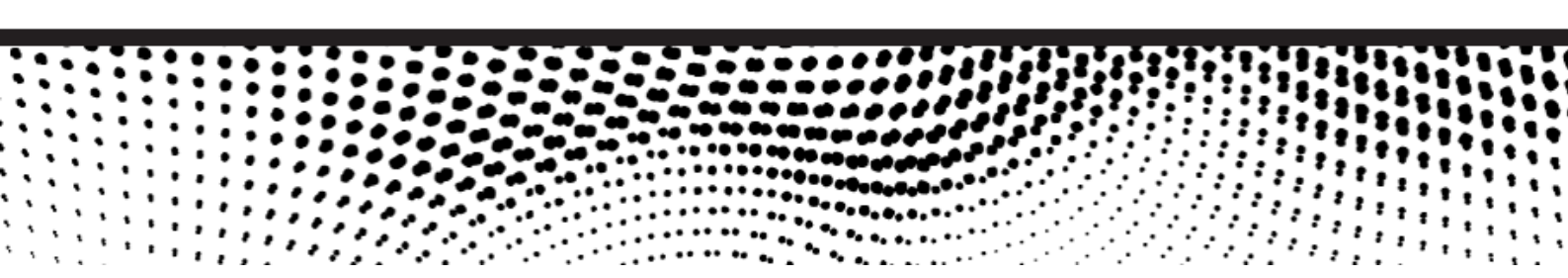


SOOT FREE FOR THE
CLIMATE

Background paper

Soot emissions from cruise ships





The "Soot-Free for the Climate" campaign is jointly organised by the major German environmental and consumer associations, the Bund für Umwelt und Naturschutz Deutschland (BUND - Association for the Environment and Nature Conservation Germany), the Naturschutzbund Deutschland (NABU – Nature and Biodiversity Conservation Union Germany), the Verkehrsclub Deutschland (VCD – Transport Federation) and the Deutsche Umwelthilfe (DUH – German Environmental Aid Association).

The campaign aims to raise awareness among policymakers, the administration and the public about the negative effects of diesel soot emissions on the climate. It calls for measures which can effect a clear reduction in soot emissions. A reduction in soot (black carbon) not only directly benefits climate protection but also human health.

For more information see: www.sootfreeclimate.org



Deutsche Umwelthilfe



VCD
Verkehrsclub
Deutschland

Background paper: (soot) emissions from cruise ships

On the outside, the “dream ships” from AIDA, TUI Cruises and others like to present themselves their shiny white side, but behind the scenes it really stinks! Cruise ships are powered with heavy fuel oil, a waste product from the oil industry which severely harms the environment and our health. Soot particle filters like the ones for diesel-powered passenger cars or trucks can not be found in cruise ships. However, cruise ships have a special responsibility with regard to the environment: unlike containers ships, they transport people, anchor in city centres, and an unspoiled nature is the main asset of a holiday dream. Clean water, white glaciers in the Arctic or pure air in Norwegian fjords - this is what the holidaymaker expects on a cruise. Yet, at the present time, the “dream boats”, in particular, contribute greatly towards placing this in danger.

1. The cruise market: a constantly growing sector at a glance

Despite the economic and financial crisis the cruise sector, in particular the German market, has been experiencing a constant growth of at least two-digit percentages in the last years,. In 2010, almost 18.8 million passengers were on an oceanic cruise worldwide. The US corporation *Carnival Cruises* is the market leader in the global cruise business, followed by *Royal Caribbean Cruise Lines* (also from the US), the Italian *Mediterranean Shipping Company* (MSC) and *Norwegian Cruise Lines*. The Carnival Group alone has 25 subsidiaries worldwide, bringing together a fleet of almost 100 cruise ships in total. The Carnival Group includes, among others, the popular German market leader *AIDA Cruises* (with presently nine ships) as well as the *Holland America Line*, *Costa Cruises* and *Princess Cruises*.

On an international level, cruise companies have come together in umbrella organisations: In Europe, the *European Cruise Council* operates from Brussels and the *Cruise Lines International Association* was established as an international lobby organisation in North America.

