Nautischer Abend in Bremerhaven

„Greenhouse Gas emissions from Shipping“

Does IMO-MEPC gives the right way to save CO_2-Emission?

by Ralf Plump, Head of Environmental Research

2009-09-17

Germanischer Lloyd

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- CO_2 / GHG emission from shipping
  - CO_2 emissions – Background IMO-UNFCCC
  - “Second GHG study 2009” from IMO
  - Emission scenarios
- Reduction strategies and energy efficiency indices
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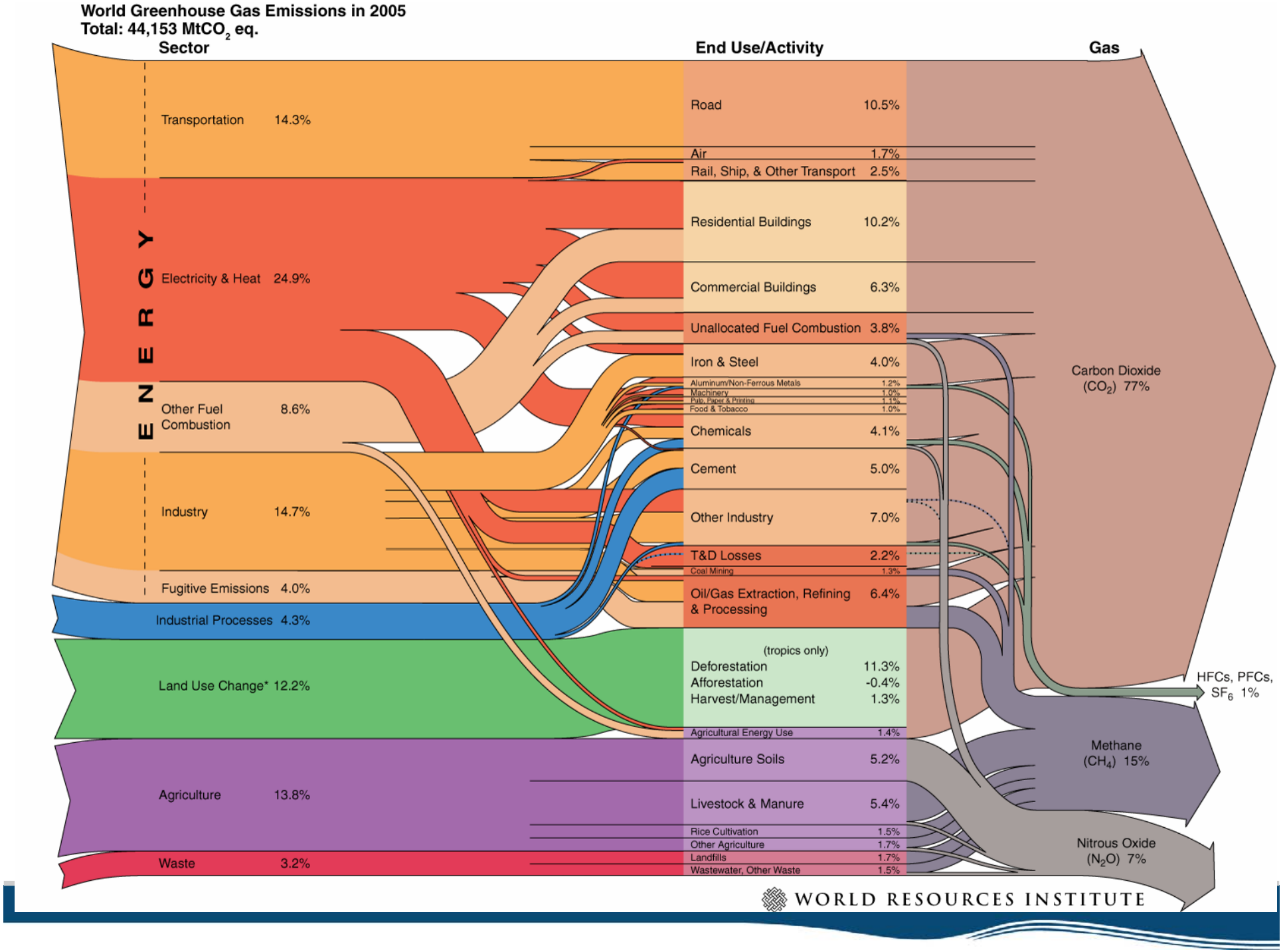
World Greenhouse Gas Emissions in 2005
Total: 44,153 MtCO2 eq.
Sector
End Use/Activity
Gas
ENERGY
Transportation 14.3%
Electricity & Heat 24.9%
Other Fuel Combustion 8.6%
Industry 14.7%
Fugitive Emissions 4.0%
Industrial Processes 4.3%
Land Use Change* 12.2%
Agriculture 13.8%
Waste 3.2%
Road 10.5%
Air 1.7%
Rail, Ship, & Other Transport 2.5%
Residential Buildings 10.2%
Commercial Buildings 6.3%
Unallocated Fuel Combustion 3.8%
Iron & Steel 4.0%
Aluminum/Non-Ferrous Metals 1.2%
Machinery 1.0%
Pulp, Paper & Printing 1.1%
Food & Tobacco 1.0%
Chemicals 4.1%
Cement 5.0%
Other Industry 7.0%
T&D Losses 2.2%
Coal Mining 1.3%
Oil/Gas Extraction, Refining & Processing 6.4%
(tropics only)
Deforestation 11.3%
Afforestation -0.4%
Harvest/Management 1.3%
Agricultural Energy Use 1.4%
Agriculture Soils 5.2%
Livestock & Manure 5.4%
Rice Cultivation 1.5%
Other Agriculture 1.7%
Landfills 1.7%
Wastewater, Other Waste 1.5%
Carbon Dioxide (CO2) 77%
HFCs, PFCs, SF6 1%
Methane (CH4) 15%
Nitrous Oxide (N2O) 7%
WORLD RESOURCES INSTITUTE

GHG emissions – Background

- IMO Assembly resolution A.963(23) (adopted in Dec. 2003) tasked the MEPC to identify and develop the necessary mechanisms needed to achieve limitation or reduction of GHG emissions from ships.
- IMO is committed taking the lead in developing GHG reduction strategies and mechanisms for international shipping and that it should co-operate with UNFCCC. The timetable of IMO sees completion of work in July 2009 (MEPC 59 / GHG-WG)

