TOWARDS **SUSTAINABLE** CRUISE TOURISM

IN THE GREATER BALTIC SEA REGION

FEBRUARY 2020

Nordic Council of Ministers

Ministry of Environment and Food of Denmark

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REPORT

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1 Executive summary

The Danish Ministry of Environment and Food has placed more sustainable cruise tourism on the agenda of the Danish Presidency of The Nordic Council of Ministers (NCM) with the aim of developing the Greater Baltic Region into Europe's greenest cruise destination. The Danish Presidency has received co-financing for a collaboration project between the Nordic and Baltic Sea countries on this issue. In this context, a need has emerged for a catalogue of initiatives that can attract greener cruise ships to the Nordics and the Baltic Sea, and ensure wider distribution of shore power in the ports in the Baltic Sea region.

This report describes the status of the efforts towards greener cruise ships in the Greater Baltic area and analyses instruments and tools which can promote the development of the cruise industry in a more environmentally sound direction.

One of the instruments to achieve greener cruise tourism in the short term is to set up facilities to provide shore power facilities for cruise ships in the Baltic Sea ports. Using shore power instead of diesel generators reduces the emissions of harmful substances such as NO_X, SO_X to vulnerable environments in nearby cities and green house gases CO_2.

To this end, an analysis has been carried out, looking into the present status and identifying instruments to deploy shore power in the Greater Baltic Region.

1.1 Shore power status

Greater Baltic Region

Shore power for ferries is relatively widespread in both large and small ports in the Greater Baltic Region, but only Norway seems to have adopted an overall national strategy to implement shore power for cruise ships. German ports seem to be just a step behind while a number of other ports in the Greater Baltic Region are considering to implement it. However, finding economically viable shore power solutions in smaller cruise ports remains a challenge.

The implementation is to a great extent driven by demands from city administrations, stemming from rising general concern about emissions and air quality.

Also, a growing proportion of cruise ships are ready to connect to shore power. This is underlined by the fact that Copenhagen Malmö Port (CMP) expects that up to 75 per cent of all cruise ships calling on Copenhagen will be shore-power ready by 2021.

The USA

For the past 15-20 years, USA has played a leading role in implementing shore power facilities for cruise ships. In 2007, the California Air Resources Board (CARB) approved a regulation which requires large container, reefer and passenger vessels, which are frequent callers, to use cleaner shore-based electricity instead of auxiliary engines while at berth, or to utilize exhaust gas cleaning systems to scrub auxiliary air emissions to achieve equivalent emission reductions. There are two shore-power facilities in Seattle, which were

established in 2004 and 2005. A third will open in 2022 and a fourth is expected in 2023. Connecting to shore power is voluntary in Seattle, but the port asks all homeport ships (ships making passenger turnarounds in the port) with shore power capability to connect. The plan is to make it mandatory to connect at the new facility, which is expected to open in 2023.

1.2 Drivers of greener technologies

The significance of emissions from both land traffic and ships is widely recognized and there is a growing focus on harmful effects from emissions. This trend is part of a general growing awareness about air quality and liveable cities.

Especially NO_x and particles give rise to a wide range of effects on human health and well-being. For example, increased frequency of bronchitis, respiratory distress, lung cancer and asthma.

Growing public attention to these effects has led to an increase in political awareness about air pollution from cruise ships. The development is reinforced by the fact that many cruise ports are located in large populous cities, which helps to increase awareness of the problem.

Whether the customers, i.e. the cruise passengers, are also more concerned with air pollution and green cruise tourism remains uncertain. This question has not been treated in this analysis. However, this question is obvious since the idea of Greater Baltic area as Europe's greenest cruise destination depends on there being a demand for green cruise tourism among passengers.

1.3 Possible actions

The analysis indicates that relevant initiatives to promote shore power can be implemented at three levels: 1) Port and city level, 2) national level and 3) cross-national level: Nordic Council of Ministers.

Port and city level

So far, investments in shore power facilities are up to each port or city to decide. Either the ports or the cities, which often own the ports, are responsible for considering investments in shore power facilities. Therefore, mayors and city councils are an important driver of an environmental transition in the cruise industry in ports.

Ports can also create incentives to attract the most environmentally friendly cruise ships. The ESI system (Environmental Ship Index) and the EPI system (Environmental Port Index) are international incentive structures designed to improve environmental performance for ships at sea and at berth.

ESI and EPI reward environmentally friendly ships. ESI and EPI cannot stand alone as incentives, but they clearly signal the environmental ambitions of each port.

Other incentives could be rewarding shore-power ready ships by offering them the berths with the most attractive locations. However, this is only an option in bigger ports with several berths.

Since the installation of shore power facilities is still very expensive, it is worth investigating if some of the investment (e.g., cable laying) can be shared with other users. This could either be ferries (as in the Port of Kiel), power plants or industries.

National level

At national level, it is important to remove barriers to the green transition in ports. Among other things, uncertainty about electricity charges can be a barrier for decisions to invest in shore power.

Furthermore, it can be considered if each country can support the installation of shore power facilities financially. In Norway, the Norwegian fund for green energy transition, ENOVA, has worked as an instrument to support shore power.

Finally, national governments can initiate dialogue with major cruise ports, e.g. through the ports' interest organizations. The aim should be a shared vision for shore power to cruise ships.

Nordic Council of Ministers

The Nordic Council of Ministers plays an important role in developing the vision for a green and environmentally sound cruise destination in the Baltic Sea Region.

This role may include bringing the relevant actors from the Baltic Sea Region together in workshops and seminars. The roll-out of shore power infrastructure across the Baltic Sea Region will require several years of port feasibility studies, city planning processes, financing discussions and sharing of best practices on operations and best available technologies. Therefore, the Nordic Council of Ministers can consider keeping sustainable cruise tourism high on the agenda for forthcoming presidencies and ensure availability of more funds. Such initiatives and clear political signals can motivate action among ports, cities and countries that are still facing the decision to invest in shore power.

A vision by the Nordic Council of Ministers to create the most sustainable cruise destination in Europe can send a signal to industry players, and the Ministers can be inspired by various industry statements such as the Norwegian declaration "14 common requirements to the cruise industry"[1].

[1] https://www.skipsrevyen.no/article/fjorder-og-byer-fronter-felles-krav-til-cruiseskip-om-lavere-utslipp/

2 Introduction

Northern Europe, especially the Baltic Sea and the Norwegian coast, is seeing a huge growth in cruise tourism. While the Central and Western Mediterranean is the largest cruise market in Europe, Northern Europe is second and seeing a higher growth in the number of passengers[2].

The Baltic Sea and the Norwegian fjords are the main attractions for the cruise industry in the region. The growth in the number of cruise tourists and number of calls from cruise ships has increased focus on the environmental impact of cruise ships. Several countries and cities in Northern Europe are considering measures to reduce emissions from the cruise ships.

The Baltic region has been at the forefront of green and clean maritime transportation since it introduced sulphur emission control areas (SECA). Such SECA areas were also introduced in the North Sea and along the American coastline. From 2020, ships operating outside SECA areas also have to meet stronger regulations regarding sulphur in shipping fuel.

This development calls for considerations regarding new steps towards cleaner cruise tourism in the greater Baltic region.

Thus, the Danish Ministry of the Environment and Food formulated a project for the Danish Presidency of the Nordic Council of Ministers about greener cruise tourism, and received co-financing for a collaboration project between the Nordic and Baltic Sea countries on this issue. In this context, a need has emerged for a catalogue of initiatives that can attract greener cruise ships to the Nordics and Baltic Sea, and ensure wider distribution of shore power in the Baltic Sea region.

This report describes the status of the efforts towards greener cruise ships in the Greater Baltic area and analyses instruments and tools which can promote the development of the cruise industry in a more environmentally sound direction.

2.1 Guide for the reader

The report first recaps the main findings in the executive summary in chapter 1. Chapter 2 explains the methodology of the analysis and presents a list of abbreviations.

Chapter 3 recaps the environmental and sustainability agenda, which sets the background for the analyses. This chapter also recaps the development of shore power and other technologies that support a green cruise industry.

Chapter 4 contains an overview of shore power today – both in the USA and in the Greater Baltic Region – and chapter 5 deals with the major drivers of shore power development.

[2] https://cruising.org/-/media/research-updates/research/final-market-report-europe-2018.pdf

Chapter 6 describes instruments and possible actions to achieve a cleaner and greener cruise industry.

2.2 Methodology

The analysis was carried out as a desk-study based on data collected via literature and qualitative, semi-structured interviews with stakeholders. The following stakeholders were interviewed:

Ports
Stockholm
Helsinki
Tallinn
Bergen
Kristiansand
Oslo
Copenhagen-Malmö Port
Skagen
Rønne
Aarhus
Seattle
Hamburg
Kiel
Cities
Bergen
Oslo
Others
Danske Havne
Bergenshalvøens Kommunale Kraftselskap (BKK)
California Air Resources Board

For structuring the analysis, we have developed an effect chain that illustrates different ways to reach the desired impact: Cleaner air in and around the Greater Baltic Region. See Table 2.1 below.

