WHEN TRUST MATTERS

# Maritime Forecast to 2050

## Energy Transition Outlook 2021

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# Maritime Forecast to 2050 – key highlights

Owners must identify their own "decarbonization stairway" to manage carbon risk

Understanding the **costs** associated with the “decarbonization stairway” is vital to stay competitive

Knowing the technical design implications of the “decarbonization stairway” is crucial to eliminate showstoppers and reduce cost

The fuel transition in shipping has started, but key fuel technologies needed will be available in 4-8 years

Incorporating basic measures at newbuild stage is key to accommodating fuel flexibility

An analysis of 12 scenarios shows that capital for onboard technology investments and the energy needs to produce the new fuels are key barriers

# DNV charts a practical path to stay under the carbon reduction trajectories

## We present our updated framework for carbon risk management

Drivers and regulations + Ship specifications + Technology and fuels

↓

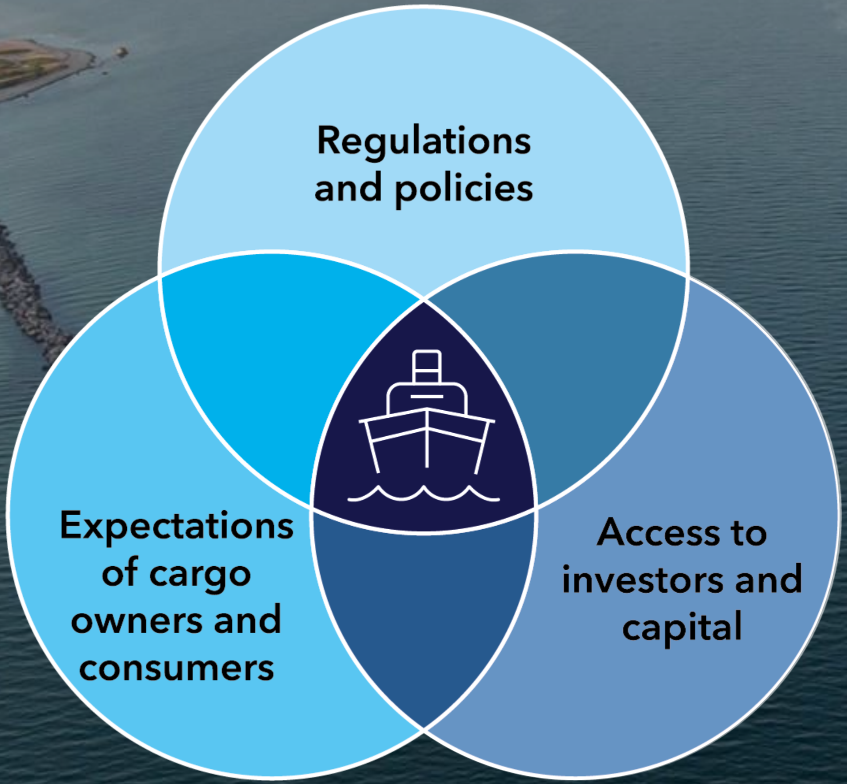
**STEP 1**
Assess economic potential of ship fuel strategies

**STEP 2**
Assess impact of chosen fuel strategy on ship design

↓

Feed results into ship building specifications

# Three fundamental key drivers are increasing the pressure for decarbonization

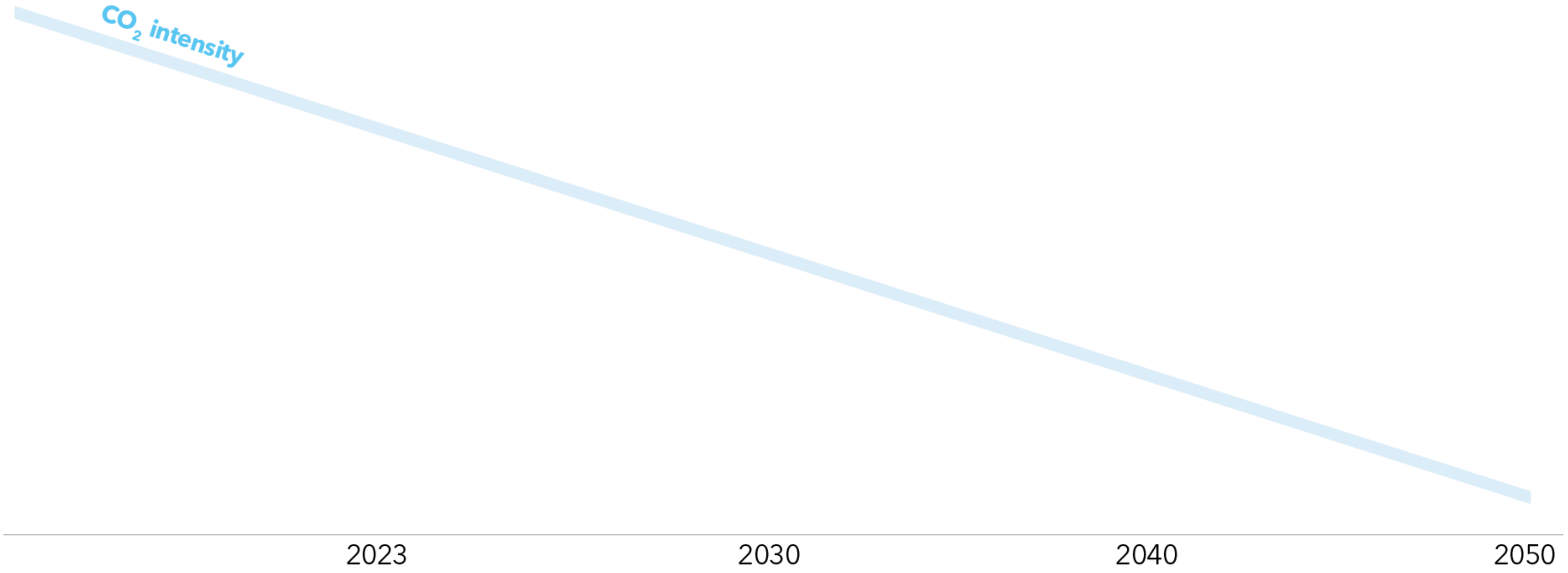



IMO regulations on carbon intensity are taking effect from 2023.

