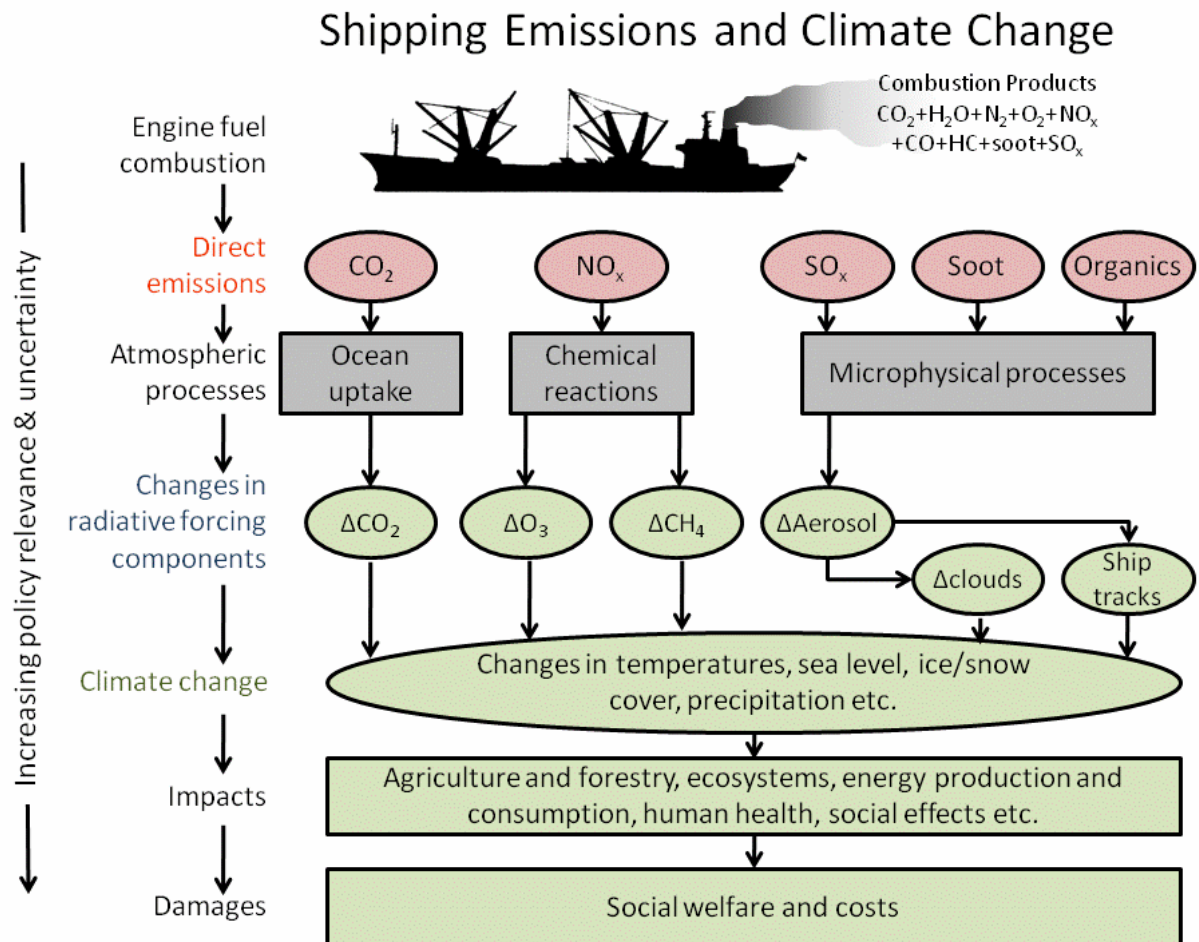


# Greenhouse Gases

## What are Greenhouse Gases?

Carbon dioxide (CO<sub>2</sub>) is the most significant GHG emitted by ships both in terms of quantity and of global warming potential. Other exhaust emissions from ships are in the atmosphere for only days. The life of CO<sub>2</sub> in the atmosphere can be in excess of 300 years and in terms on its effects on global temperatures it can be decades. Greenhouse gases such as CO<sub>2</sub> lead to positive radiative forcing and to long lasting global warming. Other exhaust gases are precursors to CO<sub>2</sub> and may contribute to impairment of the ecosystem including nitrogen nutrient loading, acidification, smog caused by NO<sub>x</sub> and VOC and ozone depletion.

