CRUISE SHIPS

ENVIRONMENT & CLIMATE

Pollution, regulation, technical solutions, and responsibility

cruise denmark
copenhagen & beyond

GREEN GLOBAL FUTURE

BACKGROUND

Cruise Denmark — Copenhagen and beyond represents a network of Danish ports and destinations that accommodate cruise ship arrivals and welcomes cruise passengers. The network includes, as well, ship agents, tour operators, transport companies, attractions, hotels and several other stakeholders, which are part of the value chain when a ship calls into port in Denmark. The value chain of cruise tourism generates numerous employment opportunities and fosters business and financial growth for both private and public stakeholders throughout the country. At the European level, cruise tourism generated 400,000 jobs and €55.3 billion in revenue in 2023. Today, 97% of the world's cruise ships are built in Europe, and by 2036, cruise lines are expected to invest an additional €57 billion in European shipyards. In 2023, approximately 14% of all cruise passengers in Europe visited Denmark. In 2024, around 500 cruise ships called at Danish ports, carrying a total of 1.2 million passengers. This number is projected to grow in the coming years.

Cruise Denmark — Copenhagen and beyond aims to actively reduce the environmental impact of cruise ships. As a network organization, our main objective in this endeavour is to foster dialogue among our partners and cruise ship companies. We are committed to providing fact-based visibility in public discussions with citizens and decision-makers. Our vision is that Copenhagen, along with the rest of the country and the entire Baltic Sea region, becomes the centre of a green transition of the cruise tourism to inspire the rest of the world. In other words, Cruise Denmark — Copenhagen and beyond has a specific task to create a sustainable development of the cruise tourism for the benefit of environment and climate, businesses, the local population, and society broadly.

Cruise Denmark — Copenhagen and beyond is an integrated part of the organisation Wonderful Copenhagen. Wonderful Copenhagen, primarily funded by the Danish state and the Municipality of Copenhagen, serves as the official tourist organization for the capital area. Its mission, as a non-profit organisation, is to promote and develop business and holiday tourism in a way that benefits the common good. Incorporating the network is essential for Wonderful Copenhagen, as it remains Denmark's largest cruise port. However, several ports outside of Copenhagen, including Aarhus, Skagen, and Rønne, are experiencing a growing influx of cruise ships in recent years.

Green Global Future is a non-profit organisation that promotes the green transition through facilitating communication in cooperation with the most progressive parts of the industry. The Head of Secretariat and the main author of this publication, environmental engineer, Ph.D., Kaare Press-Kristensen, has determinedly worked for more than 15 years to reduce the environmental and climate impact of shipping with focus on technical solutions combined with advocacy for national as well as international regulations.

The two organizations have collaboratively produced this publication, which emphasizes the environmental impact of cruise ships. It explores technical solutions, current and forthcoming regulations, and the cruise industry's initiatives

to minimize their ecological footprint. Additionally, it offers inspiration for international, national, and local actions aimed at key stakeholders who wish to support and accelerate the green transition in cruise tourism. The publication focuses on cruise ships in the seas around Denmark and in the Baltic Sea.

The purpose of the publication is to provide information regarding the environmental and climate impacts of cruise ships. We aim to inspire decision-makers and other key stakeholders to continue the regulatory process, as well as to eliminate barriers, to achieve a more rapid implementation of technical solutions that reduce the environmental impact of cruise ships for the inspiration of the broader shipping industry.

All information in this publication has been thoroughly vetted by naval engineer Hans Otto Kristensen, who possesses 45 years of experience in maritime engineering. His expertise spans various aspects of the field, including construction and environmental challenges, and he has served as an advisor for both the Danish Maritime Authority and the International Maritime Organization (IMO).

Enjoy reading!

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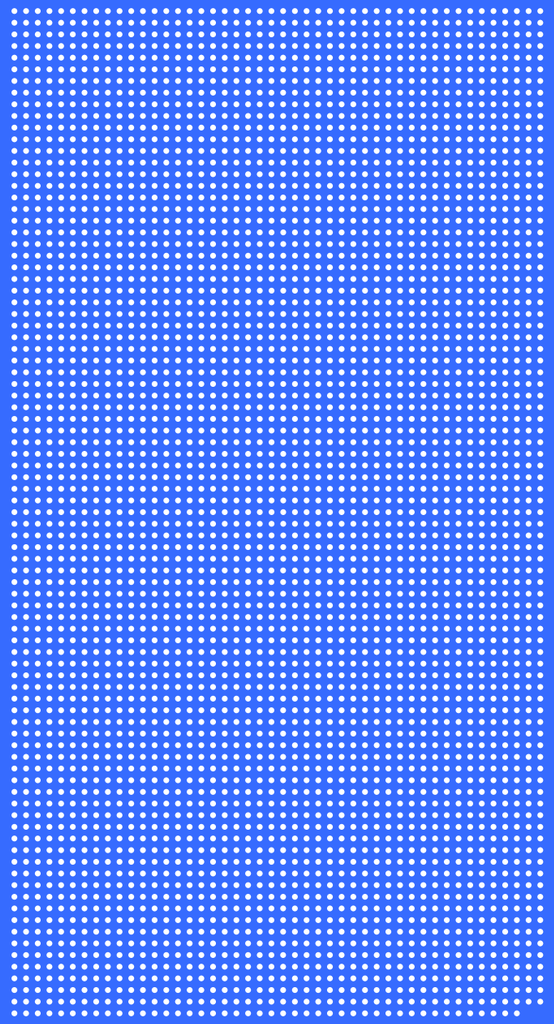
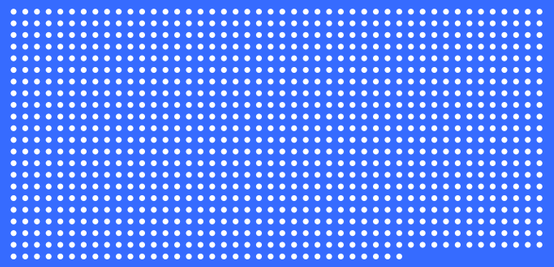
ENVIRONMENT & CLIMATE

Big cruise ships:
Cruise ships with more than 4,000 passengers



• = 1 cruise passenger

Small cruise ships:
Cruise ships with less than 1,000 passengers



A cruise ship is essentially a floating hotel. In this publication cruise ships carrying more than 4,000 passengers are considered as large whereas cruise ships carrying less than 1,000 passengers are considered small. Large cruise ships typically carry not only passengers but also over 1,000 crew members on board. This number exceeds the capacity of the largest hotel in Denmark, Next House Copenhagen, which has 1,667 beds, and is comparable to the population of a small Danish town.

However, only a minor proportion of port calls to Danish ports were large cruise ships. From April to August 2024, approximately 15% of port calls in Copenhagen were large cruise ships, which were responsible for bringing about almost half the cruise passengers. During the same period there were twice as many port calls from small cruise ships. In Aarhus and Skagen the minor share was large cruise ships, while Rønne and several other ports had no port calls from large cruise ships.

Beyond the energy required for propulsion, the ship must generate heat and electricity—primarily to support the various amenities for passengers - by utilizing ship fuel, which consequently leads to emissions that contribute to air and climate pollution. To reduce pollution in urban areas, an increasing number of ships are being retrofitted to connect to shore power while docked, and more ports are investing in shore power facilities.

Additionally, passengers require food and beverages, access to essential amenities like those available on land, and they generate significant amounts of waste and wastewater. In addition, there are environmental challenges unique to shipping, which few of us consider, for instance, underwater noise and so-called invasive species.

In each chapter the environmental challenges related to cruise ships are described along with the technical solutions, the existing/future regulations, as well as the efforts of the industry to improve. Finally, inspiring initiatives are presented on how decision-makers can accelerate the green transition of the cruise tourism.

ABSTRACT

AIR POLLUTION
Cruise ships contribute to air pollution containing health hazardous particles and gasses. In Copenhagen, which receives the most Danish cruise passengers, air pollution from cruise ships causes adverse health costs of roughly 7.4 million euro every year corresponding to about 0.7% of the adverse health costs caused by the total air pollution in the city. For comparison, the city's traffic and wood stoves each contribute with around 1.6% of the total adverse health costs from air pollution. Most health impacts in Copenhagen are caused by transboundary air pollution which is carried by the wind to the city. Just as air pollution emitted within Copenhagen add to health impacts outside the city. In the future, as cruise ships connect to shore power, their pollution at berth will be reduced by 95%.

CLIMATE
Fewer than 1% of larger vessels are cruise ships, and they account for less than 0.1% of global warming. Large cruise ships emit 5 times less CO_2 per cruise passenger than small cruise ships as larger ships are more energy efficient due to economies of scale. If you, as a passenger on a large cruise ship, visit all major cities in the Baltic Sea, the climate impacts will be the equivalent of a return flight from Copenhagen to Barcelona.

The goal of the UN is that shipping (incl. cruise ships) is climate neutral by 2050. Cruise Lines International Association (CLIA) also has the goal of climate neutrality by 2050.