Table 2.1 Possible effect chain to reach the overall goal/impact

Activities →	Output →	Outcome →	Impact
› Analysis of status: › Experiences with shore power? › What instruments have been used? › What works – in what context? › What possibilities and barriers can be identified? › What are the key stakeholders? › What roads are there to financing?	› Deployment of national and international experiences regarding shore power for cruise ships. › Clarification of possibilities and barriers regarding regulation. › Mapping of instruments that can strengthen efforts towards improved air quality.	› More ports in the Greater Baltic Region invest in shore power facilities. › Shipping companies deploy more environmentally friendly cruise ships in the Greater Baltic Region. › The Greater Baltic Region is known as a green cruise destination.	› Cleaner air quality in and around the Greater Baltic Region.

2.3 Abbreviations and expressions

The following abbreviations end expressions are used in this report:

CA	California
CARB	California Air Resources Board
CLIA	Cruise Lines International Association
CMP	Copenhagen Malmö Port
CSI	Clean Shipping Index
CO_2	Carbon dioxide
DCE	Danish Centre for Environment and Energy
DFDS	(Det Forenede Dampskibs-Selskab, The United Steamship Company)
DKK	Danish krone
ENOVA	Norwegian fund for green energy transition
EPI	Environmental Port Index
ESI	Environmental Ship Index
EU	European Union
HPA	Hamburg Port Authority
Hz	Hertz
IMO	International Maritime Organization
kV	Kilovolts
LNG	Liquified natural gas
MARPOL	Maritime Pollution – The International Convention for the Prevention of Pollution from Ships (1973/78)
MVA	Mega volt amp
MW	Megawatt
NECA	NOx Emission Control Area
NEK	The Norwegian Electrotechnical Committee
NOK	Norwegian krone
NO_x	Nitric oxide
NGOs	Non-governmental organizations
SECAs	Sulphur emission control areas
SEK	Swedish krona
SO_2	Sulphur
UN	United Nations
USA	United States of America

3 Background

This chapter provides an introduction to the cruise industry and the increasing focus on emissions from cruise ships on both a global level and in the Baltic Sea Region. In addition, the chapter presents the various technologies that can contribute to a greener cruise industry.

The cruise industry has seen high growth over the past decade. According to the Cruise Lines International Association (CLIA), the global number of cruise passengers has increased by 58 per cent from 2009 to 2018[3] – representing a significant development.

Whereas the Caribbean cruise market is still by far the largest market, Northern Europe (including the Baltic Sea) in particular has seen significant growth in recent years, and the Northern European market is expected to grow even more in coming years.

Fact box: The cruise industry

The cruise industry is a global industry, with a small number of very large shipping companies dominating the market.

Among the major players are the shipping companies MSC Cruises and Royal Caribbean Cruises, which includes also Celebrity Cruises, TUI Cruises and Pullmantur Cruises. Also Carnival Cruises, which also includes AIDA, Costa Cruises, Holland America Line and P&O. These shipping companies and associated companies are also among the largest players in the Baltic Sea.

Since cruise tourism in the Baltic Sea primarily takes place in the summer, the same ships are used in the winter in other parts of the world, for example in the Caribbean Ocean. This entails a significant exchange of ships between the continents.

However, as the cruise market in the Caribbean is the world's largest market for cruise tourism, it is the general assumption that the newest ships primarily sail in that area. The vessels arriving in the Baltic region are usually at least 4-5 years old and a large share are between 10 and 20 years old. However, the ships are constantly being modernized. The vessels vary greatly in size, from a capacity of 200-300 passengers to approx. 4,000-5,000 passengers. The average ship increases year by year.

The cruise activities are concentrated in a relatively short season of five-six months – in practice, from Easter to the autumn holidays, peaking in August. Cruise ships often sail an entire season in the Baltic Sea, with passenger replacement, say, every seven or ten days. The same ships therefore often call on ports many times. Some ships call on the same port 14-16 times in one season. In Copenhagen, some 70 ships account for approx. 325-350 calls.

High-level emissions control initiatives

Parallel to this development, greater attention has been placed on the environmental impacts of the cruise industry. Over the years, there has been a general focus on emissions from the shipping industry. The international MARPOL[4] convention regulates the sulphur content of a ship's fuel. The global upper limit for permissible sulphur content of fuel is currently 3.5 per cent, but

[3] 2019 State of the Industry. CLIA, 2019

[4] MARPOL. The International Convention for the Prevention of Pollution from Ships

in October 2016 the IMO decided that this limit should be 0.5 per cent, from 2020.

In the so-called SECAs (sulphur emission control areas), a particularly low limit of 0.1 per cent has been introduced. The area primarily comprises the North American coasts, parts of the Caribbean, the North Sea and the Baltic Sea. All Danish waters are part of the SECAs. Parallel to the introduction of SECA, a declining sulphur content in the air has been recorded over Denmark.

The MARPOL convention also comprises nitric oxide (NOx). Until now, only waters along the American and Canadian coasts have been so-called NECA areas (NOx emission control area), but the North Sea, the Baltic Sea and the English Channel will become NECA areas from 2021.

In order to comply with these rules, it is necessary to use low-sulphur fuel or alternative fuels such as liquified natural gas (LNG), batteries and other fuels. Another option is to purify the sulphur-containing smoke using a so-called 'scrubber' (flue gas cleaning system) to avoid emitting sulphur with the exhaust gas.

Air pollution and human health risk

The Danish Environmental Protection Agency refers[5] to a study carried out by the Danish Centre for Environment and Energy which assesses that long-term exposure to air pollution in Denmark leads to approx. 4,000 premature deaths a year (2019). The total health-related external costs in Denmark resulting from air pollution were estimated at approx. DKK 75 billion/year in 2018[6].

A report from the Danish Centre for Environment and Energy[7] presents more detailed survey results. The report shows that NOx emissions in specific spots in the Port of Copenhagen account for 17 per cent of total emissions in central Copenhagen, and particles account for 6 per cent of total emissions.

The harmful effects are caused by NOx, particles and sulphur. NOx emissions give rise to a wide range of effects on human health and well-being. For example, increased frequency of bronchitis, respiratory distress, lung cancer and asthma. Air pollution with particles in urban areas gives rise to serious health effects such as cancer, cardiovascular diseases and allergies. Emissions of sulphur (SO_2) cause damage to nature and corrosion of buildings, and sulphur can be converted into aerosols, which by inhalation can cause lung damage.

3.1 Global and European development

Along with the general focus on the shipping industry, the focus on the environmental impact of cruise industry has grown. Beside the substantial

[5] https://mst.dk/luft-stoej/luft/hvad-er-luftforurening/sundhedskonsekvenser-af-luftforurening/statusrapport-om-luftforureningens-indvirkning-paa-sundheden/.
[6] Danish Centre for Environment and Energy (2019): Air quality and health effects i Denmark, status 2018 (Luftkvalitet og helbredseffekter i Danmark, status 2018),
[7] DCE - Danish Centre for Environment and Energy (2019): Survey of air pollution from cruise ships in Copenhagen and Aarhus.

growth in activity, the cruise industry is characterized by cruise ships having a very high energy consumption (and therefore producing a lot of emissions), often being often very visible in ports, and by often berthing near city centres.

Industry-level green initiatives

Thus, the industry has taken initiatives to meet the environmental and sustainability agenda in several ways:

- There is a general focus on climate change and energy consumption. As cruise travels are still perceived as a luxury for the few, the quite substantial energy consumption of each ship stands out.

- Major cities – especially in North America and the western parts of Europe – have seen a growing focus on clean air and liveable cities. Green NGOs and the public in general are more concerned about emissions from diesel engines, i.e. NOx emissions and particles. This awareness has helped put air quality and the sources of air pollution on the public agenda. Here, the primary focus is on the transport sector, including the cruise industry.

- In some cities – especially in Europe – the growth in the cruise industry has been related to 'overtourism'[8], which has attracted critical public attention to the cruise industry. In Venice, Bruges, Dubrovnik and Barcelona, critics are questioning the number of cruise calls, and debating 'overtourism' and how the ships are managed in port etc. Some cities have taken measures to allocate ships to berths further away from the city centre, introduce a tourist tax or simply cut down the number of calls[9].

Increase in shore-power ready ships in Copenhagen

- A growing proportion of cruise ships are ready to connect to shore power. This is underlined by the fact that Copenhagen Malmö Port (CMP) expects that up to 75 per cent of all cruise ships calling on Copenhagen will be shore-power ready by 2021.

- Until now, only a few ports in the Greater Baltic Sea Region have established shore power facilities. An exception is the Port of Kristiansand in Norway, which introduced shore power for cruise ships in 2018, and the Port of Bergen will have shore-power ready in 2020. However, several ports are either investigating the basis for shore power plants or have concrete plans for shore power plants in the coming years. An overview is presented in the next chapter 4.2.

For years, California has made it a priority to reduce emissions from the shipping industry. Shore power connections for cargo vessels have been in operation since 2007 and shore power connections for cruise ships since 2011.

[8] See https://www.theguardian.com/business/2019/sep/16/a-rising-tide-overtourism-and-the-curse-of-the-cruise-ships
[9] https://www.ship-technology.com/features/cities-who-banned-cruise-ships/

3.2 Greater Baltic area

In the Greater Baltic area, meaning the Baltic Sea region, the Norwegian coast and Northern Germany, has only recently seen a focus on environmental issues related to cruise ships. In Denmark, Norway and St. Petersburg (Russia), the number of cruise passengers has grown quite dramatically over the past ten years. St. Petersburg has more than doubled the number of passengers in ten years, as has Denmark. Norway has also seen quite a dramatic development in the number of passengers.

