Maritime Overview

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Introduction

Over the past few years, the focus in the shipping industry has changed from topics like sulphur and NOx emissions to the reduction of greenhouse gas (GHG) emissions. IMO targets at a 50% reduction at fleet level by 2050 compared to 2008. At ship level the emissions reductions are 40% by 2030 and 70% by 2050. The European Parliament has voted for the inclusion of greenhouse gas (GHG) emissions from ships over 5,000 gross tonnes in the emissions trading system (EU ETS) by 1 January 2022. Parliament also wants firms to cut ships' annual average CO2 emissions by more than 40pc by 2030 (which is equivalent to the IMO target).

How many seagoing vessels are there?

Equasls is a multi-country initiative to provide information on the safety and quality of the global fleet. Statistics are provided on the global fleet composition, ship types, age distribution and sizes.
Below is a table which provides an overview of the composition of the global fleet in ship types and sizes.

Ship Type	Small(1)		Medium(2)		Large(3)		Very Large(4)		Total	
General Cargo Ships	4,137	7.5%	11,730	25.9%	258	2.0%			16,125	13.4%
Specialized Cargo Ships	8	0.0%	263	0.6%	63	0.5%	6	0.1%	340	0.3%
Container Ships	20	0.0%	2,258	5.0%	1,605	12.6%	1,507	22.2%	5,390	4.5%
Ro-Ro Cargo Ships	38	0.1%	607	1.3%	539	4.2%	260	3.8%	1,444	1.2%
Bulk Carriers	293	0.5%	3,762	8.3%	6,622	52.1%	1,845	27.2%	12,522	10.4%
Oil and Chemical Tankers	1,948	3.5%	7,364	16.2%	2,770	21.8%	2,117	31.2%	14,199	11.8%
Gas Tankers	36	0.1%	1,143	2.5%	406	3.2%	555	8.2%	2,140	1.8%
Other Tankers	413	0.7%	726	1.6%	14	0.1%			1,153	1.0%
Passenger Ships	4,212	7.6%	2,890	6.4%	281	2.2%	184	2.7%	7,567	6.3%
Offshore Vessels	2,750	5.0%	5,110	11.3%	123	1.0%	299	4.4%	8,282	6.9%
Service Ships	2,968	5.4%	2,877	6.3%	28	0.2%	6	0.1%	5,879	4.9%
Tugs	18,407	33.4%	944	2.1%					19,351	16.1%
Fishing Vessels	19,942	36.1%	5,661	12.5%	4	0.0%			25,607	21.3%
Total	**55,172**	**100%**	**45,335**	**100%**	**12,713**	**100%**	**6,779**	**100%**	**119,999**	**100%**

Source: Equasis (1) GT<500 - (2) 500≤GT<25.000 - (3) 25.000≤GT<60.000 - (4) GT≥60.000

Alternative Fuels used for shipping

Alternative Fuels for Shipping which will be reported on the EAFO portal are:
• Liquefied natural gas (LNG)
• Electricity (energy carrier)
• Hydrogen, Biofuels
• Methanol
• Dimethyl ether (DME)
• LPG
Most of the reporting in EAFO will be on demonstration projects using Alternative Fuels in Shipping and technology development

Alternative Fuels and LNG

LNG is the most used alternative fuel for sea going vessels. Concerning geographic scope, for sea going ships a global approach will be followed with more detail if available for the European operating area. For LNG, a traditional use is LNG carriers where most carriers use dual fuel diesel engines capable of using any combination of LNG and bunker fuels, using the LNG cargo boil off for fuel. Other sea going vessel types are already operational as well. Application of alternative fuels for inland shipping is limited and mainly aimed at trials.

LNG is also an attractive fuel option for vessels to meet the new limits for Sulphur content in marine fuels decreasing from 1 % to 0.1 % from 1 January 2015 in Sulphur Emission Control Areas (SECAs) in the Baltic Sea, North Sea and English Channel as set by the International Maritime Organisation (IMO)19. These obligations will be relevant for about half of the 10,000 ships currently engaged in intra-EU shipping. LNG is an attractive economic alternative also for shipping outside SECAs, where Sulphur limits will decrease from 3.5% to 0.5% from 1 January 2020, and globally.

The use of alternative fuels is regarded today as a key relevant area of technological development for sustainable transport. In shipping, like in other transport modes, there is today a consistent focus given to the potential application of different cleaner fuel solutions, with some of them posing significant challenges to ship design. The gradual adoption of these fuels, and the example set by first movers has been fundamental in paving the way to a wider use of alternative fuels for the future.