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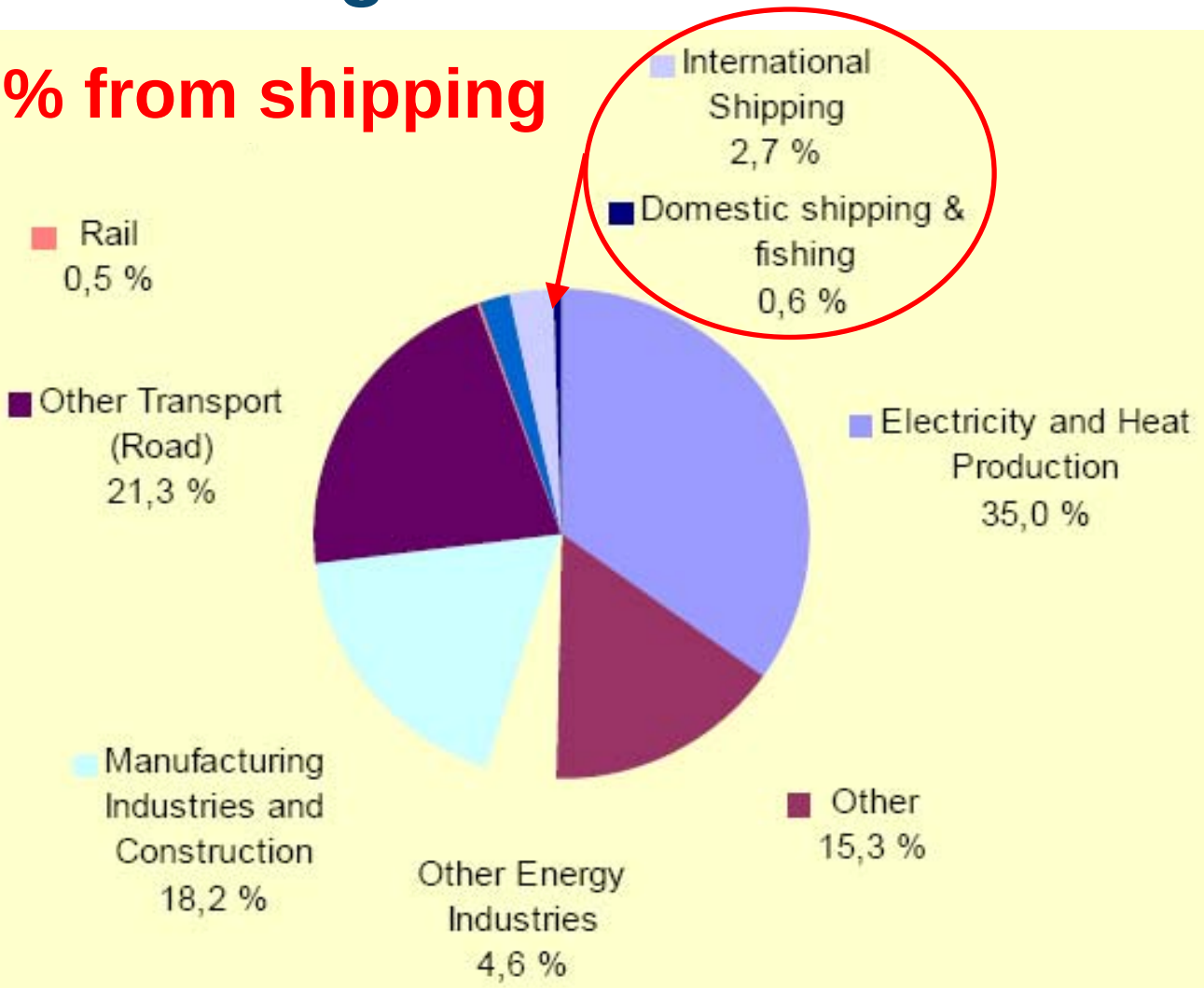
Emissions of CO2 from shipping compared with global total emissions

About 3% from shipping



Source: MEPC 59/INF. 10 “Second GHG Study 2009” (Update of the 2000 IMO GHG Study)

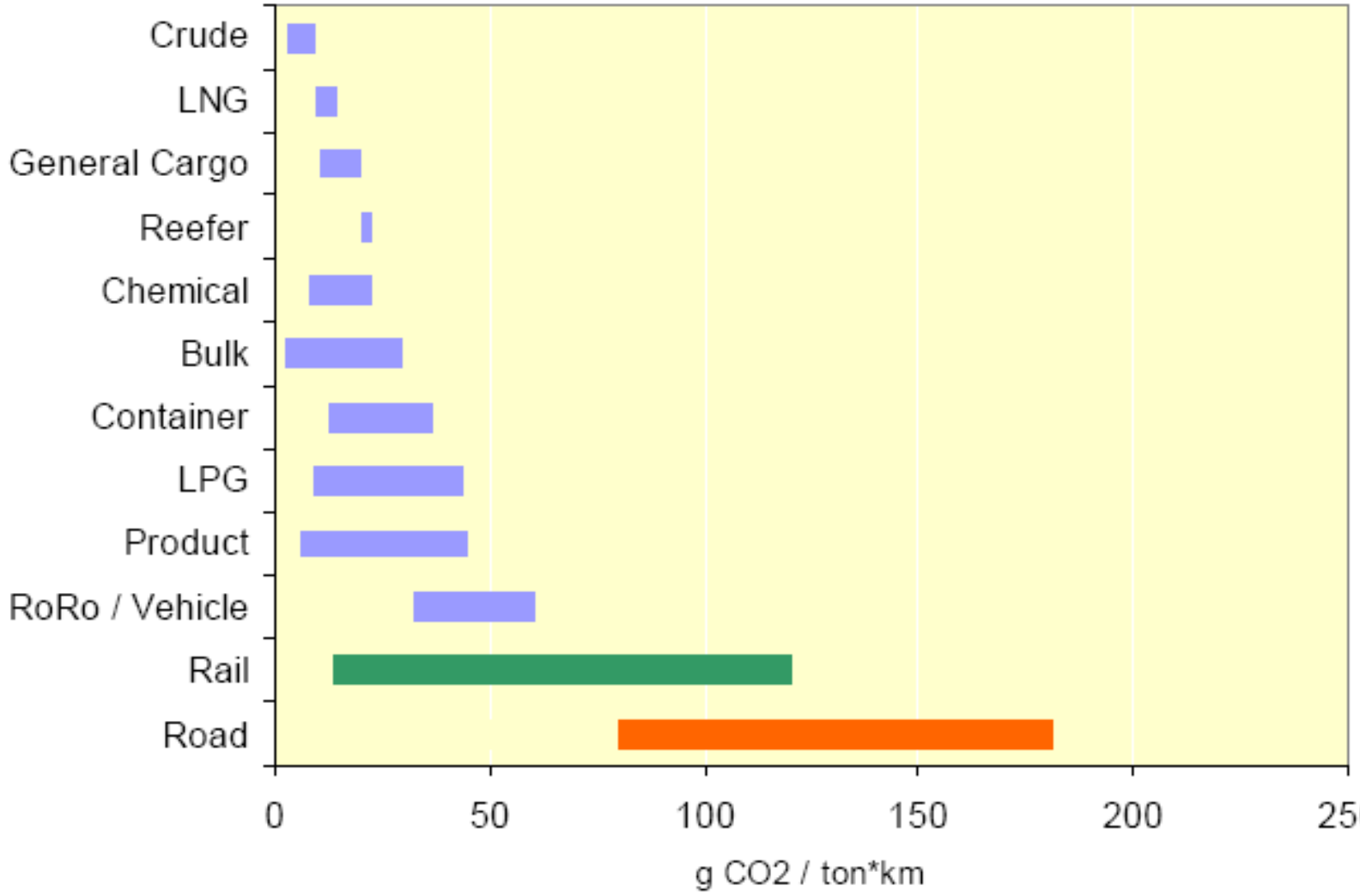
Summary of GHG emissions from shipping* during 2007

