European Maritime Safety Agency

LNG Fuelled Ships – Introductory remarks

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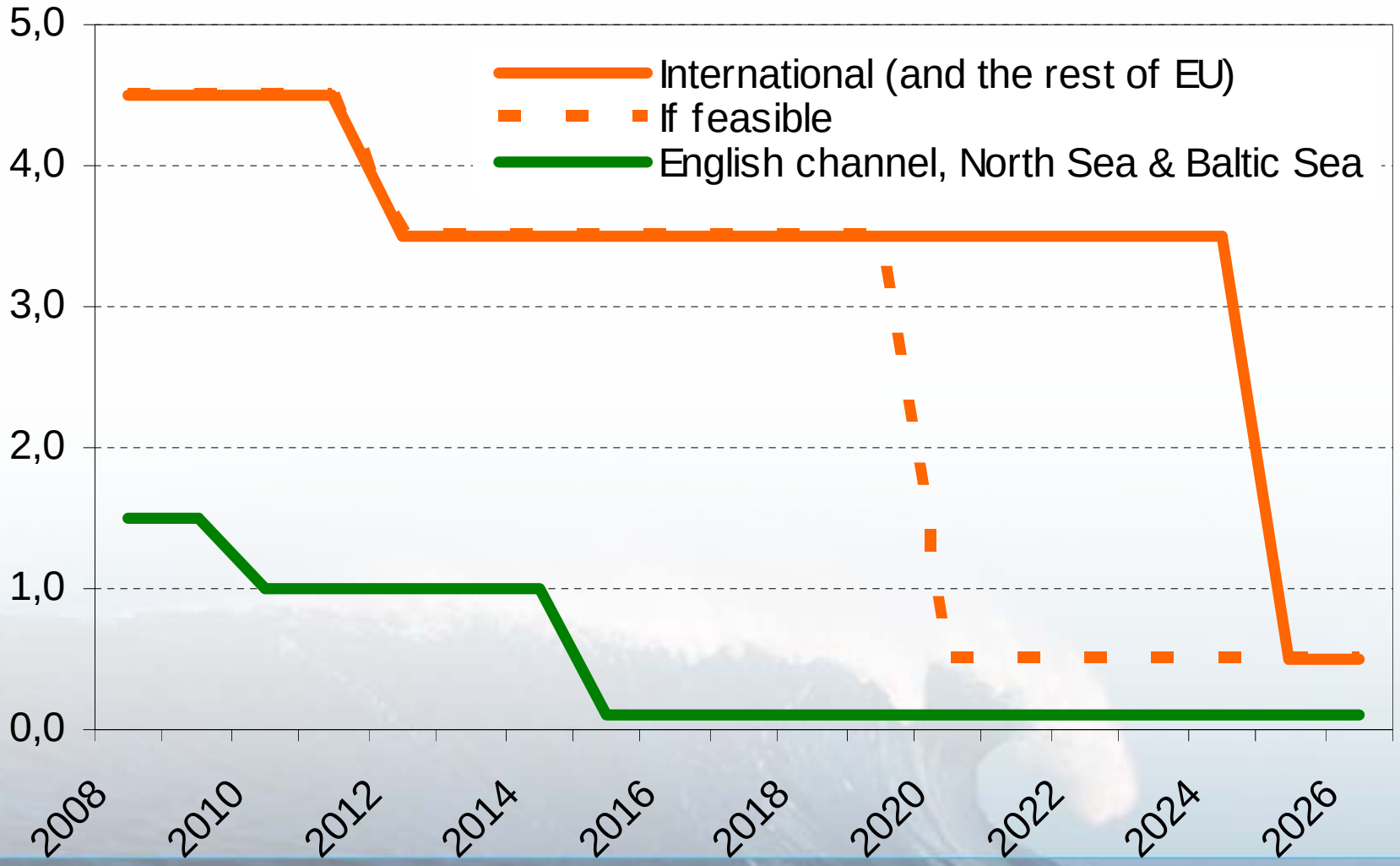
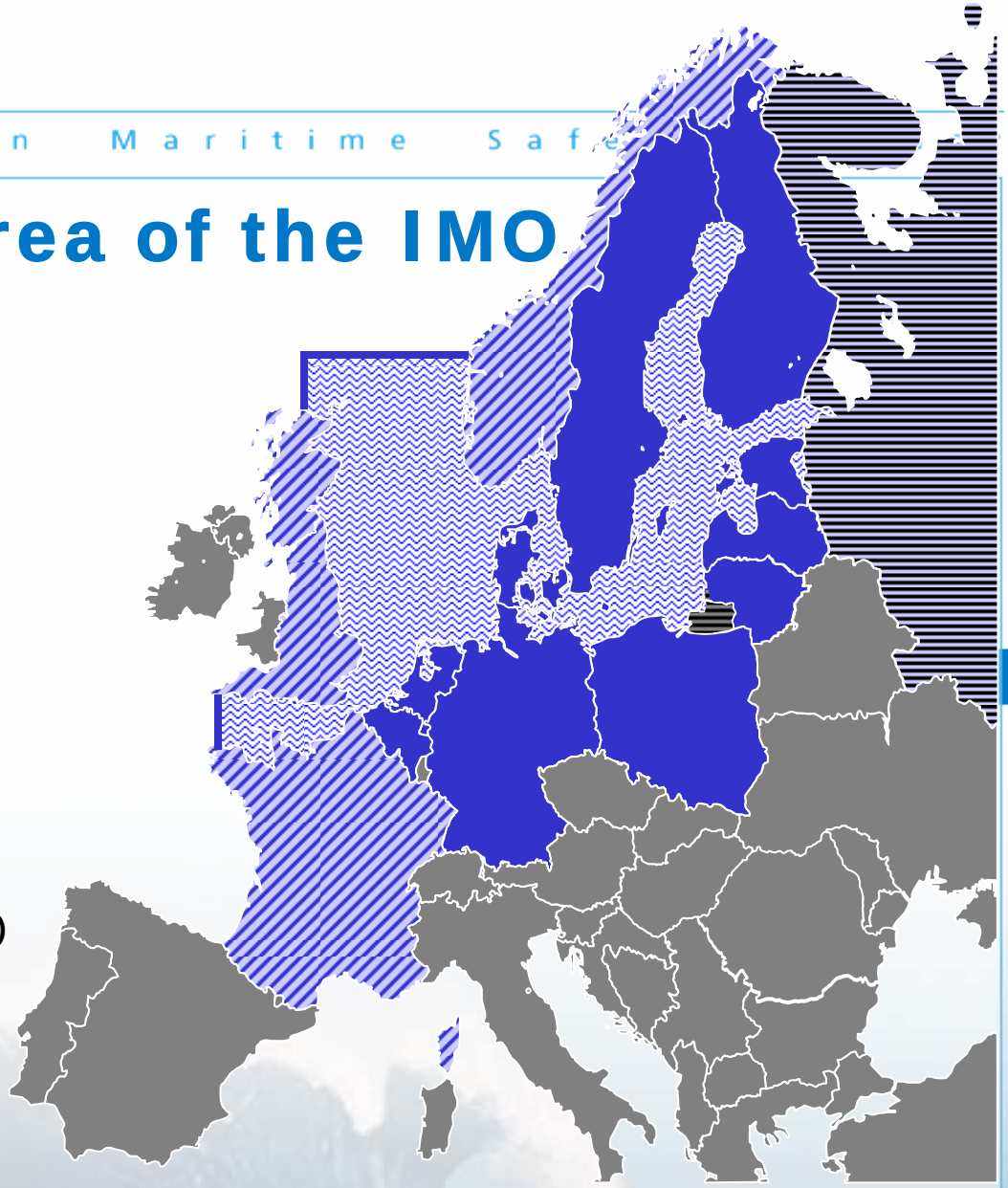
Executive Director
EMSA