WASTE
Cruise ships, often likened to floating hotels, generate waste similar to that produced on land. Onboard, waste is sorted into various categories to maximize recycling efforts when the ship docks at port, mirroring the waste separation practices found in Danish households. Furthermore, all cruise ships are required to implement a waste management plan that emphasizes both the reduction of waste generation and the proper procedures for storage and handling.

WASTEWATER
Given that cruise ships frequently accommodate over 1,000 passengers, they generate significant quantities of wastewater. Cruise ship companies have voluntarily engaged to prevent discharge of uncleaned wastewater. Hence, the wastewater must be collected and handed in at port calls or be cleaned in an approved wastewater plant onboard the ship prior to discharge at sea.

OTHER ENVIRONMENTAL CONSIDERATIONS
Several cruise ships have installed so-called scrubbers to be able to use heavy fuel oil instead of switching to cleaner fuels. The scrubbers "shower" the flue gas and discharge the captured scrubber water directly to the sea. The scrubber water contains heavy metals and tar compounds, which are toxic to marine life. Since the summer 2025 Denmark and Sweden have banned the discharge of the scrubber water. An increasing number of countries are introducing similar bans on discharge from scrubbers. Underwater noise poses a significant threat to marine mammals, including dolphins, seals, and whales.
To mitigate this issue, cruise ships have adopted various strategies, such as slow steaming in sensitive marine areas and fjords that are home to vulnerable wildlife. Cruise ships utilize environmentally friendly and non-toxic antifouling paint. Some ports, like, the port of Copenhagen, have implemented a ban against the use of outdoors loudspeakers in residential areas to reduce noise pollution.

01 AIR POLLUTION

While cruise ships today produce less pollution per passenger than in the past and contribute relatively little to overall hazardous air pollution in cities compared to other sources, they can still significantly impact air quality in port areas. Therefore, it is essential to minimize pollution as fast as possible.

01 AIR POLLUTION

POLLUTANTS AND ADVERSE EFFECTS

When oil is burned in ship engines, as well as in all other combustion engines, the process is often incomplete. This incomplete combustion results in the production of harmful pollutants, including combustion particles and tar compounds. At the same time, sulphur in the fuel is oxidised into sulphur dioxide (SO_2) and the content of natural nitrogen in the combustion air is oxidised into nitrogen oxides (NO_X). These air pollutants are emitted through the chimney stack of the ship and can then be transported thousands of kilometres by the wind.

Particles are hazardous to health and increase the risk of cancer, cardiovascular diseases, blood clots, severe respiratory diseases (asthma, bronchitis and COPD) along with several other serious diseases. The pollutants NO_2 and SO_2 gases are hazardous in high concentrations and can transform into harmful particles in the atmosphere.

Particle pollution is the most harmful form of pollution. In Copenhagen, fine particles ($PM_{2.5}$) are responsible for approximately 93% of the total annual health costs, which adds up to around 1 billion euro of damages related to illnesses and deaths caused by air pollution. In the remaining Danish cities, which have lower levels of traffic (and thereby lower levels of NO_2) than Copenhagen, fine particles have an even greater share of the health costs. Until now, no inventory of adverse health effects from soot particles (black carbon) and ultrafine particles has been conducted.

Both NO_X and SO_2 contribute to the formation of acid rain, which negatively impacts forest growth and threatens aquatic life in lakes, particularly in countries where the soil naturally lacks lime.

Additionally, NO_X contributes to over-fertilisation of Nitrogen that can deteriorate sensitive ecosystems, e.g. by contributing to algal blooms followed by oxygen depletion in vulnerable sea areas, or by stimulating forest growth in nitrogen-poor ecosystems (e.g. unique moorland ecosystems) thereby causing extinction of the original unique species, i.e. leading to a deterioration of biodiversity.

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- The combustion of oil in ship engines, as well as in other types of combustion engines, results in the formation of harmful particles and gases.
  Particles: Soot particles (black carbon), fine particles ($PM_{2.5}$), and ultrafine particles ($PM_{0.1}$).
  Gases: Nitrogen oxides (NO_X: NO_2 and NO) and sulphur dioxide (SO_2).
- **WATCH MOVIE** on air pollution

01 AIR POLLUTION

THE IMPACT OF CRUISE SHIPS

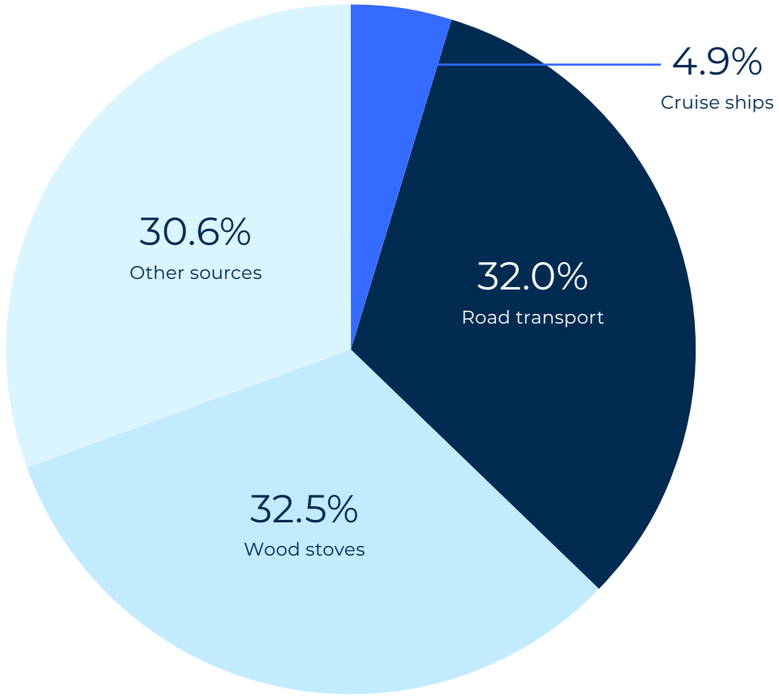
In 2017, cruise ships in Copenhagen emitted on average approximately 0.012 kg of fine particles and 0.335 kg of NO_X per passenger, respectively (calculated based on cruise ships' emissions in 2017 outlined in DCE report no. 316, and the around 850,000 cruise passengers that visited Copenhagen in 2017).

With approximately 770,000 passengers visiting Copenhagen in 2023, this leads to a total of 258 tonnes of NO_X and 9.2 tonnes of fine particles emitted, which correspond to roughly 12% and 5% of NO_X and fine particles of the total emissions from the city's pollution sources, respectively. However, this corresponds to less than one percent of the total air pollution in Copenhagen (source: DCE report no. 605). This difference results from transboundary pollution blown in by the prevailing winds, which contributes significantly to the total fine particle pollution and a substantial portion of the NO_X pollution in Copenhagen.

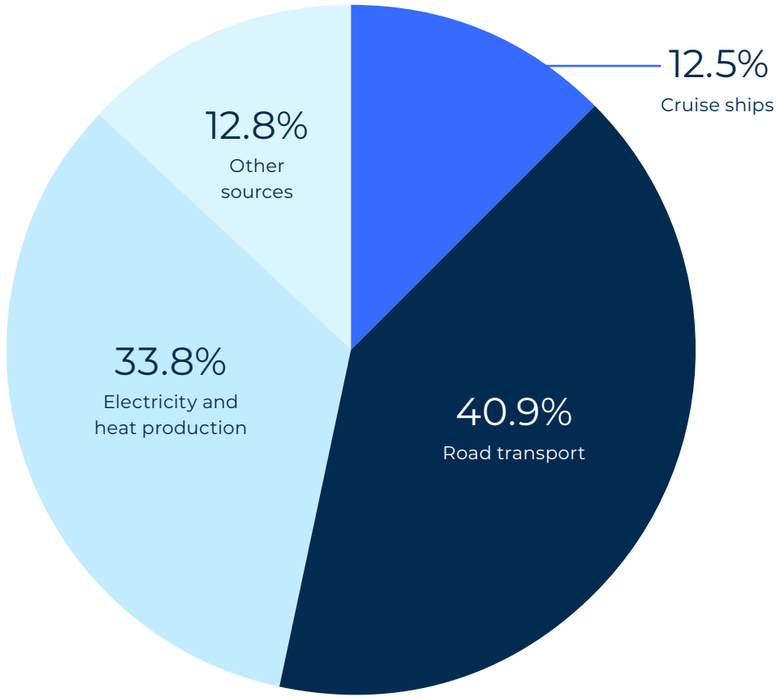
Note that transboundary air pollution is not included in the diagrams on the following page, which only display emissions from sources within Copenhagen. Air pollution sources in Copenhagen are also contributing to negative health effects beyond the city's borders.

Emissions of fine particles and NOx from cruise ships and other sources in Copenhagen.