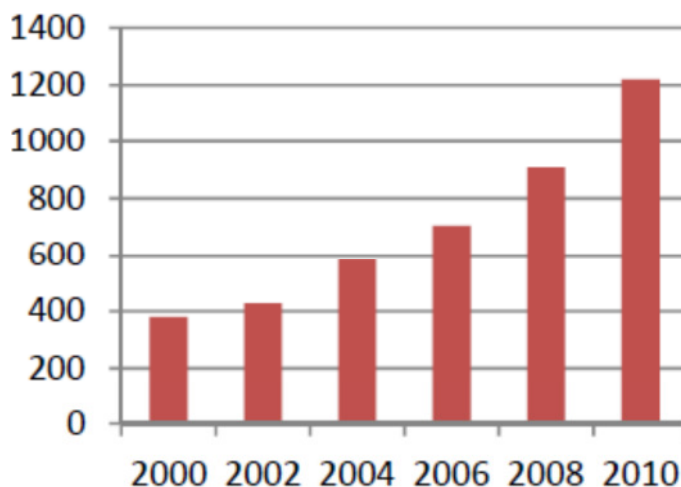


Fig. 1: Increase in German passenger numbers on the German cruise market in thousands (source NABU, graph based on European Cruise Council 2010/2011 Report)

AIDA holds (according to company information) a market share of 37 percent and is thus the German market leader. Since 2007, the fleet has been increased by one ship annually. Three more ships are planned or under construction at present. The German TUI Cruises is one of the new entrants on the market, sending two ships to the ocean so far ("Mein Schiff 1" and "Mein Schiff 2"). Almost 2,000 people can travel on each of the identical ships; in the year 2014, a new ship will provide even 2,500 beds. Hapag-Lloyd is also extending its cruise offers on the German market since some time, the popular *MS Europa* also belongs to its fleet.

Following North America (USA and Canada) and the UK, Germany is the third largest market for cruises. Almost one-tenth of all passengers came from Germany in 2010. According to a sectorial analysis made by the German Travel Association (DRV), this is an increase of 18.9 percent compared to the previous year. From 2008 to 2009, the number of passengers had already risen by 10 percent. The Seatrade Europe Cruise & Rivercruise Convention forecast a plus of 23 percent for Europe in 2011. This means that no other tourism sector is currently growing so strongly. The Rostock-based AIDA shipping company obtained a plus in sales amounting to 160 million euro and an increase in the volume of passengers of almost 100,000 persons in 2010. The German sector expects two million cruise passengers by 2018, who will travel the oceans from Germany.

In addition to the shipping companies, in particular major German port cities, such as Hamburg, Rostock, Kiel and Lübeck profit economically from this above-average growth not only through the port fees but because of the thousands of visitors to the cities, too. In 2006, for instance, about 60 cruisers landed in Hamburg, in 2010 this figure had more than doubled - Thereby the passenger volume in Hamburg has doubled, from nearly 127,000 in 2009 to almost 246,000 in 2010.

2. The ships

The size of a cruise ship can vary considerably. The Queen Mary 2, for instance, one of the most popular cruise liners worldwide, which is able to accommodate 2,600 passengers, would have exceeded the height of the Titanic by almost hundred metres, and an Airbus A 380, the currently biggest passenger airplane, appears small by comparison (see figure 2).

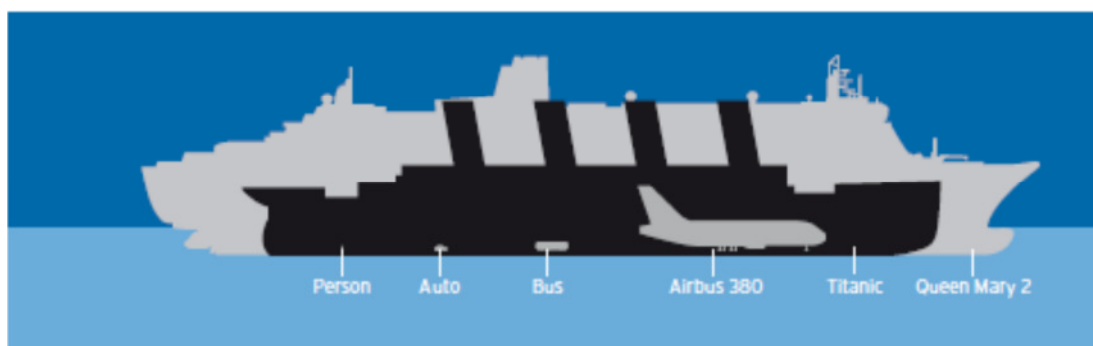
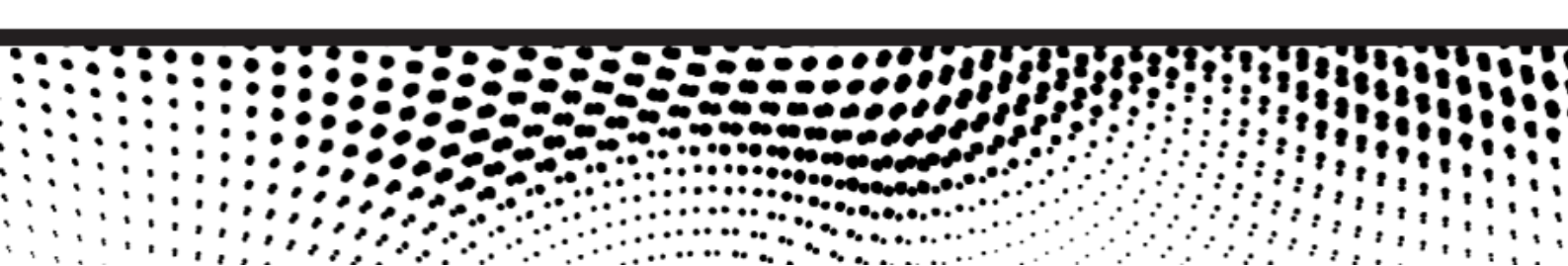


