Reducing emissions in maritime transportation

Harilaos N. Psaraftis
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3 parts

• Intro.

• Main part: CO2 (GHG) emissions

• Appendix: SOx emissions
Intro. to maritime transportation

• ~90% of volume of world trade
• ~70% of value
• EU: ~90% of external, 30% of internal trade
Trend of world seaborne trade


Note: 1990=100. Indices calculated based on GDP and merchandise trade in dollars and seaborne trade in metric tons.
Breakdown by cargo type

Maritime transport cont’d

• Key factor in world trade
• Key factor of development of many countries
• Source of income in many countries
• Safe, environment-friendly mode
The global pic today

Port throughput 2016

The list shows the ranking order of the top 100 container ports by teu throughput for 2016. Click on a port's name or bar to read the in-depth analysis. To view port percentage change click on the right hand side tab.

Tool Tip: Remember to view port percentage change, click on the right hand tab.
Country and regional breakdown

See each country's and region's contribution to the top 100 container ports by TEU throughput. Select a country from the drop down and tick or unclick to compare with others that feature. Hold the cursor over the bars to view the TEU throughput.

Tool Tip:
Remember to regional throughput, click on the right hand tab.
Types of ships

• Tankers

• Bulk carriers
Types of ships ii

- containerships
Types of ships iii

• Ro-Ro/ferries
Types of ships iv

- Cruise vessels
Types of ships

• LNG/LPG
Types of emissions

• Green House Gases-GHGs (mainly CO2, but also CH4 and others)
• Non-GHG (mainly SO2, but also NOx and others)
• P.M., etc
Despite rise in emissions, China effort wins praise

DAVOS, SWITZERLAND

Beijing is seen as trying to rein in fossil fuels and promote clean energy

BY KEITH BRADSHIER
AND LISA FRIEDMAN

The timing, China's president, recognized and supported the climate-change fight last year when he told an audience at the World Economic Forum that the effort "is a responsibility we must assume for future generations."
Main part: CO2
Reference

- Some 10 years of work in this area
- Paper at IAME 2017, Kyoto
- Extended version of IAME 2017 paper:

  Marit Econ Logist
  https://doi.org/10.1057/s41278-018-0098-8

  ORIGINAL ARTICLE

Decarbonization of maritime transport: to be or not to be?

Harilaos N. Psaraftis$^1$
Emissions 101

Q: If we burn a ton of fossil fuel (like heavy fuel oil, or diesel), how much CO2 is generated?

A: Between 3.02 and 3.11 tons, depending on the fuel
Kyoto protocol (1997)

- UNFCCC, Kyoto
- Commits State Parties to reduce greenhouse gas (GHG) emissions
- 192 signatories

- Maritime transport & aviation NOT included
Kyoto 20 years later

IAME 2017
COP21 (2015)

Brought all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects, with enhanced support to assist developing countries to do so.
COP21 ii

• Hailed by many as perhaps one the most significant achievements of humankind thus far.
• Others were less enthusiastic.
• Pres. Trump: US will get out.

• Maritime transport and aviation still left outside UNFCCC mandate
  – Shipping: IMO
  – Aviation: ICAO
International Maritime Organization (IMO)

• A UN agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships
• Based in London

• www.imo.org
3 classes of measures
(to reduce emissions incl. GHGs)

• Technological
  – More efficient (energy-saving) engines and propulsion
  – More efficient vehicle designs
  – Cleaner fuels (low sulphur content)
  – Alternative fuels (fuel cells, biofuels, etc)
  – Devices to trap exhaust emissions (scrubbers, etc)
  – Energy recuperation devices
  – “Cold ironing” in ports

• Logistics-based
  – Speed reduction
  – Optimized routing
  – Fleet management
  – Network design
  – etc

• Market-based measures (MBMs)
  – Emissions Trading Scheme (ETS)
  – Carbon Tax/Levy on Fuel
  – Others
Bubbles generated by supplying air to the vessel's bottom
3E is green
3 classes of measures
(to reduce emissions incl. GHGs)

• Technological
  – More efficient (energy-saving) engines and propulsion
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  – Optimized routing
  – Fleet management
  – Network design
  – etc

• Market-based measures (MBMs)
  – Emissions Trading Scheme (ETS)
  – Carbon Tax/Levy on Fuel
  – Others
Division is artificial!

• A Market Based Measure (MBM) can induce
  – technological measures in the long run
  – logistics-based measures in the short run
‘Technological’ example

• What can an MBM induce ship owners to do in the long run?

