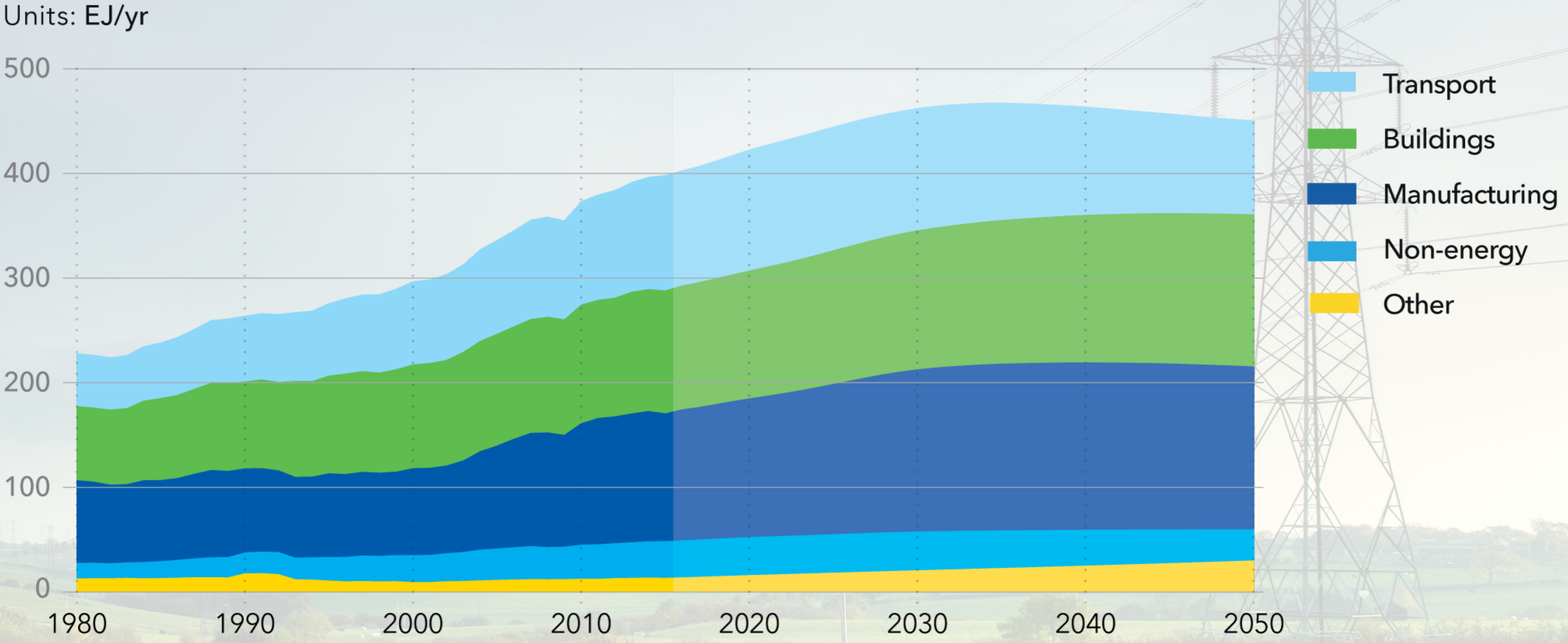

# MARITIME FORECAST TO 2050

## Energy transition outlook 2018

# “Energy Transition Outlook” and “Maritime Forecast to 2050”

- DNV GL has issued the ***Energy Transition Outlook*** forecasting the world’s energy future through to 2050
- Shipping is a vital part of the world’s transport system, and the energy future holds significant impact for the future of shipping
- This latest publication provides an independent forecast of the maritime energy future and examines how the energy transition will affect the industry
- This year focus is the challenge of **decarbonization** and financial implications facing the maritime industry

