



SHIP EMISSIONS TOOLKIT

GUIDE | Rapid assessment of ship emissions in
NO. 01 | the national context



Ship Emissions Toolkit

Guide No.1: Rapid assessment of ship emissions in the national context



Published in 2018 by the
GloMEEP Project Coordination Unit
International Maritime Organization
4 Albert Embankment
London SE1 7SR
United Kingdom

and

Institute of Marine Engineering, Science and Technology (IMarEST)
1 Birdcage Walk
London SW1H 9JJ
United Kingdom

© GEF-UNDP-IMO GloMEEP Project and IMarEST

Cover Design by Viktoria Heisig, viktoriahaisig.com

Typeset by Eyetooth-Art.co.uk

Printed by Elephant Print, Lewes, East Sussex



Copyright Notice: *All rights reserved. This document, or any part thereof, may not be photocopied, stored in any medium by electronic means or otherwise, published, transferred, reproduced or performed in public in any form or by any means without prior written permission from the copyright owner. Enquiries should be directed to the address above.*

GEF, UNDP, IMO or IMarEST shall not be liable to any person or organisation for any loss, damage or expense caused by reliance on the information or advice in this document or howsoever provided.

Please cite this document as: *GEF-UNDP-IMO GloMEEP Project and IMarEST, 2018: Ship Emissions Toolkit, Guide No.1, Rapid assessment of ship emissions in the national context.*

The GloMEEP Project is a cooperative initiative of the Global Environment Facility (GEF), the United Nations Development Programme (UNDP) and the International Maritime Organization (IMO) to assist developing countries in the uptake and implementation of energy efficiency measures for shipping, with the aim of reducing greenhouse gas emissions and preventing air pollution from ships. For more information, please visit <http://glomeep.imo.org>.

The Institute of Marine Engineering, Science and Technology (IMarEST) is the first institute to bring together marine engineers, scientists and technologists into one international multi-disciplinary professional body. IMarEST is the largest marine organisation of its kind with a worldwide membership based in over 120 countries. For more information, please visit <https://www.imarest.org>.

Contents

	<i>Page</i>
List of figures	vi
List of tables	vi
List of abbreviations	vii
Acknowledgements	ix
Preface	xi
Purpose of the Ship Emissions Toolkit	xiii
1 Background	1
1.1 Emissions from ships	1
2 Building the information base	3
2.1 Legislation and policies	3
2.2 Relevant government ministries and other institutions	8
2.3 Current port State control practices, compliance monitoring and enforcement regime	8
2.4 Shipping's role in the national economy	10
2.5 Key national maritime stakeholders	11
2.6 Shipping fleet composition	13
2.7 Fuel consumption and emissions of fleet components	17
2.8 Possible emissions scenarios	18
2.9 Existing and planned ports	19
2.10 Existing bunkering facilities and expansion plans	19
2.11 Shipbuilders and repair yards	20
2.12 Marine equipment manufacturers and suppliers	20
2.13 Maritime emissions experts, technical and training institutes	20
2.14 Uptake and implementation of technical and operational measures	20
2.15 Relevant technical cooperation and technology transfer mechanisms	22
2.16 Potential sources of finance	23
3 Evaluation of results	25
4 Conclusions and recommendations	27
5 References	29
Annex 1 – Rapid Assessment Template	31
Annex 2 – Fleet and CO₂ calculator	43

List of figures

	<i>Page</i>
Figure 1: Proportion of different cargo types transported globally in 2016 by volume	11
Figure 2: Stakeholders within the maritime sector	12
Figure 3: AIS 2012 derived traffic data coloured according to the intensity of messages received per unit area	16

List of tables

	<i>Page</i>
Table 1: Overview of stakeholders	13
Table 2: Vessel types and capacity bins	15
Table 3: Ship fuel consumption and emissions calculation methods for different fleet components	18
Table 4: Overview of barriers to the uptake of innovative emissions reduction technologies	21
Table 5: Other methods to collect data on implementation of technical energy efficiency measures	21

List of abbreviations

ADB	Asian Development Bank
AHEWG-TT	Ad Hoc Expert Working Group on Facilitation of Transfer of Technology for Ships
AIS	Automatic Identification System
CO ₂	Carbon Dioxide
CH ₄	Methane
DWT	Dead Weight Tonnes
EBRD	European Bank for Reconstruction and Development
ECA	Emission Control Area
EEDI	Energy Efficiency Design Index
EEOI	Energy Efficiency Operational Indicator
EIB	European Investment Bank
GCF	Green Climate Fund
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GloMEEP	Global Maritime Energy Efficiency Partnerships Project
GWP	Global Warming Potential
HFC	Hydrofluorocarbon
HFO	Heavy Fuel Oil
IADB	Inter-American Development Bank
IAPP Certificate	International Air Pollution Prevention Certificate
IEE Certificate	International Energy Efficiency Certificate
IMarEST	Institute of Marine Engineering, Science and Technology
IMO	International Maritime Organization
INDC	Intended Nationally Determined Contribution
ITCP	Integrated Technical Cooperation Programme
LNG	Liquefied Natural Gas
LPCs	Lead Pilot Countries
LPIR	Legal, Policy and Institutional Reforms
LRTAP Convention	1979 Geneva Convention on Long-Range Transboundary Air Pollution
MARPOL Convention	International Convention for the Prevention of Pollution from Ships
MDO	Marine Diesel Oil
MEPC	Marine Environment Protection Committee
MOU	Memorandum of Understanding
MTCCs	Maritime Technology Cooperation Centres

NAMA	Nationally Appropriate Mitigation Action
NDC	Nationally Determined Contribution
NGO	Non-governmental organisation
NMVOCS	Non-Methane Volatile Organic Compounds
NO ₂	Nitrogen Dioxide
NO _x	Nitrogen Oxides
NSERS	National Ship Emissions Reduction Strategy
O ₃	Ozone
ODS	Ozone-depleting Substances
PM	Particulate Matter
PSC	Port State Control
SEEMP	Ship Energy Efficiency Management Plan
SIDS	Small Island Developing States
SO ₂	Sulphur Dioxide
SO ₃	Sulphur Trioxide
SO ₄	Sulphate
SO _x	Sulphur Oxides
STCW	Standards Of Training, Certification & Watchkeeping
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UV	Ultraviolet
VAT	Value-Added Tax
VOCs	Volatile Organic Compounds
WMU	World Maritime University

Acknowledgements

This Guide is the product of a collaboration between the GEF-UNDP-IMO Global Maritime Energy Efficiency Partnerships (GloMEEP) Project and the Institute of Marine Engineering, Science and Technology (IMarEST).



The content of this Guide was developed by UMAS – the University Maritime Advisory Services (Isabelle Rojon, Simon Davies, Tristan Smith and Nishatabbas Rehmatulla), under a contractual agreement with IMarEST.



Great thanks are also due to the GloMEEP Project Coordination Unit (Astrid Dispert and Minglee Hoe), the IMO Marine Environment Division and Leigh Mazany who provided invaluable contributions to the development of this Guide.

Great thanks are also due to IMarEST (Maria Kouboura and Bev MacKenzie) who provided important input and support.

Valuable feedback on this Guide has been provided by the 10 GloMEEP Lead Pilot Countries (Argentina, China, Georgia, India, Jamaica, Malaysia, Morocco, Panama, Philippines and South Africa) as well as a number of individuals to whom great thanks are due: Robert Maxwell, Helena Athoussaki, Carlos González, Brigitte Behrends, James Ashworth, Muhammad Shafique, Philip Williams and Anne-Marie Warris.

For further information please contact:

GloMEEP Project Coordination Unit

Marine Environment Division
International Maritime Organization
4 Albert Embankment
London SE1 7SR
United Kingdom
Web: <http://glomeep.imo.org>

IMarEST

1 Birdcage Walk
London SW1H 9JJ
United Kingdom
Web: <http://www.imarest.org>

Preface

Maritime transport is essential to the global economy, providing the most cost-effective means of transporting bulk goods over great distances compared to road or rail. Over 80% of the volume of international trade in goods – including everything from food and fuel to construction materials, chemicals and household items – is carried by sea, with more than 90,000 commercial ships sailing the world's oceans, with a combined tonnage of 1.86 billion dead weight tonnes (UNCTAD, 2017). World trade and maritime transport are fundamental to sustaining economic growth and spreading prosperity throughout the world, thereby fulfilling a critical social as well as an economic function.

However, the sheer scale of the international shipping industry in comparison to other modes of transport means that overall emissions from ships remain a concern, having negative impacts on local port and coastal air quality and hence on human health, and contributing to regional acidification and global climate change. According to the Third IMO GHG Study 2014, maritime transport emits around 1 billion tonnes of carbon dioxide annually and is responsible for approximately 3% of global greenhouse gas emissions from fuel combustion. Shipping is forecast to grow as international trade grows. According to projections, by 2050, depending on future economic growth and energy developments, greenhouse gas emissions from shipping may increase by between 50% and 250%. Annually, international shipping is also responsible for approximately 13% and 12% of global nitrogen oxides (NO_x) and sulphur oxides (SO_x) emissions respectively.

For decades, IMO has exercised strong and decisive leadership in creating the legal and technical framework within which shipping has become progressively cleaner and safer, while continuing to provide the world with a cost-effective way to transport the goods and commodities that underpin the global economy and sustain global society. Efforts to reduce air emissions from ships took a major step forward in 1997, with the adoption of the 1997 Protocol to the International Convention for the Prevention of Pollution from Ships, known as MARPOL Annex VI, which currently regulates air emissions from 96.6% of the world's shipping tonnage. MARPOL Annex VI establishes limits on NO_x emissions and requires the use of fuel with low sulphur content, thus protecting people's health and the environment by reducing ground-level ozone-producing pollution, which can cause smog and aggravate asthma.

IMO also adopted amendments to MARPOL Annex VI, which entered into force on 1 January 2013, and made technical and operational energy efficiency measures mandatory for all ships of 400 GT and above. In April 2018, the IMO adopted resolution MEPC.304(72), Initial IMO Strategy on reduction of GHG emissions from ships, that confirms IMO's commitment to reducing GHG emissions from international shipping and, as a matter of urgency, to phasing them out as soon as possible in this century. The Initial Strategy envisages for the first time a reduction in total GHG emissions from international shipping and calls for a reduction in total annual GHG emissions by at least 50% by 2050 compared to 2008, while, at the same time, pursuing efforts towards phasing them out.

Purpose of the Ship Emissions Toolkit

The *Ship Emissions Toolkit* provides a structured framework as well as decision support tools for evaluating emissions reduction opportunities in maritime transport. It offers guidance to countries seeking to develop and strengthen national policy and regulatory frameworks related to the prevention of air pollution and the reduction of greenhouse gas (GHG) emissions from ships.

This toolkit includes three practical guides. While these three individual guides are separate documents and can be used independently, they are complementary and in large parts based on each other:

Guide No.1 – Rapid assessment of ship emissions in the national context: offers guidance for conducting a rapid assessment and generating both quantitative and qualitative information about a country's maritime emissions status at the time of analysis.

Guide No.2 – Incorporation of MARPOL Annex VI into national law: provides useful information for policy makers and legislators in countries preparing for accession to the 1997 Protocol or for contracting Parties to the 1997 Protocol which have not yet developed the legal framework to implement the regulations in MARPOL Annex VI in the domestic legislation.

Guide No.3 – Development of a national ship emissions reduction strategy: supports countries in developing a national ship emissions reduction strategy that can guide potential policy and investments options.

Each guide provides links to tools that assist the user in collecting and analysing relevant information and data, and presents assessment techniques to support development of a national ship emissions reduction strategy and related implementation plans. Many of these tools include references to websites where more detailed manuals, guidelines, references, studies and presentations can be found.

The *Ship Emissions Toolkit* is drafted wider in the sense that it not only considers emissions from international shipping but also encourages the user to assess emissions from and identify emissions reduction opportunities for the domestic fleet. It may well be the case that domestic shipping represents the largest source of emissions in certain countries, and/or becomes the proving ground for low- or zero-carbon technologies that can subsequently be adopted by international shipping.

The objective of this toolkit is to support the development of a policy framework to guide near- and long-term emissions reductions in the shipping sector. By no means does this toolkit aim to promote any kind of unilateral or regional actions that conflict with the multilateral legislation mechanism under the framework of IMO. Instead, this toolkit provides guidance to interested countries seeking to take effective actions to achieve ship emissions reductions without promoting specific emissions reduction measures or technologies.

Furthermore, the toolkit recognises that ships and ports are intrinsically connected and as such also provides links to the *Port Emissions Toolkit* that has also been developed within the framework of the GloMEEP Project and aims to support countries in the quantification of emissions in ports and the development and implementation of a port emissions reduction strategy.

While the toolkit has been developed to support developing countries in particular (including through the Maritime Technology Cooperation Centres (MTCC) that have been established under the Global MTCC Network (GMN) Project, see document MEPC 73/13/3, and other technical cooperation activities implemented

by IMO under its Integrated Technical Cooperation Programme (ITCP), see document MEPC 73/13), it can provide guidance to any country seeking to improve the environmental performance of its maritime shipping sector with regard to emissions. It is intended primarily for use by staff of maritime administrations. However, it is expected to be useful to other government officials and policy makers, investors, developers, local community leaders and international development assistance agencies involved in activities designed to address emissions reductions from ships.

This toolkit has been used and tested by the 10 GloMEEP Lead Pilot Countries. Using the guides as a basis, each GloMEEP country has developed a rapid assessment and drafted a national ship emissions reduction strategy. Those GloMEEP countries that have not yet acceded to the 1997 Protocol or incorporated MARPOL Annex VI into national law have also undertaken a detailed legal assessment and drafted national legislation to domesticate MARPOL Annex VI.

In finalising development of this toolkit the GloMEEP countries' valuable feedback and questions have been incorporated as best as possible. Lessons learned and best practices that were identified over the course of the GloMEEP Project, have also been included.

The *Ship Emissions Toolkit* includes three individual practical guides as follows:

Guide No.1: Rapid assessment of ship emissions in the national context

This guide presents a framework for conducting a rapid assessment and generating information on a country's maritime shipping profile and environmental performance related to emissions from ships. It provides guidance on how to gather and analyse relevant information quickly; the data collection and analysis should not take more than four weeks.