## What are the effects?



## Health Considerations

There are few studies on the negative health effects of exhaust emissions from vessels and most data available has been based on comparisons with public health data and studies carried out in other fields.

- Particulate Matter (PM) and ozone-related human health impacts include premature mortality, chronic bronchitis, increased hospital admissions, acute respiratory symptoms. Particulate Matter may be either fine PM (2.5) or coarse PM (10) and whilst the coarse PM is

considered the most dangerous to the health of individuals, the World Health Organisation (WHO) does not identify any threshold that may be considered safe.

- Carcinogens are normally associated with volatile organic compounds that may be in fuel emissions particularly where combustion is poor which is more likely to be an issue with vessels' cargo. Evidence, however, is that ozone exposure contributes to cardiopulmonary-related mortality.

- It has been estimated that PM emissions from commercial ships could be linked to 60,000 premature deaths annually. In the application for an emissions control area (ECA) around USA and Canada it is estimated that currently ship emissions within the ECA account for 11,500 premature deaths, 12,000 hospital admissions and 580,000 days off work. The submission believes that the ECA would reduce the non-fatal health impacts by 78% and avoid between 3,400 – 7800 premature deaths in 2020.
- The Flag of Convenience system accepts that the flag a ship flies need have no genuine link to the owner of the vessel. This effectively allows owners of over 50% of vessels under FOCs to minimise taxes, reduce crew costs and generally escape responsibilities for crew and their own country of origin.
- Of the ten top trading nations only one (China) is classed a developing country, whereas, of the top ten ships registered by tonnage only one (Greece) is considered a developed country.

### Policy Options

- Technical and operational options include the introduction of the energy efficiency design index, EEDI and the energy efficiency operational index, EEOI. With the improvement of engines, hulls, propellers power systems and the use of solar power and wind assistance, the technical and operational options are favoured by the industry and may give between 25-75% efficiency improvements.
- If the climate is to be stabilized at no more than 2°C warming over pre-industrial levels and emissions from shipping continue as projected, they would constitute between 12-18% of the total global CO<sub>2</sub> emissions in 2050 with a chance of success at less than 50%.

### Market Solutions

- There are two primary market based instruments being considered by the IMO. They are a maritime emissions trading scheme (METS) and an International Compensation Fund (ICF). The difference in these options is the way in which revenue is raised; the ICF is raised by a fuel levy whereas the METS raises revenue by auctioning allowances.
- The alternative method being proposed by the EU requires capping emission levels and paying subsequent levies to the EU emission trading system.

### Application of Kyoto Protocol in Maritime Situation

- The Kyoto Protocol establishes the principle of 'common but differentiated responsibility' recognising differences in the contributions of developed countries and developing countries. The Flags of Convenience (FOC) system of the IMO and their basic principle of 'no more favourable treatment' is totally contrary to the Kyoto principle. Within the IMO many developing countries would wish to benefit from a market based solution, however, it would only lead to an increased exodus from national flags.

- It is obvious that within the FOC system the distribution of any fund such as the International Compensation Fund (ICF) to shipping, or any subsidy to developing countries based on flags ships are flying to shipping related industries, will only exacerbate what is already an inequitable system and would in effect be classified as 'carbon leakage'.
- There are approximately 1.2 million seafarers currently working in the world international fleet predominately from labour supply, developing countries. The FOC system deprives many of these seafarers of a fair wage and social provisions. This is generally a globalised, casualised workforce that may operate under almost any flag but are unlikely to directly benefit from any carbon trading or levy system.
- Given the major pressure on shipping and their crews to comply with ever-more stringent maritime environmental legislation, seafarers are extremely conscious of their responsibility to the environment. The unfortunate situation however is that the public and political perception of the shipping industry is not sympathetic when there is an accident and too often the seafarer is unfairly criminalised.