Fig. 2:
Comparison of
different
transportation
means (source
NABU)

The biggest cruise liner in the world set to sea in December 2010: The Allure of the Seas has a length of 360 metres, a width of 60,50 metres and is able to accommodate 6.296 passengers and more than 2.165 crew members. By way of comparison: The Queen Mary 2, once the biggest ship, "only" measures 345 metres in length and 41 metres in width, and it can carry a "mere" 2.600 passengers.



The cruise liners of major shipping companies are more or less swimming hotels and sometimes almost resemble small towns. The operation of these ships requires enormous amounts of energy because their facilities need constant electrical supply; in addition to their ship technology (engines, radar, etc.) there are lifts, lighting, air conditioning, spa, swimming and sports facilities, restaurants and other entertainment facilities such as cinemas, theatres, ballrooms and casinos, and on some ships even an ice rink and a golf course. The Oasis of the Seas, for example, needs an uninterrupted power supply of 2,000 kVA and an overall power supply of 97,000 kW. In most cases, the energy supply is provided by the cruise liners' engines which can be powered by residual oil, marine diesel or gas. In total, the global fleet is currently made up of approx. 550 cruise liners, but worldwide several ships are being planned or are under construction.

3. Ship emissions

As “floating small towns”, cruise ships have a large ecological footprint. The ship engines largely contribute considerably to global and local emissions of sulphur oxide (SO_x), nitrogen oxide (NO_x) and particulate matter (PM). The latter includes soot emissions (black carbon) which are, in particular, harmful to climate and health. Therefore, they need to be strictly controlled, as is the case ashore, for example, where fixed permissible values exist for traffic. However, deep sea vessels have remained insufficiently regulated for too long, especially compared with passenger cars and trucks. At the same time they cause more pollutant emissions harming health and climate than cars, trucks, locomotives and construction machines altogether. In particular, ocean liners are responsible for a large and even increasing part of global pollutant emissions.

Due to the fuels used, ships are among the most dirty emission sources. On the high seas, residual oils are used almost exclusively, a residual refinery product which contains high amounts of sulphur, ashes, heavy metals and other toxic residues and sediments. On land, this heavy fuel oil (HFO or bunker oil) would have to be disposed of in a costly manner as hazardous waste or processed. It would destroy every engine operated on land, and it would not be allowed to be used as fuel anyway, because of its high level of contamination and toxic combustion residues.

In addition, most ship emissions occur in the immediate vicinity of the coast, from where they are carried far into the land¹. On a global level, two thirds of all ship emissions are produced within a 400 km radius from the coast. In the North Sea, even up to 90 percent of ship emissions are emitted within 90 km of the coast, and are thus particularly dangerous for people and nature². In this context, scientists from the Danish Centre for Energy, Environment and Health (CEEH) found that, in Europe, ship emissions alone are responsible for up to 50,000 premature deaths every year³. Currently, there are no comprehensive, precise emission data available with respect to cruiseships. This results, on the one hand, from the heterogeneity of the cruiser fleet and, on the other hand, from the refusal of many cruise companies to provide a detailed emission balance for their own fleet.⁴

The specific pollutant emissions of each ship depends on numerous technical, operational and environmental factors, such as size and number of engines, exhaust gas treatment, fuel and lubricant used, velocity, etc. If the forecasts of UN's International Maritime Organization (IMO) come true, shipping, including the booming international cruise tourism with its ever larger ships, will continue to cause ever more emissions which are harmful to the climate and health. This means that ship owners, port operators and politicians must take urgent action in order to prevent this.

a. Emissions of sulphur oxide and nitrogen oxide

Emissions of sulphur oxide respectively sulphur dioxide (SO_x and/or SO_2) are toxic gases which are harmful to plant vegetation and human health. Because they form sulphate aerosols (fine air particles), SO_x emissions are co-responsible for increased mortality rates, among other things, in the coastal areas of North America and Europe. In addition, concentrated SO_x emissions cause acid rain. The acidification of soils is attributed, among other things, to high concentrations of nitrogen oxide (NO_x). What is more, they have a considerable eutrophying effect on lakes, soils and coastal areas (river mouths)⁵.