Emissions of fine particles in Copenhagen



Emissions of NOx in Copenhagen



Cruise ships release harmful particulate pollution, however they contribute significantly less to air pollution compared to pollution generated by wood stoves and cars in Copenhagen.

Health impacts in Copenhagen due to air pollution are estimated to cost around 1 billion euro per year, which is mostly caused by transboundary air pollution with fine particulate matter, ground-level ozone, and NO_X (as mentioned above). The specific pollution related to cruise ships at berth is estimated to account for approximately 7.4 million euro per year based on calculation models from Aarhus University. This corresponds to about 0.7% of health costs related to air pollution in Copenhagen, even though the city receives the most cruise passengers in the country.

For comparison, health impacts caused by other pollution sources in the city (road traffic, wood stoves, etc.) adds up to approximately 46 million euro per year, or about 4.6% of health impacts related to air pollution in Copenhagen. Air pollution from cruise ships and other urban sources is released into the atmosphere, leading to adverse health effects beyond the city limits, especially when gases are transformed into fine particles.

Currently, there are no inventories of equivalent character for cruise ship pollution available at the remaining Danish ports or nationwide.

01 AIR POLLUTION

TECHNICAL SOLUTIONS

The formation of particles depends both on the type of fuel, engine conditions, and the maintenance of the engines, while the formation of SO_2 depends on the sulphur content in the fuel. The formation of NO_X depends mostly on engine conditions (particularly the combustion temperature). More than 95% of all cruise ships use heavy fuel oil as fuel.

The particle emission from ships that use heavy fuel oil can be significantly reduced by using lighter fuel oils (distillate fuels) in an efficient ship engine under optimal conditions. The particulate emissions can be eliminated almost entirely by using particulate filters similar to those used in road transport and power plants. Particulate filters are, however, still not standard use for cruise ships as there is no regulatory requirements for use of filters.

The SO_2 emissions can be reduced by using low sulphur fuel oil or by cleaning the flue gas using a scrubber (see *Other Environmental Conditions* p. 54). NO_X emissions can be minimized by reducing the combustion temperature within the engine or by purifying the flue gas with a catalyst, a method that has been employed for decades in both road transport and power generation.

Finally, the emissions of both particles, SO_2, and NO_X can be eliminated by using newer, cleaner alternative marine fuels such as natural gas (can however emit methane, a powerful GHG), ammonia (can however emit N_2O, another powerful GHG), and hydrogen. Likewise, methanol can almost eliminate the emission of particles and SO_2, while it reduces the NO_X emission by half. The reduction achieved by using alternative fuels depends also on consumption of lubrication oil and potential pilot fuels. Alternative marine fuels are described in more detail under *Climate impacts* p. 26.

At berth, a cruise ship can connect to shore power to source electricity from the electricity grid on the shore. The cruise ship must, however, be equipped onboard to connect to shore power, and the port must have a shore power facility. Even when considering the pollution generated by the production of Danish electricity, the hazardous air pollution associated with health risks is reduced by over 95% when a typical cruise ship at berth in a Danish port utilizes shore power instead of onboard combustion engines. By using electricity stored in onboard batteries for manoeuvring in port, corresponding percentage-wise reductions of pollution can be achieved.

95%

Shore power reduces the health hazardous air pollution from cruise ships at berth in Danish ports by more than 95%.

WHAT IS A SCRUBBER?

Rather than utilizing cleaner fuels, a ship may opt to comply with sulphur regulations by using traditional heavy fuel oil combined with a scrubber system. This process involves washing the exhaust flue gas within a scrubber system, after which the contaminated scrubber water is usually discharged directly into the sea (read more p. 54).

01 AIR POLLUTION

REGULATION

Parts of the North Sea and all the Baltic Sea have been designated as so-called Emission Control Areas (ECAs – low emission areas) for shipping.

SEE MAP
for Emission Control Areas for shipping

The ECAs regulate the emission of SO_2 from all ships (both old and new), while the NO_X regulation only includes new ships built after the NO_X regulation entered into force in 2021. Ships traveling through ECAs must use fuels with a maximum of 0.1% sulphur. This corresponds to an 80% reduction compared to the permitted limits outside of the ECAs.

However, it is still 100 times more than the sulphur content in road diesel in the EU. As an alternative, the ship can have a scrubber installed that removes the excess sulphur from the flue gas corresponding to equivalence of fuels with a sulphur content of 0.1%. An increasing number of cruise ships are equipped with scrubbers (read *Other environmental conditions* p. 54).

Vessels constructed after 2021 are required to achieve an 75-80% reduction in NO_X emissions while operating within the Northern European Emission Control Areas (ECAs), in comparison to their older counterparts.

Although the ECA is not directly regulating particulate emissions, all things being equal, cleaner fuels will help reduce particulate emissions compared to traditional marine fuels.

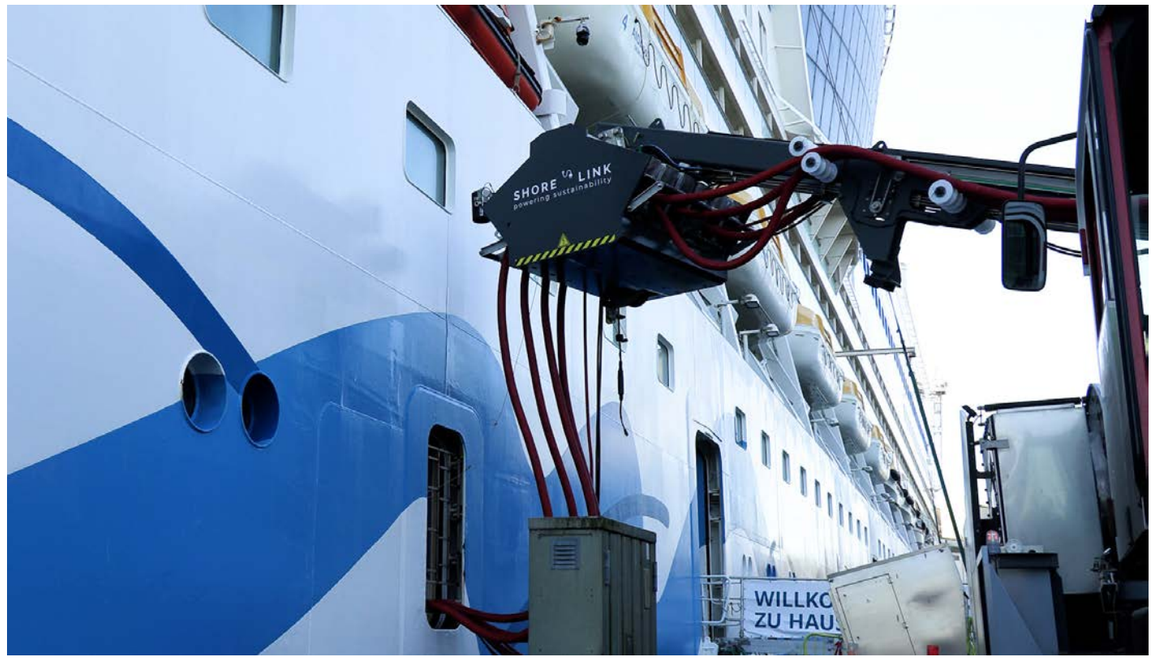
There are currently no plans to tighten international regulations on air pollution from shipping in Northern Europe. It is anticipated that an increasing number of countries will prohibit the discharge of scrubber water, compelling more ships to adopt cleaner fuels. Considering recent investigations indicating that the actual reduction of NO_X emissions at sea is significantly below the required 75-80%, particularly during slow steaming, it is anticipated that regulations will be updated to ensure that ship catalysts effectively achieve this reduction while operating in Emission Control Areas (ECAs).

However, several indirect regulations are expected to reduce air pollution from shipping. EU requires shore power facilities and the use of shore power in larger ports (TEN-T ports) from January 2030. At the UN (IMO: International Maritime Organization), a wide range of instruments will facilitate uptake of more climate friendly renewable fuels (read *Climate impact* p. 26). Some ports have implemented differentiated port fees based on environmental impacts at berth. For example, the Port of Aarhus charges between 6,700 and 10,000 euros additionally for cruise ships that opt not to connect to shore power. This encourages ships to utilize the available shore power, while ensuring that the port can profit either way. This profit helps recover the costs of installing the shore power facility, regardless of whether ships connect to the shore power and purchase electricity from the port or opt to pay an additional fee. In 2025, Copenhagen introduced port fees (environmental discounts) to attract/reward ships that pollute less, along with a price structure that incentivises ships to use shore power.

01 AIR POLLUTION

INITIATIVES OF THE CRUISE COMPANIES

Shore power eliminates the pollution from ships at berth.



Cruise companies and their associated industries rely heavily on public and political support for cruise tourism at various destinations. This support is essential to ensure a pleasant and welcoming experience for passengers. Simultaneously, travellers are reluctant to contribute to the harmful pollution that harms the destinations they pay to visit.