The guide recommends the collection of both quantitative and qualitative information, and provides a rapid assessment template to help users arrive at an overview of a country's maritime emissions situation that can provide a foundation for the development and implementation of a national ship emissions reduction strategy. Developing a rapid assessment will help to answer the following questions:

- 1 Which maritime sectors currently play the most important role for the country and why?
- 2 Which sectors, if any, could play a more important role and thereby contribute more to the country's economy in the future? How could these sectors be promoted?
- 3 How is the country's maritime industry expected to develop by 2050 and what impact will those developments have on the country? Which opportunities do these developments bring?
- 4 Who are the most important stakeholders, why are they important and how could they contribute to the reduction of maritime emissions?
- 5 Which fleet component(s), or hybrid thereof, seem to be most relevant for the country and why?
- 6 What are the emissions of the most relevant fleet component(s) and how are they likely to develop? How could these developments be influenced and emissions be reduced?



Furthermore, the rapid assessment findings will be important in order to monitor and report progress in relation to the implementation and effectiveness of a national ship emissions reduction strategy.

Guide No.2: Incorporation of MARPOL Annex VI into national law

This guide is a useful tool for States interested in acceding to the 1997 Protocol or for contracting Parties to the 1997 Protocol which have not yet developed the legal framework to implement the regulations in MARPOL Annex VI, and in particular Chapter 4 on energy efficiency for ships, in the domestic legislation.

The guide recommends undertaking a detailed assessment of a country's existing policies, strategies, legislation and other measures that address emissions from ships. This legal and policy assessment will provide important information for the development of a national ship emissions reduction strategy.

If, as part of the strategy development process (see Guide No.3), it is identified that further action needs to be taken to implement and give full effect to MARPOL Annex VI, this guide outlines the steps States need to take at the national level in order to implement the provisions of MARPOL Annex VI and, in particular, the regulations on energy efficiency for ships, taking into account the particular legal system of the country.

The guide addresses the substantive provisions of MARPOL Annex VI, i.e. the provisions which require national action by an individual country in its capacity as a flag State and port State.

The guide also includes a brief review of the legal, policy and institutional arrangements in the 10 GloMEEP Lead Pilot Countries with regard to MARPOL Annex VI.

Guide No.3: Development of a national ship emissions reduction strategy

The findings generated by methodologically working through the rapid assessment guide (Guide No.1) and the legal guide (Guide No.2) can inform the process of developing a national ship emissions reduction strategy.

While MARPOL Annex VI and other international policies, regulations and strategies exist, they are by their nature often generic, in the sense that they are designed to apply as broadly as possible. They thus need to be operationalised within a national context, giving consideration to local, national and regional environmental, legal, institutional or other issues. Thus the purpose of a national ship emissions reduction strategy is two-fold; on the one hand it can support transposing and implementing international requirements in a national context and, on the other hand, it can support the achievement of international goals and targets through complementary national action.



For example, the development of a strategy could mobilise a broad range of national stakeholders to get involved in ship emissions reduction efforts, including those in shipping-related sectors that may not necessarily be covered by IMO Conventions, and thereby bring in new ideas, experience, capabilities and resources. Countries could also, through a targeted strategy, encourage and mobilise resources for research, development and deployment of low-emissions technologies and fuels at a national level, or from international donors. Through sharing research findings, best practices and lessons learned with the wider maritime community, countries could promote the global uptake of these technologies and fuels. These and other activities could facilitate the step change needed to significantly reduce ship emissions, achieve the IMO's aims and commitments, and thereby contribute to global air pollution and GHG mitigation efforts.

In addition, a national ship emissions reduction strategy could help countries realise benefits not directly associated with reducing ship emissions, such as reduced health care costs, job creation in new sectors, creation of new business and investment opportunities, decreased energy dependency, and so forth. The strategy development and implementation process also has the potential to strengthen national institutional and technical capacity and transfer knowledge to sectoral organisations. It can also support countries coordinate among sectors and institutions that currently work in isolation from each other, and allow decision makers to identify synergies among emissions reduction sectoral plans. Furthermore, sending a credible signal regarding future plans to reduce ship emissions can stimulate investment and international support for mitigation activities, promote technological innovation, and engage the private sector.

This guide therefore provides information on the crucial planning, development and implementation phases involved in the creation of such a strategy. The guide also includes a template with recommended elements a national ship emissions reduction strategy could include, as well as information suggested for inclusion in each part of the strategy.

1 Background

1.1 Emissions from ships

Ships produce a wide range of emissions causing different health and environmental issues. Key compounds that are emitted are carbon dioxide (CO₂), nitrogen oxides (NO_x), sulphur oxides (SO_x), particulate matter (PM), ozone-depleting substances (ODSs) and volatile organic compounds (VOCs). In the following, each of these air emissions is briefly explained along with the environmental and health issues they can cause.

Carbon Dioxide (CO₂)

CO₂ is a heavy, colourless and odourless gas that is naturally present in the Earth's atmosphere. It is produced by natural processes, such as by respiration or the decomposition of organic substances, but also by human activities, primarily the combustion of fossil fuels. CO₂ is the principal GHG and traps heat in the atmosphere, thus contributing to the greenhouse effect, commonly known as global warming or climate change. According to the Third IMO GHG Study 2014, international shipping emitted 796 million tonnes of CO₂ in 2012, which accounts for about 2.2% of the total emissions volume for that year. Under business-as-usual scenarios, and depending on future economic and energy developments, CO₂ emissions from shipping are forecasted to grow between 50% and 250% in the period up to 2050.

Nitrogen Oxides (NO_x)

NO_x refers to a mixture of gases that are composed of nitrogen and oxygen, such as nitric oxide (NO) and nitrogen dioxide (NO₂). They are formed when oxygen and nitrogen react under high pressure or at high temperatures, such as in engines. NO_x contributes to acid deposition which can lead to adverse effects on aquatic ecosystems in rivers and lakes and damage to forests, crops and other vegetation. Furthermore, NO_x emissions can cause eutrophication and thus reduce water quality with subsequent impacts including decreased biodiversity, changes in species composition and dominance, and toxicity effects (EEA, 2015). In addition to these environmental issues, NO_x emissions are linked to adverse human health impacts. High concentrations of NO₂ can cause inflammation of the airways and also contribute to the formation of secondary particulate aerosols and tropospheric ozone (O₃) in the atmosphere, a constituent of smog (EEA, 2015). Annually, international shipping is estimated to produce approximately 18.6 million tonnes of NO_x (as NO₂) which represents about 13% of global NO_x emissions from anthropogenic sources (Third IMO GHG Study 2014).

Sulphur Oxides (SO_x)

SO_x are compounds of sulphur and oxygen molecules; sulphur dioxide (SO₂) is the predominant form found in the lower atmosphere. Because petroleum-derived fuels contain sulphur (to a greater or lesser extent), their combustion results in the formation of SO_x. Exposure to SO_x has been associated with reduced lung function, increased incidence of respiratory symptoms and diseases and premature mortality (World Bank Group, 1999). With regards to adverse environmental effects, SO_x emissions can damage vegetation and cause acid rain. Annually, international shipping is estimated to produce approximately 10.6 million tonnes of SO_x (as SO₂) which represents about 12% of global SO_x emissions from anthropogenic sources (Third IMO GHG Study 2014).

Particulate Matter (PM)

PM refers to a mixture of solid particles and liquid droplets found in the air. The formation of PM depends on the efficiency and completeness of the combustion process, the amount of lubricating oil used and the amount of hydrocarbons, ash and sulphur in the fuel. The link with sulphur is why PM and SO_x emissions are often grouped

together. PM, especially finer particles, can enter the respiratory system and cause breathing problems, irritation of the lung capillaries, deficiencies in lung function and initiate or worsen heart diseases (UNEP, n.d.). One of the components of PM emissions is black carbon which also contributes to global warming because it directly absorbs light and reduces the reflectivity of snow and ice through deposition on these surfaces (also known as the albedo effect). Less solar radiation is reflected back into space and is instead absorbed, thereby heating the Earth's surface and speeding up the melting of ice and snow.

Ozone-Depleting Substances (ODSs)

ODSs are man-made substances that damage the stratospheric ozone layer. The ozone layer in the stratosphere absorbs a portion of the radiation from the sun, preventing it from reaching the planet's surface. Most importantly, it absorbs the portion of UV light called UVB which has been linked to many harmful effects, including skin cancers, cataracts, and harm to some crops and marine life (EPA, n.d.). Usually in the form of chlorofluorocarbons (CFCs), ODSs are used in refrigeration systems on board ships, normally for the refrigeration of cargo, provisions and air conditioning systems. The annual release of refrigerants from global shipping is estimated at 8,412 tonnes, which corresponds to 15 million tonnes in CO₂ equivalent emissions (Third IMO GHG Study 2014).

Volatile Organic Compounds (VOCs)

VOCs are a large group of carbon-based chemicals that easily evaporate at ambient temperature and can react to form ground-level ozone. They are usually divided into non-methane VOCs (NMVOC) and methane (CH₄). They are formed when crude oil evaporates which can occur during loading, storage and transportation of crude oil on ships. Methane emissions are associated with LNG-powered vessels. They can occur as a result of: tank venting, fugitive leaks (pipework, flanges etc.) and methane slip during combustion through incomplete combustion of intake gas and gas remaining in crevices in the combustion chamber and in sections of the gas intake ports. Methane is a potent GHG with a global warming potential (100 yr GWP) 21 times greater than CO₂, thus significantly contributing to climate change. Based on the reported global crude oil transport of 1,929 million tonnes in 2012, it is estimated that VOC emissions in that year amounted to 2.4 million tonnes (Third IMO GHG Study 2014).

2 Building the information base

Reducing emissions from ships is a complex and multi-faceted problem. The introduction of relevant legal, policy and institutional changes requires a good understanding of the socio-political and institutional landscape, the key stakeholders involved, economic impacts and technical considerations.

An overview of the relevant legal, policy and institutional aspects, as well as socio-economic and technical considerations is provided below. Additional detail on the recommended elements of a rapid assessment and potential sources of information is given in Annex 1, which also serves as a template for assessing the country's maritime emissions status.

2.1 Legislation and policies

The reduction of emissions from ships, both air pollutants and GHG, is a complex issue that spans different policy areas (e.g. maritime transport, marine environment, climate change, air pollution, energy, transport, trade, infrastructure and human health) and therefore is likely to be covered by different policies for which different institutions are responsible.

Similarly, the global nature of the problem means that there is a need for international and regional policies. Effective implementation of policies at the national level therefore requires an understanding of the various interlinkages between different ministries and institutions. In reviewing existing regulatory requirements, consideration must be given to the country's international and regional obligations, national policies and legislation, as well as local regulations, where applicable.

2.1.1 International agreements and conventions

There are several international agreements and conventions related to air pollution and greenhouse gas emissions which may be of direct or indirect relevance to reducing emissions from ships. The sections below briefly summarise the most important ones.

UNCLOS

United Nations Convention on the Law of the Sea (UNCLOS), 1982, defines the rights and responsibilities of nations with respect to their use of the world's oceans and provides the broad legal framework for the conservation and sustainable use of oceans and their resources. Of particular relevance to consideration of emissions from ships are Articles 212 and 222:

- Article 212(1) requires parties to adopt laws and regulations to prevent, reduce and control pollution of the marine environment “from or through the atmosphere, applicable to the air space under their sovereignty and to vessels flying their flag or vessels or aircraft of their registry, taking into account internationally agreed rules, standards and recommended practices and procedures and the safety of air navigation.” Articles (2) and (3) require parties to take other necessary measures and to endeavour to establish global and regional rules, standards, practices and procedures with respect to “such pollution.”
- Article 222 provides that parties shall enforce the laws and regulations referred to in Article 212 against all vessels flying their flags and within their air space and take other actions to control atmospheric pollution “in conformity with all relevant international rules and standards concerning the safety of air navigation.” The purpose of these provisions is clearly to require parties to regulate emissions from aircraft and marine vessels, which were seen in 1982 as the most significant sources of atmospheric pollution affecting the oceans.

MARPOL Annex VI Regulations on Ship Air Pollution and Energy Efficiency

The main international policy relating to the control of maritime emissions and improvement of ship energy efficiency is MARPOL Annex VI. The first step will be to determine the status of ratification of MARPOL Annex VI and its incorporation into national legislation. This is discussed in detail in the *Ship Emissions Toolkit, Guide No.2: Incorporation of MARPOL Annex VI into national law*.

Air pollutants

The control of emissions from ships, in particular gases emitted from ships' exhausts, was discussed in the lead-up to the adoption of the 1973 MARPOL Convention. However, regulations concerning air pollution were not included at the time. Discussions continued and, in 1988, IMO's Marine Environment Protection Committee (MEPC) agreed to include the issue of air pollution in its work programme following a submission from Norway on the scale of the problem. In 1991 IMO Assembly resolution A.719(17) on Prevention of Air Pollution from Ships was adopted. The resolution called on the MEPC to prepare a new draft Annex to MARPOL on prevention of air pollution.

Regulations for the Prevention of Air Pollution from Ships were developed over the next six years and adopted at a Conference in September 1997. The regulations formed a new Annex VI to the MARPOL Convention which limits the main air pollutants contained in ships' exhaust gas, including SO_x and NO_x, and prohibits deliberate emissions of ODSs. MARPOL Annex VI also regulates shipboard incineration, and the emissions of VOCs from tankers.

Following entry into force of MARPOL Annex VI on 19 May 2005, MEPC 53 agreed to revise MARPOL Annex VI with the aim of significantly strengthening the emissions limits in light of technological improvements and implementation experience. A revised MARPOL Annex VI and associated NO_x Technical Code 2008 was adopted in October 2008 and entered into force on 1 July 2010. The main changes were a progressive reduction globally in emissions of SO_x, NO_x and PM and the introduction of emission control areas (ECAs) to reduce emissions of SO_x, NO_x and/or particulate matter further in designated sea areas.

Greenhouse gases

Inclusion of regulations to control CO₂ emissions from ships was discussed during the development of Annex VI, but not progressed at the time. However, during the International Conference of Parties to the MARPOL Convention, which adopted MARPOL Annex VI, resolution 8 on CO₂ emissions from ships was also adopted. This resolution invited the MEPC to consider what CO₂ reduction strategies might be feasible in light of the relationship between CO₂ and other atmospheric and marine pollutants. The resolution also invited IMO to undertake a study of CO₂ emissions from ships for the purpose of establishing the amount and relative percentage of CO₂ emissions from ships as part of the global inventory of CO₂ emissions. This led to publication of the first IMO GHG Study on GHG emissions from ships in 2000, which estimated that ships engaged in international trade in 1996 contributed about 1.8% of the world total anthropogenic CO₂ emissions.