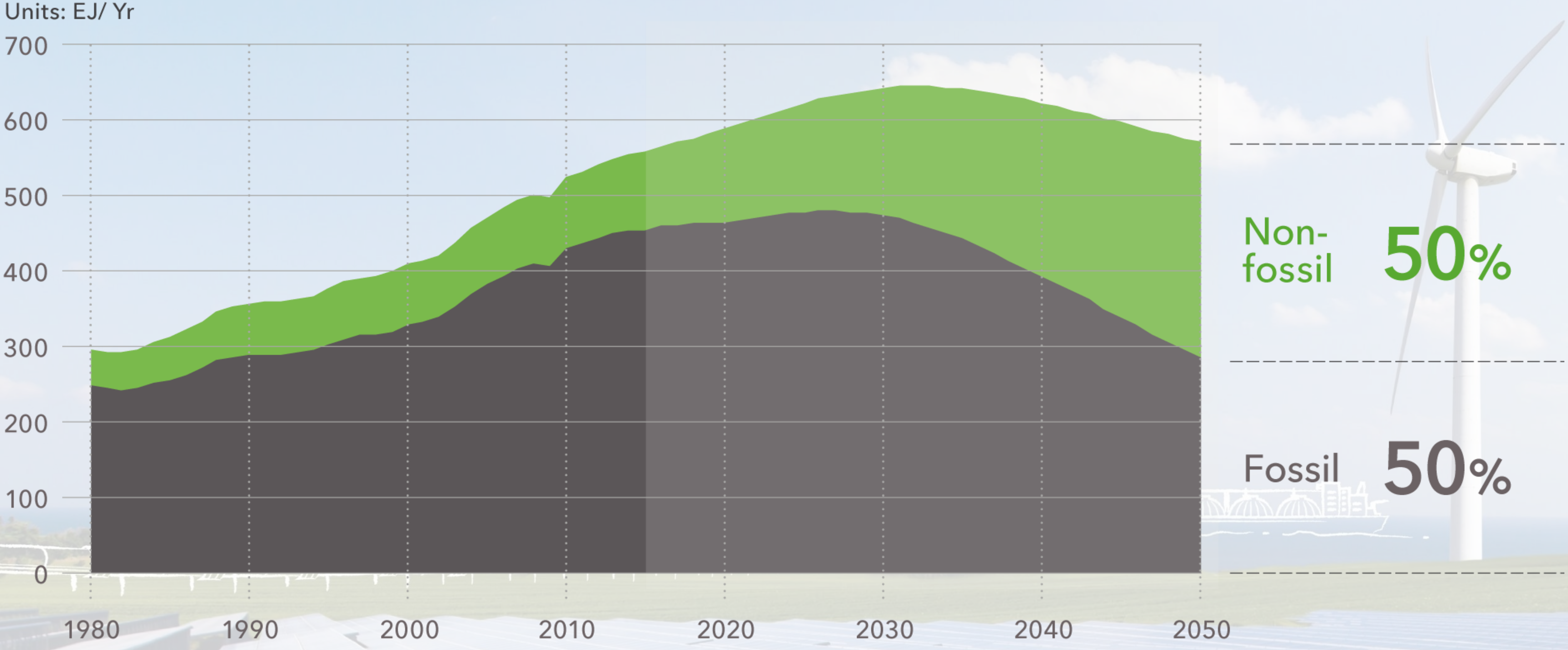
# ENERGY DEMAND PEAKING IN 2035



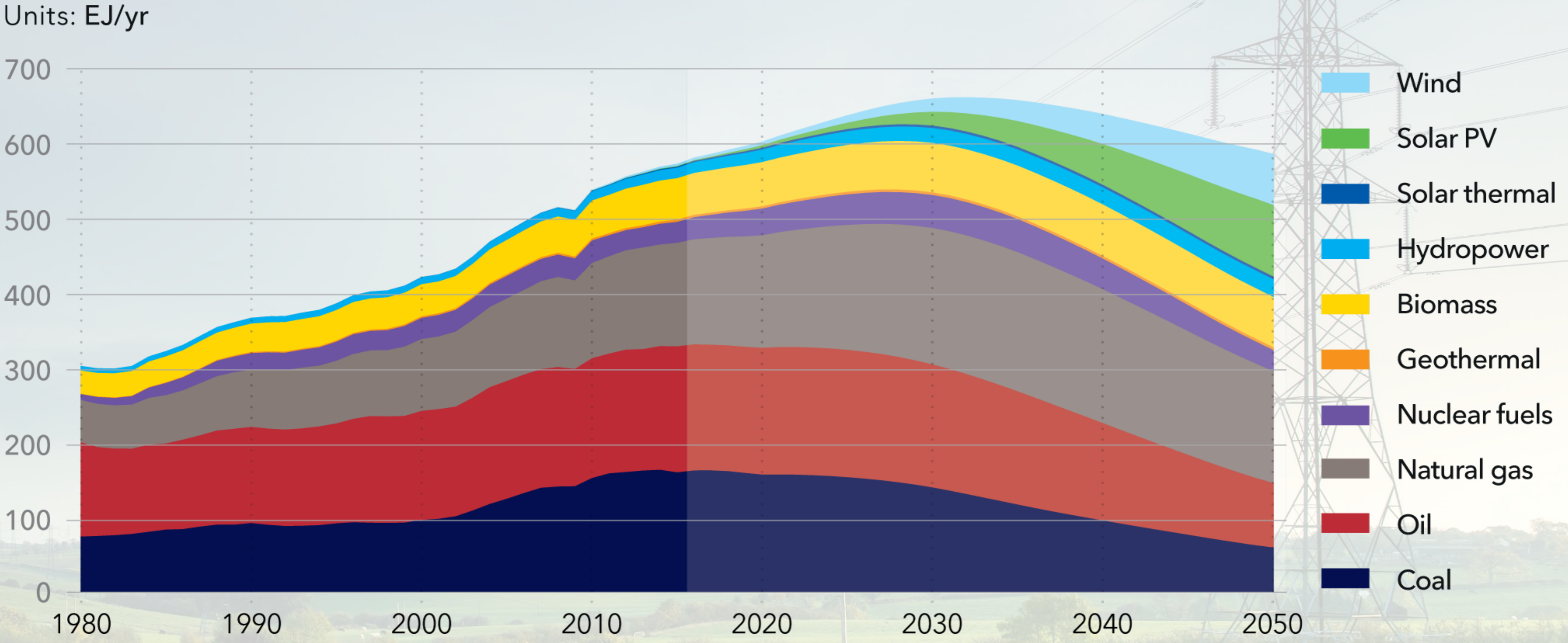



DNV·GL

# AN EQUAL SPLIT BY 2050



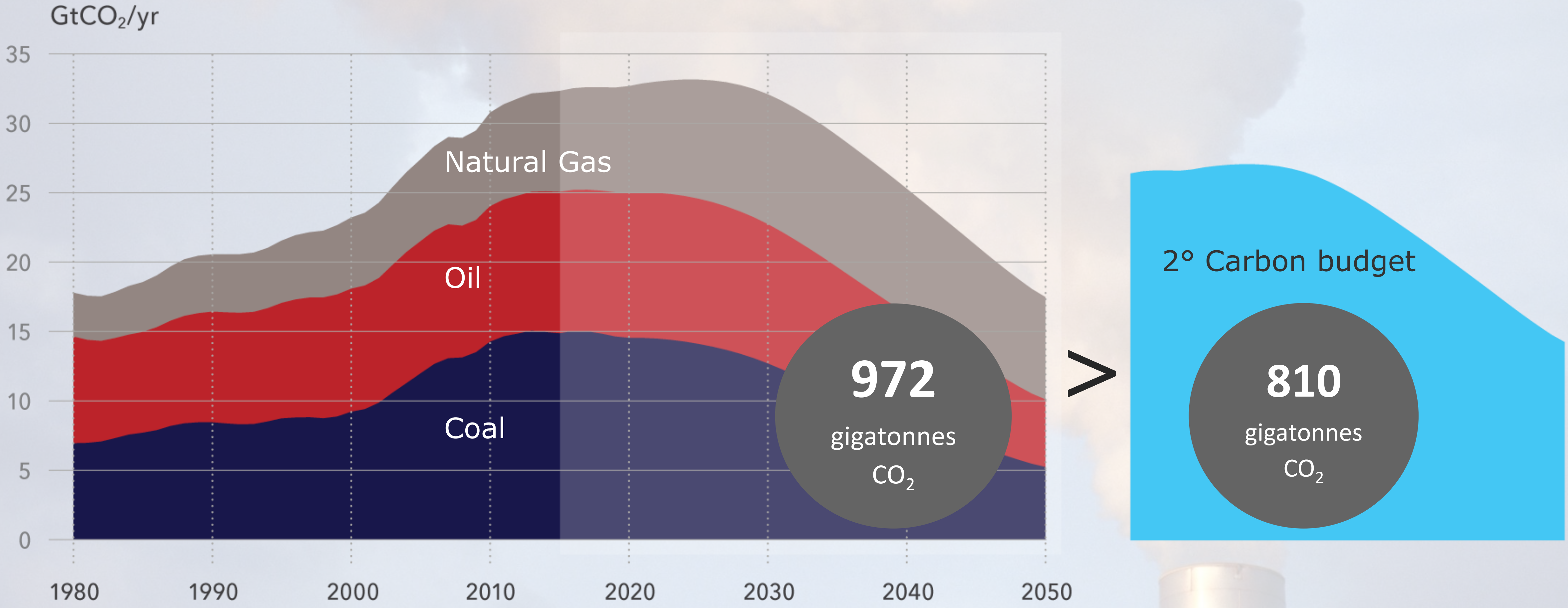
# PRIMARY ENERGY PEAKING IN 2032



DNV·GL

# EMISSIONS TO 2050 OVERSHOOT CARBON BUDGET



DNV·GL

Maritime Forecast to 2050

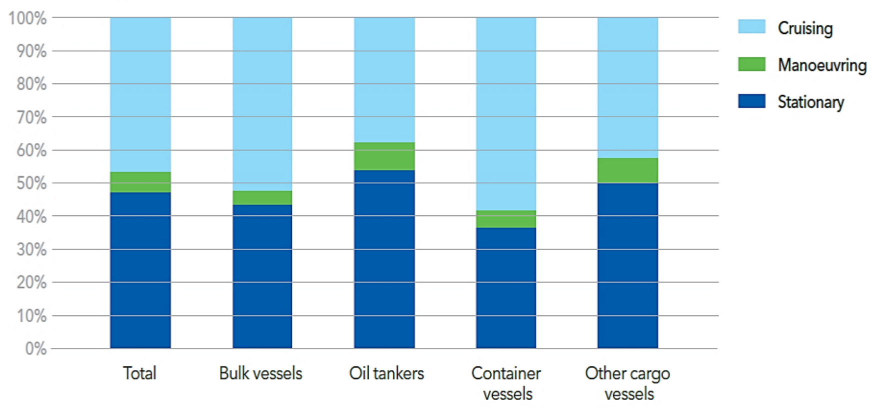
- Mapping fleet performance in 2017 by Operating mode
- World fleet projection towards 2050
- Development in the fleet fuel mix and $CO_2$ emissions

# Mapping fleet performance in 2017 by operating mode indicates an potential for the existing fleet to improve their effectiveness

- The AIS-based analyses indicates a large potential for the existing fleet to **improve their effectiveness**
- **Digitalization** will be a key enabler for exploiting this potential through measures such as:
  - Improved coordination and synchronization between ship and port
  - Better aligning size, operations and functionality of ships and with land-based infrastructure
  - More automated and effective cargo handling operations
  - Phasing in of unmanned and remotely-controlled ships of the future
  - More efficient and automated docking of ships

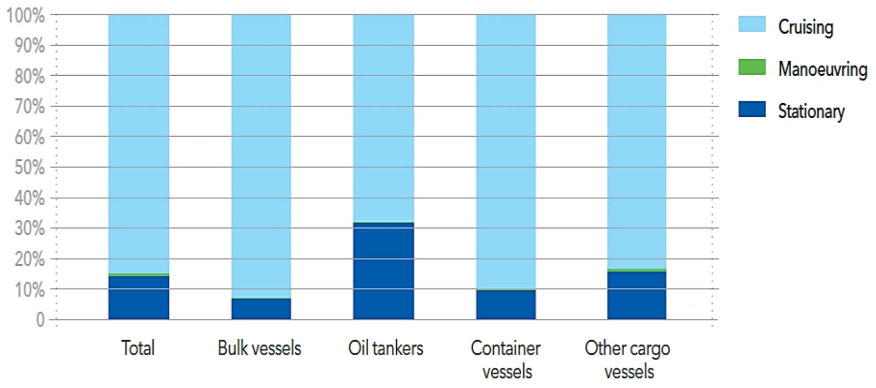
Share of time per operation mode in 2017 by cargo vessel segment

Units: Percentages




Share of fuel used in each operation mode in 2017 by cargo vessel segment

Units: Percentages



DNV·GL

# World fleet projection towards 2050

Transport demand in 2050:

- 76 000 billion tonne-miles
- Up 38% from 2016

Fleet supply in 2050:

- 2.6 billion dwt
- Up 35% from 2016

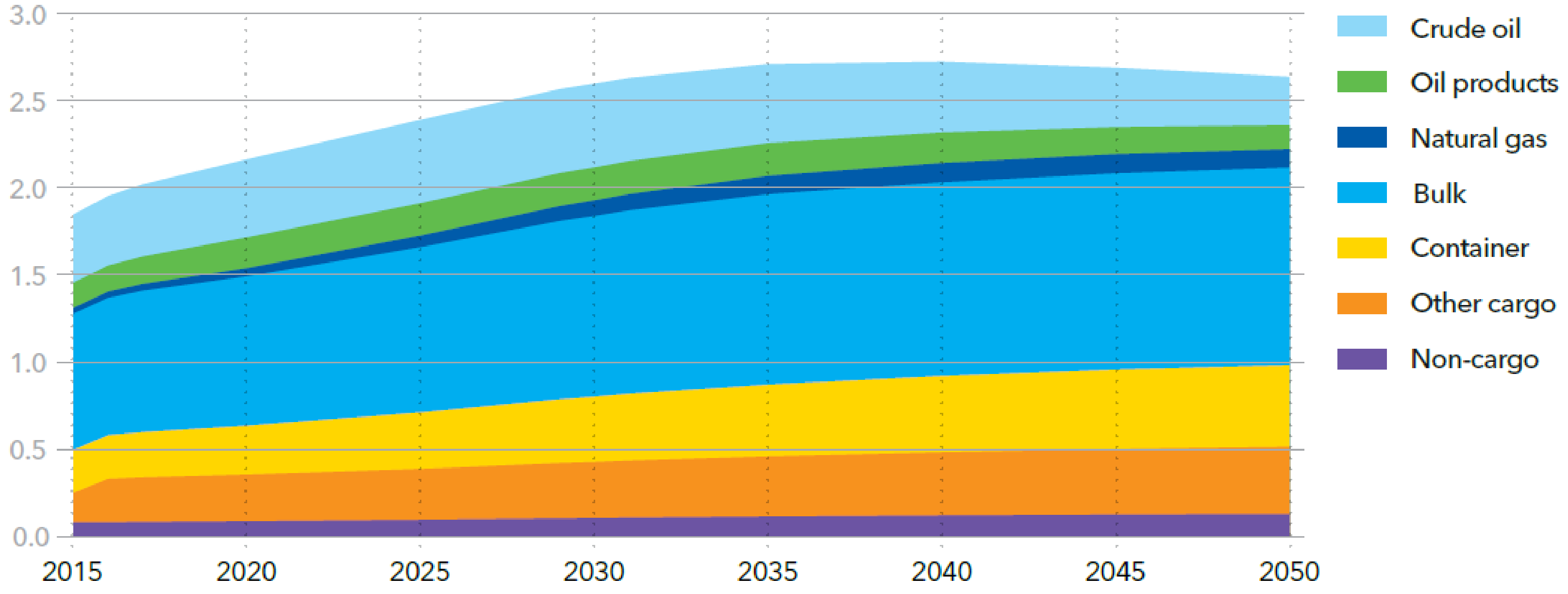
Segment specific changes:

- Crude oil: -30% (peaking around 20% greater than today in 2030)
- Product tanker: -8%
- LNG tankers: 190%
- Bulkers: 44%
- Container: 88%
- Other cargo and non-cargo: 55%

Trade projections shows increases in tonne-mileage over the forecast period for all trade segments, except crude oil and oil products

Fleet development by segment

Units: Billion dwt

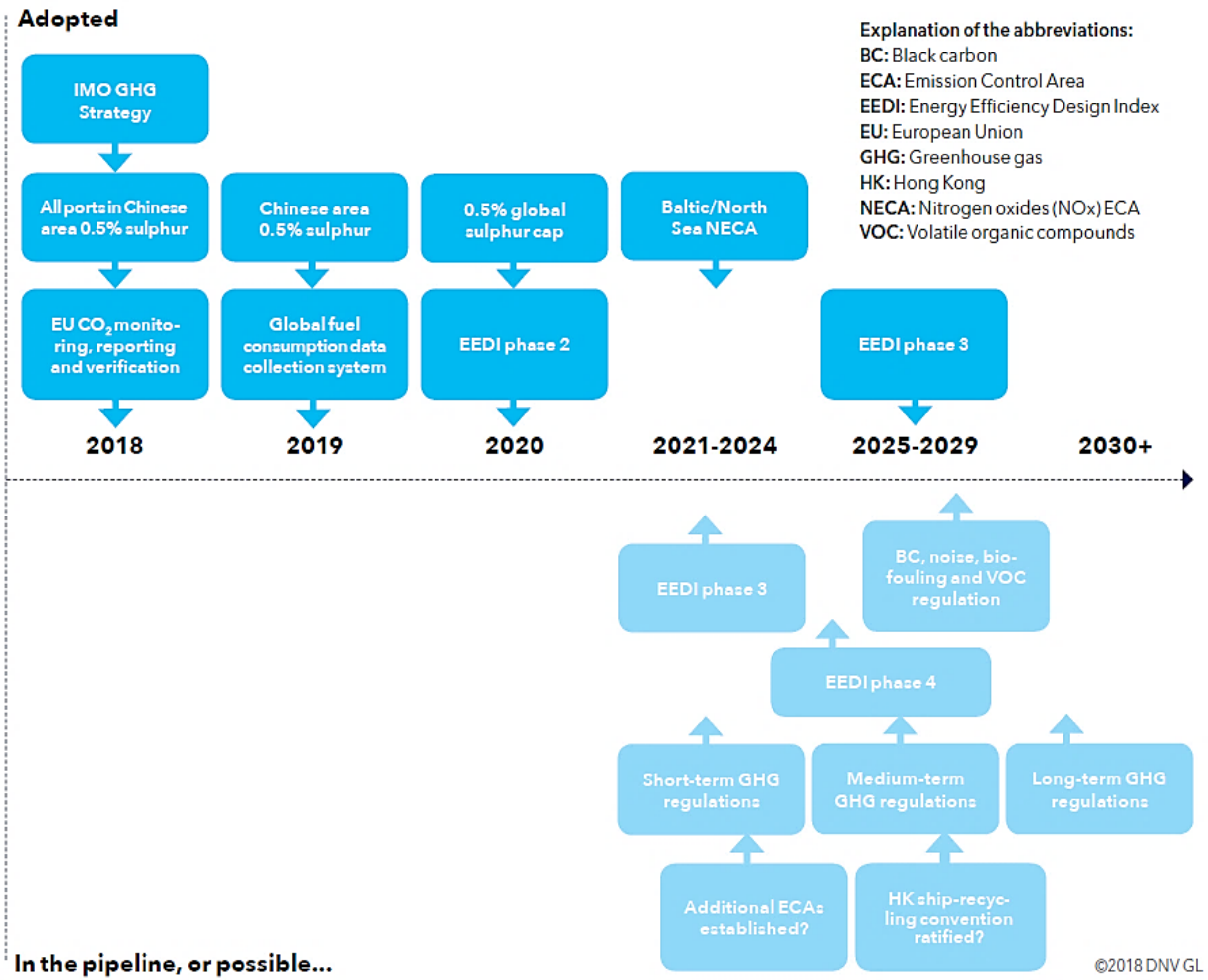



Source: Maritime Forecast to 2050, DNV GL 2018

# Shipping has experienced a surge in environmental regulations over the past decade, which is expected to continue

- **Safety regulations** expected to improve incrementally, with focus on:
  - New environmental technologies and fuels
  - Digitalization including autonomy, control systems, and cyber risk
- Other stakeholders' expectations:
  - **Consumer preferences** and pressure from investors, non-governmental organizations, politicians, and the general public
  - **Climate-risk** assessment and disclosure
  - Significance of **sustainability challenges** will increase over the next decades
  - Shipping companies have an opportunity to respond strategically to these signals and create **business benefit and value**