Commercial pressure may push shipowners to aim for a leading position in decarbonization.

Poorly performing shipping companies will be less attractive on the charter market and may also struggle to gain access to capital.

# Owners must identify their own ***"decarbonization stairway"*** to manage carbon risk



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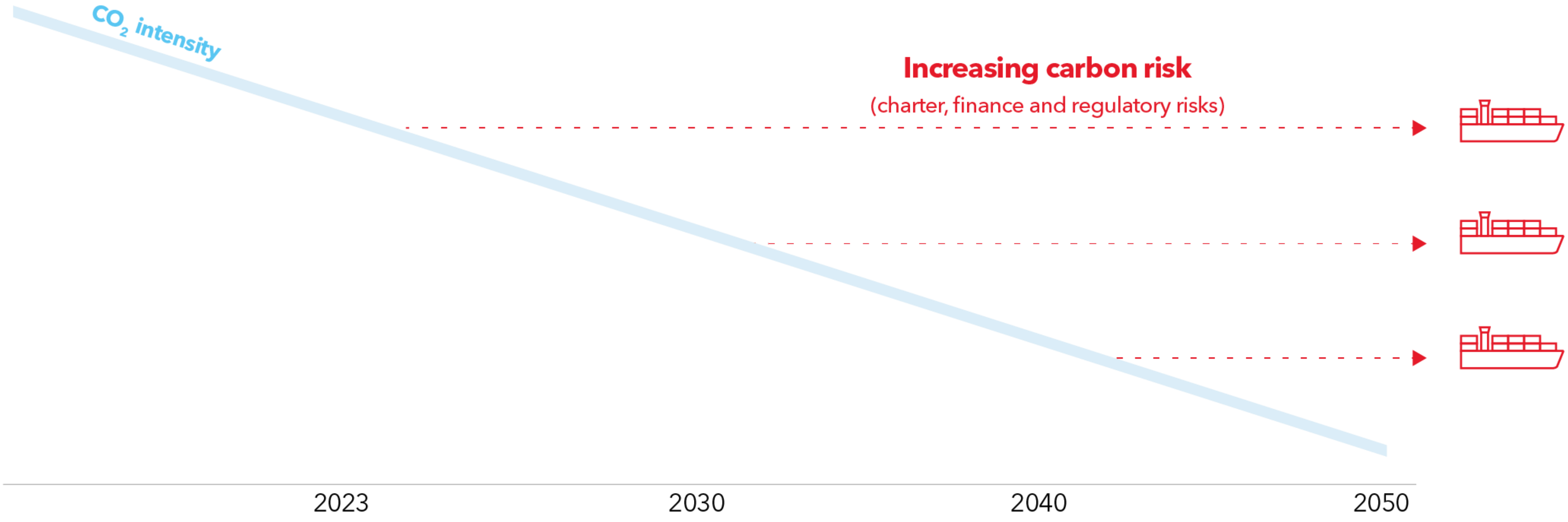