In December 2003, the IMO Assembly adopted resolution A.963(23) on IMO policies and practices related to the reduction of GHG emissions from ships, which urged MEPC to identify and develop the mechanisms needed to achieve the limitation or reduction of GHG emissions from international shipping.

After the adoption of resolution A.963(23), MEPC gave extensive consideration to the control of GHG emissions from international ships and in July 2009 finalised a package of technical and operational energy efficiency measures. In March 2010, these technical and operational measures were made mandatory for all ships irrespective of flag and ownership. This work was completed in July 2011 with the adoption of technical measures for new ships and operational reduction measures for all ships. These measures formed a new Chapter 4 to MARPOL Annex VI entitled Regulations on energy efficiency for ships and represent the first ever mandatory global GHG regime for an international industry sector or transport mode. The regulations entered into force on 1 January 2013 and apply to all ships of 400 GT and above. In October 2016, mandatory amendments were adopted for ships of 5,000 GT and above to record and report consumption data for each type of fuel oil they use, as well as other, additional, specified data including proxies for transport work. These requirements entered into force on 1 March 2018.

In April 2018, MEPC 72 adopted the Initial IMO Strategy on reduction of GHG emissions from ships which identifies levels of ambition as follows: at least 40% reduction in carbon intensity by 2030, pursuing efforts towards a 70% reduction by 2050 compared to 2008; and at least 50% total annual GHG emissions reduction by 2050 compared to 2008 levels, while pursuing efforts towards phasing them out in line with an overall vision to phase out GHG emissions “as soon as possible this century” as a point on a pathway of CO₂ emissions reduction consistent with the Paris Agreement temperature goals.

As of August 2018, 91 countries have ratified MARPOL Annex VI, representing 96.59% of the world’s tonnage.

Overall structure of MARPOL Annex VI

MARPOL Annex VI is divided into five chapters and ten appendices as follows:

Chapter 1 – General	
Regulation 1	Application
Regulation 2	Definitions
Regulation 3	Exceptions and Exemptions
Regulation 4	Equivalentents
Chapter 2 – Survey, certification and means of control	
Regulation 5	Surveys
Regulation 6	Issue or endorsement of Certificate and Statement of Compliance related to fuel oil consumption reporting
Regulation 7	Issue of a Certificate by another Party
Regulation 8	Form of Certificate
Regulation 9	Duration and validity of Certificate
Regulation 10	Port State control on operational requirements
Regulation 11	Detection of violations and enforcement
Chapter 3 – Requirements for control of emissions from ships	
Regulation 12	Ozone-depleting substances
Regulation 13	Nitrogen oxides (NO _x)
Regulation 14	Sulphur oxides (SO _x) and particulate matter
Regulation 15	Volatile organic compounds (VOCs)
Regulation 16	Shipboard incineration
Regulation 17	Reception facilities
Regulation 18	Fuel oil availability and quality
Chapter 4 – Regulations on energy efficiency for ships	
Regulation 19	Application
Regulation 20	Attained EEDI
Regulation 21	Required EEDI
Regulation 22	SEEMP
Regulation 22A	Collection and reporting of ship fuel oil consumption data
Regulation 23	Promotion of technical cooperation and transfer of technology relating to the improvement of energy efficiency of ships
Chapter 5 – Verification of compliance with the provisions of this annex	
Regulation 24	Application
Regulation 25	Verification of Compliance

Appendices	
Appendix I	Form of the International Air Pollution Prevention (IAPP) Certificate (regulation 8)
Appendix II	Test cycles and weighting factors (regulation 13)
Appendix III	Criteria and procedures for the designation of emission control areas (regulations 13.6 and 14.3)
Appendix IV	Type approval and operating limits for shipboard incinerators (regulation 16)
Appendix V	Information to be included in the bunker delivery note (regulation 18.5)
Appendix VI	Fuel verification procedure for MARPOL Annex VI fuel oil samples (regulation 18.8.2)
Appendix VII	Emission control areas (regulations 13.6 and 14.3)
Appendix VIII	Form of International Energy Efficiency (IEE) Certificate
Appendix IX	Information to be submitted to the IMO Ship Fuel Oil Consumption Database
Appendix X	Form of Statement of Compliance – Fuel Oil Consumption Reporting

In addition, there are a series of guidelines to support Member States in their uniform implementation of MARPOL Annex VI which are available on the IMO website:

<http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Index-of-MEPC-Resolutionsand-Guidelines-related-to-MARPOL-Annex-VI.aspx>.

United Nations Framework Convention on Climate Change (UNFCCC)

In 1992, the UNFCCC was adopted as a framework for international cooperation to combat climate change by limiting average global temperature increases and the resulting climate change, and by finding ways to adapt to impacts.

In 1997, the Kyoto Protocol was adopted. It legally binds developed country Parties to emissions reduction targets. The Kyoto Protocol entered into force in 2005. The Protocol's first commitment period started in 2008 and ended in 2012. The second commitment period began on 1 January 2013 and will end in 2020.

The Kyoto Protocol formally identified the IMO as being responsible for regulating GHG emissions from international shipping (Art. 2.2.): "The Parties included in Annex I shall pursue limitation or reduction of emissions of greenhouse gases not controlled by the Montreal Protocol from aviation and marine bunker fuels, working through the International Civil Aviation Organization and the International Maritime Organization, respectively."

In 2015, the Paris Agreement was adopted, and includes commitments for emissions reductions from 2020 onwards. Its central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C. The Paris Agreement makes no reference to international shipping.

1979 Geneva Convention on Long-range Transboundary Air Pollution (LRTAP Convention)

The LRTAP Convention was the first international legally binding instrument to deal with problems of air pollution on a broad regional basis. It was signed in 1979, entered into force in 1983 and now has 51 Parties.

Aimed initially at reducing the effects of acid rain through control of the emissions of sulphur, its scope was later widened through the adoption of eight protocols to include nitrogen pollutants, VOCs and photochemical oxidants. Heavy metals and persistent organic pollutants were subsequently also added.

Amongst others, the LRTAP Convention contains a requirement for Parties to exchange information on, inter alia, emissions data of agreed air pollutants. The review of compliance with the obligations to report emissions data is based on the emissions data submitted by Parties to the Centre on Emission Inventories and Projections. According to the revised 2014 reporting guidelines (ECE/EB.AIR.125), "Emissions from fuels used for international maritime shipping shall not be included in the national totals. Those emissions should be reported separately as memorandum items in the annex I reporting template. Emissions from international inland shipping shall be included in the national totals for the part that is emitted on national territory."

1985 Vienna Convention for the Protection of the Ozone Layer & 1987 Montreal Protocol

The Vienna Convention for the Protection of the Ozone Layer is a framework convention for efforts to protect the globe's ozone layer. It was adopted in 1985 and entered into force in 1988. The objectives of the Convention are for Parties to promote cooperation by means of systematic observations, research and information exchange on the effects of human activities on the ozone layer and to adopt legislative or administrative measures to control or cease activities likely to have adverse effects on the ozone layer.

In 1987, the Montreal Protocol on Substances that Deplete the Ozone Layer was adopted and entered into force in 1989. It sets forth specific legal obligations, including limitations and reductions on the calculated levels of consumption and production of certain controlled ODSs.

In 2009, the Vienna Convention and the Montreal Protocol became the first treaties in the history of the United Nations to achieve universal ratification.

MARPOL Annex VI specifically refers to the Montreal Protocol in Article 2.16 in the definition of ODS which is taken from this Protocol.

2.1.2 Regional agreements and initiatives

In addition to these international agreements, countries may be engaged in regional or supranational cooperation related to air pollution and climate change.

While there are few regional agreements that focus purely on climate change and air pollution, climate-relevant provisions can be found in other regional or supranational agreements that were launched with other objectives, but have potential implications on climate change and air pollution.

Regional trade agreements, for example, often include objectives and mechanisms to reduce emissions and establish platforms for regional cooperation on mitigation and adaptation to climate change. Examples are:

- Common Market for Eastern and Southern Africa Climate Initiative
- North American Agreement on Environmental Cooperation Commission for Environmental Cooperation (Grunewald et al., 2013)

Another important focus of regional cooperation related to air pollution and climate change is the research, development and demonstration of low-carbon energy technologies, as well as the development of policy frameworks to promote the deployment of such technologies within different national contexts. Examples are:

- Carbon Sequestration Leadership Forum
- International Partnership for the Hydrogen Economy
- Global Methane Initiative (formerly Methane to Markets Partnership)
- Mediterranean Climate Change Initiative
- Arab Climate Resilience Initiative
- Mekong River Commission Climate Change and Adaptation Initiative
- ASEAN Multi-Sectoral Framework on Climate Change
- Asia Pacific Partnership on Clean Development and Climate
- Pacific Climate Change Science Program (Grunewald et al., 2013)

In addition, there are a few initiatives focusing on providing finance for climate mitigation and adaptation measures. These include:

- Global Energy Efficiency and Renewable Energy Fund
- Global Climate Change Alliance
- Global Climate Financing Mechanism
- Regional Reducing Emissions from Deforestation and Forest Degradation (Grunewald et al., 2013)

Understanding which agreements and initiatives the country is involved in is important not only for ensuring that relevant obligations are met, but can also help in understanding what resources (both financial and knowledge) might be accessed through these agreements and initiatives.

2.1.3 National policy and legislation

Air pollution and climate change are complex issues with links to different policy areas. For example, air pollution can have negative impacts on human health, the natural environment and in some cases also the built environment. Climate change is closely linked to energy consumption which in turn is of major importance to the economy. In connection with shipping, these issues are also linked to global trade.

These interlinkages can be reflected in the variety of legislation with potential implications on climate change and air pollution. Examples could include:

- Legislation to reduce one or several air pollutants in other sectors
- Legislation to increase energy efficiency in other sectors
- Legislation to incentivise the use of renewable energy in other sectors
- Health legislation
- Legislation regulating pollution from ships
- Port regulations
- Trade regulations

A list of such policies, strategies and legislation – together with the key relevant provisions – should be compiled to serve as a starting point for any legislative reform that might be required in terms of the national strategy.

2.2 Relevant government ministries and other institutions

The links between climate change and air pollution to various other topics mean that several ministries, government agencies or other institutions can be responsible for, or impacted by, national legislation to reduce air pollution and GHG emissions from ships.

The rapid assessment should therefore include a list of key national, sub-national or local institutions or agencies which are expected to play a role in the reduction of air pollution and GHG emissions from ships. At the national level, these are likely to be:

- Ministry of Environment and Climate Change
- Ministry of Transport
- Maritime Safety Authority
- National Port Authority
- Any other related ministry, e.g. trade, energy, etc.

2.3 Current port State control practices, compliance monitoring and enforcement regime

Port State control (PSC) is the inspection of foreign ships in national ports to verify that the condition of the ship and its equipment comply with the requirements of international regulations and that the ship is manned and operated in compliance with these rules. Any Party to the MARPOL Convention can exercise enforcement jurisdiction against any ships visiting its ports to ensure compliance with the Convention.

Typically, PSC officers inspect the vessel's certificates, look at the vessel's condition, equipment and the crew at work as well as at any prioritised target areas, such as security, working conditions on board or pollution. If some aspects of the vessel do not comply with applicable regulatory requirements, deficiencies are noted down. The number and nature of the deficiencies found determine what corrective action the vessel needs to take, e.g. how quickly the deficiency is to be rectified. If the vessel is found to be unsafe to proceed to sea or the deficiencies on the vessel are considered very serious, the vessel may be detained.

IMO has encouraged the establishment of regional PSC organisations and agreements, known as Memoranda of Understanding (MOU), on PSC in order to promote and realise more effective PSC for a given region and to eliminate the operation of sub-standard vessels through a harmonised application of PSC. They generally make the outcome of their inspections publicly available in an inspection database.

To date, nine different MOUs have been concluded covering all of the world's oceans:

- Paris MOU (European coastal States and the North Atlantic basin from North America to Europe)
- Tokyo MOU (Asia-Pacific region)
- Acuerdo Latino or Acuerdo de Viña del Mar (South and Central America)
- Caribbean MOU (Caribbean Sea and Gulf of Mexico)
- Mediterranean MOU (southern and eastern Mediterranean region)
- Indian Ocean MOU (Indian Ocean region)
- Abuja MOU (West and Central Atlantic Africa)
- Black Sea MOU (Black Sea region)
- Riyadh MOU (Persian Gulf region)

Some PSC regimes use specific target factors to decide if a vessel should be inspected or not. Under the Paris MOU, for example, each ship is attributed a ship risk profile which determines the ship's priority for inspection, the interval between its inspections and the scope of the inspection.

In addition, there are industry vetting inspections. Ship vetting is a risk assessment process carried out by charterers, primarily on tankers and dry bulk carriers, in order to avoid using deficient ships. It generally involves sourcing data on ships and evaluating the potential risks such as the ship's structural integrity, competence of owners, managers and crew, past casualties and incidents. Some vetting services also collect information on emissions and offer an energy efficiency rating. At present there are three major vetting services available: Chemical Distribution Institute, Ship Inspection Report Programme and RightShip. RightShip also provides a GHG emissions rating.

Another mechanism to monitor a ship's air emissions and energy efficiency is provided via a number of voluntary ship environmental evaluation schemes and port incentive schemes. These schemes generally aim to increase transparency around a ship's environmental and/or safety credentials and offer incentives for performance beyond regulatory requirements. Whilst the scope of the schemes differs, the majority cover CO₂ emissions or energy efficiency, and NO_x, SO_x and PM emissions. The main voluntary schemes are listed below:

- Clean Cargo Working Group
- Clean Shipping Index
- Environmental Ship Index
- Green Award
- Shipping Efficiency

2.4 Shipping's role in the national economy

Shipping is the backbone of the global economy, transporting goods between and within countries and thereby facilitating trade. It is likely to be a key contributor to most national economies. Its role in this regard, however, can differ and should be reflected in the country's strategy for legal, policy and institutional changes.