Timeline of adopted and possible environmental regulations towards 2030





DNV·GL

# Global warming (Greenhouse gases) - a global challenge
# April 2018: IMO GHG Strategy with targets and policy measures

## Possible measures

**Short term (-2023)**

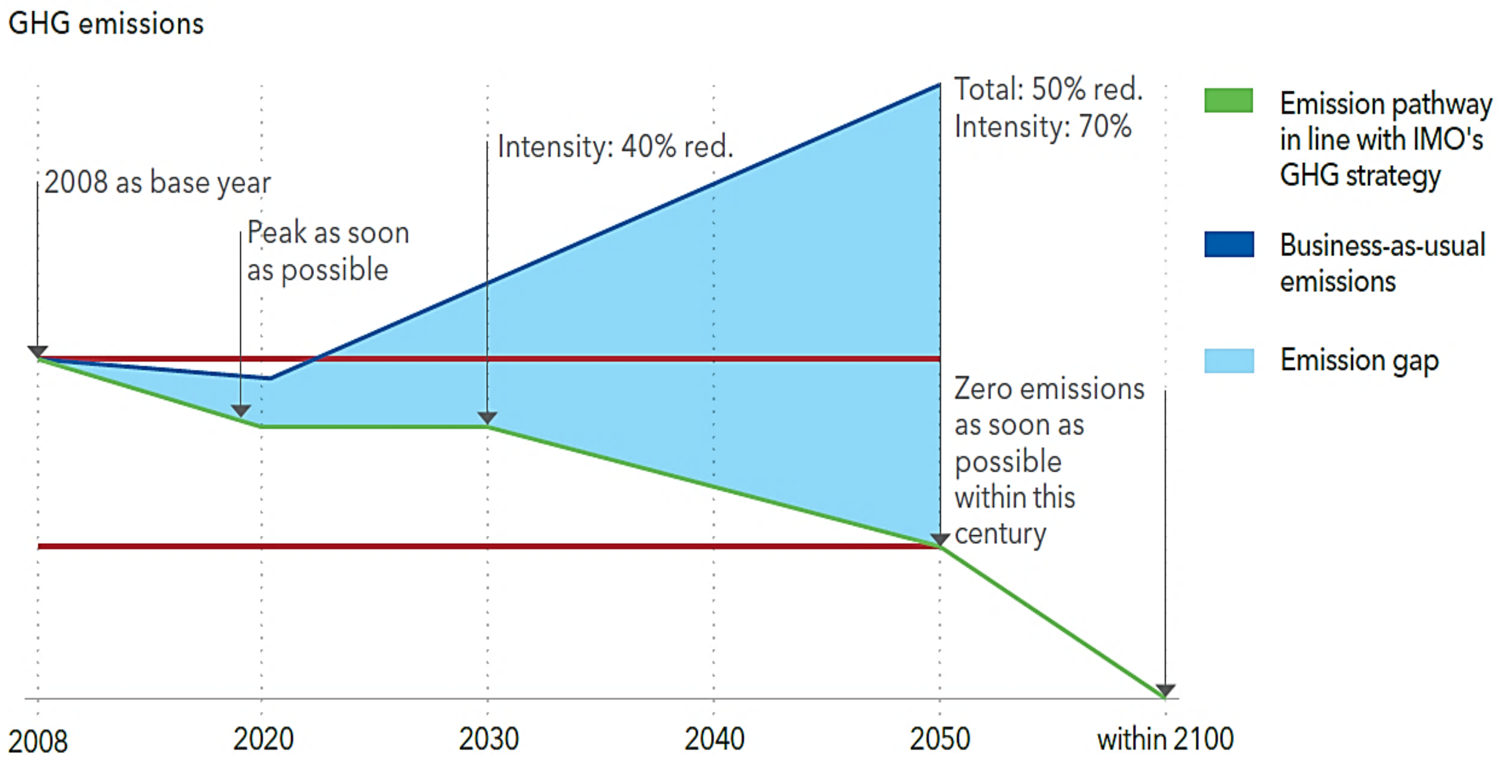
- Review and strengthen EEDI, including new phases
- Develop operational indicators
- Speed reduction/optimization
- National Action Plans
- Lifecycle GHG/carbon intensity guidelines for fuels

**Medium term (2023-2030)**

- New reduction mechanism, possibly including operational indicators
- Market-based measures
- Implementation program for **low-carbon** fuels

**Long term (2030-)**

- Development and provision of **zero-carbon** fuels
- Other innovative reduction mechanisms



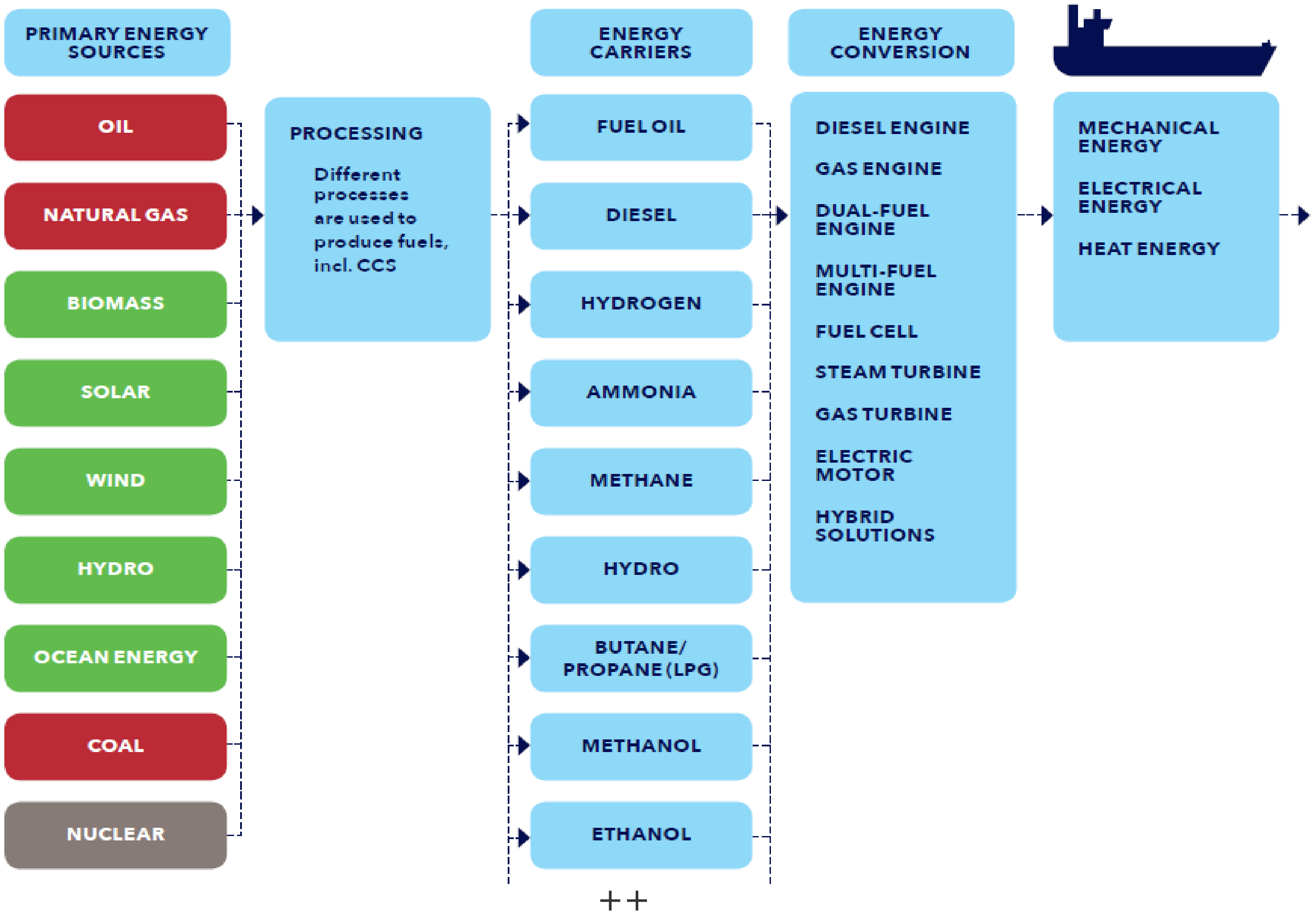

Carbon intensity is measured as $CO_2$ emission per tonne-mile, while Total is the absolute GHG emission from international shipping.