The Norwegian cruise market is by far the strongest market in the Greater Baltic area, accounting for approx. 4 times as many passengers as Denmark[10]. The number of passengers in both St. Petersburg and Tallinn (Estonia) equals the level in Copenhagen, i.e. approx. 645,000[11]. In Finland and Sweden, the number is significantly lower.

In Denmark, Copenhagen is the dominant destination, receiving 82 per cent of all passengers. Copenhagen is moreover a preferred turnaround port for the Greater Baltic area because of its major airport close to the city[12].

There are no signs that the number of passengers will decline in the coming years. In a report for the City of Copenhagen[13], it was estimated that the number of passengers would grow by a trend of 4.8 per cent a year until 2030. This means that the number of passengers will reach 1.2 million in 2030.

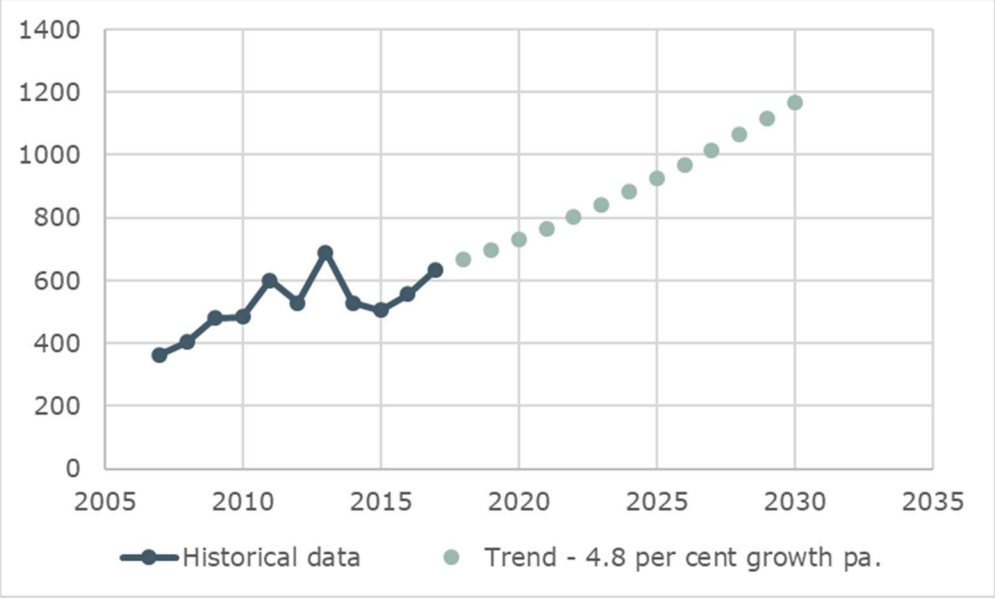

Figure 3.1: Number of cruise tourists. Copenhagen 2006-2030.
Source: Alternative energy supply for cruise ships. COWI, February 2019

[10] https://www.cruise-norway.no/viewfile.aspx?id=5635 and Statistics Denmark, SKIB35
[11] https://portspb.ru/en/about/info_about_port/SN and https://news.err.ee/911178/cruise-tourists-spend-more-than-50-million-in-tallinn-in-2018
[12] A 'turnaround port' refers to the day that old passengers get off and new passengers get on
[13] Alternative energy supply for cruise ships. COWI, February 2019.

Setting standards for green cruise industry

As mentioned above, the Norwegian cruise market is very attractive for shipping companies and holds a leading position in the cruise industry in the Greater Baltic area.

As a result of this position, when Norwegian ports and authorities make demands related to shore power facilities, shipping companies adapt to these requirements. Therefore, to some extent, the Norwegian market sets the standard for the development in the rest of the Greater Baltic area.

The cities of Bergen and Stavanger are major destinations, but the main attractions are the Norwegian fjords, like Sognefjorden and Geiranger, and several small towns in the fjords.

3.3 Norway

The development of the sustainable cruise agenda in Norway is triggered by a combination of factors:

- Norway pursues a green agenda in a broader perspective, exemplified by the large investment in electric cars, which is backed financially by the state.
- The Norwegian topography underlines the problems with emissions from cruise ships. The high rocky slopes along the fjords make it difficult for the emissions from ships to disperse naturally. Smoke from the ships can be seen hanging in the air for hours after a ship has left the port. This has given rise to a public focus on environmental problems associated with cruise ships.
- Norway is also increasingly concerned about overtourism, especially in smaller towns and hamlets. This development has been linked to cruise ships as well.

Norway is implementing a consistent policy towards introducing shore power facilities in Norwegian ports. Introducing shore power targets both local ferries and cruise ships. The Port of Kristiansand opened Norway's first shore power facility in 2018 and a major facility in Bergen will be fully operational in 2020.

The Norwegian fund for green energy transition, ENOVA, is a co-financing partner for several shore power projects, providing almost NOK 580 million in investment support to 90 onshore power projects.

Fact box: The ENOVA fund

The ENOVA fund was established in Norway in 2001. Its purpose is to contribute to the conversion of the Norwegian society into a low-emission community. The fund's financing consists of transfers from the Norwegian state budget, including income from a part of the network tariff.

The ENOVA fund contributes financially to the implementation of energy and climate-friendly projects that would otherwise not be possible. The projects may concern industry, land transport, maritime transport, construction and real estate.

Since 2001, the fund has supported more than 7,000 projects. The principle behind the funding is that the fund supports those projects that provide the greatest climate and energy improvement in relation to the financial support.

In 2018, the fund awarded NOK 2.1 billion to projects. The transport sector, including the maritime sector, was the largest recipient of financial support. In total, ENOVA has supported approximately 90 projects related to shore power, mainly to local ferries, but also cruise-related projects.

3.4 Technologies towards a green cruise industry

The increased focus on a more environmentally friendly maritime sector has developed over several years and the efforts of the International Maritime Organization (IMO) has been an important driver of the development.

The general maritime sector and the cruise industry have involved several technologies in efforts to achieve a cleaner industry.

The restrictions in the IMO MARPOL Protocol have placed a greater focus on the development of both new propulsion and environmental technologies.

3.4.1 Scrubbers

Washing out SOx and particles

Scrubbers clean the exhaust by 'washing out' sulphur oxides and particles. Scrubbers are widely used by the shipping industry, both as an alternative to cleaner fuels and in combination with cleaner fuels, i.e. low-sulphur fuel.

The maritime sector as well as national and international authorities recognise the limitations of this technology since ship emissions remain quite significant and play a major role in the local environment when ships are at berth.

This means that scrubbers remain an applied technology on ships that use oil as fuel. But there is a growing realization that scrubbers cannot stand alone.

3.4.2 LNG

Natural gas as propulsion

One alternative to installing scrubbers on ships is to use liquified natural gas (LNG) as fuel. LNG is a natural gas, which cools down to -161 degrees Celsius, at which point the gas condenses and becomes liquid and the volume of gas is significantly reduced compared to when the gas is airy. LNG-powered vessels are equipped with special tanks and pipe systems, but LNG basically acts as a fuel, in line with oil. A LNG-powered vessel needs to be supplied with gas every eight to ten days.

Compared to oil, LNG has a number of environmental benefits: a complete removal of sulphur emissions, plus a significant reduction of NOx and particle emissions.

The world's first LNG-powered cruise ship was taken into service in 2019 by the cruise line AIDA (under Carnival Cruises Cooperation). According to CLIA[14], more LNG-powered ships will be taken into service in the coming years. However, the deployment of the technology will be slow because it is not possible to convert existing cruise ships to use LNG. It is expected that 17 per cent of the cruise ship capacity will be LNG-powered by 2030[15], but the figure is uncertain as the shipping companies' plans may change.

[14] Cruise Ship Order Book, February 2020.

[15] Alternative energy supply for cruise ships. COWI, February 2019.

LNG propulsion comes with challenges. The supply chain is costly as natural gas is transformed to LNG in so-called liquefaction plants, and relatively few exist in Europe. Moreover, since the gas must stay cooled to remain liquid, it is not financially and practically possible to store LNG for long. Therefore, a LNG supply station must regularly receive supplies from outside the port, e.g. from Lithuania or the Netherlands, both of which have LNG terminals.

It is important to emphasize that LNG and shore power are not mutually exclusive, as the vessels can choose both solutions, i.e. use LNG as fuel during sailing and shore power at berth.

3.4.3 Shore power

In recent years, shore power has developed to be a more widespread technology.

A shore power solution consists of a power cable that connects to the local power grid, and a frequency converter that converts the frequency from 50 Hz to the cruise ship's 60 Hz power system. In addition, the system includes a cable management system, i.e. a method by which the ship can quickly and easily connect to the shore power supply.

Implementation requirements

A shore power facility is quite a big plant. A 16 MVA facility (which corresponds to the international standard), like the facility in Kristiansand, Norway, takes up space (in the range of six 20-foot containers). In practice, a facility of this size is not mobile, and the network connection becomes complicated and expensive.