	International shipping	Total shipping	
	million tonnes	million tonnes	CO_2 equivalent
CO_2	870	1046	1046
CH_4	Not determined*	0.24	6
N_2O	0.02	0.03	9
HFC	Not determined*	0.0004	≤ 6

* A split into domestic and international emissions is not possible.

Source: MEPC 59/INF. 10 “Second GHG Study 2009” (Update of the 2000 IMO GHG Study)

Typical ranges of CO_2 efficiencies of ships (in gram CO2 per ton*km)



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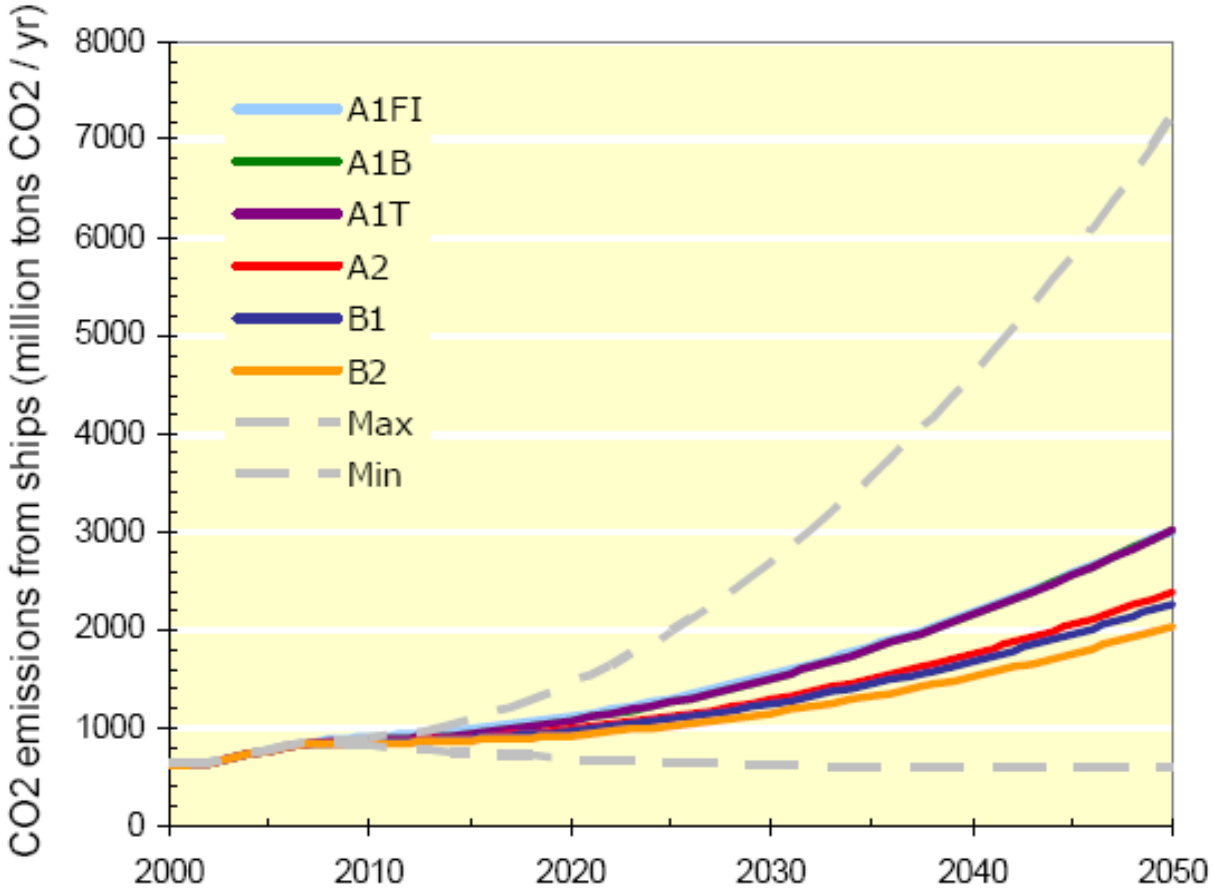
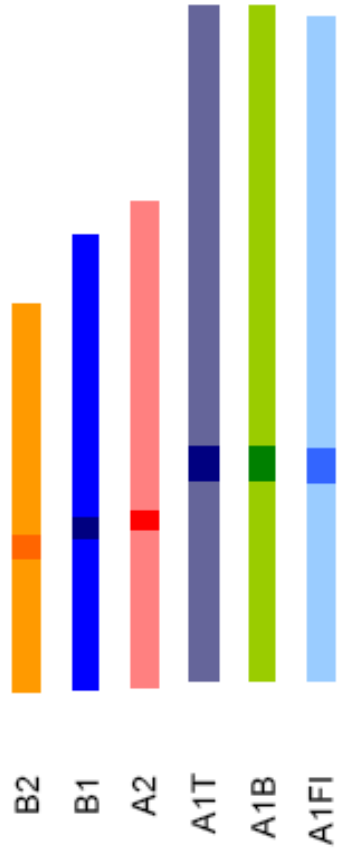
International shipping CO_2 emission scenarios





Trajectories of the emissions from international shipping. Columns on the right-hand side indicate the range of results for the scenarios within individual scenario families

Source: MEPC 59/INF. 10 “Second GHG Study 2009” (Update of the 2000 IMO GHG Study)

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Policy options for reduction of emissions