Taking into account the large share contribution of shipping to the in the worldwide transport market (accounting for over 80% of world trade by volume, 3% of global greenhouse gas emissions and contributing to air pollution close to coastal areas and ports), the gradual adoption of alternative fuels by shipping would have a significant positive immediate environmental impact.

LNG Statistics

EAFO LNG Fuelled vessels: new and converted vessels

(Update May 2020, including 2020 forecast)

Global (all vessels)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Vessel type														
Bulk carriers								1	1		2	1	0	5
Car carriers				1					2			0	4	3
Car/passenger ferries		4	4		4	4	0	4	4	3	3	5	4	35
Container ships								1	1	1	3	3	18	9
Crude oil tankers											3	5	7	8
Cruise ships											1	1	5	2
Gas tanker							2	4	4	7				17
General cargo ships					1	1	2				1	1	2	6
Offshore supply ships	1	1		2	5	1	2	4	1	1	1	0	10	28
Oil/chemical tankers				1				1	3	3	5	4	4	20
Ro-Ro cargo ships								2						2
RoPax						2	1			2	1	3	4	9
Tugs						2	2	2	1	3	2	4	2	18
Other		1	2			1	1		1	2	2	2	5	15
Total	**1**	**6**	**6**	**4**	**10**	**11**	**10**	**19**	**18**	**22**	**24**	**29**	**65**	**225**

Operation area: Europe (excl. Norway)	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
Vessel type														
Bulk carriers								1	1		2	1		5
Car carriers									2					2
Car/passenger ferries								2			1		4	3
Container ships										1	1	3	2	5
Crude oil tankers											3	3		6
Cruise ships														
Gas tanker							2	1	1					4
General cargo ships													1	
Offshore supply ships														
Oil/chemical tankers								1	1	1	3	4	3	13
Ro-Ro cargo ships														
RoPax						1				2	1	3	4	7
Tugs														
Other							1		1	2	2	2	3	11
Total						**1**	**3**	**5**	**6**	**6**	**13**	**16**	**17**	**67**

Source: DNV

Challenges

However, posed by the adoption of most alternative fuels are their physico-chemical characteristics, typically with associated low flashpoints, higher volatilities, different energy content per unit mass and, in some cases, even toxicity. The adoption and entry into force of the draft International Code of Safety for Ships using Gases or other Low flashpoint Fuels (IGF Code), along with proposed amendments to make the Code mandatory under SOLAS, by MSC95, on 11 June 2015, was a decisive step forward in addressing those challenges, at the regulatory level. The IGF Code includes mandatory provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems using low flashpoint fuels, such as liquefied natural gas (LNG), to minimize the risk to the ship, its crew and the environment, having regard to the nature of the fuels involved. LNG has been the first focus of the IGF Code; however, provisions for Methyl/Ethyl alcohols, Fuels Cells and Low Flashpoint Oil Fuels are being drafted for the expected first revision of the code, in 2020/21.

Fuels

There is a long list of fuels or energy carriers that can be used in shipping. The ones most commonly considered today are

- **Liquefied Natural Gas (LNG)**
- **Electricity**
- **Biodiesel**
- **Methanol.**

Other fuels that could play a role in the future are

- **Liquefied Petroleum Gas (LPG)**
- **Ethanol**
- **Dimethyl Ether (DME)**
- **Biogas**
- **Synthetic Fuels**
- **Hydrogen (particularly for use in fuel cells)**
- **Nuclear fuel.**

All these fuels are virtually sulphur free and can be used for compliance with sulphur content regulations. They can be used either in combination with conventional, oil-based marine fuels, thus covering only part of a vessel's energy demand, or to completely replace conventional fuels. The type of alternative fuel selected, and the proportion of conventional fuel substituted will have a direct impact on the vessel's emissions, including GHG, NOx, and SOx.

Maritime Regulations

Being international in its operation and organization, the maritime sector is regulated by the International Maritime Organization (IMO) under the UN. IMO handles issues regarding safety, security and pollution associated with international shipping. A major issue of pollution from shipping are the particles emitted due to the high levels of sulphur in the fuels. The IMO has put forward strict regulation of the fuel sulphur levels. Emission Control Areas (ECAs) have been set up in coastal waters in Europe, North America, and Asia. Within these areas only 0.1% low- sulphur fuels are allowed, and from 2020 ships sailing in non-ECA areas will need to use less than 0.5% sulphur in their fuel. If low sulphur fuels are not used, scrubbers needs to be installed in order to remove the SOx emissions.

These regulations means that an estimated 70% of the fuels currently used by the sector needs to be modified or changed. Greenhouse gas emissions, i.e. CO2 are currently not regulated, but expectations are that regulation of CO2 emissions will be implemented in the short to medium term.

