

STUDY ON THE COMPLETION OF AN EU FRAMEWORK ON LNG-FUELLED SHIPS AND ITS RELEVANT FUEL PROVISION INFRASTRUCTURE

LOT 1: Analysis and evaluation of identified gaps and of the remaining aspects for completing an EU-wide framework for marine LNG distribution, bunkering and use

European Commission DG MOVE



Report No.: Final, Rev. 0
Document No.: 1HJCT2Q-4
Date: 2015-06-10

Project name: Study on the completion of an EU framework on LNG-fuelled ships and its relevant fuel provision infrastructure DNV Belgium N.V. DNV GL Oil & Gas
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Report title: LOT 1: Analysis and evaluation of identified gaps and of the remaining aspects for completing an EU-wide framework for marine LNG distribution, bunkering and use

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Date of issue: 2015-06-10

Project No.: PP111984

Organisation unit: DNV GL Oil and Gas Belgium

Report No.: Final, Rev. 0

Document No.: 1HJCT2Q-4

Applicable contract(s) governing the provision of this Report:

Objective:

- To analyse, further evaluate and propose solutions to the identified gaps and barriers on the basis of the findings of the EMSA study, while taking into account the on-going work and preliminary results at the ISO and the IMO; work and initiatives that have been already undertaken at local and national level; findings from relevant TEN-T projects
- To identify and address the remaining issues related to the regulatory framework, standardisation of the LNG bunkering process, the permitting process, QRA and incident reporting, proposing solutions for an EU-wide harmonisation

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[Keywords]

Rev. No.	Date	Reason for Issue	Prepared by	Verified by	Approved by
0	2015-06-10	First issue	DNV GL and PWC expert team	SVVO	MBEK



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List of Abbreviations

ADN	International carriage of dangerous goods by inland waterways
ADR	International carriage of dangerous goods by road
ATEX	Atmosphères Explosibles
BDN	Bunker Delivery Note
CCNR	Central Commission for the Rhine
CEN	European Committee for Standardization
DG-MOVE	European Commission Directorate General for Mobility and Transport
DMA	Danish Maritime Authority
EC	European Commission
ECA	Emission Controlled Area
EIA	Environmental Impact Assessment
EMSA	European Maritime Safety Agency
EN	European Norm
EU	European Union
IGC	International Gas Carrier Code
IGF	International Code of Safety for Ships using Gases or other Low-Flashpoint Fuels
IMO	International Maritime Organization
ISGOTT	International Safety Guide for Oil Tankers & Terminals
ISO	International Organization for Standardization
LNG	Liquefied natural gas
LPG	Liquefied petroleum gas
MARPOL	International Convention for the Prevention of Pollution from Ships
MSC	Maritime Safety Committee
NMA	Norwegian Maritime Authority
OCIMF	Oil Companies International Marine Forum
PGS	Dutch guidelines for dangerous goods
QRA	Quantitative Risk Assessment
RVIR	Rhine Vessel Inspection Regulations



SIMOPS	Simultaneous Operations
SOLAS	International Convention for the Safety of Life at Sea
STCW	Seafarers' Training, Certification and Watchkeeping Code
TEN-T	Trans European network transport
TC	Technical Committee
UN	United Nations
UNECE	United Nations Economic Commission for Europe

0 EXECUTIVE SUMMARY

One of the possible solutions for compliance with the more stringent air emission requirements for vessels in the sulphur emission control areas (SECAs) is the use of LNG as propulsion fuel for shipping, next to the use of low sulphur fuels and the installation of exhaust gas scrubbers. With the exception of Norway, the take-up of LNG as ship fuel in Europe is still in an early stage, and key stakeholders typically identify three main barriers: the lack of adequate bunker facilities for LNG, the gaps in the legislative or regulatory framework, and the lack of harmonized standards.

The recently adopted Directive on the deployment of alternative fuels infrastructure 2014/94/EU aims to solve the first barrier by enforcing the Member States to ensure that an appropriate number of LNG refuelling points for maritime and inland waterway transport are provided in maritime ports of the TEN-T Core Network by 31 December 2025 and in inland ports by 31 December 2030.

The aim of this study is to propose solutions for the second and third barrier. In a previous study commissioned by EMSA and published in February 2013, a detailed description of the existing rule framework related to LNG bunkering was made and through a gap analysis missing rules for bunkering LNG and related aspects were identified.

The overall objective of this study is to analyse, further evaluate and propose solutions to the identified gaps and barriers based on the findings of the EMSA study and the evolutions since.

Furthermore, for the remaining issues, solutions are proposed for an EU-wide harmonization. The study therefore covers the following key elements: an update of the legal and regulatory framework analysis, the permitting process, quantitative risk assessment, incident reporting and remaining gaps and possible recommendations how to solve these gaps.


This study will result in a report giving an overview of currently applicable standards, rules and regulations governing the maritime LNG supply chain, a gap analysis identifying the gaps in the current regulatory framework in order to make LNG bunkering and LNG fuelled vessels feasible in the EU, a set of recommendations addressing the gaps identified, and an impact assessment of the prioritised recommendations and actions.

The assessment of the existing rules, standards and guidelines shows that from a legal point of view, there are no remaining major showstoppers for the use of LNG as fuel - both for seagoing vessels and inland waterway vessels - nor for the deployment of LNG bunker facilities.

Recently, legislation and rules previously prohibiting the use of LNG as fuel for seagoing vessels and inland waterway vessels have been adapted or are being adapted to allow the use of LNG as fuel. The bulk of the proposed recommendations mainly address issues where further harmonisation is possible. An important harmonisation opportunity is the bunkering activity itself, which is today not harmonised in EU ports. Furthermore, EU-wide standards for LNG bunkering installations and requirements for LNG bunkering equipment are missing. Some suggested standards are not strictly required from a legal point of view but are perceived as strong enablers, disseminating codes of good practice.

One of the specific aims of this study was to identify harmonisation opportunities with respect to following focus areas: permitting, quantitative risk assessment and incident reporting. Most important findings are summarised below.

The design of the permit process and the related practices vary between the Member States. In some Member States permitting procedures are considerably more complex than in others. Several factors are leading to slow and inefficient permit processes. There are on-going initiatives to speed up the overall permit process via e.g. all-in-one permits with only one authority coordinating, and via specific LNG



guidance documents. In some Member States specific regulation is in force to smoothen the permit process for selected critical projects.

Although the permit processes are well enforced by law in the EU Member States, the overall process is not fully transparent to all involved parties, this includes information on milestones and deliverables, authorities responsible, documents to be produced, In addition various Member States have no clear time targets for the different steps in the permitting procedure and/or no enforcement/consequences if the delays are not respected.

The responsible authorities are not always familiar with LNG and its benefits. This in combination with lack of LNG skilled people (specific knowledge on LNG and LNG installations) at authorities and clear standards might lead to an overkill of environmental studies to be executed for LNG developments. Some Member States have already created platforms to share best practices and information between all LNG stakeholders.

The current risk assessment (e.g. QRA) practices and risk acceptance criteria are identified to provide recommendations for harmonization and improvements to LNG bunkering risk assessment practices across EU Member States and ports. EU countries apply different methodological approaches and criteria to determine and assess external risk for LNG establishments that are subjected to the Seveso directive. It is found that harmonization of the latter is difficult to achieve due to the fact that each Member State has transposed their own interpretation and implementation of the directive in their legislation. For non-Seveso LNG establishments and activities, EU-wide harmonization of the risk assessment approach seems feasible.

Several other more specific knowledge gaps have been identified that should be considered as potential improvements in the overall risk analysis process of small scale LNG infrastructure and activities.


The current incident reporting structure needs to be adapted to be able to efficiently capture data from LNG bunkering incidents and the lessons learned. The aim of such an updated reporting structure is to capture LNG specific incident data in a European database and to make these data accessible for all relevant stakeholders. The proposed database will combine data from existing databases (e.g. eMARS, EMCIP, ADR, port databases, ...). This necessitates that the mentioned existing databases are populated and thus implies that detailed incident reporting routines are in place and followed.

The incident database should be implemented at EU level and should cover all incidents, accidents and near-misses with (potential) implications on safety and operations related to the small scale LNG value chain.

The preceding part has resulted in a long list of potential interventions (via recommendations) that could help achieve the overall study objective, namely the reduction of emissions by shipping and to stimulate harmonisation across EU and further serves as input to the analysis of the social, economic and environmental impact. The impact assessment is meant as a key tool to ensure that Commission initiatives and EU legislation are prepared on the basis of transparent, comprehensive and balanced evidence. The analysis was ultimately aimed at achieving insight into the (policy) ways of stimulating the use of LNG as clean shipping fuel.

Following policy scenarios have been considered:

1. Do nothing scenario (= Business as usual or baseline scenario);
2. Alternative policy options:
 - 2.1. No harmonisation across EU; ("Must haves")



2.2. Low/Moderate harmonisation across EU; (“low hanging fruits”)

2.3. Full harmonisation across EU. (“Nice to have”)

Each of the policy options above corresponds with a certain set of measures related to the full closure of any existing legal/regulatory gaps and knowledge gaps identified. As can be concluded from the impact assessment, both maximum and minimum harmonisation entails demerits. Notwithstanding the full harmonisation has the best overall score for environmental, safety and social criteria, this is strongly counterbalanced by a significant higher implementation effort, more rigidity and higher risks of delays (administrative burden). Full harmonisation may result in complex compromises to be made at EU level, resulting in the policy objective not reached or reached at a much slower pace than anticipated.

Based on the above analysis we therefore consider the low/moderate harmonisation scenario as most workable policy option in terms of the efforts versus impact ratio to meet the foregoing defined policy objectives. With the choice for this policy option, Member States can transpose the Directive on Alternative Fuels with a ‘light-touch’ while retaining the benefits. With this policy option EU can remain confident that all Member States apply minimum and somehow harmonised standards.

1 INTRODUCTION

More stringent air emission requirements for seagoing vessels are introducing a new challenge for maritime administrations and services. These challenges are all the more daunting in the IMO (International Maritime Organisation) Emission Control Areas (ECAs).

One of the possible solutions to compliance is the use of LNG as propulsion fuel for shipping, next to the use of low sulphur (LS) fuels and the installation of exhaust gas scrubbers.

Engine manufacturer Rolls-Royce compared the relative emissions for these various compliance options, clearly demonstrating the LNG propulsion option as the overall environmental winner.

The lack of adequate bunker facilities for LNG appears to be one of the obstacles for an effective breakthrough of this alternative fuel.

In September 2011, the Commission issued a staff working paper on a "sustainable waterborne transport toolbox" describing possible measures to minimise the compliance costs for the industry in view of the proposed new sulphur limits on sulphur content of marine fuels. As part of the toolbox implementation, the European Maritime Safety Agency (EMSA) has carried out a study (/1/) on standards and rules for bunkering gas fuelled ships. The study made an inventory of the existent rules and standards, as well as on-going regulatory developments at international level on LNG as ship fuel. The final report provides a "gap analysis" relating to LNG bunkering and recommends the development of possible EU standards.

A preparatory action was subsequently adopted based on this "gap analysis" study and the recommendations it puts forward, as well as on the outcome of the on-going regulatory developments at international level (within the IMO, ISO, SIGTTO, and IAPH). This preparatory action aims to obtain an overview of market developments as regards the introduction of LNG-fuelled ships or "LNG ready" ships, as well as LNG fuel provision infrastructure (on-shore or by bunker barges) in the EU.


1.1 Study Objectives

The main objectives of this study are:

- To analyse, further evaluate and propose solutions to the identified gaps and barriers on the basis of the findings of the EMSA study, while taking into account the:
 - on-going work and preliminary results at the International Standardisation Organisation (ISO) and the International Maritime Organization (IMO);
 - work and initiatives that have been already undertaken at local and national level;
 - findings from relevant TEN-T projects
- To identify and address the remaining issues related to the regulatory framework, standardisation of the LNG bunkering process, the permitting process, QRA and incident reporting, proposing solutions for an EU-wide harmonisation for seagoing as well as inland vessels (beyond local rules and procedures already in place), including safety and security aspects of LNG storage, bunkering and handling (ports/supply side, and ships).

1.2 Approach

The first part of this study, which builds on the EMSA study (/1/), gives an overview of the existing rules, standards and guidelines relevant for the small scale LNG industry.