The power demand for cruise ships is very high. The demand ranges from 5-7 MW for the average cruise ship[16] to 12-15 MW for the largest vessels. This means that the cost of electricity supply via shore power is also very high: Both the electricity cable from the main electricity or transmission grid and the frequency converter imply large establishment costs.

In most cases, only newer vessels are equipped with shore power connection. However, more and more ships are retrofitted (redesigned to be able to connect to shore power). The average costs of retrofitting a ship to shore power connection is generally estimated to EUR 1-2 million per ship.

Besides, a shore power facility makes high demands on the capacity of the local electricity grid. This is especially a challenge in smaller communities with sparse electrical infrastructure and a high number of cruise calls.

Shore-power ready ships

The next step in shore power is expected to be so-called hybrid-ships. In other words, ships that are equipped with batteries, which can supply the propulsion. A hybrid solution means that ships sail to quay without using their engine, e.g.

[16] https://www.tu.no/artikler/landstrom-na-er-cruiserederiene-klare-bergen-kan-bli-tredje-ut-i-europa/446943

by manoeuvring the last 30 minutes on battery. If the ship uses a battery for propulsion, the battery must also be charged by the shore power facility.

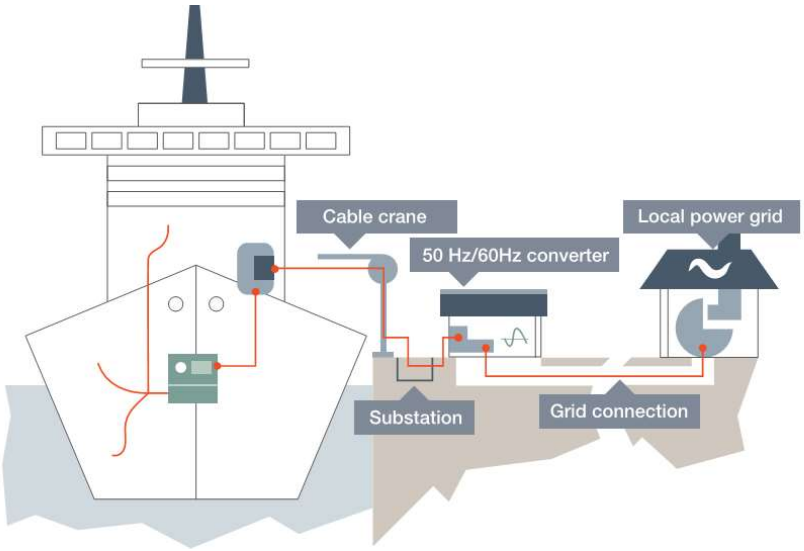

Figure 1: Principle sketch for a shore power plant.

Figure 1 presents a principle sketch for a shore power plant. The system consists of the following elements:

- Connection to the local power grid: The local power grid (often the local utility company) delivers high-voltage power for the shore power facility.
- Grid connection: The grid connection is the high-voltage cable from the local power grid to the converter. The cable is installed in a dedicated trench, running from a switch station on the local grid to the port converter. The distance depends on the local conditions.
- Converter (50 Hz/60 Hz): A power converter converts the 50 Hz local power to the 60 Hz shore power typically used onboard cruise ships. The converter is a complicated high-voltage installation manufactured by a specialist company. Depending on the desired capacity, the converter can take up 120-200 m^2. The converter is placed relatively close to the relevant berth.
- Substation: A substation is a connection point at the berth. The cables which are used to connect to the ships are connected to the substation.
- Cable crane and cable management system: The cable crane is mostly mobile and carries the cable reel and the connector and lifts the cable to the connection point on the ships' side.

General electrification effort

In parallel to the development of shore power facilities for cruise ships in ports, a more general effort to electrify port operations is under way. A few ports consider connecting cargo ships – e.g., containerships – to shore power.

Several ports store ships for shorter or longer periods of time. In most cases, the ships need a minimum of power supply during their stay and if they are not able to connect to a shore power facility, they depend on a diesel-powered auxiliary engine.

Most of the ports interviewed for this analysis have shore power facilities to accommodate ferry traffic. This goes for all the larger ports (Oslo, Stockholm, Helsinki and Tallinn) and a number of the minor ports:

- The Port of Esbjerg, Denmark, has announced an interest in this type of initiative in combination with self-generated electricity from solar panels and wind turbines.

- The Port of Grenaa, Denmark, has invested in a shore power facility. The installation has a capacity of 2 MW and targets ships and drilling rigs etc. which berth for long periods. This facility is not big enough to supply cruise ships.

- The Port of Rønne established shore power for ferries in 2000.

More general electrification of the ports could possibly promote the distribution of shore power, as an expanded electricity infrastructure simplifies the distribution of shore power and reduces costs. At present, it is a barrier that the electricity needs of cruise ships are so big that synergy opportunities are limited.

4 A status of shore power for cruise ships

This chapter provides an overview of the distribution of shore power in the USA and the Baltic Sea region. The chapter also describes the decision-making processes and rationales behind the introduction of shore power in the individual ports.

The deployment of shore power for cruise ships is very diverse across the globe. The major cruise ports in the USA have offered shore power connection for several years, whereas it is still quite a new technology in Europe. This chapter reviews the status of shore power technologies in the USA and in the ports in the Greater Baltic area. Interviews with the California Air Resources Board (CARB) and the Port of Seattle were carried out for this section.

4.1 The USA

In the USA, especially ports on along the Pacific coast in California and Washington (Seattle) are far ahead in terms of introducing shore power facilities for cruise ships.

4.1.1 California

The state of California actively promotes shore power to reduce air pollution and greenhouse gases from the state's ports. As a result, California has become a global centre of shore power innovation, research and development, producing a boom in business[17]. Regulations have driven ship owners to upgrade their vessels.

Global development

In 2007, CARB approved the At-Berth Regulation[18], which requires large container, reefer, and passenger vessels that are frequent callers (five or more visits per year to any single CA port) to use cleaner shore-based electricity instead of auxiliary engines while at berth, or utilize exhaust gas cleaning systems to scrub auxiliary air emissions to equivalent emission reductions[19].

The regulation defines a California port as the ports of Los Angeles, Long Beach, Oakland, San Diego, San Francisco and Hueneme. Compliance options are classified as 1) **Reduced Onboard Power Generation**, which requires fleets to reduce overall auxiliary engine operation, effective since January 2010, and 2) **Equivalent Emissions Reduction Option**, which requires percentage reductions in a fleet's NOx and PM emissions, effective since January 2014.[20]

As of 2019, the CARB plans to propose new regulations that would require *all* cruise ships docking in the state to plug into shore power. The current Shore

[17] https://www.wartsila.com/twentyfour7/innovation/how-shore-power-protects-california-from-fatal-pollutants
[18] *"Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth in a California Port"* Regulation
[19] https://ww3.arb.ca.gov/ports/shorepower/shorepower.htm
[20] Port of Los Angeles – Environmental Management Division. 2014.

Power Regulation is administered by the CARB, and requires ships visiting the major Californian ports five or more times to plug in while at berth[21]. Under the new rules, ships previously visiting four or fewer times would remain exempt from the regulations until 2023[22].

Regulations and financial penalties

Vessel operators that visit a berth or terminal in California would be required to plug in to shore power on each visit to a compatible shore power berth, if available[23]. Vessel operators would face financial penalties for not complying with the regulation, and a shipping line can accrue multiple violations for one visit that failed to plug into shore power [24]. However, exemptions apply if any of the following occurs: Vessel safety and emergency events; bulk and general cargo vessels; vessel commissioning; research vessel visits that participate in testing of an alternative technology.[25]

In this respect, ports like those in California can remain aligned with the IMO *"Right of Ship Access to Port State Under International Law"*, requiring that foreign flagged vessels have the right to navigate waters and enter port states, while port authorities keep the power to set conditions for accessibility.

4.1.2 Seattle

The Port of Seattle is a government agency of Washington State, and sees itself as committed to being environmentally proactive. Cruise lines have partnered with the port in this effort, and there is a longstanding history of cruise lines voluntarily going above and beyond, with regard to regulatory compliance.

The Port of Seattle has 210-220 cruise calls a year. Most of the calls concern just 11 ships, which means that the port is oriented towards a relatively small number of large ships, which visit regularly. In this respect, the port differs from most Northern European ports.

In the Port of Seattle, the cruise lines installed one shore power facility in 2004 and one in 2005. At the moment, there are two facilities. A third will open in 2022 and a fourth is expected in 2023.

Cooperation between ports and companies

In the port, Holland America Cruise Line and Princess Cruise Line own and operate the shore power equipment. Moving forward, the port is seeking partnerships and grants to expand the availability of shore power.

Connecting to shore power is voluntary in Seattle, but the port asks all homeport ships (ships making passenger turnaround in the port) with shore power capability to connect. The port plans to make it mandatory to connect at the new facility, which they expect to open in 2023.

[21] http://www.polb.com/civica/filebank/blobdload.asp?BlobID=10587
[22] https://www.cruiseindustrynews.com/cruise-news/21964-california-to-propose-shorepower-rule-changes.html
[23] https://ww3.arb.ca.gov/regact/2019/ogvatberth2019/appa.pdf
[24] Penalties are spelled out in California Health and Safety Code Section 42400.
[25] https://ww3.arb.ca.gov/regact/2019/ogvatberth2019/appa.pdf

In Seattle, an agreement and payment scheme for power has been made directly between Seattle City Light and the cruise lines. The port is not involved in the cost or payment structure.