Sulphur Level as a main issue

The sector is currently looking at solving the issue of reducing sulphur levels by using more refined fuels, an operation done at the oil refinery. This will not only add an extra cost, but it will also increase the CO2 emissions associated with the fuel as more refining will be required. The low sulphur fuels currently introduced are labelled Very low Sulphur Fuel Oil (VLSFO) having between 0.1 to 0.5% sulphur and Ultralow Sulphur Fuel Oil (ULSFO) having below 0.1% sulphur content. Another solution to reduced sulphur emissions is to use liquefied natural gas (LNG) as fuel, but this requires a refitting of the engines, just as pressurized fuel storage needs to be installed onboard.

Other fuels such as methanol are used to a smaller degree with the latest generation of diesel engine technology but are still at a supply infrastructure premature state.

Biofuels have very low sulphur levels and low CO2 emissions, as such they are a technically viable solution to low-sulphur fuels meeting either the VLSFO or ULSFO requirements. The immediate challenge is that the shipping sector has little knowledge on handling and applying biofuels as part of their fuel supply. Another challenge is that the volumes of biofuels required to supply the shipping sector are large. A single very large ship may consume the annual production from a single medium sized biofuel facility e.g. 100 mio. liters. The market entry for biofuels in the marine sector is therefore most favorable onboard smaller vessels for coastal waters or for use as auxiliary ultra-low sulphur fuel in ports

Biofuels, but how?

Of the current biofuels commercially available, only plant biodiesel derived from plant oil or pulping residues and bioethanol are produced at a level where they can supply significant volumes of fuel. The current renewable diesel type fuels are mainly produced from plant-based oils or products thereof e.g. used cooking oil (UCO), and the potential supply of sustainable renewable diesel with the current technology is an estimated 10-20 Mt. Another issue is that the plant oil-based fuels are the main fuel type currently used at a significant scale for bio jet fuels, leading to competition for feedstocks between the shipping and aviation sectors.

Pilots

Roald Amundsen

The **hybrid expedition cruise ship**, the [Roald Amundsen,](#) can take 500 passengers and is designed to sail in harsh climate waters.

Named after the Norwegian explorer who navigated the Northwest Passage in 1903-1906 and was first to reach the South Pole in 1911, the ship heads for the Arctic from Tromsoe this week and will sail the Northwest Passage to Alaska before heading south, reaching Antarctica in October.

While the engines run mainly on marine gasoil, the ship's battery pack enables it to run solely on batteries for around 45 to 60 minutes under ideal conditions, Hurtigruten Chief Executive Daniel Skjeldam told Reuters. The company estimates that the battery pack will reduce fuel consumption and save about 20% in carbon dioxide emissions, compared to if the ship was operating on marine gasoil alone.

Ellen e-ferry

The **e-ferry** is capable of carrying 30 vehicles and 200 passengers and is powered by a battery "with an unprecedented capacity" of 4.3MWh, according to Swiss battery maker Lechanché which provided the system.
"Over one year, it will prevent the release of 2,000 tonnes of CO2, 42 tonnes of NOx [Nitrogen Oxide], 2.5 tonnes of particulates and 1.4 tonnes of SO2 [Sulfur Dioxide] into the atmosphere," Lechanché CEO Anil Srivastava said in a statement.

The director for traffic for Aero, Keld M. Moller, meanwhile, said he is "pleased to be able to offer the passengers an extraordinary, pleasant journey free from noise, vibrations and diesel fumes."

The vessel can sail up to 22 nautical miles between charges — seven times farther than previously possible for an e-ferry. It will now need to prove it can provide up to seven return trips per day

Port Infrastructure

Onshore Power Supply (OPS)