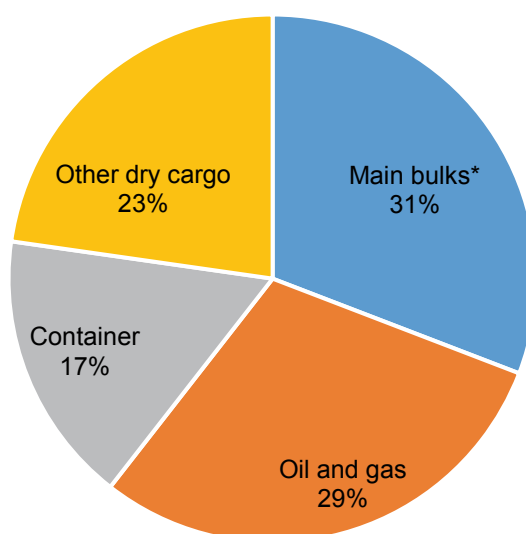
The role played by a country's maritime sector will reflect the structure of the economy and particular circumstances of that country. For example, the role of the maritime sector in Panama will be significantly different from that in China and India. The role and impact of the sector on a national economy can be broadly categorised as follows:

- Direct employment contribution: employment of nationals in shipping activities, including shipbuilding and repair (including scrapping), crew, onshore personnel
- Supply chain support: e.g. steel manufacturing (for shipbuilding, and so forth), engine and technology support, bunker supply and services
- Classification society activities and fees
- Direct contribution to the national GDP through the trade of goods and raw materials
- Direct tax contributions: e.g. income tax, VAT and indirect taxes
- Specific maritime taxation and fees: e.g. port and harbour fees, tonnage tax
- Multiplier contributions: the national maritime sector will stimulate the economy through other types of expenditure, such as the purchase of goods and services (Oxford Economics, 2015)

It is also important to note that the maritime sector will have different economic impacts within regions of a country. For example, the majority of all directly employed individuals will be in areas with port and harbour facilities.

Another crucial aspect for developing an understanding of shipping's role in the national economy is to analyse the volumes and types of cargo imported and exported. With over 80% of global trade by volume and more than 70% by value being carried on board ships (UNCTAD, 2017), sea transportation is likely to play an important role for most countries. The demand for the sea transportation of raw materials and goods is shaped by national and international economic conditions. The volumes of goods and raw materials transported in and out of a country reflect the specific characteristics of each country. Figure 1 illustrates the proportion of different cargo types transported globally in 2016 by volume.

In order to better understand the importance of seaborne transportation for a country, it is helpful to assess the volume, type and, if possible, value of raw materials and goods imported and exported by the country, as well as identify the country's main trading partners for each cargo category. In addition, estimating future demand will be useful for understanding how trade might develop and what challenges and opportunities may arise from these developments.



*iron ore, grain, coal, bauxite, alumina and phosphate rock

Figure 1: Proportion of different cargo types transported globally in 2016 by volume (UNCTAD, 2017)

2.5 Key national maritime stakeholders

A country's maritime industry is normally made up of a wide range of different stakeholders. Figure 2 sets out a high level view of the wide range of stakeholders within the maritime sector, including maritime operations, the demand and supply side of the sector as well as regulatory and finance organisations.

In order to successfully undertake the rapid assessment and subsequently develop and implement a national strategy to address emissions from ships, the cooperation and support of these stakeholders would be essential.

In the initial stages of the development of a national ship emissions reduction strategy, the focus will likely be on engaging with operational stakeholders, as well as those from the supply and demand side (see Figure 2), particularly in determining the nature and scope of existing and projected fleet emissions. In later stages, engagement with policy and regulatory and finance stakeholders will be required to ensure the national policy and regulatory frameworks support the objective of reducing emissions from ships, and also to ensure that the appropriate levels of finance and capital are available to implement the actions to achieve this objective.

Each country will have a different maritime stakeholder map. An early activity is the identification and mapping of stakeholders and the identification of the various relationships across the stakeholder map. When working through the different aspects of the rapid assessment, it is recommended the relevant stakeholders be identified, with information on why they are important and how they could contribute to the rapid assessment or later the strategy development and implementation. This information should then be compiled into a comprehensive stakeholder overview.

Some examples of stakeholder groups and their relevant areas of responsibility are provided in Table 1.

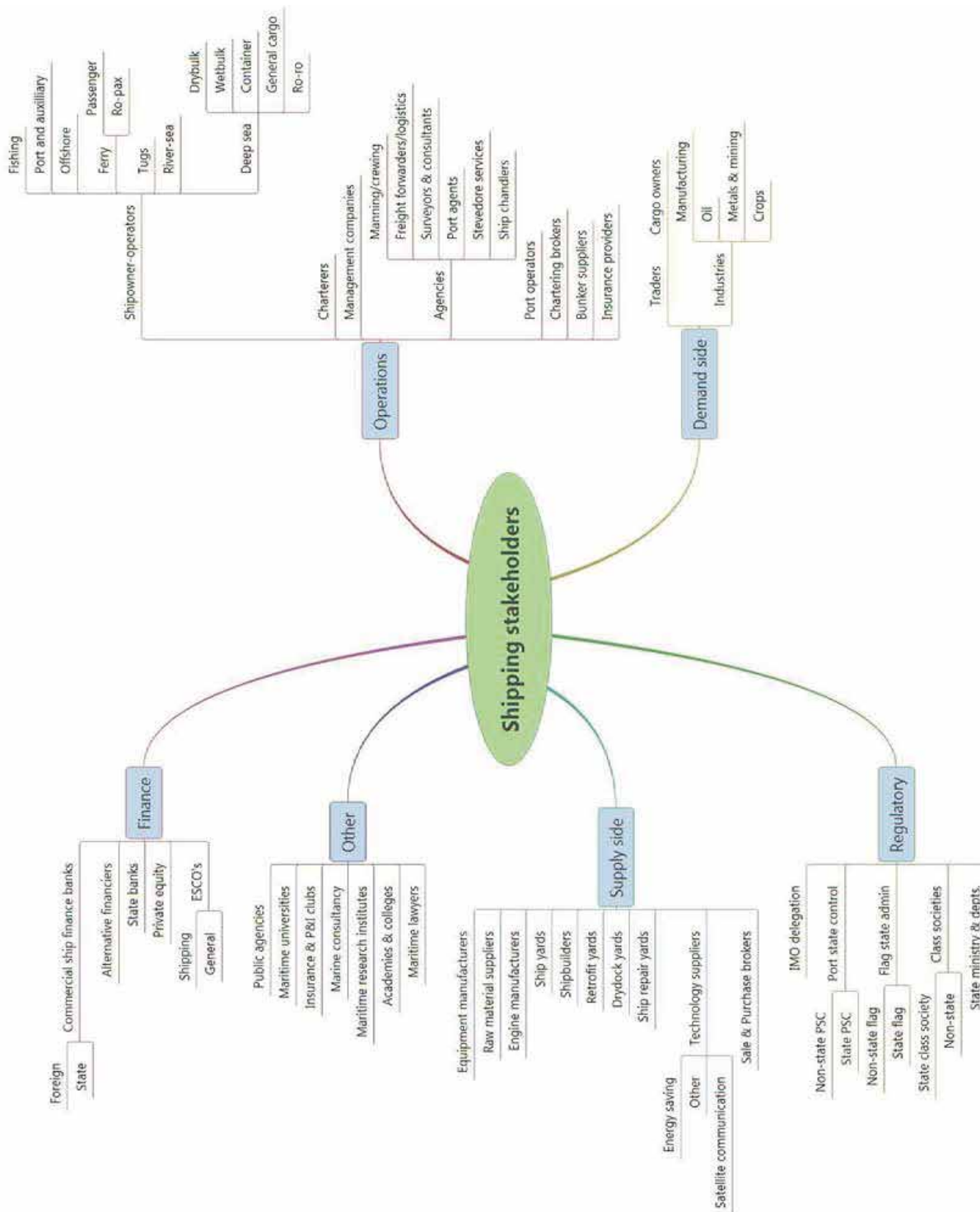


Figure 2: Stakeholders within the maritime sector

Table 1: Overview of stakeholders

Stakeholders	Relevant areas of responsibility
National maritime authority (Ministry of Transport or other agency, e.g. Navy, Coast Guard)	Coordination and control of shipping, including maritime safety and environmental aspects. Flag and port State control. Implementation and enforcement of shipping related conventions and legislation.
Shipowners & agencies	Responsible for the procedures and activities on board ships. Responsible for informing ship masters about the requirements of the ports to be visited, including port, maritime, health, immigration and customs authority regulations.
Shipyards, shipbuilders, naval architects, etc.	Retrofitting existing ships and the building of new ships, according to the standards adopted internationally for reducing air pollution from ships and increasing their energy efficiency.
Universities and research institutes	Research in the monitoring, measurement and modelling of air quality and climate change, economic assessment of technology development and deployment in the maritime sector etc.
Environmental NGOs, recreational bodies and general public	Play a watchdog role and exert pressure on governments to implement air pollution reduction and climate change mitigation strategies. May assist in commissioning research towards this end.

2.6 Shipping fleet composition

It will be important to identify which ships are of particular relevance to the country that is being analysed. For the sake of developing this understanding, it is suggested to consider and analyse five different fleet components:

- 1 Registered fleet
- 2 Domestic fleet
- 3 Fleet servicing the country's international transport demand
- 4 Fleet passing through the country's territorial waters
- 5 Fleet owned by national shipowners

1 Registered fleet

The first fleet component when analysing a country's fleet is the fleet flying the country's flag, i.e. vessels that are registered in the country, regardless of whether they are actively trading in the country's waters or not. This component is likely to include vessels whose owners are not citizens or nationals of the country. In fact, the tonnage registered under a foreign flag (that is, where the nationality of an owner differs from the flag flown by a vessel) is 70.2% of the world total, with the three largest vessel registries – Panama, Liberia and the Marshall Islands – accounting for a combined 41% of world tonnage (UNCTAD, 2016).

The registered fleet will be of high importance to countries with a large ship registry – and hence the associated responsibility as a Flag State – but also to countries where ship registration constitutes an important income source.

2 Domestic fleet

The domestic fleet consists of vessels servicing the country's domestic transport demand by moving goods and people from one port of the country to another port of the country, both along a country's coast and on inland waterways. The distinction between domestic and international shipping is determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship. By this definition, the same ship may be engaged in both international and domestic voyages. There are overlaps between domestic and international shipping and it may be difficult for governments to divorce policies for domestic shipping from policies for international shipping.

In 2012, according to the Third IMO GHG Study 2014, total domestic shipping in the world accounted for 131 million tonnes CO₂ which represented about 14% of the total CO₂ emissions from all shipping (938 million tonnes). Furthermore, domestic shipping can significantly contribute to poor air quality in coastal, urban and city environments through the emissions of SO_x, NO_x and black carbon.

Domestic shipping falls under the country's national jurisdiction and inventory of domestic emissions (IPCC, 2006). It could also, for example, be included in a country's Nationally Determined Contribution (UNFCCC, n.d.) under the Paris Agreement on Climate Change.

The domestic fleet is likely to be of high importance to countries with long coastlines or extensive inland waterways, as well as for island countries.

3 Fleet servicing the country's international transport demand

The fleet servicing the country's international transport demand consists of those vessels moving goods and people between one of the country's ports and a port of another country.

In 2012, total international shipping accounted for 796 million tonnes CO₂ which represented about 85% of the total CO₂ emissions from all shipping (938 million tonnes) and about 2.2% of global CO₂ emissions. Annually, international shipping is estimated to emit approximately 18.6 million and 10.6 million tonnes of NO_x (as NO₂) and SO_x (as SO₂) respectively; this converts to totals of 5.6 million and 5.3 million tonnes of NO_x and SO_x respectively. NO_x and SO_x emissions from international shipping represent approximately 13% and 12% of global NO_x and SO_x emissions respectively (Third IMO GHG Study 2014).

This fleet might be of particular importance to countries with high volumes of imports and/or exports carried by sea and large or many ports.

4 Fleet passing through the country's territorial waters

The fleet passing through the country's territorial waters includes those vessels that enjoy the right of innocent passage through the territorial sea (UNCLOS, article 17), i.e. vessels that operate in the territorial waters, but do not stop at a port of that country.

This fleet might be of particular relevance to countries with long coastlines as well as to countries close or adjacent to international key trading routes, which are generally located between major markets such as North America, Western Europe and East Asia. Along these routes, there are locations at which ships are forced to pass through in order to reduce distance travelled and costs. These points can be regarded as bottlenecks or choke points and include, for example, the Panama Canal, the Suez Canal, the Strait of Malacca, the Strait of Hormuz, the Strait of Gibraltar and the Strait of Dover. These areas of high ship densities give rise to significant navigation risks and can also result in poor air quality affecting coastal communities.

5 Fleet owned by national shipowners

When analysing a country's fleet, another fleet component to consider is those ships owned by companies registered in the country. In this context, UNCTAD (2014) distinguishes between the concept of the "nationality of ultimate owner" and the "beneficial ownership location". The latter reflects the location of the primary reference company; that is, the country in which the company that has the main commercial responsibility for the vessel is located. The "nationality of ultimate owner" is the nationality of the ship's owner, independent of the location of the primary reference country. Just as today most ships fly a flag from a different country than the owner's nationality, owners are increasingly locating their companies in third countries, adding a possible third dimension to the "nationality" of a ship (UNCTAD, 2014).

According to UNCTAD (2017), Greece is the largest shipowning country in terms of cargo-carrying capacity, followed by Japan, China, Germany and Singapore. Together, these five countries control almost half of the world's tonnage. Yet on the basis of the estimated commercial value of the fleet, a somewhat different picture emerges in which the United States' fleet leads with a value of \$96 billion, followed by Japan, Greece, China and Norway.

2.6.1 Characteristics of the fleet components relevant to the country

For each of the five different fleet components outlined above, it is recommended information on certain characteristics be collected. This will not only be helpful in determining the relevance of each fleet component to the country, but also provide important input to the estimation of emissions from each fleet component.

The main information required relates to the number of ships per ship type and size category as well as their traffic patterns and major routes.

2.6.1.1 Ship types

There is a significant range of ship types and sizes, the characteristics of which reflect the cargo and trade route, business use, or mode of shipping employed. Based on general voyage and trade patterns, some ship types and sizes are more likely to engage in international shipping than in domestic shipping.

Table 2 shows a list of common ship types, along with the carrying capacity categories used in the Third IMO GHG Study 2014 and information on whether they tend to engage in mainly international or domestic shipping. It may be helpful to use the same categories as found in Table 2 for the rapid assessment because data on the average annual fuel consumption per ship type is available from the Third IMO GHG Study 2014 and can be used for estimating the fuel consumption of a country's different fleet components.