1. mandatory limit on the Energy Efficiency Design Index (EEDI) for new ships (baselines ship type dependend)
2. mandatory or voluntary reporting of the EEDI for new ships
3. mandatory or voluntary reporting of the Energy Efficiency Operational Indicator (EEOI)
4. mandatory or voluntary use of a Ship Energy Efficiency Management Plan (SEEMP)
5. mandatory limit on the EEOI value, combined with a penalty for non-compliance
6. Maritime Emissions Trading Scheme (METS)
7. “International Compensation Fund (ICF)”, to be financed by a levy on marine bunkers (“bunker levy”)

Considered CO_2 reduction strategies

- for new ships
  - introduce a “design CO_2-Index”
    >> an “EEDI”: Energy Efficiency Design Index
- for ships in service
  - Energy Efficiency Operational Indicator, “EEOI”
    (MEPC Circular 684 from August 2009)
  - Ship Energy Efficiency Management Plan “SEEMP”
    (MEPC Circular 683 from August 2009)
  - market based instruments:
    - Maritime Emission Trading Scheme (METS), ...
      or Clean Development Mechanism (CDM)

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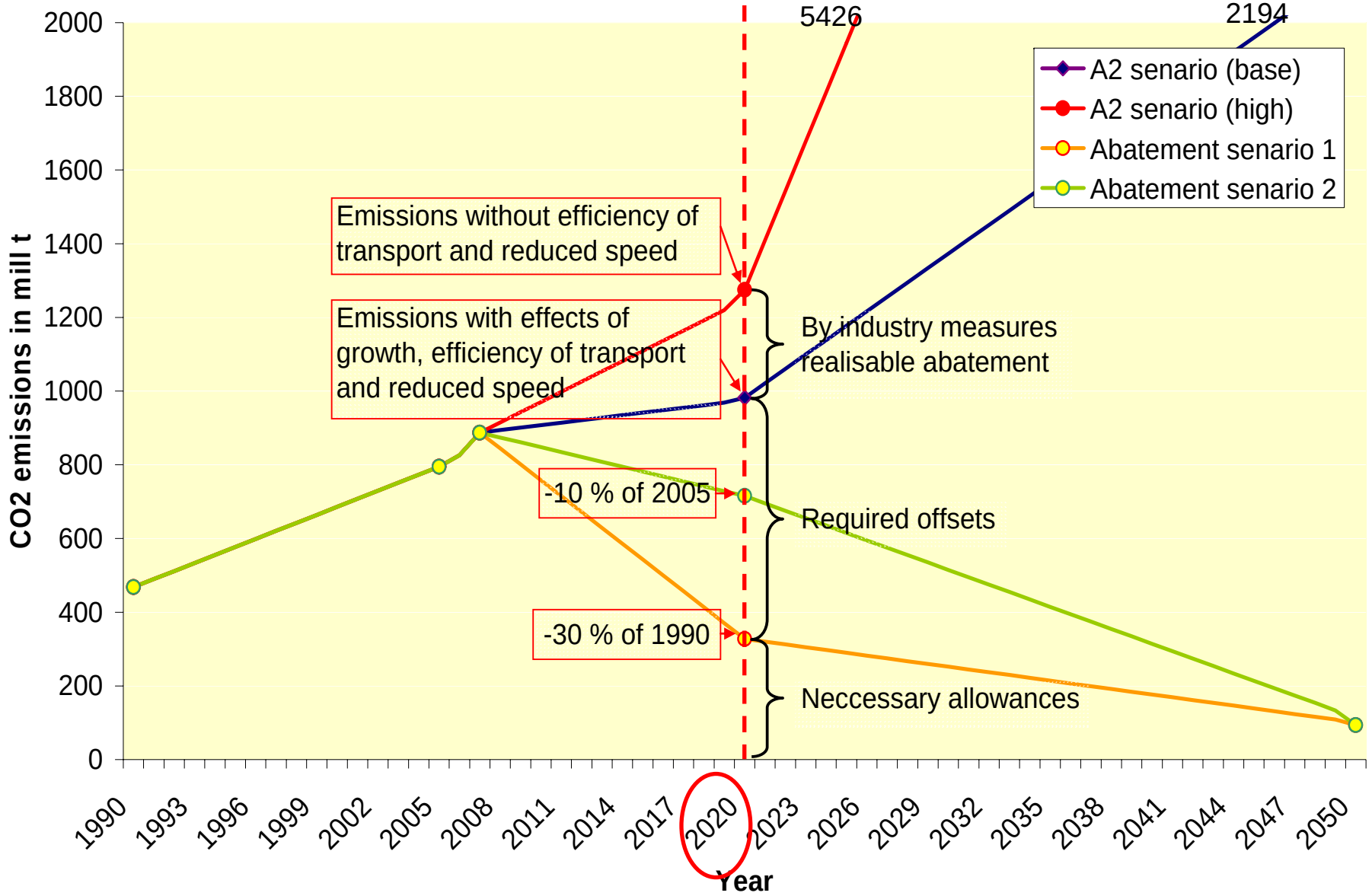
Emission targets: Compliance under an ETS



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The Energy Efficiency Index – the concept

- An Energy Efficiency Index is a transport-efficiency indicator (concept for new ships and ships in service)
- It displays the ratio between environmental impact and benefit for society

$$EE\text{-}Index = \frac{\text{Air pollution (emitted } CO_2\text{)}}{\text{Transport work}}$$

Energy Efficiency Design Index (EEDI)

- The EED Index (former design CO_2-Index) represents a theoretical transport-efficiency

$$EEDI = \frac{SFOC \cdot Installed\_power \cdot C_{Carbon}}{Capacity \cdot v_{ref}}$$

- The design index may be further used as benchmark between new ships.
- The EEDI may be based on different cargo-units depending on ship type:

➔ [gCO_2/t*nm], [gCO_2/TEU*nm], [gCO_2/m^3*nm], [gCO_2/lane m*nm], [gCO_2/pax*nm], ...