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The ITF Seafarers' Section is actively involved in addressing the issue of Greenhouse gases in a number of forums, including the International Maritime Organisation (IMO) and will be attending UNFCCC COP 15 in December 2009 as part of an ITF Delegation.

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# Shipping Emissions

## International Shipping

- Between 80-90% of world trade, by volume, is carried by sea.
- In 2007 the world fleet comprised of more than 100,000 ships over 100gt and the overall annual growth in tonne miles was an estimated 4.1%.
- Annual increase in shipping emissions is in the region of 1.9-2.7%, which is driven by the expected growth in trade transported by sea.
- On a tonne mile basis shipping is the most efficient form of transportation, however it must be remembered that ships may operate in ballast or not at their optimum speed for much of their journey. Trade is also invariably intermodal and cannot be considered in isolation from other parts of the chain.
- International shipping uses primarily, high sulphur, residual fuels that are the 'bottom of the barrel' in the refining process. These fuels also often contain a range of metals, chemicals, or other contaminants.

## Emissions from Shipping

- In 2007, shipping CO<sub>2</sub> emissions were estimated to be 1,046 million tonnes (3.3% of global emissions), of which international shipping accounted for 870 million tonnes (2.7% of global emissions).
- Exhaust gases are the primary source of emissions from ships, with nitrogen oxide (NO<sub>x</sub>), Sulphur Oxide (SO<sub>x</sub>) and particulate matter (PM) being the primary gases. There may also be volatile organic compounds (VOCs) in the exhausts.

## Effects of Emissions

- Air pollution from ships contributes to the impairment of various ecosystems including nitrogen nutrient loading, acidification, smog caused by NO<sub>x</sub> and other precursor gases, and changes in visibility.
- SO<sub>x</sub> and NO<sub>x</sub> emissions from ships are carried over land and they and their derivatives (including PM and sulphur and nitrogen containing compounds) are deposited on surface waters, soils and vegetation.
- Importantly, air pollution can contribute a significant portion of the sulphur and nitrogen loading that an ecosystem receives.
- Some areas are more sensitive than others and many have multiple stressors.
- Emissions have both positive and negative effects on global warming due to radiative forcing.

- Some ecosystems are sensitive especially to acidification due to sulphuric and nitric acids formed from SO<sub>x</sub> and NO<sub>x</sub>, whilst other ecosystems are particularly sensitive to excess nitrogen, which contributes to aquatic eutrophication that alters biogeochemical cycles and harms animal and plant life.

## Why Shipping is an Issue at COP 15

- One outcome of the Kyoto protocol in 1997 was that the responsibility for management of CO<sub>2</sub> emissions from shipping rests with the International Maritime Organisation (IMO), however, as with the International Civil Aviation Organisation (ICAO) this will come under review at COP 15 in December 2009.
- The European Union position is that, should the IMO fail to deliver tangible progress soon they will enforce the EU emissions trading system by 2012.
- There is increasing pressure by ports and coastal waters for ships to reduce emissions and regional restrictions may be applied before IMO regulation.

## RECENT IMO LEGISLATION

### *Future NO<sub>x</sub> Emission limits in MARPOL Annex VI*

The revised Annex VI introduces a stepped approach to the reduction of NO<sub>x</sub> emissions. The original emission limit from Annex VI is now referred to as "Tier I", while future emission limits, named "Tier II" and "Tier III", will be introduced in 2011 and 2016 respectively.