Meeting on LNG as alternative fuel
ECSA, Brussels, 24.11.09

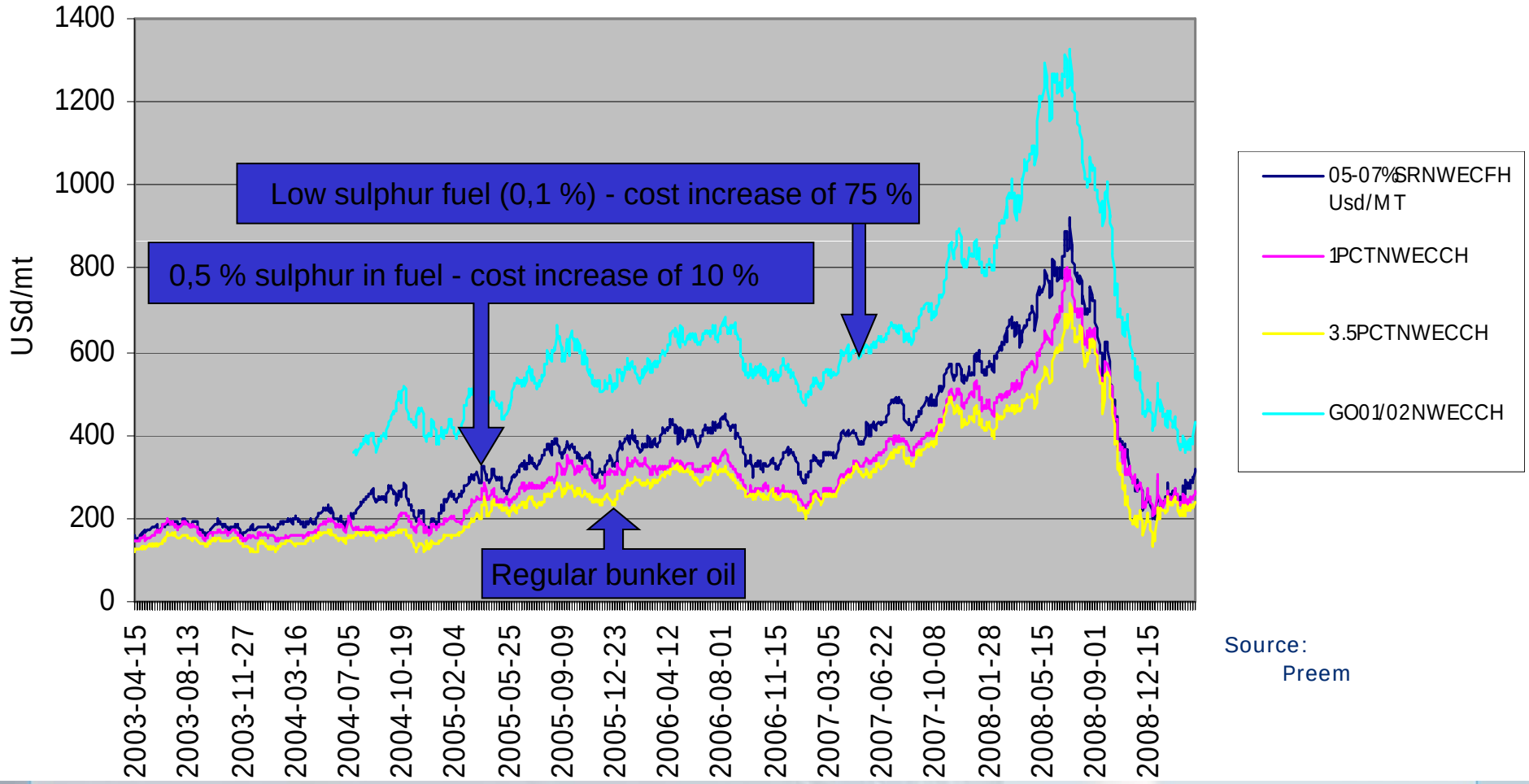
Sulphur regulations for Marine Fuel



Geographical area of the IMO SECAs

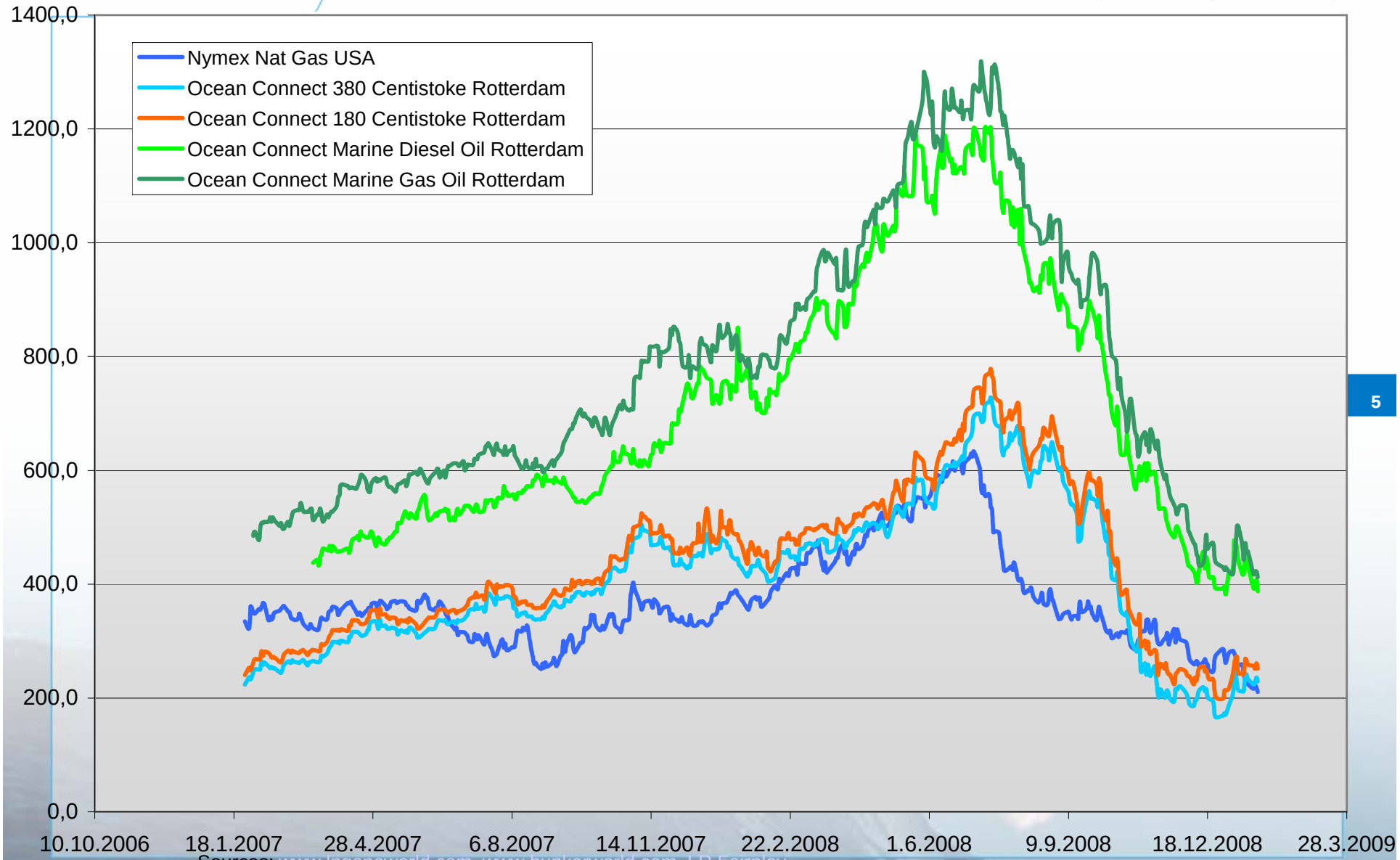


The Sulphur Emission Control Area (SECA)
Countries with water only in SECA
Countries with part of the coast in SECA
Countries without coast in SECA
Has not ratified Marpol Annex VI