Moreover, cruise companies face internal competition, and cruise tourism must also compete with other vacation options. Consequently, cruise ship companies have invested in environmental technology only to the extent that such investments are either profitable or mandated.

Cruise ship companies are increasingly focused on retrofitting their vessels to enable connections to shore power in the future. Currently, many cruise ships operating in the North Sea and the Baltic Sea already have the capability to connect to shore power. Unfortunately, numerous ports still lack the infrastructure to provide these connections. However, the European Union's regulations, local advocacy, and the growing demand for more environmentally friendly cruising options have motivated many larger ports to develop shore power facilities.

Several of the larger cruise ship companies have committed to receive shore power if power is available at a fair price. The experience from ports with shore power facilities is that cruise ships that can connect to shore power usually will do so by default.

Cruise ship companies have increasingly invested in ships powered by liquid natural gas (LNG). This shift significantly reduces hazardous air pollution, but it does not address the broader climate impact (read *Climate impacts* p. 34).

02 CLIMATE IMPACT

When oil and liquefied natural gas (LNG) is combusted in ship engines (and all other combustion engines), the carbon is oxidated to CO_2 while energy is released for ship propulsion along with other energy needs. Carbon dioxide (CO_2) is not captured from the flue gas on ships and is directly released into the atmosphere, contributing to global warming alongside CO_2 emissions from vehicles, power plants, and other sources.

Although ships using LNG emit less CO_2 than ships using traditional fuel oil, several investigations have shown that a significant amount of the LNG (methane) slips through the ship engines and directly out into the atmosphere. Methane is a significant contributor to global warming, being nearly 30 times more potent than CO_2 per tonne over a 100-year period, and approximately 85 times more potent over a 20-year span. Consequently, ships that utilize LNG may have a greater impact on global warming compared to those that operate on fuel oil.

Greenhouse gases, such as CO_2 and methane from various sources, play a significant role in global warming, which is regarded as one of the most urgent challenges of our time. Furthermore, the increasing levels of CO_2 in the atmosphere will lead to greater CO_2 absorption and acidification of the oceans, resulting in increased acidity. This, coupled with the warming of the seas due to global warming, presents a serious threat to coral reefs and organisms that depend on calcium carbonate to form their shells and exoskeletons, ultimately jeopardizing oceanic biodiversity.

It is important to reduce global warming — also for the sake of the coral reefs and marine biodiversity.

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02 CLIMATE IMPACT

THE IMPACT OF CRUISE SHIPS

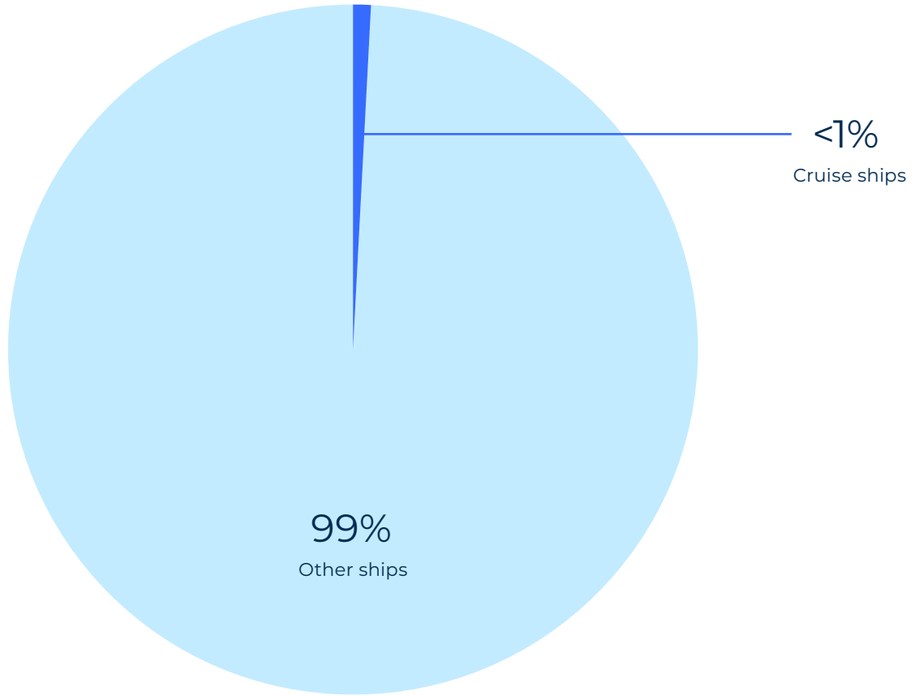
Shipping is responsible for almost 3% of the contribution to the human-induced global warming. If shipping was a country, it would be the world's sixth-largest emitter of CO_2. Currently, there are only 450 to 500 cruise ships operating globally (2024). In contrast, the total number of large ocean-going vessels stands at 55,000. This indicates that cruise ships make up less than 1% of the entire fleet of ocean-going ships worldwide.

Although cruise ships consume significantly more fuel per vessel than most ocean-going ships, and even though they function as floating hotels, they contribute to less than 0.1% of global warming. Nevertheless, cruise companies should take responsibility for reducing emissions in collaboration with the rest of the industry. This process is already underway.

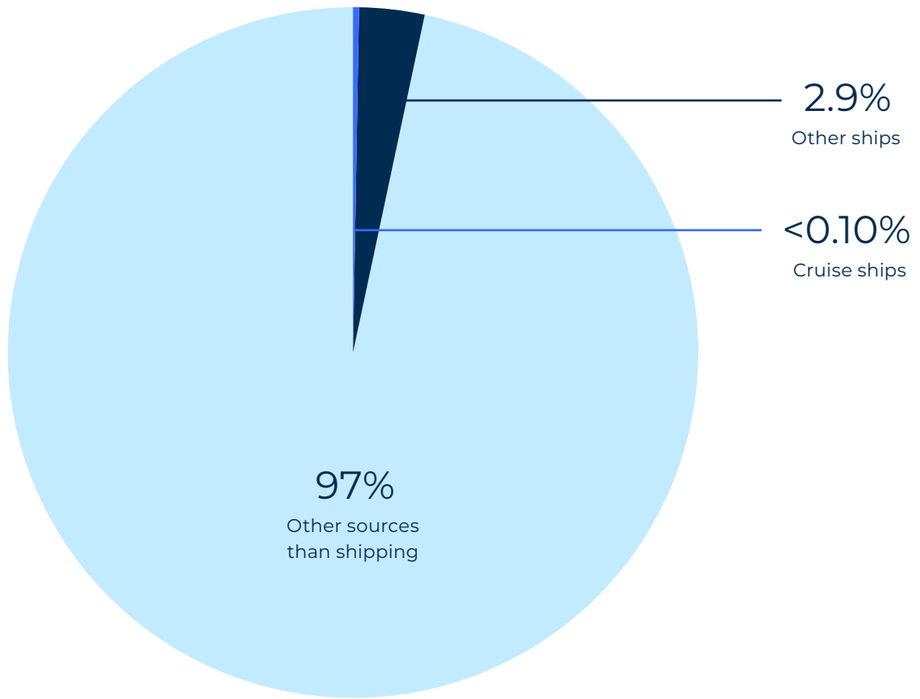
Recent reports on the EU's Monitoring, Reporting, and Verification (MRV) system indicate a significant reduction of approximately 25% in climate impact per passenger per kilometre for average-sized and large cruise ships operating between EU ports from 2022 to 2023. This is likely due to increased occupancy rates, along with cruise ships increasingly adopting various technical options to reduce their climate impact (read on p. 34).

Cruise ships are a small fraction of shipping and a small fraction of the climate burden.

The world's ocean-going ships



Climate impact from shipping and other sources



02 CLIMATE IMPACT

OUR HOLIDAYS IMPACT

Our holidays affect the climate, whether we travel by cruise ship, airplane, car, or motorhome. While CO_2 emissions are often the focus, they are not the only factor to consider. When flying, the emissions of soot particles (black carbon), nitrogen oxides (NO_X), and contrails at high altitudes contribute to a significantly greater climate impact than CO_2 alone. Ships also emit soot particles, especially affecting the Arctic, where a substantial amount settles on the ice cap, darkening it and increasing sunlight absorption, which in turn accelerates ice melting.

Furthermore, the length of the trip (and stopovers) is highly significant for determining the climate impact. Hence, it is not just the emission per passenger per kilometre that is important to consider, but also to the number of total travelled kilometres. A plane travels about 900 km/hr. for longer distances, i.e. a passenger has travelled about 900 kilometres when flying for an hour. In comparison, a cruise ship has only travelled about 40 kilometres during the same time.

If a passenger on a large cruise ship sailing from Copenhagen visits all greater cities in the Baltic Sea, this roundtrip is roughly 3,000 kilometres. With a climate impact of roughly 200 g CO_2 per passenger-kilometre and 15% fuel consumption at port calls that adds up to an impact of around 0.7 tonne CO_2. This corresponds to the same climate impact as a return flight to Barcelona, according to ICAOs climate calculator, multiplied with a non-CO_2 factor of 2.5.

