Addressing GHG emissions from international maritime transport

ICAO/IMO Side Event UNFCCC COP 20
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Marine Environment Division, 1st December 2014
International Maritime Organization

- The IMO Convention adopted in 1948 and IMO first met in 1959
- A specialized agency of the UN
- 170 Member States
- Role is to develop and maintain a comprehensive regulatory framework for shipping
- Safety, environment, legal, technical co-operation, security

Safe, secure and efficient shipping on clean oceans
Key factors for international maritime transport emissions:

1. World economy / trade volumes
2. Economics of shipbuilding / ship operation
3. Changes to trades / types of vessels needed
4. Cost of fuel / energy efficiency
5. Charter rates
6. Regulatory drivers e.g. emission limits
7. Scrutiny by stakeholders e.g., carbon footprint
Trade is growing

- Food, energy, raw materials and finished products
- Around 90% of global trade by volume

World merchandise trade volumes expanded by 2.2% in 2013 to 9.6 billion tonnes (UNCTAD, 2014)

Source: Royal Academy of Engineering, Future Ship powering options, Exploring alternative methods of ship propulsion, July 2013
Growth in major trade routes

Figure 1.5 (c): Estimated containerized cargo flows on major East–West container trade routes, 1995–2013 (Millions of TEUs)

Source: UNCTAD Review of Maritime Transport 2014
Energy efficiency of shipping

Source: International Council on Clean Transportation (ICCT), Long-term potential for increased shipping efficiency through the adoption of industry-leading practices, Wang & Lutsey, 2013
IMO work to address GHG emissions from international shipping
IMO Resolution A.963(23)


- IMOs work to address GHG emissions has investigated three distinct routes:
  
  **Technical**
  Mainly applicable to new ships - EEDI

  **Operational**
  Applicable to all ships in operation – SEEMP (EEOI – voluntary)

  **Market-based Measures (MBM)**
  carbon price, incentive, may generate funds
  - consideration suspended at MEPC 65 (May 2013)
Regulations on energy efficiency for ships

- New chapter 4 added to MARPOL Annex VI (regulations 19 to 23)
- Entered into force on 1 January 2013
- First ever global and legally binding CO$_2$ reduction regime for an international industry sector or transport mode
- Apply to internationally trading ships of $\geq 400$ GT

**Resolution MEPC.203(62)**

*Adopted on 15 July 2011*

**Amendments to the Annex of the Protocol of 1997 to Amend the International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto**

(Inclusion of regulations on energy efficiency for ships in MARPOL Annex VI)
Potential energy efficiency improvements

Operational
- Weather routing: 1-4%
- Autopilot upgrade: 1-3%
- Speed reduction: 10-30%

Auxiliary power
- Efficient pumps, fans: 0-1%
- High efficiency lighting: 0-1%
- Solar panel: 0-3%

Aerodynamics
- Air lubrication: 5-15%
- Wind engine: 3-12%
- Kite: 2-10%

Thrust efficiency
- Propeller polishing: 3-8%
- Propeller upgrade: 1-3%
- Prop/rudder retrofit: 2-6%

Engine efficiency
- Waste heat recovery: 6-8%
- Engine controls: 0-1%
- Engine common rail: 0-1%
- Engine speed de-rating: 10-30%

Hydrodynamics
- Hull cleaning: 1-10%
- Hull coating: 1-5%
- Water flow optimization: 1-4%

Source: ICCT, 2013
The EEDI is likely to promote innovation at the design stage of ships for a reduction of their energy consumption at full load.