• Build/buy a more fuel efficient ship (with better hulls, engines, propellers, etc)

• Better do this than pay the MBM
‘Logistics-based’ example

- Impose a Levy on bunker fuel
- Induces ships to slow steam
- Slow steaming will reduce CO2 emissions
- Will also reduce fuel consumption, hence is potentially a win-win-win proposition
Logistics-based problems

- Routing and scheduling
- Pickup and delivery
- Fleet deployment
- Fleet size and mix
- Optimal speed
- Weather routing
- Intermodal network design
- Modal split
- Transshipment
- Queueing
- Terminal management
- Berth allocation in ports
- Supply chain management
- Etc etc

- Optimize with respect to traditional criteria
- Optimize with respect to environmental criteria
- Optimize with respect to both environmental and traditional criteria
- Try to find ‘win-win’ solutions!
In search of WIN-WIN solutions

• “Win-win” is a nice set of words
• What it means is a set of solutions which are “win” with respect to both economic and environmental criteria
• Problem: Finding win-win solutions may not always be easy!
Emissions 101b: How much CO2?

2009 IMO GHG study
• (2007 data)

2014 IMO GHG study
• (2012 data)
• 2.7% reduced to 2.2%
• 796 million tonnes of CO2 in 2012, down from 885 million tonnes in 2007
• Mainly attributed to slow steaming due to depressed market conditions after 2008
IMO: the GHG track

Subtrack I
• EEDI

Subtrack II
• MBMs
IMO: the GHG track

Subtrack I

• EEDI

Subtrack II

• MBMs

Since 2016: The IMO Roadmap
Subtrack I:
thus far the only mandated measure on GHGs

• IMO’s adoption of EEDI, July 2011
• Adopted as an amendment to MARPOL’s Annex VI
• Fierce resistance by China, India, Brazil, Saudi Arabia and other developing countries
• Matter highly political
Energy Efficiency Design Index (EEDI)

• Defined as

\[ \left( \prod_{j=1}^{M} f_j \right) \left( \sum_{i=1}^{nME} P_{ME(i)} C_{FME(i)} \cdot SFC_{ME(i)} \right) + \left( P_{AE} \cdot C_{FAE} \cdot SFC_{AE} \right) + \left( \prod_{j=1}^{M} f_j \right) \left( \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{nEff} P_{AEeff(i)} \right) C_{FAE} \cdot SFC_{AE} - \left( \sum_{i=1}^{nEff} f_{Eff(i)} \cdot P_{Eff(i)} \cdot C_{FME} \cdot SFC_{ME} \right) \]

\( f_j \): Capacity

\( V_{ref} \cdot f_w \)

• Numerator: Ship’s CO2 emissions
• Denominator: Ship’s transport work

• Units: Grams of CO2 per ton-mile
Energy Efficiency Design Index (EEDI)

• Defined as

\[
EEDI = \left( \prod_{j=1}^{M} f_j \right) \left( \sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FAE(i)} \cdot SFC_{ME(i)} \right) + \left( P_{AE} \cdot C_{FAE} \cdot SFC_{AE} \cdot f_{\text{ref}} \right) \cdot V_{\text{ref}} \cdot f_w
\]

- Ship’s capacity (usually DWT)
- Ship’s reference speed: Speed corresponding to 75% of MCR
EEDI contd

- Mandatory for newbuildings as of 2013
- Attained EEDI ≤ Required EEDI
- Required EEDI = \((1 - \frac{X}{100})^{\frac{aDWT}{c}}\)

- X=0% for ships built from 2013-2015
- X=10% for ships built from 2016-2020
- X=20% for ships built from 2020-2025 and
- X=30% for ships built from 2025-2030.
Coefs $a$ and $c$: determined by regression from world fleet database

<table>
<thead>
<tr>
<th>Ship type</th>
<th>$a$</th>
<th>$c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulk carrier</td>
<td>961.79</td>
<td>0.477</td>
</tr>
<tr>
<td>Gas carrier</td>
<td>1120.00</td>
<td>0.456</td>
</tr>
<tr>
<td>Tanker</td>
<td>1218.80</td>
<td>0.488</td>
</tr>
<tr>
<td>Container ship</td>
<td>174.22</td>
<td>0.201</td>
</tr>
<tr>
<td>General cargo ship</td>
<td>107.48</td>
<td>0.216</td>
</tr>
<tr>
<td>Reefer</td>
<td>227.01</td>
<td>0.244</td>
</tr>
<tr>
<td>Combination carrier</td>
<td>1219.0</td>
<td>0.488</td>
</tr>
</tbody>
</table>
Reference line EEDI