At the moment, the Port of Seattle does not offer discounts to ships which connect to shore power. The number of ships with shore power capability is very high and almost all ships with shore power capability are connecting. Therefore, a discount would not make sense.

4.2 Greater Baltic area

To establish a status of shore power facilities in the Greater Baltic area, a number of interviews were conducted with different ports. In the following sections, we recap the status of each of the interviewed ports, with the exception of the smaller ports, which are described in the same chapter.

To gain an overview of the status of shore power facilities, see table 4.1. The overview is based on COWI's interviews in December 2019.

Table 4.1 Overview of shore power facilities in ports in the Greater Baltic area

Port	Shore power facilities	Plan for shore power (ferries/cruise ships)	Incentive/driver for establishing shore power	Use of incentives such as ESI/EPI/CSI
Helsinki	One for a ferry (Tallinn-Helsinki)	Yes. Nine on-shore power (OSP) facilities to be established before 2035.	Plan for carbon neutrality in City of Helsinki. The port is owned solely by CoH. Demand from customers	ESI – difficult to say how many vessels are covered
Tallinn	For passenger ships (ro-pax) in 2020	OSP options for cruise ships under consideration	Memorandum – Baltic cities 2016	ESI, EPI
Stockholm	Facilities for four ferries	More to be established in 2020 (ferries) and action plan for shore power for cruise ships in 2030	Owner (City of Stockholm) and demand from customers	Clean Ship Index (CSI) from 1.1.19. ESI from 1.1.20. Through former incentive model, large amounts have been paid in rebates for shipping companies
Bergen	15 low-voltage points (coastal and international ferries)	Three high-voltage points for cruise ships in 2020	Differentiated port fees (based on ESI and EPI)	EPI bonus system: Encourages ships to invest in green measures
Kristiansand	Facilities for four ferries and one cruise ship	No plans for more high-voltage points for cruise ships	Booking policy incentive: If vessel can receive shore power, it will have priority for best berths	EPI bonus system: If cruise ship has shore power, it receives full/high score; will introduce EPI fully in 2020
Oslo	International ferry lines (5) are all on OSP before January 2020	Political agreement in 2019 on OSP for cruise ships in all larger ports in Norway	Zero-emission plan for the Port of Oslo and common understanding between 14 largest ports in Norway regarding OSP	EPI, ESI
Hamburg	The port has offered shore power since 2017.	Plans of expanding the facility for both cruise ships and container ships from 2022	A combined pressure from the City of Hamburg and interest from a shipping company	ESI
Kiel	The port has offered shore power for ferries since 2019.	The port is planning a new dual shore power system for both ferries and cruise ships	The port wishes to contribute green solutions, but there is also political attention on air pollution	ESI
Skagen	No shore power facilities	No plans at the moment	There is some attention, but not to a great extent	NA
Rønne	OSP for ferries since 2000	No further plans, but the new harbour is ready to receive OSP		NA
Copenhagen		Expecting shore power for ferries (DFDS) and cruise ships in 2021/2022	There is widespread political attention to air pollution from cruise ships	NA
Aarhus		Shore power for ferries will be ready in late 2020. Shore power for cruise ships is under consideration.	There is rising public and political attention to air pollution from cruise ships	Has adapted to ESI in January 2020.

In 2016, the Ports of Tallinn, Helsinki, Stockholm and Turku signed a memorandum of understanding on a common approach to shore power supply for ferries and combined cargo and passenger ships (ro-pax vessels). The Ports agreed to provide new connections with a voltage of 11 kV a frequency of 50 Hz for ro-pax vessels.

ESI, Environmental Ship Index, is a voluntary index designed to improve the environmental performance of sea going vessels. The ship index gives a numerical representation of the environmental performance of ships regarding NO_X and SO_X and CO_2. ESI enables ports and other interested parties to stimulate ships to improve their environmental performance.

Ships with a good performance as regards to NOx and SOx and CO_2 will be offered a discount on port fees in ports which have joined ESI. ESI only includes ships that perform over and above current international legislation (IMO). ESI is free of charge for ship owners.

EPI, Environmental Port Index, is a relatively new initiative from a number of Norwegian ports. EPI is also focused on reducing emissions like NO_X, SO_X and CO_2. While the Environmental Ship Index (ESI) focuses on ships at sea, the EPI focuses on emissions from ships while at berth. The index uses economic incentives for ships with the lowest environmental footprint when at berth.

CSI, Clean Shipping Index, is a non-profit organization offering a voluntary environmental performance label for ships and shipping companies. It is a practical tool for differentiating port and fairway fees, and providing market incentives for clean shipping or choosing more sustainable shipping alternatives[26].

4.2.1 Port of Stockholm

The Port of Stockholm is strongly influenced by its owner, the City of Stockholm, which has set ambitious goals regarding environment and climate, and sets demands for shore power facilities in environmental approvals.

Also, the port aims to meet the demands from its customers and play an active role in helping customers reduce their environmental impact.

The port received some attention in traditional and social media in the summer of 2019, regarding idling cruise ships and the environmental and health consequences in terms of air quality, CO_2 emissions and to some extent also noise.

The Port of Stockholm has not yet established shore power for cruise ships, but anticipates that facilities will be established within the next ten years.

The port has high-voltage shore power facilities for four ferries in Värtahamnen (two for Helsinki and two for Tallinn). Since the 1980s, the port has had two low-voltage shore power facilities for local ferries. The high-voltage shore power facilities were established in dialogue with the shipping company (Tallink Silja) and Östersjöhamnen in Helsinki to ensure that the same technology was established in both ports.

[26] https://www.cleanshippingindex.com/

Photo: AS Tallink Group

The port has an action plan from 2019 regarding the need for renovation of quays and establishment of new quays and harbours. The action plan contains a prioritised list of quays for ferries, cruise ships and container ships.

A new container harbour, Stockholm Nordvik, will open in 2020 with all quays prepared for shore power. In the environmental approval for this new harbour, the City of Stockholm requires the establishment of shore power facilities.

Incentives and rebates

Since January 2019, the port has used the Clean Shipping Index (CSI) and will introduce the Environmental Ship Index as from January 2020. The CSI was chosen because it was also used by the Swedish Sea Authorities (Sjöfartsverket). Before 2019, another incentive model was used. Rather large amounts (amounting to SEK 10-12 million, on several occasions) have been transferred as environmental rebates to shipping companies.

The former model was static, allowing shipping companies to receive rebates by meeting environmental standards. Now, the port has created a dynamic model (small action = small rebate; large action = large rebate) to encourage the shipping companies to constantly strive to doing better.

The Port of Stockholm pays up to SEK 1 million to shipping companies to retrofit vessels to shore power. So far, Tallink Silja Line has accepted, and four ferries have been retrofitted and the rest will follow in 2020 and 2021[27].

4.2.2 Port of Helsinki

In Helsinki, the carbon neutrality agenda is seen as the main reason for promoting shore power. The City of Helsinki aims to become fully carbon neutral in 2035. In the Port of Helsinki, vessels represent the largest source of

[27] https://www.faergenyt.dk/landstroem-til-tallink-silja-faerger-i-vartahamnen/

emissions by far, and the main tool for reducing emissions is shore power. In providing shore power for cruise ships, the port hopes that it will not affect the volume of cruise ships, rather improve the quality of vessels – that shipping companies will send newer ships, for instance.

Consumer demand and competitive advantage

The Port of Helsinki has been affected by discussions in traditional and social media regarding emissions from cruise ships. The port anticipates higher future demand from customers, i.e. consumers at the end of the logistics chain, who want to travel with the lowest possible carbon emissions – this is seen as a competitive edge.

The Port of Helsinki has one shore power facility for a ferry line between Stockholm and Helsinki. The City of Helsinki, which is the sole owner of the port, launched a carbon neutrality action plan in November 2019, which aims at vastly increasing shore power facilities. The plan is to build nine new facilities before 2035. Five berths will be operational in five years' time, servicing ferry traffic and cruise ships. The port uses the Environmental Ship Index, not the Environmental Port Index. External financing comes mainly from the EU. The electricity supply company pays for the grid needed in the area.

4.2.3 Port of Tallinn

The Port of Tallinn is experiencing a general pressure from the local community and municipality to reduce noise and air emissions in the city centre.

The Port of Tallinn is a listed company with 67 per cent of the shares belonging to the Republic of Estonia. Shore power facilities will be available in the Old City Harbour for passenger (ro-pax) ships in 2020. For cruise vessels, on-shore power (OPS) options are under consideration.

Discounts and marketing

The Port of Tallinn has introduced different environmentally based discounts:

- 2014: Discounts for cruise ships sorting their waste
- 2018: Discounts for LNG ships
- 2019: Discounts based on ESI (Environmental Ship Index).

Apart from the above, the port has experiences with using different types of environmentally friendly marketing such as: EcoPorts, and the Responsible Business Index Silver label issued by Responsible Forum of Estonia. The marketing schemes are very effective and work with both shipping companies and cruise ships.

The Port of Tallinn assesses that, in the future, more and more of these types of incentives will motivate tourists or shipping companies to pursue green efforts, and also suggests including waste management and ballast water management in an index to make it more attractive.

