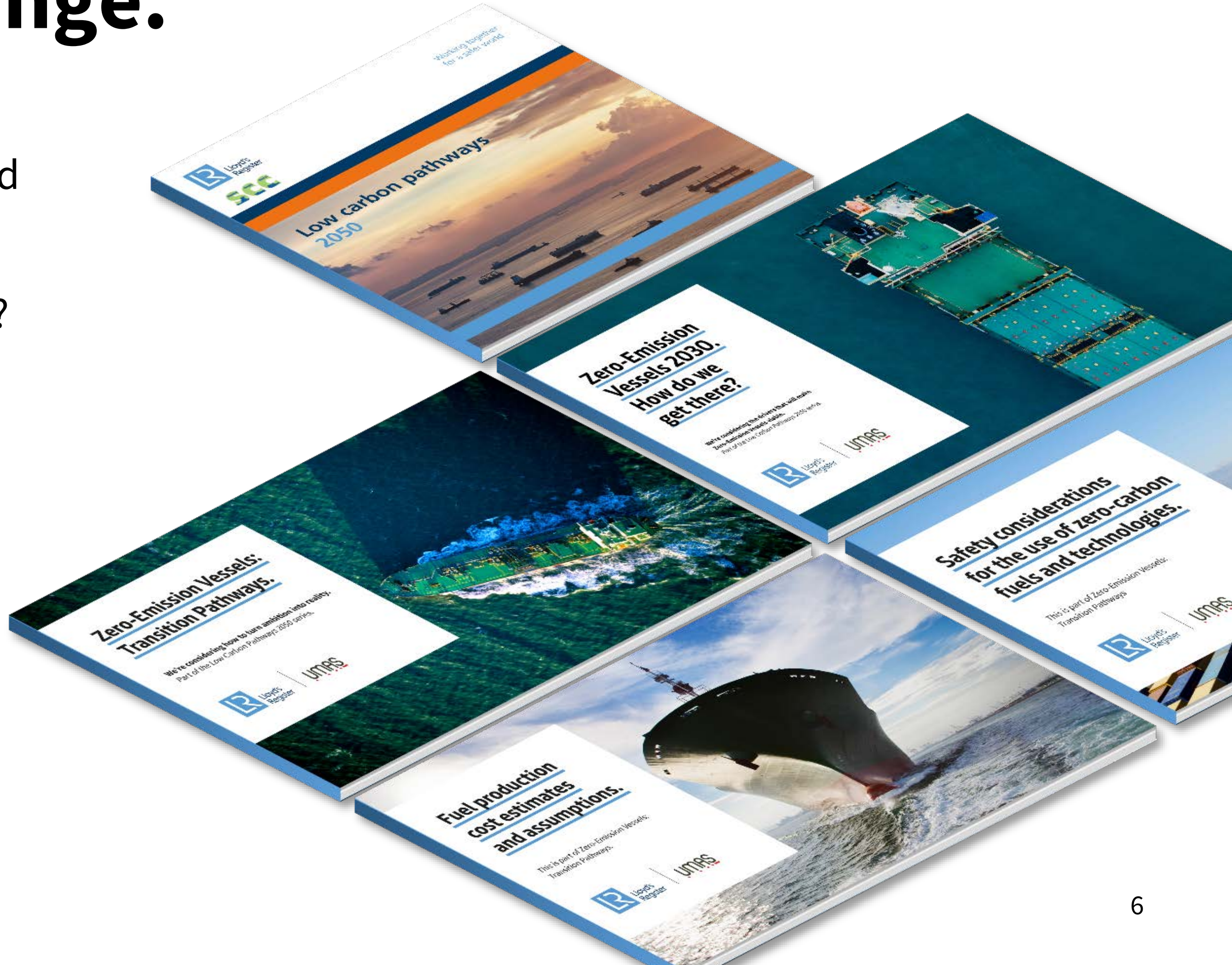
Putting shipping into the wider energy context as we transition to alternative energy sources and technologies



Resources	Production , conversion and system integration	Bunkering and Ports integration	Fuel storage and handling onboard	Propulsion
• Biomass • Electricity from non-biogenic renewable energy (e.g. solar, wind) • Fossil fuels (e.g. natural gas)	• Energy conversion systems (e.g., gasification, SMR, electrolysis) • Transportation of both intermediate products or end-product • Fuel storage • Competing markets	• Refuelling (e.g. barge, berth) • Shore side storage • Safety zone	• Fuel supply system (piping) • Fuel tanks (materials, capacity, location) • Safety (venting and detection) • Competence of crew	• Main propulsion machinery • Auxiliary engines • (e.g. internal combustion engines, fuel cells system, reformers, electric motor, batteries) • Energy efficiency technologies

Developing new knowledge and tools to help the industry understand the complexities of the challenge.

