Key environmental issues

- Key concerns being addressed through recent environmental regulatory developments;
  - Ballast water
  - Scrapping / recycling
  - SOx / NOx
  - PM (partly)
  - Scrubbers
  - VOC

- However, CO₂ is pre-eminent on the regulatory and political agenda
Shipping fuel cost and CO$_2$ emissions

- Shipping burns some 350 million ton of heavy fuel per year
- The associated fuel cost is some USD 140 billion per year (USD 400/ton)
- The associated emission of CO$_2$ is around 1 billion ton of CO$_2$ per year

The business case for improving energy efficiency and thereby reducing CO$_2$ emissions is strong
A future price of carbon will make the business case even stronger
CO₂ emissions divided by main ship categories and assumed typical type of operation

- **Tank**: High CO₂ emissions (majorly Ocean going)
- **Bulk**: Moderate CO₂ emissions (mixed Ocean going and Coastwise)
- **General Cargo**: Medium CO₂ emissions (Ocean going significantly)
- **Container**: High CO₂ emissions (majorly Ocean going)
- **RoRo/Vehicle**: Low CO₂ emissions (mainly Coastwise)
- **Ropax Cruise**: Moderate CO₂ emissions (mixed Ocean going and Coastwise)
- **Other**: Low CO₂ emissions (mixed Ocean going and Coastwise)

(Coastwise shipping is mainly ships < 15000 dwt, RoPax, Cruise, Service and Fishing)

Source: MARINTEK presentation on IMO Study on Greenhouse Gas Emissions from Ships, 2008
Possible emission futures

Scenarios for CO2 emissions from International Shipping from 2007 to 2050 in the absence of climate policies

Source: MARINTEK presentation on IMO Study on Greenhouse Gas Emissions from Ships, 2008
Regulatory drivers - EU climate change political developments

- Commission has given IMO until end 2011 to act, if not the EU will act unilaterally, imposing regional regulations by 2013. In practical terms this is a decision that is both binding and non-revocable.

- Content still unclear, but market based instrument indicated as key component

- Willingness to carry through indicated by Airline inclusion in ETS from 2012
Regulatory drivers – IMO politics

IMO under strong pressure to deliver results by UNFCCC
Copenhagen climate conference (COP15) December 2009

Political barriers - clashing IMO and UNFCCC principles

- Significant differences in national positions as regards IMO’s role in curbing ship emissions of GHG in relation to the mandate of the UNFCCC and Kyoto protocol

- Developing countries (non-Annex I) generally in consensus that IMO must adopt the principles of UNFCCC / Kyoto, i.e. “Common But Differentiated Responsibilities (CBDR)”

- This is strongly opposed by delegations of the developed countries (chiefly Annex I), invoking the IMO principle of “No More Favourable Treatment”

- So far not possible to break this impasse, in-depth discussions on application of CO2 regulations, as well as on introduction market based instruments (MBI’s), deferred until MEPC60 (March ’10)

- Disagreements among MBI advocates on instrument most appropriate for international shipping - bunker tax or emission trading
No agreement on regulatory matters – decisions deferred to MEPC 60 earliest (March 2009)

Discussion on market based instruments deferred until MEPC60, pending developments at UNFCCC COP15 (Dec. 09), MEPC work plan indicates decision at MEPC62 earliest

Finalisation of guideline for Energy Efficiency Operational Index (EEOI) to be used on a voluntary basis

Consensus reached on interim guidelines for Energy Efficiency Design Index (EEDI) and verification scheme, to be used on a voluntary trial basis.

Consensus on draft guidance on the development of a Ship Energy Efficiency Management Plan (SEEMP) to be used on a voluntary basis

Developments at COP15 (Dec. ’09) will be instrumental for further progress on ship GHG regulations
The evolution of an index

- **The principle:**

  \[
  \frac{C_F}{\text{Capacity}} \times \frac{SFC}{P} \times \frac{V_{\text{ref}}}{\text{Capacity}}
  \]

- **Japan:** MEPC 57/4/12

  \[
  \prod_{j=1}^{M} f_j \sum_{i=1}^{N} C_{F,MEi} \times SFC_{MEi} \times P_{MEi} + \prod_{k=1}^{L} f_k \sum_{i=1}^{N} C_{F,AEi} \times SFC_{AEi} \times P_{AEi}
  \]