Figure 1: Dry bulk carriers
All data: 2,259 ships. Without outliers (shown in blue ♠): 2,218 ships
A closer look at the EEDI formula

**ATTAINED EEDI** (of a specific ship)

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

- \( f_j \): Capacity
- \( V_{ref} \): Reference speed
- \( f_w \):

Ship’s capacity (usually DWT)

Ship’s reference (design) speed: Speed corresponding to 75% of MCR
Attained EEDI is a ratio

• If $V$ is the ref. speed corresponding to 75% MCR (the speed at the denominator)

• Numerator typically grows like $V^3$
• Denominator grows like $V$

• Hence, attained EEDI grows like $V^2$
EEDI compliance

• Attained EEDI ≤ (1 - X/100) aDWT⁻ｃ

• Attained EEDI grows like V²

• Required EEDI is independent of V

• Therefore EEDI compliance implies an upper bound on V!
(And a corresponding upper bound on MCR)
The horsepower limit deficiency

• To be EEDI compliant, the correct solution would be to optimize hull, engine and propeller

• The easy solution would be to reduce installed power
The horsepower limit deficiency ii

• Any energy inefficient design can be made EEDI compliant by reducing installed power
• The existence of this easy way out is hardly an incentive for more fuel efficient ships

• This could also lead to **underpowered ships**
• More CO2 to maintain speed in bad weather
Compromise on safety?

• A ship needs to have adequate power to maintain speed in bad weather, manoeuvering, etc.
• Big discussion at the IMO (MSC & MEPC), how to reconcile these 2 issues
• Issue STILL UNRESOLVED
• Impasse imminent?
Alternative EEDI formulations

• Can we eliminate the “easy way out”?  

• CONSIDER:

\[
\text{EEDI (reference line)} = aDWT^{-c}V^k
\]  
(with \( k=2 \) or \( 3 \))
Modified regressions with $k=2$ or $3$

Table 2. Regression results for EEDI (reference line)

<table>
<thead>
<tr>
<th>Ref. line</th>
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<th>Bulk carriers</th>
<th>Tankers</th>
<th>Containerships</th>
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</thead>
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<tr>
<td>Standard eq. (2)</td>
<td>IMO (2011a)</td>
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<td>$1,218.80\text{DWT}^{-0.488}$ ($R^2 = 0.96$)</td>
<td>$186.52\text{DWT}^{-0.200}$ ($R^2 = 0.62$)</td>
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<tr>
<td>Modified eq. (4), $k=2$</td>
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<td>$19.164\text{DWT}^{-0.599}\text{V}^2$ ($R^2 = 0.96$)</td>
<td>$12.74\text{DWT}^{-0.534}\text{V}^2$ ($R^2 = 0.92$)</td>
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<td>This paper</td>
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<td>$3.5918\text{DWT}^{-0.707}\text{V}^3$ ($R^2 = 0.93$)</td>
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EEDI/$V^2$ - Containerships

- without outliers
- outliers
### Modified regressions with k=2 or 3

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<tr>
<td></td>
<td></td>
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#### EEDI$/V^2$ - Containerships

- **without outliers**
- **outliers**

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Technical University of Denmark

Shanghai 30/01/2018
Fate of modified regressions

• $k=2$ case submitted by Greece to the IMO in 2010

• (abt 1 yr before EEDI was finalized)
Fate of modified regressions

• $k=2$ case submitted by Greece to the IMO in 2010.
Fate of modified regressions

- k=2 case submitted by Greece to the IMO in 2010

- Stated reason: Ship owner should retain the power reduction option

- Real reason: discussion would detract from finalization of EEDI
Subtrack II: Market Based Measures (MBMs)

- 11 MBM proposals at MEPC 60 (March 2010)
- Expert Group formed by IMO Sec. General
- Feasibility study (300-page report)
- Work: May- August 2010
- Report presented at MEPC 61 (Sep. 2010)
- Various discussions since then
Spot the speaker!
How does an MBM work?

• It induces operators and investors to adopt measures that will reduce CO2 emissions

• These measures can be
  – Logistics-based (short run) or
  – technological (long run)
What else can an MBM do?