Fleet average emission factors depend on the composition of the fleet each year, which in turn depends on vessel lifetimes and the growth of the fleet. Growth of the fleet is also linked with reductions in speed; therefore speed reductions could have an indirect positive effect on NO<sub>x</sub> by accelerating the introduction of new ships and engines. Future emission factors for NO<sub>x</sub> are based on a scenario of growth of the fleet by 3% per year and an average ship lifetime of 30 years.

### *Future SO<sub>x</sub> Emission limits in MARPOL Annex VI*

Present Global limit 4.5% and Emission Control Areas 1.5%

01 July 2010	Emission Control Areas 1.0%
01 January 2012	Global limit 3.5%
01 January 2015	ECA limit 0.1%
01 January 2020*	Global limit 0.5%

\*Note. This may be postponed to 2025, subject to review in 2018

Particulate Matter (PM), otherwise known as ash, is significantly reduced in a ship when the sulphur content of fuel is < 1% (distillate)

## Policy options

A number of policies to reduce GHG emissions from ships are conceivable. Studies have set out to identify a comprehensive overview of options. The options that are relevant to the current IMO debate have been analysed in detail. These options are:

- A mandatory limit on the Energy Efficiency Design Index (EEDI) for new ships;
- Mandatory or voluntary reporting of the Energy Efficiency Operational Indicator (EEOI);
- Mandatory or voluntary use of a Ship Efficiency Management Plan (SEMP);
- Mandatory limits on the EEOI value, combined with a penalty for non-compliance;
- A Maritime Emissions Trading Scheme (METS);
- An International Compensation Fund (ICF), financed by a levy on bunkers.

The IMO has agreed to the formula for the technical and operational EEOI and EEDI but has not made progress on Market Based measures before COP 15. Dependent on the outcome of COP 15 the IMO will give the market based measures consideration in 2010.

## Coastal Action

- The IMO have currently adopted two sulphur emission control areas (SECAs) in the North Sea and the Baltic Sea and is currently considering an ECA around the USA and Canada extending for 200 miles from their coast line.
- 'Cold Ironing' is the practice of shutting down the ships' own power in ports and the use of shore side power. This is a complex matter and not easy to provide for or harmonise for all shipping systems. This also may be a false measure to reduce emissions where shore power stations are coal fired.

## Other Operational and Technical Solutions

- There are continued improvements in engine performance both in reducing emissions, particularly NOx, and increasing overall efficiency; however, there are various engine types and configurations so it is extremely important to match optimum efficiency with the normal operating speed of the vessel.
- The primary operational consideration is voyage optimisation including weather routing, just in time arrival, optimum ballast and trim.
- Technical design can include, engine recycle systems, hull design, hull resistance, propeller design and resistance, wind assisted, solar power etc.
- It is considered that by 2040 there could be 59% efficiency improvement.

## Abatement systems

- The new legislation allows the use of abatement systems as an alternative method to reduce exhaust emissions from ships using high sulphur residual fuels despite the fact these systems are to date unproven. Sea water scrubbing of the exhaust will undoubtedly be the preferred by the oil industry as ultimately it saves the refineries from investment into upgrades and allows them to continue selling residual fuels. Scrubber systems unfortunately have been estimated to increase the ships workload by 70%. There is also the problem of disposing of acidic sludge ashore and controlling the quality of the waste seawater discharge overboard within limits.
- Urea based catalytic converters are increasingly used to reduce the NOx emission but are not suited to all ships.

## Availability of low sulphur fuels

- In a catch 22 situation the oil industry will not invest in updated refineries producing low sulphur fuels until the demand is certain and even then there is at least a six year lead in period. The new Marpol Annex VI legislation allows for the availability of fuels to be reviewed in 2018 and if they are not available in sufficient quantity the implementation may be deferred to 2025.
- Carbon capture, particularly to dry wells, is much more feasible at the refinery than any current system on ships but unfortunately there is little indication that refineries are taking any measures to introduce this technology.

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