Table 2: Vessel types and capacity bins (Third IMO GHG Study 2014)

Vessel type	Capacity bin	Capacity unit	Mainly engaged in international vs domestic shipping
Cargo-carrying transport ships			
Bulk carrier	0-9,999	DWT	International
	10,000-34,999		
	35,000-59,999		
	60,000-99,999		
	100,000-199,999		
	200,000-+		
Chemical tanker	0-4,999	DWT	International
	5,000-9,999		
	10,000-19,999		
	20,000-+		
Container	0-999	TEU	International
	1,000-1,999		
	2,000-2,999		
	3,000-4,999		
	5,000-7,999		
	8,000-11,999		
	12,000-14,500		
	14,500-+		
Cruise	0-1,999	GT	International
	2,000-9,999		
	10,000-59,999		
	60,000-99,999		
	100,000-+		
Ferry – passengers (pax) only	0-1,999	GT	Domestic
	2,000-+		International
Ferry – roll-on passengers (ro-pax)	0-1,999	GT	Domestic
	2,000		International
General cargo	0-4,999	DWT	International
	5,000-9,999		
	10,000-+		
Liquefied gas tanker	0-49,999	m ³	International
	50,000-199,999		
	200,000-+		
Oil tanker	0-4,999	DWT	International
	5,000-9,999		
	10,000-19,999		
	20,000-59,999		
	60,000-79,999		
	80,000-119,999		
	120,000-199,999		
	200,000-+		
Other liquids tankers	0-+	DWT	International

Vessel type	Capacity bin	Capacity unit	Mainly engaged in international vs domestic shipping
Refrigerated cargo	0-1,999	DWT	International
Roll-on/roll-off (ro-ro)	0-4,999	GT	International
	5,000-+		
Vehicle	0-3,999	Vehicles	International
	4,000-+		
Non-merchant ships			
Yacht	All sizes	GT	Domestic
Miscellaneous – fishing	All sizes	GT	Domestic
Work vessels			
Service – tug	All sizes	GT	Domestic
Offshore	All sizes	GT	Domestic
Service – other	All sizes	GT	Domestic

2.6.1.2 Traffic patterns and major routes

Ship movements are influenced by a number of factors; all things being equal, the shortest route between ports will be the quickest and most economical route to take. However, circumstances such as weather, ice, security, political sensitivity, traffic separation schemes, sea depth, and so forth, will ultimately affect the actual routes taken by vessels. There is also potential for transport to be disrupted or prevented, e.g. through the closure of a trading route or canal due to political instability or regional conflict.

It is important that countries understand the overall nature of vessel movement of the different fleet components that might be relevant to their country, but in particular, those vessel movements in and around their territorial waters. Developments in Automated Information System (AIS) and satellite-based AIS have enabled the accurate tracking of vessels. AIS is a radio-frequency based communication system that broadcasts a range of details about a ship’s position and operating details. AIS systems broadcast more or less continuously and automatically, allowing nearby ships and shore-based receivers to collect position data for the range of vessels in the vicinity.

By accessing this data, countries will be able to monitor ships and build up an accurate picture of vessel movements and patterns. In addition, this data can be used to develop emissions profiles within identified ship lanes. Such data can also be used to create and police buffer zones or ECAs with stricter emissions controls.

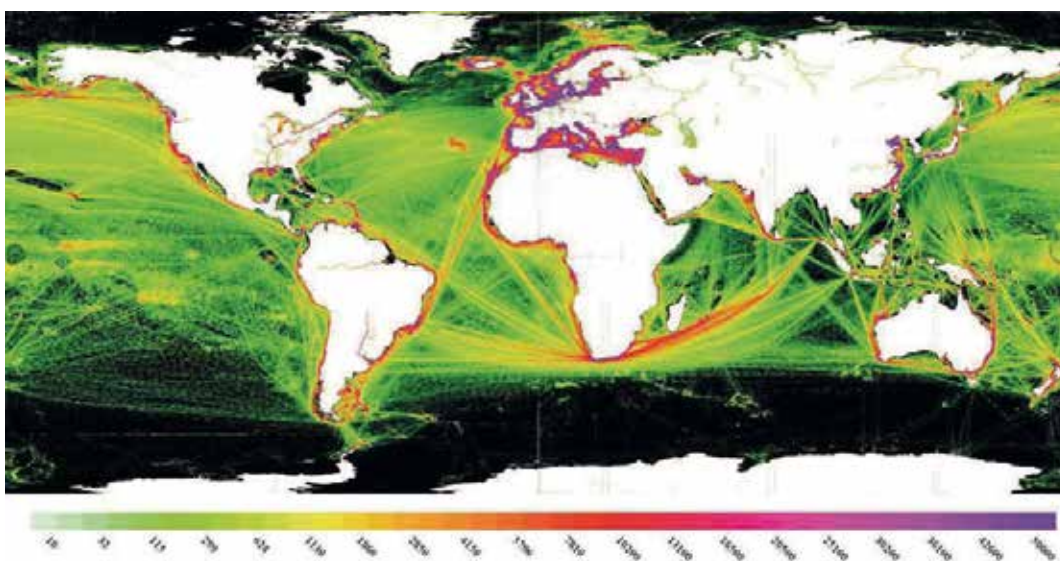


Figure 3: AIS 2012 derived traffic data coloured according to the intensity of messages received per unit area (Third IMO GHG Study 2014)

2.7 Fuel consumption and emissions of fleet components

With data on the five different fleet components gathered, ships' fuel consumption and emissions can be calculated or estimated, depending on the availability and quality of the data. It is recommended this be done for each of the five different fleet components, as this will help identify which of the components are most relevant to the country in terms of fuel consumption and emissions.

There are three proposed methods for calculating/estimating ships' fuel consumption and emissions. The methods have varying levels of complexity, reliability and ability to disaggregate the emissions and attribute them to different sectors of the fleet.

Method A, top-down – marine fuel sales data/statistics:

- To use this method, access to all of the national bunker fuel data over a period of time is needed. The emissions can then be calculated using internationally accepted emission factors (see Third IMO GHG Study 2014).
- The method's accuracy is dependent on the quality of the country's bunker fuel data.
- Outputs from this method will provide an estimate of the emissions produced on a national basis.
- Calculations using this method are relatively easy to complete in a short time period. The method follows the approach used for the top-down method in the Third IMO GHG Study 2014.
- This method may not be representative of the fuel consumed by the five different fleet components, particularly if ships purchase bunkers in other countries during the course of their operation. That is why the method is most suited for estimating the emissions of the domestic fleet and, albeit to a lesser extent, of the fleet servicing the country's international transport demand.
- This method is also unable to apportion fuel consumption and emissions between the different sectors of the fleet.

Method B, bottom-up 1 – data reported by shipowners/operators:

- This method requires the submission of fuel consumption data from individual ships. The data can be derived from:
 - Ships' noon reporting data
 - Bunker Delivery Notes
 - Fuel tank monitoring (tank soundings) to estimate ullage
 - Fuel flow meters
 - Direct emissions measurements with sensors (see MEPC 68/INF.3)
- Data reported via this method will include mass/volume plus the density of fuel consumed over a given period of time together with information on the type of fuel consumed.
- In order to report yearly statistics on fuel consumption, these data sources need to be aggregated across the different ships and the voyages made by the ships.
- Emissions are then derived by applying the appropriate emission factors.
- This method can be difficult to implement and requires clear definitions, e.g. annual fuel consumption, consumption since last port of call, and so forth.
- If details of the vessel's activity (cargo movement domestic/international) are reported together with fuel and emissions data, then some disaggregation and apportionment to different sectors of the fleet relevant to the country may be possible.
- For vessels transiting the country's territorial waters that may not make port calls in the country, it may not be possible to obtain a vessel's reported fuel consumption and emissions.

Method C, bottom-up 2 – data on shipping activity and models for energy consumption:

- The second bottom-up method derives estimates of fuel consumption and emissions from data sources describing shipping activity and those describing ship technical characteristics. The primary source of vessel activity used is AIS data which describes, among others, a ship’s identity, position, speed and draught at a given time-stamp. This data can be used to build time-histories of shipping activity, which could be deployed, in conjunction with the technical specifications of a ship, in the calculation of time-histories of estimated fuel consumption and emissions. This approach follows the bottom-up method described in the Third IMO GHG Study 2014.
- The use of an activity-based method can provide insight into the emissions of differently defined fleets.
- Where there is an absence of AIS derived data, but data about the ship’s technical specifications are available, alternative methods that extrapolate estimates from third-party data (e.g. as described in the Third IMO GHG Study 2014) can be deployed to estimate ship-based activity and the associated energy consumption and emissions from ships.
- For the purpose of the rapid assessment, particularly for its first iteration, it might also be possible to do a simplified back-of-the-envelope calculation which involves estimating ships’ activity. For example, in the case of determining emissions for the fleet passing through territorial waters, one needs to know how many ships of which ship type and size category pass through the country’s territorial waters and then estimate for each ship type and size category, how much time per year approximately the ships spend in the country’s territorial waters (e.g. 10% of their time). These estimates can then be inputted into a template that already includes the per ship average annual fuel consumption values and emission factors of the Third IMO GHG Study 2014. This calculation template and further information on its application are set out in Annex 2.

Table 3: *Ship fuel consumption and emissions calculation methods for different fleet components*

Fleet component	Able to calculate		
	Method A	Method B	Method C
1 Registered fleet	No	No	Yes
2 Domestic fleet	Yes	Yes (if activity is also reported)	Yes
3 Fleet servicing the country’s international transport demand	Yes (low accuracy)	Yes (if activity is also reported)	Yes
4 Fleet passing through the country’s territorial waters	No	No	Yes
5 Fleet owned by national shipowners	No	No	Yes

Both the top-down and the two bottom-up calculation methods are discussed in greater detail in sections 1.4 and 1.5 of the Third IMO GHG Study 2014.

Using the above methods, top-down and bottom-up estimates of various air emissions (CO₂, SO_x, PM, NO_x) can be derived using established emission factors for fuels (HFO, MDO, LNG) and engine types (main, auxiliary, gas turbines, steam boilers, high, medium and slow speed) as outlined in Annex 6 of the Third IMO GHG Study 2014. For VOCs and ODSs, existing forms of recording under MARPOL Annex VI, such as the ODS Record Book and VOC Management Plan, can provide information about the quantity of emissions generated by ships.

2.8 Possible emissions scenarios

Estimates of future emissions scenarios are driven by external factors such as population and GDP growth, commodities trends and shipping related factors, such as energy efficiency, transport demand (tonne miles), fuels used and emissions treatment technologies. An important element of the rapid assessment is the projected levels of economic development within the country. This information can be found in national development plans and needs to be factored into projections and estimates of shipping and maritime services demand within the country.

The Third IMO GHG Study 2014 projects transport demand for unitised cargo to rapidly increase, a steady increase in non-coal dry bulk demand and an increase or decrease for oil and coal demand depending on climate policies. Ultimately in all scenarios modelled, emissions are projected to increase. Depending on future economic and energy developments, the scenarios forecast an increase of CO₂ emissions by 50% to 250% in the period up to 2050.

2.9 Existing and planned ports

Ports are major hubs of economic activity and their performance – as determined by various factors including number and type of cargo handling equipment, port access channels, land-side access, customs efficiency, etc. – is important because it affects a country's trade competitiveness (UNCTAD, 2015).

It is therefore important to understand the country's ports in terms of their capacity or throughput by freight types (e.g. for containers and bulk commodities), the type, size and number of ships they handle and any future expansion plans.

Ports can also be a major source of air pollution. In 2011, emissions from ships in ports accounted for 18 million tonnes of CO₂, 0.4 million tonnes of NO_x, 0.2 million tonnes of SO_x and 0.03 million tonnes of PM10 (PM with diameter inferior to 10 micrometres), mostly attributable to container ships and tankers (Merk, 2014). Most of these emissions are estimated to grow fourfold by 2050, with the greatest increases expected to occur in Asia and Africa due to projected strong port traffic growth and a lack of regional mitigation measures. European and North American ports have shown relative declines of emissions, due to relatively slower traffic growth and to stricter regulatory measures. For example, due to implementation of stricter emissions controls within ECAs, SO_x emissions in European and North American ports are projected to amount to 5% of the total SO_x emissions in ports, even though their combined port traffic is expected to account for 24% of the total port traffic in 2050 (Merk, 2014).

In order to reduce the harmful health and environmental effects associated with shipping emissions in ports, some ports have introduced environmental management systems, vessel speed reduction programmes, environmentally differentiated port dues for ships that voluntarily reduce their emissions below levels required by legislation. Some also provide emissions abatement technologies, such as onshore power supply (OECD, 2018).

In addition to ship-based emissions, countries can choose to include emissions from ports and harbours in their national maritime emissions inventory. For further guidance on port emissions inventories, please refer to the *Port Emissions Toolkit, Guide No.1: Assessment of port emissions*.

If port and harbour emissions come under national legislation for the control of emissions from stationary sources, data and information may be available from statutory reporting requirements, should they exist.

2.10 Existing bunkering facilities and expansion plans

Facilities for the storage of marine bunkers are generally found at most major ports and harbours around the world, the majority of which offer various bunker types ranging from HFO to light distillates and LNG. Bunkers are held in large above-ground or underground storage tanks, either for direct supply to vessels at port side or through delivery by an intermediary bunker supply vessel which provides its services to quay side vessels or to vessels waiting to access the port facilities. Larger bunkering facilities tend to be located along high-density shipping lanes and close to oil refining centres, with good fuel availability and little limitation on supply volumes.

Due to stricter air quality regulations and growing expectations for the shipping industry to reduce its emissions, bunkering demands are likely to change in the future. The entry into force of ECAs to control emissions of SO_x has already led to an increase in demand for low sulphur fuel oils and LNG. In light of the 2020 global 0.5% sulphur limit, this trend is expected to continue. In response to growing demands for the industry to reduce its GHG emissions and to meet the emissions targets adopted by IMO (IMO, 2018), opportunities to use low- or zero-carbon fuels and energy sources, such as hydrogen, ammonia, biofuels and batteries, will likely be increasingly explored.

2.11 Shipbuilders and repair yards

For many countries, the shipbuilding sector is of national importance in terms of direct financial return, employment and supply chain contributions.

When considering the current status of the country's shipbuilding sector, the first step is to clearly identify all existing yards (including those that may have been mothballed), their locations, their building and/or repair capacity as well as their ownership structures (e.g. private or publicly owned, or a hybrid of the two). In addition, factors such as the size and capacity of dry dock facilities, proximity to supply chain organisations, access to skilled and trained labour, should be assessed.

It will also be important to analyse the current operation of the yards and the services provided, including the delivery of innovative (emissions reduction) technologies, to determine their future economic outlook and viability. In this context, it might help to identify future (e.g. economic and policy) scenarios at a regional, national and global level and analyse what implications these scenarios might have on the economic outlook of the country's ship yards and whether any changes (e.g. structural, policy and financial) might be needed to ensure future viability.