• Collect money to be used for various purposes (even for the environment!)
In-sector vs out-of-sector

In-sector

• **Direct** reduction of emissions (eg, reduce speed due to a fuel tax)

Out-of-sector

• **Indirect** reduction of emissions (eg, use the money to build a wind farm in New Zealand)
9 Criteria for evaluation

.1 Environmental effectiveness

.2 Cost-effectiveness and potential impact on trade and sustainable development

.3 The potential to provide incentives to technological change and innovation

.4 Practical feasibility of implementing MBM

.5 The need for technology transfer to and capacity building within developing countries, in particular the least developed countries (LDCs) and the small island development states (SIDS)
9 criteria cont’d

.6 The relation with other relevant conventions (UNFCCC, Kyoto Protocol and WTO) and the compatibility with customary international law

.7 The potential additional administrative burden and the legal aspects for National Administrations to implement and enforce MBM

.8 The potential additional workload, economic burden and operational impact for individual ships, the shipping industry and the maritime sector as a whole, of implementing MBM

.9 The compatibility with the existing enforcement and control provisions under the IMO legal framework.
MBM proposal groups

• International GHG Fund (Denmark et al) (LEVY)
• 4 distinct Emissions Trading Schemes (ETS) (Norway, UK, France, Germany)
• Various hybrids, based on EEDI (Japan, USA, WSC)
• Port-based (Jamaica)
• Rebate mechanism (IUCN)
• Bahamas proposal
Emission reductions in 2030
Modelled emission reductions across various scenarios

<table>
<thead>
<tr>
<th></th>
<th>SECT</th>
<th>VES</th>
<th>Bahamas</th>
<th>GHG Fund</th>
<th>LIS</th>
<th>PSL</th>
<th>ETS (Norway France)</th>
<th>ETS (UK)</th>
<th>RM</th>
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</thead>
<tbody>
<tr>
<td>Mandatory EEDI (Mt)</td>
<td>123-299</td>
<td>123-299</td>
<td>123-299*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>MBM In sector (Mt)</td>
<td>106-142</td>
<td>14-45</td>
<td></td>
<td>1-31</td>
<td>32-153</td>
<td>29-119</td>
<td>27-114</td>
<td>27-114</td>
<td>29-68</td>
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<tr>
<td>MBM Out of Sector (Mt)</td>
<td></td>
<td></td>
<td></td>
<td>152-584</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total reductions (%) BAU</td>
<td>19-31%</td>
<td>13-23%</td>
<td>10-20%</td>
<td>13-40%</td>
<td>3-10%</td>
<td>2-8%</td>
<td></td>
<td>13-40%</td>
<td>13-28%</td>
</tr>
<tr>
<td>Potential supplementary reductions (Mt)</td>
<td>45-454</td>
<td>104-143</td>
<td>232-919</td>
<td>917-1232</td>
<td>696-870</td>
<td>187-517</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Included if the mandatory EEDI is adopted by the committee
• assumptions, assumptions, & more assumptions!

• 300-page report
• No recommendation!
MEPC 63: Greece’s proposal

- Keep on table only Levy and ETS proposals
- Put on hold hybrid MBMs* (US, Japan, WSC)
- Discard all others (Bahamas, Jamaica, IUCN)

*MBMs embedding EEDI
MEPC 63: Greece’s proposal

• Keep on table only Levy and ETS proposals
• Put on hold hybrid MBMs (US, Japan, WSC)
• Discard all others (Bahamas, Jamaica, IUCN)

• KEEP ALL ON THE TABLE
MEPC 63

- Draft Resolution on Technical Co-operation and Transfer of Technology

- Brought forward by developing countries (China, India, Brazil, etc)
MEPC 63

• Draft Resolution on Cooperation and Transfer of Technology

• Brought forward by developing countries (China, India, Brazil, etc)

• NO CONSENSUS
MEPC 63

• Proposal for an Impact Assessment Study on MBMs
• Brought forward by the Chairman of MEPC
• Supported by developed countries
MEPC 63

- Proposal for an Impact Assessment Study on MBMs
- Brought forward by the Chairman of MEPC
- Supported by developed countries

- NO CONSENSUS
MBMs

- Some proposals merged (Japan, WSC)
- Bahamas proposal reformulated and then withdrawn
- US proposal reformulated
- Basically, no real progress since 2010
MBMs

• Some proposals merged (Japan, WSC)
• Bahamas proposal reformulated and then withdrawn
• US proposal reformulated
• Basically, no real progress since 2010

MEPC 65 (May 2013):

• MBM DISCUSSION SUSPENDED!
Main cause of disagreement?

• CBDR!
CBDR: Common But Differentiated Responsibilities

• Widely accepted principle after the Kyoto Protocol.
• Has two aspects. The first is common responsibility, which reflects the duty of countries to equally share the burden of environmental protection for common resources.
• The second is differentiated responsibility, which addresses different social and economic situations across countries.