SFOC – Specific fuel oil consumption; v_{ref} – reference velocity

The Attained EEDI- Formula

Auxiliary Engines

Main Engines

f_j – correction factor for ship specific design elements

P_{MEi} – 75 % $(P_{MCRi} - P_{PTOi})$ of the rated installed power

$P_{PTI(i)}$ – 75 % of rated power of shaft motors

$P_{AEeff(i)}$ – auxiliary power reduction of innovative electrical technologies at $P_{ME(i)}$

$P_{AE} = f(P_{ME})$

Innovative technologies

P_{eff} – main engine reduction due to innovative energy efficiency technologies

f_{eff} – availability factor of any innovative efficient technology

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} C_{FMEi} SFC_{MEi} P_{MEi}\right) + P_{AE} C_{FAE} SFC^*_{AE} + \left(\prod_{j=1}^{M} f_j \sum_{i=1}^{nPTI} P_{PTIi} - \sum_{i=1}^{neff} f_{effi} P_{AEeffi}\right) C_{FAE} SFC_{AE} - \left(\sum_{i=1}^{neff} f_{eff} P_{eff} C_{Feff} SFC_{MEi}\right)}{f_i \, Capacity \; V_{ref} \; f_W}$$

Transport work

f_i – coefficient for technical/regulatory limitation on capacity

$Capacity$ – depending on ship type

V_{ref} – reference speed

f_W – coefficient indicating decrease of speed due to wind and waves

Formula acc. to MEPC/Circ. 683

Explanation P_{AE}

.1 For cargo ships with a main engine power of 10000 kW or above, P_{AE} is defined as:

$$P_{AE(MCRME>10000KW)} = \left(0.025 \times \sum_{i=1}^{nME} MCR_{MEi} \right) + 250$$

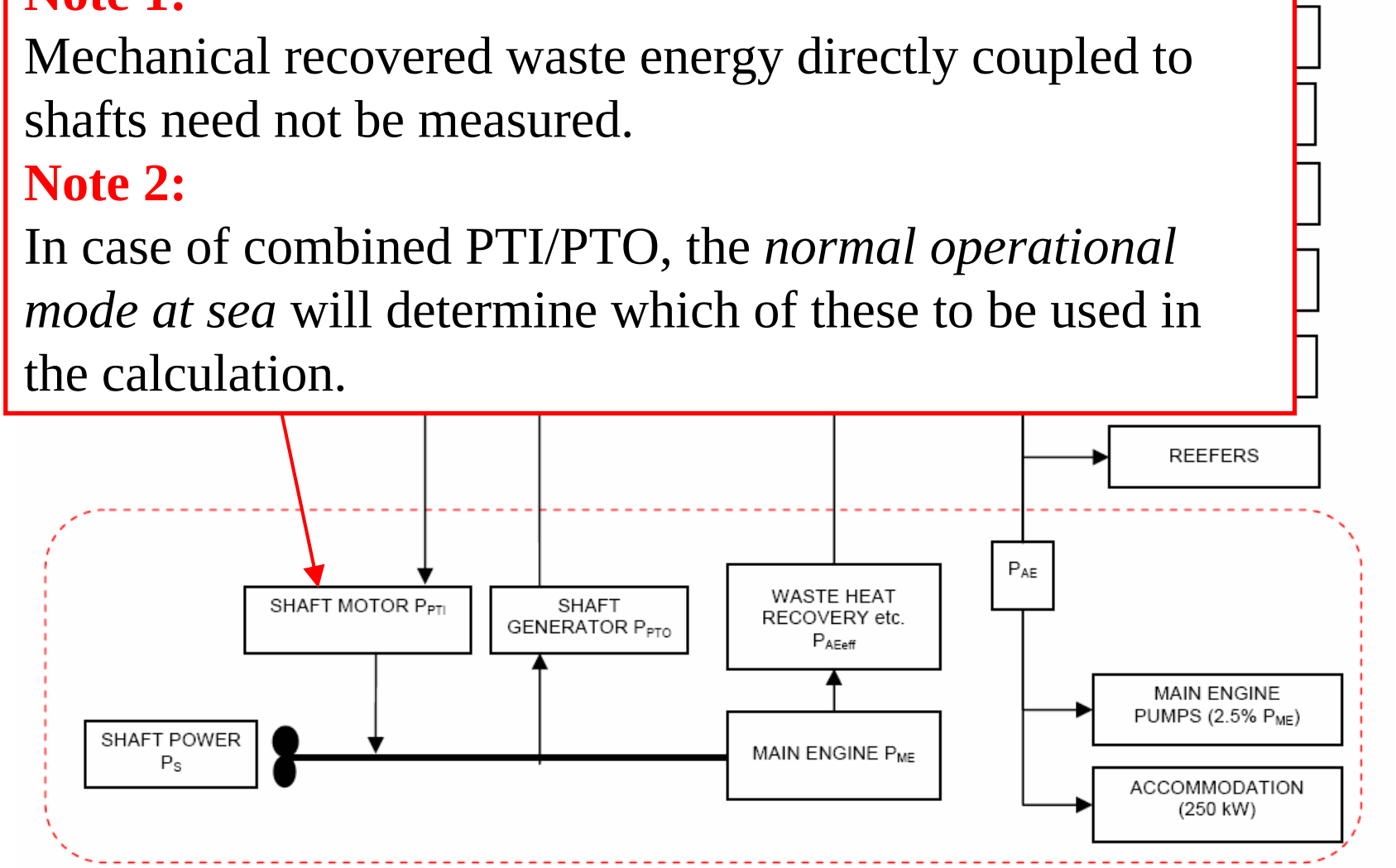
.2 For cargo ships with a main engine power below 10000 kW, P_{AE} is defined as:

$$P_{AE(MCRME<10000KW)} = 0.05 \times \sum_{i=1}^{nME} MCR_{MEi}$$

A generic and simplified marine power plant

Note 1:
Mechanical recovered waste energy directly coupled to shafts need not be measured.

Note 2:
In case of combined PTI/PTO, the *normal operational mode at sea* will determine which of these to be used in the calculation.



Benchmark against a baseline

- From public databases (LRFP*) a baseline for the ship types in the current MEPC discussion is derived
  - Bulker
  - Tanker
  - Gas carrier
  - Container ships
  - General cargo ships
  - Ro-ro passenger ships

- The “Attained EEDI” of a new ship shall be below the baseline
  → $EEDI_{attained} < EEDI_{baseline}$