Beside this overview of rules, standards and guidelines, this part deals with three specific areas of focus, i.e.:

- Permitting process
- QRA and risk acceptance criteria;
- Incident reporting.

Due to their importance, each of these focus points is discussed separately in a specific chapter of this report.

In the second part of this study, the remaining gaps and barriers for a consolidated EU-wide regulatory framework for LNG distribution, LNG bunkering and use as marine fuel are identified and concretised through a set of recommendations that elaborate on possible policy actions, rules, standards and guidelines. The identified gaps are classified according to 3 different types: legal gaps, harmonization gaps and knowledge gaps.

The above outcome has served as input to the analysis of the social, economic and environmental impact. The analysis was ultimately aimed at achieving insight into the (policy) ways of stimulating the use of LNG as clean shipping fuel.

1.3 Report structure

This report starts with an overview of authorities and regulators, relevant in the context of LNG as shipping fuel. This overview is given in Chapter 2.

Chapter 3 continues with a list of previous studies, and a short description of the scope and outcome of these studies. This list of studies is used as overall input to the further chapters.

The study on the regulations and standard relevant for LNG as shipping fuel is covered within four separate chapters. Next to a general introduction to the EU framework aiming at reduction of emissions from shipping (chapter 4), both the shore side (Chapter 5) as the waterside (Chapter 6) are covered, as well as the bunkering interface (Chapter 7).

After the discussion on the regulatory framework, the three focus points, i.e. Permitting Processes, QRA and Incident Reporting, are dealt with in Chapter 8 till 10 respectively.

Chapter 11 gives a summary of the identified gaps related to the LNG bunkering process, followed by potential recommendations to solve these gaps. Results of the impact assessment are explained in Chapter 12 of this report. In order to enable policymakers to verify to what extent the policy is achieving its set objectives, potential means of monitoring are addressed in Chapter 13. The report concludes with a summary in Chapter 14.

2 OVERVIEW OF RELEVANT ORGANISATIONS & REGULATORS

Different organisations and regulators are active in the development of standards, legislation and guidelines related to LNG bunkering. Some of them are focusing on one specific working domain, e.g. only maritime issues, whereas others deal with a broader range of aspects.

A brief overview of the main organisations and regulators at an International/European level, relevant for LNG bunkering, is given in this chapter, together with their way of working and their main responsibilities.

2.1 International Bodies

2.1.1 International Maritime Organisation (IMO)

IMO is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships¹. As a specialized agency of the United Nations, IMO is the global standard-setting authority for the safety, security and environmental performance of international shipping. Its main role is to create a regulatory framework for the shipping industry that is fair and effective, universally adopted and universally implemented.

In other words, its role is to create a level playing-field so that ship operators cannot address their financial issues by simply cutting corners and compromising on safety, security and environmental performance. This approach also encourages innovation and efficiency.

Shipping is a truly international industry, and it can only operate effectively if the regulations and standards are themselves agreed, adopted and implemented on an international basis. IMO is the forum at which this process takes place.

IMO measures cover all aspects of international shipping – including ship design, construction, equipment, manning, operation and disposal – to ensure that this vital sector for remains safe, environmentally sound, energy efficient and secure.

Figure 2-1 gives an overview of the structure and different sub-committees of IMO.

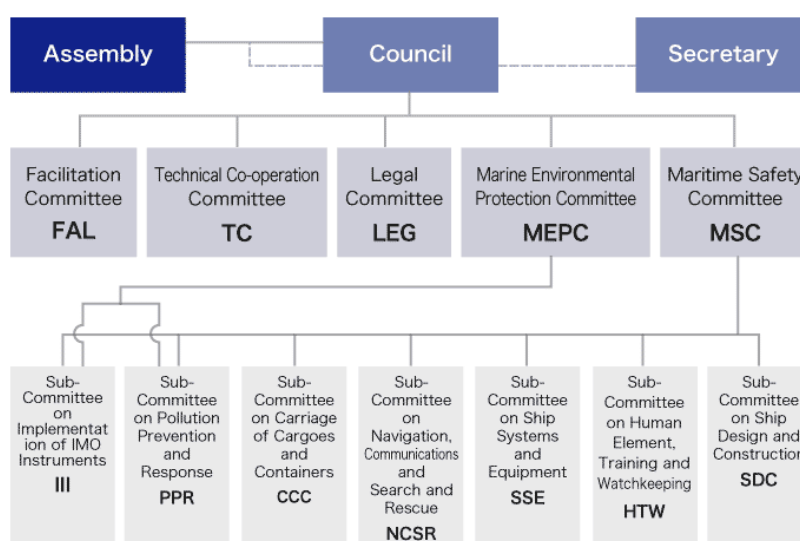


Figure 2-1: IMO structure (source: ClassNK)

¹ www.imo.org

The Maritime Safety Committee (MSC) is the highest technical body of the Organization. It consists of all Member States. The functions of the MSC are to “consider any matter within the scope of the Organization concerned with aids to navigation, construction and equipment of vessels, manning from a safety standpoint, rules for the prevention of collisions, handling of dangerous cargoes, maritime safety procedures and requirements, hydrographic information, log-books and navigational records, marine casualty investigations, salvage and rescue and any other matters directly affecting maritime safety”.

2.1.2 International Organisation for Standardisation (ISO)

ISO is an independent, non-governmental organization made up of members from the national standards bodies of 165 countries². These national standards bodies make up the ISO membership and they represent ISO in their country. The ISO is also involved in the development of standards for the shipping industries and closely works together with the IMO.

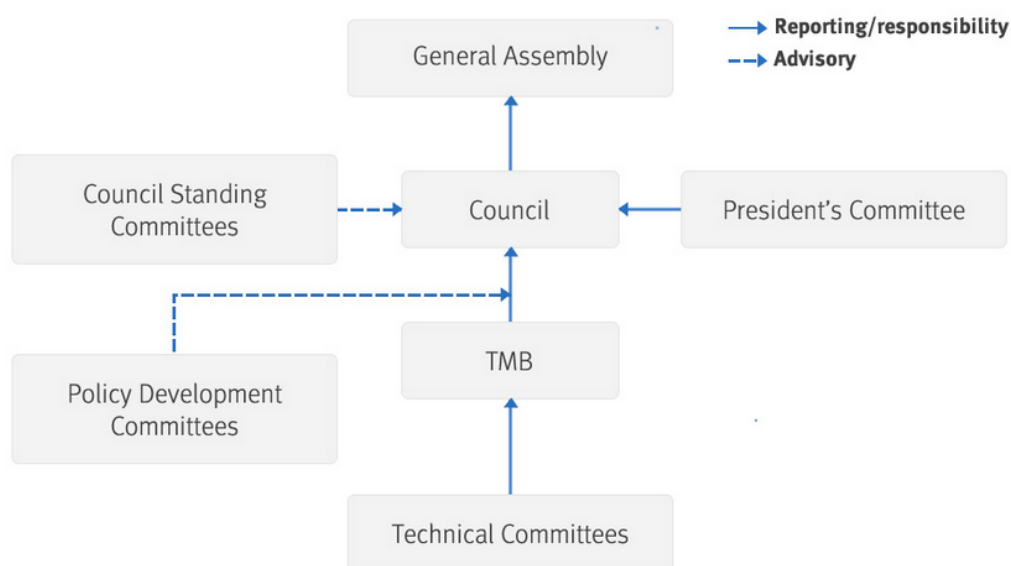


Figure 2-2: ISO governance structure (source: ISO)

The management of the technical work is taken care of by the Technical Management Board (TMB). This body is also responsible for the technical committees that lead standard development and any strategic advisory boards created on technical matters.

The Technical Committees involved in the development of standards related to the gas industry are:

- ISO/TC 28 Petroleum products and lubricants;
- ISO/TC 67 Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries;
- ISO/TC 193 Natural Gas.

² www.iso.org

2.1.3 Society of International Gas Tanker & Terminal Operators (SIGTTO)

The SIGTTO was formed as an international organisation through which all industry participants might share experiences, address common problems and derive agreed criteria for best practices and acceptable standards³. The purpose of the SIGTTO is to promote shipping and terminal operations for liquefied gases which are safe, environmentally responsible and reliable. To fulfil this mission, SIGTTO develops best operating practices and guidelines.

2.1.4 Oil Companies International Marine Forum (OCIMF)

The OCIMF is a voluntary association of oil companies with an interest in the shipment and terminalling of crude oil, oil products, petrochemicals and gas⁴. Their mission is to be the foremost authority on the safe and environmentally responsible operation of oil tankers, terminals and offshore support vessels, promoting continuous improvement in standards of design and operation. The current membership of OCIMF comprises 98 companies worldwide.

2.1.5 Intergovernmental Organisation for International Carriage by Rail (OTIF)

The OTIF mainly focuses on the further development of rail transport law. 48 States are Members of OTIF at the present time. The following areas are dealt with⁵:

- contracts of carriage for the international carriage of passengers and goods (CIV and CIM);
- carriage of dangerous goods (RID);
- contracts of use of vehicles (CUV);
- contract on the use of railway infrastructure (CUI);
- validation of technical standards and adoption of uniform technical prescriptions for railway material (APTU);
- procedure for the technical admission of railway vehicles and other railway material used in international traffic (ATMF).

³ www.sigtto.org

⁴ www.ocimf.org

⁵ www.otif.org

2.2 European bodies

2.2.1 European Commission (EC)

The European Commission represents the interests of the EU as a whole. It proposes new legislation to the European Parliament and the Council of the European Union, and it ensures that EU law is correctly applied by member countries⁶. The Commission has the right of initiative to propose laws for adoption by the European Parliament and the Council of the EU (national ministers). In most cases, the Commission makes proposals to meet its obligations under the EU treaties, or because another EU institution, country or stakeholder has asked it to act.

Before making proposals, the Commission consults widely so that stakeholders' views can be taken into account. In general, an assessment of the potential economic, social and environmental impact of a given piece of legislation act is published along with the proposal itself.

Once EU legislation has been adopted, the Commission ensures that it is correctly applied by the EU member countries.

The existing legal framework allows the Commission to request one or several European standardisation organisation to draft a European standard or European standardisation deliverable. European standards are adopted by the European standardisation organisations, namely CEN, CENELEC and ETSI.

2.2.2 European Committee for Standardisation (CEN)

CEN, the European Committee for Standardization, is an association that brings together the National Standardization Bodies of 33 European countries⁷. CEN is one of three European Standardization Organizations (together with CENELEC and ETSI) officially recognized as competent in the area of voluntary technical standardization. The European Union (EU) Regulation (1025/2012) which settles the legal framework for standardization, has been adopted by the European Parliament and by the Council of the EU, and entered into force on 1 January 2013.

CEN provides a platform for the development of European Standards and other technical documents in relation to various kinds of products, materials, services and processes. CEN supports standardization activities in relation to a wide range of fields and sectors.

The European standards are developed by Technical Committees (TC) which consists in of a panel of experts and is established by the Technical Board. The Technical Committees under which working groups (WG) may exist in which the experts develop the EU standards for the gas industry are:

- CEN/TC 12 – Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries;
- CEN/TC 234 - Gas infrastructure;
- CEN/TC 235 - Gas pressure regulators and associated safety devices for use in gas transmission and distribution;
- CEN/TC 236 - Non industrial manually operated shut-off valves for gas and particular combinations valves-other products;
- CEN/TC 237 - Gas meters;

⁶ ec.europa.eu

⁷ www.cen.eu

- CEN/TC 282 - Installation and equipment for LNG;
- CEN/TC 326 - Gas supply for Natural Gas Vehicles (NGV);
- CEN/SS N21 - Gaseous fuels and combustible gas.

2.2.3 United Nations Economic Commission for Europe (UNECE)

The UNECE is one of five regional commissions of the United Nations⁸. UNECE's major aim is to promote pan-European economic integration. To do so, it brings together 56 countries located in the European Union, non-EU Western and Eastern Europe, South-East Europe and Commonwealth of Independent States (CIS) and North America. All these countries dialogue and cooperate under the aegis of UNECE on economic and sectorial issues.

The most relevant contribution related to the LNG supply chain is the work of the Transport Division which is guided by the mandates and work programmes of the UNECE Inland Transport Committees (ITC) and its subsidiary bodies. The ITC provides a pan-European intergovernmental forum to create tools for economic cooperation and to adopt international legal instruments on inland transport.