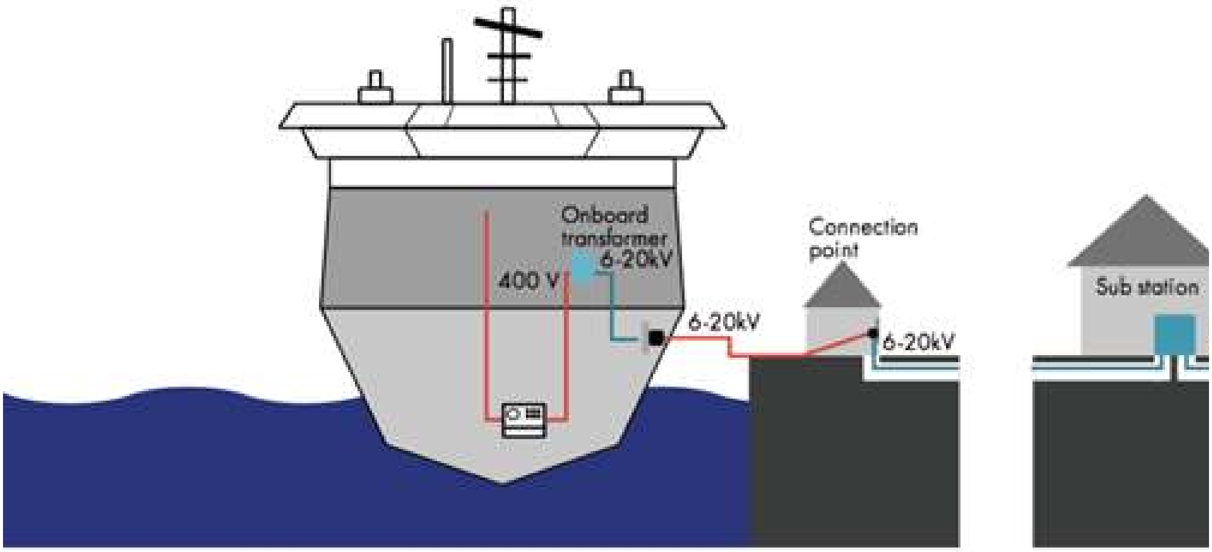
Ships can shut down their engines while berthed and plug into an onshore power source, the ship's power load is transferred to the onshore power supply without disruption to onboard services. Emissions to the local surroundings are eliminated

Onshore power supply (OPS) is also known as

• Shore side electricity (SEE)
• Shore Connection
• Shore-to-ship Power
• Cold ironing
• Alternative Maritime Power

Shore power is especially applicable to ships operating on dedicated routes and vessels that consume large amounts of power and emit high levels of air pollutants when berthed. Typical vessel types include ferries, cruise ships, LNG carriers, tankers and container ships.

In the figure below a general design of high-voltage OPS facilities is given. An electrical cable is extended from the pier and plugged into the ship's receptacle to supply power to operate the machinery, allowing the ship to shut down the diesel engines that normally drive the electrical generators.



International standards and OPS facilities

Shore-to-ship power standards overview:

- **IEC / ISO / IEEE 80005-1**, High Voltage shore side electricity (up to 20 MVA per vessel)
- **IEC / ISO / IEEE 80005-2**, Communication Protocol
- **IEC / ISO / IEEE 80005-3**, Low Voltage shore side (typically less than 1 MVA).
- **IEC:** International Electrotechnical Commission; IEEE: Institute of Electrical and Electronics Engineers
- **ISO:** International Standardisation Organisation

Since August 2012 there is an international standard for the plug used when connecting a ship. From a technical perspective, the various implementations worldwide have proven the viability of the technology. The frequency conversion issue (50hHz versus 60Hz) has been covered by main manufacturers since several years and a global standard provides worldwide guidance on safety and compatibility (standardised plugs and cables). This High Voltage Shore Connection standard has been validated in August 2012 by IEC, ISO and IEEE (80005-1) and enables to cover most of European ship traffic (Roro, Ferry, containers, tankers, LNG and cruise ships).to the port OPS facility. The plug is for high-voltage connection systems (HVSC) and the standard is named ISO/IEC/IEEE 80005-1. According to the IEC the standard is applicable to the design, installation and testing of HVSC systems and addresses among other things shore-to-ship connection and interface equipment. It does not apply to the electrical power supply during docking periods, e.g. dry docking and other out of service maintenance and repair.

The standard 80005-2 regulates the communication between ship and shore. This standard allows the onshore part of SSE to be remote-controlled from the ship. The standard 80005-3 regulates Low Voltage shore side electricity.
Most components used in OPS installations are standard and widely used in various types of electrical equipments in other industries. Thereby, there is no technical barrier anymore to the development of OPS in Europe.

What investments are required on shore side to install SSE infrastructure?

A OPS installation typically requires a building, or a shelter, containing the necessary technical equipment that include switchgear, transformers and frequency converters which aim is to adapt the shore electrical characteristics to the ship's ones (voltage, frequency..etc.). According to the ISO IEC IEEE 80005-1 standard, for cruise, ferry, Roro & Ropax, and cargo ships, the cables management system should also be on the shore side.

The cost of an investment in OPS is likely to be very different from one port to another. It mainly depends on the ship type and the power requirement: the higher the power demand is, more expensive it will be. Hence, an OPS for a cruise berth (requiring up to 20MVA) is likely to be more expensive than an installation for a ferry

What investments are required on ship side to enable them to plug into OPS infrastructure?