2.12 Marine equipment manufacturers and suppliers

Shipbuilding and repair depend of course on the supply of marine equipment which is estimated to make up to 75% of a newbuilt ship in terms of value (SEA Europe, 2013). Marine equipment manufacturing and supply is an important sector for many countries or regions. The European Ships and Maritime Equipment Association (SEA Europe), for example, estimates that there are approximately 22,000 big-, small- or medium-sized marine equipment manufacturers and suppliers in Europe, generating an annual turnover of about €60 billion and employing more than 350,000 people directly (SEA Europe, 2017).

It will be important to understand the role of marine equipment manufacturers and suppliers in the country's maritime industry in more detail and to identify the number and size of national manufacturers and suppliers, the equipment they provide, the overall annual value creation of the sector, the number of jobs they provide, and the amount invested in R&D. The latter, in particular, may be important in ensuring that the shipping sector can benefit from future developments, including those around the regulation of emissions from ships.

2.13 Maritime emissions experts, technical and training institutes

A list of individuals, academic institutions or organisations with expertise in matters related to maritime emissions (e.g. energy efficiency or emissions abatement technologies, maritime environmental law, environmental impacts) should be compiled with a view to assessing the capacity available within the country to develop and implement a national ship emissions reduction strategy.

Similarly, sources of relevant data and other information, such as databases, websites, and so forth, should be identified and listed.

As the implementation of MARPOL Annex VI on board the ship ultimately comes down to the crew, it is also important to identify maritime training institutes that can educate seafarers on MARPOL Annex VI requirements and their implementation on board vessels.

2.14 Uptake and implementation of technical and operational measures

A wide range of energy efficiency or emissions abatement technologies and operational measures is available to the shipping industry, many of which offer proven fuel, and thus cost, savings. However, their uptake to date has been limited, leaving room for potentially significant reductions of emissions from ships. This low uptake of technical and operational measures can be attributed to the existence of different barriers, an overview of which is shown in Table 4. For a full overview of these, please refer to Rehmatulla & Smith 2015.

Table 4: Overview of barriers to the uptake of innovative emissions reduction technologies

Barrier	Description	Relevance to shipping
Information	<ul style="list-style-type: none"> Lack of information, cost of obtaining information and accuracy of information. 	<ul style="list-style-type: none"> Misrepresentation of savings by manufacturers. Low frequency of data (e.g. noon reports) makes it difficult to understand the variability in the ship's operating conditions and hence to accurately assess the impact of emissions reduction technologies. Cost of advanced monitoring systems.
Split incentives	<ul style="list-style-type: none"> Arise due to the contractual arrangements between the charterer and shipowner. This occurs most commonly in the time charter markets where the charterer pays fuel costs and exacerbated by the length of contracts and whether owners are rewarded for energy efficiency. 	<ul style="list-style-type: none"> Low investments by shipowner in emissions reduction technologies.
Risk	<ul style="list-style-type: none"> Technical risk – includes technical performance and unreliability of the measure. External risk – includes overall economic trends, fuel price, policy and regulation. Business risk – includes financing risk and sectoral trends. 	<ul style="list-style-type: none"> For some innovative technologies, technical risks (e.g. stability, safety) could outweigh the potential benefits. Fuel costs are paramount in the industry and fuel cost expectation can shape the investment in energy efficiency. There is also uncertainty in future regulations in shipping which may not be factored in during design but could potentially be implemented in the ship's life cycle.
Finance	<ul style="list-style-type: none"> Access to external capital and cost of capital. Investments may therefore not be profitable because companies face a high price for capital. 	<ul style="list-style-type: none"> Traditional shipping banks have decreased their loan books on shipping finance due to the global economic crisis and as a result are less willing to participate in loans to retrofit ships. Lack of alternative methods of finance for both the clean technology providers and shipowners/operators.

As a first step, it is recommended the uptake of emissions reduction technologies and measures for the different fleet components be evaluated or estimated. This will generally be a challenging undertaking as data to assess the uptake is not readily available. One possible way to overcome this challenge is by talking to relevant stakeholders or conducting surveys with shipowners and operators. The latter was done by Rehmatulla et al. (2017) who attempted to gauge the implementation of over 30 energy efficiency and CO₂ emissions reduction technologies. Besides surveys, potential additional methods to collect data on the implementation of technical energy efficiency measures are briefly outlined in Table 5.

Table 5: Other methods to collect data on implementation of technical energy efficiency measures (Rehmatulla et al. 2017)

Method	Strength	Weakness
1 Shipowning companies: case studies on implementation of measures.	Can provide detailed insight into the decision-making process ex ante and ex post results. Can reveal characteristics of diffusion of the measure within the fleet.	Results may not be generalisable and can be resource and time intensive to collect the data.
2 Technology suppliers: data regarding sales and/or installations.	Can provide an accurate picture of the implementation of a particular measure, especially where there are few monopoly suppliers.	Difficult to access data from some technology suppliers. Can suffer from coverage issues, when many suppliers provide a single technology.
3 Classification societies: data regarding newbuild designs/ EEDI, approvals and installations of retrofits.	Can provide a good picture of the measures implemented by customers of particular class societies. Obtaining data from top classification societies can lead to good coverage of the population.	Difficult to access data from some classification societies. Some classification societies do not record this information centrally (e.g. data held in different offices globally).

	Method	Strength	Weakness
4	Shipyards and ship repair yards: data on retrofit installations during drydock/ ad hoc.	Data from the largest shipyards can provide good information on measures being implemented.	Difficult to access data from most shipyards and fragmented industry especially drydock yards because of commercial confidentiality concerns.
5	Banks and insurance providers: data on approvals or financing projects.	Can generally show which measures are being retrofitted by the shipowners.	Can suffer from coverage issues as not all retrofits will be financed by banks and because of commercial confidentiality concerns.

Once the uptake of operational and technical measures is known or has been estimated, it will be useful to identify the reasons for the uptake or lack thereof, the existence of barriers, such as those outlined in Table 4, and to develop options to overcome the identified barriers.

It is possible that conducting the rapid assessment will already start addressing or removing some of the barriers, in particular those related to lack of information and quality of data. One of the early benefits of the rapid assessment will be the acquisition, compilation and assessment of information and data. Where there are gaps and inaccuracies, measures should be adopted in order to improve the coverage of the data and its accuracy over time.

2.15 Relevant technical cooperation and technology transfer mechanisms

Existing technical cooperation and technology transfer mechanisms may offer opportunities to increase the uptake of emissions control or energy efficiency technologies, as well as to build up human and institutional capacities to support effective implementation of and compliance with the relevant regulatory frameworks. It will be useful to identify these mechanisms, assess which ones could be applicable, and identify where there are gaps and how they could be filled.

The following sections briefly outline current IMO mechanisms or activities related to the reduction of maritime emissions and improvement of ship energy efficiency.

To ensure a smooth and effective implementation and enforcement of MARPOL Annex VI regulations worldwide, IMO has also been focusing its efforts on technical cooperation and capacity building and has been undertaking a series of regional and national workshops on implementation of the measures to address emissions from international shipping, under the Integrated Technical Cooperation Programme (ITCP) of IMO.

Furthermore, with financial support from the Global Environment Facility (GEF), UNDP and IMO are cooperating in a global effort to transition the shipping industry towards a lower carbon future, through the GloMEEP project. GloMEEP assists developing countries in the implementation of the energy efficiency measures adopted by IMO.

Also, IMO has established a global network of Maritime Technology Cooperation Centres (MTCCs) which seeks to promote the uptake of low-carbon technologies and operations in maritime transport. This four-year project, administered by the IMO with €10 million in funding from the European Union, is designed to assist beneficiary regions to limit and reduce GHG emissions from their shipping sectors through technical assistance and capacity building, while encouraging the uptake of innovative energy efficiency technologies among a large number of users through the widespread dissemination of technical information and know-how.

Regulation 23 (Promotion of technical cooperation and transfer of technology relating to the improvement of energy efficiency of ships) of Chapter 4 of MARPOL Annex VI requires Administrations, in cooperation with IMO and other international bodies, to promote and provide, as appropriate, support directly or through IMO to Member States, especially developing States that request technical assistance. It also requires the Administration of a Party to MARPOL Annex VI to cooperate actively with other parties, subject to its national laws, regulations and policies, to promote the development and transfer of technology and exchange of information to States which request technical assistance, particularly developing States. Linked to Regulation 23, MEPC 65 (May 2013) adopted resolution MEPC.229(65) which, among other things, requests the IMO, through its various programmes, to provide technical assistance to Member States to enable cooperation in the transfer of energy efficiency technologies to developing countries in particular; and further assist in the sourcing of funding for capacity building and support to States, in particular developing States, which have requested technology transfer.

2.16 Potential sources of finance

Activities resulting from the rapid assessment, such as the development and implementation of a national ship emissions reduction strategy, will require some level of financial resources. For this reason, it will be useful to get an initial understanding of the sources of finance that could potentially be accessed.

These sources could include private, public and institutional investment.

Private investors will typically be technology investors, private equity and venture capital organisations. Public investment can be provided by national governments and local government.

Institutional investment can be supplied through organisations such as the European Bank of Reconstruction and Development (EBRD), European Investment Bank (EIB), Asian Development Bank (ADB), African Development Bank (AfDB) and the Inter-American Development Bank (IDB), a number of which have previously financed ship newbuilds and retrofits, as well as port/harbour and other infrastructure development.

In addition, the United Nations has established a number of mechanisms and organisations focused on providing financial support for climate change mitigation and adaptation, including:

- Green Climate Fund (GCF) is the largest entity under the financial mechanism of the UNFCCC and invests in low-emission, climate-resilient development through mitigation and adaptation projects and programmes in developing countries.
- Global Environment Facility (GEF) is an independent international financial entity established to help defray the costs of making projects environmentally friendly and reduce global environmental threats in developing countries and countries transitioning to a market economy.
- Adaptation Fund finances projects and programmes that help vulnerable communities in developing countries adapt to climate change. Initiatives are based on country needs, views and priorities.
- Least Developed Countries Fund (LDCF) was established to support a work programme to assist least developed countries carry out, inter alia, the preparation and implementation of national adaptation programmes of action (NAPAs).
- Special Climate Change Fund (SCCF) was established to finance projects relating to: adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification. Unlike the LDCF, the SCCF is open to all developing countries, prioritising most vulnerable countries in Africa, Asia and SIDS.

Further technical and financial support may exist in the form of bilateral mechanisms. Support mechanisms for developing a low-emissions shipping sector can also be provided through government tax incentives and discounted lending arrangements.

3 Evaluation of results

The purpose of this rapid assessment guide and the template set out in Annex 1 is to support countries in generating a high-level understanding of the current status of the national and international maritime sector's contribution to their country's inventory of GHG emissions and air pollution.

To generate this understanding, it will be necessary not only to gather data and information, but also to evaluate the quality of the data and information gathered. In order to do this, it is recommended that a process of data standardisation, quality assessment and assurance be applied. This is important in order to build the credibility and robustness of the rapid assessment report and, critically, to underpin future investment cases for new technologies and shipbuilding capacity.

As a result of working through the rapid assessment, it is suggested that the questions in the Evaluation of results section in the template set out in Annex 1 be considered and the answers factored into the next iteration of the rapid assessment and the strategy development process. For example, it is possible that following the rapid assessment, the country determines that there is a lack of information on a number of critical aspects, e.g. size of the fleet, limited access to credible data, and so forth. In this case, the country may decide that improving knowledge and availability and accuracy of data constitutes a strategic objective that needs to be addressed. This could be achieved by adopting tools and methods of analysis, such as the use of trade-based maritime scenario planning models and tools, and the use of AIS and S-AIS data sources for vessel tracking and emissions reporting.

4 Conclusions and recommendations

The main purpose of the rapid assessment of ship emissions in the national context is to inform the process of developing a national strategy to address emissions from the maritime sector. It is therefore important that the findings of the assessment be presented in a manner which will allow relevant decision-makers to quickly gain a clear understanding of the issues and what is required to address them.

The template provided in the Annex provides a guide to both the structure and content of such a report. Each section should provide an overview of the key issues rather than in-depth information, and it is recommended to use figures and illustrations as much as possible. The information provided should clearly support the conclusions and recommendations of the report which should answer the following questions:

- Which maritime sectors currently play the most important role for the country and why?
- Which sectors, if any, could play a more important role and thereby contribute more to the country's economy in the future? How could these sectors be promoted?
- How is the country's maritime industry expected to develop until 2050 and what impact will those developments have on the country? Which opportunities do these developments bring?
- Who are the most important stakeholders, why are they important and how could they contribute to the reduction of maritime emissions?
- Which fleet component(s), or hybrid thereof, seem to be most relevant for the country and why?
- What are the emissions of the most relevant fleet component(s) and how are they likely to develop? How could these developments be influenced and emissions be reduced?

Based on the report's main findings, recommendations can be formulated for the development and implementation of the country's strategy for the reduction of ship emissions. These could, for example, include recommendations on which, if any, data gaps the strategy could address, which of the fleet components to focus on, which stakeholders to involve, which challenges and opportunities to take into consideration, and so forth.

5 References

Aldous, L., Smith, T., Bucknall, R. & Thompson, P. (2015). *Uncertainty analysis in ship performance monitoring*, Ocean Engineering, vol. 110, pp. 29-38.

EEA (2018). *Nitrogen oxides (NO_x) emissions*, <http://www.eea.europa.eu/data-and-maps/indicators/eea-32-nitrogen-oxides-nox-emissions-1>, European Environment Agency.

EPA (n.d.) Basic Ozone Layer Science, <https://www.epa.gov/ozone-layer-protection/basic-ozone-layer-science>, United States Environmental Protection Agency.

Fischbacher, A., Warris, A-M., Holloway, J., Palmer, K., Reid, K., Mortensen, N-B., Tunnel, P., Woodall, P., Vie, R., Collier, R. & Smith, T. (2015). *Goal-based approach to fuel and CO₂ emissions monitoring – uncertainty considerations*, MEPC 68/INF.3, IMO.

Grunewald, N., Butzlaff, I., & Klasen, S. (2013). *Regional Agreements to Address Climate Change: Scope, Promise, Funding, and Impacts*. Courant Research Centre, Discussion Papers 152, 26.

IMO (2013). *MARPOL – How to do it*, 2013 Edition.

IMO (2018). *Initial IMO Strategy on reduction of GHG emissions from ships*, Resolution MEPC.304(72).

IPCC (2006). *2006 IPCC Guidelines for National Greenhouse Gas Inventories*, Volume 2 (Energy), Chapter 3 on Mobile combustion – Section 5 on water-borne navigation.