4.2.4 Port of Oslo

The implementation of shore power facilities is, to a large extent, influenced by political pressure from the City of Oslo. The Port of Oslo is owned by the City of Oslo. The City Council has decided that the Port must be a zero-emission port by 2025. In practice, this means that from 2025, all cruise ships expect to use shore power when arriving in Oslo. The Environmental Ship Index (ESI) has been used in Oslo for some years and the Environmental Port Index (EPI) will be introduced by 2020. Until now, focus in Oslo has been on reducing emissions from international ferries. It is expected that from January 2020, all international ferry lines (five in total) will be connected to shore power.

In 2019, there were 123 cruise calls in Oslo. There are still no shore power facilities for cruise ships in Oslo and no concrete plans for investing in such facilities. However, the City Council has decided to reduce the number of cruise ships in the Port of Oslo.

Cooperation through joint initiatives

The City of Oslo has taken the initiative to bring together the 14 largest cruise ports in Norway for a joint effort to introduce shore power for cruise ships by 2025[28]. The point is to develop a critical mass in shore power infrastructure in Norway, with the aim of attracting the most environmentally friendly ships.

Through the joint effort, the City of Oslo, together with other large cruise ports, aims to indicate its expectations to the shipping industry. Consequently, major cruise lines expressly encouraged a 14-point joint declaration and requested regular meetings with Oslo City Council, to be briefed on further developments. The 14 points set out common requirements and serve as a roadmap for green cruise ships.

Many shipping companies, such as international ferry lines, also decided to retrofit older vessels for shore power as a result of similar dialogue forums. The introduction of the Environmental Port Index in 2020 will enable the City of Oslo to differentiate port fees according to the environmental status of ships, further strengthening its signals to the shipping industry.

4.2.5 Port of Kristiansand

The Port of Kristiansand has experienced both political and popular pressure to implement shore power as a result of media attention. There is strong public awareness and scepticism towards the cruise industry. Also, the public acknowledges that it is better that cruise ships visit Kristiansand, which has onshore power available, rather than go to Stavanger and emit CO_2. The Port of Kristiansand is a pioneer in shore power facilities: The port introduced shore power to ferries in 2014 and in 2018 the port invested in a shore power facility for cruise ships.

[28] https://www.skipsrevyen.no/article/fjorder-og-byer-fronter-felles-krav-til-cruiseskip-om-lavere-utslipp/

The facility for cruise ships was partly financed by the EU Horizon 2020 program. When it opened, it was the largest shore power facility in Europe.

Shore power as a tourism booster

Kristiansand is not a major cruise port, but it has seen a significant rise in the number of cruise calls in recent years. The numbers speak for themselves: A few years ago, the number of calls was approximately 40-50 a year. However, in 2020, the expected number of calls is 71, and 110 in 2021. In 2019, 14 out of 51 calls used shore power. The future expectation is 24 of 71 in 2020 and >50 out of 110 in 2021.

Investing in shore power facilities put Kristiansand on the map in the cruise industry. The port recognizes that this has led to a higher traffic volume of cruise ships than there would have been otherwise. In other words, the port estimates that the investment in a shore power facility has meant an increase in the number of ship calls.

In Kristiansand, it is not mandatory to connect to shore power, but ships with shore power connections are offered the most attractive berths. The port has never experienced a situation where a ship that was able to accept shore power did not accept it. Thus, the impression is that the sale prices for shore power have not been too high, although it is still higher than the costs of the ship's own production of power, i.e. producing power by its own engine.

4.2.6. Port of Bergen

The Port of Bergen is the most attractive cruise port in Norway, seeing more than 330 calls a year. Shore power has been considered for many years, but in 2020 a large shore power facility with three connection points will open. The facility is prepared to for an expansion with a fourth connection later on, if needed.

The main owner of the port is the City of Bergen, which sets the agenda on air quality, and plays an active role in the initiatives regarding greener cruise ships in the port. Furthermore, the city sets limits for the annual number of cruise passengers.

Putting a cap on cruise customers, and giving attractive berths to shore-power ready ships

The Port of Bergen complies with international rules, meaning that it does not reject ships without shore power ability. Ships with shore power connections are offered the most attractive berths, though. The number of cruise tourists visiting south-western Norway is predicted to increase considerably in coming years. Destinations like Bergen will not have the capacity to meet the expected increase in passenger numbers[29].

The City has decided on a maximum limit for the total number of passengers that will be accepted in the port on an annual basis. While limiting the permitted number of cruise passengers aims to reduce traffic, the effects depend on whether corresponding initiatives are implemented in other cruise regions. It

[29] Mer bærekraftig cruiseturisme, Petter Dybedal, TØI-rapport 1686/2019, Jens Kr. Steen Jacobsen, UiS

also depends on how cruise lines and customers respond to cruises that do not include key destinations like Bergen, but prioritise alternative destinations.

The Port of Bergen has established a joint venture with the local power company BKK. The new company Plug AS will develop, build and operate facilities to supply ships with clean energy. A greener port in Bergen is the first goal, but BKK and Plug also want to be a driver for establishing shore power in other Norwegian ports.

The Port of Bergen uses the Environmental Shipping Index and was initiator of the Environmental Port Index.

4.2.6 Port of Kiel

The number of cruise tourists visiting Kiel is growing rapidly. Though the intensity of cruise shipping emissions is insignificant in the City of Kiel (which was measured in 2018), the port wants to contribute to protecting the environment, as well as to help operators respond to the societal pressure they are facing.

Dual use as a cost-saving measure

The Port of Kiel has had one shore power facility for ferries since 2019, which is used for the Oslo-Kiel ferry (rated at 4.5 MW, with daily use). Since August 2019, Kiel has been building a dual system for cruise-ships and ferries which can be used for ferries as well as cruise ships. The facility is rated at 16 MW and can operate on both 50 and 60 Hz. The dual facility will be used for two different terminals: the Baltic Sea terminal for cruise ships and the Sweden terminal for ferries. The terminals are located 1.5 km apart and will be linked by a power cable.

Use of the shore power facility is voluntary. Port of Kiel port points out that the ports are in competition with another, and the power facility is not economically competitive with the ships' diesel engines.

The Port of Kiel anticipates saving EUR 4 million by installing a dual system, but this figure is very dependent on the context. The overall investment costs are EUR 15 million.

The port’s tariff structure for cruise ships has been amended, and ships receive a 20 per cent discount by using the power facility or LNG. The dual use facility is the first of its kind in the Baltic Sea Region and in the world, according to the Port of Kiel.

4.2.7 Port of Hamburg

The Port of Hamburg is one of the largest in Europe, and measurements have documented that the ambient air quality regularly exceeds the limits at four measuring stations in four different streets. Since almost one third of SO_X emissions in Hamburg originates from the port, it has been a priority to reduce emissions from port activities.

Since 2016, the Port of Hamburg has had one shore power facility in operation for cruise ships. The investment was EUR 10 million.

Hamburg Port Authority (HPA) aims to install a second unit for cruise ships by 2022/2023. There are in total three cruise ship terminals, and all terminals are planned to be equipped with shore power in the long run.

As an interim solution, an LNG-powered barge provided shore power support in 2015 and 2016 and is currently used as a mobile terminal to provide power for a building. HPA furthermore aims to install shore power facilities for eight container ship terminals.

Lower impact in large port

HPA has not registered any change in cruise ship volume by introducing shore power. The traffic is independent of the power-situation, as the shore supply is voluntary for cruise ships.

HPA has adopted the Environmental Shipping Index (ESI). Ships with more than 20 points (out of 100) get a discount on port fees in Hamburg. The discount is small, but it is relevant to cruise ship operators that work with ESI, as discounts across multiple ports accumulate to a good amount of money.

4.2.8 Smaller ports

In order to map the conditions of the smaller ports, interviews were conducted with the ports of Rønne (Bornholm) and Skagen (Frederikshavn Municipality), both located in Denmark.

Both the ports of Rønne and Skagen are smaller cruise destinations. The number of calls in both ports is between 40 and 45, but the number of passengers is significantly higher in Skagen, since the average ship size is much larger in this port.

Lower priority in smaller ports

There are no actual plans for shore power in either Rønne or Skagen. Neither of the ports have experienced that shipping companies expect onshore power plants to be available in the ports. It is commonly accepted that this technology is not available in smaller cruise destinations.

In Skagen, capacity in the local power grid would be a challenge for shore power, and both ports emphasize that the business case for a shore power facility would be very negative. They also stress that cruise tourism has a significant positive local economic impact, which means that there is a high degree of acceptance of cruise tourism (and related environmental impacts) in the local community.

Finally, it is a point that their development as cruise destinations has been under way for relatively few years. This means that they cannot be sure that the cruise activity will be a stable business for many years.

5 Major drivers behind shore power development

In this chapter, we identify the major drivers behind developing shore power facilities in the ports in the Greater Baltic area. As described in the chapter regarding the environmental and sustainability agenda, more factors are driving the development towards a larger supply of shore power facilities. The drivers are connected to the main stakeholders in developing a sustainable basis for power facilities, meaning the shipping companies and the ports.

5.1 Shipping companies

The shipping companies in the cruise industry are affected by mainly two factors, namely international regulation and consumer demand.