- Low carbon pathways 2050: how might shipping be required to change?
- Zero-Emission Vessels 2030: what is the economic viability?
- Zero-Emission Vessels: Transition Pathways: What conditions are required to achieve the goal?
- Safety considerations: How do we safely use zero-carbon fuels?
- Fuel Production cost estimates & assumptions: What are the relative production costs?



Lifecycle emissions

There is a material risk of moving the problem upstream.

- As the global economy decarbonizes energy generation will need to do so
- Upstream production will happen overtime
- This will need to be factored into shippings transition

Figure 9 – Upstream, operational and net CO_2 emissions for each fuel.

Comparative energy equivalence.

LNG
Mass ~x0.8
Volume ~x2

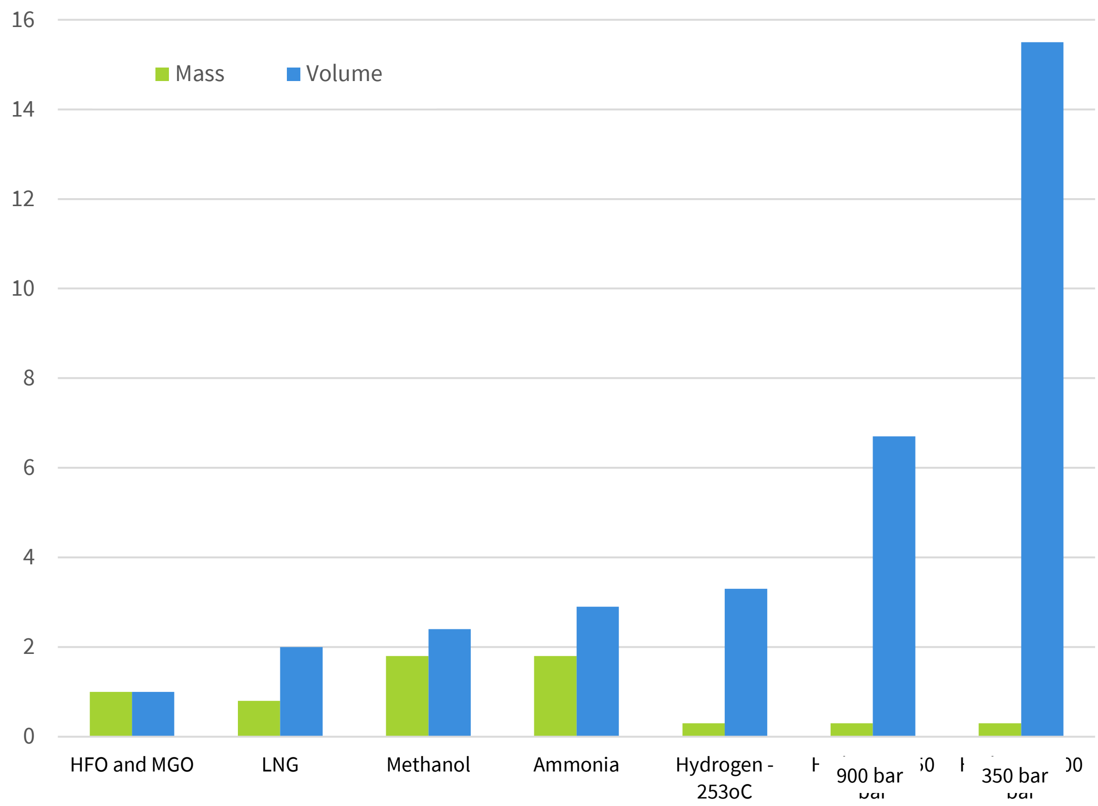
Methanol
Mass ~x1.8
Volume ~x2.4

Ammonia
Mass ~x1.8
Volume ~x2.9

Hydrogen 350 bar
Mass ~x0.3
Volume ~x15.5

Hydrogen 900 bar
Mass ~x0.3
Volume ~x6.7

Hydrogen -253 °C
Mass ~x0.3
Volume ~x3.3



Total cost of operation.

The cost of e-ZEVs have a decreasing trend over time.