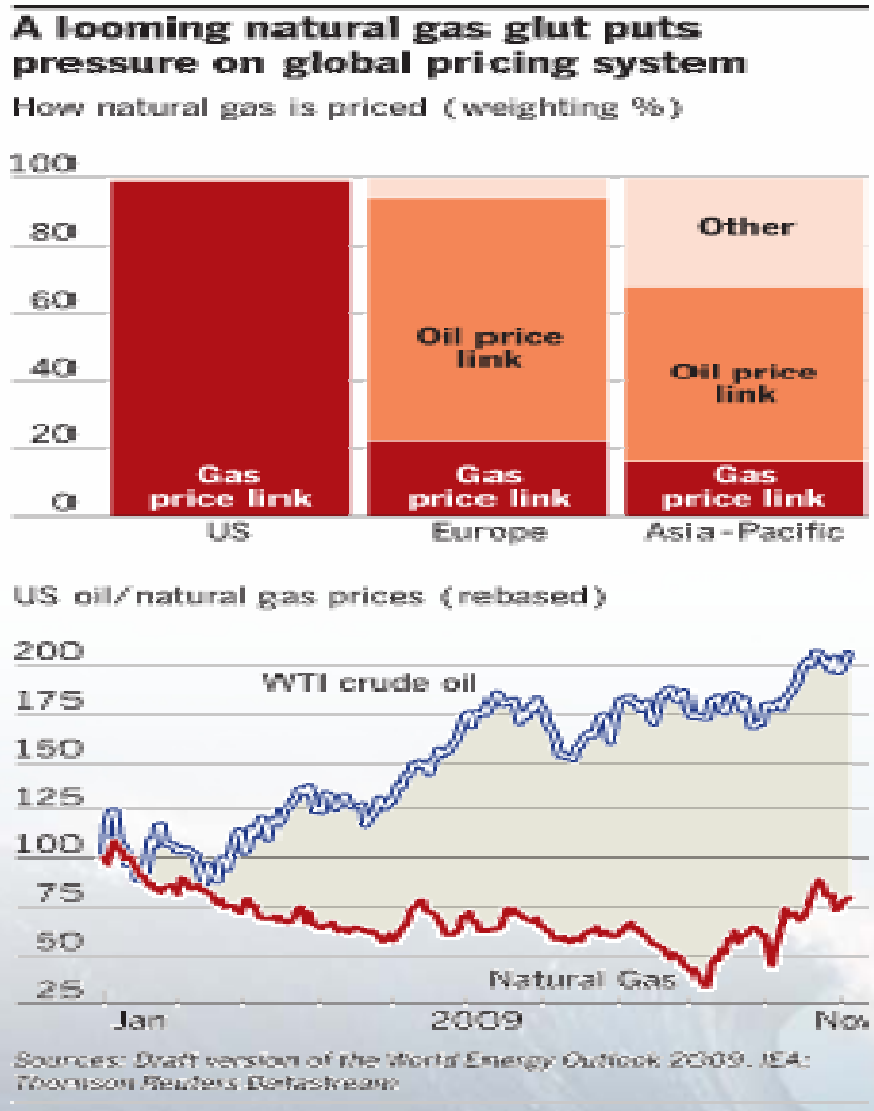


Source:
Preem

Bunker fuel Prices



Sources: www.ingoneworld.com, www.bunkerworld.com, LR Fairplay


A looming natural gas glut puts pressure on global pricing system
How natural gas is priced (weighting %)
100
80
60
40
20
0
Gas price link
Oil price link
Gas price link
Other
Oil price link
Gas price link
US
Europe
Asia-Pacific
US oil/natural gas prices (rebased)
200
175
150
125
100
75
50
25
WTI crude oil
Natural Gas
Jan
2009
Nov
Sources: Draft version of the World Energy Outlook 2009, IEA; Thomson Reuters Datastream

$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_w}$$

The IMO EEDI formula
as in MEPC.1/Circ.681

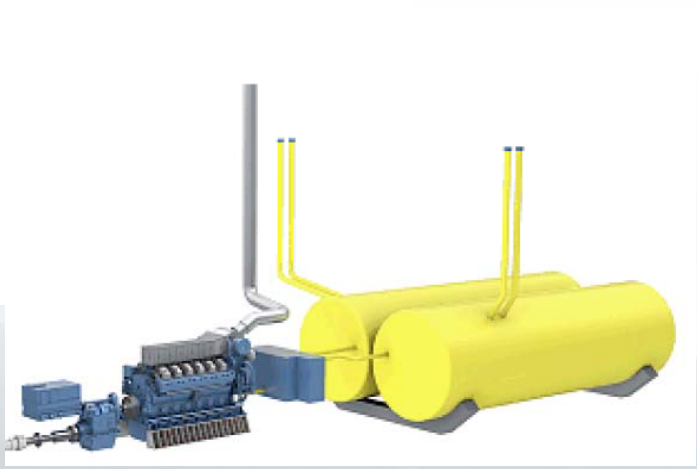
$$\frac{\left(\prod_{j=1}^{M} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}\right) + \left(\left(\prod_{j=1}^{M} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\right)}{f_i \cdot Capacity \cdot V_{ref} \cdot f_w}$$

