MARITIME FORECAST TO 2050

Energy Transition Outlook 2019
Maritime forecast to 2050 in a nutshell

GHG regulation

World fleet CO₂ outlook

Decarbonization options

Ship design performance
The foundation for the outlook is the IMO GHG strategy

Units: GHG emissions

- Emission pathway in line with IMO’s GHG strategy
- Business-as-usual emissions
- Emission gap

- 2008 as base year
- Peak as soon as possible
- Intensity: 40% reduction
- Total: 50% reduction
- Intensity: 70%
- Zero emissions as soon as possible within this century
New ‘CO₂ Barometer’ signals shipping decarbonization is off course

1. **World fleet CO₂ emissions**
   - Slight increase in CO₂ emissions in recent years

2. **Alternative fuels uptake**
   - 0.3% uptake ships in operation
   - 6% for newbuildings

3. **Regulation**
   - Current policy scenario will not meet the IMO ambitions without further policy

The **CO₂ Barometer** provides a high-level decarbonization status in the form of a ‘transition pressure level’.
Decarbonization options for shipping

- **Significant GHG reduction** can be achieved by technical and operational measures
- **Up to 100%** GHG reduction can only be achieved with Alternative fuels. Barriers to implementation includes:
  - Cost
  - Availability and infrastructure
  - Onboard storage

<table>
<thead>
<tr>
<th>Logistics and Digitalization</th>
<th>Hydrodynamics</th>
<th>Machinery</th>
<th>Fuels and Energy Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vessel utilization</td>
<td>Hull-form optimization</td>
<td>Waste heat</td>
<td>Electrification</td>
</tr>
<tr>
<td>Alternative routes</td>
<td>Cleanliness</td>
<td>Engine derating</td>
<td>Biofuel</td>
</tr>
<tr>
<td>10%–15%</td>
<td>5%–20%</td>
<td>Battery hybridization</td>
<td>Hydrogen etc.</td>
</tr>
<tr>
<td>0%–100%</td>
<td>0%–100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Decarbonization options for shipping - alternative fuels and energy sources

- **Three** main “family types” of fuels, categorized based on energy source.
  - Similar fuels can originate from different energy sources, but lifecycle emissions and cost vary greatly
  - A given energy converter (e.g. combustion engine) may apply many alternative fuels

<table>
<thead>
<tr>
<th>Fossil-based</th>
<th>Electricity-based</th>
<th>Bio-based</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen/Ammonia</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other fuels</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Barriers exist on many levels for different fuels.

Adoption of alternative fuels depend on:
- demand from charters/cargo owners,
- proactive regulators,
- procurement policies and
- incentive schemes and international cooperation

- Designer, yard, engine/equipment supplier, shipowner, cargo owner
- Feedstock suppliers, fuel suppliers, authorities
- Fuel supplier, authorities, terminals, ports
- IMO, Class, regional, national
- Equipment supplier, designer, yard, incentive schemes
- Feedstock supplier, fuel suppliers, competition authorities
- R&D, designer

- HVO
- LNG
- H₂ (FC)
- NH₃ (ICE)
- Battery
Alternative fuels must evolve over time to increase marked penetration

Gradual steps allow for:
- maturing of technology
- scaling of supply and infrastructure

Not all the options have the potential to reach the deep-sea stage, mainly due to limited energy density

It took LNG around 20 years to climb all steps. To reach the IMO targets, carbon-neutral fuels must mature faster!
Fuel flexibility and bridging technologies

– can facilitate the transition from traditional fuel, via fuels with lower-carbon footprints, to carbon-neutral fuels

– require limited investments and modifications along the way

Alternative 1

LNG

Bio-LNG

Hydrogen

Alternative 2

LPG

Ammonia

2020

2050
The three pillars of the bridging philosophy

THE BRIDGING PHILOSOPHY

Fuel-flexible energy converters

Fuel-flexible storage tanks and onboard systems

Fuel-flexible shore-side fuel infrastructure

H₂, HVO, LBG, LNG, LPG, MGO, NH₃, etc.