The amount of sulphur oxide emissions depends on the sulphur content in the fuels used. The largest component is sulphur dioxide at approx. 95 percent. Nitrogen oxide occurs during fuel combustion in the engine. If the combustion time and combustion temperature increase, NO_x -emissions also rise. Currently, the sulphur content in the fuel can vary between a maximum of 3.5 percent (fuel oil) and approx. 0.1 percent (so-called marine diesel oil). By way of comparison: since January 2009, the maximum sulphur content permitted in the EU for regular diesel fuels for passenger cars and trucks has been limited to 0,001 percent only. This means that the sulphur content in marine fuels exceeds that of land fuels by up to 4.500 times, and on average by 3.000 times.

In the year 2000, ships emitted approx. 2,3 million tonnes of sulphur oxide and 3,3 million tonnes of nitrogen oxide around Europe⁶. If the currently valid emission regulations remain unchanged, emissions of sulphur dioxide will increase by approx. 40 to 50 percent by 2020. The International Maritime Organisation of the UNO (IMO) forecasts an increase of all three pollutants (SO_x , NO_x and PM) by up to 72 percent by the year 2020, if no effective measures are taken immediately.⁷ This would mean that in 2020, sulphur dioxide emissions from European shipping traffic would be comparable to or higher than those of all mobile, stationary and other emission sources on land together (see figure 3). In this case, shipping would destroy the considerable successes achieved on land with respect to passenger cars, trucks and locomotives.

SO_x -Emissionen

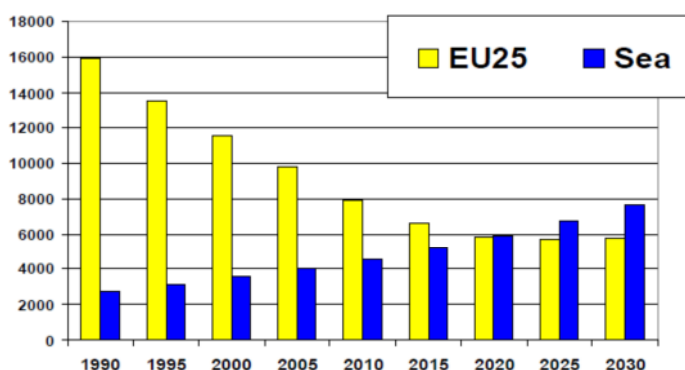
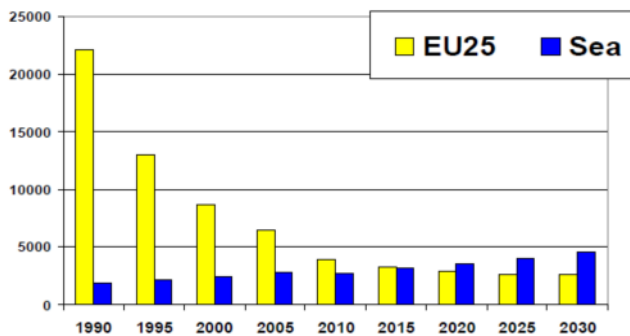


Fig. 3: Comparison of SO_x and NO_x emission developments in the 25 EU states (land-based emission sources) and European shipping traffic between 1990 and 2030 under the currently valid regulations (source: IASA 2004 und EMEP 2007)

NO_x-Emissionen



b. Soot emissions

The combustion of fossil fuels (oil or diesel) for ship engines and the energy generation on board produces soot particles which are harmful to climate and health. They belong to particulate matter (PM). Depending on the size of the particles, emissions are classified as PM₁₀ or PM_{2.5}. Studies show that particulate emissions are related to the sulphur content of the fuel used. Soot emissions which take place in Arctic regions and/or are transported there with the wind have a particularly harmful effect on the climate. Since the black particulates are deposited directly on the white ice and snow surfaces, the sun reflection (albedo) of the ice is reduced. In addition, the black particulates warm up. Both effects together cause an increase in temperature and accelerate the melting of the Arctic ice. Against this backdrop, cruise ships in (Ant)Arctic regions (so-called polar cruises) without any soot reduction system on board pose a particular ecological risk.

Studies also investigated the harmful effect of soot particulate on health, and found that the ultrafine and respirable particles may trigger heart and lung diseases, chronic bronchitis as well as asthmatic diseases. In particular, soot particulates are responsible for thousands of premature deaths, as mentioned above, especially in coastal and port regions. Indeed Emission Control Areas (ECAs), (see below) have been established, in which emissions must be limited, but ship emissions outside these areas amount to 50 to 90 percent of local emissions of sulphur oxide, nitrogen oxide and soot⁸. According to a study, all ships in the EU ports caused 21,000⁹ tonnes of soot emissions in the year 2000. In the same year, merchant vessels which operated in the areas around Europe (Baltic States, North Sea, North East Atlantic, as well as the Mediterranean Sea and the Black Sea) were responsible for a total of 250,000 tonnes of soot particulate emissions. Worldwide, shipping traffic caused 1.67 million tonnes of soot emissions in the year 2000¹⁰.