C_F	= conversion factor between consumed fuel and emitted CO2. ME(i) and AE(i) refer to main- and auxiliary engines.
V_{ref}	= ship speed, measured in knots, in maximum design load condition, assuming deep water and calm sea and no wind.
Capacity	= for conventional vessel types deadweight and gross tonnage for passenger ships and RoRo passenger ships.
$P_{ME(i)}$	= power of main engines measured in kW at 75% MCR having deducted shaft generators.
$P_{AE(i)}$	= auxiliary engine power in kW, the electrical load required to supply normal maximum sea load.
$P_{PTO(i)}$	= shaft generator power in kW at 75% output of each installed shaft generators.
$P_{PTI(i)}$	= shaft motor power in kW at 75% output of installed shaft motors.
$P_{eff(i)}$	= 75% of the main engine power reduction (kW) due to innovative mechanical energy efficient technology.
$P_{AEeff(i)}$	= auxiliary power reduction (kW) due to innovative electrical energy efficient technology measured at $P_{ME(i)}$.
SFC	= specific fuel oil consumption of engines, measured in g/kWh. ME(i) and AE(i) refer to main- and auxiliary engines.
f_j	= non-dimensional correction factor to account for ship specific design elements.
f_w	= non-dimensional coefficient indicating the decrease of speed in representative sea conditions.
$f_{eff(i)}$	= availability factor of each innovative energy efficiency technology.
f_i	= capacity factor for any technical or regulatory limitation on capacity.

LNG will change carbon conversion factor from 3,1144 to 2,75.

Heat value of LNG is also higher than for HFO.

These two issues give about -20% benefit in specific CO2 emission.



Cost:	4,000,000 €
Benefit:	**-6 units**
EEDI:	29,4 -> 23,4 (target: 25,3)

Various EEDI reduction measures
Cost / Benefit

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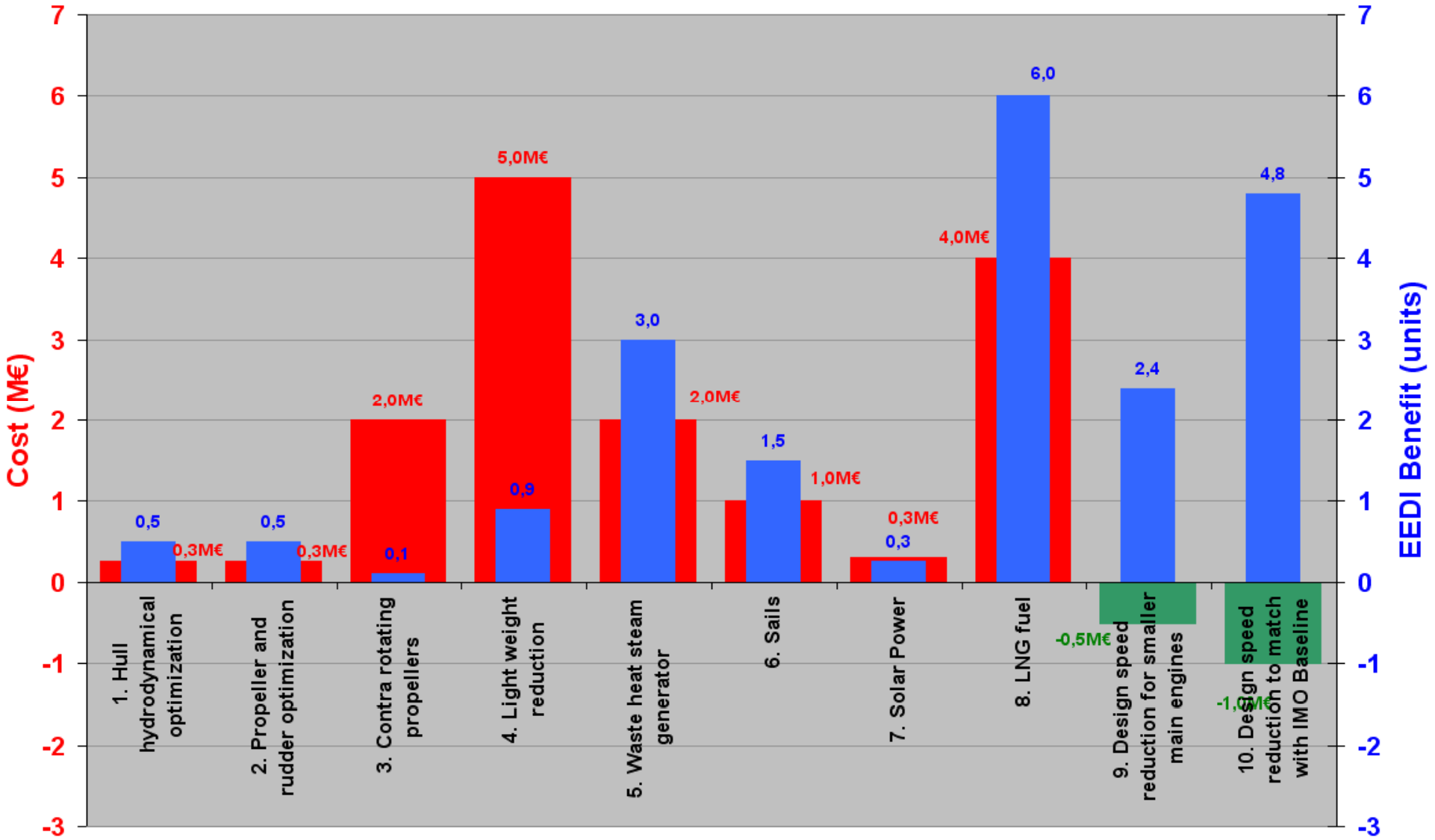
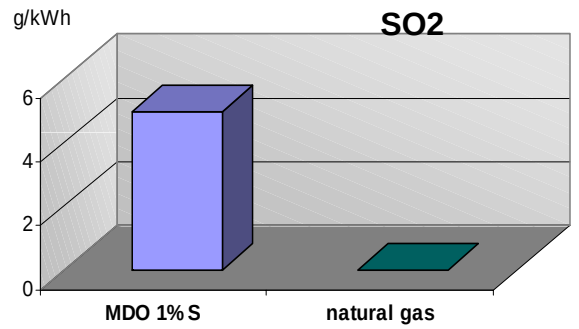
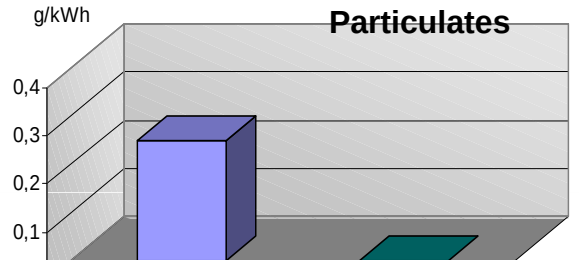