**Decarbonization**



Source: Maritime Forecast to 2050, DNV GL 2018

# Sourcing, processing and converting energy is key to sustainable and decarbonized shipping




## Key aspects

**Primary energy sources:**
- Renewables, nuclear?

**Processing:**
- Captured carbon to produce electro-fuels?

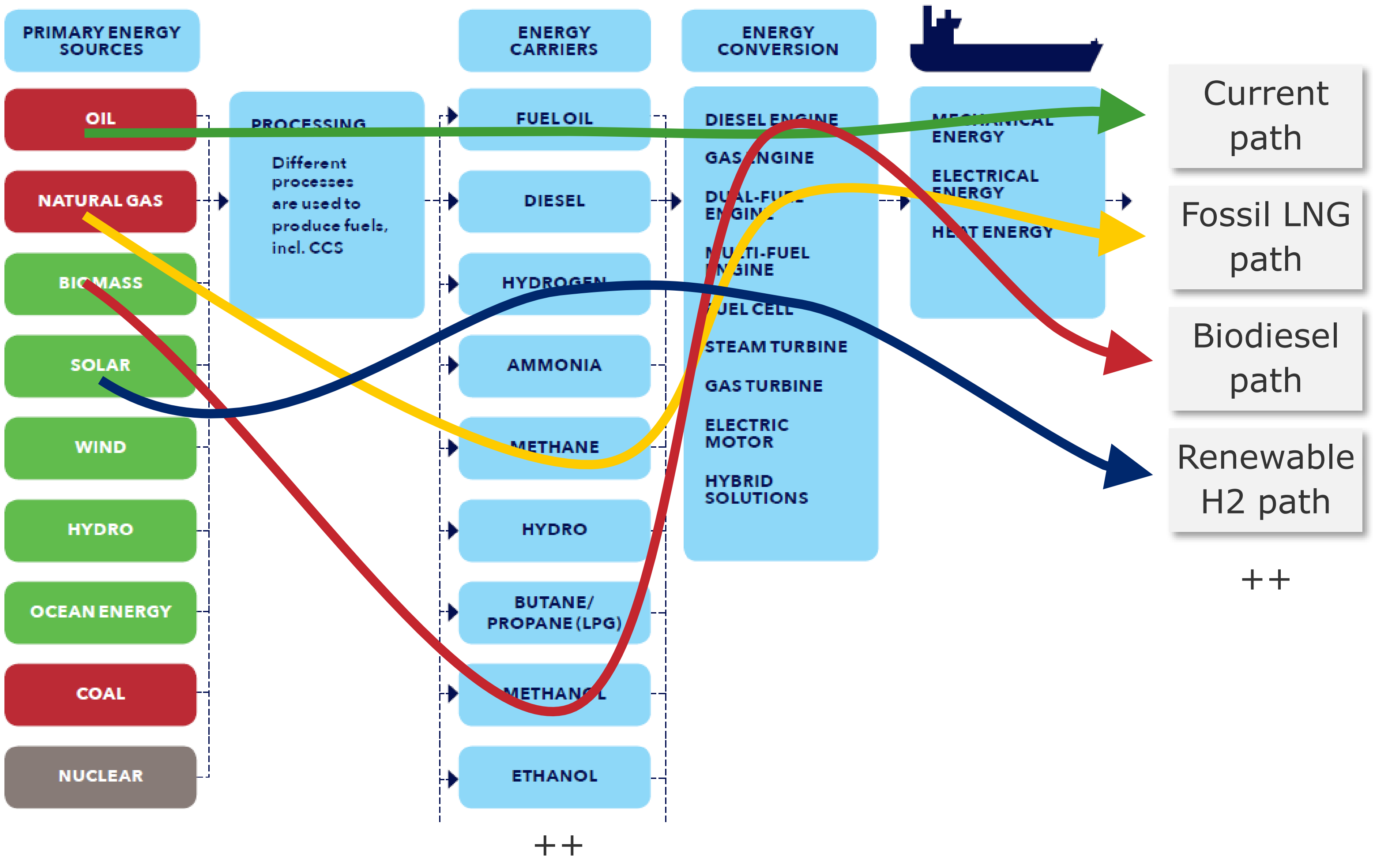
**Which energy carriers:**
- Liquid, gas, hydrocarbons?

**Which energy converter:**
- Internal combustion, fuel cells, electric motors?



*Inspired by Brynolf S. (2014), 'Environmental assessment of present and future marine fuels'*

# Alternative fuel paths




*Inspired by Brynolf S. (2014), 'Environmental assessment of present and future marine fuels'*

- **Safety** is a primary concern
- **Cost** associated with machinery, expected fuel **prices**, and **availability** of fuel itself and bunkering **infrastructure**, will be key barriers
- Storage of certain alternative fuels will **require more space** on board compared with traditional fuels
- All **environmental aspects** must be considered: GHG, NOx, SOx, PM, noise
- **Distinguish between short-sea and deep-sea** shipping regarding barriers and applicability of various fuels



Source: Maritime Forecast to 2050, DNV GL 2018

# Evaluation of fuel paths – globally today

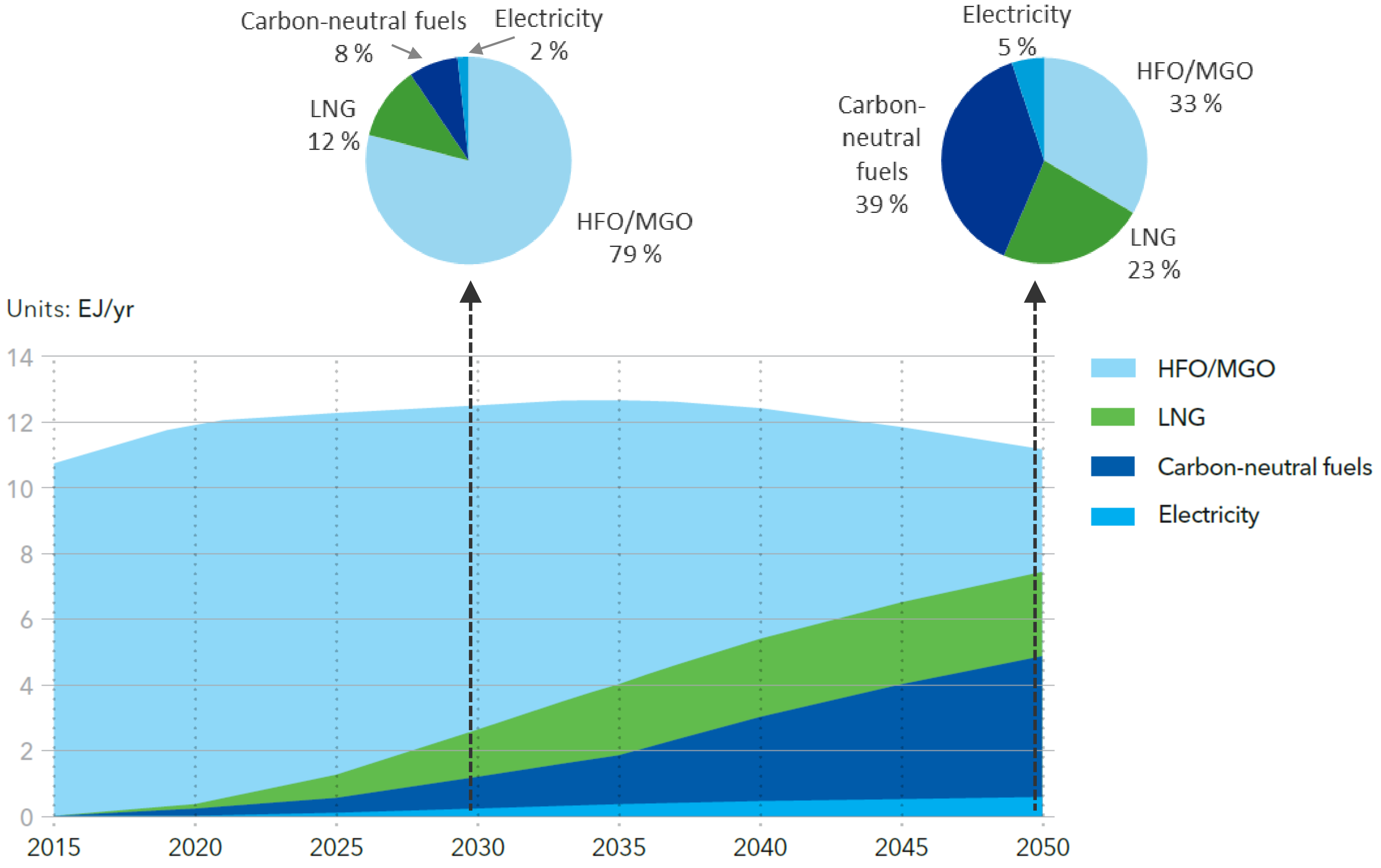
| Fuel path | Primary source | Energy carrier | Energy converter | Scalability | Economy | Environment |
|---|---|---|---|---|---|---|
| Current | Oil | HFO/MGO | Diesel engine | Green | Green | Red |
| Fossil LNG/LPG | Gas | LNG/LPG | Gas/dual fuel engine | Yellow–green | Yellow–green | Yellow |
| Biofuels | Biomass | Diesel/LBG | Diesel/gas/dual fuel engine | Red–yellow | Red–yellow | Yellow–green |
| Electrofuels | Solar/wind/ hydro/nuclear | Diesel/LNG | Diesel/gas/dual fuel engine | Red | Red | Yellow–green |
| Electricity | Solar/wind/ hydro/nuclear | Battery | Electric motor | Red | Yellow–green | Green |
| Renewable $H_2/NH_3$ | Solar/wind/ hydro/nuclear | Hydrogen/ ammonia | Fuel cell | Red | Red | Green |

***Environment:*** *air emissions, bunker spill.* ***Economy:*** *ship, infrastructure.* ***Scalability:*** *technical, applicability, availability*

***Biofuels****: fuels based on carbon from biomass that would otherwise have been in circulation through natural cycles*
***Electro-fuels****: carbon-based fuels such as diesel, methane, and methanol, produced from CO2 and water using electricity as the source of energy*