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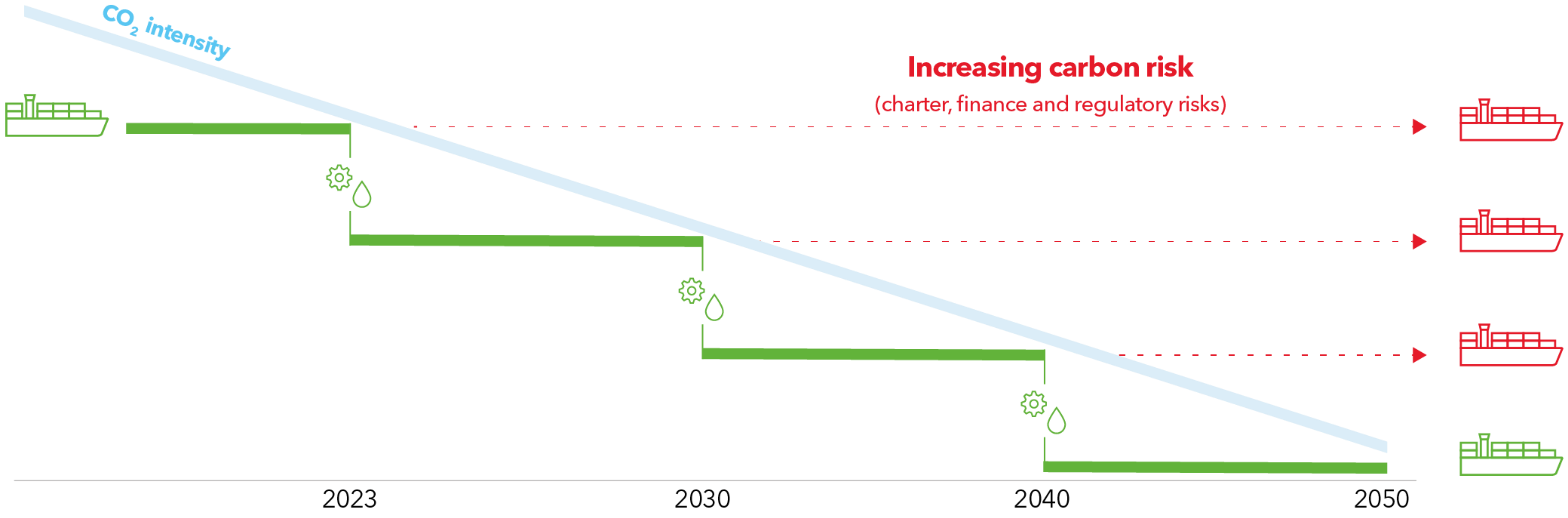
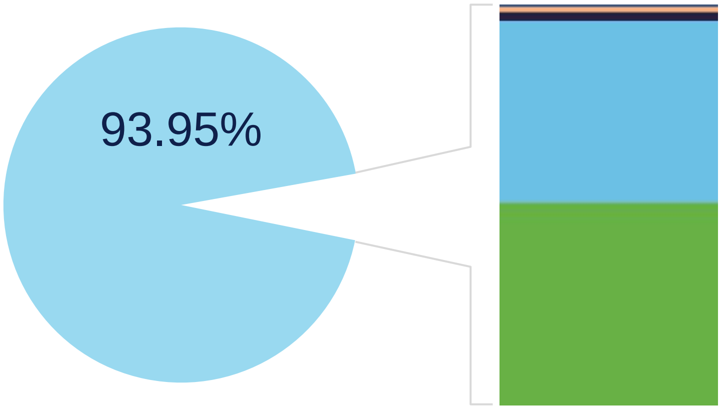


# The fuel transition in shipping has started and is gaining momentum

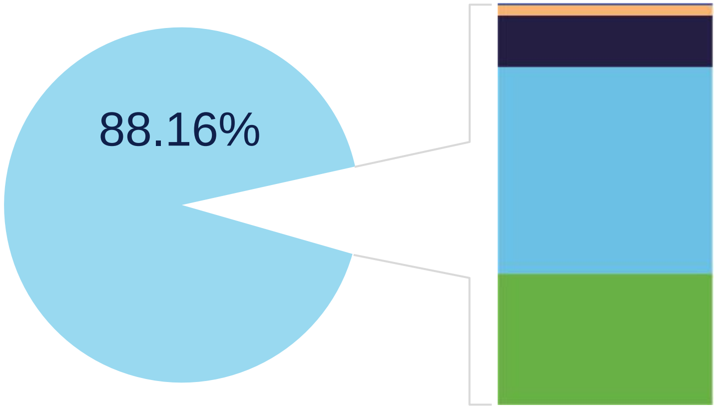
## Ships on order, alternative fuel uptake in number of ships

### 2019




| | |
|---|---|
| Hydrogen | 0.04% |
| Methanol | 0.08% |
| LPG | 0.13% |
| LNG | 2.73% |
| Battery | 3.07% |
| **Total** | **6.05%** |