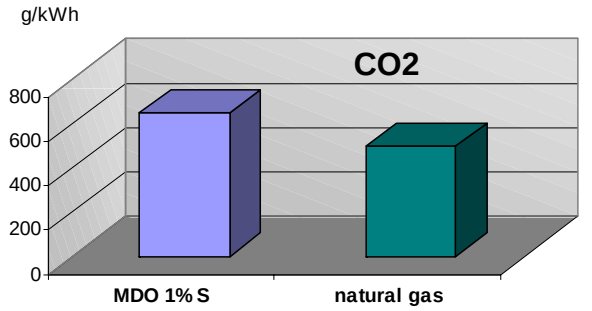
Exhaust emission - Natural gas vs MDO

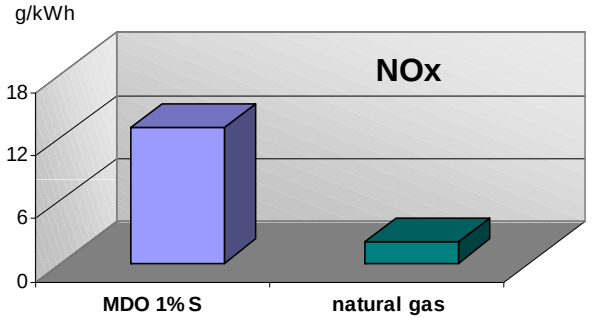
- Sulphur emission is eliminated
- Particulate matters is close to zero
- CO2 is reduced by 26%
  Due to unburned methane the net reduction of greenhouse gases is somewhat lower
- NOx is reduced by 80-90%