- **Denmark:** GHG-WG 1/2/1

  \[
  \left( \prod_{j=1}^{M} f_j \right) \left( \sum_{i=1}^{N} C_{F,MEi} \times SFC_{MEi} \times P_{MEi} \right) + \left( \prod_{k=1}^{L} f_k \right) \left( \sum_{i=1}^{N} C_{F,AEi} \times SFC_{AEi} \times P_{AEi} \right)
  \]

- **MEPC 58/4**

  \[
  \left( \sum_{i=1}^{N} C_{F,MEi} \times SFC_{MEi} \times P_{MEi} \right) + \left( \sum_{i=1}^{N} C_{F,AEi} \times SFC_{AEi} \times P_{AEi} \right) - \left( \sum_{i=1}^{N} f_{\text{eff}} C_{F,\text{eff}} \times SFC_{\text{eff}} \times P_{\text{eff}} \right)
  \]

- **USA:** MEPC 58/4/35

  \[
  \left( \prod_{j=1}^{M} f_j \right) \left( \sum_{i=1}^{N} C_{F,MEi} \times SFC_{MEi} \times P_{MEi} \right) + P_{AE} \times C_{F,AE} \times SFC_{AE}^{*} \times P_{AE} + \left( \sum_{i=1}^{nPTI} P_{PTi} \right) \times C_{F,AE} \times SFC_{AE} - \left( \sum_{i=1}^{nWHR} P_{WHRi} \right) \times C_{F,AE} \times SFC_{AE}
  \]

- **MEPC 58/23**

  \[
  \prod_{j=1}^{M} f_j \sum_{i=1}^{N} P_{MEi} \times C_{F,MEi} \times SFC_{MEi} + \left( P_{AE} \times C_{F,AE} \times SFC_{AE}^{*} \times P_{AE} \right) + \left( \prod_{j=1}^{N} f_j \sum_{i=1}^{nPTI} P_{PTi} \right) \sum_{i=1}^{nWHR} f_{\text{eff}} P_{AEi} \times C_{F,AE} \times SFC_{AE} \times P_{AEi}
  \]

- **GHG WG2**

  \[
  \prod_{j=1}^{M} f_j \sum_{i=1}^{N} P_{MEi} \times C_{F,MEi} \times SFC_{MEi} + \left( P_{AE} \times C_{F,AE} \times SFC_{AE}^{*} \times P_{AE} \right) + \left( \prod_{j=1}^{N} f_j \sum_{i=1}^{nPTI} P_{PTi} \right) \sum_{i=1}^{nWHR} f_{\text{eff}} P_{AEi} \times C_{F,AE} \times SFC_{AE} \times P_{AEi}
  \]

- **Environmental cost benefit for society**
Present EEDI formulation

\[
\left( \prod_{j=1}^{M} f_j \right) \left( \sum_{k=1}^{n_{ME}} P_{ME(k)} \cdot C_{FME(k)} \cdot SFC_{ME(k)} \right) \left( \prod_{j=1}^{M} f_j \right) \left( \sum_{i=1}^{n_{PTI}} P_{PTI(i)} \cdot f_{eff(i)} \cdot P_{AEeff(i)} \right) C_{FAE} \cdot SFC_{AE} \left( \prod_{j=1}^{M} f_j \right) \left( \sum_{k=1}^{n_{ME}} P_{ME(k)} \cdot C_{FME(k)} \cdot SFC_{ME(k)} \right)
\]

- Ice strengthening factor
- Main Engine
- Aux. Engine
- Transport work capacity
- Waste heat and shaft motors
- Weather factor
- Efficient design options

### Ship type

<table>
<thead>
<tr>
<th>Ship type</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Bulk</td>
<td>Deadweight (DWT)</td>
</tr>
<tr>
<td>Tankers</td>
<td></td>
</tr>
<tr>
<td>Container ships</td>
<td></td>
</tr>
<tr>
<td>General cargo ships</td>
<td></td>
</tr>
<tr>
<td>Gas tankers</td>
<td></td>
</tr>
<tr>
<td>Ro-Ro cargo ships</td>
<td></td>
</tr>
<tr>
<td>Passenger ships</td>
<td>Tonnage (GT)</td>
</tr>
</tbody>
</table>
Possible EEDI timeline

- **MEPC 59 - July 2009**
  - EEDI formula finalised and agreed as voluntary measure

- **MEPC 60 – March 2010**
  - EEDI approved as mandatory measure, including application issues (scope of application, requirement levels, verification issues, non-compliance consequences, entry into force date, etc.)
  - Diesel electric ships possibly included

- **MEPC 61 – October 2010**
  - Decision of MEPC 60 adopted

- Entry into force – assuming Marpol Annex VI is used as instrument; somewhere between 2013 - 2018
What can shipping do?