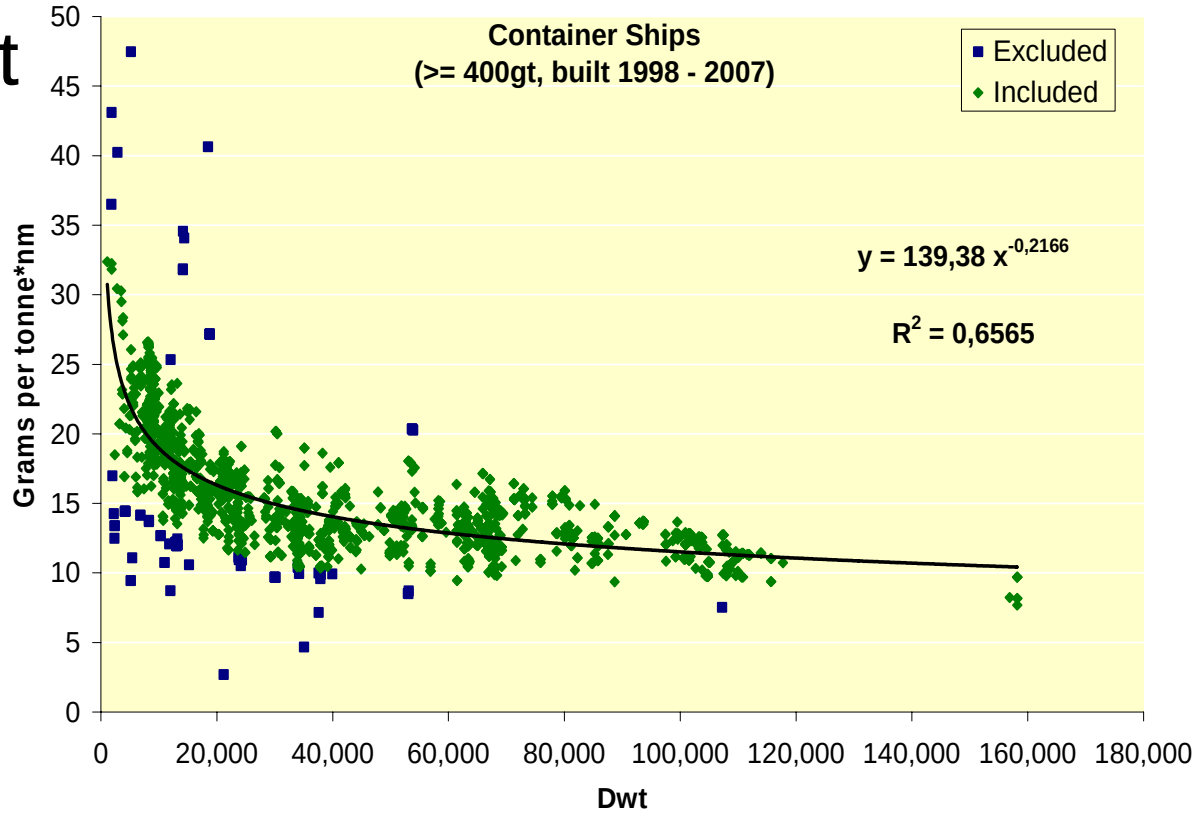
*LRFP – Lloyd's Register Fairplay

Determination of the attained EEDI

- The attained EEDI will be determined on the ship's sea trail (MEPC/Circ. 682), where power and the attained reference velocity (v_{ref}) will be measured
- The EEDI will be confirmed by a verifier

Baseline evaluation

- For each ship included of LRFP the EEDI is calculated
- All ships which are at least two standard deviation away from the regression curve are excluded
- From the remaining data points a baseline is derived



Issues in current baseline discussion

- Accuracy of the input parameters is not for every ship assured , this counts especially for v_{ref}
- Faster ships seem to be disadvantaged (relationship speed ~ power)
- Specific transport tasks may not be considered and could yield to a disadvantage for the EEDI

Energy Efficiency Operational Indicator (EEOI)

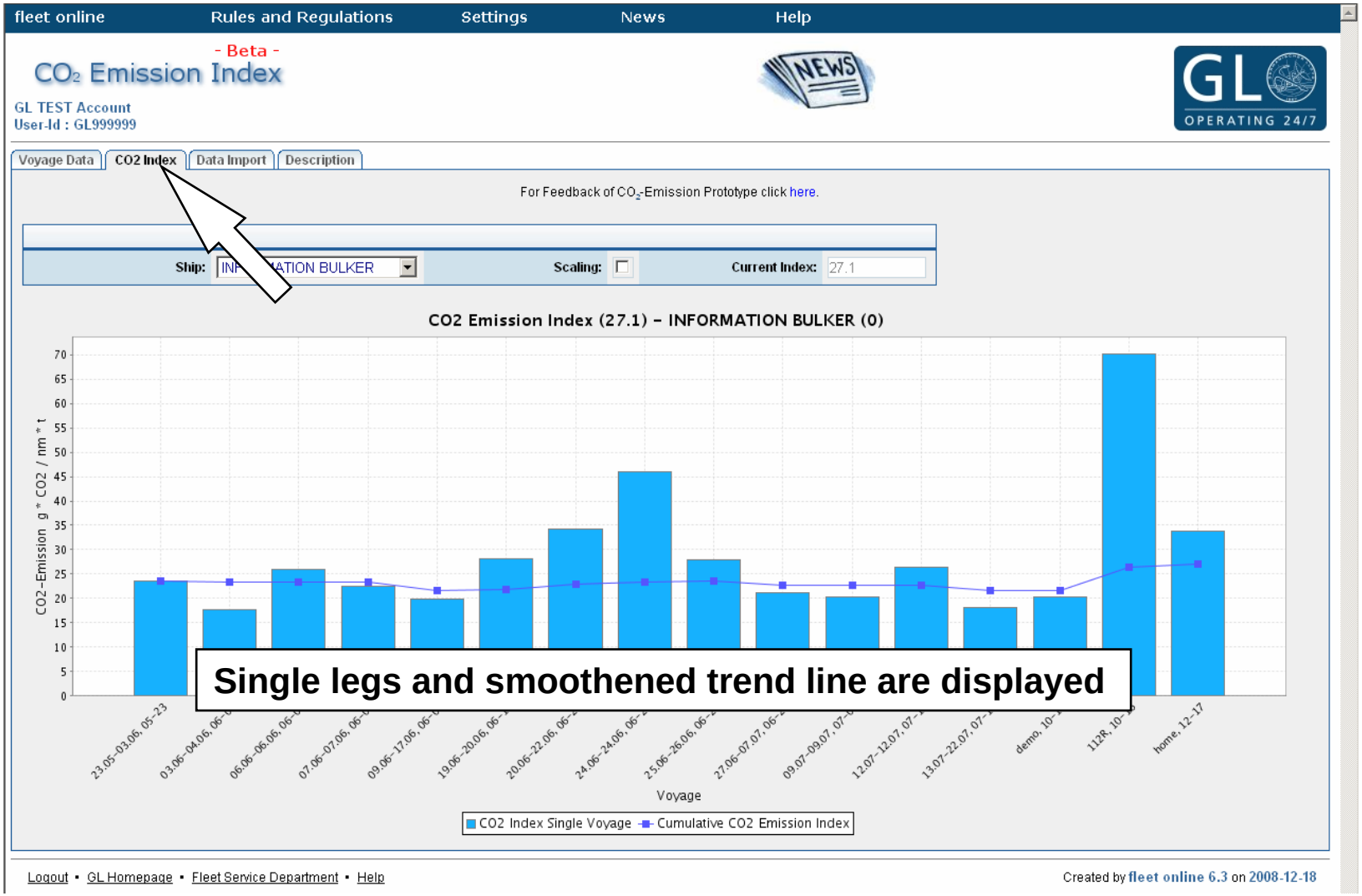
- The EEOI (former operational CO_2-Index) represents the actual transport-efficiency of a ship in service and shall be part of the SEEMP

$$EEOI = \frac{Fuel\ consumed \cdot Emission\ factor}{Cargo\ transported \cdot Distance\ sailed}$$

- The collected data will be averaged over a number of voyages.
- The CO_2 -Index may be based on different cargo-units depending on ship type:
  - [gCO_2/t*nm], [gCO_2/TEU*nm], [gCO_2/m^3*nm], [gCO_2/lane m*nm], [gCO_2/pax*nm], ...