• Not compatible with the non-discrimination principle (measures should be the same for all ships)
Monitoring, Reporting and Verification (MRV)

- Only for CO2
- Discussion started when MBM discussion was suspended
- 2 different regimes (IMO, EU)
- Differences may create distortions & admin. burden

- Biggest difference is vs MRV for road transport
  - Road: Fleet level, manufacturer liable
  - Maritime: Individual ship level, operator liable
The IMO roadmap

OCTOBER 2016

• Adoption of an *initial strategy* in 2018 to meet the targets of COP21, which entered into force in November 2016.

• The strategy will be validated by actual emission figures gathered through the IMO’s *fuel data collection system* as of 2019.

• This will then lead to a final agreement on targets and measures, including an implementation plan, by **2023**.
Enter the EU Parliament!

FEBRUARY 2017

• Decision of EU Parliament to include shipping in EU ETS!
Was this a good development?

• Big protests from industry circles such as
  – ECSA (the European Community Shipowners Associations),
  – ICS (the International Chamber of Shipping) and
  – many national shipowners associations.

• Big concern that an EU ETS may create
  – significant distortions and obstacles for efficient trade
  – may not be compatible with the IMO roadmap, and in fact
  – may not be a good instrument for reducing GHG emissions.
Latest

NOVEMBER 2017

• After negotiations between the EP and the EU Council of Ministers, it was agreed to **align the EU with the IMO process.**

• essentially refrain from taking action on ETS before seeing what the IMO intends to do on GHGs.

• Industry circles, concerned with the effects of an early EU ETS, welcomed this development.

• BUT! The European Commission will closely monitor the IMO process, starting from what is agreed on the initial strategy in 2018 and all the way to 2023.
IMO Roadmap progress

- MEPC 71 (June 17)
- 2 intersessional meetings (June 17, Oct. 17)
- 3rd intersessional meeting (Apr. 18)
- MEPC 72 (Apr. 18)
Shipping at COP 23 (Bonn)
Way ahead

• Q: Can we see something in the policies that are being currently pursued that would really guarantee significant fuel consumption (and hence GHG emissions) reductions?

• A: No!

• Lots of discussions
• Lots of “positive spin” press releases
• No concrete results yet
Way ahead ii

• Conceivable to reach an agreement in one of the forthcoming IMO meetings.
• Nature and level of ambition of such an agreement are pretty open at this point.
• Divergence of views is still very wide.
Thus!

• In spite of much talk about the maritime industry’s commitment toward serious GHG emissions reductions,

• it is fair to say that such reductions are, as things stand, only a wish at this point in time.
Q: any measure that might work?

• A: Investigate the impact of a **significant** bunker levy

• But chances of this being implemented any time soon very slim (mainly for political reasons)
VLCC emissions

- Gkonis and Psaraftis (2012)
Conclusions Part I

• The international scene for the decarbonization of maritime transport has been rendered way too complex and fragmented, as well as political.
• Unnecessary complexity and fragmentation, coupled with factors that are mostly within the political sphere, will not help a speedy resolution of the issue.
• In fact they will definitely hinder prospects for substantial progress in the years ahead.
Appendix: SOx
### Background: Marpol Annex VI

<table>
<thead>
<tr>
<th>Areas</th>
<th>2005-2012</th>
<th>2015</th>
<th>2015-2020</th>
<th>2020 on</th>
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</thead>
<tbody>
<tr>
<td>Within SECA</td>
<td>1.5</td>
<td>1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Outside SECA</td>
<td>4.5</td>
<td>3.5</td>
<td>3.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>
IMO MARPOL Annex VI: Emissions Control Areas (ECAs)
Chinese ECAs
Special issue

Transportation Research Part D xxx (2014) xxx–xxx

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Editorial

Emission control areas and their impact on maritime transport

Kevin Cullinane\textsuperscript{a,}\ast, Rickard Bergqvist\textsuperscript{b,1}

\textsuperscript{a} Transport Research Institute, Edinburgh Napier University, Merchiston Campus, EH10 5DT Edinburgh, United Kingdom

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The possible designation of the Mediterranean Sea as a SECA: A case study

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Results

• Shift to road >5%
• Less SOx

• (paradoxically)
  Less CO₂!

• RoPax going 23 knots
• Low load factor
The RoRoSECA project

• Funded by the Danish Maritime Fund (DMF)

• Supplementary funding: Orients Fund

Industry partner: DFDS
The problem

• Higher fuel prices due to 0.1% sulphur content as of 1 Jan. 2015 risk making Ro-Ro shipping less competitive vis a vis land based modes.
• Possible modal shifts.
• Risk of route closure.
• Some operators have shut down some of their routes.