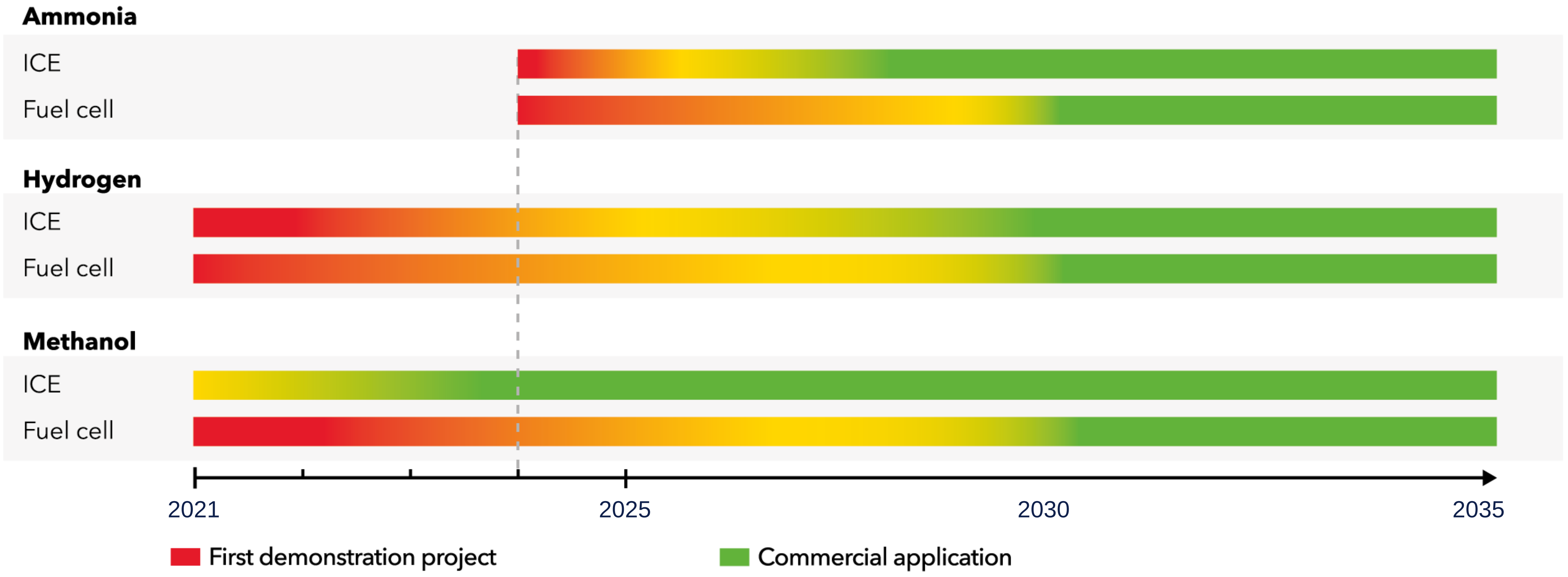
### 2021




| | |
|---|---|
| Ammonia | 0.02% |
| Hydrogen | 0.06% |
| Methanol | 0.30% |
| LPG | 1.51% |
| LNG | 6.10% |
| Battery | 3.85% |
| **Total** | **11.84%** |

# Key fuel technologies facilitating the transition will be available in 4-8 years

## Timeline for expected availability of alternative fuel technologies – our best estimate for when these may be available for onboard use



# We use a bulk carrier case study to illustrate the carbon risk-management framework

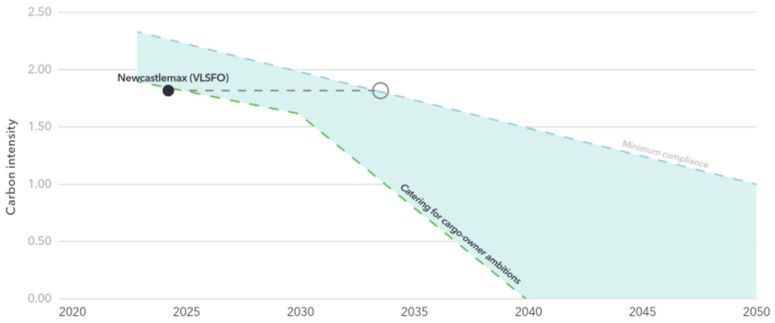
**STEP 1**

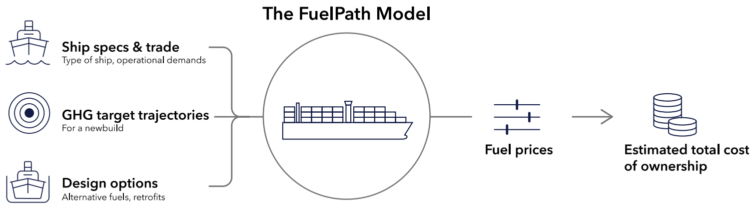
Assess economic potential of ship fuel strategies

We translate regulations and commercial drivers into carbon trajectories reflecting a shipowner's particular circumstances.

We translate available fuels and technologies into seven practical design options for a newbuild.

Our modelling capability allow us to assist owners in calculating the cost of various fuel strategies over the lifetime of a ship.



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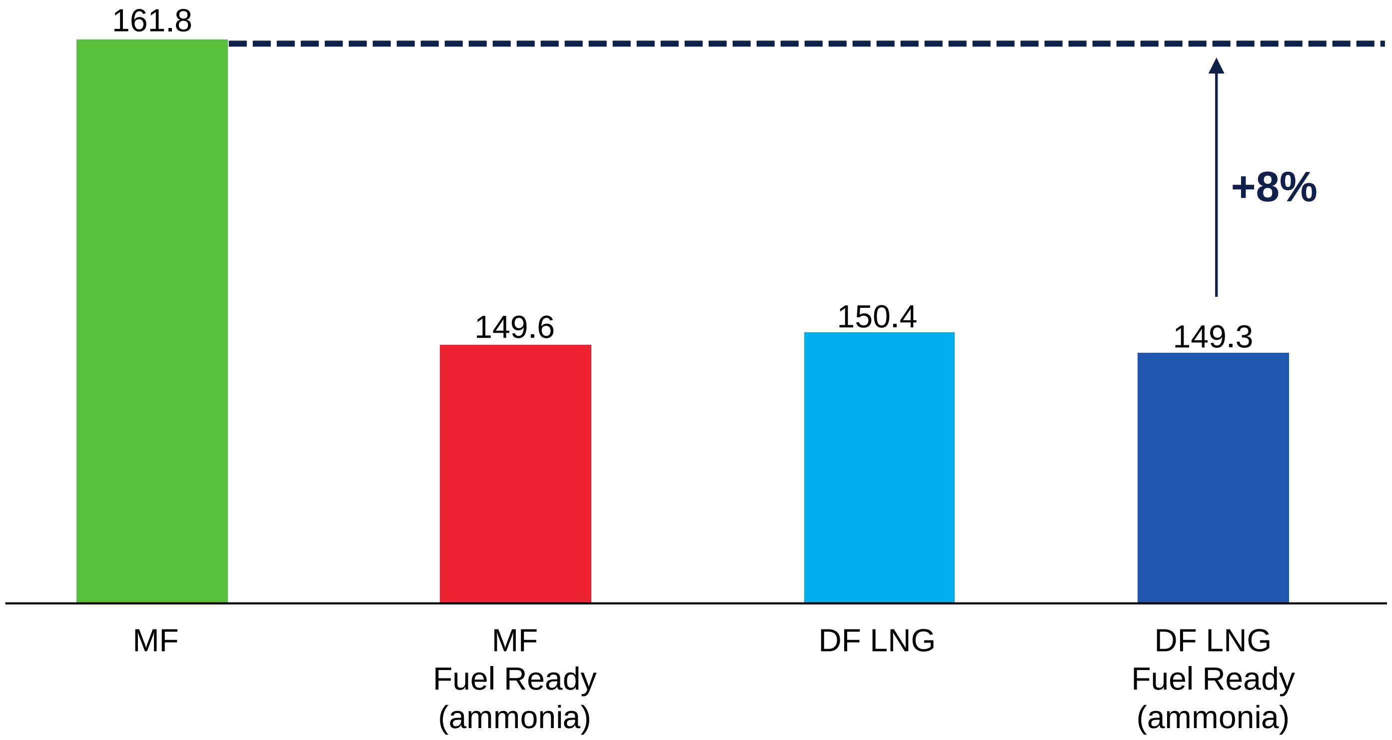
# A conventionally designed ship is burdened by high lifecycle cost under a strict GHG target trajectory