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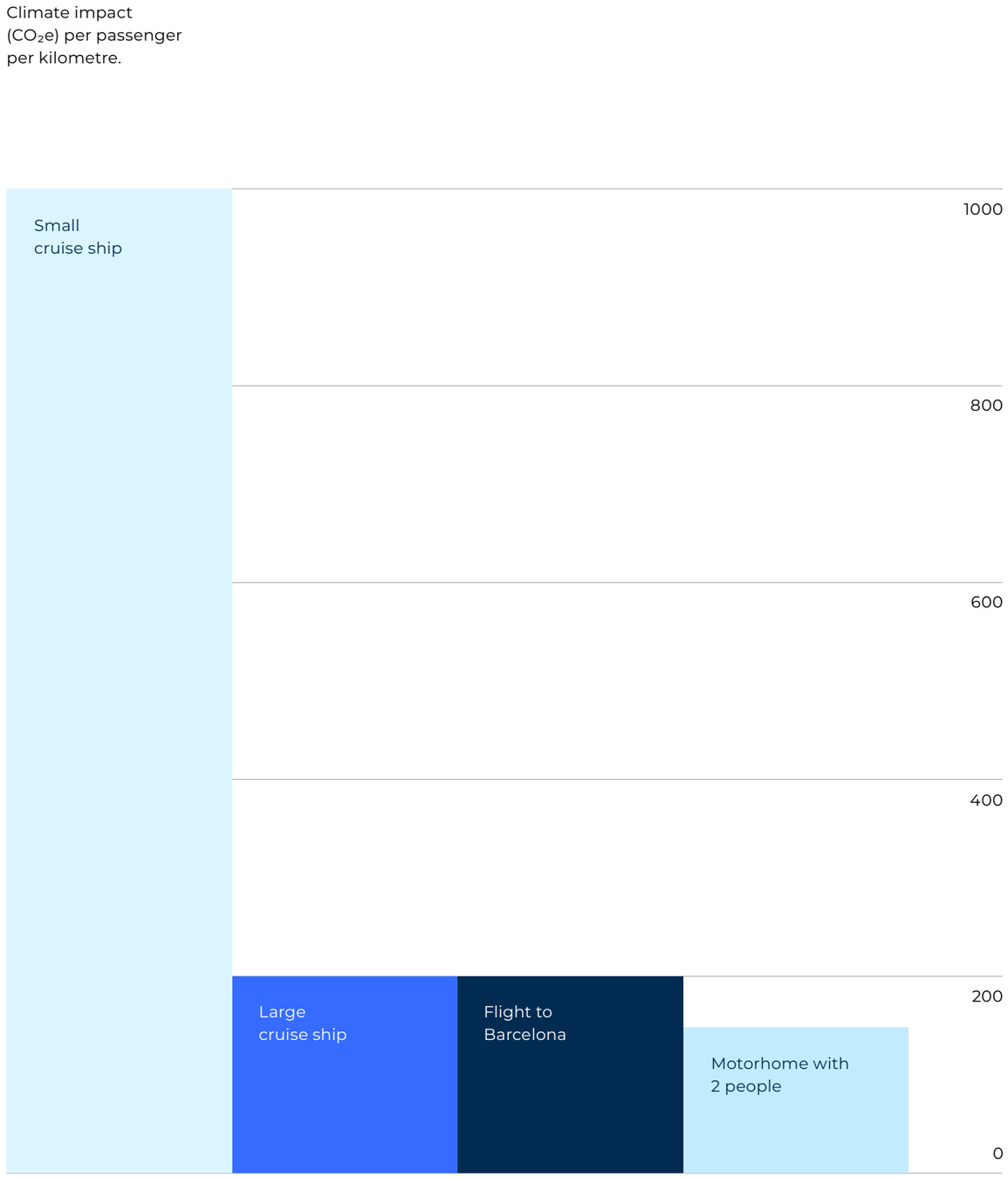
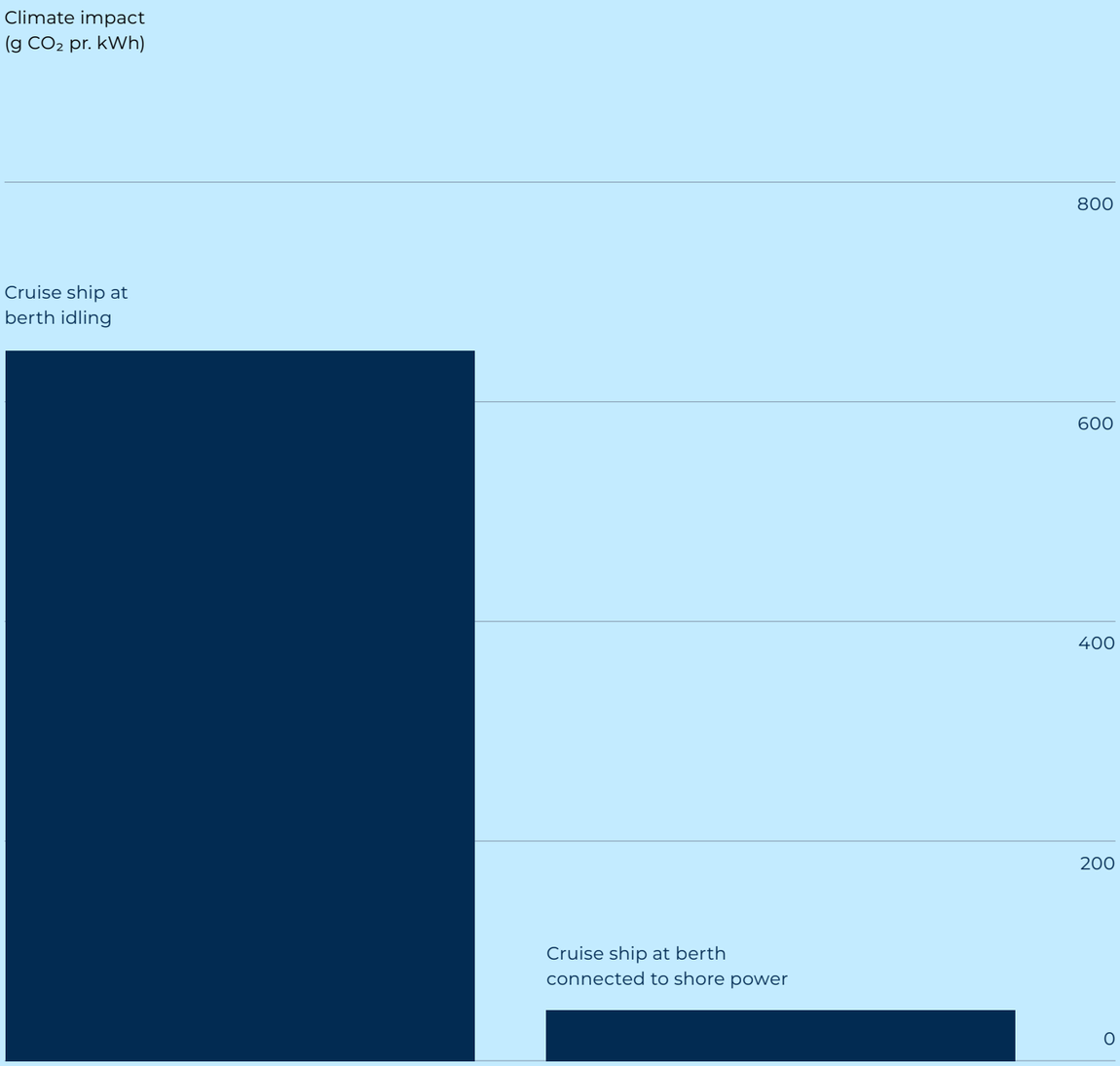
Large cruise ships have a climate impact comparable to that of flying per passenger-kilometre. However, achieving a high mileage and climate impact is significantly easier and quicker when flying.



02 CLIMATE IMPACT

TECHNICAL SOLUTIONS



The formation and emissions of climate harmful CO_2 from cruise ships are closely related to the ships' use of fossil fuels (oil and liquid natural gas). The climate impact over the short to medium term, specifically within the next 15 years, can be reduced by decreasing energy consumption per passenger through both technical and operational solutions. Additionally, an increasing number of cruise ships will be able to connect to shore power, as previously mentioned. When a cruise ship in Copenhagen connects to shore power instead of idling, it significantly reduces its climate impact by approximately 90%. However, this does not address the environmental effects experienced at sea, which account for over 80% of the total climate impact from cruise ships. While fully battery-driven cruise ships are not feasible with current technology, partially battery-driven operations, such as port manoeuvring, are achievable today.