# By 2050, 39% of shipping energy will be supplied by carbon-neutral fuels, surpassing liquid fossil fuels

- Total energy use in international shipping will be 11 EJ/270 Mtoe in 2050:
  - 33 % (90 Mtoe) HFO/MGO
  - 23 % (60 Mtoe) by LNG
  - 39 % (100 Mtoe) carbon-neutral fuels
  - 5 % (160 TWh) of electricity
- 11 % of energy in short sea and non-cargo supplied by electricity



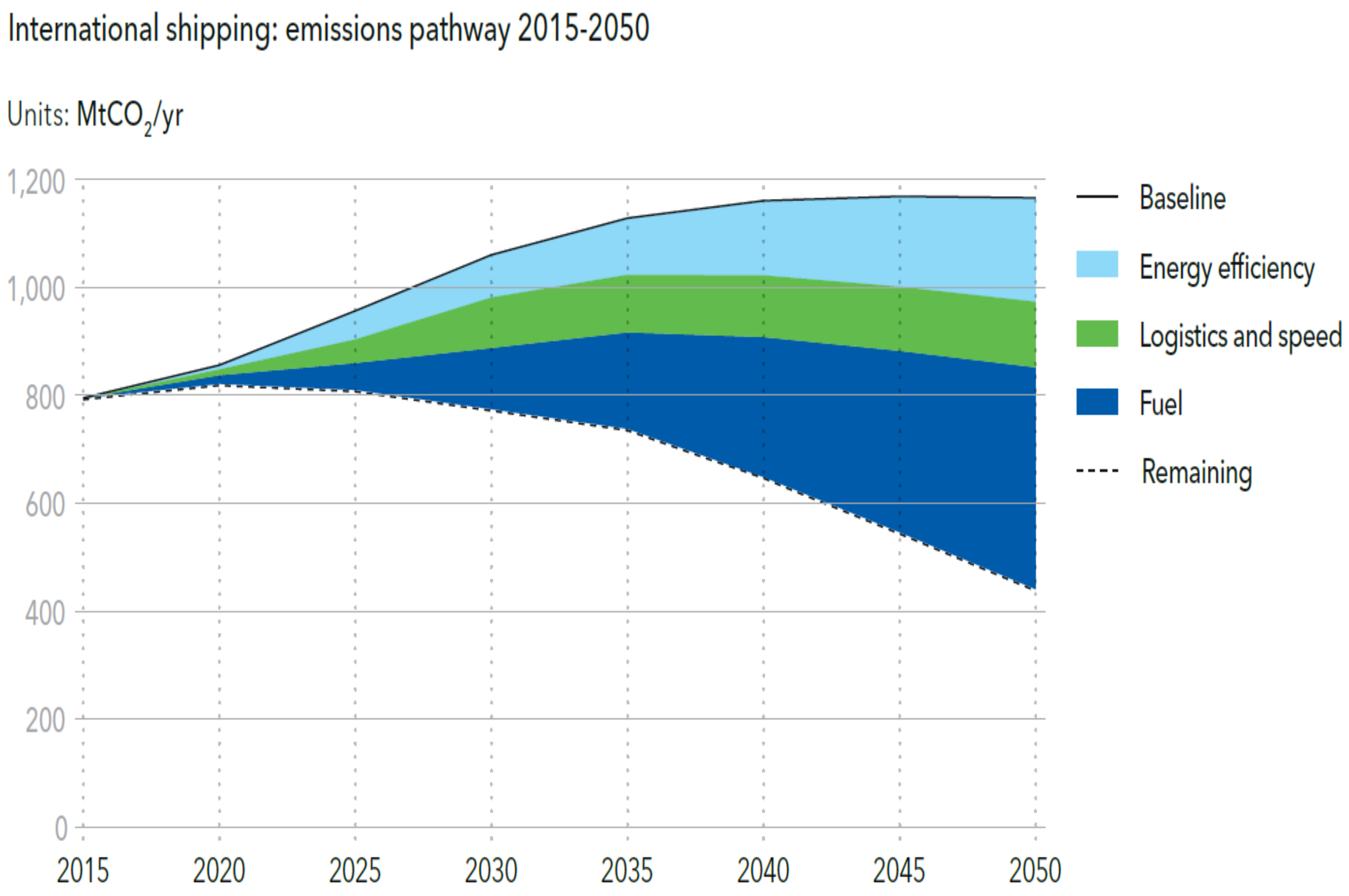

Source: Maritime Forecast to 2050, DNV GL 2018




DNV·GL

# Decarbonization requires combination of energy-efficiency, logistics and speed and carbon-neutral fuels

- Fuel consumption per tonne-mile will **decline 30%** on average due to energy-efficiency measures
- Real-time virtual representations of physical assets (Digital twin), combined with sensor data are emerging, providing **safe and energy-effective** operations for ships
- Impact of logistical measures, incl. lower speed, can be achieved to full effect early in the period up to 2035
- Beyond 2035, we will see the full impact of gradually improving the **energy efficiency** of new ships, and of the shift to alternative fuels
- **Carbon-neutral fuels** are needed to reach the ambitions in the IMO GHG Strategy




Source: Maritime Forecast to 2050, DNV GL 2018

DNV·GL

**The carbon-robust ship concept : Case study - Handy Max bulk carrier**

- The carbon-robust model is used to evaluate **fuel and technology options** by comparing the break-even costs of a design versus competing fleet
- It is a **scenario-based model,** aiming to support maritime stakeholders in evaluating the short and long-term **competitiveness**
- Our case study indicates the **robust choice** with regard to cost competitiveness

# Carbon Robust Model

## Competitiveness is evaluated by:

**1. Break-even cost**

- Investment cost (CAPEX)
- Voyage cost (fuel)
- Operational cost

**2. $CO_2$ emission**

### Design A: The standard ship

- Running on **MGO/LSHFO**
- **Standard** newbuild energy-efficiency levels; no additional investment

### Design B: The LNG-powered ship

- Running on **LNG** with investment in engine, fuel tanks, and systems
- **Standard** newbuild energy-efficiency levels; no additional investment