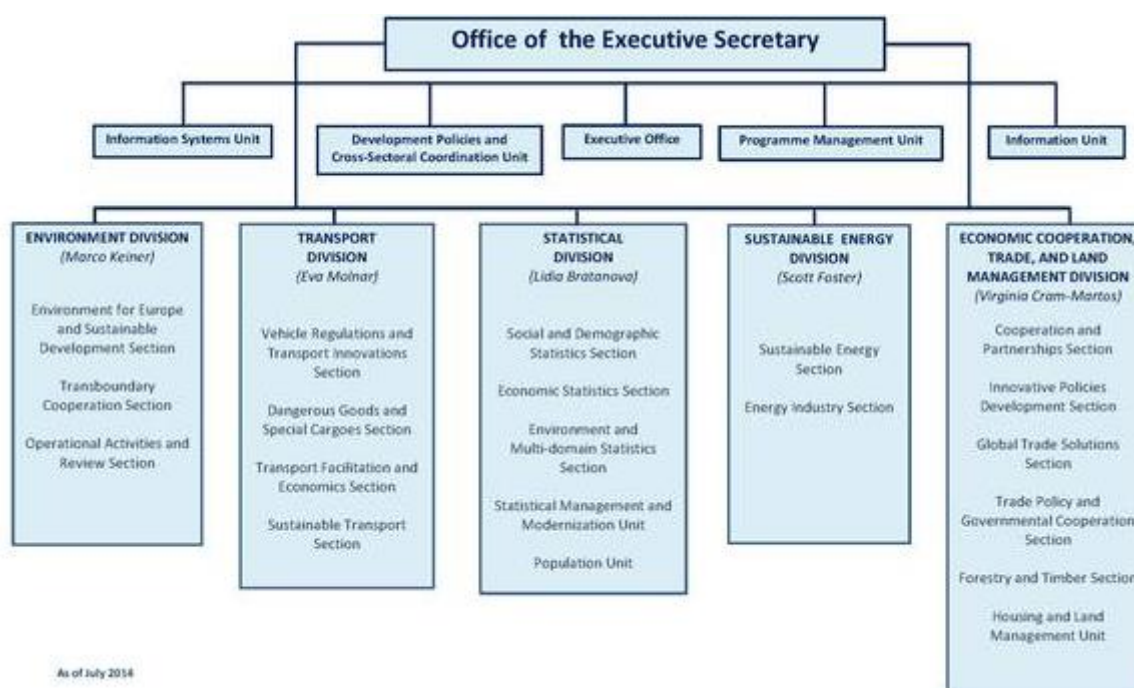


Figure 2-3: Organizational Chart UNECE

2.2.4 Central Commission for the Rhine (CCNR)

The CCNR is an international institution which addresses all the issues concerning inland navigation⁹. It promotes the development of close cooperation with the other international organisations working in the field of European transport policy and with non-governmental organisations active in the field of inland navigation

⁸ www.unece.org

⁹ www.ccr-zkr.org

The objectives of the CCNR are to ensure efficient, safe and environmentally friendly transport of the Rhine as well as ensuring sustainable development. The CCNR cooperates with the UNECE and other river commissions.

2.3 National Standardisation Bodies

2.3.1 European Bodies

Most of the European countries have established national standardisation bodies which develop their own national regulatory instruments and as well as represent national standardisation interests e. g. as a member of ISO and CEN.

Table 2-1 gives an overview of the different national standardisation bodies for ECA countries and potential future ECA countries. However, all 30 CEN members are obliged to adopt European standards as substitutes for their former national standards. Most of formerly relevant national standards have been integrated in or substituted by CEN European Standards.

Table 2-1: National standardisation bodies¹⁰

Country	Organisation	Acronym
Belgium	Bureau de Normalisation / Bureau voor Normalisatie	NBN
Croatia	Croatian Standards Institute	HZN
Cyprus	Cyprus Organization for Standardisation	CYS
Denmark	Dansk Standard	DS
Estonia	Estonian Centre for Standardisation	EVS
Finland	Suomen Standardisoimislitto r.y.	SFS
France	Association Française de Normalisation	AFNOR
Germany	Deutsches Institut für Normung	DIN
Greece	National Quality Infrastructure System	NQIS/ELOT
Italy	Ente Nazionale Italiano di Unificazione	UNI
Latvia	Latvian Standard Ltd.	LVS
Lithuania	Lithuanian Standards Board	LST
Malta	The Malta Competition and Consumer Affairs Authority	MCCAA
The Netherlands	Nederlands Normalisatie-instituut	NEN
Poland	Polish Committee for Standardization	PKN
Spain	Asociación Española de Normalización y Certificación	AENOR
Sweden	Swedish Standards Institute	SIS
United Kingdom	British Standards Institution	BSI

2.3.2 American Bodies

2.3.2.1 National Fire Protection Association (NFPA)

The NFPA is an international non-profit organisation. The company's mission is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education. ¹¹.

2.3.2.2 American Petroleum Institute (API)¹²

The American Petroleum Institute (API) produces standards, recommended practices, specifications, codes and technical publications that cover each segment of the industry. Most of the standards and recommended practices are dedicated to a single type of equipment.

¹⁰ <http://standards.cen.eu/>

¹¹ www.nfpa.org

¹² www.api.org

2.4 Classification Societies

Seagoing ships are designed to and built under the class rules of a Classification Society. The objective of ship classification is to verify the structural strength and integrity of essential parts of the ship's hull and its appendages, and the reliability and function of the propulsion and steering systems, power generation and those other features and auxiliary systems which have been built into the ship in order to maintain essential services on board. Classification Societies aim to achieve this objective through the development and application of their own Rules.

With the introduction of the first LNG carrier the classification societies developed specific rules for the construction and safety of LNG carriers, for example DNV Class Rules Part 5 Chapter 5 – "Liquefied Gas Carriers". More recently, also Class Rules for LNG fuelled ships were published:

Table 2-2: Class Rules for LNG fuelled ships

No	Name of Class	Class short sign	First publication	Title of Guideline
1	American Bureau of Shipping	ABS	May 2011	Guide for propulsion and auxiliary systems for gas-fuelled ships
2	Bureau Veritas	BV	May 2011	Safety rules for gas-fuelled engine installations in ships; Rule note NR 529 DT R01 E
3	China Classification Society	CCS	-	-
4	Croatian Register of Shipping	CRS	-	-
5	Det Norske Veritas	DNV	Oct. 2010	Gas-fuelled engine installations
6	Germanischer Lloyd	GL	May 2010	Guidelines for the use of gas as fuel for ships
7	Indian Register of Shipping	IRCLASS	-	-
8	Korean Register of Shipping	KR	July 2012	Guidance for gas-fuelled ships
9	Lloyds Register	LR	July 2012	Rules and regulations for the classification of natural gas-fuelled ships
10	Nippon Kaiji Kyokai	NK	February 2012	Guidelines for the issuance of ship fuel gas
11	Polish Register of Shipping	PRS	July 2012	Guidelines on safety for natural gas-fuelled engine installations in ships; publication No. 88/P
12	Italian Register	RINA	June 2011	Rules for the classification of ships, Amendments to part C, Chapter 1: New Appendix 7 – Gas-fuelled ships
13	Russian Maritime Register of Shipping	RS	-	-

3 OVERVIEW OF RELEVANT PREVIOUS STUDIES

3.1 LNG Masterplan

In order to facilitate the development of LNG as fuel and cargo for the inland waterways the LNG Masterplan was created, a project that addresses Priority Project Nr. 18 "Waterway axis Rhine/Meuse/Danube" of the TEN-T network. Part of this project is the "Safety Study LNG Masterplan" of DNV GL, which addresses the technical, safety and operational risk aspects of LNG bunkering and LNG loading and unloading on the Rhine corridor.

In the report of sub-activity 2.3, an overview of the current regulatory framework relevant for LNG bunkering is presented. Based on the overview, the gaps in the regulatory framework are identified and it is defined what regulations need to be developed to enable bunkering of LNG for inland navigation for each country (Switzerland, France, Germany, Belgium and the Netherlands) on the Rhine corridor.

The results of this study are used as input to this study.

3.2 LNG Bunkering Study for US Maritime Administration (MARAD)

MARAD contracted with DNV GL to execute a study with the objective of analysing existing LNG bunkering infrastructure, safety, regulations and training, and identifying and recommending best practices. Over the course of this study, DNV GL has made recommendations for specific audiences concerning standards and integration of LNG bunkering into U.S. maritime operations. The study is divided into four sections that analyse the following topics: LNG bunkering; LNG bunkering safety; regulations and personnel training.

The results of this report are used as input to this study /9/.

3.3 Liquefied Natural Gas, A Marine Fuel for Canada's West Coast


In 2013, a joint industry/government project was initiated to develop an understanding of the opportunities and barriers associated with establishing a marine LNG supply chain on the West Coast of Canada. The project scope included an exploration of the regulatory challenges to introducing LNG as marine fuel, including potential barriers at the federal, provincial, and municipal levels, and recommend ways to overcome these barriers.

The results of this report are used as input to this study /8/.

3.4 North European LNG Infrastructure Project (DMA)

An infrastructure of marine LNG bunkering (filling) stations has two dimensions: a "soft" dimension focusing on regulations and industry standards, etc. and a "hard" dimension focusing on the physical system consisting of terminals, bunker ships and tank trucks, etc., i.e. basically the same elements as those of the oil based fuel infrastructure system.

This study focuses on the development of an LNG filling station infrastructure based on these two dimensions and along the LNG supply chain from large European LNG import terminals and/or liquefaction plants to the use on board ships. The infrastructure is analysed from the business case point of view for ports, LNG providers and ship owners.



The outcome of the work are recommendations which target the challenges of setting up such an infrastructure, what must be done to solve each problem and who has to do it. The project partners include states, ports, natural gas and LNG terminal companies and selected other companies from the maritime cluster, hereby representing the LNG supply chain. Furthermore, the project has received funding from the EU Trans-European Transport Network, Motorways of the Sea.

3.5 Clean North Sea Shipping (CNSS) Project

The Clean North Sea Shipping (CNSS) Project, involving 18 partners from six countries, seeks to address the problems caused by air pollution and greenhouse gases produced by ships operating along the North Sea coast and within North Sea ports and harbours. A reduction in exhaust gas emissions from ships will improve the general environmental situation in the North Sea Region.

The CNSS project aims to create awareness, share knowledge and convince influential stakeholders, including regional and European politicians, ports, shipping companies and cargo owners, to take action /3/.

3.6 Legal and Regulatory Study for LNG Supply in Flemish Ports

In this study the possibilities and options for the organisation and facilitation of bunkering of LNG in Flemish ports are evaluated. The Flemish Government and the port authorities of Antwerp, Zeebrugge and Ghent, in cooperation with Fluxys LNG (operator of the LNG terminal at Zeebrugge) are the initiators and stakeholders of this study.

The aim of this study was to identify the necessary regulations concerning bunkering of LNG and ultimately to create possibilities for efficient and safe LNG bunkering in these port in the near future. The study covers the following key elements: a market survey, a risk and safety analysis, the legal and regulatory framework and the logistical organisation.

The Legal & Regulatory study, executed by DNV, resulted in an overview of currently applicable rules & regulations governing the maritime LNG supply chain, a gap analysis identifying the gaps in the current regulatory framework in order to make LNG bunkering feasible in the ports concerned, and a set of recommendations addressing the gaps identified.

The results of the Legal and Regulatory study of this report are used as input to this study /5/.

3.7 Dutch Legal and Safety Assessment (LESAS) Project for Small Scale LNG

In 2011, TNO started a joint industry project for the Legal and Safety Assessment of a possible small scale LNG supply chain for the Rotterdam Area. In the LESAS project, a preliminary regulatory assessment was made for the establishment of a small scale LNG supply chain for various bunkering operations.

3.8 LNG Bunkering Infrastructure Study

As a response to increasing developments in emission regulations and their impacts on shipping globally, Lloyd's Register has commissioned a study with the aim of understanding how a global LNG bunkering infrastructure may develop.

The overall concept for the study has been to review the case for LNG as a ship propulsion fuel for deep-sea shipping by examining:

- Shipping trade patterns and current bunkering trends by most ship types and size ranges.