**STEP 1**
Assess economic potential of ship fuel strategies

- **Fuel Ready (ammonia)** designs are identified as the most favourable fuel strategy in this specific example case.

**Total discounted cost**
Units: USD million

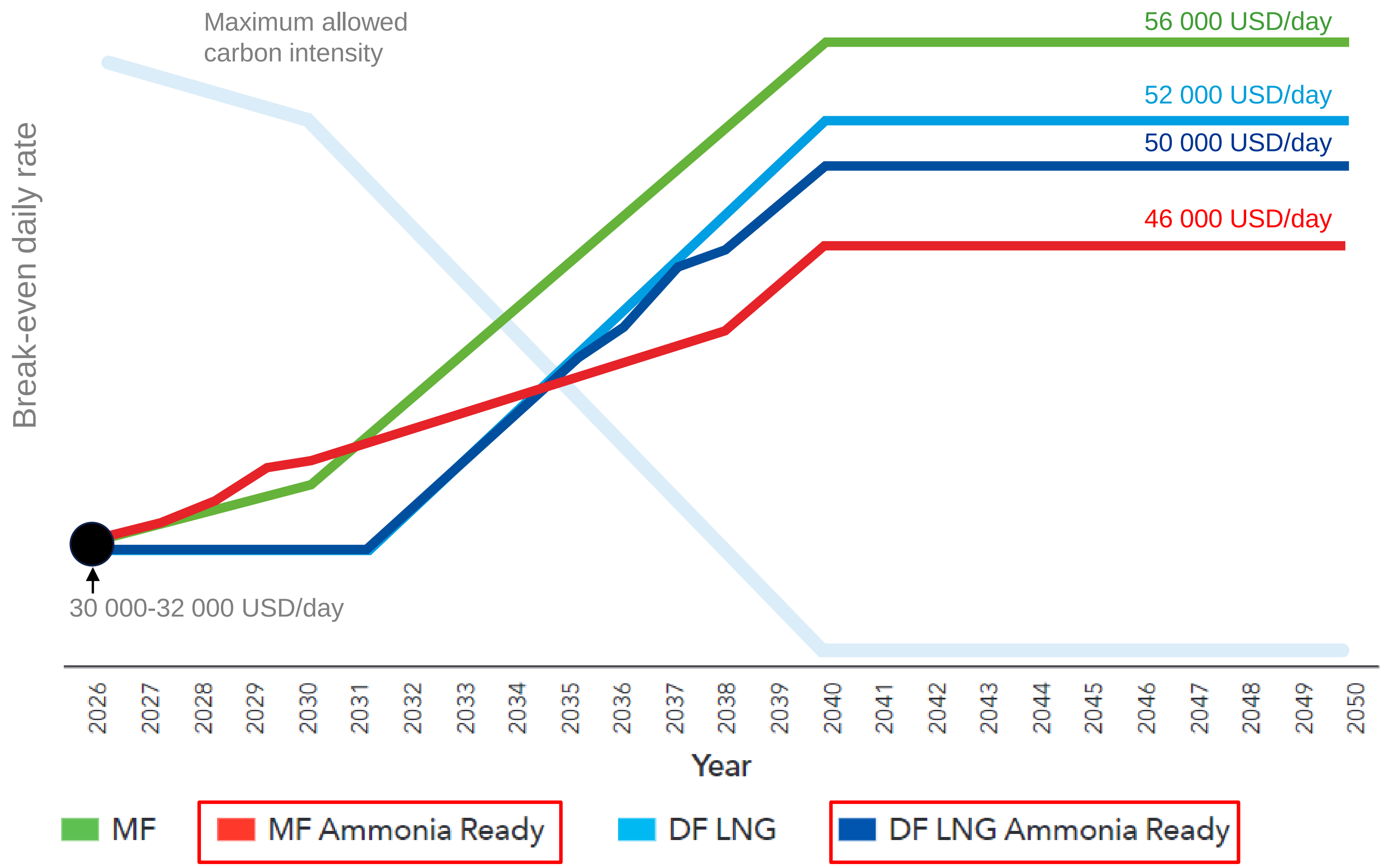



Dual-fuel (DF); mono-fuel (MF)

# Break even rates will change significantly over lifetime

**STEP 1**

Assess economic potential of ship fuel strategies




Dual-fuel (DF); mono-fuel (MF)

