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SAFEMED III Seminar on MARPOL Annex VI

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GHG/Relevant Substances Efficiency & Emissions

Part III (tackling with SOx & PM, NOx and CO_2)

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Contents (all parts)

- **Ship Technology - Tackling with Air Pollutants**
- **EMSA's Research/Studies - MRV**

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Technological and Operational Potential for Emissions Reduction

- **Fundamental Categories for Reducing Emissions**

1. Improving Energy Efficiency (Design and/or Operation)
2. Renewable Energy Sources (Wind and Solar)
3. Using Alternative Fuels (Biofuels and Natural Gas)
4. Emission Reduction Technologies (before and after treatment)

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Technological and Operational Potential for Emissions Reduction

- Significant potential for emissions reduction can be achieved either trough **technical** and **operational** measures.
- Improving Energy efficiency will lead to fuel savings and consequently emissions reduction of all exhaust gases.

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Table 5.1 *Principal options for improving energy efficiency*

DESIGN	OPERATION
Concept, design speed and capability	Fleet management, logistics and incentives
Hull and superstructure	Voyage optimization
Power and propulsion systems	Energy management

Source: 2nd IMO GHG Study 2009

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Technological and Operational Potential for Emissions Reduction

- Merged, these measures would represent an increase in ships' energy efficiency and subsequently reduce emissions by **25% to 75%** below the actual values.

Table 1.2 *Assessment of potential reductions of CO_2 emissions from shipping by using known technology and practices*

	Saving of CO_2/tonne-mile	Combined	Combined
DESIGN (New ships)			
Concept, speed and capability	2% to 50%†		
Hull and superstructure	2% to 20%		
Power and propulsion systems	5% to 15%	10% to 50%+	
Low-carbon fuels	5% to 15%*		
Renewable energy	1% to 10%		25% to 75%+
Exhaust gas CO_2 reduction	0%		
OPERATION (All ships)			
Fleet management, logistics & incentives	5% to 50%+		
Voyage optimization	1% to 10%	10% to 50%+	
Energy management	1% to 10%		

* CO_2 equivalent, based on the use of LNG.
† Reductions at this level would require reductions of operational speed.

Source: 2nd IMO GHG Study 2009

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Technological and Operational Potential for Emissions Reduction

- From the revised MARPOL Annex VI requirements...

Table 5.4 *Maximum reductions in emissions in the revised Annex VI*

	Global	ECA
NO_x (g/kW·h)	15–20%	80%
SO_x* (g/kW·h)	80%	96%
PM (mass)†(g/kW·h)	73%	83%

* Reduction relative to 2.7% sulphur content in fuel.
† Expected reduction of PM from fuel change.

Source: 2nd IMO GHG Study 2009

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Technological and Operational Potential for Emissions Reduction

- **Emission Reduction options for NOx**

1. Fuel modification e.g. water emulsion / Alternative fuel
2. Modification of the charge air e.g. humidification and Exhaust Gas Recirculation (**EGR**)
3. Modification of the combustion process e.g. adjusting fuel injection rate, timing, compression ratio, etc.
4. Exhaust gas treatment systems e.g. Selective Catalytic Reduction (**SCR**)

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Technological and Operational Potential for Emissions Reduction

- **Emission Reduction options for SOx and PM**

1. Low-sulphur fuel (**MDO/MGO**) or alternative fuel (**LNG**)
2. Exhaust gas treatment systems e.g. EGCS (**Scrubbers**)

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EU rules addressing GHG

- **GHG from ships currently not adopted in EU legislation.**
- Nonetheless, EU emissions from maritime transport should be cut by **40% by 2050** compared to 2005 levels. Therefore, additional instruments have to be developed on top of current IMO technical and operational measures (EEDI & SEEMP).

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A joint statement from Commissioners Hedegaard (CLIMA) and Kallas (MOVE) in 1 October 2012:

A simple, robust and globally-feasible approach towards setting a system for Monitoring, Reporting and Verification (**MRV**) of emissions based on fuel consumption is the necessary starting point.

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EU rules addressing GHG

More recently, on the 28th June, the EC published a legislative package including a Proposal for a

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on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport and amending Regulation (EU) No 525/2013

The proposal is presently being discussed in the Council and European Parliament. Without having a defined role on the proposal, **EMSA**, while closely following the discussions has been providing its input i.e. technical contribute to the EU debate.