Acknowledging the shortage of bio-oils and biogas to cover the energy demand from shipping, it is however expected that cruise ships on the long term will switch to new fuels, the so-called electrofuels or P2X fuels, produced from green electricity, water and possibly CO_2 (which would have anyways been emitted to the atmosphere). The actual electrofuels available are hydrogen (H_2), ammonia (NH_3), and methanol (CH_3OH). All electrofuels can technically be used by new cruise ships. The challenge lies in the fact that electrofuels are anticipated to be considerably more costly than traditional fuel oil. Furthermore, assuming all factors remain constant, it will take decades before there is a sufficient surplus of green electricity to produce electrofuels on a large scale, especially as the rest of society must also decarbonise and electrify. The safety aspects of ammonia, which is highly toxic if leaked or spilled, must be resolved before it ever could be considered for use onboard passenger ships.

The climate impact per passenger can be reduced significantly if the individual cruise ship company acts by:

- Ensuring high passenger occupancy
- Using slow steaming
- Using shore power and electric propulsion for manoeuvring
- Optimising route planning/maintenance.
- Reducing passengers' energy consumption.
- Implementing waste heat, air lubrication, etc.
- Using the largest possible cruise ships.
- Ordering the most energy efficient ships.

The international organisation for cruise ship companies aims on reducing the climate impact per transport-work by a minimum of 40% in 2030 compared to 2008, and for cruises to be climate neutral in 2050.

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02 CLIMATE IMPACT

REGULATION

International regulation of shipping is governed by the International Maritime Organization (IMO).

The United Nations International Maritime Organization (IMO) governs the climate impact of shipping. At the IMO, the world's 176 so-called *flag states*, that is, countries where larger ships are registered in and carry their flag, as well as non-governmental interest groups (environmental organisations, cruise ship organisations, industry groups, etc.) have the opportunity to suggest and discuss proposals, and set reduction targets and regulation mechanisms for shipping. Regulations established by the IMO are mostly global and applies to most forms of shipping.

To achieve climate targets, the International Maritime Organization (IMO) will strengthen existing regulatory mechanisms for shipping in the coming years. Simultaneously, discussions have focused on adopting new regulatory mechanisms, including a global fuel standard aimed at gradually reducing the climate impact of fuels. Additionally, a financial incentive, such as a climate levy to price climate pollution from shipping, has been proposed to facilitate the transition to climate-neutral shipping. This will be complemented by systems designed to enforce these new regulations.

The European Union mandates the implementation of shore power facilities and the utilization of shore power at major ports starting in 2030. The European Union has announced that starting in 2024, all larger vessels, including cruise ships, will be incorporated into the EU quota system. This decision mandates that these ships must purchase CO_2 quotas to cover 100% of their climate impact while operating between EU ports, as well as 50% of the impact for journeys to and from ports outside the EU. The agreement will be implemented gradually over a three-year period, allowing cruise companies to progressively obtain quotas. The goal is to achieve 100% coverage of emissions by 2027 (covering climate impact from 2026).

IMO'S CLIMATE TARGET for shipping on a global level (decided in 2023)

2030:
- 20-30% reduction of the climate impact compared to the climate impact in 2008.
- 40% reduction of the climate impact per transport-work compared to 2008.
- 5-10% of the energy consumption covered by zero emission technologies/energy sources/fuels.

2040:
- 70-80% reduction of the climate impact compared to the climate impact in 2008.

2050
- (or thereabout): Shipping must be climate neutral.

02 CLIMATE IMPACT

INITIATIVES OF THE CRUISE COMPANIES

As fuel is a significant expense for cruise companies, the companies have already implemented the most profitable energy savings: deploying several technical solutions (read p. 35), which along with a higher degree of occupancy - while expanding capacity with larger cruise ships combined with new technology - have significantly reduced the climate impact per passenger per kilometre.

Currently, cruise companies are actively retrofitting their ships to ensure that most vessels operating in the North Sea and the Baltic Sea will be able to connect to shore power once ports have established the necessary facilities. Many companies have committed to purchasing shore power when it is offered at reasonable prices.

The Cruise Lines International Association (CLIA), representing 95% of the global cruise market, has committed to two significant climate goals set by the International Maritime Organization (IMO). As part of its commitment, CLIA aims to reduce the climate impact per transport-work by at least 40% by 2030, compared to 2008 levels, and strives for climate neutrality in cruises by 2050. Consequently, many CLIA members are actively engaged in research and pilot projects that focus on developing new fuels with a lower climate impact.

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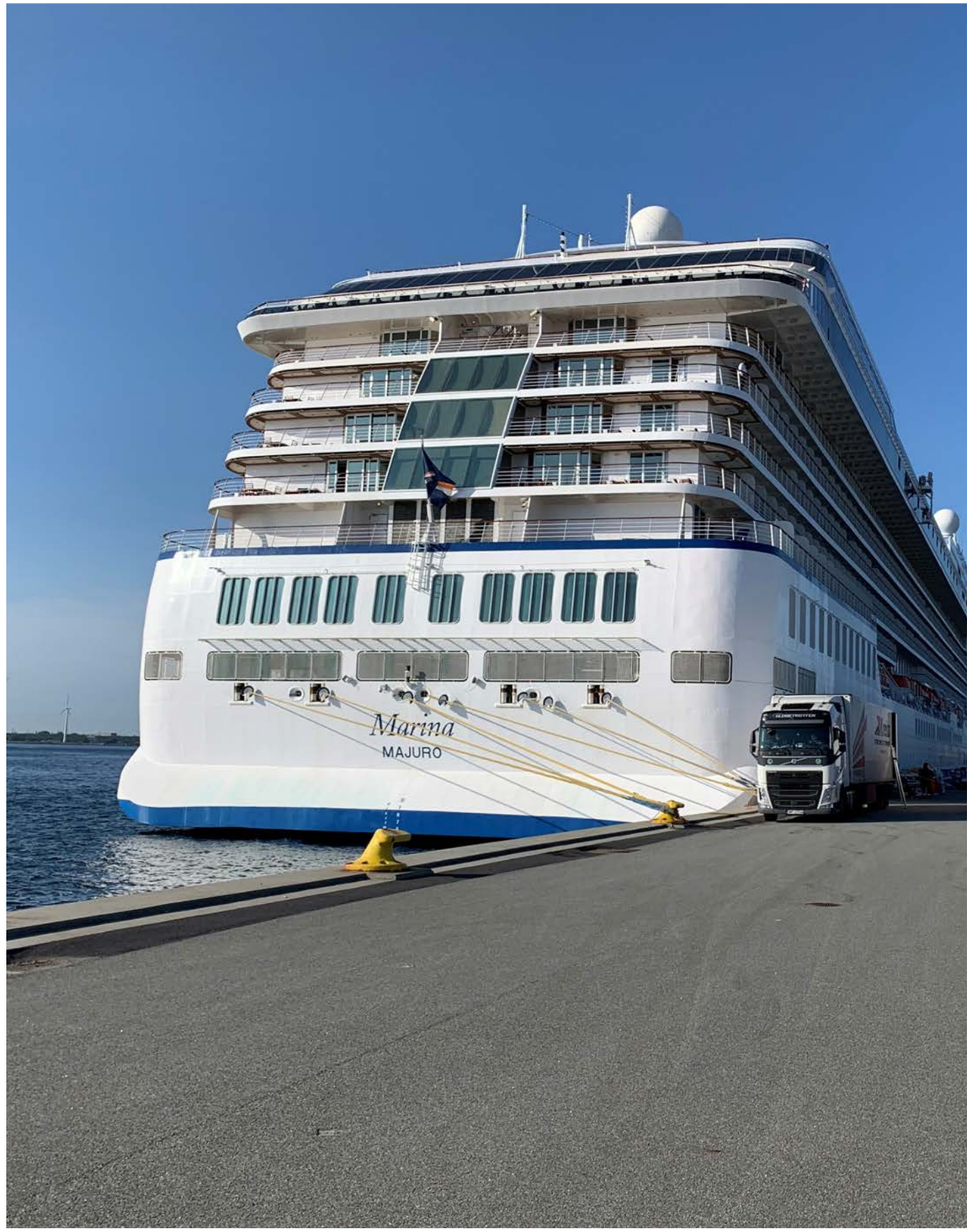

03 WASTE MANAGEMENT

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Cruise ships, often compared to floating hotels, produce waste just like any other part of society. It is essential to sort this waste to enable proper handling and recycling upon arrival at port, akin to household waste management practices. Typically, the crew on board is responsible for sorting and managing the waste to ensure effective categorization.

It is forbidden to throw waste overboard according to IMO regulations (read about IMO p. 38), as waste poses a significant threat to biodiversity while also being aesthetically problematic. There are exceptions, for instance, for food waste. Furthermore, all cruise ships are required to implement a waste management plan that focuses on minimizing waste generation and establishing proper procedures for handling and storage.

The IMO recommends to sort waste in the following fractions: residual waste for incineration or landfilling, recyclable waste (sorted as food oils, glass, aluminium, metal, paper, cardboard, wood, and plastic), electronics, and hazardous waste. Likewise, the IMO regulation states that ports must provide the necessary receival facilities. The IMO lacks the authority to ensure that ports receive and manage sorted fractions as intended. For example, it is essential to ensure that sorted plastics are redirected to recycling facilities.

