



Facts on CRUISE SHIPS & EMISSIONS

CruiseBaltic 

Introduction

During recent years, cruising has quite frequently been in the media. Unfortunately, rarely portrayed positively.

The media has relatively uncritically published press releases received from various environmental organisations and NGOs.

When reading the most unreasonable articles in the media, we in Cruise Baltic, have attempted to write posts and letters to editors hoping for a more nuanced debate. However, we have come to the realisation that facts and valid data seems to be playing a much less significant role today compared to the many myths we see in the media. This is a new reality for us, which is to be welcomed, if the debate is based on a solid factual foundation. Unfortunately, this is, in our opinion, not currently the case.

Due to the above, we have prepared this material in a humble attempt to nuance the debate on air pollution and cruise ships. We have tried to be as objective as possible. I do

apologise if it sometimes gets a bit technical, however, the objective is to explain a complicated topic in a language everyone understands.

The purpose of sending this material to Cruise Baltic's partners, is to extend knowledge and facts on the actual circumstances surrounding cruise ship emission, so that when you come face to face with over-simplistic ideas, opinions and statements, you will hopefully be in a better position to nuance the debate. In other words, we wish to deliver some "ammunition" to you, so the debate on cruise ship emission can be based on a much more factual foundation.

I hope that this material is useful and that you can put the information here to good use.

Happy reading,
The Cruise Baltic team



Table of contents

1.

What are the operational phases of a ship engine?

2.

Which harmful pollutants from cruise ships are we dealing with?

3.

What is stated in the legislation?

4.

What else are cruise lines doing to minimise air pollution?

5.

What do the air pollution measurements show?

6.

Is it possible to compare pollution from cruise ships with that of cars?

7.

Conclusion

8.

References





1

What are the
operational
phases of a ship
engine?

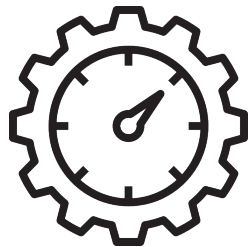
1. What are the operational phases of a ship engine?

To understand air pollution from ships, it is important to look at how an engine in a cruise ship works. This is a bit technical, so please bear with us.

When it comes to pollution, there are four different operational phases of a cruise ship:

Maximum speed at sea

In fact, a cruise ship very rarely sails at full speed. This is primarily done in emergencies. The reason for this, is that sailing at slower speeds means using much less fuel which is a highly important parameter for any cruise ship.



Optimal speed at sea

The word “optimal” refers to the speed which optimises both speed and use of fuel. All vessels will always sail as economically as possible. When the ship is at sea, its speed and the operational circumstances in the engine is close to being at a constant. A modern cruise ship, with correctly adjusted engines, have a white or light grey smoke coming from the exhaust pipes.

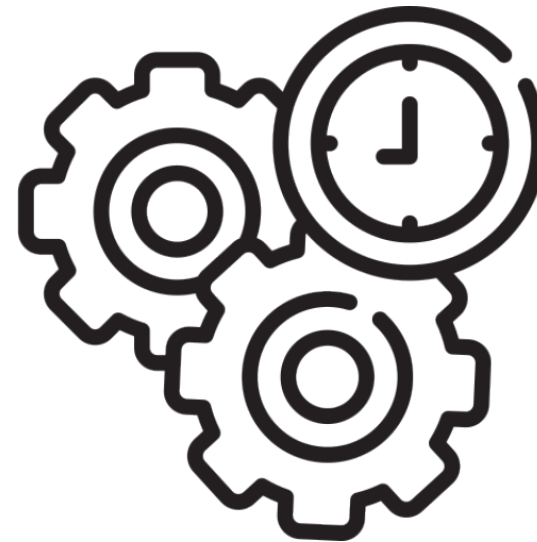
Maneuvering upon arrival or departure from port

In this transition, the power of the engine varies significantly depending on the commands given from the command bridge. As a result of this, the pollution is higher due to the larger variation in engine power. During these periods, you will often see black smoke coming out of the exhaust pipes. The time frame in which the arrival and departure takes place will naturally vary depending on the port, but it is not unusual that it takes between one and two hours.

At berth

When the ship is at berth [or anchored], the main engines will immediately be turned off. They will not be turned on again before the ship departs from the port. The only engine running while the ship is at berth is the generator, which creates electricity onboard. Generally speaking, only 10% of the engine power is at use when the ship is at berth.