# We perform a structured engineering review identifying key pressure points

**STEP 2**

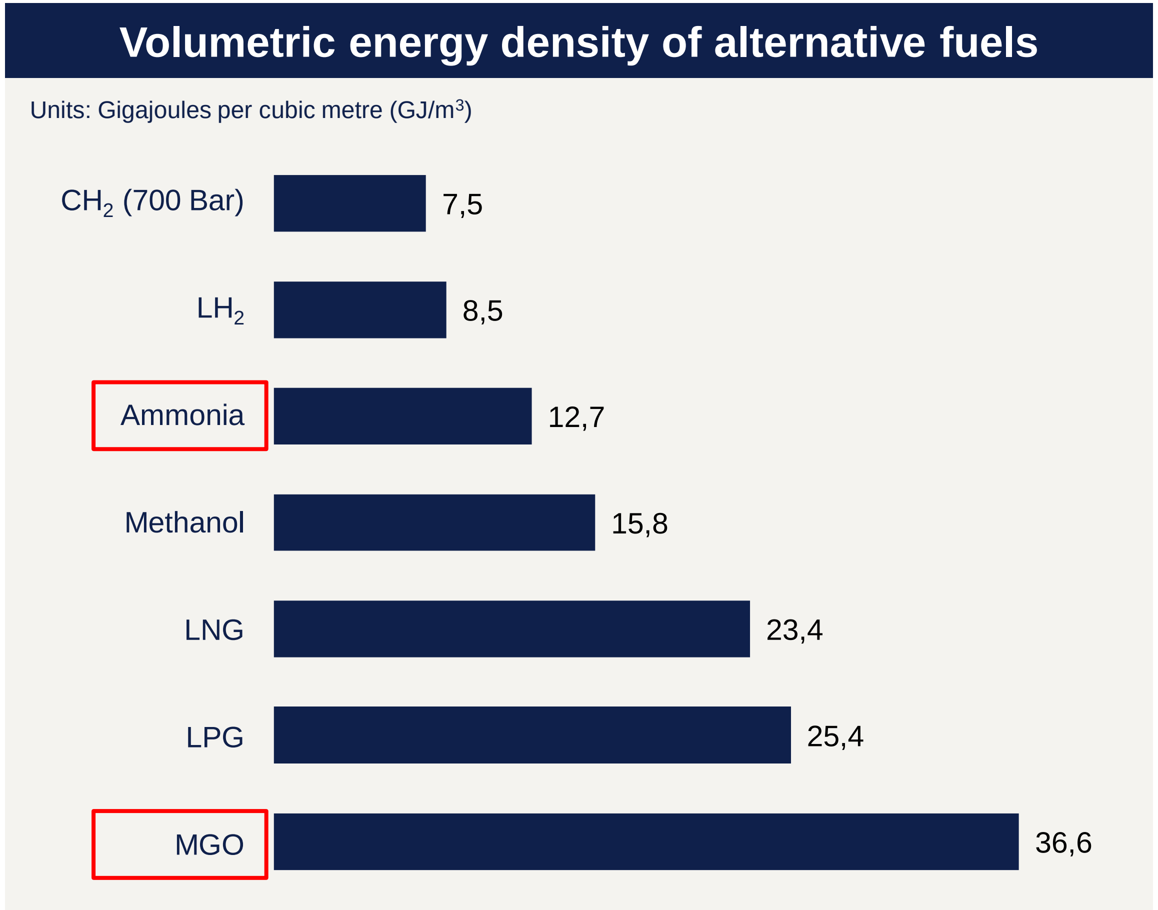
Assess impact of chosen fuel strategy on ship design

- Fuel storage
- Onboard power plant
- Integration of the fuel system in the ship design

# Fuel storage

**STEP 2**
Assess impact of chosen fuel strategy on ship design

- Space constraints
  - Minimise loss of cargo carrying capacity
  - Low volumetric energy density
  - Filling limit constraints



# Fuel storage

**STEP 2**

Assess impact of chosen fuel strategy on ship design

➢ Compensating measures

- Shorter bunkering intervals
- Increased amount of pilot oil fuel
- Blend-in of carbon-neutral pilot oil fuel

# Fuel storage

**STEP 2**
Assess impact of chosen fuel strategy on ship design

- Suitable tank types
  - Pressure-less prismatic tanks
  - Pressurised circular tanks

# Onboard power plant

**STEP 2**
Assess impact of chosen fuel strategy on ship design

- Consequences of a fuel change for installed energy converters
- Consequences for any existing fuel preparation and supply system

# Integration of the fuel system in the ship design

**STEP 2**

Assess impact of chosen fuel strategy on ship design

- Toxic and hazardous zones, fire safety, safety distances
- Strength considerations
- Trim and stability within acceptable boundaries