Today prepared for tomorrow

CO_2 Monitoring with GL Fleet Online



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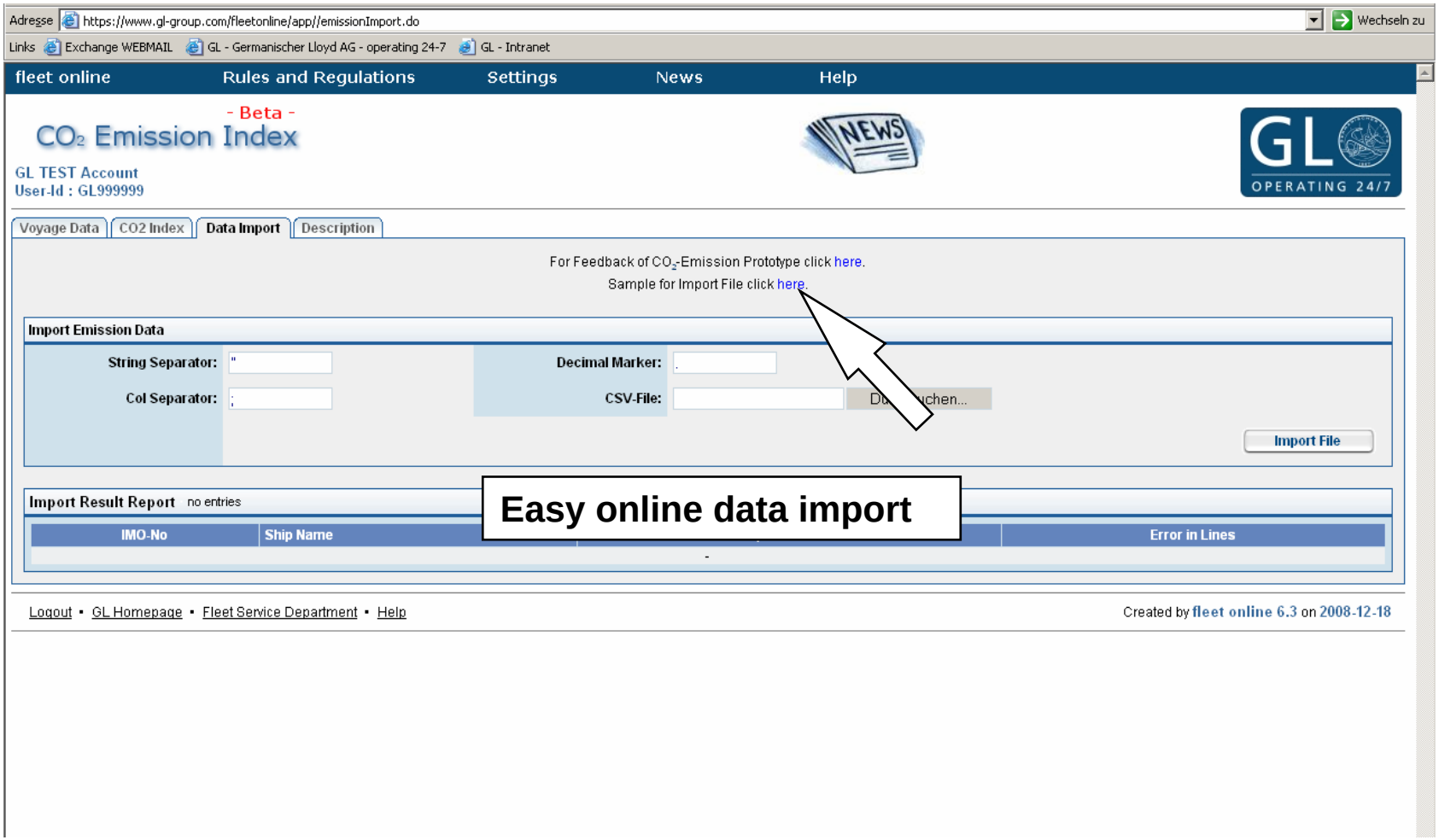