- Biofuels maybe more competitive in the short-term
- But lose this advantage as prices are expected to increase
- NG-ammonia is as competitive today as the most expensive biofuel
- Overall e-fuels become more competitive in the 2040s

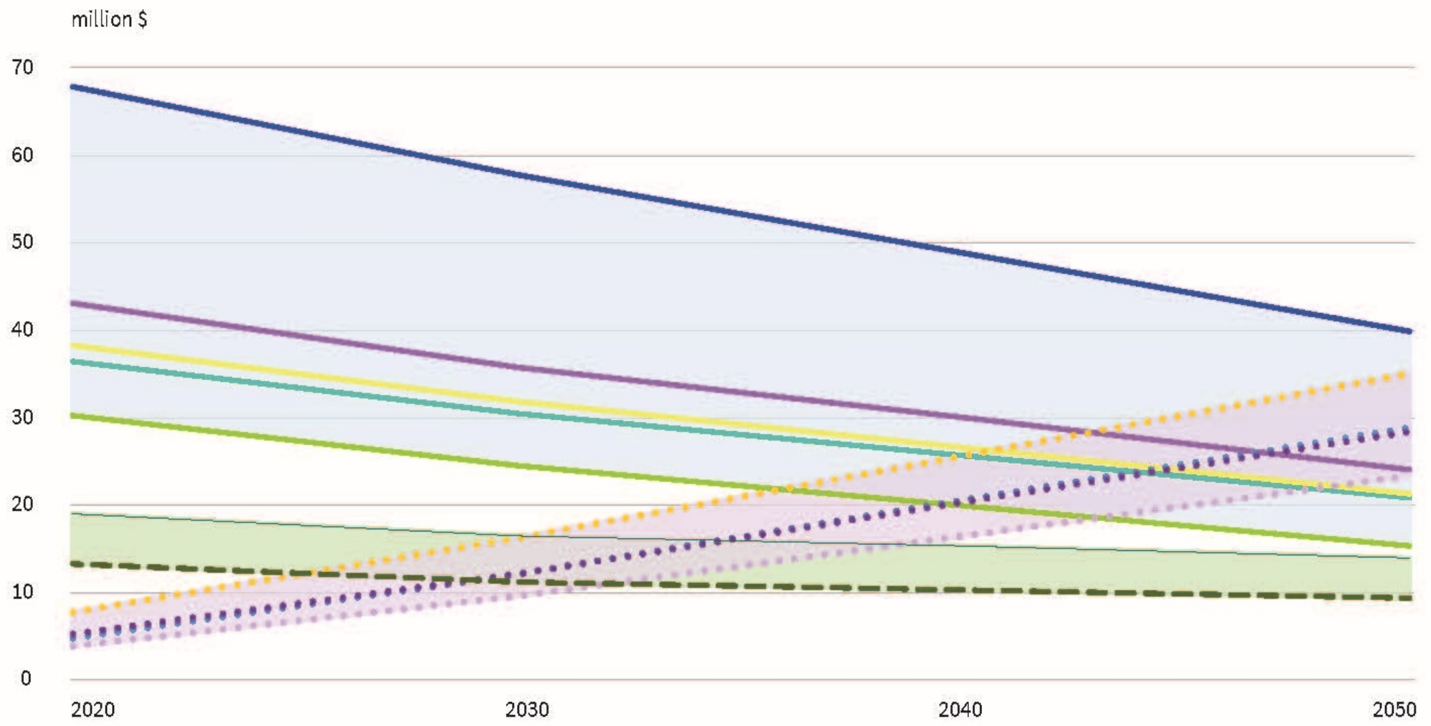


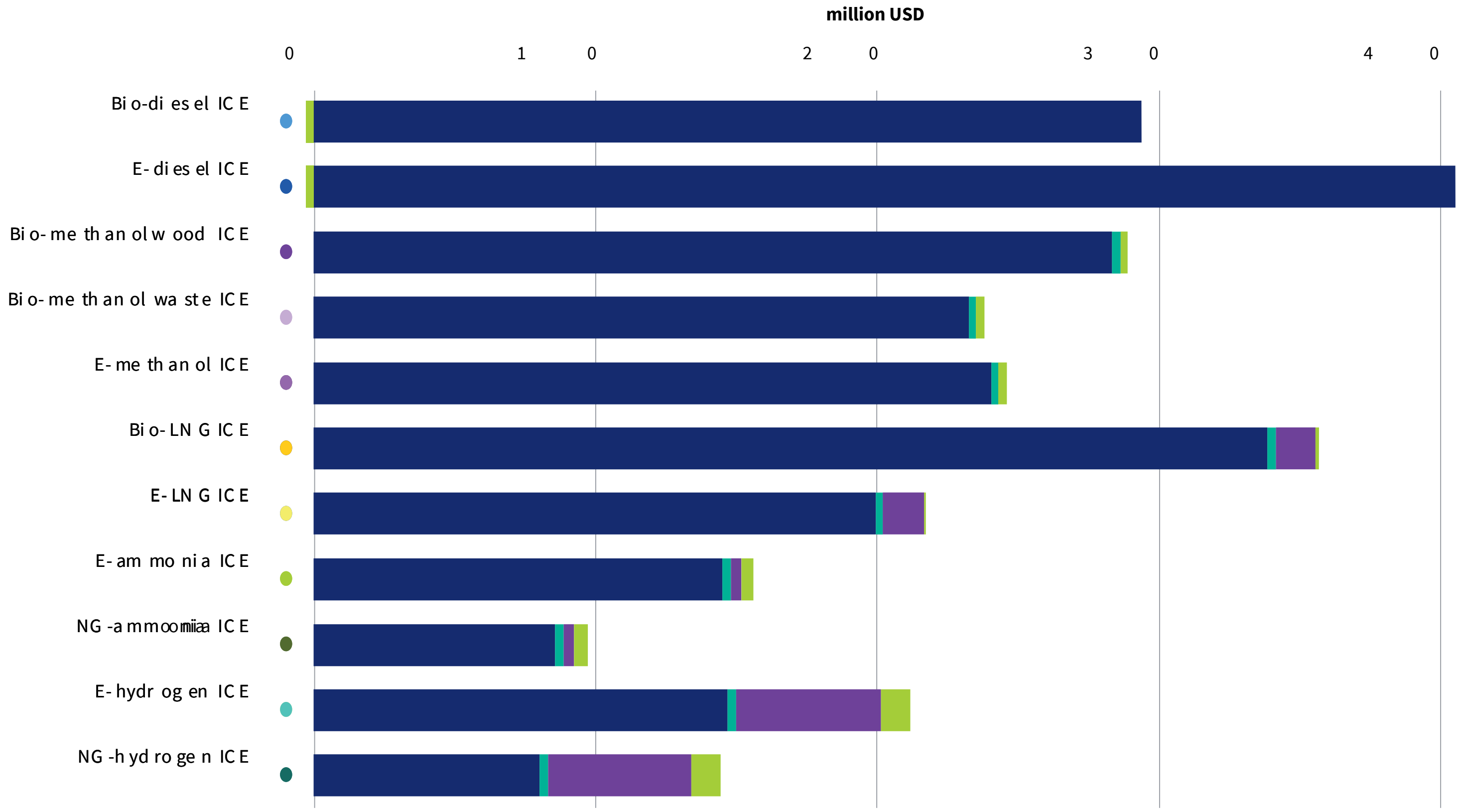
Figure 3d – Scenario 3; high-price scenario; TCO Trends for a Bulk Carrier (only ZEVs with ICE).

Fuel-related voyage costs.

Fuel cost is a significant proportion of the overall TCO.

- The main cost driver is fuel price
- Hydrogen has a high capital cost of storage and a loss of cargo-carrying capacity which impacts revenue
- E-ammonia is lower than e-hydrocarbons because the production processes are still under development and energy intensive
- A carbon price is essential to close the gap with fossil-based fuels

2050 (high price scenario)



Figures 4b – Relative cost implications of ZEV technologies for bulk carrier under high-price scenario and no carbon price.

