



Project MariEMS

Shipping Emissions and a Way
Forward to Reduce These
Harmful Pollutants

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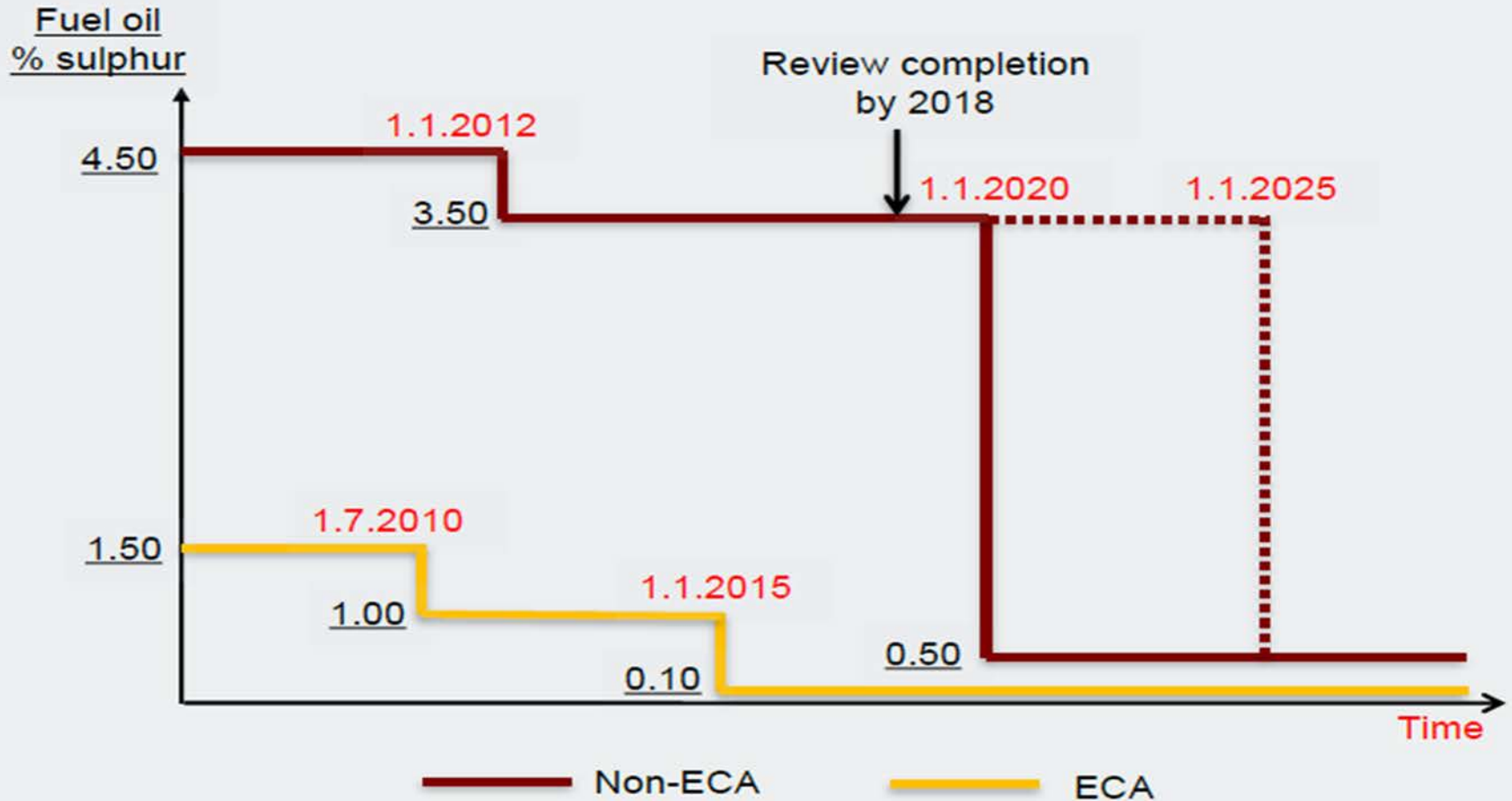
Key Statistics

- Air pollutants from international shipping in the European waters amounted 20~30% of NO_x and SO₂ emissions from all land-based source in EU in year 2000.
- In 2007 the global shipping industry estimated to have emitted 1,100 million tonnes of CO₂, 3.5% of global emissions, and in 2012 this reached 972 million tonnes some 2.5% of world total (Ziarati et al; 2017)
- Annex VI of MARPOL 73/78 entered into force on 19th May 2005.
- Global shipping has been increasing some 5% before the 2008 crisis.
- Increased in shipping activities has offset the positive impact of the emission regulations.
- IMO agreed on stricter measures on NO_x and SO_x from ships