Higher energy efficiency can be achieved through:

- Technical measures
- Operational measures
- Structural measures

DNV believes that combined technical and operational means can reduce per-ship CO2 emissions by 50% from today's level for a ship delivered in 2030 and by 70% for a ship delivered in 2050.
Example from A.P. Moller - Maersk – Eco-efficient new design

- 16 new 7450 TEU container vessels from Daewoo - notably different from standard design

- Fuel reduction:
  - Slow running main engine – 3%
  - Greater diameter propeller – 5 %
  - Tailor made hull design for intended route – 8%
  - Waste Heat recovery – 9%

- Total fuel reduction estimated to 23%
## Effect of vessel size

Big is beautiful – 400k vs 175k ore carrier:

<table>
<thead>
<tr>
<th>Vessel capacity [DWT]</th>
<th>Engine [kW]</th>
<th>30% reduction in fuel consumption and CO$_2$, SOx and NOx emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>400k</td>
<td>29400</td>
<td></td>
</tr>
<tr>
<td>175k</td>
<td>18375</td>
<td></td>
</tr>
</tbody>
</table>

A reduction in speed from 15 kn to 13 kn can lead to additional 17% fuel savings.
Design - hull

- Lines
- Aft / fore ship design
- Propeller and rudder designs

- Hull coatings – e.g. silicone based coatings
- Creation of air cushions

- Increase in vessel size
- Multi hull designs without ballast
- Lighter superstructures applying new materials
Design - propulsion

- More flexible use of main engines, plant optimisation
- Electronically controlled main engines
- Waste heat recovery plants
- Introduction of assisting sails and/or kites
- Miscellaneous technologies to improve minor energy consumers
  - Air conditioning
  - Lighting
  - Pumps
  - Boilers
  - Pipe insulation
  - Deck paint
Example from A.P. Moller - Maersk – Slow steaming

- A.P. Moller - Maersk has the last two years run engines down to 10% loads
- Comprehensive monitoring and analysis demonstrated this was possible; MAN and Wärtsilä have adjusted recommendations accordingly
- APM-Maersk reports significant fuel savings

Used courtesy of APM
Operational means - examples

- More frequent cleaning of hull or recoating with new paint types with less resistance
- More frequent cleaning of propellers or propeller coating
- Optimizing ship condition with respect to ballast and trim
- More efficient controls for large energy consumers
- Better route planning, weather routing systems and autopilots
Infrastructure & frame conditions - examples

- Developing infrastructure (e.g. cranes, berths, port logistics) to allow for larger capacity ships
- Improving slot time and turn-around systems in ports and canals, just-in-time arrivals
- Shortening travel distance
  - expansion of the Panama Canal,
  - less costly passage of the Suez Canal,
  - assistance to allow safe passage through the North West Passage or North East Passage
- Creating incentives, removing barriers
  - green ports
  - flexibility in sailing speed
  - “who pays for the fuel?”
Abatement calculations show that a number of technical and operational means are profitable with today’s fuel prices and without a price on CO₂ emissions.

Elimination of other than financial barriers for realising such means is important.
The graph illustrates the average marginal CO₂ reduction cost per reduction option on the world fleet. The x-axis represents CO₂ reduction (mill tonnes per year), while the y-axis shows the cost per tonne CO₂ averted ($/tonne). The chart highlights various reduction options such as voyage execution, boiler consumption reduction, engine monitoring, auxiliary power reduction, optimal trim, wind power, fleet optimization and speed reduction, weather routing, hull condition, propulsion efficiency devices, and propeller efficiency. The baseline is set at 925 MT.
What does the future hold?

- COP15 of utmost importance for IMO regulatory progress in 2010
- Technical regulations (EEDI) may enter into force between 2013 - 2018
- Market-based instruments will be established, either internationally or regionally (EU) between 2013 – 2014; uncertain effect
- Regulations expected to have medium to long term impact
- Economic considerations and customer/charterer requirements, not regulations, will remain chief near-term driver for efficiency improvements
15 % global CO2 reduction – now

- With today’s technology
- With today’s vessels
- With improved bottom line

- No reason to wait