Voyage Engine Storage Storage impact

Key messages

Investment

The primary driver is fuel price therefore this is an OPEX and not a CAPEX issue

- A carbon price is needed to close the competitiveness gap

Technology

Zero-carbon fueled ships are technology possible in the next 3- 5 years

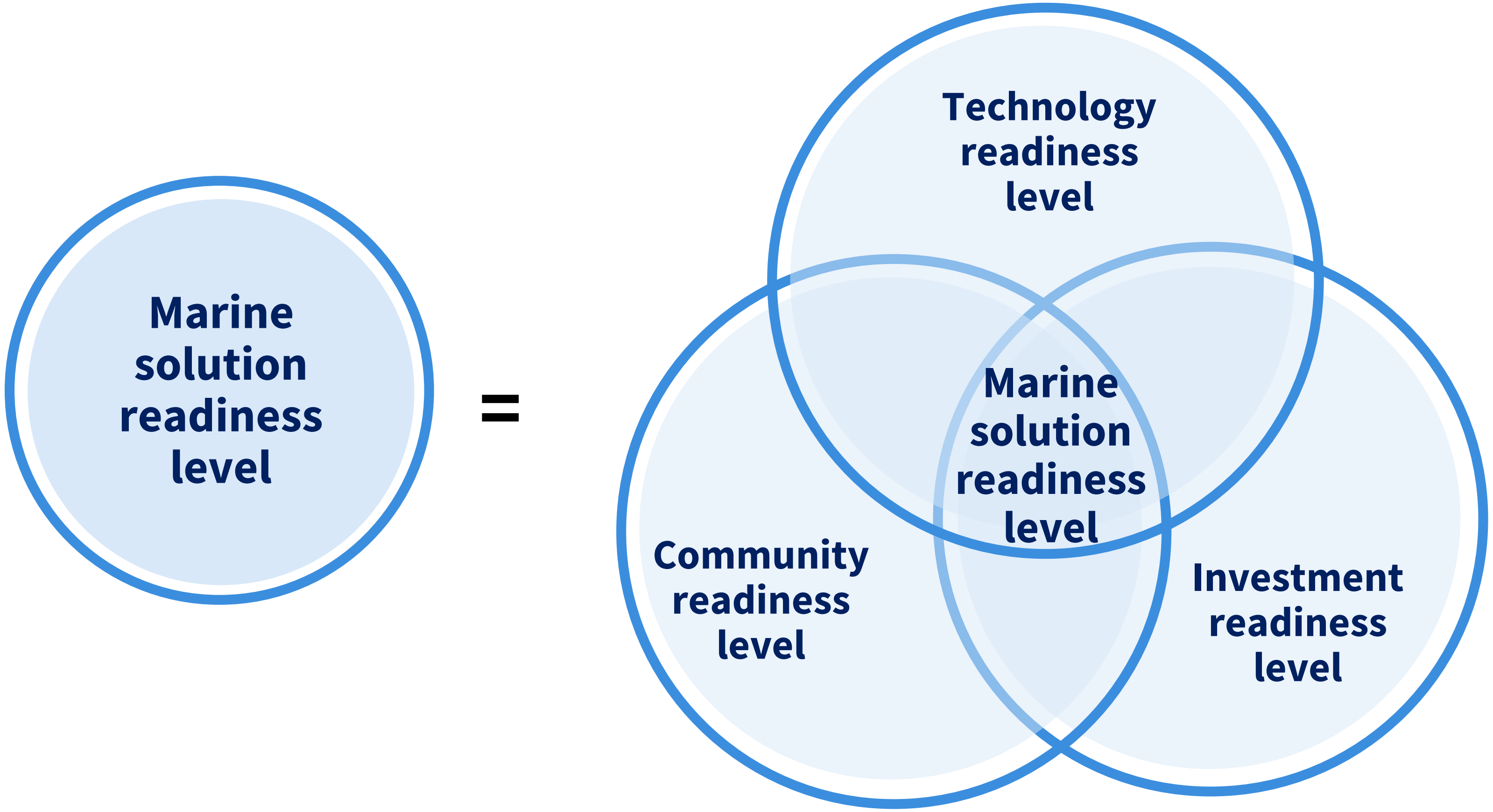
- Safety challenges can be addressed
- The bulk of the technology challenge is on land infrastructure and fuel production

Community

Strong policy interventions and a fundamental shift to market incentives are needed