- Fuel consumption requirements for power generation by most ship types and ship size ranges and the potential required volume requirements.
- Availability of existing and future LNG supply channels as a possible bunker fuel globally.
- Two stakeholders' surveys (ship-owners and port operators)

3.9 Operational Assessment of LNG Bunkering in Singapore (DNV JIP)

This report is the result of the work undertaken during a five-month Joint Industry Project from January to June 2012. It addresses the technical feasibility of LNG bunkering in Singapore, identifies risks and mitigating measures and provides preliminary thoughts on regulatory considerations that would serve as important enablers for safe and efficient operations.

The report documents the main findings from the JIP work and proposes a set of key recommendations that should be taken into account when operationalizing LNG bunkering in Singapore. These recommendations have been developed for the consideration of the Singaporean Governmental Agencies and Authorities.

The JIP has been sponsored by the MPA, managed by DNV and has involved a consortium of 17 selected industry Partners representing key players in the LNG bunkering value chain. The work of the JIP was developed in consultation with four relevant Singaporean Government Agencies.

3.10 Requirements for LNG Bunkering in Australia

Det Norske Veritas (DNV) and nine key members of the Australian maritime, port and energy sectors have established a four-month study organized as a Joint Industry Project (JIP).

This JIP's intention is to facilitate the adoption of LNG fuelled vessels in Australian waters. Using LNG as marine fuel eliminates SOx and particulate matter emissions, nets a 15% reduction in GHG emissions and diminishes that of NOx by 85-90%. This addresses both local and global pollution issues.

The study aims to cover the infrastructure and regulatory requirements as well as the potential benefits and risks faced by energy majors, ports and ship-owners considering LNG fuelled vessels. The study concentrates on LNG fuelled OSVs and tugs plying in Australian waters, but the key recommendations developed will be valid for most ship types.

3.11 TEN-T supported projects

TEN-T has supported a number of LNG related projects, in light of the Motorway of the Sea (MoS) programme. An overview of these projects is given in Table 3-1. Results of these studies are not described in detail in this report. However, they were screened for potential relevant recommendations.

Table 3-1: Overview of MoS LNG projects

MoS and port portfolio in SECA only:

Project Code	Title	Action type	Planned (years)	duration	Initial End Date	Estimated End Date
2010-EU-21112-S	LNG infrastructure of filling stations and deployment in ships	Studies/Pilot	3.2		31/03/2013	31/12/2013
2009-EU-21010-P	Baltic Link Gdynia-Karlskrona	Works	4.8		31/10/2013	31/10/2013
2011-EU-21005-S	LNG in Baltic Sea Ports	Studies	3.0		31/12/2014	31/12/2014
2011-EU-92079-S	Make a Difference	Study	1.2		31/12/2014	31/12/2014
2011-FR-92026-S	Technical and design studies concerning the implementation of a LNG bunkering station at the port of Dunkirk	Study	2.4		31/12/2014	31/12/2014
2011-SE-92148-P	Fjalir project	Works	1.2		31/12/2013	31/12/2013
2011-EU-21010-M	Green Bridge on Nordic Corridor	Mixed (studies & works)	4.0		31/12/2014	31/12/2014
2012-EU-21009-M	LNG Bunkering Infrastructure Solution and Pilot actions for Ships operating on the Motorway of the Baltic Sea	Studies/Works	4.0		31/12/2015	31/12/2015
2012-EU-21008-M	WINMOS	Studies/Works	4.0		31/12/2015	31/12/2015
2012-EU-21006-S	SEAGAS	Studies	4.0		31/12/2015	31/12/2015
2012-EU-21003-P	LNG Rotterdam Gothenburg	Works	4.0		31/12/1015	31/12/2015
2012-EU-21017-S	Methanol: The marine fuel of the future	Studies/Pilot	3.0		31/12/2015	31/12/2015
2012-EU-21023-S	Sustainable Traffic Machines - On the way to greener shipping	Studies/Pilot	4.0		31/12/2015	31/12/2015
2012-EU-21010-S	PILOT SCRUBBER – New Generation Lightweight Pilot Scrubber Solution installed on a Ro-Ro Ship operating on the Motorway of the Baltic Sea	Studies/Pilot	4.0		31/12/2015	31/12/2015

Project Code	Title	Action type	Planned (years)	duration	Initial End Date	Estimated End Date
2012-BE-92063-S	Shore Power in Flanders	Study	2.9		31/12/2015	31/12/2015
2012-DE-92052-S	Tackling the environmental impact of shipping: Pilot implementation of a shore-side electricity supply for ships with increased energy demand (market innovation)	Study/Pilot	2.9		31/12/2015	31/12/2015
2013-EU-21003-S	Into the future - Baltic So2lution	Studies/Pilot	1.9		1/09/2015	1/09/2015
2013-EU-21006-S	Deployment of next generation scrubber technology for clean and sustainable short sea shipping in the North Sea ECA	Studies/Pilot	1.9		31/12/2015	31/12/2015
2013-EU-21007-S	LNG in Baltic Sea Ports II	Studies	1.9		31/12/2015	31/12/2015
2013-EU-21005-P	Channel LNG	Works/pilot	1.9		31/12/2015	31/12/2015
2013-EU-21010-P	Sustainable Traffic Machines II – The green link between Scandinavia and Continental Europe	Works	1.9		31/12/2015	31/12/2015
2013-EU-21011-S	Study in the form of a Pilot Action for a small scale LNG bunkering network for the European Emission Control Area (PASCAL = PilotActionSmallsCale Lng)	Studies/Pilot	1.9		31/12/2015	31/12/2015
2013-EU-21015-P	Sustainable Motorway of the Sea Ghent-Gothenburg through environmental upgrade and compliance while maintaining competitiveness of short sea shipping	Works	1.9		31/12/2015	31/12/2015

Project Code	Title	Action type	Planned (years)	duration	Initial End Date	Estimated End Date
2013-EU-21016-P	Sustainable Motorway of the Sea Immingham-Gothenburg through environmental upgrade and compliance while maintaining competitiveness of short sea shipping	Works	1.9		31/12/2015	31/12/2015
2013-EU-21018-S	Pilot Implementation of a LNG-Propulsion System on a MoS Test Track in the Environmental Model Region 'Wadden Sea'	Studies/Pilot	1.9		31/12/2015	31/12/2015
2013-DE-92041-S	Innovative LNG-powered hopper barge deployed under real-life conditions in the ports of Bremen and Bremerhaven	Study/Pilot	1.9		31/12/2015	31/12/2015
2013-DE-92056-S	Realizing, real-life demonstration and market introduction of a scalable, multi-modal LNG-terminal in the seaport of Bremen for the reliable supply of LNG as alternative fuel to all transport modes	Study/Pilot	1.9		31/12/2015	31/12/2015
2013-DE-92079-S	Pilot deployment of a LNG propulsion system for combined passenger and freight transportation for the year-round provision to the peripheral and island region of Helgoland	Study/Pilot	1.9		31/12/2015	31/12/2015
2013-DK-92060-S	Pilot Project to promote the use of LNG fuel: Installation of 200 tons LNG tank and filling facility at the port of Hirtshals, Denmark for fuelling of passenger/cargo vessels with a view to later establishment of a larger tank at the port	Study/Pilot	1.9		31/12/2015	31/12/2015

Project Code	Title	Action type	Planned (years)	duration	Initial End Date	Estimated End Date
2013-EU-92045-S	LNG uptake in the UK: a real-life trial with the first small scale bunkering infrastructure in Teesport and innovative LNG vessels	Study/Pilot	1.9		31/12/2015	31/12/2015
2013-FR-92008-S	SAFE SECA - Study for Alternative Fuels and Experiment in the Seine and Channel Area	Study/Pilot	1.9		31/12/2015	31/12/2015
2013-NL-92007-S	Pilot deployment of emissions reduction technologies on general cargo vessels on North Sea and Baltic MoS corridors	Study/Pilot	1.9		31/12/2015	31/12/2015
2013-SE-92044-S	Biomethane and LNG in the North for growth and competitiveness in EU (BioGaC) Fuels and Experiment in the Seine and Channel Area	Study/Pilot	1.9		31/12/2015	31/12/2015

MoS LNG projects

Project Code	Title	Action type	Planned (years)	duration	Initial End Date	Estimated End Date
2010-EU-21112-S	LNG infrastructure of filling stations and deployment in ships	Studies/Pilot	3.2		31/03/2013	31/12/2013
2011-EU-21005-S	LNG in Baltic Sea Ports	Studies	3.0		31/12/2014	31/12/2014
2011-EU-21007-S	COSTA	Studies	2.8		31/12/2013	31/12/2013
2012-EU-21003-P	LNG Rotterdam Gothenburg	Works	4.0		31/12/1015	31/12/2015
2012-EU-21008-M	WINMOS	Studies/Works	4.0		31/12/2015	31/12/2015
2012-EU-21006-S	SEAGAS	Studies	4.0		31/12/2015	31/12/2015
2012-EU-21009-M	LNG Bunkering Infrastructure Solution and Pilot actions for Ships operating on the Motorway of the Baltic Sea	Studies/Works	4.0		31/12/2015	31/12/2015
2013-EU-21003-S	Into the future - Baltic So2lution	Studies/Pilot	1.9		1/09/2015	1/09/2015
2013-EU-21007-S	LNG in Baltic Sea Ports II	Studies	1.9		31/12/2015	31/12/2015
2013-EU-21005-P	Channel LNG	Works/pilot	1.9		31/12/2015	31/12/2015
2013-EU-21011-S	Study in the form of a Pilot Action for a small scale LNG bunkering network for the European Emission Control Area (PASCAL = PilotActionSmallsCale Lng)	Studies/Pilot	1.9		31/12/2015	31/12/2015
2013-EU-21018-S	Pilot Implementation of a LNG-Propulsion System on a MoS Test Track in the Environmental Model Region 'Wadden Sea'	Studies/Pilot	1.9		31/12/2015	31/12/2015
2013-EU-21019-S	Costa II East - Poseidon Med	Studies	1.9		31/12/2015	31/12/2015

MoS Scrubber projects

Project Code	Title	Action type	Planned (years)	duration	Initial End Date	Estimated End Date
2011-EU-21010-M	Green Bridge on Nordic Corridor	Mixed (studies & works)	4.0		31/12/2014	31/12/2014
2012-EU-21010-S	PILOT SCRUBBER – New Generation Lightweight Pilot Scrubber Solution installed on a Ro-Ro Ship operating on the Motorway of the Baltic Sea	Studies/Pilot	4.0		31/12/2015	31/12/2015
2012-EU-21023-S	Sustainable Traffic Machines - On the way to greener shipping	Studies/Pilot	4.0		31/12/2015	31/12/2015
2013-EU-21006-S	Deployment of next generation scrubber technology for clean and sustainable short sea shipping in the North Sea ECA	Studies/Pilot	1.9		31/12/2015	31/12/2015
2013-EU-21010-P	Sustainable Traffic Machines II – The green link between Scandinavia and Continental Europe	Works	1.9		31/12/2015	31/12/2015
2013-EU-21015-P	Sustainable Motorway of the Sea Ghent-Gothenburg through environmental upgrade and compliance while maintaining competitiveness of short sea shipping	Works	1.9		31/12/2015	31/12/2015
2013-EU-21016-P	Sustainable Motorway of the Sea Immingham-Gothenburg through environmental upgrade and compliance while maintaining competitiveness of short sea shipping	Works	1.9		31/12/2015	31/12/2015

4 REGULATIONS AND STANDARDS- EUROPEAN FRAMEWORK

This study takes into account the overall EU policy aiming at reductions of emissions from shipping and looking for alternative energy sources, in view of growing constraints on the use of heavy fuels.

Most relevant recent European legislation is: firstly, the Directive on sulphur content in marine fuels (2012/33/EU) which allows the use of LNG as an alternative fuel to comply with more stringent emission standards. Secondly, the Directive on deployment of alternative fuels infrastructure (2014/94/EU) which aims at ensuring minimum coverage of LNG refuelling points in main maritime and inland ports across Europe by 2025 and 2030 respectively, with common standards for their design and use.

4.1 Directive on sulphur content in marine fuels (2012/33/EU)

As of 1 January 2015, EU Member States have to ensure that ships in the Baltic, the North Sea and the English Channel are using fuels with a sulphur content of no more than 0.10% and to 0.5% in other European sea areas by 2020.

Higher sulphur contents are still possible, but only if the appropriate exhaust cleaning systems are in place. Previously, the maximum sulphur content of marine fuels was limited to 3.5%.