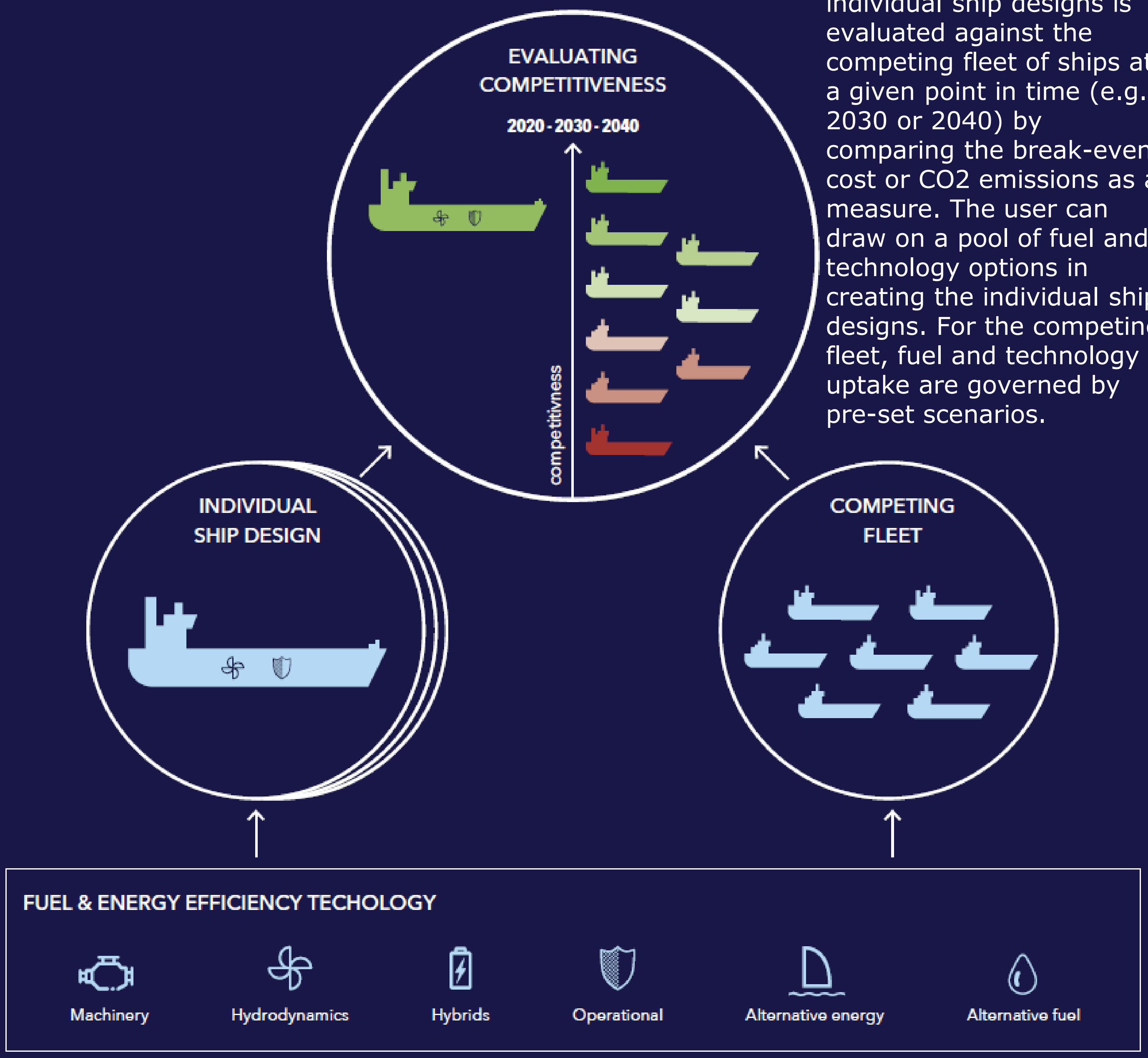
### Design C: The fuel-efficient ship

- Running on **MGO/LSHFO**
- **Enhanced** levels of energy efficiency, with additional investment



Source: Maritime Forecast to 2050, DNV GL 2018

OUTLINE OF THE CARBON ROBUST MODEL




Competitiveness of selected individual ship designs is evaluated against the competing fleet of ships at a given point in time (e.g., 2030 or 2040) by comparing the break-even cost or CO2 emissions as a measure. The user can draw on a pool of fuel and technology options in creating the individual ship designs. For the competing fleet, fuel and technology uptake are governed by pre-set scenarios.

# Case Study: 55K dwt Handy Max Bulk Carrier

| Today | Scenario/Storyline | Resulting fleet in 2040 |
|---|---|---|

**Approx 500 Handy Max bulk carriers**

## Dull blue scenario

- Shipping **will not** reduce GHG emissions to meet the set IMO targets for 2050
- The EEDI is slightly strengthened
- Only a few policy measures for developing carbon-neutral fuels are initiated

**Fuel and energy efficiency in 2040**

| | |
|---|---|
| MGO/LSHFO | 75% |
| HFO + scrubber | 17% |
| LNG | 8% |

Note: Almost all vessels have baseline energy efficiency

## Bright green scenario

- Shipping **will reduce** GHG emissions to meet the IMO targets for 2050, followed up by strengthening the EEDI
- Traditional oil-based fuels are replaced, first by LNG and then by carbon-neutral alternatives
- In 2030, IMO introduces a market-based measure, a fuel levy of USD 50 per tonne of CO2

**Fuel and energy efficiency in 2040**

| | |
|---|---|
| MGO/LSHFO | 55% |
| HFO + scrubber | 3% |
| Battery hybridization | 4% |
| LNG | 18% |
| Biofuels | 19% |

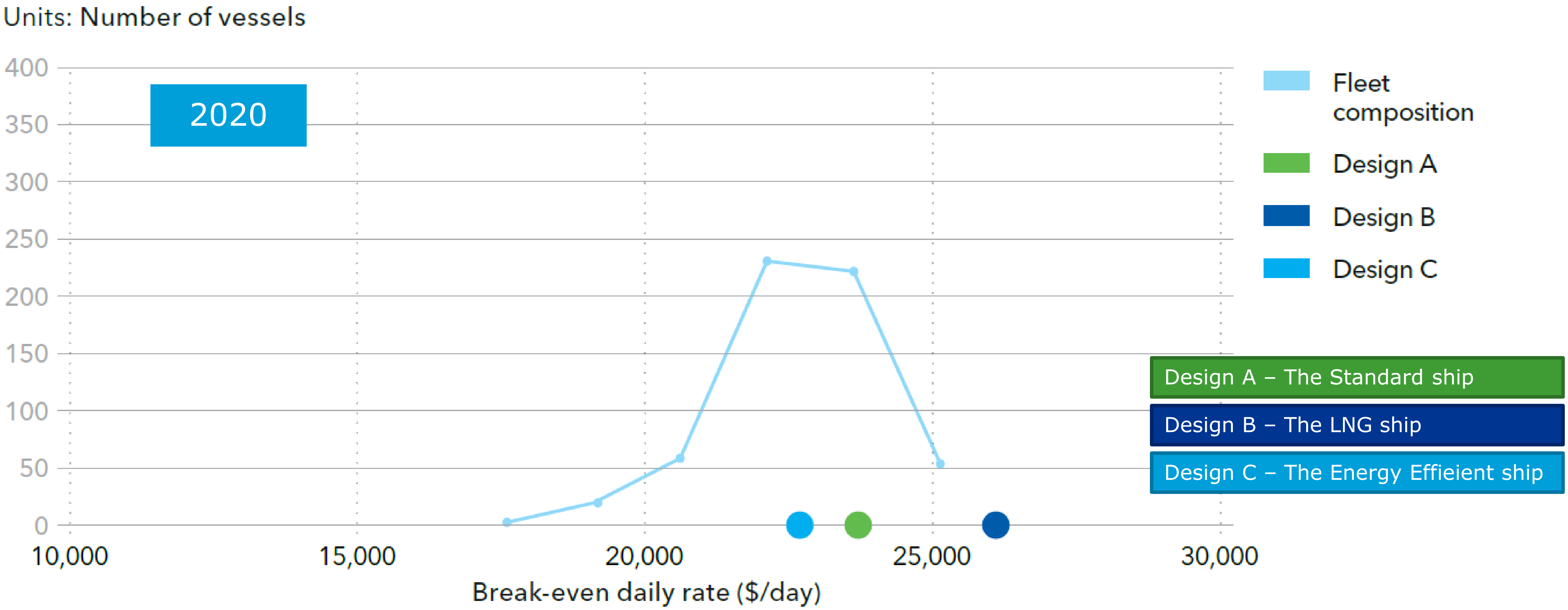
Note: Some 20% of ships have energy-efficiency levels beyond baseline



Source: Maritime Forecast to 2050, DNV GL 2018

# The results;
# How does our designs perform against the competition?

Fleet brake-even rate distribution and break-even daily rate for the three reference vessels, 2020 – both scenarios