Some cruise ships have been equipped with their own onboard waste incinerators, to enable them to efficiently manage waste and optimize storage space. However, the incineration of waste onboard, contributes to harmful air pollution (read p.12) and prevents waste recycling i.e., waste incineration is not consistent with the implementation of circular economy.

Photo: Copenhagen Malmö Port

03 WASTE MANAGEMENT

INITIATIVES OF THE CRUISE COMPANIES

Many cruise ships have made concerted efforts to reduce waste by focusing on minimizing food waste, eliminating disposable products, and decreasing the use of packaging. The focus has been to reduce the number of items that end up as waste onboard the ship. Likewise, the focus is to minimise the use of plastic onboard. Additionally, many cruise ships meet most of their freshwater needs by converting seawater into freshwater onboard.

Cruise ships typically manage waste by adhering to the guidelines set forth by the International Maritime Organization (IMO), unless they choose to incinerate some or all of their waste using onboard incinerators.

An investigation conducted at 12 Danish ports during the fall of 2024, which receive calls from cruise ships, reveals that these vessels effectively adhere to the waste management recommendations established by the International Maritime Organization (IMO). Several ports even praise the high sorting standard the cruise ships bring to light and facilitate the further waste handling of the fractions for the ports. The larger ports aim to optimize the volume of waste directed to recycling facilities. Conversely, smaller ports may need to consolidate various waste fractions and transport them to incineration plants, especially when managing smaller quantities of waste. However, electronics and hazardous wate is always managed separately.

When asked if the cruise ships sort out their waste, an employee responsible for the Port of Helsingoer in Denmark responds without hesitation: “They do, and they are very good at it. Packed and wrapped. Really surprisingly well. They have that under control. If not, it is reprimanded.”

04 WASTEWATER MANAGEMENT

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Cruise ships function as floating mobile hotels, accommodating thousands of passengers. Consequently, they generate a significant volume of wastewater from various sources, including toilets, baths, and restaurant kitchens, similar to any densely populated area in our society.

According to the current regulations set by the International Maritime Organization (IMO), cruise ships are prohibited from discharging blackwater and greywater within 22 kilometres of the shore and in particularly sensitive sea areas (PSSAs). This restriction is in place because wastewater, like all domestic wastewater, contains organic compounds and nutrients that can lead to oxygen depletion and excessive algal growth, ultimately harming the natural environment. The wastewater presents not only an aesthetic issue but also a potential risk of infection. Currently, the Baltic Sea is classified as a Particularly Sensitive Sea Area (PSSA). Consequently, wastewater must be collected and disposed of at port whenever possible, or treated at an approved wastewater treatment facility onboard the ship prior to discharge. Likewise, the IMO regulation states that ports must provide receival facilities for the disposal of wastewater.

Most cruise ships have installed efficient wastewater treatment plants. The downside of these onboard installation is the increase in ships' energy consumption (fuel use) along with an increase of the associated emissions of air and climate pollution (described above). By handing in the wastewater (the wastewater sludge) at port the biogas potential is also utilised which can potentially benefit the green transition. However, this requires a vast amount of space for storage onboard the ship.

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Cruise ships generate significant quantities of wastewater from various sources, including toilets, baths, and restaurant kitchens, similar to a small city.

04 WASTEWATER MANAGEMENT

INITIATIVES OF THE CRUISE COMPANIES

Cruise companies have committed voluntarily to not discharge wastewater anywhere — not even far offshore (more than 22 km) where direct discharges would be permitted according to IMO regulations. Most cruise ships have advanced wastewater treatment plants which clean as efficiently as smaller land-based wastewater treatment plants.

Furthermore, cruise ships are working to minimise the production of wastewater through an actively promoting water savings (installation of showerheads with water conserving flow, toilets with water conserving flush or vacuum, dishwashing and washing machines with low water consumption, etc.). Additionally, passengers onboard are encouraged to take shorter showers, reuse towels, and take other steps to conserve water.

An investigation conducted at 12 Danish ports in the fall of 2024, which all receive calls from cruise ships, shows that all 12 ports can receive wastewater from these vessels. Typically, this wastewater goes straight to the sewage system and subsequently to an existing wastewater treatment plant on shore. However, at some smaller ports, the wastewater is transported to the treatment facility using vacuum tankers.

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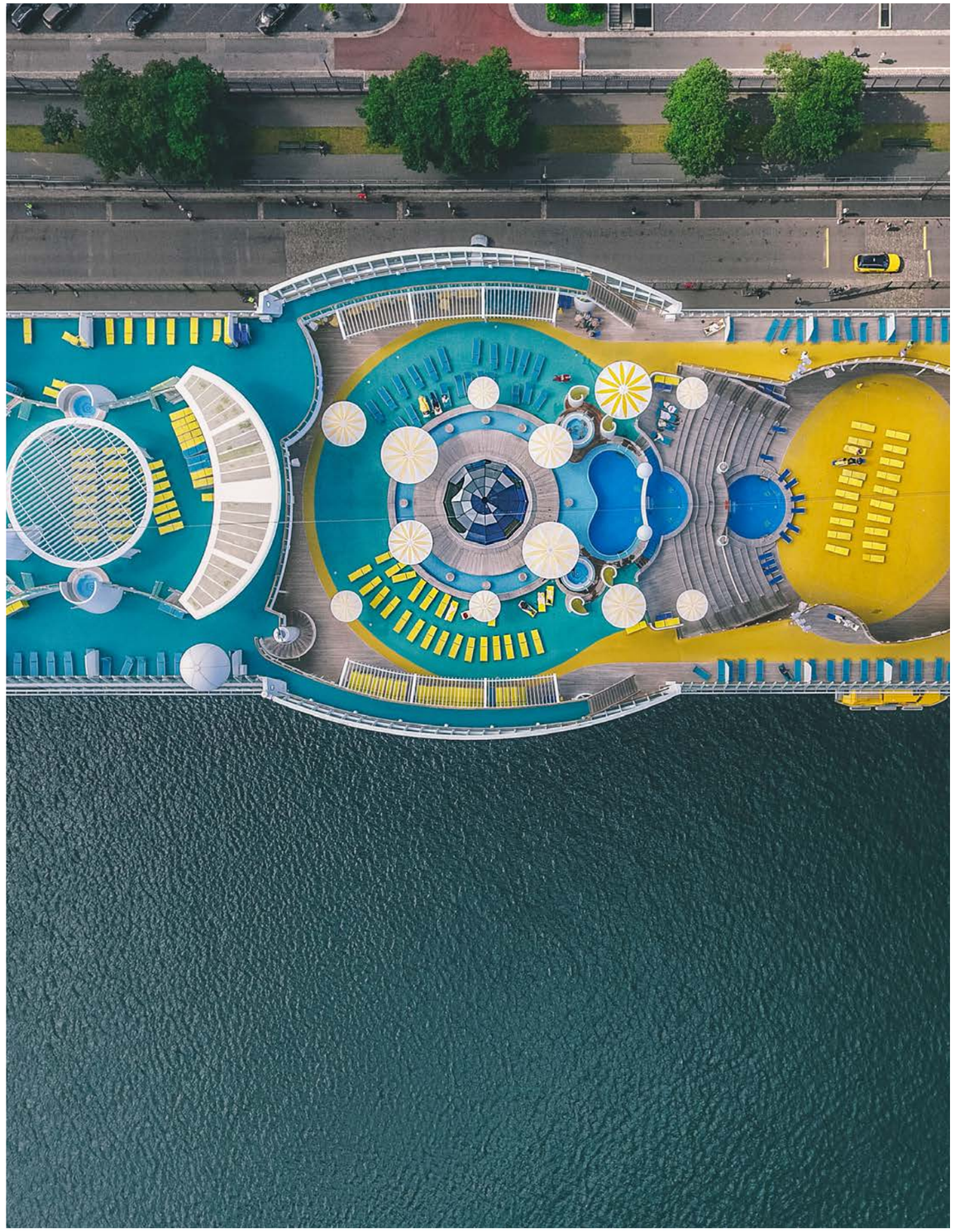

05 OTHER ENVIRON-MENTAL CONSIDERA-TIONS

The subsequent discussion addresses various environmental challenges associated with shipping, which are also pertinent to cruise ships. These challenges include the use of scrubbers, the impact of underwater noise, and the presence of toxic chemicals in antifouling paint.

Currently, nearly 10% of all larger ships have installed a scrubber, while an even greater proportion of cruise ships have adopted this technology. When a ship has a scrubber installed, it can continue to use traditional heavy fuel oil and therefore can avoid switching to cleaner (more expensive) fuels. The type of scrubbers installed on cruise ships “shower” the flue gas to capture part of the air pollution into the water after which the scrubber water is typically discharged directly into the sea transferring the air pollution to water pollution. The scrubber water contains heavy metals and tar compounds, which are toxic to marine ecosystems. Additionally, scrubbers increase the fuel consumption and the associated air pollution by 2-3%.

