GREEN SHIPS AND GREEN GROWTH
ASSESSMENT OF SELECTED POLICIES
PROMOTING THE CONSTRUCTION AND
OPERATION OF GREENER VESSELS

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• Green house gases (GHG)
• Air pollutants (SOx, NOx)
• Innovation
## Policies and measures promoting the construction and operation of green ships

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<th>Level of implementation</th>
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<td>IMO</td>
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<td>Denmark</td>
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<td>Turkey</td>
<td>Subsidies for scrapping</td>
<td>2015</td>
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<td></td>
<td>National</td>
<td>Norway</td>
<td>Subsidies for scrapping and building</td>
<td>2016</td>
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<td>National</td>
<td>China</td>
<td>Subsidies for scrapping and building</td>
<td>2009</td>
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<td>Romania</td>
<td>Policy mix</td>
<td>2018</td>
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- Green house gases (GHG)
- Air pollutants (Sox, NOx)
- Innovations
CO2 emissions from ships

• International maritime shipping currently accounts for about 800 million tonnes of carbon dioxide equivalent (CO2e) emissions per year
• A figure that could almost double by 2060 under current energy and climate commitments made by the International Maritime Organization.

Source: IEA
Green house gases (GHG)

• Paris Agreement (December 2015)
  – International shipping is not included

• Kyoto Protocol
  – “Parties in Annex I should work through the International Maritime Organisation (IMO) on the limitation or reduction of GHGs emissions from ships”

• International Maritime Organisation (IMO)
  – Mandatory energy-efficiency regulation based on the Energy Efficiency Design Index (EEDI)
Energy Efficiency Design Index (EEDI)

- Minimum energy efficiency level for different ship types

Simplified formula:

\[
EEDI_{att} = \frac{(75\% \times P_b + P_{AE}) \times sfc \times C_f}{f_v \times DWT \times V_{ref}}
\]
CO₂ emissions with and without EEDI, million CO₂-ton

![Graph showing CO₂ emissions with and without EEDI from 2015 to 2035 for different segments: Bulker with EEDI, Tanker with EEDI, Container with EEDI, Bulker without EEDI, Tanker without EEDI, Container without EEDI, and 3 segments total with EEDI and 3 segments total without EEDI.](image URL)
Estimation of EEDI values of individual vessels

(a) Bulker

(b) Tanker
Evolution of ship design affecting EEDI, bulk carriers

Speed of vessels by fleet size category, knots

SFC of vessels by fleet size category

Admiralty coefficient of vessels by fleet size category

L.W. / LBD of vessels by fleet size category, ton per m³
Summary of EEDI assessment

• EEDI: significant impact on shipping emissions
  – It contributes to a reduction by 115 million CO2 ton by 2035, or 38% of emission from bulkers, tankers, containers in 2015.

• EEDI leads to improve vessel design rather than to reduce design speed.

• EEDI more effective to restrict low energy efficient vessels rather than promote energy efficient ones
  – Encouraging over compliant vessels in terms of fuel efficiency necessary in order to seek further reduction in CO2 emissions from shipping
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IMO regulation on SOx and NOx

MARPOL Annex VI fuel sulfur limits

MARPOL Annex VI NOx emission limits

Source: Diesel net

MARPOL Annex VI: Emission Control Areas

<table>
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<tr>
<th>Area</th>
<th>Emissions</th>
<th>In effect from</th>
</tr>
</thead>
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<tr>
<td>Baltic Sea</td>
<td>SOx</td>
<td>19 May 2006</td>
</tr>
<tr>
<td>North Sea</td>
<td>SOx</td>
<td>22 November 2007</td>
</tr>
<tr>
<td>North American</td>
<td>SOx, NOx</td>
<td>1 August 2012</td>
</tr>
<tr>
<td>United States Caribbean Sea ECA</td>
<td>SOx, NOx</td>
<td>1 January 2014</td>
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</table>

Shares of MGO or LNG capable vessels are increasing notably in SECA

Share of number of new built vessels by fuel type, % in total counts

(a) All vessels

(b) SECA flagged vessels

Source: OECD calculation based on Clarkson World Fleet Register

*MGO is Marine Gas Oil with Low-sulphur (<0.1%) contents
Growth rate in ship number of LNG capable vessels is high in SECA