Sulphur dioxide emissions cause acid rain and generate fine dust. This dust is dangerous for human health, causing respiratory and cardiovascular diseases and reducing life expectancy in the EU by up to two years.

The new legislation, Directive 2012/33/EU amending Directive 1999/32/EC, was published in the Official Journal of the European Union on 17 November 2012, and the deadline for bringing Member States' legislation into compliance was 18 June 2014.

These new limits are the end of a lengthy process. Back in 2005, the European Commission's thematic strategy on air pollution concluded that without further action, sulphur emissions from shipping would exceed those from all land-based sources in the EU by 2020 (Source: Clean Air for Europe impact assessment, p31, 2005). Further action was therefore needed to improve human health and the environment.

The basic legislation for regulating sulphur emissions from ships was Directive 1999/32/EC. This was amended by Directive 2005/33/EC, which designated the Baltic Sea, the North Sea and the English Channel as sulphur emission control areas (SECAs) and limited the maximum sulphur content of the fuels used by ships operating in these sea areas to 1.5%. The fuel standards also applied to passenger ships operating on regular service outside the controlled areas. But even at the time of adoption, it was widely recognised that these standards would not be enough to address the air pollution impacts of shipping.

As shipping is an international industry, environmental, security and safety standards are developed by the International Maritime Organization (IMO), a United Nation specialized agency. Directive 1999/32/EC was amended to include provisions of Annex VI of IMO's Marine Pollution Convention, MARPOL 73/78. But the Commission called for further action at the International Maritime Organization (IMO) to reduce emissions, and in October 2008 an amended Annex VI was adopted, lowering the maximum permissible sulphur content of marine fuels inside and outside of SECAs. These are the limits that are now in EU law as Directive 2012/33/EU.

4.2 Directive on deployment of alternative fuels infrastructure (2014/94/EU)

The Directive on deployment of alternative fuels infrastructure is an integral part of the Clean Power for Transport package. This package aims to facilitate the development of a single market for alternative fuels for transport in Europe:

- A Communication laying out a comprehensive European alternative fuels strategy, for the long-term substitution of oil as energy source in all modes of transport;
- the Directive on the deployment of alternative fuels recharging and refuelling infrastructure;
- an accompanying Impact Assessment;
- A Staff Working Document setting out the needs in terms of market conditions, regulations, codes and standards for a broad market uptake of LNG in the shipping sector.

The final Directive, as adopted by the European Parliament and the Council on 29 September 2014 following the inter-institutional negotiations:

- Requires Member States to develop national policy frameworks for the market development of alternative fuels and their infrastructure;
- Foresees the use of common technical specifications for recharging and refuelling stations;
- Paves the way for setting up appropriate consumer information on alternative fuels, including a clear and sound price comparison methodology.
- The required coverage and the timings by which this coverage must be put in place is as follows:

	Coverage	Timings
Electricity in urban/suburban and other densely populated areas	Appropriate number of publically accessible points	by end 2020
CNG in urban/suburban and other densely populated areas	Appropriate number of points	by end 2020
CNG along the TEN-T core network	Appropriate number of points	by end 2025
Electricity at shore-side	Ports of the TEN-T core network and other ports	by end 2025
Hydrogen in the Member States who choose to develop it	Appropriate number of points	by end 2025
LNG at maritime ports	Ports of the TEN-T core network	by end 2025
LNG at inland ports	Ports of the TEN-T core network	by end 2030
LNG for heavy-duty vehicles	Appropriate number of points along the TEN-T core network	by end 2025

The Member States have two years to submit their national policy frameworks. The Commission will then assess and report on those national policy frameworks in order to ensure coherence at Union level.

5 REGULATIONS AND STANDARDS RELATED TO THE LNG SUPPLY CHAIN: SHORE SIDE

An overview of the main international and European regulations, standards and guidelines, relevant for shore side of the LNG supply chain, i.e. onshore installations and activities, is given in Table 5-1. Each of them is further described in the paragraphs below. Beside these main standards, regulations and guidelines, some more specific standards, for example regarding the design of LNG storage tanks, are included in the paragraphs below.

Table 5-1: Main standards, regulations and guidelines for LNG bunkering: ONSHORE

Title	Responsible	Type	Scope
EN 1473 – Installation and equipment for liquefied natural gas – Design of onshore installations	CEN	European Norm	Design onshore LNG installations with LNG storage >200t
EN 13645 – Installation and equipment for liquefied natural gas – Design of onshore installations with a storage capacity between 5 t and 200 t	CEN	European Norm	Design onshore LNG installations with LNG storage 5t-200t
PGS33-2 - Dutch national guideline for LNG bunkering of ships		Dutch Guideline	Shore-to-ship LNG bunker station design
ISO/DTS 16901 - Guidance on performing risk assessment in the design of onshore LNG installations including the Ship/Shore interface	ISO	ISO Technical Specification	Risk assessment for LNG facilities onshore and at shoreline (export & import terminals)
ISO/TS 18683 - Guidelines for systems and installations for supply of LNG as fuel to ships	ISO	ISO Technical Specification	Systems and installations for supply of LNG as fuel to ships
Seveso II – Directive	EC	Directive	Control of major-accident hazards for onshore installations involving dangerous substances
ADR – European agreement concerning the International Carriage of Dangerous Goods by Road	UNECE	Convention	Transport of hazardous goods by road
ISO 28460 – Standard for installation and equipment for LNG – Ship to shore interface and port operations	ISO	International Standard	Onshore LNG terminals and LNG carriers
EN 1474-1/2/3 – Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems	CEN	European Norm	Design of LNG transfer systems (transfer arms, hoses and offshore transfer systems)
LNG Transfer Arms and Manifold Draining, Purging and Disconnection Procedure	SIGTTO	Guideline	Purging and disconnection of rigid transfer arms in terminals

5.1 Storage and Production Facilities

5.1.1 Siting and Design of Onshore LNG Installations

The design of large onshore LNG installations in Europe is based on existing international codes. Most of the following standards are developed for large scale LNG facilities, however some elements of these standards can be used for the design of smaller LNG installations.

- **EN 1473:2007 – Installation and equipment for liquefied natural gas – Design of onshore installations.**

For large storage facilities, EN 1473 is the prevailing standard. This standard is based on a risk assessment approach. According to the scope this standard covers all kinds of LNG storage but is limited to atmospheric storage tanks. The standard is valid for LNG storage above 200t. Pressurized intermediate storage tanks are excluded from this standard, as well as satellite plants with a storage capacity of less than 200t, which are covered by EN 13645 /15/.

EN 1473:2007 will be replaced in the future by EN 1473:2014. At this moment, this is still a draft European Standard (DRAFT prEN 1473) /6/. The standard will be valid for plants with LNG storage at pressure lower than 0.5 bar and capacity above 200t and for the following plant types:

- LNG liquefaction installations (plant);
- LNG regasification installations (plant);
- Peak-shaving plants;
- The fix part of an LNG bunker station.

Floating solutions (FPSO, FSRU, SRV), whatever off-shore or nearby shore, are not covered by this draft European standard, even if some concepts, principles or recommendations could be applied.

- **EN 13645:2002 – Installations and equipment for liquefied natural gas – Design of onshore installations with a storage capacity between 5 t and 200 t.**

EN 13645 covers smaller LNG storage facilities. This European Standard specifies requirements for the design and construction of onshore stationary liquefied natural gas (LNG) installations with a total storage capacity between 5 t and 200 t /13/.

- **PGS 33-2 – Dutch national guideline for LNG bunkering of ships**

The Dutch national guideline for LNG bunkering of ships (*Aardgas: afleverinstallaties van vloeibaar aardgas (LNG) voor vaartuigen*) is one of the PGS guidelines, which are formulated to provide design requirements for a safe installation. These guidelines are considered to represent Best Available Techniques (BAT). Although PGS 33-2 in itself is no regulation, these guidelines are used by the authorities and industry to prove conformity to the regulation by complying with the requirements of PGS. Authorities can chose to make reference to the guideline and thereby enforce it.

PGS 33-2:2014 provides a consistent and transparent framework for shore-to-ship LNG bunker station design /21/.

- **NFPA 59A: Standard for the production, storage and handling of liquefied natural gas (LNG)**

This standard provides minimum fire protection, safety, and related requirements for the location, design, construction, security, operation, and maintenance of liquefied national gas (LNG) plants /17/. This is a

US standard that has been used globally and can be used to support (but not replace) EN 1473 for European developments. The standard also deals with the training of personnel involved with LNG.

- **USCG NVIC No. 01-2011 – Guidance related to waterfront LNG facilities**

This circular from the United States Coast Guard provides guidance to an applicant seeking a permit to build and operate a shore side LNG terminal. It also includes information on assessing the suitability of waterways for LNG marine traffic.

- **EN14620:2006 – Design and manufacture of site built, vertical, cylindrical, flat-bottomed steel tanks for the storage of refrigerated, liquefied gases with operating temperatures between 0°C and -165°C.**

This European Standard is a specification for vertical, cylindrical tanks, built on site, above ground and of which the primary liquid container is made of steel. The secondary container, if applicable, may be of steel or of concrete or a combination of both /14/. The maximum design pressure of the tanks covered by this European Standard is limited to 500 mbar.

- **API Standard 620 (2002) – Design and construction of Large, Welded, Low-Pressure Storage Tanks**

Appendix Q of this standard covers specific requirements for the material, design and fabrication of tanks to be used for the storage of liquefied ethane, ethylene and methane /1/.

- **ISO/AWI TR 18624 – Guidance for conception, design and testing of LNG storage tanks**

This guideline is under development by the ISO/ TC67, but is still in preparatory stage. More specific information about the content is not yet available at the time of writing.

- **EEMUA Publication 147 – Recommendations for the design and construction of refrigerated liquefied gas storage tanks**


This publication contains basic recommendations for the design and construction of single, double and full containment tanks for the bulk storage of refrigerated liquefied gases down to -165 C, for both metal and concrete material /28/. Liquids covered by the scope of this publication, which is intended for international application, include LPG, ethylene, LNG and similar hydrocarbons.

5.1.2 Safety and Risk Assessment for Onshore LNG Plants

Although there is no specific international/European regulation covering risk assessments for LNG bunker stations, some ISO technical specifications exist, giving guidance on how to perform risk assessments. However, there are European / country specific regulations for installations dealing with hazardous substances, which automatically include LNG installations. More information regarding these country specific regulations for hazard/risk assessment is given in Chapter 9.

- **ISO/DTS 16901 – Guidance on performing risk assessment in the design of onshore LNG installations including the Ship/Shore interface**

This technical specification, published in March 2015, provides a common approach and guidance to those undertaking assessments of the major safety hazards as part of the planning, designing and operation of LNG facilities onshore and at shoreline using risk based methods and standards, to enable a safe design and operation of LNG facilities /18/. The environmental risks associated with an LNG release are not addressed in this Technical Specification.



The technical specification is aimed to be applied both to export and import terminals but can be applicable to other facilities such as satellite and peak shaving plants.

It applies to all facilities inside the perimeter of the terminal, including all hazardous materials including LNG and associated products such as LPG, pressurised natural gas, odorizers, and other flammable or hazardous products handled within the terminal.

- **ISO/TS 18683 – Guidelines for systems and installations for supply of LNG as fuel to ships**

This guideline is recently published (January 2015).

Chapter 7 ('Risk Assessment') of this guideline requires that development of a bunkering facility is conducted in line with a risk assessment approach comprising the following:

- Definition of study basis;
- Performing a risk assessment of the LNG bunkering system and operation;
- Establishing safety distances for the operation;
- Verification that design is in accordance with recognized standards and that agreed safeguards are implemented.

According to this guideline, at a minimum, a qualitative risk assessment shall be carried out. The following are the minimum requirements to bunkering facilities:

- Compliance with the defined standard bunkering scenario; and
- Meeting all functional requirements and all requirements with regards to components and systems, training and documentation.

The guideline refers to ISO/DTS 16901 for risk assessment of onshore LNG installations.

- **EN 1473:2007 – Installation and equipment for liquefied natural gas – Design of onshore installations.**

EN 1473, i.e. the prevailing standard for large storage facilities (see § 5.1.1), describes an approach for hazard assessment, and contains different acceptability criteria in Annex L. It gives two examples of risk acceptability criteria matrixes for the cumulative total of all plant risks and so can only be used when all hazards have been assessed within the risk assessment.