When the various environmental organisations discuss cruise ship emissions, it is highly important that they establish which operational phase they use for their comparisons. For instance, it is vital that when they calculate emission from ships at berth, that the calculation is not based on ships going at full speed at sea but is in fact based on the engine power used at berth.





2

Which harmful
pollutants from
cruise ships
are we dealing
with?

2. Which harmful pollutants from cruise ships are we dealing with?

It is vital to separate the different types of emissions and their effects on either climate or the local environment. CO₂ emissions from cruise ships do not lead to health risks. However, this is the case with harmful pollutants emitted locally. And let's be clear – cruise ships do pollute the air, because as they burn sulphur, the below harmful pollutants are emitted:

NO_x

NO_x is a term used to commonly describe two pollutants, nitrogen oxide [NO] and nitrogen dioxide [NO₂] which are both harmful and causes increased mortality as well as a long list of other health issues, for example difficulties breathing, asthma, strokes and lung cancer. The main source of pollution with NO_x is primarily traffic and power plants.

The Danish consultancy firm Cowi states that new ships sailing the Baltic Sea Region from 2021 and onwards will have to submit to a stricter set of requirements when it comes to NO_x emissions. This will result in approximately a 75 %

reduction of NO_x emissions from new ships.

There are limit values of NO_x which are established based on health issue assessments. NO_x is not a greenhouse gas and therefore only contributes indirectly to the greenhouse effect.

SO_x

Ships use fuel containing sulphur which is then emitted into the atmosphere as sulphur dioxide. Sulphur dioxide is harmful for living organisms and can contribute to acid rain.

As is the case with the NO_x, there are also limit values on SO_x and we will later elaborate more on Sulphur emitted from cruise ships.

Fine particles

Air pollution with fine particles in urban areas give rise to serious health risks. This includes long term risks, where particle pollution can cause cancer and cardiovascular diseases, but also short term, where particles can lead to

asthma and irritation of eyes, nose and throat.

Generally, particle pollution is more local in character compared to the other two pollutants which means the negative impacts are much greater when they are emitted in urban areas.

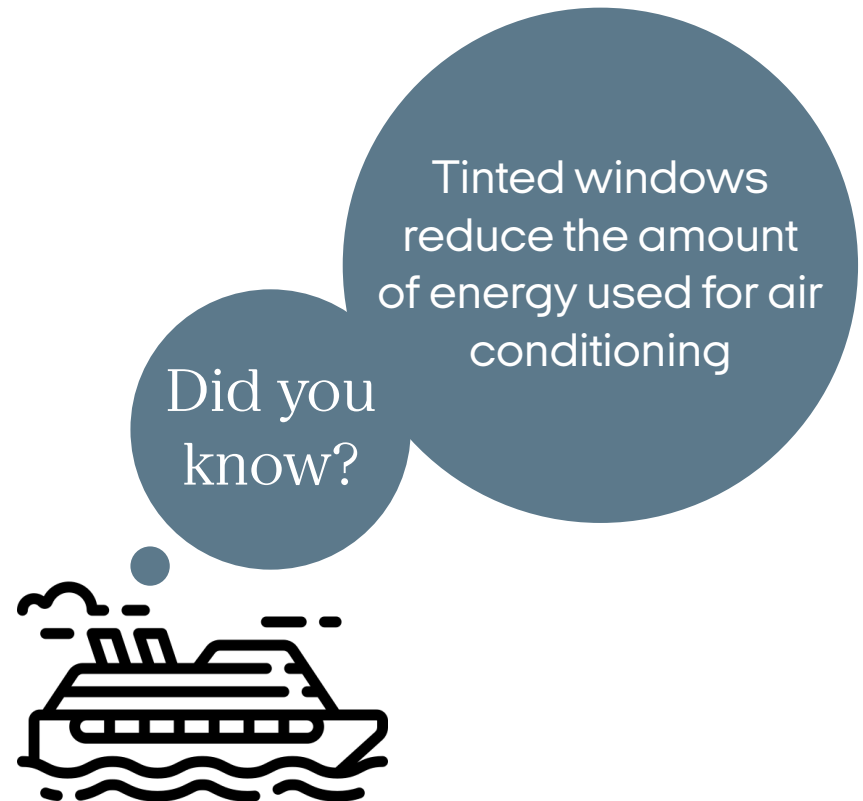
An EU directive determines the limit values for the annual average.