# Identifying design pressure points brings zero-carbon ships closer to reality

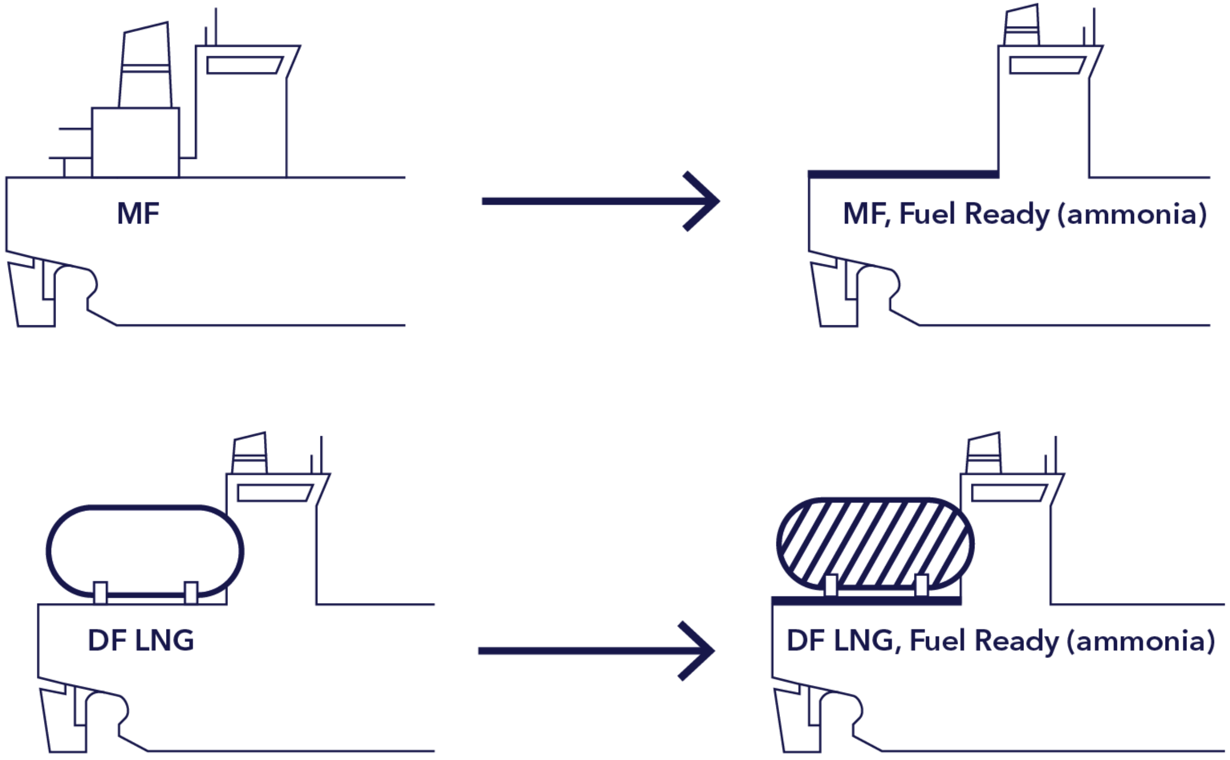
**STEP 2**

Assess impact of chosen fuel strategy on ship design

- We perform a structured engineering review including:
  - Fuel storage
  - Onboard power plant
  - Integration of the fuel system in the ship design
- In our bulk carrier case study the **Fuel Ready (ammonia)** designs are investigated:
  - A main design challenge is to allocate sufficient space for fuel storage while retaining cargo carrying capacity.
  - New safety challenges must be addressed in the ship design.
  - We identify practical design solutions to meet these challenges.

# Incorporating basic measures at newbuild stage is key to accommodate fuel flexibility

**STEP 2**
Assess impact of chosen fuel strategy on ship design




Preparations for **MF, Fuel Ready (ammonia)**:

- Ensure feasibility in design including toxic zones
- Structural preparations
- Trim and stability
- Engines suitable for conversion

Preparations for **DF LNG, Fuel Ready (ammonia)**:

- LNG tanks suitable for ammonia
- Toxic zones
- Structural preparations
- Trim and stability
- Engines suitable for conversion

Dual-fuel (DF); mono-fuel (MF)

# Fuel Ready – preparations at newbuilding stage and conversion for a dual-fuelled (LNG) ship

**STEP 2**
Assess impact of chosen fuel strategy on ship design

| Newbuild | Conversion |
|---|---|
| Install LNG tanks suitable for ammonia:<br>✓ Material selection<br>✓ Strength and fatigue calculations based on greater weight of tank and fuel | Modify energy converters – LNG to ammonia |
| Base structural preparations on greater ammonia density<br>✓ Hull strength and tank support | Modify fuel-supply system |
| Ensure that trim and stability calculations are acceptable with ammonia in tanks | Modify bunkering station and associated safety systems |
| Ensure that toxic zones for ammonia are accounted for | Fit boil-off gas system for ammonia |
| Investigate possibility for partial re-use of fuel system with ammonia | Modify auxiliaries to the fuel system (heating, cooling, purging) |
| Install energy converters suitable for conversion to ammonia | Modify control and safety systems for fuel installation |
| | Provide water curtains at exits, emergency showers and eye washes, water spray bunkering stations, PPE equipment |