Leeuwen, J. V. (2010). *Who green the waves? Changing authority in the environmental governance of shipping and offshore oil and gas production*, Environmental Policy Series Vol. 1, Wageningen Academic Publishers, Wageningen.

Maddox Consulting (2012). *Analysis of market barriers to cost effective GHG emission reductions in the maritime transport sector*.

Merk, O. (2014). *Shipping emissions in ports. Discussion paper 2014-20*. International Transport Forum, OECD.

OECD (2018). *Reducing Shipping Greenhouse Gas Emissions, Lessons From Port-Based Incentives*, International Transport Forum, OECD.

Oxford Economics (2015). *The Economic Impact of the UK Maritime Services Sector: Shipping 2015*.

Parker, S. & Smith, T. (2014). *Understanding the Energy Efficiency Operational Indicator: data analysis on tanker ships for INTERTANKO*, UCL Energy Institute.

Parker, S., Raucci, C., T, S & Laffineur, L. (2015). *Understanding the Energy Efficiency Operational Indicator: An empirical analysis of ships from the Royal Belgian Shipowners' Association*.

Rehmatulla, N. (2014). *Market failures and barriers affecting energy efficient operations in shipping* (unpublished PhD thesis), UCL Energy Institute.

Rehmatulla, N. & Smith, T. (2015). *Barriers to energy efficient and low carbon shipping*, Ocean Engineering, vol. 110, no. Part B, pp. 102-112.

Rehmatulla, N. & Calleya, J. (2016). *The implementation of technical energy efficiency measures in shipping*, MEPC 69/INF.8, IMO.

Rehmatulla, R., Parker, S., Smith, T., Stulgis, V. (2017). *Wind technologies: Opportunities and barriers to a low carbon shipping industry*, Marine Policy 75 (2017) 217-226, UCL Energy Institute and Carbon War Room.

Rojon, I. & Smith, T. (2014). *On the attitudes and opportunities of fuel consumption monitoring and measurement within the shipping industry and the identification and validation of energy efficiency and performance intervention*, UCL Energy Institute.

Sainlos, J. C. (2011). *The International Maritime Organization and the protection of the marine environment*, in: Vidas, D and P J Schei (eds) *The world ocean in globalisation: climate change, sustainable fisheries, biodiversity, shipping, regional issues*, Dordrecht: Martinus Nijhoff Publishers.

SEA Europe (2013). *Supplying, Building and Maintaining the Future*, SEA Europe.

SEA Europe (2017). *The Voice of Maritime Civil & Naval Industries in Europe*, SEA Europe.

Smith, T., Jalkanen, J., Anderson, B., Corbett, J., Faber, J., Hanayama, S., O’Keefe, E., Parker, S., Johansson, L., Aldous, L., Raucci, C., Traut, M., Ettinger, S., Nelissen, D., Lee, D., Ng, S., Agarwal, A., Winebrake, J., Hoen, M., Chesworth, S, S. Pandey, A. (2015). *Third IMO GHG Study 2014*, IMO.

Smith, T., O’Keefe, E., Aldous, L. & Agnolucci, P. (2013). *Assessment of shipping’s efficiency using satellite AIS data*, UCL Energy Institute.

UNCLOS (1982). *Convention on the Law of the Sea*, Dec. 10, 1982, 1833 U.N.T.S. 397. Enacted as: entered into force as the “United Nations Convention on the Law of the Sea” on Nov. 1, 1994.

UNCTAD (2014). *Review of Maritime Transport 2014*.

UNCTAD (2015). *Review of Maritime Transport 2015*.

UNCTAD (2017). *Review of Maritime Transport 2017*.

UNEP (n.d.). *Pollutants: Particulate matter (PM)*. Available online: <http://www.unep.org/tnt-unep/toolkit/pollutants/facts.html>.

UNFCCC (n.d.). *Nationally Determined Contributions (NDCs)*, <https://unfccc.int/process/the-paris-agreement/nationally-determined-contributions/ndc-registry>.

Wang, H., Faber, J., Nelissen, D., Russel, B. & St Amand, D. (2010). *Marginal abatement costs and cost-effectiveness of energy efficiency measures*, MEPC 61/5/7 and MEPC 61/INF.18, IMO.

World Bank Group (1999). *Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production*.

WPCI, Carbon Footprinting Work Group (2010). *Carbon Footprinting for Ports – Guidance Document*, Port of Los Angeles.

Annex 1

Rapid Assessment Template

The template below lists the recommended Table of Contents for a rapid assessment of the country's maritime emissions status. It includes a description of the information suggested for inclusion in each section (to be removed when the report is written), and potential sources of such information.

It is recommended that any existing information be included under each of the headings below; this may include information on trade statistics, national inventories under the country's nationally determined contribution, etc.

<p>1 Legislation and policies</p> <ul style="list-style-type: none">• Identify if the country has ratified MARPOL Annex VI and if it has passed national legislation to give effect to MARPOL Annex VI, or where it currently stands in the process. This is discussed in detail in the <i>Ship Emissions Toolkit, Guide No.2: Incorporation of MARPOL Annex VI into national law</i>• Identify international obligations, regional agreements and initiatives and national policies and legislation that may directly or indirectly affect maritime emissions. These can span a wide range of topics, for example maritime transport, marine environment, climate change, air pollution, energy, transport, trade, infrastructure and human health• Analyse how these policies and legislation affect maritime emissions and ship energy efficiency and identify any obligations, guidelines, or recommendations that must or should be taken into consideration <p>Stakeholders:</p> <ul style="list-style-type: none">• Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions <p>Suggested sources of information:</p> <ul style="list-style-type: none">• Ministry of Foreign Affairs, State Legal Advisors, parliamentary structures• Relevant line Ministries (e.g. Environment, Oceans, Maritime Transport)• MARPOL – How to do it, 2013
<p>2 Relevant government ministries and other institutions</p> <ul style="list-style-type: none">• List key national, sub-national and local institutions which are expected to play a role in the control of maritime emissions• Describe why they are important and what role they are likely to play <p>Stakeholders:</p> <ul style="list-style-type: none">• Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions <p>Suggested sources of information:</p> <ul style="list-style-type: none">• Ministry of Foreign Affairs, State Legal Advisors, parliamentary structures• Relevant line Ministries (e.g. Environment, Oceans, Maritime Transport)

3 Current port State control practices, compliance monitoring and enforcement regime

- For each fleet component, identify compliance with the MARPOL Annex VI requirements
- Identify if the country is a Member State of one of the nine MOUs
- Review and report on the current inspection and enforcement practices of the national PSC authorities of MARPOL Annex VI (nationally transposed) regulations. In particular, identify:
 - Number of inspections
 - Number of enforcement actions
 - Number of enforcement actions against MARPOL Annex VI requirements
 - Number of successful actions taken against MARPOL Annex VI requirements
- Identify if national ports and ships included under the different fleet components already participate in voluntary incentive schemes and how (a higher level of) participation could be encouraged
- Identify if PSC Officers require specific training with regard to enforcement of MARPOL Annex VI provisions

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- IMO's Global Integrated Shipping Information System: provides an electronic database for contact points, including for offices of designated national authorities, PSC matters, casualty investigation services and ships' inspection services
- Port State Control (MOUs) Annual Reports and statistics
- Annual Reports on PSC produced by classification societies
- Websites of ship vetting services
- Websites of voluntary incentive schemes

4 Shipping's role in the national economy

- Provide an overview of volumes of cargo transported by sea, both in and out of the country as well as for intra-country trade. Distinguish by cargo type
- Identify the country's main trading partners for each cargo category
- Outline expected future demand for each cargo type
- Identify and provide information on the maritime sector's direct contribution to the national GDP through the trade of goods and raw materials transported at sea
- Identify and quantify the Direct Employment Contribution – the employment of nationals in shipping activities including shipbuilding and repair (including scrapping) and crew
- Identify supply chain-related industrial/commercial organisations, e.g. steel manufacturing (for shipbuilding etc.), engine and technology support, bunker supply and services
- Quantify and report maritime sector direct tax contributions, e.g. income tax, VAT and indirect taxes
- Identify specific maritime taxation and fees, e.g. port and harbour fees, tonnage tax
- Where appropriate, identify multiplier contributions that the national maritime sector will stimulate, e.g. through other types of expenditure, the purchase of goods and services

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- State Ministries (e.g. Trade, Industry, Transport)
- National Statistics Departments
- UN Comtrade
- UNCTAD statistics on maritime transport
- Atlas of Economic Complexity (online tool developed by Harvard's Center for International Development)

5 Key national maritime stakeholders

Compile all the information on stakeholders collected under the different sections of this rapid assessment into a comprehensive stakeholder overview:

- Identify those stakeholders likely to be the most important for the rapid assessment or later for the development and implementation of the national ship emissions reduction strategy and describe how they could contribute to these activities

6 Shipping fleet composition

Identify which ships are of particular importance to your country by analysing five different fleet components:

- Registered fleet: vessels registered in the country, regardless of whether they are actively trading in the country or not
- Domestic fleet: vessels servicing the country's domestic transport demand by moving goods and people from one port of the country to another port of the country
- Fleet servicing the country's international transport demand: vessels moving goods and people between one of the country's ports and a port of another country
- Fleet passing through the country's territorial waters: vessels operating in the country's territorial waters, but without stopping at a port of that country
- Fleet owned by national shipowners: ships owned by companies registered in the country

For each of the five fleet components, collect information on:

- Number of ships per ship type and size category. For a more detailed analysis, also:
 - Develop a database of these vessels to include details such as installed engine power, fuel types consumed, auxiliary power
 - Determine the types of cargoes and volumes transported by the fleet
- Vessel movement patterns and major routes, paying particular attention to vessel movements in territorial waters, including near ports and harbours

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- National Maritime Registry of Shipping: vessels registered with this classification engage in international transport and transport on the inland waterway system. Typically, these registries have been used for international vessels
- River registry: this registry contains vessels registered for transport on the national inland waterway system. It is expected that for some countries, only nationally registered vessels will be permitted navigation/trade on the country's inland waterway system
- Clarkson's World Fleet Register: can also be utilised to generate the technical specification of vessels and also for any gap filling in these areas
- Within the country – from the relevant line Ministries and agencies (e.g. Transport, Maritime Safety Authority, Trade & Industry etc.), port authorities and from the shipping companies themselves
- Lloyd's List Shipowners Directory
- Clarkson's Shipping Information Network
- World Shipping Register
- IHS Sea-web Directory
- Proprietary data services for vessel tracking and monitoring and reporting of emissions
- AIS and S-AIS data

7 Fuel consumption and emissions of fleet components

There are three main methods for calculating or estimating ships' fuel consumption and emissions:

- Method A, top-down: marine fuel sales data
- Method B, bottom-up 1: data reported by shipowners/operators
- Method C, bottom-up 2: data on shipping activity and models for energy consumption
- Alternative simplified method

These three methods, their advantages, drawbacks and applicability to each of the five fleet components are described in detail in section 2.7.

Using the above methods and the data collected under 2.6 Shipping fleet composition, estimate the fuel consumption and emissions for the five different fleet components. During the first iteration of the rapid assessment in particular, this can be a rough back-of-the-envelope calculation. The resulting energy consumption and emissions estimates will provide important input to the decision on which fleet component(s), or combination thereof, to focus on going forward, for example, during the development of a national ship emissions reduction strategy. Once this decision has been taken, more data can be gathered (if necessary) to improve the accuracy of the emissions estimates.

Suggested sources of information:

- National Bunker trade statistics
- IEA Bunker Statistics from World Energy Statistics¹
- Data reported by shipowners/operators, e.g. ships' noon reporting data; Bunker Delivery Notes; fuel tank monitoring; fuel flow meters; direct emissions measurements with sensors; power output measuring and recording for propulsion, ship operations/cargo load
- IMO Data Collection System
- AIS data: can be obtained from various providers; studies show that there can be gaps in the data (Aldous et al., 2015)
- IMO Third GHG Study 2014
- IPCC Emission Factors

8 Possible emissions scenarios

- Determine the projected levels of economic development within the country
- Determine expected future demand for seaborne trade
- Identify global trends and outlooks relevant to the development of your country's fleet components
- For each fleet component, outline or model the expected development of the fleet and its emissions as well as infrastructure requirements up to 2050
- Identify a range of maritime technology roadmaps or scenarios for reducing emissions from the maritime sector
- Evaluate the national maritime transport emissions scenarios against a range of technological development and adoption scenarios

Suggested sources of information:

- IMO Third GHG Study 2014: uses IPCC Representative Concentration Pathways (RCPs) for future demand of coal and oil transport and Shared Socioeconomic Pathways (SSPs) for economic growth. This dataset is the most comprehensive dataset on future scenarios
- National Economic Development Plans
- Regional Economic Development Plans
- World Bank Global Economic Prospects
- IMF World Economic Outlook
- OECD Economic Outlook
- UNCTAD
- Wärtsilä Shipping Scenarios
- DNV GL Scenarios
- Lloyd's Register: Global Marine Trends 2030; Global Marine Fuel Trends 2030; Global Marine Technology Trends 2030; Low Carbon Pathways 2050
- CE Delft, Update of Maritime Greenhouse Gas Emissions Projections
- National Trade and Transport Modelling (e.g. GloTraM)

¹ IEA data is compiled in detail for its 29 member countries. However, statistics are available for non-member countries which include high level information on marine bunkers. IEA non-member countries have in a number of cases collaborated with the IEA in developing better access to information and in cooperation projects. Where appropriate countries may wish to consider establishing a working relationship with the IEA specifically in relation to marine bunker data.