As for ports, rarely are two ships identical: it is therefore difficult to describe any specific technical requirements applying equally to all ships. However, most ships' retrofits require modification of the main switchboard, a new receiving circuit breaker close to the power receiving point, power socket(s) and an upgrade of the ship power management system.

In addition, some mechanical modifications are needed (build a door on the hull to receive the socket outlet as well as the cables) and in case of a container ship, the cable management shall be installed on board instead of the socket(s) (based on ISO IEC IEEE 80005-1 standard). Finally, the ship owner will have to request the certification of the installation by the corresponding classification societies. A very rough thumb value of the investment costs including cabling would be: 500K€ to 1M€. But it must be underlined that this investment is only needed in the case of retrofit of ships. But OPS is nowadays already installed in the majority of newly built ships, directly during the construction phase, which drastically reduces the costs for ship owners.

Application and advantages of OPS

When berthed, ships require electricity to support activities like loading, unloading, heating, lighting and operation of other technical installations. Normally, the ships’ propulsion engines are turned o when berthed and the power needed is provided by auxiliary engines that are running on diesel oil or other fossil-based fuel. Most of the new cruise ships, which are the biggest single sources for air emission in a port, use diesel electric propulsion system and get the all the electricity they need from the same generators. Exhausts from the auxiliary engines affect the environment negatively both locally and globally by emissions of CO2 and other air pollutants.

Since 2010 a European Union directive (2005/33/EC) limits the sulphur content in marine fuel to 0.1% (from 1%) for ships at berth (see directive for exemptions) in order to reduce the emissions discharge from vessels. Ships can either choose to use an alternative ship fuel while at berth, or to connect to shore-side electricity, that is, OPS.

The use of OPS reduces the negative environmental aspects of ships, such as noise and air pollution, since the ships’ auxiliary engines can be switched off. Moreover, implementation of OPS provides an opportunity not only to improve air quality, but also to reduce emissions of CO2, one of the main contributors to global warming.

General design of high-voltage OPS facilities. An electrical cable is extended from the pier and plugged into the ship’s receptacle to supply power to operate the machinery, allowing the ship to shut down the diesel engines that normally drive the electrical generators.

Classification and verification of Onshore Power Supply installations and connections.

DNV GL is an international accredited registrar and classification society headquartered in Høvik, Norway. It is the largest classification company for shipping globally. A section on OPS is included in its RULES FOR CLASSIFICATION SHIPS (Part 6 Additional class notations, Chapter 7 Environmental protection and pollution control, Section 5 Electrical Shore Connections (edition July 2019).

The objective of the additional class notation Shore power is to provide requirements for a transfer of power utilizing an electrical shore connection while in port.

Additional class notation Shore power provides requirements for the design of electrical shore connections, the ship side installation of necessary equipment and the verification of the installations.

The system design comprises the following aspects:

— **system functionality of the electrical shore connection** as a total system. In addition, requirements to circuit breakers, earthing switches and protective functions are given

— **control systems and control system interface** between the shore and the vessel. Requirements are given for necessary functionality. However, the physical installations on shore are not covered by these rules

— **ship side electrical equipment and installations**. However, only specific requirements related to electrical shore connections are given. Generally, equipment and installations shall comply with relevant parts of Pt.4 Ch.8

Classification and verification of Onshore Power Supply installations and connections.

Operational characteristics and requirements with respect to power availability during loading and unloading are not within the scope of these rules.

Shore side electrical equipment and installations, apart from the functional requirements to the installation, are governed by national regulations, and are not a part of these rules. The additional class notation Shore power is not intended for shore connections used during service and maintenance docking.The additional class notation Shore power applies to vessels utilizing electrical shore connections while in port and is mandatory for vessels with high voltage shore connection and low voltage shore connection with power rating greater than or equal to 1 MVA. This is applicable for shore power supplying the distribution grid and/or charging electrical energy storage systems onboard the vessel

OPS projects under construction

OPS for cruiseships Port of Bergen (Norway)

> "We are building a shore power facility that will supply three cruise vessels with power simultaneously. The aim is for the facility to be ready at the beginning of the cruise season in 2020. Furthermore, with the support of the municipality of Bergen, a more limited facility that will serve one cruise vessel at a time will be ready by 2019"

Bergen is Norway's largest cruise port and the fourth largest in Europe. Throughout 2018 342 cruise vessels will have visited Port of Bergen, which is an increase of about 31 vessels from the previous year. Vessels that dock at Port of Bergen emit large quantities of particles, NOX and CO2, and the motivation for the joint company is to reduce these emissions as soon as possible.

Read more!