5.1.3 Seveso II Directive

The Seveso II directive includes obligations for the operator of the installation and requirements for measures to prevent and inform about major-accident with dangerous substances. Transport and temporary storage of dangerous goods including loading and unloading is specifically excluded from this directive. As LNG is mentioned as one of the dangerous substances in the Seveso II Directive, this directive is applicable for onshore LNG installations.

All onshore establishments which hold more than 50 tonnes of LNG fall under the scope of the directive and need to establish a major accident prevention policy. In addition, operators of high tier establishments holding more than 200 tonnes of LNG (equivalent to 440 m³) need to establish a safety report before construction is commenced. The safety report must include identification and assessment of major hazards and necessary measures to prevent such accidents, a safety management system and an emergency plan. The Seveso II directive is converted into national legislation.

The new Seveso III directive (2012/18/EU) will succeed the Seveso II directive as per June 2015, although this update will have no specific impact for LNG installations.

5.2 LNG Cargo Transport via Road Vehicles & Truck Loading

- **ADR – European agreement concerning the International Carriage of Dangerous Goods by Road**

The transport of hazardous goods by road is covered in the European Agreement concerning the International Carriage of Dangerous Goods by Road, commonly known as ADR (*'Accord européen relatif au transport international des marchandises dangereuses'*) from the Economic Commission for Europe (UNECE or ECE). The ADR is translated and included in the national legislation of the applicable countries. The Agreement itself is short and simple. The key article is the second, which describes that, excluding some excessively dangerous goods, other dangerous goods may be transferred internationally in road vehicles subject to compliance with the conditions laid down in Annexes A (packaging and labelling) and B (construction, equipment and operation of the vehicle carrying the goods in question) /23/.

Trucks that transport LNG are subjected to Annex A with respect to labelling of hazardous materials and to Annex B when it comes to construction of the cargo tank. Trucks that are using LNG as fuel are subjected to Annex B for the construction of the fuel tank.

A new version of the ADR will enter into force the 1st of January 2015. However no modifications impacting LNG transport via trucks are made.

- **LNG access code for truck loading for the Zeebrugge LNG terminal**

This LNG access code for truck loading consists of a standard set of rules and procedures governing regulated access to the LNG services offered at the LNG terminal in Zeebrugge. It contains operating rules for LNG truck loading, an LNG truck approval procedure, LNG specifications and detailed procedures for determining the LNG mass loaded.

5.3 Interfaces and transfer systems

5.3.1 Shore interface

- **ISO 28460:2010 – Standard for installation and equipment for liquefied natural gas – Ship to shore interface and port operations**

ISO 28460:2010 specifies the requirements for ship, terminal and port service providers to ensure the safe transit of an LNG carrier through the port area and the safe and efficient transfer of its cargo /7/. It is applicable to:

- pilotage and vessel traffic services (VTS);
- tug and mooring boat operators;
- terminal operators;
- ship operators;
- suppliers of bunkers, lubricants and stores and other providers of services whilst the LNG carrier is moored alongside the terminal.

ISO 28460:2010 includes provisions for:

- a ship's safe transit, berthing, mooring and unberthing at the jetty;
- cargo transfer;
- access from jetty to ship;
- operational communications between ship and shore;
- all instrumentation, data and electrical connections used across the interface, including OPS (cold ironing), where applicable;
- the liquid nitrogen connection (where fitted);
- ballast water considerations.

ISO 28460:2010 applies only to conventional onshore LNG terminals and to the handling of LNG carriers in international trade. However, it can provide guidance for offshore and coastal operations.

5.3.2 Transfer arms and hoses

- **EN 1474-1: 2009 – Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems – Part 1: Design and testing of transfer arms**

This European Standard specifies the design, minimum safety requirements and inspection and testing procedures for liquefied natural gas (LNG) transfer arms intended for use on conventional onshore (LNG) terminals /16/. It also covers the minimum requirements for safe LNG transfer between ship and shore.

Standard EN 1474-1 will be replaced in the future by ISO 16904:2013 – Petroleum and natural gas industries – Design and testing of LNG marine transfer arms for conventional onshore terminals. Currently, this standard is still a draft version (prEN ISO 16904:2013). This International Standard specifies the design, minimum safety requirements and inspection and testing procedures for liquefied natural gas (LNG) marine transfer arms intended for use on conventional onshore LNG terminals, handling LNG carriers engaged in international trade. It can provide guidance for offshore and coastal operations. This International Standard needs not be applied to existing facilities.

- **EN 1474-2:2009 - Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems – Part 2: Design and testing of transfer hoses**

This European Standard gives general guidelines for the design, material selection, qualification, certification, and testing details for Liquefied Natural Gas (LNG) transfer hoses for offshore transfer or on coastal weather-exposed facilities for aerial, floating and submerged configurations or a combination of these. Whilst this European Standard is applicable to all LNG hoses, it is acknowledged that there may be further specific requirements for floating and submerged hoses.

- **EN 1474-3:2008 - Installation and equipment for liquefied natural gas – Design and testing of marine transfer systems – Part 3: Offshore transfer systems**

This European Standard gives general guidelines for the design of liquefied natural gas (LNG) transfer systems intended for use on offshore transfer facilities or on coastal weather exposed transfer facilities /11/. The transfer facilities considered may be between floating units, or between floating and fixed units. The specific component details of the LNG transfer systems are not covered by this European Standard.

- **EN 13766:2010 – Thermoplastic multi-layer (non-vulcanized) hoses and hose assemblies for the transfer of liquid petroleum gas and liquefied natural gas – Specification**

This European Standard specifies requirements for two types of thermoplastic multi-layer (non-vulcanized) transfer hoses and hose assemblies for carrying liquefied petroleum gas and liquefied natural gas. Each type is subdivided into two classes, one for onshore duties, and the other for offshore. This European Standard is applicable for hose sizes from 25 mm to 250 mm, working pressures from 10,5 bar to 25 bar and operating temperatures from - 196 °C to + 45 °C.

- **EN12308:1998 - Installations and equipment for LNG - Suitability testing of gaskets designed for flanged joints used on LNG piping**

This standard specifies the tests carried out in order to assess the suitability of gaskets designed for flanged joints used on LNG pipes /12/.

- **SIGTTO – The selection and testing of valves for LNG applications**

This document provides guidance to designers and operators on the general requirements for valves for LNG service, which are generally designed with an operating temperature range of +80°C to -196°C. This guidance is primarily intended for the shipping and storage of these products but may be applied throughout the LNG and LPG industries as appropriate.

- **SIGTTO – LNG Transfer Arms and Manifold Draining, Purging and Disconnection procedure, 2012**

This advice specifically pertains to terminals employing rigid transfer arms. (The basic principles are applicable for hose systems that may be used for LNG ship-to-ship transfer, but there will be differences in the detail.)

- **BS 4089:1999 – Specification for Metallic Hose Assemblies for Liquefied Petroleum Gases and Liquefied Natural Gases**

This British Standard specifies requirements and test methods for metallic hose assemblies used for the loading and unloading of LPG and LNG under pressure. These hoses are primarily used for road and rail tankers or for ship to shore duties.

6 REGULATIONS AND STANDARDS RELATED TO THE LNG SUPPLY CHAIN: WATERSIDE

An overview of the main international and European regulations, standards and guidelines, relevant for the waterside of the LNG supply chain, is given in Table 6-1. Each of them is further described in the paragraphs below. Beside these main standards, regulations and guidelines, also some more specific information regarding training is included in the paragraphs below.

Table 6-1: Main standards, regulations and guidelines for LNG bunkering: MARITIME

Title	Responsible	Type	Scope
International Code for Construction and Equipment of Ships carrying Liquefied Gases in Bulk (IGC Code)	IMO	Code	Vessels transporting liquefied gases
International convention on standards of training, certification and watch keeping for seafarers (STCW Code)		Code	Minimum standards of competence for seafarers
Crew Safety Standards and Training for large LNG carriers	SIGGTO		Requirements for the training of LNG tanker crews
European Agreement concerning the International Carriage of Dangerous Goods by Inland waterways (ADN)	UNECE	Convention	Transport of dangerous goods via inland waterways
International convention for the Safety of Life at Sea (SOLAS)	IMO	Convention	Safety standards in construction, equipment and operation of seagoing vessels
International Code for the Construction of Gas Fuelled Ships (IGF code)	IMO	Code	Construction of gas-fuelled, seagoing vessels
International Convention for the Prevention of Pollution from Ships (MARPOL)	IMO	Convention	Prevention of pollution of the marine environment by ships.
Rhine Vessel Inspection Regulations (RVIR)	CCNR	Regulation	Technical rules and requirements for inland waterway vessels
2006/87/EC – Directive of the European Parliament and the council laying down technical requirements for inland waterway vessels	EC	Directive	Inland waterway vessel requirements for certification, carrying dangerous goods and inspections

6.1 Cargo Transport via Seagoing Vessels

6.1.1 Construction and Operation of LNG Tankers

- **International Code for Construction and Equipment of Ships carrying Liquefied Gases in Bulk (IGC Code)**

The purpose of the IGC code is to provide an international standard for the safe transport by sea in bulk of liquefied gases and certain other substances, by prescribing the design and construction standards and the equipment that these ships should carry so as to minimize the risk to the ship, its crew and the environment. The IGC code is applicable to vessels transporting liquefied gases and thus is applicable to LNG carriers and small scale LNG carriers in international voyages. The code is not applicable to inland water transportation of LNG. The IGC Code is being reviewed; MSC93 amendments to IGC Code will enter into force on 1 January 2016 but apply to ships whose keels are laid on or after 1 July 2016¹³.

- **International Maritime Dangerous Goods Code (IMDG Code)**

The International Maritime Dangerous Goods (IMDG) Code was developed as a uniform international code for the transport of dangerous goods by sea covering such matters as packing, container traffic and stowage, with particular reference to the segregation of incompatible substances. The IMDG code does not cover requirements related to storage of ship fuels and as such does not contain direct requirements for LNG as a fuel.

6.1.2 Training for Seagoing Gas Tanker Crews

- **International Code for Construction and Equipment of Ships carrying Liquefied Gases in Bulk (IGC Code) – Chapter 18 Operating Requirements**

The minimum requirements for qualification and training of gas tanker crews are stated within Chapter 18 of the current draft of the revised IGC Code.

Personnel training

18.7.1 Personnel shall be adequately trained in the operational and safety aspects of liquefied gas carriers as required by the STCW Convention, the ISM Code and the Medical First Aid Guide (MFAG).

As a minimum:

1. All personnel shall be adequately trained in the use of protective equipment provided on board and have basic training in the procedures, appropriate to their duties, necessary under emergency conditions;
2. Officers shall be trained in emergency procedures to deal with conditions of leakage, spillage or fire involving the cargo and a sufficient number of them shall be instructed and trained in essential first aid for the cargoes carried.'

- **International convention on standards of training, certification and watch keeping for seafarers (STCW Code)**

In the STCW Convention, the minimum standards of competence for seafarers are described. It does not reference gas handling. An IMO subcommittee is discussing the introduction of qualifications for LNG-fuelled ship personnel, based on the IGF Code's personnel requirements for operating LNG-fuelled ships.

¹³ ABS, MSC 93 Brief

- **SIGTTO Crew Safety Standards and Training for large LNG carriers**

This document has been prepared primarily for the guidance of ship owners and operators who may be entering LNG ship operation for the first time /22/. It is also of use to existing LNG operators who are training new crews due to expansion.

The document highlights the salient statutory requirements for the training of LNG tanker crews and the provisions of the International Standards of Training and Watch Keeping Convention, as it applies to gas tankers. It outlines the publications which are recommended for carriage on board all LNG tankers. It also provides advice on the application of the International Safety Management Code to the training and management of tanker crews. In all these matters, it draws heavily on the experience of SIGTTO member companies that have extensive operating experience with this class of vessel. Hence, it may be considered, as a guide to current best industry practice

6.2 Cargo Transport via Inland Waterway Vessels

6.2.1 Construction and Operation of LNG Inland Tankers

- **European Agreement concerning the International Carriage of Dangerous Goods by Inland waterways (ADN)**


The ADN is published together with the Central Commission for the Navigation of the Rhine (CCNR). The provisions annexed to the ADN concern dangerous substances and articles, provisions concerning their carriage in packages and in bulk on board inland navigation vessels or tanks vessels, as well as provisions concerning the construction and operation of such vessels /26/.