CO2 emission

What really contributes to the greenhouse gas effect and thereby climate changes, is the emission of CO2 [or carbon dioxide] which is emitted for instance when burning coal or rubbish to produce electricity. CO2 is not dangerous, in fact, CO2 is a basic element in the biological cycle since the air we exhale contains CO2 and since plants and trees naturally takes in CO2.

Cruise lines acknowledge that their ships emit CO2 and thereby contribute to the greenhouse effect. Therefore, there is even more focus on reducing fuel consumption which is the main source leading to CO2 emissions.

The cruise lines that are members of Cruise Line International Association [industry association, hereafter referred to as CLIA], and who are in charge of approximately 95 % of the world's cruise ship fleet, has announced that their objective is to reduce CO2 emissions by 40 % before 2030, which is a bit more than 10 years from now.





3

What is
stated in the
legislation?

3. What is stated in the legislation?

MARPOL Annex VI regulations to restrict the sulphur in ship's fuel was adopted in 2008 by UN's International Maritime Organization [IMO]. Today, the global upper limit for allowed sulphur content in fuels is 3.5 %.

In the Baltic Sea Region as well as a few other places in the world, so-called Sulphur Emission Control Areas exist [SECA – see map below]. In January 2015, the maximum allowance of sulphur content in these areas was reduced by no less than 90 % [from 1.0 % to 0.1 %]. As shown on the map below, the whole Baltic Sea Region is subject to these strict sulphur rules.

Except from the SECA areas which already have a much lower maximum allowance, IMO have decided that the upper limit of sulphur content in fuels has to be limited to 0.5 % globally from 2020. This is, however, still five times higher than the 0.1 % allowed in the Baltic Sea Region.



Emission Control areas - sulphur oxides (SOx) and particulate matter
Overview of all SECA areas

It has been allowed to dispose of the so-called greywater [lightly polluted wastewater from showers, sinks, washing machines etc.] in the sea, provided that the ship is more than 12 nautical miles from land and is sailing at a speed of minimum 4 knot. 95 % of all cruise ships in the world, and members of CLIA, have agreed to NEVER dispose of uncleaned greywater at sea.

In this instance, cruise lines have committed themselves to a set of strict stipulations which is in fact, more restrictive than the actual legislation.

In 2019 [for new ships] and in 2021 [for all ships] a new regulation will come into effect stating that ships can no longer dispose of greywater at sea and that everything must be disposed of in the next port. Many of the Baltic ports have therefore invested in port reception facilities for greywater so the wastewater will be purified at water purification plants.

Since this regulation solely applies to the Baltic Sea Region – and no other places in the world – it is no exaggeration to conclude that the Baltic Sea Region has the world's strictest environmental regulations for cruise ships. Thankfully.

Did you know?

The cruise industry has committed themselves to reducing CO2 emissions by 40% before 2030

Air bubbles, pumped out underwater from the bottom of the ship, reduce the surface area of the hull that is in contact with the sea. This reduces friction and improves the ship's fuel efficiency



4

What else
are cruise
lines doing to
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pollution?

4. What else are cruise lines doing to minimise air pollution?

The strict environmental regulations of the Baltic Sea Region require that cruise lines choose a resolution which ensures that they stay below the 0.1 % upper limit of sulphur emission.

The cruise industry invests massively in bringing down emissions of the harmful pollutants and some of the innovations are described below.

Scrubbers

In the Baltic Sea Region, there are two solutions that makes it possible for the ships to comply to the regulations of maximum 0.1 % sulphur in emissions - scrubbers or marine gas oil.

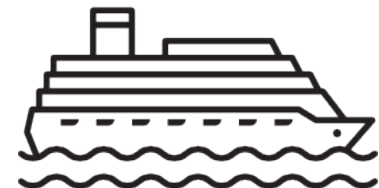
Scrubbers are giant filters which hurls around the exhaust gasses before it is emitted through the exhaust pipes. When the exhaust gas is hurled around, it is mixed with sea water, which results in most of the harmful pollutants being accumulated in the scrubber and only the cleaned exhaust is

passed out of the system and into the atmosphere.

A modern scrubber system can eliminate up to 90 % SO_x and fine particles, so a scrubber is indeed a very effective tool.

It is worth noting that the emission from ships with scrubbers most often is white due to the large water content [steam] in the exhaust. By using scrubbers, a cruise ship can use the cheaper heavier bunker oil, but due to the cleansing of harmful pollutants inside the scrubbers, the pollution is significantly reduced.

It is estimated that most ships sailing in the Baltic Sea Region have scrubbers installed and according to CLIA, 110 out of 350 cruise ships worldwide are equipped with scrubbers.