Growth rate of share of MGO/LNG capable vessels in fleet number, %

(a) MGO capable vessels  
(b) LNG capable vessels

Source: OECD calculation based on Clarkson World Fleet Register
LNG fueled LNG carriers in non-SECA
LNG fueled non-LNG carriers in SECA

Fleet number of LNG-fueled vessels by vessel type, #
(a) Non-SECA flagged fleet number
(b) SECA flagged fleet number

Source: OECD calculation based on Clarkson World Fleet Register
Scrubber equipped vessels are increasing in SECA, but growing similarly regardless of SECA/non-SECA

Scrubber equipped vessels share in total fleet, %

(a) Owner countries

(b) Flag countries

- Owned by ECA countries
- Owned by non-ECA countries

- Flagged in ECA countries
- Flagged in non-ECA countries
National policies in response to the regulation on emission of air pollutants

- **Finland; the Investment aid** scheme for purchasing greener ships or retrofitting green equipment.
- **Norway; the NOx tax** was introduced in 2007 to address NOx emissions from industry sectors. A substantial part (60 per cent) of the funding in the maritime sector was linked to LNG powered vessels.

<table>
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<th>Measures</th>
<th>Target pollutant</th>
<th>Start/End year</th>
<th>Budget</th>
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<tr>
<td>Finland Investment aid</td>
<td>SOx</td>
<td>2010/2014</td>
<td>EUR 44 million per year</td>
</tr>
<tr>
<td>Norway NOx tax and NOx fund</td>
<td>NOx</td>
<td>2007/On-going</td>
<td>NOK 700 million per year</td>
</tr>
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</table>
Different reactions by countries to tighter restrictions on air pollutants emission

Share of scrubber retrofitting, LNG capable vessels and denitrification system equipped vessels
Summary of the assessment of stricter restriction on air pollutants in ECAs

• Stricter restriction on sulphur content in ECAs has an impact on developments of LNG capable vessels.

• National policies and measures appeared to significantly affect the owners’ decisions on how they comply with regulations.
Contents

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Significant increase in ship sector patent applications

Patent application counts in ship sector by country

(a) Patent application counts by selected country, 

(b) Patent application per SB capacity, # per cgt

Source: OECD calculation based on IHS Seaweb and OECD Stat
Patent activities are more intense for technologies which are less likely to be introduced into the market

- Increase in patent activities (Propeller < Air lubrication ≈ Wind power)
- Marginal CO₂ abatement costs (Propeller < Air lubrication < Wind power)

Indexed patent trends (2000 = 100) for ship technologies related to climate change

Source: OECD St
Patent activities are more intense for technologies which are less likely to be introduced into the market

- Increase in patent activities (Propeller < Air lubrication ≈ Wind power)
- Marginal CO$_2$ abatement costs (Propeller < Air lubrication < Wind power)

Source: International Council on Clean Transportation (ICCT), 2011
Case study on R&D support for green innovation in Japan

- R&D support for ship sector since 2009 in a form of grant, aiming to develop technologies which contribute reduction of CO₂ emissions from shipping

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
</tr>
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<tr>
<td>Million JPY</td>
<td>783.17</td>
<td>684.87</td>
<td>428.31</td>
<td>333.19</td>
<td>354.61</td>
<td>301.19</td>
</tr>
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Indexed patent trends (1990 = 100) for various ship and waterborne technologies
Increase in patent applications in Japan since 2008 is driven by energy efficient hull design (i.e. air lubrication) and innovation in traditional propulsion system.

PCT counts for hull design and propulsion system, #, Japan

- Energy efficient hull design, Japan
- Hull design total, Japan
- Renewable energy use for ship propulsion, Japan
- Propulsion total, Japan
Summary of analysis on patent activity in ship sector

- Patent activities are more intense for technologies which are less likely to be introduced into the market, but type of invented technology may depend on country and its policy.
Concluding remarks

- International regulation has an impact on
  - the environmental performance of ships
  - patent activities in the ship sector
  - business opportunities for shipbuilding and repair industries

- Regional and national measures impact stakeholders’ decisions on how they
  - comply with regulations
  - undertake patent activities
Thank you.