The EEDI is applicable to ship types responsible for 85% of CO₂ emissions from international shipping.
### EEDI – applicable ship types

**Attained EEDI:** For ships over 400 GT:
- Bulk carrier
- Gas carrier
- Tanker
- Container ship
- General cargo ship
- Refrigerated cargo carrier
- Combination carrier
- Passenger ships
- Ro-ro cargo ship (vehicle carrier)
- Ro-ro cargo ship
- Ro-ro passenger ship
- LNG Carrier*
- Cruise passenger ship having non-conventional propulsion*

**Required EEDI:** For ships above a given size (regulation 21, Table 1):
- Bulk carrier
- Gas carrier
- Tanker
- Container ship
- General cargo ship
- Refrigerated cargo carrier
- Combination carrier
- Ro-ro cargo ship (vehicle carrier)*
- Ro-ro cargo ship*
- Ro-ro passenger ship*
- LNG carrier*
- Cruise passenger ship having non-conventional propulsion*

*MEPC 66 (April 2014) adopted amendments to MARPOL Annex VI to add these ship types to regulation 20 and 21 respectively. These amendments are expected to enter into force on 1 September 2015.
Ship Energy Efficiency Management Plan

SEEMP – operational management tool to include:

- All ships 400 gross tonnage and above
- Improved voyage planning (Weather routeing/Just in time arrival at port)
- Speed and power optimization
- Optimized ship handling (ballast/trim/use of rudder and autopilot)
- Improved fleet management
- Improved cargo handling
- Energy management
- Monitoring tools
  - EEOI (MEPC.1/Circ.684)
Brief history of IMO GHG studies

First IMO GHG Study 2000
Base year 1996

Second IMO GHG Study 2009
Base year 2007
Historical emissions from 1990
Future scenarios to 2050

Third IMO GHG Study 2014
Years 2007-2012
Future scenarios to 2050

Global CO₂ IPCC       Shipping CO₂ IMO

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Global CO$_2$ and economy trends

Global CO$_2$ IPCC  Shipping CO$_2$ IMO

Shipping: small fraction (2-3%) of global CO$_2$
  But it contributes similar amounts as major nations

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Global CO\textsubscript{2} and economy trends - indexed

Global CO₂ and economy trends – indexed


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Methodology

- Calculations of activity, fuel consumption (per engine) and emissions (per GHG and pollutant substances) for each in-service ship during each hour of each of the years 2007-2012
- Aggregation to find totals of each fleet
- Aggregation to find total shipping (international, domestic, and fishing) and international shipping only

Advantages:

- Approach removes any uncertainty attributable to use of average values
- Substantial improvement in resolution of shipping activity, energy demand and emissions data
Year 2007 best-estimates for both IMO Study 2009 and 2014 are in close agreement

Greater differences between BU/TD than between studies
Consensus CO₂ emissions estimate (tonnes) and shipping as a % share of global CO₂ emissions

<table>
<thead>
<tr>
<th>Year</th>
<th>Global CO₂¹</th>
<th>Total shipping</th>
<th>IMO GHG Study 2014 CO₂</th>
<th>International shipping</th>
<th>Percent of global</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007</td>
<td>31,409</td>
<td>1,100</td>
<td>3.5%</td>
<td>885</td>
<td>2.8%</td>
</tr>
<tr>
<td>2008</td>
<td>32,204</td>
<td>1,135</td>
<td>3.5%</td>
<td>921</td>
<td>2.9%</td>
</tr>
<tr>
<td>2009</td>
<td>32,047</td>
<td>978</td>
<td>3.1%</td>
<td>855</td>
<td>2.7%</td>
</tr>
<tr>
<td>2010</td>
<td>33,612</td>
<td>915</td>
<td>2.7%</td>
<td>771</td>
<td>2.3%</td>
</tr>
<tr>
<td>2011</td>
<td>34,723</td>
<td>1,022</td>
<td>2.9%</td>
<td>850</td>
<td>2.4%</td>
</tr>
<tr>
<td>2012</td>
<td>35,640</td>
<td>949</td>
<td>2.7%</td>
<td>796</td>
<td>2.2%</td>
</tr>
<tr>
<td>Average</td>
<td>33,273</td>
<td>1,016</td>
<td>3.1%</td>
<td>846</td>
<td>2.6%</td>
</tr>
</tbody>
</table>

From 2007 to 2012 study estimates a reduction in CO₂ emissions from international shipping in both absolute terms and as a percentage of global CO₂ emissions.
Consensus CO₂e emissions estimate (tonnes) and shipping as a % share of global CO₂e emissions