# A successful Fuel Ready design must be detailed in the newbuild specification

Drivers and regulations + Ship specifications + Technology and fuels

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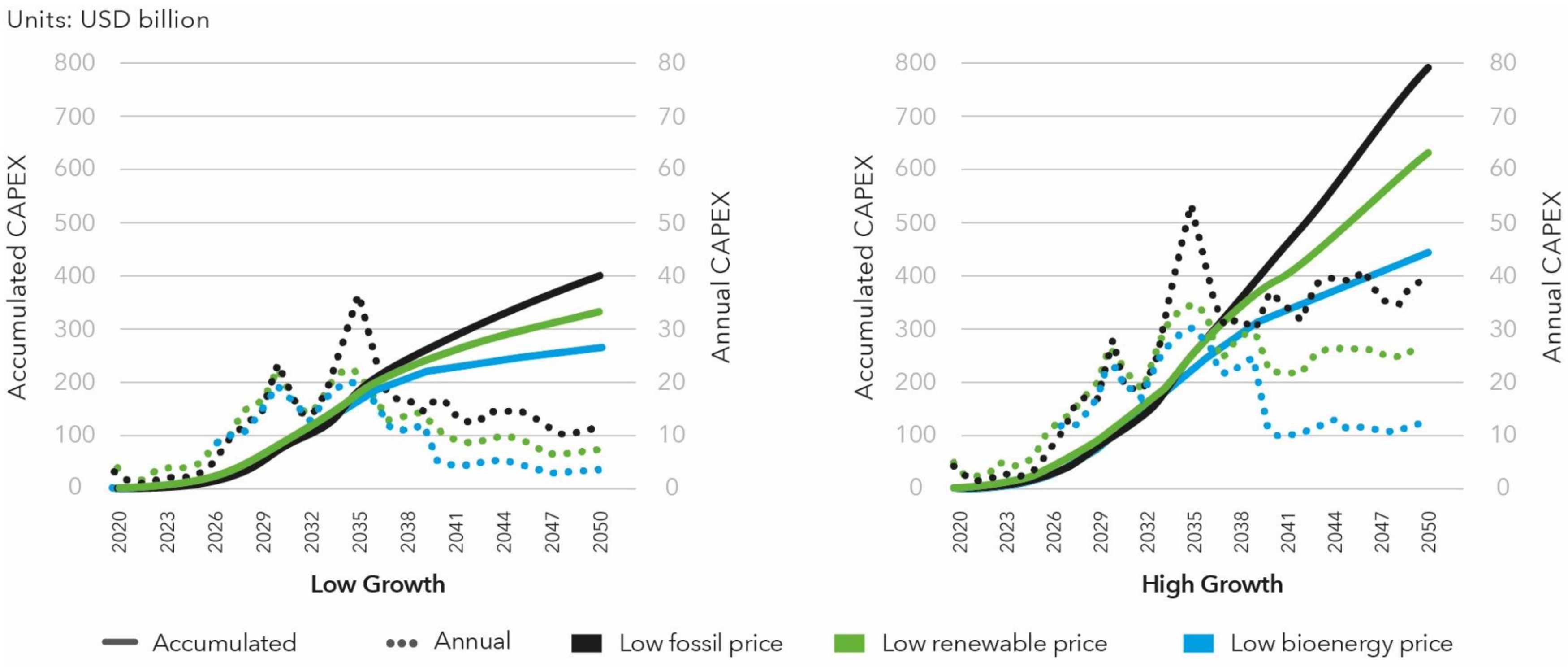
Feed results into ship building specifications

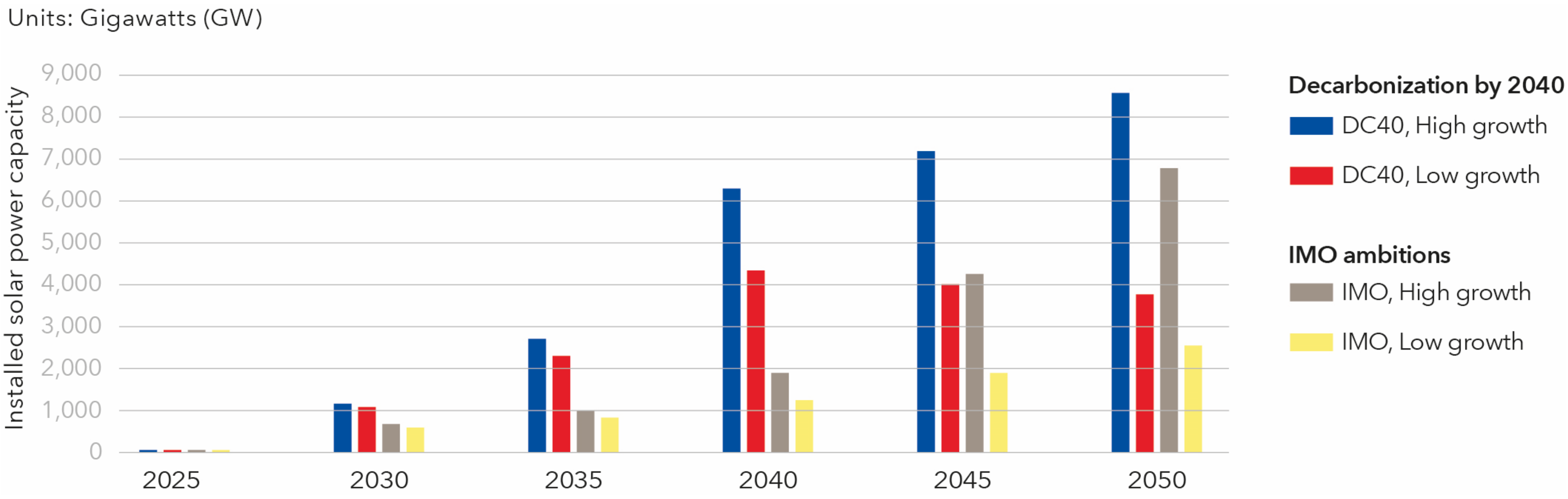
# On board investment need for the global fleet to meet IMO ambitions depends on fuel price scenario




CAPEX is the sum of on board investment costs for fuel and energy technology,
including engine/converter and tank systems, as well as energy-efficiency technologies.

# The transition to carbon-neutral fuels requires major investments in infrastructure and energy supply

**Installed solar power capacity for electrofuel production in scenarios with low renewable electricity price**



# Maritime Forecast to 2050 – summary

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Owners must identify their own "decarbonization stairway" to manage carbon risk.

Understanding the **costs** associated with the «decarbonization stairway» is vital to stay competitive.

Knowing the technical design implications of the «decarbonization stairway» is crucial to eliminate showstoppers and reduce cost.

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Incorporating basic measures at newbuild stage is key to accommodate fuel flexibility.



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# Thank you.

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