4. Measures for the reduction of soot and sulphur oxide

Emission reductions for ships can be achieved in the short and medium term by means of numerous technical and political measures. A mix of both would be an optimum approach, i.e. to promote technological developments and create political motivation for ecological shipping traffic. The simplest measure causing an immediate effect, is the use of low-sulphur fuels. This would reduce both sulphur oxide and heavy metal emissions (above all lead and tin) without any technical conversions. This measure can be either decided politically or taken voluntarily by ship owners.



a. Political framework conditions: UNO and EU

The International Maritime Organisation (IMO) of the United Nations, which Germany is a member of, sets the international framework for the regulation of pollutant reductions in shipping traffic at high sea. Its International Convention for the Prevention of Pollution from Ships (the so-called MARPOL Protocol) defines in Annex VI the permissible values regarding sulphur and nitrogen oxides, and bans the deliberate emission of substances harmful to the ozone layer¹¹. From 2012 onwards, Annex VI specifies a maximum value of 3,5 percent sulphur content in fuels. On a global average, the sulphur content in fuels is approx. 2,7 percent at the present time. The maximum limit will only be reduced to 0,5 percent from 2020 onwards - and this hesitant regulation is, among other things, a consequence of the fierce opposition from the shipping sector. Germany has already transposed the IMO limit values into national law by means of MARPOL-ZuwV. However, some sectors have been trying to achieve a delay in the transposition into EU law until 2025.

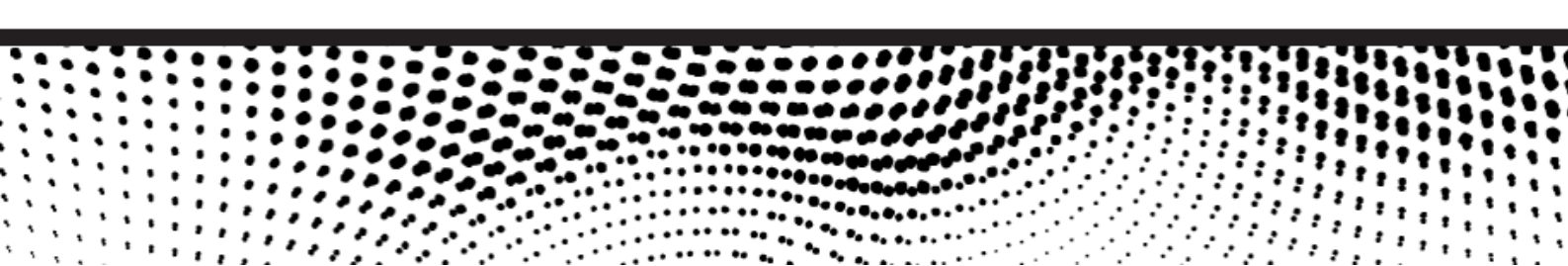
The IMO can work towards a reduction in particulate matters (PM) and emissions of sulphur dioxide and nitrogen dioxide by establishing so-called Emission Control Areas (ECAs). In these specified areas, stricter regulations apply: the North Sea and the Baltic Sea are ECAs (for sulphur emissions) and the permissible maximum value for sulphur content in fuels has been established at 1.0 percent there since January 2010. In addition, the USA and Canada together successfully applied to the IMO for the designation of the west and east coasts of both countries as ECAs in May 2010, which will come into force in August 2012. From 2015 onwards, the permissible value in the ECAs will again be reduced to 0.1 percent¹². Germany has already transposed this regulation into national law.

There have been no dedicated ECAs so far for soot and nitrogen oxide emissions. According to the IMO, the reduction in nitrogen oxides is regulated by the installation of so-called Tier I-III engines which must be installed in all ships built from January 2016 onwards. This will reduce NO_x emissions to 3,4 g/kWh at an engine output of less than 130 revolutions per minute, compared to 17,0 g/kWh for Tier I engines (ships built between January 1st, 2000 and January 1st, 2011) and 14,4 g/kWh for Tier II engines (built between January 1st, 2011 and January 1st, 2016).