• Q: What can be done to alleviate problem?
SECA SHUTS DOWN TRANSFENNICA IBERIAN SERVICE

The Dutch-owned short-sea shipping line Transfennica (part of the Spliethoff Group) has announced that it is to cease its “Motorways of the Sea” ro-ro service between Bilbao, Portsmouth and Zeebrugge at the end of this month (December).

The decision is a direct result of the introduction of stricter new low-sulphur emission controls from 1 January 2015 in the Baltic Sea, the Kattegat, the North Sea and English Channel. A further SECA extends in a 200 nautical miles wide belt along the coasts of the USA and Canada.

DFDS closes Sassnitz-Klaipeda connection

 DFDS Seaways has decided to close the ferry service between Sassnitz, Germany and Klaipeda, Lithuania with effect from the end of September.

Previously a busy connection, the route has over the years become economically unviable. As Vice President of DFDS, Anders Refsgaard, stated: “We have fought hard to get new customers and improve revenue and profit, but unfortunately without success”. He added, that with the outlook on continued decline in profits, and in light of the new sulphur regulations to be introduced from 1 January 2015, the company does not believe that it will be possible to turn the tide on the crossing.

SECA requirements lead to new European rail link

CARRIERS: Railway company ERS is opening a new route in Europe in light of rising customer demand following the implementation of new sulphur regulations. Many customers and countries are willing to change their mode of transport in order to save money.
What actually happened

Stena Line records 16% yearly growth on North Sea route

Stena Britannica sails between the UK port of Harwich and the Hook of Holland in the Netherlands

DFDS Wraps Up Record Year, Expects Higher Revenue in 2016

Danish shipping and logistics company DFDS posted a profit of DKK 1.07bn (USD 151m), up by 89pct when compared to last year’s DKK 571 million.

For the full-year 2015, the group reported revenue increase of 5% to DKK 13.5bn. Organic revenue growth, adjusted for route closures and acquisitions, was 7% mainly driven by 7% higher freight shipping volumes and 8% more passengers. In the fourth quarter, organic revenue growth was 10%.

P&O breaks Channel freight record in 2015

By Charlie Bartlett from London

P&O Ferries transported more freight between Dover and Calais in 2015 than any other year in its “modern history,” amounting to 1,340,317 trucks.

The result is a 22% year-on-year increase over 2014, and is due in part to disruptions at the channel tunnel, which caused a 172% year-on-year increase in HGVs on its separate RoRo service to Zeebrugge route throughout the month of July.

The group pressed a sixth ship back into service on the English Channel that month in order to increase capacity.
Fuel prices after mid 2014

[Graph showing fuel price trends for MGO, HFO, and their difference over quarters from Q1 2014 to Q4 2016.]
Lucky with fuel prices

• The fact that fuel prices have dropped precipitously since the summer of 2014 has somehow alleviated the repercussions of the new regulations.
• This has also masked the extent of the problem.
• However, the risk of route closure still exists, particularly if fuel prices rise again in the future.

• → Need to be on the alert.
Project challenge

• Q: Can one isolate the effect of the sulphur legislation from that of other developments that happened in parallel?
  – Precipitous drop in fuel prices
  – Russian economic crisis
  – Others

• A: YES!

• First attempt to examine the effect of the new SECA limits, and dissect it from the record low fuel prices that were observed in the last two years
DFDS network

• 18 Routes (22 links)
• ~38 vessels
• Up to 535 departures/week, 13 countries, 30 ports
• 4 main areas
  – North Sea (9 Routes, 20 vessels)
# Active routes to study (7+2)