Marine gas oil

The other solution used now, is the use of marine gas oil, which is a lighter oil product with a sulphur content of less than 0.1 %. The disadvantage for the cruise lines is that marine gas oil is significantly more expensive than the traditional heavy bunker oil used for the scrubber solution.

In other words, cruise lines must choose between investing in costly scrubbers or expensive fuel to live up to the 0.1 % sulphur cap.

Liquified natural gas

Liquified natural gas [or LNG] is still a fossil fuel, but it reduces SOx emissions with close to 100 % and the NOx emission with 85-90 % compared to traditional fuel. The emission of greenhouse gasses will likewise be reduced by approximately 15-20%.

The first cruise ship powered completely by LNG was delivered on December 2018 and started its first cruise shortly after. The next LNG powered ship is due to be delivered during fall of 2019, and there are more than 30 LNG powered cruise ships in the order books which will be delivered during the coming years. LNG ships are hybrid

ships as they can also sail using biogas.

Shore power

When ships are at berth, a shore power facility can be used and the power then comes directly from the city's electricity supply. This will reduce the emission of harmful pollutants with 100% - provided that the energy used is renewable and clean. Approximately every fourth cruise ship today can receive shore power, but the cruise lines have, in fact, declared that they are willing to equip more vessels with shore power installations if the ports can supply the appropriate power.

Out of the approximately 2.000 cruise ports worldwide, the following have shore power facilities available at the time of writing:

- | | |
|-----------------|----------------|
| • Brooklyn | • Halifax |
| • Hamburg | • Kristiansand |
| • Montreal | • San Diego |
| • San Francisco | • Los Angeles |
| • Long Beach | • San Pedro |
| • Seattle | • Shanghai |
| • Vancouver | • Juneau |

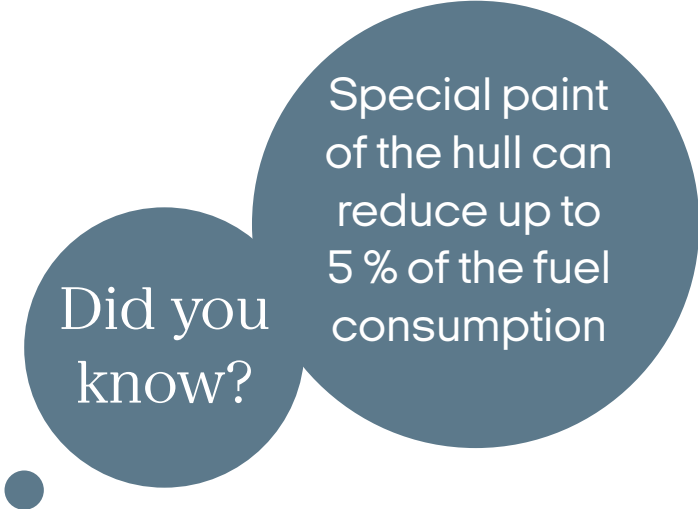
In addition to the abovementioned 14 ports in the world, also Kiel and Rostock are planning to build shore power facilities for cruise ships.

The media often mention that certain ports have shore power, but it is mostly intended for ferries or offshore vessels. The ferry traffic very commonly uses shore power because ferries arrive all year round at a certain regularity, which is not the case with cruise ships. Furthermore, shore power facilities for cruise ships requires a totally different capacity of power.

Finally, shore power is a very costly solution. It is estimated that a shore power facility costs between 5 and 8.5 million EUR per berth.

As the ports can never be completely sure how many future port calls, they will get, the business case is unfortunately very uncertain.

As previously mentioned, it is important that the power comes from clean and preferably renewable sources. As an example, in Denmark, we can see that the clean energy sources such as wind [40 %] and water [12 %] comprise more than half of the electricity production in the country.



Did you
know?

Special paint
of the hull can
reduce up to
5 % of the fuel
consumption

Other initiatives

More than 70 % of the cruise ship fleet is today able to operate as a hybrid cruise ship, which means they can use both traditional fuel but also, for example, methanol and biodiesel. A few ships are even able to sail using their own food waste.

The cruise line Hurtigruten has earlier in the summer of 2019 launched a new cruise ship – Roald Amundsen – which has extensive battery packs with enough power to sail the ship for about an hour. As technology is evolving fast, it might be that the batteries can last 5-10 hours in 5 years. This will open completely new horizons – both in port and at sea.