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International and Regional (EU) Regulations/Legislation

Regulatory Schemes should preferably be:

- Aiming to provide incentives for emissions reduction
- Easy to survey and verify, for a practical and robust enforcement
- Ships' delay in ports and the administrative burden on ships' crew and authorities should be kept to minimum levels
- Following clear, harmonised and globally adopted Guidelines

Accuracy + Completeness + Consistency + Verifiability

- Make use of dedicated equipment for monitoring & recording, built on proved, certified, word-wide available on-board use technology

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International Regulations & Guidance

Data is available through either Mandatory and Voluntary information

Fuel Type supplied and consumed

- Mandatory: Bunker Delivery Notes / Oil Record Book / Fuel Oil Sampling, kept on-board - *PSC survey and verification*
- Voluntarily but recognised as normal practice among the shipping industry: On-board monitoring fuel oil consumption - Main & Auxiliary Engines, Oil-fired Boilers, IG Generators and Incinerators

Note: Verifying fuel oil quality testing according to International Standards e.g. **ISO 8217:2010** on Petroleum products - Fuels (class F) - Specifications of marine fuels

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International Regulations & Guidance

Data is available through either Mandatory and Voluntary information

Cargo Carried

- Mandatory (SOLAS & MARPOL): Cargo/Load Manifest, Cargo Record Book, kept on-board - *PSC survey and verification*
- Voluntarily: CDWT information obtained through Displacement *vs* Lightweight; draught measurements and stability documentation.

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Distance travelled

- Mandatory (SOLAS): Navigation Log Book, Nautical Charts, ECDIS, Positioning Systems like AIS, LRIT, records on-board - *PSC survey and verification*

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EMSA's Research - findings

Monitoring Fuel Oil Consumption: being widely used by owners/operators to assess its operational effectiveness and environmental performance. Room for continuous improvement.

Tools: Tank sounding/measurement and/or fuel flow meters installed in referred machinery items, frequently using continuous monitoring and recording methods.

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Technical Feasibility: some limitations may exist although thought to be relatively easy to overcome,

- Accuracy of fuel measurements being highly dependent on the type of equipment used and from the method itself. Modern fuel flow meters, installed in vessels' fuel systems can be extremely accurate, even considering wide range of fuel-type specifics (e.g. density&viscosity)
- Modern tank sounding systems (radar/electric) are of high precision

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EMSA's Research - findings

Direct Monitoring of Ships' Air Emissions: presently available technologies in use by some shipping companies. On-going close cooperation between manufacturers and owners is recognised.

Tools: Exhaust gas measurement using fixed or portable equipment with analysis and recording capability; usually installed on the vessels' stack (exhaust gas funnel) or at a more suitable section of the exhaust gas piping systems.

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Technical Feasibility: there are still some limitations that need to be overcome,

- Accuracy of the exhaust gases measurements/analysis are highly dependent on the type of method used, equipment/sensors (e.g. sensitivity and calibration)

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EMSA's Research - findings

Cont...

- Modern systems, installed in vessels' funnels are already very accurate, even considering the wide range of fuel-type specifics (e.g. density, viscosity and low sulphur content values).

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- Several physical uncertainties associated with the flue gas (real fluid-flow dynamics) proprieties like temperature, density (e.g. volumetric mass), humidity and viscosity variations, etc. should be properly taken into account therefore carefully and specifically addressed.

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Others Research - IMarEST MEPC 65

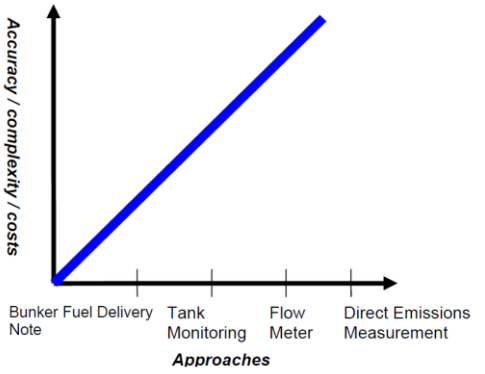

Figure 1: *Simplified relationship between fuel-monitoring approaches and goal-based attributes (accuracy, complexity and relative through-life costs)*

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Considerations

- MRV can work in many different ways, aiming to reduce the burden on both the port/flag state authorities and ships' crew
- The use of ships' commercial data bases together with a MR system (e.g. sort of simplified VDR) is possible; basic equipment could comprise: Ships' positioning system, fuel flow meters, propeller shaft torsion meter, speed log, RPM counter, trim and ballast, all gathered into a multi-channel data receiver/analyser computer-based tool. It shall also be type approved/certified for on-board use
- Data could be secured to preserve its confidentiality and access could be restricted Port/Flag State Authorities to verify compliance and monitor progress within regular time periods

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EMSA's Research/Studies - Example

From 2010 **EMSA** has been working together with the **FMI** (Finish Meteorological Institute) on the ***S.T.E.A.M.*** (Ship Traffic Emission Assessment Model) Project.

Upon agreement with the EU MSs (AIS ownership) an MoU was signed between EMSA and the FMI to proceed accordingly.