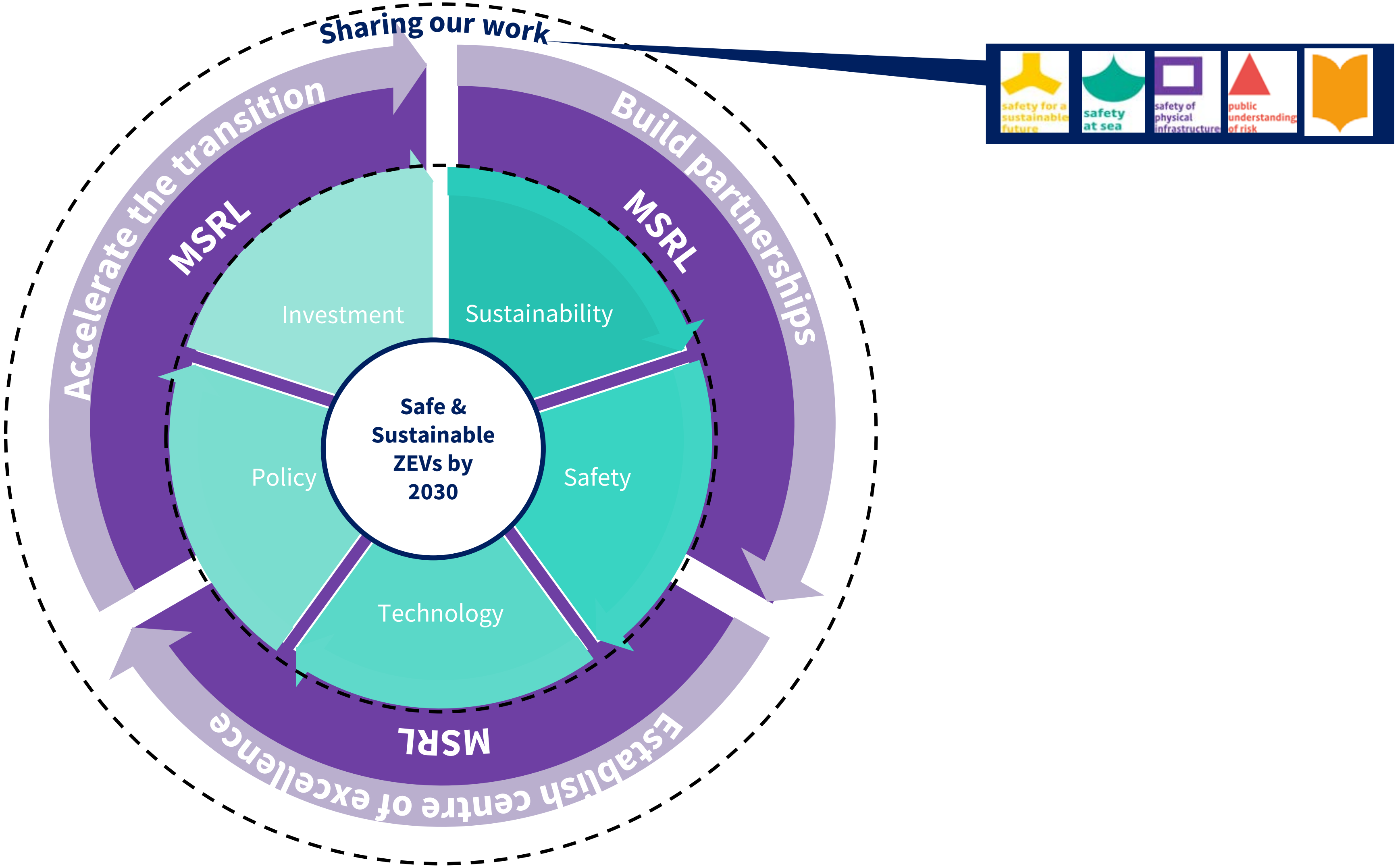
- Lifecycle emissions need to considered in policy
- Sustainability impacts across the lifecycle need to factored into decision-making

Our ‘Getting to Zero’ model.



Maritime Decarbonisation Hub

Our Vision is to have safe, sustainable, technically feasible and commercially viable zero-emission shipping by 2030.



Testbeds and pilots using ammonia

Manifold Times

Lloyd's Register awards Approval in Principle to EXMAR for its ammonia-fuelled gas carrier

12 Mar 2021

Hyundai Mipo Dockyard wins LR approval for ammonia-powered ship

VESSELS

July 24, 2020, by Jasmina Ovcina

the CASTOR INITIATIVE

MISC · Lloyd's Register · YARA · MPA Singapore · MAN Energy Solutions · MAN · Samsung · SAMSUNG HEAVY INDUSTRIES

Lloyd's Register awards Approval in Principle to ammonia-fuelled 23,000 TEU ultra-large container ship

6th October 2020 | 0 | 172

How do we play our part?

Collaborative platforms

GLOBAL MARITIME FORUM

GETTING TO ZERO COALITION 2030

United Nations Global Compact

sustainable shipping initiative

Policy makers

IMO

European Commission

Private Sector partnerships

MAERSK

MAN Energy Solutions

seaspan

misc moving energy

SAMSUNG HEAVY INDUSTRIES

CMB

EXMAR

mca Maritime and Coastguard Agency

YARA

DSIC

ANGLO BELGIAN CORPORATION We power your future

Industry Associations

AMMONIA ENERGY ASSOCIATION

METHANOL INSTITUTE