Source: Rolls-Royce Marine









LNG bunkering station at ferry berth

Capacity bunkering station: 2x 500m^3 LNG

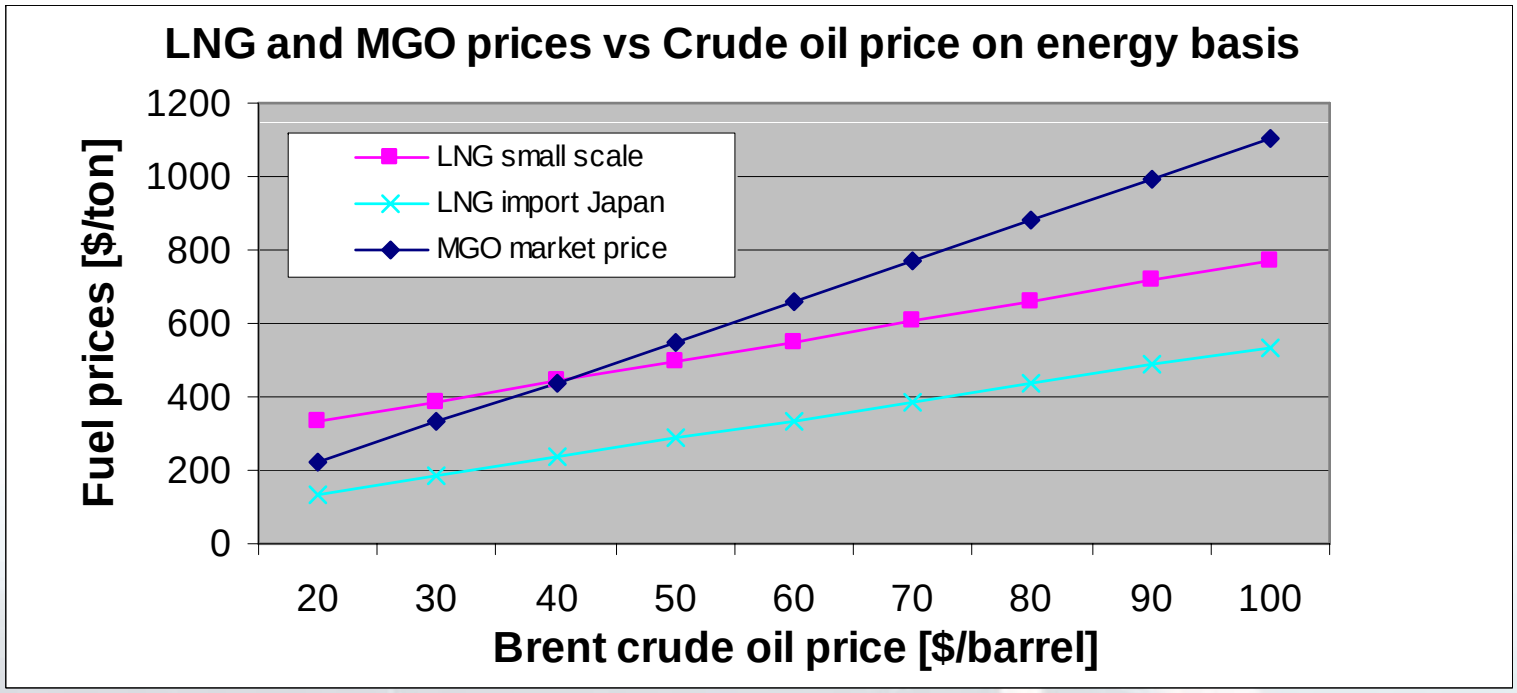
LNG transferred by pump

Filling time for the large LNG ferries about two hours

Refuelled every third night

Bunkering LNG ferry

Price level LNG vs Marin Diesel Oil (MDO)



At high crude oil price LNG has a significant price margin to Marin Diesel Oil (MDO)

IMO NOx – Regulation 13

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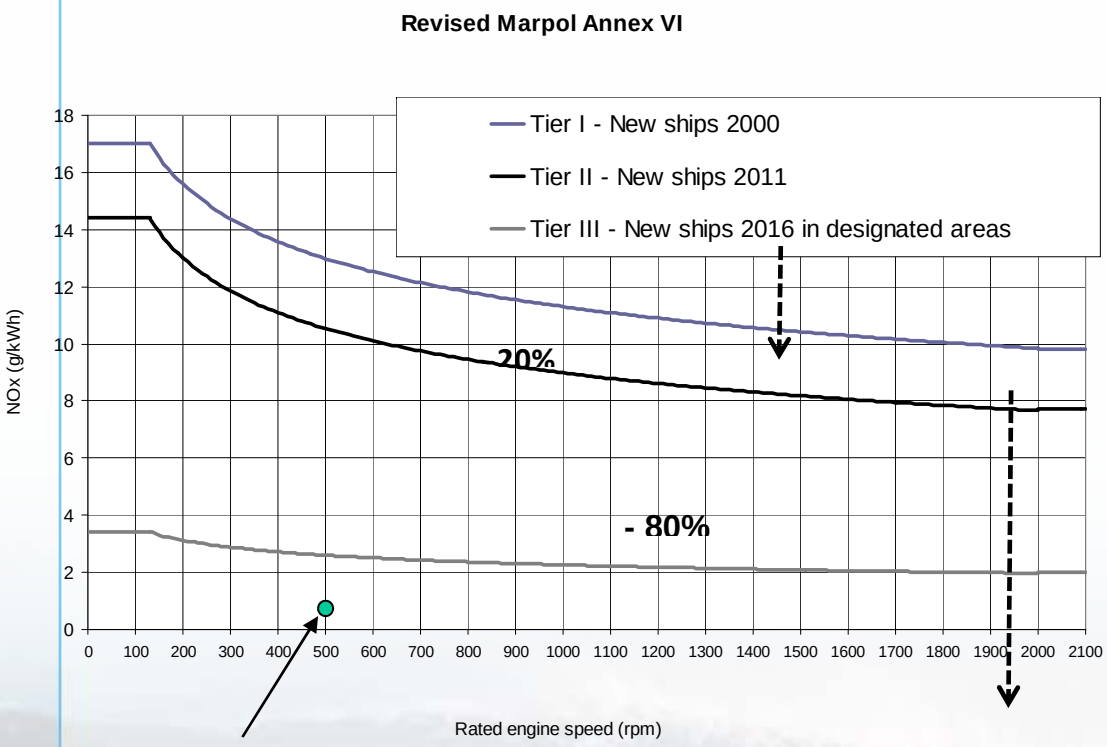