## Main

<table>
<thead>
<tr>
<th>Route</th>
<th>Vessel Type</th>
<th>Tech</th>
<th>Lane meters</th>
<th>Passengers</th>
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<tbody>
<tr>
<td><strong>NORTH SEA</strong></td>
<td></td>
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<td></td>
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<tr>
<td>Gothenburg – Ghent – Brevik</td>
<td>RoRo</td>
<td>Scrubber</td>
<td>3831</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>RoRo</td>
<td>Scrubber</td>
<td>3831</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>RoRo</td>
<td>Scrubber</td>
<td>3831</td>
<td>12</td>
</tr>
<tr>
<td>Copenhagen – Oslo</td>
<td>Cruise</td>
<td>Scrubber</td>
<td>(450 cars)</td>
<td>1790</td>
</tr>
<tr>
<td></td>
<td>Cruise</td>
<td>MGO</td>
<td>(320 cars)</td>
<td>1989</td>
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<tr>
<td>Esbjerg – Immingham</td>
<td>RoRo</td>
<td>Scrubber</td>
<td>3000</td>
<td>12</td>
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<tr>
<td></td>
<td>RoRo</td>
<td>MGO</td>
<td>3000</td>
<td>12</td>
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<td></td>
<td>RoRo</td>
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<td><strong>BALTIC SEA</strong></td>
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<tr>
<td>Klaipeda – Kiel</td>
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<td>328</td>
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<td>Scrubber</td>
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<td>2490</td>
<td>600</td>
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<td>MGO</td>
<td>2496</td>
<td>600</td>
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<td>MGO</td>
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<tr>
<td></td>
<td>RoPax</td>
<td>MGO</td>
<td>1949</td>
<td>405</td>
</tr>
</tbody>
</table>

**plus**

- Esbjerg- Harwich (shut down)
- Marseille-Tunis (outside SECA)
Modal split model development and calibration

Adjust CBA (Recalculate) (New Env. Balance)
Potential source: SHIPPAX journal

Task 2.3
New Economic Balance

Environmental Balance of the System
Emissions for each mode in Selected Route

Route Profitable

Benefit > Costs
YES

Route Profitable

NO

Shut Down?

Assign all Road/Rail?

New Modal Split
(Recalculate CBA)
(New Env. Balance)

Higher Costs may lead to Changes in Overall Demand for Transport

New Values:
Fuel Costs
Revenue
Time in Maritime Mode
New Transit Time
Cost of Transport

Alternative Policies:
Speed reduction
Change Fuel surcharges
Change Frequency
Change Policy?
Change Fleet?
Other technology?

Change in Explanatory Variables

New Environmental balance

Task 2.2
Set of Routes Served by DFDS

Select Route

Market Share

YES

NO

Road/Rail Alternative?

YES

NO

Assign all Maritime?

Data for Maritime Leg:
Distance (NM)
Sailing Speed (knots)
Time at each Port (hr)
Capacity (Lane meter)
MGO or scrubber
Ship Specs

Maritime Competitor?

NO

YES

Potential source: DFDS Logistics, Volvo, other?

Fuel Prices (MGO, HFO)

Potential source: SHIPPAX journal

Maritime Mode (DFDS)

Maritime Mode (Competitor)

Time
Inventory
Cost

Time
Inventory
Cost

Perspective of Shipper

Calibrate Multinomial Model
Using Market shares

COSTS

Benefits

COSTS

Benefits

Shipping Company

Scrubber CAPEX

Revenue
Services

Market Share

Select Route

Select OD pairs using DFDS link

Calibrate Multinomial Model
Using Market shares

New Modal Split
(Recalculate CBA)
(New Env. Balance)

Publicly available

Some Confidential

Confidential

LEGEND on Data confidentiality
Modal split model development and calibration

Task 2.2

Set of Routes Served by DFDS

Select Route

OD pairs using DFDS link

Maritime Competitor?

YES

Market Share

Road/Rail Alternative?

YES

Assign all Maritime?

NO

Potential source: DFDS Logistics, Volvo, etc.

Potential source: SHIPPAX journal

Scrubber CAPEX

Fuel Prices (MGO, HFO)

Benefits

Revenue

Services

Costs

Scrubber

Port Costs

Vessel Staff

Capital

Maintenance

Fuel Costs

Perspective of Shipper

Maritime Mode (DFDS)

Time

Inventory

Cost

Land Mode

Time

Inventory

Cost

Maritime Mode (Competitor)

(Generalized Cost for each option)

Calibrate Multinomial Model Using Market shares

Data for Maritime Leg:

- Distance (NM)
- Sailing Speed (knots)
- Time at each Port (hr)
- Capacity (Lane meter)
- MGO or scrubber
- Ship Specs

LEGEND on Data Confidentiality

Publicly available

Some Confidential

Confidential

Task 2.3

New Economic Balance

Environmental Balance of the System

Emissions for each mode in Selected Route

Check Route Profitability

Benefits > Costs

YES

Route Profitable

New Environmental balance

NO

Shutdown?

Assign all Road/Rail?

New Modal Split

(new Env. Balance)

Higher Costs may lead to Changes in Overall Demand for Transport

New Values:

- Fuel Costs
- Revenue
- Time in Maritime Mode
- New Transit Time
- Cost of Transport

Alternative Policies:

- Speed reduction
- Change Fuel surcharges
- Change Frequency
- Change Policy?
- Change Fleet?
- Other technology?