Figure 6-1 shows the ADN contracting countries.



Figure 6-1: ADN Contracting Countries (source: UNECE)

In “Table A” of the addendum, a list of substances is mentioned specifying the conditions of transportation via inland waterways for each of these substances. In the past, transport of LNG as cargo through inland waterways was prohibited by ADN. ADN also prohibited the installation and utilization of engines that use a fuel with a flashpoint below 55 °C.



However, in August 2013, the ADN Safety Committee adopted the proposal for the carriage of LNG on inland waterways /25/. In 2014, the ADN safety committee has completed this project to include LNG as cargo in inland navigation. These regulations are expected to come into force on 1/1/2015. All draft amendments to regulations annexed to ADN with scheduled date of entry into force of 1/1/2015 have been published on 17 April 2014 (ECE/ADN/27) /24/. Technical requirements for the loading and unloading procedure for liquefied natural gas (LNG) are not in scope of the update of ADN.

- **International Safety Guide for Inland navigation Tank-barges and Terminals (ISGINTT)**

The Oil Companies International Marine Forum (OCIMF) together with other stakeholders for inland waterways, like the CCNR developed the International Safety Guide for Inland Tank-barges and Terminals (ISGINTT). The International Safety Guide for Inland Tank-barges and Terminals is not intended to replace or to amend current legislation as ADN and RVIR, but to provide additional recommendations. The CCNR supports the Guide as the principal industry reference manual on the safe operation of tankers and terminals that serve them.

The ISGINTT does not give restrictions on fuel properties that can or cannot be used for the propulsion of inland ships. The link with LNG can be found in the hazards that arise for liquids with a flashpoint below 60°C. The ISGINTT does distinguish between volatile and non-volatile liquids based on their flashpoints. However, this link is purely based on hazard identification and not on shipping fuel related activities.

6.2.2 Training for Inland Gas Tanker Crews

- **European Agreement concerning the International Carriage of Dangerous Goods by Inland waterways (ADN)**

Annex B.1 – Part 1, section 3 of the ADN contains a paragraph regarding '*Dangerous goods training*'. This paragraph states that an expert shall be on board the vessel, not less than 18 years of age, who has special knowledge of the ADN. This knowledge has to be proven with a certificate from a competent authority or from an agency recognized by the competent authority. The training requirements for this person are also included in this paragraph.

Furthermore, Annex B.2 – Part 1 of the ADN contains a specific paragraph on '*Knowledge of gases*', which requires an expert for the carriage of gases on board the vessel. This person has a specific knowledge of the carriage of gases in tank vessels and his knowledge has to be proven by a certificate. Specific points that have to be included in the training program, such as knowledge of common properties of gases, purging and sampling of gases, explosion hazards presented by liquefied gases, action to be taken in case of emergency, ... are listed in this paragraph.

However, due to the gap in the ADN for carrying liquefied gases, specific training requirements for crew of inland LNG tankers are missing.

- **Regulation for Rhine navigation personnel (RPN)**

With Resolution 2010-I-8-Annex 1, the Central Commission has adopted the Regulations for Rhine navigation personnel (RPN), which came into force on 1 July 2011 /62/. The Regulations for Rhine navigation personnel includes all the pre-existing Rhine regulations for navigation personnel.

The regulations cover the qualifications of personnel, particularly the skills required of boat masters and the manning requirements of crews. Furthermore it contains the Rhine navigation certificate regulations

adopted in June 2007. The annexes mainly contain model certificates and the list of documents issued by non-member states that have been recognised by the CCNR as valid for the Rhine.

For vessels that carry dangerous goods, a crew member on board must be in possession of a certificate of special knowledge of ADN.

6.3 Gas-fuelled Seagoing Vessels

6.3.1 Use Gas as Ship Fuel for Seagoing Vessels

- **International convention for the Safety of Life at Sea (SOLAS)**

The SOLAS convention is an international maritime safety treaty. It is generally regarded as the most important of all international treaties concerning safety of (merchant) ships. SOLAS requires Flag States to ensure that their ships comply with minimum safety standards in construction, equipment and operation. Of main relevance for LNG are the following:

Chapter VII – Carriage of dangerous goods

The chapter requires carriage of dangerous goods to be in compliance with the relevant provisions of the International Maritime Dangerous Goods Code (IMDG code). Part C requires that the construction of ships carrying liquefied gases in bulk and gas carriers to comply with the requirements of the International Gas Carrier Code (IGC code).

Chapter II-2 – Fire protection, fire detection and fire extinction; Part B – Prevention of fire and explosion

Regulation 4.2.1.1 states that no oil fuel with a flashpoint of less than 60 °C shall be used.

The use of LNG as a fuel is not covered by the SOLAS convention. Therefore, the development of the International Code of safety for ships using gases or other low-Flashpoint fuels (IGF code) was initiated by the Norwegian administration.

- **International Code for the Construction of Gas Fuelled Ships (IGF code)**

Currently, there is no formal IMO rule concerning LNG fuelled vessels other than the IGC code that allows LNG carriers to use their boil-of-gas as a fuel. The international code for the construction of gas fuelled ships (IGF code) is under development.

The mandatory IGF code will replace the current IMO Interim guidelines on Safety for Natural Gas-Fuelled Engine Installations in Ships, i.e. MSC.285(86). This interim guideline was published by the IMO in 2009, to allow vessels to use fuels with a low (<60°C) flashpoint. MSC.285(86) indicates arrangement and installation of LNG fuelled machinery to achieve an equivalent level of safety, reliability and dependability compared to conventional oil fuelled machinery.

The IGF code is applicable for the receiving vessel, i.e. the ship using LNG as fuel.

A draft version of the IGF code was published in March 2014. The Code addresses all areas that need special consideration for the usage of low flashpoint fuels by seagoing vessels, based on a goal-based approach and functional requirements specified for each section forming the basis for the design, construction and operation of ships using this type of fuel. Requirements for bunker operations are included in section 18.3 of the draft IGF code. In September 2014, the Code was agreed in draft form by the IMO Sub-Committee on Carriage of Cargoes and Containers (CCC). The committee agreed that IGF

should apply to seagoing new ships and to existing ships converting to the use of gases or other low flashpoint fuels. The code will not apply to cargo ships of less than 500 gross tonnage.

The IGF code, along with proposed amendments to make the Code mandatory under SOLAS, were agreed in draft form by the IMO Sub-Committee on Carriage of Cargoes and Containers¹⁴.

Furthermore, the IMO's Maritime Safety Committee (MSC) approved, in principle (MSC 94), the draft IGF Code and also approved the proposed amendments to make the Code mandatory under SOLAS, with a view to adopting both the IGF Code and the SOLAS amendments at the next session, MSC 95, scheduled to meet in June 2015¹⁵. The entry into force is foreseen in January 2017.

- **International Convention for the Prevention of Pollution from Ships (MARPOL)**

The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. Of main relevance for LNG as a fuel is the following:

Annex VI Regulation 18: Originally it is stated that "the sulphur content of gas fuels delivered to a ship specifically for combustion purposes on board that ship shall be documented by the supplier". However, in a recent update LNG has been exempted from the requirement to take samples to determine the sulphur level.

6.3.2 Training for Gas-fuelled Seagoing Vessel Crews

- **International Code for the Construction of Gas Fuelled Ships (IGF code) – Part D, Chapter 18**

The IGF Code contains a chapter on the Development of Training and Certification Requirements for seafarers for Ships Using Gases or Low-flashpoint Fuels.

- **ISO/TS 18683 – Guidelines for Systems and Installations for Supply of LNG as Fuel to Ships**

This ISO Technical Specification covers Training (Chapter 10) and the Requirements for Training Documentation (Chapter 11, § 11.7). More information is given in § 7.2.

- **DNV Standard for Certification No. 3.325 – Competence related to the On board Use of LNG as a Fuel**


This standard specifies the competence requirements of a shipboard-working environment in which LNG is used as a fuel, and specifies required competence of those having to manage such operations. The standard assists with aligning global competence development for Category A, B, and C training as defined in the Interim Guidelines on Safety for Natural Gas-Fuelled Engine Installations in Ships (IMO Resolution MSC.285 [86]), and expects to support further industry initiatives.

The following categories are defined as:

- Category A - Basic: Basic competence for all officers/crew, regardless of role or function
- Category B - Deck: Competence requirements for deck officers/operational deck crew
- Category C - Engine: Competence requirements for engine officers/operational engine crew

¹⁴ IMO Press Briefings, Briefing 28, September 16, 2014

¹⁵ IMO Press Briefings, Briefing 40, November 26, 2014



There are four levels of what a person has to master based on instructional design principles: knowledge, understanding, application, and integration. For each level, it is a prerequisite that the preceding level is mastered. Familiarity with similar activities aboard a conventionally fuelled vessel is considered part of the skill set of the crew and is not addressed.

This standard serves as a guide to competence requirements that employers should place on their crew as well as a guide to training providers who are to develop courses according to the requirements of the standard. Crew assessment is addressed, as well as providing a reference document for competence related services such as competence management system certification or learning program certification.

- **DNVGL-RP-0006:2014-01 – Development and Operation of Liquefied Natural Gas Bunkering Facilities - Section 6.2.10 – training**

The overall objective of this recommended practice (RP) is to ensure that:

- Safety targets are met for all involved in or potentially affected by LNG bunker operations.
- During normal conditions, the operations are conducted without emissions of methane to the environment. The aim is to achieve zero emissions of methane to the environment during normal operations.

A key practice is that release of natural gas into the atmosphere shall be avoided because it is for inspection or testing operations. All natural gas released during inspection shall be properly disposed without venting.

Further objectives are to increase the overall understanding of the risks associated with LNG bunkering and demonstrate how to best manage such risks.

In general, this RP recommends that all staff should obtain appropriate training to be competent in designated roles and to perform their responsibilities safely. Besides the initial training, refreshment training is important in order to maintain competence and perform safe operations. Training should include human and organizational factors.

Training requirements in Europe for personnel involved in LNG bunkering operations are structured according to the IMO Resolution MSC.285(86), STCW, the ISO/TS 18683, ADN/ADR regulations and industry codes (e.g., SIGTTO).

All personnel working with LNG bunkering operations are to be trained and authorized for working with cryogenic and flammable liquids. It is also recommended that the records of training of crew personnel shall be maintained and documented.

A direct link between Safety Management System, Risk Analysis, and Training is described.

- **NMD - Regulation of 9 September 2005 No. 1218 – Regulation of the Norwegian maritime directorate concerning the construction and operation of gas-fuelled Passenger Ships – Chapter 4 Training**

All training should comply with the Norwegian Maritime Directorate guidelines. This regulation assists with aligning global competence development for Category A, B, and C training (reference IMO Resolution MSC.285 [86]) for personnel on a gas-fuelled passenger ship. The Norwegian Maritime Directorate must approve the structure for training of the three categories and completed training documentation (internal and external) must be available on board:

- Category A - Basic: Basic competence for all officers/crew, regardless of role or function

- Category B - Deck: Competence requirements for deck officers/operational deck crew
- Category C - Engine: Competence requirements for engine officers/operational engine crew

Internal refresher courses are mandatory for crewmembers to assume duties on board, if such crewmembers have been absent for a continuous period of more than six months.

6.4 Gas-fuelled Inland Vessels

6.4.1 Using Gas as Ship Fuel for Inland Vessels

- Rhine Vessel Inspection Regulations (RVIR, CCNR)

The CCNR technical rules and requirements for inland waterway vessels are captured in the RVIR /2/. The Rhine inspection regulations, which are only legally applicable on the Rhine itself, have become Europe's technical reference base for the construction of new vessels, irrespective of whether they are intended for use on the Rhine or somewhere else. The regulation was adopted by UNECE and was integrally included in EU directive 2006/87/EC and has since been transposed into national regulations.

The prohibition of the use of fuel with a flashpoint below 55°C is stated in Article 8.01 item 3 of RVIR. Hence, the use of LNG as a fuel for inland waterway vessels is not allowed. RVIR does give ship owners and builders the opportunity to develop alternative arrangements (for example fuel supply system) if comparable guarantees can be provided. For several vessels the Netherlands started this waiver process for acceptance of LNG powered inland vessels to UNECE, ADN and RVIR. In this case the safety of the LNG propulsion system was demonstrated through execution of Hazard Identification (HAZID) studies.