Finally, Viking Cruises have announced that they wish to manufacture a cruise ship which runs solely on liquified hydrogen. If so, this will be the first ever CO2 neutral cruise ship. Experts claim that if Viking Cruises succeed in manufacturing a hydrogen ship, then it will pave the way for a completely CO2 neutral cruise industry. The main challenge with hydrogen is that it must be kept at minus 253 degrees Celsius, or it will vaporise. It is also extremely flammable.

The above examples show that right at this moment, cruise lines invest significant amounts in sustainable solutions, both to benefit the environment but also because it is great business for them.

The cruise industry reuses 60 % more per person compared to a person on land

Did you know?

Did you know?

The world's largest cruise corporation, Carnival, use 15 % of their total costs on fuel. The cruise lines therefore have an huge interest in reducing their fuel consumption – and thereby reducing pollution



5

What do the
air pollution
measurements
show?

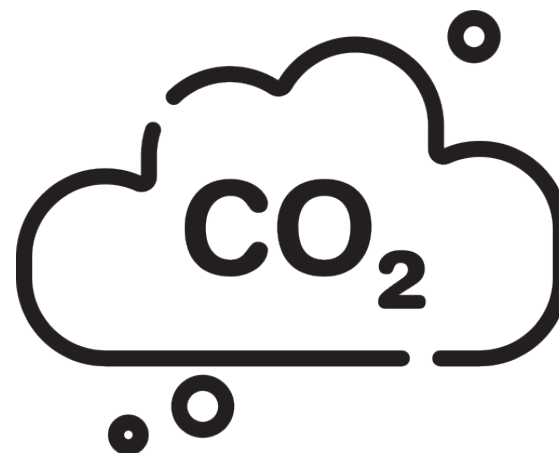
5. What do the air pollution measurements show?

As mentioned, Copenhagen Malmö Port [CMP] took the initiative to produce a report on the environmental impact of cruise ships on Langelinie Allé in Copenhagen. The report was made by the impartial institute FORCE Technology during the summer of 2018. The reason for measuring at Langelinie Allé rather than the berths at Langelinie is because residents live on Langelinie Allé and CMP wanted to measure the impacts from cruise ships on the nearby residential area.

The reason for initiating the report was a press release from The Eco Council [Det Økologiske Råd] which states that the pollution by the cruise ships at Langelinie supposedly were greater than what you would find on H.C. Andersens Boulevard [HCAB] – one of Copenhagen's most central streets and certainly one of the most polluted streets in Copenhagen.

As evident on the index below from FORCE Technology's report, the pollution at Langelinie is more likely to be comparable to a one-way street in the Copenhagen

neighbourhood of Vesterbro – far from the pollution levels at H.C. Andersens Boulevard.



	Unit	2014 ¹ Before one-way	2015 ¹ After one-way	2018 ²	2016 ³	2016 ³	Sept-Oct 2018 ⁴	Limit value
		Road in Vesterbro		Langelinie Allé	Suburb of Copenhagen	HCAB	HCAB	
Number of measurement hours for NO ₂	Number	2,362	2,667	2,630	8,248	7,720	729	-
NO ₂ average value	µg/m ³	29	23	12	13	47	34	40
NO ₂ – 99.8 percentile	µg/m ³	80	76	96	65	129	110	200
NO _x average value	µg/m ³ NO ₂	45	33	18	18	116	70	-
NO _x – 99.8 percentile	µg/m ³ NO ₂	213	231	381	281	556	389	-
Measurement hours for ultrafine particles	Number	2,362	1,797	1,909	7,200	3,777	-	-
Ultrafine particles average value (>3 nm)	Number/cm ³	13,200	11,100	11,200	-	-	-	-
Ultrafine particles average value	Number/cm ³	-	-	-	3,700 ⁵	13,000 ⁶	-	-

Table 1. Results of the measurements at Langelinie Allé during the period 3rd May – 19th September 2018

Source: FORCE Technology, Copenhagen Malmö Port AB, Langelinie Measurement of Ambient Air Quality, 2018

1. Report for the City of Copenhagen, FORCE Technology, Case 114-22813
2. Measurement June-September 2018, FORCE Technology, Case 118-27013
3. National Measurement Programme, Report 2016, Aarhus University
4. Link to current measurement data: <https://envs2.au.dk/Luftdata/Presentation/table/Copenhagen/HCAB>
5. Measured in the range 11-478 nm
6. Measured in the range 6-700 nm

FORCE Technology states in their report:

“Table 1 is a summary of the measurement results on Langelinie Allé. It states that the NO₂ concentrations clearly comply with the limit values and are clearly lower than on H. C. Andersens Boulevard. The 99.8 percentile shows that although the average value is clearly lower than other locations in inner Copenhagen, the highest concentrations are higher than at the other locations [except H. C. Andersens Boulevard]. This is attributed to the fact that cruise ships can cause short-term high concentrations that are still below the limit value.”