A relevant EU directive with respect to ports and/or docking times is 1999/32/EC "regarding the sulphur content of marine fuels" from 2005. It has bindingly established the use of fuels with a maximum sulphur content of 0.1 percent during docking times since 1 January 2010. The directive has been revised since summer 2011 and is to be adapted to the permissible sulphur values of Annex VI of the MARPPOL Protocol with respect to ECAs and at sea. This is a good opportunity to establish ambitious permissible values early on, whereas some industries try to use the amendment of the directive to achieve postponements and exceptions.

b. Technical measures

The use of low sulphur fuels is the simplest and quickest measure to reduce the emissions of sulphur oxides and heavy metals (mainly lead and tin). Ship owners are supposed to use fuel with a maximum sulphur content of 0.1 percent in the vicinity of coasts and ports and in regions which are particularly ecologically sensitive, such as the Arctic. Although this leads to a reduction in sulphur also leads to a measurable reduction in particulate matters (PM), soot emissions are not sufficiently reduced by that. A soot particulate filter, which is already obligatory for new passenger cars, could also be used for ships when fuel with a maximum sulphur content of 0.5 percent is used, thus reducing soot emissions



almost completely. Currently, subsidy projects for the retrofitting of inland vessels with particulate filters have been carried out successfully in some cases¹³. Cruise liners operate without any filters so far, although the possibility of retrofitting exists, especially for new ships. The major German ship operators have not signalled any preparedness for action in this respect so far, although shipping companies have a special responsibility to protect the health of their passengers and the environment.

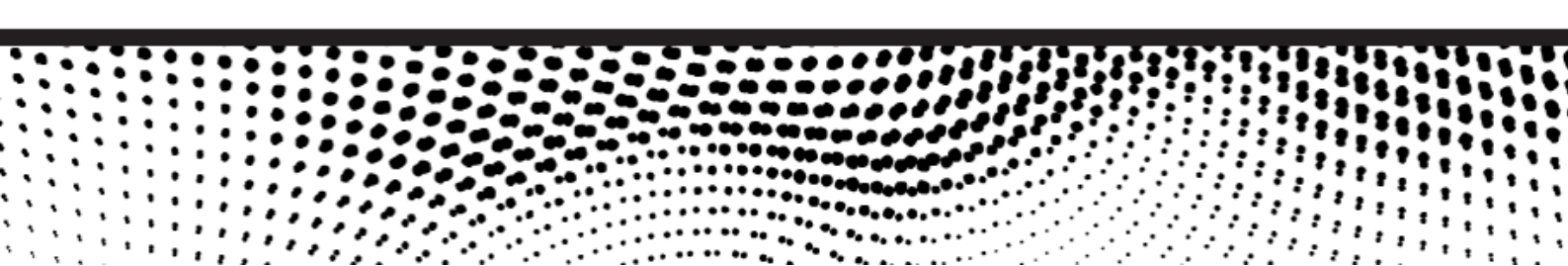
A further technical measure is the so-called seawater scrubbing. The ship's exhaust gases are washed with seawater in a subsequent treatment process and thus cleaned from harmful particles and residues. Depending on the system and the fuel used, the sulphur emissions can be reduced by 70 to 95 percent. Almost all scrubbing systems also reduce PM emissions. This procedure has, however, the disadvantage that the extremely dirty water is often drained into the sea with the residues unfiltered, or that a dry granulate that binds the sulphur must be disposed of on land.

c. Infrastructural measures

During their docking times in ports, cruise ships also cause lots of emissions, because the engines keep on running in the port to provide energy supply on board. There are various technical solutions and emission-free alternatives to the use of oil in ports, which are currently being discussed or have already been implemented. The power supply from land ("cold ironing") is one possibility to provide cruise ships with electricity at berth. The cruise ships must then be connected to a kind of "socket" at the marine terminal (on land). However, depending on their construction type, cruise ships need different electrical voltage. An IMO working group is currently working on an (international) standardisation of shore-side power connections and board-side installations, however without results so far. From the technical point of view, a standardisation poses no problem, rather it can be assumed that political disagreements have prevented a regulation so far.

There are some positive examples on a regional level. The USA, for example, has taken a pioneer role as far as shore-side power supply is concerned. Along the US West Coast an increasing number of seaports is offering a standardised shore-side supply. This means that many cruise ships can shut off their engines during docking time in the major ports. In Europe, opposition against the installation of shore-side power supply is still strong. The main argument of the shipping companies is that, without any standardisation, the expensive and often subsequent installation of a power connection on board is uncertain and therefore not profitable. Another controversial issue is the question of who bears the shore-side costs for the provision of infrastructure - the ship owners, the city, the grid operator or the port operator? A further problem, which could be solved however, is that a single cruise ship needs as much power as a small town. This means that the shore-side supply facilities must provide an enormous quantity of constant power which, on the other hand, has to be generated from renewable energies in order to bring about real environmental relief. In addition to the port of Gothenborg, which operates cold ironing at four terminals without any technical problems since 2005, the ports of Rotterdam and Antwerp, among others, provide shore-side power supply. In 2011, the first connection for a ferryboat was put into operation in Oslo.