<table>
<thead>
<tr>
<th>Year</th>
<th>Global CO₂e²</th>
<th>Total shipping</th>
<th>IMO GHG Study 2014 CO₂e</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>International shipping</td>
</tr>
<tr>
<td>2007</td>
<td>34,881</td>
<td>1,121</td>
<td>903</td>
</tr>
<tr>
<td>2008</td>
<td>35,677</td>
<td>1,157</td>
<td>940</td>
</tr>
<tr>
<td>2009</td>
<td>35,519</td>
<td>998</td>
<td>873</td>
</tr>
<tr>
<td>2010</td>
<td>37,085</td>
<td>935</td>
<td>790</td>
</tr>
<tr>
<td>2011</td>
<td>38,196</td>
<td>1,045</td>
<td>871</td>
</tr>
<tr>
<td>2012</td>
<td>39,113</td>
<td>972</td>
<td>816</td>
</tr>
<tr>
<td>Average</td>
<td>36,745</td>
<td>1,038</td>
<td>866</td>
</tr>
</tbody>
</table>

From 2007 to 2012 study estimates a reduction in equivalent CO₂ emissions from international shipping in both absolute terms and as a percentage of global equivalent CO₂ emissions.
Fuel consumption 2012 by ship type (bottom-up method)

<table>
<thead>
<tr>
<th>Ship Type</th>
<th>Sum of Main Engine</th>
<th>Sum of Auxiliary Engine</th>
<th>Sum of Boiler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yacht</td>
<td>1,100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle</td>
<td>7,900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service - tug</td>
<td>6,700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Service - other</td>
<td>3,800</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ro-Ro</td>
<td>9,300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Refrigerated bulk</td>
<td>5,700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other liquids tankers</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oil tanker</td>
<td></td>
<td>39,700</td>
<td></td>
</tr>
<tr>
<td>Offshore</td>
<td></td>
<td>8,600</td>
<td></td>
</tr>
<tr>
<td>Miscellaneous - other</td>
<td>2,300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Miscellaneous - fishing</td>
<td></td>
<td>16,100</td>
<td></td>
</tr>
<tr>
<td>Liquefied gas tanker</td>
<td></td>
<td>15,700</td>
<td></td>
</tr>
<tr>
<td>General cargo</td>
<td></td>
<td>21,700</td>
<td></td>
</tr>
<tr>
<td>Ferry-RoPax</td>
<td></td>
<td>9,900</td>
<td></td>
</tr>
<tr>
<td>Ferry-pax only</td>
<td>3,700</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cruise</td>
<td></td>
<td>11,100</td>
<td></td>
</tr>
<tr>
<td>Container</td>
<td></td>
<td></td>
<td>66,000</td>
</tr>
<tr>
<td>Chemical tanker</td>
<td></td>
<td>17,500</td>
<td></td>
</tr>
<tr>
<td>Bulk carrier</td>
<td></td>
<td></td>
<td>53,400</td>
</tr>
</tbody>
</table>
Scenarios for projections (2012 – 2050)

- 2nd IMO GHG Study 2009 projected rapid emissions increase, but since publication:
  - new set of long-term socio-economic scenarios has been developed by IPCC
  - larger & more efficient container ships have entered market
  - new emission projection methods have been developed:
    - based on transport work activity, rather than tonnes of cargo
    - taking into account non-linear relations between activity drivers (e.g. GDP) and activity (i.e., transport work)

- 3rd Third IMO Study 2014 has developed new projections
The Triple-E ship is able to move one tonne of cargo 184 kilometres using one kilowatt-hour of energy, for the same amount of energy, a Boeing 747 can transport a tonne of cargo 0.5 kilometres.
Shipping CO₂ emissions are projected to increase by 50% to 250% in the period to 2050, despite fleet average efficiency improvements of about 40%.
Maritime CO₂ emissions are projected to increase significantly in the coming decades

Depending on future economic and energy developments, BAU scenarios project increase by 50% to 250% in the period to 2050

Further action on efficiency and emissions can mitigate emissions growth, although all scenarios but one project emissions in 2050 to be higher than 2012

Demand for transport of unitized cargoes projected to increase most rapidly in all scenarios
Thank you for your attention

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