Change in Explanatory Variables

New Modal Split

(Recalculate CBA)

Potential source: SHIPPAX journal

Publicly available

Some Confidential

Confidential
3 scenarios on Fuel Price

• **Fuel case 1:** What actually happened (MGO with actual prices)

• **Fuel case 2:** What would happen if MGO prices returned to 2014 levels

• **Fuel case 3:** What would happen if HFO was still allowed (Actual prices)
Conclusions I

• Maritime shares actually increased due to observed low prices

• Maritime shares would have increased further if HFO were still allowed

• Maritime shares would drop if fuel levels returned to 2014 levels

• Profitability of ship operator is masking the negative effects of the sulphur regulation
Measures to mitigate or reverse modal shifts

- Measures from the Ro/Ro operator
  - Speed reduction
  - Service frequency and schedule reconfiguration
  - Fleet and network reconfiguration
  - Alternative fuels such as LNG
  - Other technical measures such as scrubbers
  - Appropriate pricing policies

- Measures from policy makers
  - Full or partial internalization of external costs, all modes
  - Easing of port dues/fairway dues/ice dues for relevant shipping
  - Public funding or subsidies
  - Any other potential policy measure
Conclusions II

• Slow steaming reduces fuel consumption (low speed - less hours at port)

• But there are constraints on allowed increase of sailing time

• In 2016 certain routes actually sped up

• Frequency of sailing service can be used to improve load factors

• Mainly on very frequent services. On 6/7 sailings per week, some flexibility

• Vessel swapping can help with load factors

• Investing in scrubbers critically depends on fuel prices, and level of subsidies
Policy measures

• Consider the following policy measures to reverse/mitigate negative effects

  – Full or partial internalization of external costs, all modes
  – Easing of port dues/fairway dues for relevant shipping
  – ECO bonus-like system, with refund to freight haulers boarding a vessel
  – Subsidies for environmental investments (LNG, scrubbers, others)
  – Additional tax on landbased modes
  – Other policy measures?
Additional tax on landbased modes

• To cause a similar increase in the generalized cost of transport of competing modes

• Will also increase cost of maritime modes (the road parts)

• Use of GIS tool to show heatmaps on their effects
Global conclusion of project

• RoRo shipping got lucky on ECAs

• But needs to be on the alert
Possible users and uses of the tools developed in the RoRoSECA project

A. USERS

• RoRo operators
• Intermodal operators
• Other short sea shipping companies operating in ECAs
• Maritime policy makers
Possible users and uses of the tools developed in the RoRoSECA project

B. USES

• Estimate emissions and external costs
• Evaluate possible modal shifts in ECAs
• Evaluate possible modal shifts when 0.5% global S cap applies in 2020
• Assess the merits of alternative mitigation measures
• Assess the merits of alternative mitigation policies
• Identify routes that exhibit risk of being non-viable
• Assist operators and policy makers perform “what if” analyses of alternative scenarios
• Assist operators and policy makers select among alternatives
Recent paper

The implications of the new sulphur limits on the European Ro-Ro sector

Thalis Zis*, Harilaos N. Psaraftis

Technical University of Denmark, Copenhagen, Denmark
Project title: Mitigating and reversing the side-effects of environmental legislation on Ro-Ro shipping in Northern Europe...

Period: 15/06/2015 → 14/06/2017

The main objective of this project is to identify and assess possible technical, operational, regulatory and financial measures for the mitigation and reversal of the negative repercussions of environmental legislation to the market shares of RoRo shipping in Northern Europe. This problem is already a serious source of concern not only to RoRo operators in the Baltic and North Sea, which have or are contemplating shutting down some routes as unprofitable, but also to manufacturing, mining and forest industries in the area.

To address this problem, the Danish Maritime Fund has awarded a two-year research project to DTU Transport. Sulphur regulations are the specific focus of this environmental legislation. RoRo operator DFDS is an industry partner to the project, which also bears endorsements from Interferry and the European Community Shipowners Association (ECSA).

This web site provides information on the project. It also provides additional information, not directly related to the project, but related to the general issues addressed by the project. We hope you find the contents of this web site useful.

The project is funded by the Danish Maritime Fund (DMF)
Maybe of interest

- 15 chapters
- All modes covered
- Also green corridors (EU project SuperGreen)
Additional recent work on

• Ship weather routing
• Speed optimization
• Combined speed and routing decisions
• Liner shipping with flexible frequencies
• Corridors studies
• Etc
Thank you very much!

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