Key Offenders

- Sulphur derivatives SO_x – Due to fuel type and/or poor combustion)
- Nitrogen derivatives NO_x – Mainly due more efficient combustion and hence high temperatures
- Carbon derivatives CO_x – Mainly poor combustion)
- Particulate matter PM - Condensation of HC and Sulphates, unburned carbon; poor combustion - No IMO regulations
- Unburned hydrocarbons HC - Poor combustion - No IMO regulations

Fuel Oil % Sulphur ECA Vs Non-ECA



NO_x Emission

MARPOL Annex VI NO_x Emission Limits

Tier	Date	NO _x Limit, g/kWh		
		$n < 130$	$130 \leq n < 2000$	$n \geq 2000$
Tier I	2000	17.0	$45 \cdot n^{-0.2}$	9.8
Tier II	2011	14.4	$44 \cdot n^{-0.23}$	7.7
Tier III	2016 [†]	3.4	$9 \cdot n^{-0.2}$	1.96

[†] In NO_x Emission Control Areas (Tier II standards apply outside ECAs).

International Conventions

Kyoto Protocol (Article 2.2)

- The Parties included in Annex I shall pursue limitation of emissions of GHG from marine bunker fuels, working through the International Maritime Organization
- Kyoto Protocol commitment period ends 2020

Paris Agreement

- No specific reference to shipping in the final agreement
- Focus on “nationally determined contributions”
- Target is a temperature increase “well below 2°C”

IMO Efforts - GHG

- IMO Resolution A.963(23) –IMO Policies and Practices Related to the Reduction of Greenhouse Gas Emissions from Ships, adopted by Assembly 23 in December 2003
- IMO's work to address GHG emissions has three distinct routes:
 - Technical
 - Mainly applicable to new ships –EEDI
 - Operational
 - Applicable to all ships in operation –SEEMP
 - Market-based Measures (MBM)
 - Carbon price for shipping, incentive, may generate funds

IMO SEEMP

- Each ship of 400 Gt and above shall keep on board a ship specific SEEMP.
- Operational management tool applicable for all ships of 400 GT and above and includes:
 - 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 (Energy Efficiency Operational Indicator)

Key Areas for Ship Energy Efficiency

Operational

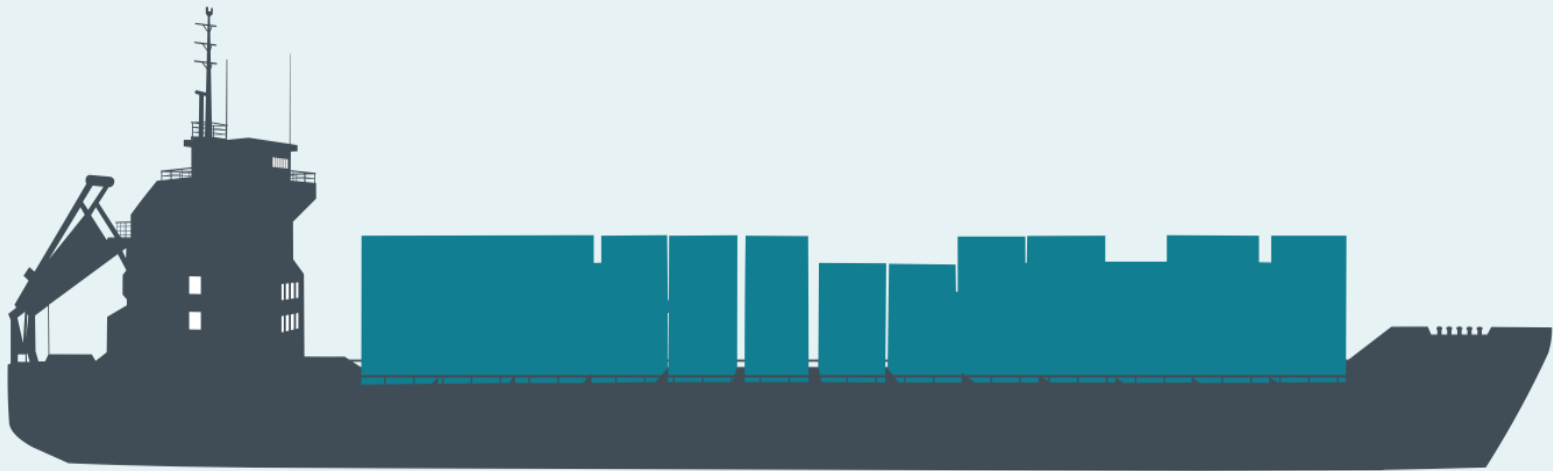
Weather routing **1-4%**
Autopilot upgrade **1-3%**
Speed reduction **10-30%**

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%**