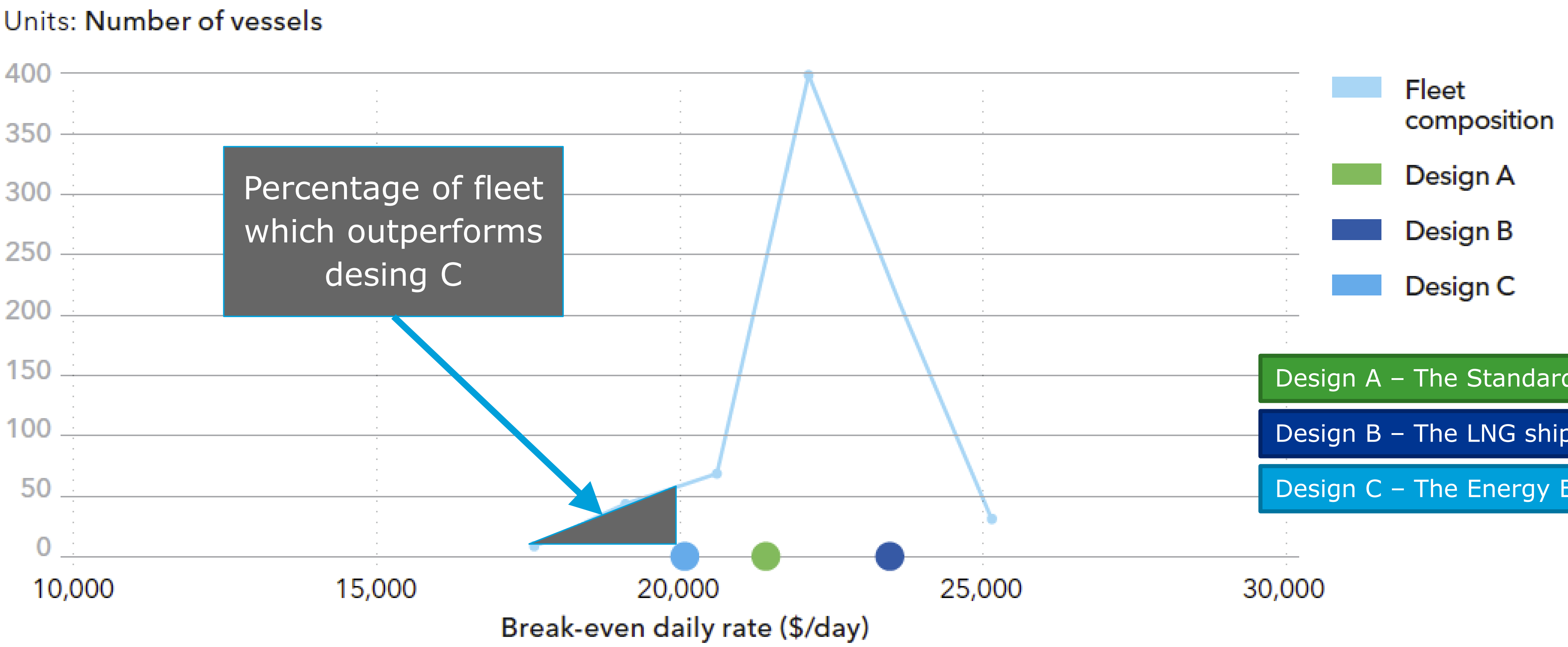


Source: Maritime Forecast to 2050, DNV GL 2018

# The results;
# Performance changes over time

2030 – Dull Blue Scenario




Design A – The Standard ship

Design B – The LNG ship

Design C – The Energy Effieient ship

Source: Maritime Forecast to 2050, DNV GL 2018

  DNV·GL

# Results; Performance depend on scenario

Relative performance; the percentage of the fleet that performs better than our designs

| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| The Standard ship | 60% | 16% | 3% | 60% | 16% | 3% | 5% | 7% | 10% | 5% | 28% | 51% |
| The LNG ship | 100% | 80% | 21% | 100% | 54% | 16% | 1% | 1% | 1% | 1% | 10% | 24% |
| The Energy Effieient ship | 52% | 8% | 3% | 52% | 7% | 3% | 1% | 4% | 9% | 1% | 19% | 38% |

Source: Maritime Forecast to 2050, DNV GL 2018

# Using the model to explore options, asking 'what if?' questions

**Base case**

| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| Design A | 60% | 16% | 3% | 60% | 16% | 3% | 5% | 7% | 10% | 5% | 28% | 51% |
| Design B | 100% | 80% | 21% | 100% | 54% | 16% | 1% | 1% | 1% | 1% | 10% | 24% |
| Design C | 52% | 8% | 3% | 52% | 7% | 3% | 1% | 4% | 9% | 1% | 19% | 38% |

What if the **cost of fuel** increases?


| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| Design A | 60% | 16% | 3% | 60% | 16% | 3% | 5% | 7% | 10% | 5% | 28% | 51% |
| Design B | 100% | 80% | 21% | 100% | 54% | 16% | 1% | 1% | 1% | 1% | 10% | 24% |
| Design C | 52% | 8% | 3% | 52% | 7% | 3% | 1% | 4% | 9% | 1% | 19% | 38% |


???


| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| Design A | 60% | 16% | 3% | 60% | 16% | 3% | 5% | 7% | 10% | 5% | 28% | 51% |
| Design B | 100% | 80% | 21% | 100% | 54% | 16% | 1% | 1% | 1% | 1% | 10% | 24% |
| Design C | 52% | 8% | 3% | 52% | 7% | 3% | 1% | 4% | 9% | 1% | 19% | 38% |


What if we use **heavy fuel oil with exhaust scrubbers** instead of marine gas oil?


| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| Design A | 60% | 16% | 3% | 60% | 16% | 3% | 5% | 7% | 10% | 5% | 28% | 51% |
| Design B | 100% | 80% | 21% | 100% | 54% | 16% | 1% | 1% | 1% | 1% | 10% | 24% |
| Design C | 52% | 8% | 3% | 52% | 7% | 3% | 1% | 4% | 9% | 1% | 19% | 38% |


What if we **add more energy efficiency** measures to our design?


| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| Design A | 60% | 16% | 3% | 60% | 16% | 3% | 5% | 7% | 10% | 5% | 28% | 51% |
| Design B | 100% | 80% | 21% | 100% | 54% | 16% | 1% | 1% | 1% | 1% | 10% | 24% |
| Design C | 52% | 8% | 3% | 52% | 7% | 3% | 1% | 4% | 9% | 1% | 19% | 38% |


What if we select a liquefied natural **gas-ready concept**?


| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| Design A | 60% | 16% | 3% | 60% | 16% | 3% | 5% | 7% | 10% | 5% | 28% | 51% |
| Design B | 100% | 80% | 21% | 100% | 54% | 16% | 1% | 1% | 1% | 1% | 10% | 24% |
| Design C | 52% | 8% | 3% | 52% | 7% | 3% | 1% | 4% | 9% | 1% | 19% | 38% |


Source: Maritime Forecast to 2050, DNV GL 2018

# What if fuel prices increase?

**Change impacting our designs, as well as the fleet:**

**MGO: + 25%**

**HFO: + 40 %**

**LNG: no change**

| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| The Standard ship | 60% | 16% | 3% | 60% | 28% | 11% | 5% | 7% | 10% | 5% | 28% | 51% |
| The LNG ship | 53% | 10% | 3% | 53% | 14% | 3% | 1% | 1% | 1% | 1% | 10% | 24% |
| The Energy Effieient ship | 29% | 7% | 3% | 29% | 6% | 1% | 1% | 4% | 9% | 1% | 19% | 38% |

Source: Maritime Forecast to 2050, DNV GL 2018



DNV·GL

# What if we use HFO?

## Design A (Standard Ship) & C (Energy Efficient Ship) run on HFO+scrubber

| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| The Standard ship | 9% | 1% | 1% | 9% | 1% | 1% | 64% | 75% | 81% | 64% | 82% | 95% |
| The LNG ship | 100% | 80% | 21% | 100% | 54% | 16% | 1% | 1% | 1% | 1% | 10% | 24% |
| The Energy Effieient ship | 9% | 1% | 1% | 9% | 1% | 1% | 3% | 6% | 9% | 3% | 25% | 47% |

Source: Maritime Forecast to 2050, DNV GL 2018



DNV·GL

# What if we increase energy efficiency levels?

## Design B & C bump up

## Energy efficiency

| | BREAK-EVEN DAILY RATE | | | | | | $CO_2$ EMISSIONS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Scenario: Dull Blue | | | Scenario: Bright Green | | | Scenario: Dull Blue | | | Scenario: Bright Green | | |
| | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 | 2020 | 2030 | 2040 |
| The Standard ship | 60% | 16% | 3% | 60% | 16% | 3% | 5% | 7% | 10% | 5% | 28% | 51% |
| The LNG ship | 91% | 50% | 3% | 91% | 10% | 3% | 1% | 1% | 1% | 1% | 7% | 19% |
| The Energy Effieient ship | 53% | 8% | 3% | 53% | 1% | 1% | 1% | 1% | 1% | 1% | 9% | 23% |

Source: Maritime Forecast to 2050, DNV GL 2018

# Findings from the case study- Handy Max bulk

**Base case (two scenarios):**

- The energy-efficient ship (design C) is the most robust choice in terms of break-even competitiveness, striking a balance between short-term and long-term interests
- In comparison, the standard ship (design A) faces the risk of being outperformed under several likely conditions
- The LNG vessel (design B) struggles with high investment costs, and fuel prices that are advantageous only under certain conditions

**«What if»**

- Adding exhaust scrubbers make sense, given the HFO/MGO price, but risks creating a ship with relatively low $CO_2$ performance
- The case study also reveals that vulnerability to $CO_2$ ranking is potentially high, and could easily expose an owner to significant market and carbon price risk in 2030 and 2040. In this respect, the LNG vessel (design B) is a safer choice

# Key take-aways: The carbon-robust ship concept

The study shows significant differences in competitiveness over the life of a vessel, depending on different scenarios

- One striking finding is that investing in energy efficiency and reduced carbon footprint **beyond current standards** seems to increase competitiveness over the lifetime of the ship
- The study also suggests that owners of **high-emitting vessels** could be exposed to significant market risks in 2030 and 2040 in scenarios where low-emission vessels attract premium rates or avoid $CO_2$ taxes or levies
- To 2050,the energy transition and regulatory changes will have a significant impact on the industry. The pace of technological change has increased rapidly, and the impact of each new cycle is harder to assess. We believe the **carbon-robust** approach could be a valuable supplement to stakeholders to stay ahead of industry developments and remain competitive moving forward.

# Decarbonization will be one of the megatrends that will shape the maritime industry over the next decades.

**Yoshinori Miura**
yoshinori.miura@dnvgl.com
078-291-1301

**www.dnvgl.com**

**SAFER, SMARTER, GREENER**