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Goals:

To calculate ships' emissions (GHG & Relevant Substances) for the whole EU sea-area

To make the calculations for the whole year of 2011

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EMSA's Research/Studies - Example

Quality Control / Model Validation

Predicted emissions can be easily and directly compared to:

on-board measurements and/or ship owner/operator fuel reports

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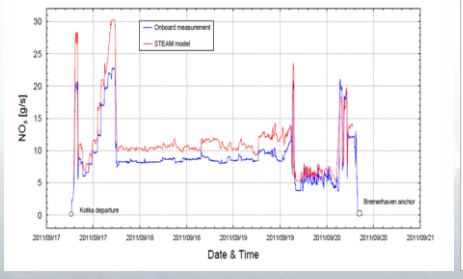

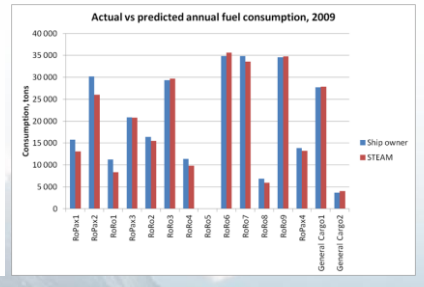

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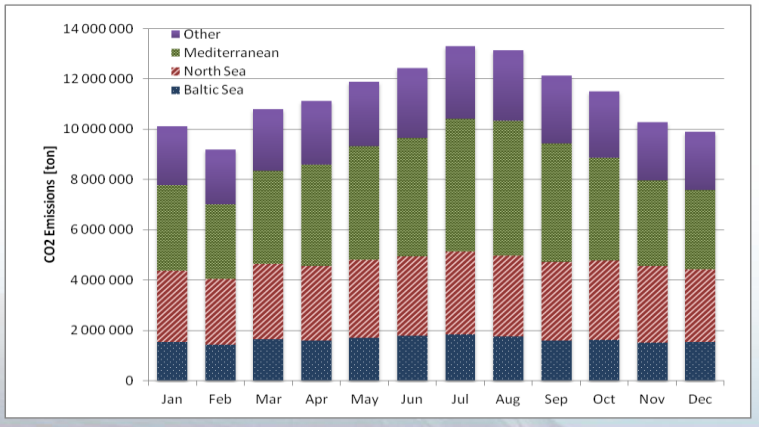
EMSA's Research/Studies - Example

Emissions Project 2012 - Results, CO_2 by EU Sea Areas



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EMSA's Research/Studies

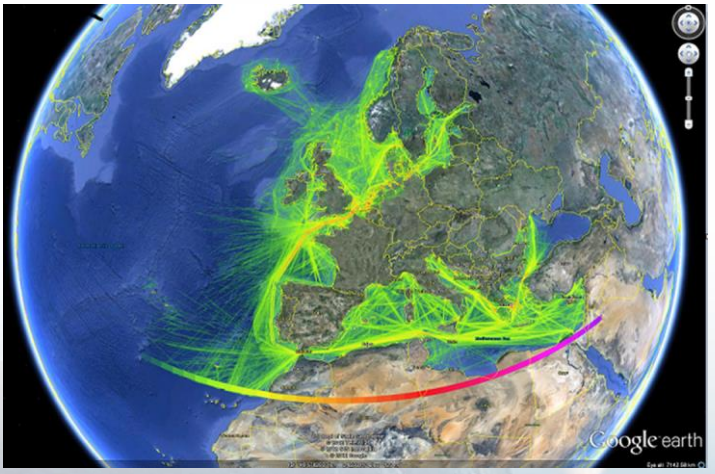

Illustration output of the whole SSN area CO2 emissions calculated by STEAM

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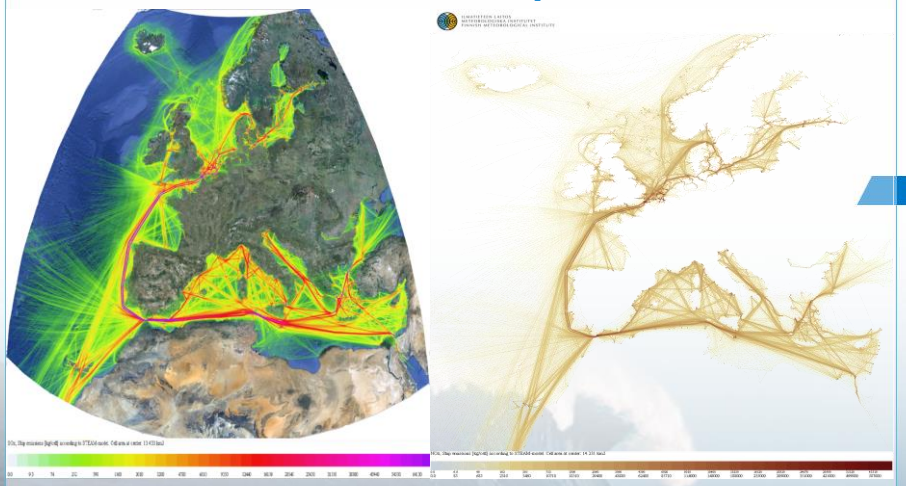
EMSA's Research/Studies



Illustrations output of the whole SSN area SOx and NOx emissions calculated by STEAM

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THANK YOU FOR YOUR ATTENTION

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