Ships generate underwater noise, posing a considerable threat to marine ecosystems, especially for higher mammals like dolphins, seals, and whales. Furthermore, cruise ships generate local noise at their destinations, including sounds from loudspeakers and the ship's horn during arrival and departure. Some ports, including Copenhagen, have banned outdoor loudspeakers at quay berth in close vicinity to residencies.

Historically, ships have played a significant role in the release of toxic chemicals from antifouling paint. They have also facilitated the introduction of invasive species through ballast water transport, posing a threat to native species. Additionally, emissions resulting from energy consumption and the materials used in constructing new ships contribute to environmental harm. Furthermore, the conditions associated with shipbreaking are detrimental to the environment.

The hermit crab species *Pagurus longicarpus* Say is thought to have been introduced via ballast water. While it may appear harmless, it actually poses a threat to various native species impacting biodiversity.

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05 OTHER ENVIRONMENTAL CONDITIONS

REGULATION AND INITIATIVES OF THE CRUISE COMPANIES

The International Maritime Organization (IMO) (see p. 38 for more information) has approved the use of scrubbers as a more affordable alternative to cleaner fuels. As a result, the number of ships equipped with scrubbers has increased dramatically — by a factor of 1,000 over the past 15 years. However, this trend raises serious concerns, as the discharge of scrubber water arguably violates Article 195 of the UN Convention on the Law of the Sea, which prohibits transforming air pollution into water pollution — precisely what scrubbers do. In response, a growing number of countries, including Denmark and Sweden, have announced plans to ban the discharge of scrubber water into the sea in 2025. Several other countries and international organizations — such as the EU, HELCOM, and OSPAR — are also expected to implement similar bans.

The IMO has agreed guidelines for the reduction of underwater noise from ships (currently voluntary), which include recommendations on how to reduce underwater noise from each ship. To ease the burden, IMO has consolidated the existing knowledge on underwater noise and how it can be reduced, as well as how better designs of new ships (including a particular focus on propellor design), can reduce underwater noise.

The work of the IMO has resulted in a convention which prohibit the use of harmful organic tin compounds in the antifouling paint and prevents a potential future use of other harmful compounds. IMO has agreed a convention, which requires that all ships have ballast water management plans and impose all ships to neutralize the ballast water prior to discharging. The Hong Kong Convention is entering into force in June 2025 and must ensure that shipbreaking practices comply with international standards and manage hazardous materials appropriately.

Cruise ships have introduced systems to reduce underwater noise and have implemented slow steaming practices in particularly sensitive sea areas and fjords containing vulnerable fauna. Newer cruise ships have hulls, propellors and other devises to reduce underwater noise. They avoid anchoring as much as possible in sensitive areas. Cruise ships use toxic-free antifouling paint.

Ports and destinations in the Baltic Sea that receive cruise calls and are part of the Cruise Baltic network committed as early as 2019 to a manifesto aimed at systematically and decisively reducing the environmental and climate impacts of cruise tourism. This commitment is also reflected in the European alliance that Cruise Baltic joined in 2024, alongside Cruise Norway, Cruise Britain, Cruise Europe, and MedCruise.

READ MORE ABOUT HELCOM AND OSPAR

- **HELCOM** (Helsinki Commission) is the Baltic Marine Environment Protection Commission.
- **OSPAR** is the mechanism by which 15 governments and the EU cooperate to protect the marine environment of the North-East Atlantic.

06 MORE ENVIRONMEN-TALLY FRIENDLY CRUISES

In the short and medium term, it will not be possible to make cruises into a sustainable vacation. However, many initiatives proposed in this publication can be made to further reduce the environmental and climate impacts from cruise ships.

Cruise ship companies cannot do this alone. They are dependent on close cooperation with ports and cities, for instance, in relation to shore power and recycling of sorted waste. They also depend on technological development and political decisions, to enable the green transition without impacting the transition of other sectors and without causing unintended anti-competitive practices.

New cruise ships must become more environmentally friendly by always connecting to shore power and using partial electric propulsion for manoeuvres. Potentially in the future, cruise ships can use pure hydrogen (H_2) for propulsion produced by wind and solar power as well as hydropower. The most efficient use of hydrogen should be in fuel cells

onboard, which would produce electricity for propulsion and for the many facilities onboard. Highly efficient heat pumps could also produce heat. The by-product from use of hydrogen as a form of energy onboard is pure water which could be further used onboard.

Sludge and waste must be disposed of in port (as is already done by many cruise ships) to enable recycling of the wastes as part of the circular economy, and to enable the use of sludge in biogas facilities to support the green transition of the destinations by biogas production.

Underwater noise can be minimised by new ship design, propellors, and fuel cells (electric propulsion). When designing new ships, recycling materials from old ships – as well as a general use of sustainable materials – will be a vital focal point for the entire sector.

We look forward to participating in the journey towards green transition of the cruise tourism along with all other key stakeholders that dedicatedly work for a green transition of our society.

Increasingly, cruise ships are serving more delicious plant based and vegetarian meals using ingredients from destinations thus contributing to the green transition by introducing new eating habits and contributing towards shifting the taste of passengers. There is a ban on outdoor loudspeakers at residential areas.

07 INSPIRATION FOR FURTHER ACTIONS

To facilitate a successful green transition in cruise tourism and to realize our vision of becoming a global leader in this area, it is essential to establish an effective framework at global, regional, national, and local levels to inspire the rest of the world.

By 2030, the Internationale Maritime Organization could introduce at a global level:

- Requirements on the use of efficient catalysts (e.g. SCR) and particulate filters (or equivalent).
- A climate fee of at least 100 euro per tonne of CO_2-equivalent, which will increase gradually each year.
- Global ban on discharging toxic scrubber water and the use of heavy fuel oil.
- A requirement that ships must connect to shore power, and that larger ports must offer shore power.

EU, OSPAR, HELCOM (read p. 58) could at a regional level from 2030 introduce:

- Efficient enforcement of the existing environmental and climate requirements.
- A ban against discharging toxic scrubber water.
- A termination of fossil investments (incl. liquid natural gas).

By 2028, countries could introduce at a national level:

- Efficient enforcement of the existing environmental and climate regulations.
- A ban against discharging toxic scrubber water.
- Extra port fees for ships without SCR catalysts and particle filters (or equivalent).
- Extra port fees for ships using heavy fuel oil.
- A termination of fossil investments (incl. liquid natural gas).

By 2028, cruise ship companies could introduce for all ships:

- Connection to shore power at ports for all ships (when possible).
- Partial electric propulsion for manoeuvring in port.
- The use of SCR catalysts and particle filters (or equivalent).
- A phase-out of scrubbers and the use of heavy fuel oil.

From 2028, larger ports could introduce:

- Shore power facilities for all cruise ships (and other ships).
- Financial incentives for ships to connect to shore power.
- Financial incentives that promote port calls by environmentally friendly ships.
- Financial incentives to prevent ships from using heavy fuel oil.
- A ban against discharging toxic scrubber water in the port area.
- A termination of fossil investments (incl. liquid natural gas) in ports.
- Provide the fossil free renewable fuels of the future.
- Offer fossil free terminal management and introduce fossil free operation.
- Increase availability of environmental and climate friendly experiences at the destination.

08 MORE INFORMATION

- https://dce2.au.dk/pub/SR413.pdf
(In Danish)

- https://dce2.au.dk/pub/SR316.pdf
(In Danish)

- https://dce.au.dk/fileadmin/dce.au.dk/Udgivelser/Videnskabelige_rapporter_600-699/SR605.pdf
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- https://mim.dk/nyheder/pressemeddelelser/2024/april/bred-politisk-aftale-danmark-forbyder-udledning-af-scrubbervand-fra-skibe-til-havmiljoeet
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- https://www.maritimedanmark.dk/soren-og-soren-enige-om-co2-afgift
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- https://climate.ec.europa.eu/eu-action/transport/reducing-emissions-shipping-sector_en

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- https://www.imo.org/en/ourwork/environment/pages/garbage-default.aspx

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- https://www.imo.org/en/MediaCentre/Pages/WhatsNew-1818.aspx

- https://www.imo.org/en/OurWork/Environment/Pages/BallastWaterManagement.aspx

- https://www.imo.org/en/OurWork/Environment/Pages/Anti-fouling.aspx

- https://www.imo.org/en/OurWork/Environment/Pages/Ship-Recycling.aspx

- https://api.cruisebaltic.com/media/mpjnq3eu/cruise-baltic-sustainability-manifesto.pdf?_gl=1*ic99qi*_ga*MTM1Mjc3Nzg0OC4xNjc1MzMxNDA2*_ga_ETL56G01ZW*MTczODU5Mzk5NC45NC4xLjE3Mzg1OTM5OTkuNTUuMC4w