International regulation

As the shipping industry – including the cruise industry - to a great extent is a global business, there is a long-standing tradition of global regulation of the shipping industry. There is a widespread recognition that only commonly accepted rules are an efficient tool to regulate the shipping industry, for regulation to be efficient. The general regulation of the shipping industry is conducted by the UN body IMO, International Maritime Organization. IMO is behind the MARPOL convention which regulates emissions of nitric oxide (NO_x), sulphur (SO_2) from ships.

Whereas international regulation through IMO is a method that requires consensus and thus is a relatively slow method of change, the regulation is widely accepted, and the regulation is accepted to be efficient. But it is also recognised that regulation through IMO is not an efficient way to introduce shore power to the shipping industry in a foreseeable time, as there is currently a great difference in the ability of individual countries to adapt to such regulation. This is due to both different economic opportunities and the differences in countries' focus on environmental issues

Demand from customers

Since cruise tourism is very much a part of the experience economy[30], the industry is very sensitive to consumer reactions. A cruise travel is a mode of travel which brings you close to both larger cities and natural areas and in this case, it is not very positive to be connected to a polluting mode of travel, which exposes the local environment to air pollution.

As the general environmental and sustainability agenda rises, the public awareness is growing regarding both climate changes and emissions of greenhouse gasses and the impact on the local environment when you are travelling. Although there is no comprehensive overview of tourists' demand for eco-friendly cruise tourism.

[30] Experience Economics is a categorization within the business economy that is based on the sale of experiences, either directly or indirectly as some form of experiences related to the sale of a product or service. The most important experiences are: 1) Tourism, 2) Culture, arts and entertainment, 3) Design, image and branding

In that perspective, the cruise industry is sensitive towards negative consumer reactions, especially when the travel industry tries to attract a broader group of consumers to travel with cruise ships.

5.2 Ports

All the interviewed ports mention the city administrations as driving forces towards decisions regarding shore power. The cities have all set up ambitious environmental/climate targets and having most of the ownership of the ports the city administrations to a large extent determine the targets for the ports.

Also, a lot of the cities experience a general public opinion expressing scepticism towards the cruise industry – mainly because of the impact on air quality.

Top-down and bottom-up demand

Therefore, the study identifies the following, major drivers for ports to establish shore power facilities:

- Demand/influence from owners
- Demand from customers (in all parts of the logistics chain)
- Public awareness – expressed in traditional and social media

6 Instruments to attract cleaner cruise ships

This chapter summarizes the possible instruments that the analysis has identified in relation to increasing the distribution of shore power in the Baltic Sea Region.

The most important element of this report is to develop a set of tools and instruments which can be used to reach the overall goal of attracting greener cruise ships to the Nordics and Baltic Sea area.

The analysis of the development in the cruise market and energy solutions for cruise ships shows that both the cruise industry and ports in the Nordics and the Baltic Sea area are seeing a significant development towards initiatives to ensure cleaner cruise ships.

The analysis also points out that the different tools and instruments require different prerequisites in the different ports.

In the presentation of the relevant instruments, we point out under what conditions the instrument or action in question is relevant and possible to apply in specific situations.

It is worth noting, that a common feature applies to the analysis of tools and instruments. Ports with extensive cruise activity have more opportunities to implement initiatives for cleaner cruise tourism than ports with more limited cruise activity. Ports with many calls will have greater security for their investments and they will also have a better position for engaging in active dialogue with the shipping companies on initiatives in relation to, e.g., connecting to shore power.

It is also a general observation that the ports' efforts to regulate air pollution from cruise ships reflect the city's general environmental efforts: When a city wants to take active action against air pollution, the effort in practice also includes the local port, as the two are closely linked, both physically and often organically (via ownership).

The analysis carried out in this report points to the following primary initiatives:

Instrument	Possible initiatives
Regulation	› International regulation › National laws › Port rules
Incentives	› Economic incentives, i.e. port fees etc. › Energy taxes etc. › Local port management, allocating attractive berths to green cruise ships
Cooperation	› Develop common goals for green and cleaner tourism › A common voice towards shipping companies, suppliers and authorities
Branding and marketing	› Development of a common environmental strategy › Development of a green cruise brand › Using CSI (Clean Shipping Index), ESI (Environmental Shipping Index) or EPI (Environmental Port Index)
Technology development	› Development of new technology which overcomes obstacles to implementation of shore power

The analysis shows that both ports and other actors have different opportunities and prerequisites for using these instruments in practice.

6.1 Regulation

Shipping, including cruise ships, is a global industry that is generally regulated internationally, primarily through the UN agency IMO (International Maritime Organization). Nevertheless, some countries, cities and ports wish to regulate the environmental behaviour of ships in different ways.

Regulation on a national, city or port level in practice means mandatory requirements for the ships to connect to a shore power facility.

6.1.1 Mandatory shore power connection

Regulation which entails the obligation to connect to a shore power facility is used in several ports in California, the USA, under the CARB regulation.

In Norway, the Port of Bergen and the Port of Oslo plan to be emission-free in respectively 2030 and 2025. In practice, it will be compulsory to switch off ship engines when at berth. This will regulate the access of cruise ships to the ports, as the ships will need an alternative energy source to their own engine.

Possibilities

The California Air Resources Board (CARB) have for some years enforced a quite strict regulation, meaning that cruise ships are obligated to connect to a shore power facility.

However, there are exemptions from this regulation. Ships which visit major Californian ports less than five times are not obligated to connect to shore power. This means that the rules comply with IMO regulation "Right of Ship Access to Port State under International Law".

The introduction of shore power as a condition for access to ports is, in practice, primarily an opportunity for ports which are very popular with the shipping companies. Especially the Californian ports and, e.g., the Port of Bergen in Norway are examples of ports that have a very strong market position as attractive destinations. Therefore, they can stipulate the conditions for ships' access to the port, without losing customers to any significant extent.

Barriers and obstacles

Compulsory shore power connection is only an option when all primary cruise ports have established onshore power plants.

Especially for minor ports (port with relatively few calls), it will be difficult to introduce regulation which requires connection to shore power. Minor ports are not necessarily 'must-visit' destinations, so they risk being overlooked by shipping companies.

6.2 Incentives

Incentives to distribute shore power to cruise ships may include several efforts.

Incentives can include both efforts from national authorities with the purpose of getting ports to invest in shore power facilities, and efforts from ports with the purpose of motivating cruise ships to connect to shore power when at berth.

Incentives to join shore power may be necessary to shipping companies, as the cost of shore power is most often higher than the price of generating it themselves.

6.2.1 Attractive berths for shore-power ready cruise ships

In the Port of Kristiansand and the Port of Bergen, Norway, ships with shore power connections are offered the most attractive berths. That is to say, the quays that bring the tourists closest to the city centre, have the most attractive views etc.

Possibilities

Larger ports with several alternative berths for cruise ships will be able to offer the most environmentally friendly shipping companies a more attractive location

in the port. For the guests on board (and thus also for the shipping companies), it is very important to the cruise experience that you have a positive experience of the destination you come to.

Barriers and obstacles

Smaller cruise ports often have very few, if any, alternative berths for cruise ships. For these ports, this incentive will not be applicable.

6.2.2 Making shore power connections cheaper

Attractive prices for shore power would also be considered an incentive to connect to shore power. However, it will be very costly (depending on the port size and number of cruise ships) to offer prices for shore power which are lower than the ship's own power production price.

Possibilities

There are two ways to offer cheaper shore power connections: by reducing construction costs and thus reducing financing costs, or by reducing the price of electricity.

In Norway, the government has for some years supported investments in shore power facilities in several Norwegian ports. The subsidies come from the ENOVA fund, which contributes financially to the implementation of energy and climate-friendly projects that would otherwise not be possible.

Also, in Germany and in California, the USA, construction of shore power facilities has been partly funded by states, development funds etc.

It is a possibility for the Nordic Council of Ministers to establish support funds, development programs etc. which financially support the establishment of onshore power facilities in ports.

If the electricity price is subject to electricity taxes, it is possible to investigate the possibilities of removing or reducing these costs to lower the total cost of shore power.

In Denmark, sales of electricity to ships are currently subject to an exemption from electricity tax. The tax exemption is approved by the EU and is in principle temporary and will expire in July 2021, but the Danish government can decide to extend the exemption. If the tax is reinstated, the port will pay a significantly higher price for electricity purchases. The general electricity tax is DKK 0.89 at the moment.

Barriers and obstacles

By nature, tax reductions and support funds directed at a cleaner cruise industry compete with other issues or needs for public environmental investments.

6.3 Cooperation and dialogue

Cooperation and dialogue on shore power may occur between ports within and across countries, as well as between ports and other entities, such as trade associations, innovation hubs, public utilities and shipping companies. Ports that have operational experience with a shore power facility for cruise ships can become role models for ports that want to operate a shore power facility. Having the first dual use facility in the world in the Port of Kiel could attract worldwide and regional attention to learn from this operating model.

Dialogue forums may include conferences within international or interregional frameworks, such as the Interreg Baltic Sea Region Programme[31], national forums such as committees of industry groups and municipalities, and local forums such as meetings between companies and city councils. In particular, large cruise ports signal their expectations to the shipping industry through such forums.

Stakeholders may cooperate through joint declarations, or initiatives to develop common goals for green and cleaner tourism, to attract shore-power ready cruise ships, and encourage shipping companies to convert vessels to be shore-power ready.