9 Existing and planned ports

- Identify the number and location of all existing and planned ports and harbours
- Identify the annual volumes of traded goods – imports and exports – passing through each port
- Identify the type and frequency of vessels visiting each port
- Identify design capacities for port operation, e.g. depth of mooring, quayside infrastructure provision (e.g. facilities for cold ironing, hull cleaning, and so forth)
- Evaluate operational performance against design capacity, i.e. evaluate whether ports are operating under or over capacity
- Evaluate existing capacity against projected national economic performance projections and economic development plans
- Identify the nature and value of other uses of the port area
- Determine the in-country capacity for building and operating new ports and harbours
- Determine the length of time and resources required to add new port and harbour infrastructure
- Determine the efficiency of the existing port hinterland, e.g. are there sufficient road and rail facilities connecting the port with distribution centres of raw material generation?
- Provide and evaluate any evidence-based information (reports, papers, and so forth) on air quality and GHG emissions standards and reported levels of emissions linked with port and harbour marine traffic and sea lanes within national territorial waters. Port and harbour emissions may come under national legislation for the control of emissions from stationary sources. Where this is the case, data and information can be derived from statutory reporting requirements, should they exist

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- Lloyd's List Ports Directory
- World Port Index
- World Port Source
- For shipping, trade and regulatory aspects: the relevant line Ministries and agencies (e.g. Transport, Maritime Safety Authority, Finance, Customs etc.) and/or from the Port Authority
- Port statistics and port annual reports and accounts
- National Infrastructure Plan
- National Economic Development Plans
- For information on how to estimate emissions from ports:
 - GloMEEP Port Emissions Toolkit
 - Guidance on how to estimate emissions from ports can be found in: WPCI Carbon Footprinting Work Group (2010) Carbon Footprinting for Ports – Guidance Document
 - North American West Coast ports, such as Tacoma² and Vancouver³, have developed methodologies for estimating port emissions
- Information on emissions control and energy efficiency measures for ships in ports can be found in: MEPC 68/INF.16, Study of emission control and energy efficiency measures for ships in the port area

² <http://portoftacoma.com/community/environment/air>

³ <http://www.portvancouver.com/environment/air-energy-climate-action/clean-air-strategy/>

10 Existing bunkering facilities and expansion plans

- Identify existing bunker supply locations
- Evaluate and report the supply and demand for marine bunkers in each of the port and harbours identified. It is possible that bunkers are supplied at locations other than ports and harbours. These locations should also be identified
- Provide statistics on annual (monthly/weekly) bunker supplies, both in type of bunker fuel supplied and volume of bunker supplied
- Evaluate the levels of bunker supply capacity at bunkering locations (over/under capacity)
- Report the condition of existing bunker storage and supply infrastructure
- Identify existing or planned infrastructure for low-carbon and low-sulphur fuels
- Research studies analysing opportunities for developing such infrastructure and report their main findings
- Report the country's existing oil refining capacity and the role that the supply of marine bunkers plays
- Identify the country's access to low-carbon and low-sulphur fuels
- Identify the country's potential for low-carbon and low-sulphur fuels production
- Determine whether a low-carbon and/or low-sulphur marine bunker strategy could be linked to a wider national/regional energy policy
- Determine whether the country developed a strategic plan for future national bunker operations

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- National Energy Supply Statistics
- Oil Refining company reports
- National Strategic Plans
- IEA statistics

11 Shipbuilders and repair yards

- Identify and list all existing national shipbuilding businesses and the location of their yards
- Identify and list all ship repair businesses and the location of their yards
- Identify and list yards that provide both shipbuilding and ship repair services
- Evaluate and report the capacity for shipbuilding and repair in the yards identified above
- Analyse and report the state of existing business undertaken in each yard against the full operational capacity, i.e. what is the designed 100% utilisation of the yard
- Determine under- or over-utilisation
- Categorise yards in terms of services provided, including the delivery of innovative (emissions reduction) technologies
- Provide data on the shipbuilding and repair contribution to the national economy, both in terms of direct income generation (direct taxation and job creation) and indirect contribution (supply chain)
- Determine the suitability of existing yards to maintain current levels of innovation and identify changes (structural, policy and financial) needed to meet future demand for low-emissions ships (both supply and maintenance)
- Identify what improvements can be made to current shipbuilding practices that could reduce emissions from ships built in the country

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- National business registries and directories
- Maritime clusters
- Lloyd's List Maritime Directory of Shipping Services
- Ship Technology Company A-Z

12 Marine equipment manufacturers and suppliers

- List the in-country national marine equipment manufacturers and suppliers, identify the equipment they provide and their size
- Identify whether the equipment provided could contribute to the reduction of emissions from ships
- Quantify the overall annual value and job creation of the sector
- Estimate the amount invested in R&D, in particular that related to the reduction of ship emissions
- List companies that invest heavily in R&D and that are particularly innovative
- Provide information on national intellectual property rights and technology licensing arrangements, including patent protection and enforcement

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- National business registries and directories
- National associations for marine equipment manufacturers and suppliers
- Maritime clusters
- Lloyd's List Maritime Directory of Shipping Services
- Ship Technology Company A-Z

13 Maritime emissions experts, technical and training institutes

- Identify the skill sets and competencies required to reduce emissions of the fleet relevant to your country
- Identify and list all providers of maritime training within the country, including universities, technical colleges, in-company training scheme, trade apprenticeships
- Provide a register of national experts drawn from national universities, colleges and institutions including technical end users
- Evaluate and report the level of adequacy of current in-country educational and training provision
- Assess the further development and capacity building needs of the country's education and training establishments
- Identify any gaps in expertise and potential mechanisms to overcome them, e.g. institutional development, strengthening and capacity building to develop a national capability
- Provide information on how to establish dialogue with the identified institutions and individuals

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- IMODOCS: provides a list of MEPC participants which includes not only the official country representatives, but also advisors to the country delegations and which organisation they belong to, so this will be a good place to start identifying relevant experts and organisations
- World Maritime University: conducts research and offers academic and professional courses on energy efficiency, air pollution and GHG emissions from ships. To identify national experts affiliated with the World Maritime University, it might be helpful to check the staff list
- International Association of Maritime Universities: provides a list of its members, maritime universities, academies, faculties and training institutes
- European Maritime Safety Agency: has developed a Standards of Training, Certification & Watchkeeping (STCW) Information System which provides information, inter alia, on maritime education and training establishments in EU and non-EU countries
- National Education and Training Boards
- Higher education training and funding boards and administrations
- National and international maritime universities
- Private sector training and education providers
- Private sector end users
- GISIS module 'Information on Simulators Available for use in Maritime Training'
- Maritime clusters

14 Uptake and implementation of technical and operational measures

- For each fleet component, estimate the current uptake of technical or operational measures to reduce ship emissions
- Identify the rationale for the level of uptake or lack thereof
- Assess whether higher uptake is currently impeded by the existence of barriers (e.g. lack of information, split incentive, technology risk, finance, lack of access to suitable technologies). If so, determine which barriers are most important and identify options to overcome them
- For each fleet component, identify the proportion and composition of the fleet that are suitable for implementing technical or operational measures to reduce ship emissions. List the factors to be considered in determining this proportion of the fleet, e.g. vessel age, condition and type, and so forth
- Identify shipowners and operators that could be early adopters of technical or operational measures

Suggested sources of information:

- GloMEEP Energy Efficiency Technologies Information Portal and Appraisal Tool
- Second and Third IMO GHG Study
- Lloyd's Register (2015) Marine Technology Report: Driving new technologies
- ABS (2013) Ship Energy Efficiency Measures Advisory
- Fathom Maritime Intelligence (2013) Ship Efficiency: The Guide
- Technology energy efficiency predictions and operational (type tested) results
- Commercial databases
- Marginal Abatement Cost Curves
- Rehmattulla and Smith (2015) 'Barriers to energy efficient and low carbon shipping', Ocean Engineering, vol. 110, Part B, pp. 102-112
- Maddox Consulting (2012) Analysis of market barriers to cost effective GHG emission reductions in the maritime transport sector
- Stakeholder consultation, survey or interviews

15 Relevant technical cooperation and technology transfer mechanisms

- Identify existing technology transfer relationships or mechanisms that are or could be relevant in the context of maritime emissions reductions
- List existing technology transfer relationships or mechanisms within any other sector in the country and determine whether these can be adopted for the purpose of technology transfer in the maritime sector
- Determine existing multi-lateral and bi-lateral technology transfer relationships
- Determine the level of engagement with existing UN and UNFCCC based low-carbon technology transfer mechanisms

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- Ministry of Foreign Affairs, State Legal Advisors, parliamentary structures
- Relevant line Ministries, e.g. Environment, Oceans, Maritime Transport etc.
- Nationally Determined Contribution

16 Potential sources of finance

- List sources of finance (private, public and institutional) that could potentially be accessed for the purpose of reducing maritime emissions
- Identify examples of private finance/capital investment in low-emissions technologies within the country
- List any current economic incentives to encourage inward investment in low-emissions maritime technologies
- Identify existing relationships that the country has with global public financing organisations
- Provide information on any maritime technology investment and technology transfer dialogue with international and regional funding organisations, e.g. Green Climate Fund, Asian Development Bank, Inter-American Development Bank, African Development Bank
- Report the current status of national credit rating and assess whether it may limit the availability of investment

Stakeholders:

- Identify relevant stakeholders, why they are important and how they could contribute to the reduction of maritime emissions

Suggested sources of information:

- Relevant line Ministries, e.g. Finance, Environment, Oceans, Maritime Transport
- Nationally Determined Contribution
- National Designated Authority to the Green Climate Fund
- National Focal Point to the Green Environment Facility
- World Bank, IMF, OECD, UNFCCC, UNEP (and others) reports on climate finance
- Multilateral development banks
- National registry of financial institutions

Evaluation of results					
For each section of the rapid assessment, evaluate the availability and quality of data and information gathered. It is recommended to follow the five steps outlined in the table below.					
Subject Under Evaluation	Step 1	Step 2	Step 3	Step 4	Step 5
	Is there sufficient information for the rapid assessment? If yes, progress to step 3. If no, implement step 2	Undertake a process of information and data gathering and analysis. Set timeframe in which to complete this step. When complete, progress to step 3	Where information is available, is it fit for purpose, i.e. complete, up-to-date, accurate and dependable? If yes, progress to step 4. If no, establish action plan to develop robust information	Consider information and data in the setting of emissions reduction objectives for the national maritime sector (link to actions plans or include brief description) in-line with guidance provided in the Strategy Development Guide Template (Annex 1 of Guide No.3)	Periodically review (e.g. annually) information and data gathered in the preliminary assessment Set date for review
Legislation and policies	Yes	No		Yes	No
Relevant government ministries and other institutions					
Current port State control practices, compliance monitoring and enforcement regime					
Shipping's role in the national economy					
Key national maritime stakeholders					
Shipping fleet composition					
Fuel consumption and emissions of fleet components					
Possible emissions scenarios					
Existing and planned ports					
Existing bunkering facilities and expansion plans					

Evaluation of results					
	Step 1	Step 2	Step 3	Step 4	Step 5
Subject Under Evaluation	Is there sufficient information for the rapid assessment? If yes, progress to step 3. If no, implement step 2	Undertake a process of information and data gathering and analysis. Set timeframe in which to complete this step. When complete, progress to step 3	Where information is available, is it fit for purpose, i.e. complete, up-to-date, accurate and dependable? If yes, progress to step 4. If no, establish action plan to develop robust information	Consider information and data in the setting of emissions reduction objectives for the national maritime sector (link to actions plans or include brief description) in-line with guidance provided in the Strategy Development Guide Template (Annex 1 of Guide No.3	Periodically review (e.g. annually) information and data gathered in the preliminary assessment Set date for review
	Yes	No		Yes	No
Shipbuilders and repair yards					
Marine equipment manufacturers and suppliers					
Maritime emissions experts, technical and training institutions					
Uptake and implementation of technical and operational measures					
Relevant technical cooperation and technology transfer mechanisms					
Potential sources of finance					

Note: In instances when a decision cannot be made, default to: No

Conclusions and recommendations

Summarise the main findings of the rapid assessment, paying special attention to the following questions:

- Which maritime sectors currently play the most important role for the country and why?
 - Which sectors, if any, could play a more important role and thereby contribute more to the country's economy in the future? How could these sectors be promoted?
 - How is the country's maritime industry expected to develop until 2050 and what impact will those developments have on the country? Which opportunities do these developments bring?
 - Who are the most important stakeholders, why are they important and how could they contribute to the reduction of maritime emissions?
 - Which fleet component(s), or hybrid thereof, seem to be most relevant for the country and why?
 - What are the emissions of the most relevant fleet component(s) and how are they likely to develop? How could these developments be influenced and emissions be reduced?
- Based on your findings, formulate recommendations for the development and implementation of the country's strategy for the reduction of ship emissions. These could include recommendations on which, if any, data gaps the strategy could address, which of the fleet components to focus on, which stakeholders to involve, which challenges and opportunities to take into consideration, and so forth.

Annex 2

Fleet and CO₂ calculator

This CO₂ calculator is a computer-based tool to support estimation of CO₂ emissions for one of the country's fleet components for an individual year (see section 2.3 of this guide for more information on the different fleet components). The calculator is developed in MS Excel and can be downloaded on the GloMEEP Project webpage (<http://glomeep.imo.org>). It is based on data used from the Third IMO GHG Study 2014 and includes assumptions and uncertainties on operational and design speed, draught, installed power, metocean (that is, meteorological and oceanographic) conditions, specific fuel consumption and emission factors, which vary in quantity by vessel size and type category. Results obtained using this tool should therefore be interpreted as indicative and providing guidance, rather than exact numbers for the emissions of the fleet component that is being analysed.

The CO₂ calculator uses data from the Third IMO GHG Study for the year 2012 and assumes that ships use Heavy Fuel Oil with a CO₂ emission factor of 3,114 kg CO₂/tonne fuel. All the data is shown in the tab called 'Third IMO GHG Study – Data 2012'.

The columns pre-filled with data from the Third IMO GHG Study (highlighted in light grey) are:

- 'Ship type'
- 'Size category'
- 'Per ship average annual fuel consumption'

In order to estimate CO₂ emissions for a fleet component for year X, fill in two columns (highlighted in light blue) as follows:

- Number of ships in the fleet component: insert the number of ships per ship type and size category that in year X were included in the fleet component you are estimating CO₂ emissions for.
- Average time spent (in %) in fleet component: per ship type and size category, estimate for how much time in year X (in %, e.g. 60%), these ships have fallen under the fleet component in question.
 - Registered and domestic fleet, ships owned by companies registered in the country: this value will be 100% as the ships that fall under these fleet components fall under it 100% of the time.
 - Fleet servicing the country's international transport demand and the fleet passing through the country's territorial waters: this value will be less than 100% as the ships that fall under these fleet components serve other countries' transport demand or pass through other countries' territorial waters. For these two fleet components, estimate (roughly) the amount of time the ships (per ship type and size category) have spent in your territorial waters. In order to arrive at an estimate of the percentage, it might help to look at AIS-derived traffic data.

The CO₂ calculator then calculates the following (highlighted in dark blue):

- Per ship fuel consumption share allocated to fleet component
- Total fuel consumption per ship type and size category
- Total CO₂ emissions per ship type and size category



MORE INFORMATION?

GloMEEP Project Coordination Unit
International Maritime Organization

4 Albert Embankment,
London SE1 7SR, United Kingdom

<http://glomeep.imo.org>