H₂, hydrogen; HVO, hydrotreated vegetable oil; LBG, liquid biogas; LNG, liquefied natural gas; LPG, liquefied petroleum gas; MGO, marine gas oil; NH₃, ammonia

©DNV GL 2019
Flexible **modelling tool** for assessing alternative futures, handle various scenarios including:
- regulatory and trade developments
- fuel-price assumptions
- energy-efficiency technologies

- The **pathway model** projects the
  - future fleet
  - fuel mix and CO₂ emissions
  - abatement cost.
Pathway Model; We explore the impact of specific GHG regulations

1. What would happen if no further decarbonization policies are put in place?
2. What is the effect of stricter operational requirements?
3. What if main focus is on stricter design requirements?

Regulatory input to the model: Three different policy designs

Model

Output

INPUT
- Baseline fleet
- Seaborne trade
- Technology costs and effects
- Fuel prices
- Regulation

FLEET DEVELOPMENT MODULE (newbuilding and scrapping)
ABATEMENT UPTAKE MODULE (newbuilding and retrofit)

OUTPUT 2018-2050
- Future fleet
- CO2 emissions
- Fuel mix
- Cost

Year-by-year feedback: capacity and learning

Units: EJ/yr

2020 2025 2030 2035 2040 2045 2050

1 2 3
CO₂ emissions towards 2050 in the ‘Design requirements’ pathway

- Both the **design** and **operational** focused regulatory pathways fulfill the IMO ambitions:
  - New fuels, alongside energy efficiency, will play a key role.
  - Carbon-neutral fuels need to supply 30%–40% of the total energy in 2050.

- The “Current policy” pathway is **not** fulfilling the IMO ambitions.
In all three pathways modelled, liquefied methane (both fossil and non-fossil) ends up dominating the fuel mix.
Several ways to meet the IMO targets - policy matters

Focusing on **operational requirements**, the uptake of alternative fuel for newbuilding's is more gradual

If main focus is on **design requirements**, the shift in fuel and fuel-converter technology on newbuildings is very abrupt

LNG play an important role – transition to carbon neutral fuels will be needed
What is the future competitiveness of your ship?

DNV GL has developed a model to test **competitiveness** under different scenarios – taken into account:

- Fuel & technology
- Regulations
- Risks related to the market

Competitiveness of individual **ship designs** is assessed using:

- Break-even cost
- CO₂ emissions
Stress-testing designs against multiple future scenarios

**INPUT**
- Your design and fuel choices
- Scenarios for the competing fleet

**The Carbon-Robust MODEL**
- Stress-testing designs against multiple future scenarios

**OUTPUT**
- Break-even cost
- Your ship’s competitiveness
- Carbon-risk exposure

---

DNV GL © 2019
How well is your design performing under different scenarios

The model evaluates the break-even cost of a design to that of the competing fleet.

A multi-scenario approach is applied, spanning the commercial, regulatory and technology opportunity space.

This will help to build resilience and readiness, and provides input to a robust newbuilding strategy.

(The break-even cost is the minimum rate that a ship must secure to cover all costs)
What is the exposure to carbon risk under different scenarios?

The model also evaluates the CO₂ emissions of a design to that of the competing fleet.

It is possible to assess the balance between short-term cost reduction and long-term carbon-risk exposure.

CO₂ emissions could become an additional differentiator.
Key findings

- Shipping decarbonization is off course
- Uptake of alternative fuels is picking up, but needs to breakthrough to the large ocean going ships
- In addition to LNG, carbon-neutral fuels will be needed towards 2050
- Bridging technologies and fuel flexibility can smooth the transition from traditional fuels
- Ships should be future proof in a changing environment, securing competitiveness and mitigating carbon risk
- We have provided tools to support policy makers, ship owners and other stakeholders
Reports available for download

https://eto.dnvgl.com
Thank you!

Tony Linden
antony.robert.linden@dnvgl.com

www.dnvgl.com