Possibilities

The City of Oslo, Norway, has taken the initiative to bring together the 14 largest cruise ports in the country to make a joint effort to introduce shore power for cruise ships by 2025[32]. Major cruise lines encouraged the development of a joint declaration from the 14 ports to serve as a roadmap for green cruise ships. Cruise lines also requested regular meetings with Oslo City Council, to be briefed on further developments.

Joint ventures, such as Plug – a cooperation between the Port of Bergen and local utility company BKK – have proven effective at motivating investments in shore power. Such joint ventures should be encouraged, and the Nordic Council of Ministers can consider funds for exploring such models.

Examples of other cooperation and dialogue include: NCE Maritime CleanTech, a maritime commercial hub focusing on the development of energy-efficient and environmentally friendly technologies; the Norwegian Electrotechnical Committee (NEK), which promotes shore power and standardisation in the electrotechnical field; and Norske Havner, a trade association of Norwegian ports aimed at improving their commercial and environmental competitiveness.

[31] For example, the "Green Cruise Port" project that concluded in 2019: https://projects.interreg-baltic.eu/projects/green-cruise-port-3.html'

[32] https://www.regjeringen.no/contentassets/2ccd2f4e14d44bc88c93ac4effe78b2f/handlingsplan-for-gronn-skipsfart.pdf

Barriers and obstacles

It is easier for capital cities such as Oslo, or major cruise destinations such as Bergen, to initiate cooperation and dialogue on shore power, than it is for smaller ports.

To implement shore power, small ports often depend on a larger port to lead the way, e.g., by developing standardised solutions and business models.

6.4 Branding and marketing

The ports surrounding the Baltic Sea are not yet ready to match the development in the cruise ships where (according to Copenhagen-Malmö Port) up to 75 % have facilities to adapt to of shore power. However, branding and marketing a port as a 'green' alternative is an instrument that will probably play a more central role in the future. At the moment, the ports are affected by sustainability and low-carbon agendas in the surrounding cities and set up targeted plans to reduce emissions from first of all ferries and in a longer perspective for cruise ships, as well.

The ports are aware that rising demands from end-customers will play a role in the future. They anticipate that the customers at the end of the logistics chain (cruise guests) will expect cruise ships to be if not carbon neutral then to have as low carbon emissions as possible.

In an interview one port expresses *".. focus of the surrounding world and customer needs are the strongest drivers".*

Possibilities

Fees, such as CPI, EPI and ESi, can be seen as both economic incentives but also as means to branding ports and shipping companies as 'green' and potiantially more attractive to cruise ships and cruise guests. Thus, offering low carbon possibilities using either ESI or establishing shore power facilities will give a port a competitive edge compared to other ports.

Other means of branding could be targeted towards crusise guests by putting up signs in the ships and on the quay drawing the guests' attention to the ship/port being environmentally friendly.

Barriers and obstacles

It remains unknown whether eco-friendly tourism will seriously affect cruise guests. For the very eco-friendly tourist, cruise tourism might not be the obvious mode of travel. Furthermore, for many tourists, it will be unclear how the value chain in cruise tourism is composed: is it the ship, the shipping company, the port or the overall tourist destination that has to live up to guests' expectations regarding environmental issues?

6.5 Technology development/smart technology utilization

Shore power is a technology undergoing rapid development, both in terms of technical development and market penetration. There are different drivers of the technological development: Consumer demands and requirements from authorities, development in the energy sector, and efforts to reduce the price for shore power.

The main drivers behind technology development and smart technology utilization are the following:

- A general increase in demand from consumers and authorities for cleaner technology.
- Development in energy supply where electrification of the energy supply is a general driving force, due to the increased share of renewable energy (wind, solar and hydropower) in the general energy supply.
- Shore power is currently a relatively expensive technology, and in many ports, the utilization rate of a plant is limited, since shore power is mainly used during the daytime and in the summer months. Therefore, attempts are made to reduce the cost of onshore power plants, e.g., by examining whether more electricity consumers can be connected to one plant.

6.5.1 Dual use of facilities

One of the challenges associated with shore power is the high investment costs, compared to a relatively low utilization rate.

Possibilities

The Port of Kiel in Germany has established a so-called 'dual use' shore power facility. Dual use means that the shore power facility can be used by both ferries and cruise ships. This solution distributes the investment over several players, thus making the installation of the plant relatively cheaper.

Barriers and obstacles

Infrastructure for electricity supply is very costly. In practice, it has proved difficult to reduce costs, especially since cruise ships have special demands for the magnitude of the electricity supply, primarily because their need for power is very high (mega-watts) and because cruise ships imply special technical requirements for the plant.

A large part of the investment in a shore power plant concerns a converter that converts local 50 Hz electricity to the ships' 60 Hz system (the vessels are built to American standards). 60 Hz power systems are practically not used by other types of electricity consumers. Therefore, only in very specific situations can multiple users be identified for such systems.

6.5.2 LNG barges for shore power production

In cases where access to the local electricity grid is difficult or power supply is limited, alternative sources of electricity supply have been developed.

Possibilities

An LNG barge is a separate and independent floating power plant providing power to cruise ships. The barge hosts a big power generator, supplied with LNG (liquified natural gas).

In practice, the barge is given a permanent location in the port, from where cables run to connection points where cruise ships berth.

Figure 2: Illustration of LNG barge. The barge at the bottom of the photo is connected to the cruise ship by cables running along the quay and a junction box by the ship. Source: Hybrid Port Energy. Becker Marine Systems.

Barriers and obstacles

An LNG barge is a considerable investment in a system that only operates for four to five months a year. LNG barges are demanding in terms of space, and generate noise, which will be a problem in port areas close to city centres and close to cruise ships. A barge also has operational disadvantages since it must regularly be supplied with LNG and must be staffed to ensure monitoring of engines.

6.5.3 Mobile shore power plants

For smaller ports, installing a shore power facility represents a huge investment that is often not realistic to implement.

Possibilities

Considerations have been given to the possibility of acquiring mobile onshore power plants. The advantage should be that several ports can share a facility to reduce investment costs.

Barriers and obstacles

Although the idea of mobile shore power plants may seem obvious, the possibility has disadvantages as well. A shore power plant with an effect of 16

MVA is very big and difficult to move, as it almost takes up the space of six 20-foot containers. In addition, cable connections, substations, cable cranes are also needed in each port.

Furthermore, demand for a facility in several different ports can coincide, as the cruise season is the same for all ports in the Baltic Sea.

Appendix A Sources

The following sources has been used in preparation of this report:

A.1 Interviews

Organisation	Name
Port of Aarhus	Anne Zachariassen
BKK Bergenshalvøens Kommunale Kraftselskap	Thor Andre Berg
CARB, California Air Resources Board	Nicole Densberger, Jonathan Foster, Angela Csondes
City of Oslo	Ragnhild Møller Stray
Copenhagen-Malmö Port	Henrik Ahlqvist
Danish Ports Association	Tine Kirk Pedersen
Hamburg Port Authority	Manfred Lebmeier
Port of Bergen	Even Husby
Port of Helsinki	Andreas Slotte
Port of Kiel	Lisa Sarodnick
Port of Kristiansand	Mathias Bernander
Port of Oslo	Heidi Leander Neilson
Port of Rønne	Thomas Bendtsen
Port of Seattle	Marie Ellingson, Alex Adams
Port of Skagen	Willy B. Hansen
Port of Stockholm	Charlotta Solerud
Port of Tallinn	Ellen Kaasik

A.2 Bibliography

2018 Europe Market Report	CLIA, Cruise Lines International Association. 2019
2019 State of the Industry	CLIA, Cruise Lines International Association. 2019
Alternative energy supply for cruise ships.	City of Copenhagen. COWI, February 2019
Analysis of the electric transportation sector	The WISEgrid project (European Union, Horizon 2020). 2017
Cruise Order Book	Cruise Industry News, February 2020
Green Cruise Port Action Plan 2030	Green Cruise Port, Interreg BSR. 2019
Mer bærekraftig cruiseturisme. Framtidsskisser for cruiseutvikling på Vestlandet.	TØI rapport. Transportøkonomisk institutt. 2019
Regjeringens handlingsplan for grønn skipsfart	Departementerne (Norway). 2019
Ship at berth regulation - proposed regulation order	CARB, California Air Resources Board. 2019
Shore Power for Ocean-going Vessels	CARB, California Air Resources Board, (web). 29 January 2020
Shore Power for Vessels Calling at U.S. Ports: Benefits and Costs	American Chemical Society. 2015
Shore Power Regulation Fact Sheet	Port of Long Beach, (web). 6 January 2020

A.3 Important websites

CARB: Airborne Toxic Control Measure for Auxiliary Diesel Engines Operated on Ocean-Going Vessels At-Berth in a California Port" Regulation	https://ww3.arb.ca.gov/ports/shorepower/shorepower.htm
Cruise Industry News	https://www.cruiseindustrynews.com/
CLIA Cruise Lines International Association	www.cruising.org
Enova, Norway	https://www.enova.no/
Green Cruise Port	http://www.greencruiseport.eu/Home.html
Port of Long Beach, Shore power FAQ	http://www.polb.com/environment/air/shorepowerfaq.asp