6

Is it possible
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6. Is it possible to compare pollution from cruise ships with that of cars?

It seems evident that just as there is a difference in fuel consumption depending on which car we look at, there is obviously also a difference in fuel consumption on various cruise ships. Just like cars, the size of the ship also means a great deal and whether the ship is old or new. Finally, there are different types of bunker oil for ships, exactly as there are different types of fuel for cars.

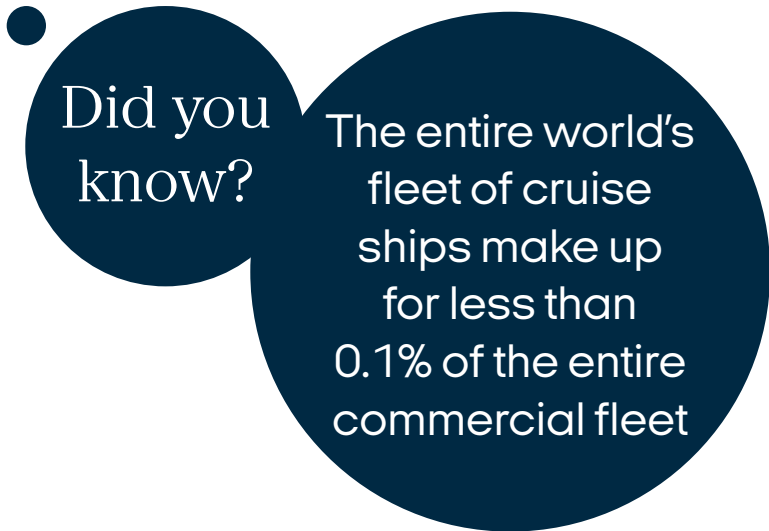
At last, there is a difference in what is being measured. Which of the harmful pollutants [SO_x, NO_x or fine particles], is being compared to cars?

Typically, environmental organisations compare cars to ships going at full speed using the most polluting type of bunker oil. In fact, this rarely ever happens, as going at full speed means burning lots of fuel which is not economical. Naturally, a ship never sails at full speed in a port area, as seems often assumed.

It is, however, a fact that while we operate with a maximum

limit of sulphur of 0.1 % emission in the Baltic Sea Region, a diesel car in Europe only emits 0.001 %. In other words, a cruise ship must have 100 % greater amount of sulphur content in their exhaust compared to a car, which is hardly tenable in the long run.

CLIA estimates that the emission from an average cruise ship compared to an average car in city traffic comes to approximately 3.500 cars in terms of NO_x and approximately 5.000 cars in terms of ultra-fine particles per unit of time.



Did you know?

The entire world's fleet of cruise ships make up for less than 0.1% of the entire commercial fleet



7

Conclusion

7. Conclusion

The Baltic Sea Region has the world's strictest environmental laws for cruise ships. The cruise lines work actively towards further reducing their fuel consumption as well as coming up with new alternative propellants.

When all this is said, we must also state that cruise ships do pollute with both pollutants harmful for health locally and indirectly with a CO2 emission affecting the greenhouse gas effect. The fact that cruise ships pollute less in the Baltic Sea Region than in the rest of the world is obviously poor consolation.

The entire cruise industry acknowledges their responsibility while we simultaneously live on being able to offer guests clean seas and clean air. Without these two components, the cruise industry would quickly vanish.

Consequently, cruise lines invest tremendous amounts in research which can reduce the pollution further and it has, as previously mentioned, committed itself to a 40 % reduction in

CO2 emissions before 2030.

In the media, you can often read that cruise lines and ports do not do anything to reduce air pollution. We hope, that this material is proof of the opposite. The fact that limit values of sulphur content in emissions is globally being reduced more and more, while cruise lines simultaneously invest large amounts of money in reducing emissions [to economize], is a great indication that the authorities, ports and cruise lines are working together at an international level towards a reduction of the harmful pollutants from cruise ships. Ultimately, this is what we all wish for.





8

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- Miljøstyrelsen [Ministry of Environment and Food of Denmark]
- Danmarks Statistik [Statistics Denmark]