Wärtsilä DF / SG engine meet already Tier III

- New buildings (diesel engines > 130 kW): Tier II from 2011; Tier III to be applied in designated areas from 2016* (Tier II to be applied outside these areas)

- Existing ships: Tier I to be applied for vessels constructed between 1990 and 2000 (diesel engines > 5000 kW and > 90 liters / cylinder). Some exemptions are considered

* Date of keel laying

IMO SOx and PM – Regulation 14

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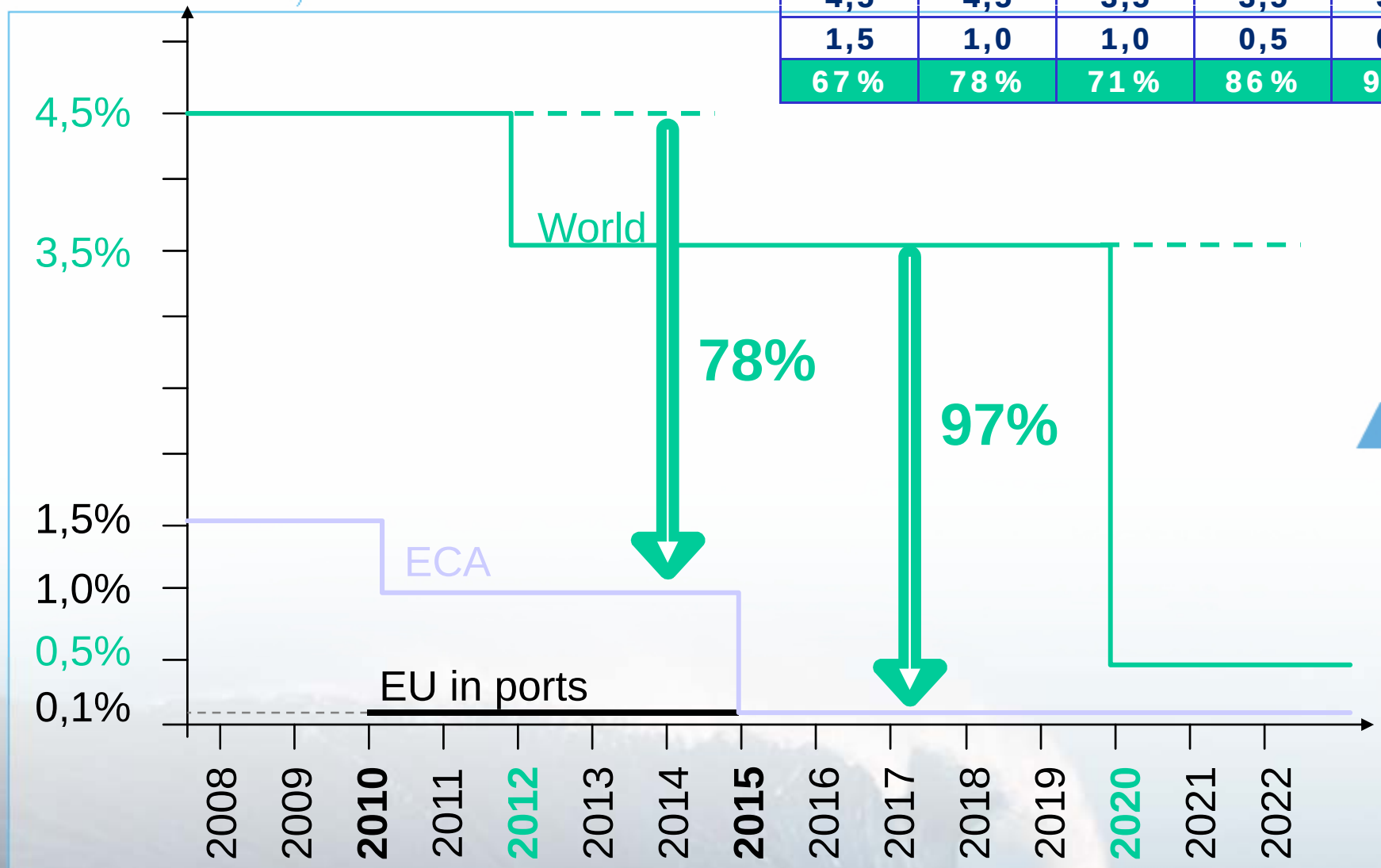
4,5	4,5	3,5	3,5	3,5
1,5	1,0	1,0	0,5	0,1
67 %	78 %	71 %	86 %	97 %



Applies to both new buildings and existing ships !

- **25-30% lower CO_2**
  - Low Carbon to Hydrogen ratio of fuel
- **85% lower NO_X**
  - Lean burn concept (high air-fuel ratio)
- **No SO_X emissions**
  - Sulphur is removed from fuel when liquefied
- **50% lower PM Particulates**
  - Particulates vary across operating range
- **No visible smoke**
- **No sludge deposits extends engine life**

Emission comparison

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