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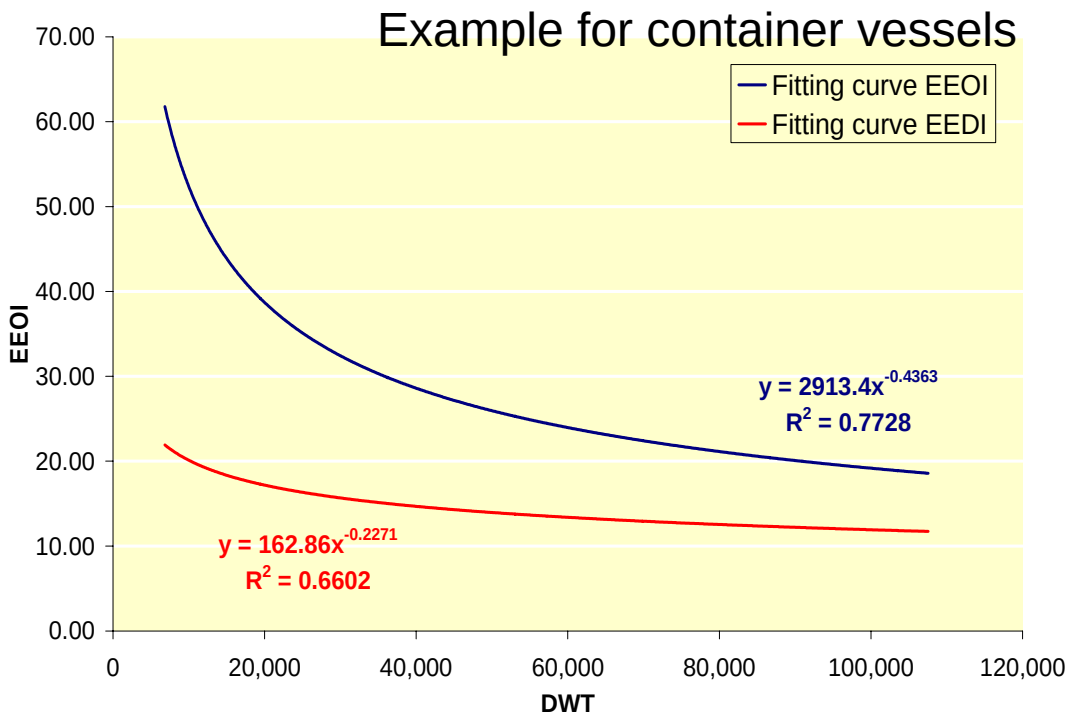
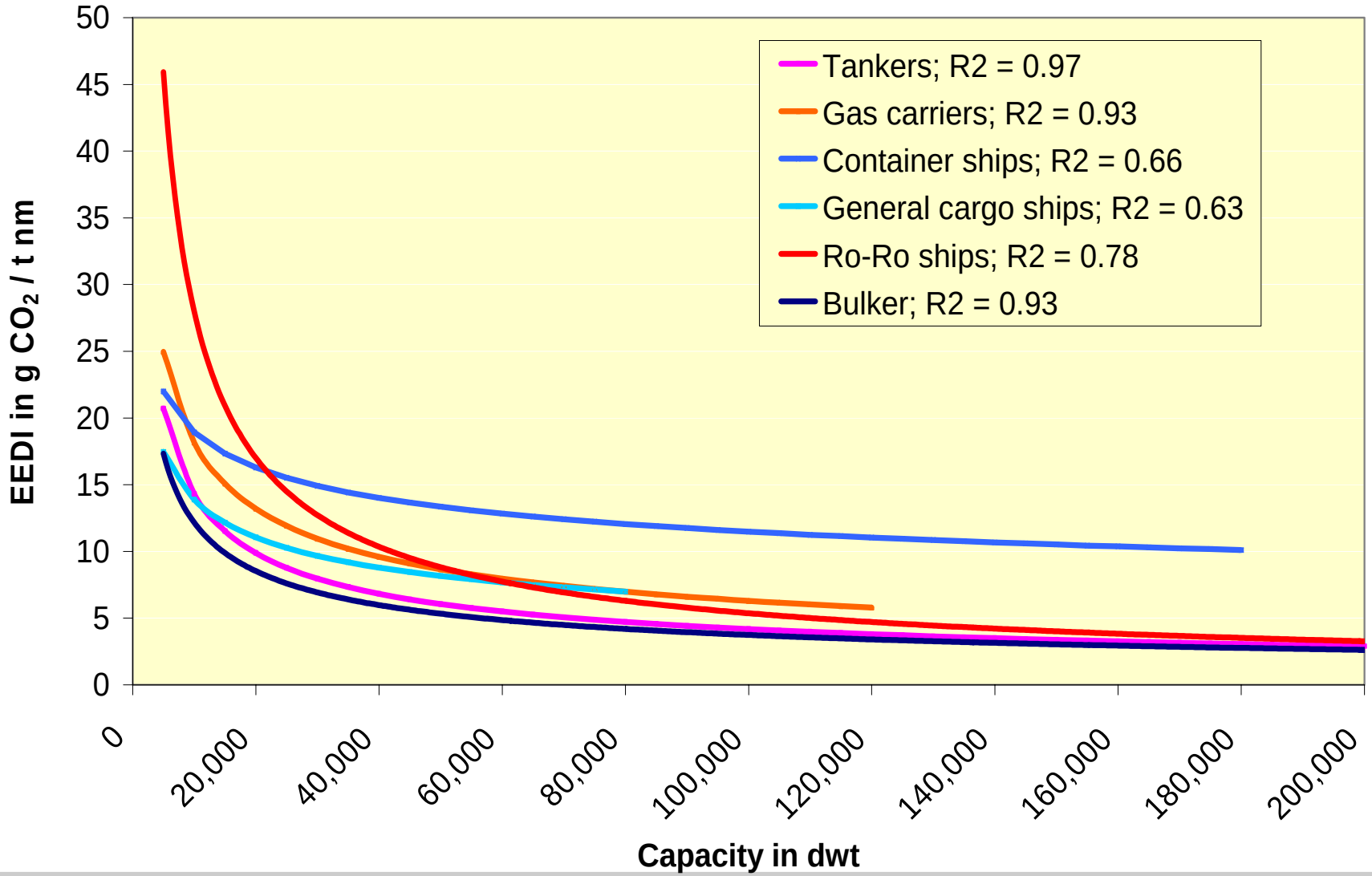
Insight into the business

- The ratio of EEOI and EEDI decrease from 2.7 for small DWT to 1.6 for large DWT
- Data give an understanding in the current GHG reduction and CO_2 abatement discussions
- Basis for individual benchmark



baselines in discussion (“GHG-WG 2/2/7”)



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Outlook

- Items to be expected
  - Mandatory **Energy Efficiency Design Index** incl. baseline as building standard
  - **Energy Efficiency Operational Indicator**, possibly connected to *emission certificate trading system* or part of Mandatory *Ship Efficiency Management Plan*
- Timeline
  - Correspondence Group for further Development of EEOI
  - MEPC 59, working group, July 2009, London
  - UNFCCC CoP15, Dec. 2009 in Copenhagen
  - MEPC 60, working group, March 2010, London

Conclusion

- The EEDI itselfs cannot avoid emissions, but could give a good advise of efficiency for ships (benchmarking)
- The EEOI can give a general approach for efficient operation of ships
- Both indices and a “bunker levy” cannot guarantee an absolute reduction of CO2 emissions from shipping
- A “METS” with reasonable limitation targets might be the right way to achive absolute reduction goals
- Undesired shift of transportation modes (shipping to street) should be avoided

Thank you for your attention!

excerpt from building spec **5600TEU** ship

- SPEED

Service speed **at the design draught** and at the normal continuous rating (**38,165 kW**) of main engine with 30% sea margin (NCR = 100%) at the condition of clean bottom in calm and deep sea to be about **23.7 knots**.

- FUEL OIL CONSUMPTION

Daily fuel oil consumption at the normal continuous rating (38,165 kW) of main engine to be about **149.4/157.1 metric tons** based on marine diesel oil of **42,700/40,600 kJ/kg** in lower calorific value at shop test under ISO reference condition.

>> SFOC = 163 / 171 g/kWh