A further possibility to reduce ship emissions during docking times in ports, is a shore-side gas supply. From the technical point of view, this type of energy supply is also not fully mature, compared to shore-side electrical power, however, the technical infrastructure is simpler. Nevertheless, only few ships possess a gas or so-called LNG (Liquid Natural Gas) engine, and a subsequent retrofitting is often expensive or technically not feasible, which is particularly the case with existing cruise ships.



Indeed the use of LNG promises a comparably emission-free ship operation (no sulphur or soot emissions, 25 percent less CO₂ and 86 percent less NO_x), but this technology is not yet fully mature. An issue to be solved is the “methane slip”: If methane escapes from the LNG tank, this has a considerable impact on the climate, since methane is 21 to 25 times more harmful to the climate than CO₂. LNG technology has been tested successfully in numerous research and pilot projects, but market maturity cannot be expected before the year 2015. That means that cruise ships that are built in the coming four years will probably not yet be operated with LNG.

d. Voluntary measures taken by ports and ship owners

Each port authority is free to take further local soot reduction measures that go beyond the measures decreed, such as the collection of so-called ecological port fees. This means that incoming (cruise) ships must pay different amounts of port fees in line with their respective emission balance. In order to prevent a distortion of competition between those ports charging ecological port fees and those not, ports should coordinate with one another and agree on comparable fee arrangements. In Germany, some port operators prefer ecological port fees to motivate ship operators to invest more quickly in clean technologies.

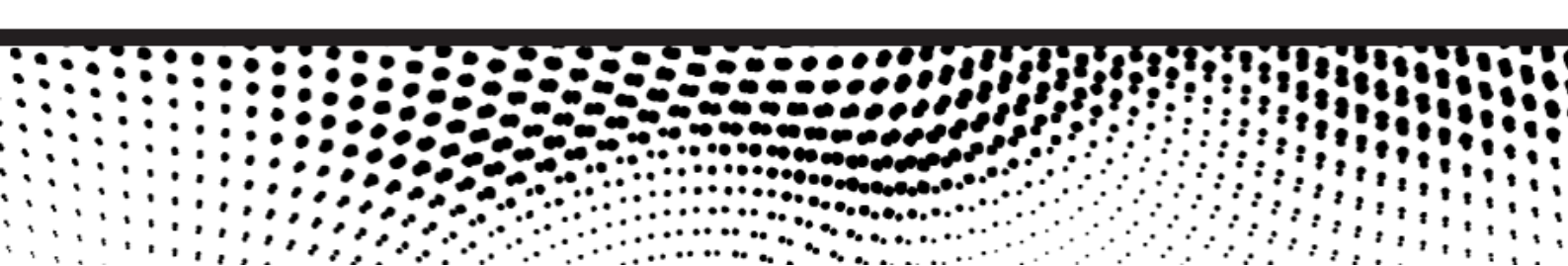
Furthermore, some European ports have joined in an initiative for the development of an “Environmental Ship Index” (ESI), among others Bremen/ Bremerhaven, Hamburg, Amsterdam, Rotterdam and Oslo. This index is to be a transparent tool to document environmental impacts of ships and to identify ships that are particularly environmentally friendly. All ships will be certified with a point value of 0 to 310, and the value rises the more environmentally friendly the ship is. The ESI has been used since the beginning of 2011 and now includes 518 ships.¹⁴

e. Further measures

For some time now, a reduction in the travelling speed has been discussed as the most simple measure to minimise ship emissions (slow steaming). This measure can, in particular, reduce CO₂ and sulphur emissions, but also soot emissions. Some shipping companies have slowed down the speed of their ships on long distances during the last months due to the economic crisis, however, mostly for cost reasons. Whether this slowdown will continue remains unclear. But one thing is certain: if ship owners reduce the speed of their ships on a permanent basis, but operate additional ships to maintain their transportation capacities, the ecological effect will be annulled.

f. The USA, Canada and Rotterdam as models

The ECA in the USA and Canada, successfully applied for in May 2010, is expected to reduce the emissions of SO_x, NO_x and PM from deep sea vessels. The protected waters applied for include the Pacific, Atlantic and Gulf Coasts as well as the eight main islands of Hawaii, and extend to an area of 300 km off the coast line. Nevertheless, the especially sensitive Arctic areas of Canada and the USA are both not included. According to estimates by the US American environment authority, the establishment of ECAs will reduce NO_x emissions by 320,000 tonnes annually (-23 percent), PM_{2.5} emissions by 90,000 tonnes annually (-74 percent) and SO_x emissions by 920,000 tonnes annually (-86 percent) by 2020.¹⁵ This reduction in pollutants is expected to diminish the estimated number of 14,000 premature deaths, and respiratory diseases and symptoms of almost 5 million people are expected to be alleviated.¹⁶ In addition, there are numerous ports along the North American West



Coast, like the Californian ports for instance, which provide or advise shore-side supply of energy now during docking times. A regional ECA was established there some time ago, where a maximum sulphur content in marine fuels of 0.5 percent is allowed. Since the port of Los Angeles is the major port of call for cruise ships on the North American West Coast, this is of great importance.

Further positive examples of soot reduction measures in ports can be seen in Gothenborg, Rotterdam and Antwerp. The Rotterdam port authority has equipped all inland vessel berths with shore-side power supply and promotes the use of this shore-side supply during docking times. A corresponding offer for deep sea vessels is being investigated. In May 2009, the Antwerp port started a pilot project for the shore-side power supply of container ships which had not been able to dock on to the existing shore-side power supply installations before.

5. Demands of the “sootfree for the climate” - campaign

In view of the growth in the cruise sector and the corresponding increase of soot, sulphur oxide and nitrogen oxide emissions, the “MIR STINKT'S! Kreuzfahrtschiffe sauber machen!” [It stinks! Clean up cruise ships] campaign demands that politicians, industry and port operators take effective climate and health protection measures to reduce emissions from cruise ships comparable to those of transportation on land.

In detail, the campaign demands that....

- shipping companies voluntarily oblige themselves to use only better-quality fuels with a sulphur content of maximum 0,5 percent, even though 3,5 percent fuel is allowed.
- cruise companies voluntarily oblige themselves to use fuel with a maximum sulphur content of 0.1 percent close to the coast and ports as well as in the Arctic.
- cruise line operators install treatment facilities for exhaust gases in their ships, for example soot particulate filters, to protect the health of people on board and on land.
- all coastal and port areas of the EU be established as SECAs. No fuel with a sulphur content of more than 0.1 percent should be allowed there.
- ambitious, ecological port fees be introduced in all European ports, applying a uniform staggering system.
- limit values for particulate matter (PM) and soot emissions be included in all conventions and regulations agreed upon by IMO and the EU regarding pollutant reductions in shipping traffic.
- IMO establishes the Arctic regions as SECAs with a maximum permissible sulphur content of 0.1 percent.
- the international standardisation of shore-side power infrastructure be promoted.
- shipping traffic be integrated in the EU emission trade system.

6. Contact persons among the German campaign members

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(As of May 2012)

¹ See also the study by Hassellöv (2009): *Die Umweltauswirkungen des Schiffsverkehrs (the environmental impact of shipping)*, available online at: http://www2.michael-cramer.de/uploads/die_umweltauswirkungen_des_schiffsverkehrs.pdf, as well as by the EU Commission (2001): *The Influence of shipping traffic emissions on the air concentrations of particulate matter*

² See, among others, Corbett, J.J. et al. (1999): *Global Nitrogen and Sulphur Emissions Inventories for Oceangoing Ship*, as well as IMO (2000): *Study of Greenhouse Gas Emissions from Ships*, available online at: http://unfccc.int/files/methods_and_science/emissions_from_intl_transport/application/pdf/imoghqmain.pdf and http://www.transportenvironment.org/Publications/prep_hand_out/lid:354

³ Brandt, J. et al. (2011): *Assessment of health-cost externalities of air pollution at the national level using the EVA model system*. Centre for Energy, Environment and Health (CEEH) scientific Report No. 3. www.ceeh.dk

⁴ The NABU sent a corresponding enquiry to nine cruise companies operating on the German market in spring 2011. Only one company gave feedback with respect to the request to provide detailed information about fuel consumption and emission inventory, simply indicating that valid permissible limits and regulations are adhered to.

⁵ See the EMEP Report 2002: *Transboundary Acidification, Eutrophication and Ground Level Ozone in Europe*, available online at: <http://www.emep.int/UniDoc/node7.html#SECTION00712000000000000000>

⁶ See Hassellöv 2009 (footnote 1)

⁷ German Bundestag (2007): *Antrag Klima- und umweltpolitische Herausforderungen in der Hochseeschifffahrt (application for climate and environmental challenges in the deep sea shipping (printed matter 16/6790))*

⁸ See footnotes 1 and 2

⁹ See Hassellöv 2009 (footnote 1)

¹⁰ See Hassellöv 2009 (footnote 1)

¹¹ See <http://www.imo.org/About/Conventions/ListOfConventions/Pages/International-Convention-for-the-Prevention-of-Pollution-from-Ships-%28MARPOL%29.aspx>

¹² <http://www.imo.org/Environment/mainframe.asp?topic id=233>

¹³ See background paper on waterway inland vessels for the "Soot-free for the climate" campaign

¹⁴ <http://esi.wpci.nl/Public/Home>

¹⁵ See information provided by EPA under <http://www.epa.gov/nonroad/marine/ci/420f10015.htm>

¹⁶ See information by EPA under <http://www.epa.gov/nonroad/marine/ci/420f10015.htm>