A Dutch delegation together with classification societies Lloyds Register, Germanischer Lloyd and Bureau Veritas has drafted a proposal for additional regulation to include LNG as a fuel in RVIR. The LNG Masterplan Integral Coordination Group on Regulatory adjustments (IGCR) is in the process of reviewing the proposed amendments to draft chapter 8b and Annex T. In this way, the CCNR prepares the way for the use of LNG for inland navigation. The proposed amendments will then be sent to CCNR for approval and are scheduled to be adopted in 2015. It is expected that new CCNR regulation for LNG as fuel will form the basis for an update of the EU directive 2006/87/EC.

An evaluation of items relevant for LNG bunkering in the RVIR draft chapter 8b and Annex T is presented in Table 6-2.

Table 6-2: Items relevant for LNG bunkering in draft RVIR chapter 8b and Annex T /32/


draft RVIR chapter 8b and Annex T	
Reference	Description
Article 8b.03 Safety aspects	Vessels equipped with propulsion or auxiliary systems operating on fuels with a flashpoint equal to or lower than 55 °C shall keep safety instructions on board. It shall include information on the measures to be taken in the event of accidental release of liquid or gaseous fuel, for instance during bunkering.
Annex T Part 1 LNG, Chapter 2 Vessel arrangements and system design, 2.1 General	A risk assessment shall be conducted on any new or altered concept or configuration or other significant changes. Hazardous areas shall be restricted and equipment installed in hazardous areas shall be minimized. Sources of ignition in hazardous areas shall be limited. Components of LNG system shall be protected against external damage. Bunkering arrangements shall be capable of taking on board and containing the fuel in the required state without leakage or environmental emissions (venting). Control, alarm, monitoring and shutdown systems along with fired detection, protection and extinction measures shall be provided.

draft RVIR chapter 8b and Annex T	
<i>Reference</i>	<i>Description</i>
Annex T Part 1 LNG, Chapter 2 Vessel arrangements and system design, 2.2 LNG containment	Requirements for LNG storage tanks are presented in this section. Under specific conditions, LNG storage tanks can be single or double walled, location below or on open deck. Design shall be according to EN 13530, EN 13458-2:2002, IGC-code (type C tank), the ADN or another appropriate standard to the satisfaction of the competent authority.
Annex T Part 1 LNG, Chapter 2 Vessel arrangements and system design, 2.3 Engine rooms	Engine rooms shall be gas safe or designed as ESD protected and specific requirements are given in this section.
Annex T Part 1 LNG, Chapter 2 Vessel arrangements and system design, 2.4 LNG piping systems	Requirements for LNG piping are given in this section. It covers items such as location, isolation, design pressure and pressure relieve valves.
Annex T Part 1 LNG, Chapter 2 Vessel arrangements and system design, 2.8 LNG bunkering system	<ul style="list-style-type: none"> - The LNG bunkering system shall be so arranged that no gas is discharged to the atmosphere during filling of LNG storage tanks. - The LNG bunkering station shall be located on open deck. - The bunkering manifold shall be so positioned and arranged that any damage to the gas piping does not cause damage to the vessel's LNG containment system. The bunkering manifold shall be designed to withstand external mechanical loads during bunkering. The connections shall be of dry-disconnect type equipped with additional safety dry break-away coupling/ self-sealing quick release. - Suitable means shall be provided to relieve the pressure and remove liquid contents from pump suctions and bunker piping. - Hoses used for LNG transfer shall be suitable for LNG. Hoses shall be designed for a bursting pressure not less than five times the maximum bunkering pressure. - It shall be possible to operate the master gas fuel valve for bunkering operations from a safe control station on the vessel. - Bunkering piping shall be arranged for inerting and gas freeing. During operation of the vessel the bunkering piping shall be free of gas.
Annex T Part 1 LNG, Chapter 2 Vessel arrangements and system design, 2.9 filling limits for LNG storage tanks	The level of LNG in the storage tank shall not exceed the filling limit of 95 % full at the reference temperature (temperature corresponding to the vapour pressure of the fuel at the opening pressure of the PRV's). A filling limit curve dependent of the actual LNG filling temperatures shall be prepared.
Annex T Part 1 LNG, Chapter 3 Fire safety	<p>This section gives all the requirements related to fire safety, covering alarm system, insulation, prevention, cooling and extinguishing. Specific for bunkering are:</p> <ul style="list-style-type: none"> - bunker station shall be separated by class A-60 insulation from engine rooms, accommodation and high fire risk spaces. - two additional dry powder fire extinguishers of at least 12 kg capacity shall be located near the bunkering station.
Annex T Part 1 LNG, Chapter 5 Control monitoring and safety systems, 5.2 LNG bunkering system and LNG containment system monitoring	This section gives all the requirements related to control, monitoring and safety systems for the LNG bunkering and containment system. It covers items such as pressure and level indicators and alarms.

Also requirements regarding construction and operation of gas-fuelled inland vessels are laid down in RVIR.

With the update of the RVIR, also specific requirement for LNG storage tanks, engine rooms and LNG piping systems on inland vessels (see Table 6-2) will be included.

- **2006/87/EC – Directive of the European Parliament and the council laying down technical requirements for inland waterway vessels**



This directive covers the transport of dangerous goods on inland waterways at a European level. Annex II of this EC directive integrally includes the CCNR Rhine Vessel Inspection Regulation. It includes inland waterway vessel requirements for certification, carrying dangerous goods and inspections.

In the current version of RVIR (and therefore also in this EC directive) the use of fuel with a flashpoint below 55°C is prohibited. Hence the use of LNG as fuel for inland waterway vessels is not allowed in the directive. However, it is expected that new CCNR regulation for LNG as fuel will form the basis for an update of the EU directive 2006/87/EC.

- **European Agreement concerning the International Carriage of Dangerous Goods by Inland waterways (ADN)**

Although ADN mainly focuses on cargo transport of dangerous goods (see § 6.2.1), it also gives some restrictions regarding fuels used by inland waterway vessels. In the past, ADN prohibited the installation and utilization of engines that use a fuel with a flashpoint below 55 °C. With the update of ADN however, use of LNG as fuel will be allowed.

6.4.2 Training for Gas-fuelled Inland Vessel Crews

Since LNG fuelled inland vessels are currently not yet allowed by RVIR and 2006/87/EC, specific requirements regarding training for gas-fuelled vessels are missing. Therefore, for the time being the competence and training requirements for crews of gas-fuelled inland vessels are not regulated. Also in the applicable chapters of the new draft RVIR (chapter 8b and annex T), no specific training requirements are mentioned.

6.5 Ship Interfaces and Transfer of LNG as Cargo

- **SIGTTO – ESD Arrangements & linked ship/shore systems for liquefied gas carriers**

This SIGTTO guidance note has been produced due to members' concerns about the different interpretations of the functional requirements for ESD systems, particularly those differences between the needs of the LNG industry and those of the LPG industry and how these may interact with linked ship/shore shutdown systems.


This guideline is applicable for LNG carriers.

- **SIGTTO – Ship/shore interface – Safe working practice for LPG & Liquefied Chemical Gas Cargoes**

The main objective of this document is to improve safety at the ship/shore interface. The document considers cargo transfer operations and the processes involved within the ship/shore interface to ensure cargo transfer of LPG and liquefied chemical gases is carried out safely and reliably.

- **SIGTTO - LNG ship to ship transfer guideline**

The LNG Ship to Ship Transfer Guidelines, published in 2001, covers the transfer of LNG from LNG carriers at anchor, alongside a shore jetty or while underway. They are also useful for reference when establishing rules and procedures for transfer operations between seagoing ships and LNG regasification vessels (LNGRV) or LNG floating storage and offloading vessels (FSOs) in inshore waters.



The guideline is applicable on the transfer of large amounts of LNG from ship to ship and is not legally binding. It does not cover the bunkering process. However it can be used as a starting point for the development of LNG ship-to-ship bunkering guidelines.

- **ISGOTT – International safety guide for oil tankers & terminals**

The International Safety Guide for Oil Tankers & Terminals (ISGOTT) is devolved for the safe carriage and handling of crude oil and petroleum products on tankers and at terminals. To ensure that the ISGOTT reflects the current best practice and legislation the guideline is reviewed by the ICS and OCIMF, together with the International Association of Ports and Harbours (IAPH). It is recommended by the industry that a copy of the International Safety Guide for Oil Tankers & Terminals (ISGOTT) is kept and used on board every tanker and in every terminal so that there is a consistent approach to operational procedures and shared responsibilities for operations at the ship/shore interface.

- **SIGTTO – Site selection and Design for LNG Ports and Jetties**

This SIGTTO guideline is designed for port developers and contains minimum design criteria for building or altering ports to accommodate LNG carriers.

- **SIGTTO – Liquefied Gas Handling Principles on Ships and in Terminals**

This book serves officers and terminal operational staff responsible for cargo handling operations and personnel about to be placed in positions covering these duties.

7 REGULATIONS AND STANDARDS RELATED TO THE LNG SUPPLY CHAIN: BUNKERING INTERFACE & OPERATION

Although different national and port-specific initiatives have been taken, at this moment the bunkering of LNG as fuel for ships is not yet regulated at international or European level. The IGF code exists, but this code mainly focuses on the receiving vessel, i.e. the ship using LNG as fuel. Chapter 8 – ‘Bunkering’ of the draft IGF Code contains requirements for the bunkering station, the manifold and the bunkering system, but they are all related to the gas-fuelled ship itself. Elaborate regulations for the bunkering interface are not foreseen in this code.

7.1 Rules for Bunkering Gas-fuelled Vessels and related Activities

7.1.1 ISO Technical Committee 67 Working Group 10

- ISO/TS 18683 – Guidelines for Systems and Installations for Supply of LNG as Fuel to Ships

The objective of this technical specification is to provide guidance for the planning and design of

- the bunkering facility;
- the ship/bunkering facility interface;
- procedures for connection and disconnection;
- the emergency shutdown interface;
- the LNG bunkering process control,

thereby ensuring that an LNG fuelled ship can refuel with a high level of safety, integrity and reliability regardless of the type of bunkering facility.

This technical specification is applicable to bunkering of both seagoing and inland trading vessels. It covers LNG bunkering from shore or ship LNG supply facilities, as shown in Figure 7-1. It addresses all operations required such as inerting, gassing up, cooling down, and loading /19/.

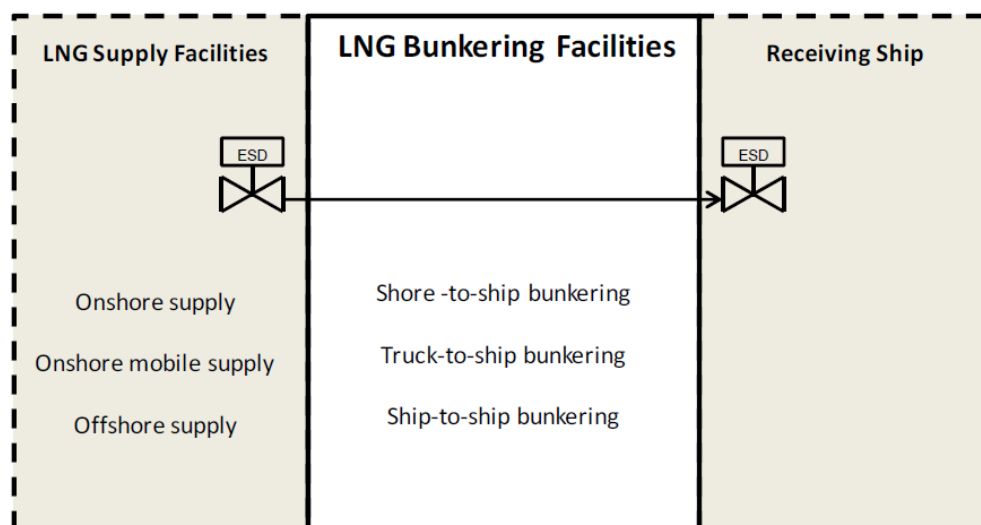



Figure 7-1: Scope of ISO/TS 18683



The technical specification also provides requirements and recommendations for operator and crew competency and training. Furthermore, it contains functional requirements for equipment necessary to ensure safe LNG bunkering operations of LNG fuelled ships.

ISO/TS 18683 has been published in January 2015. However, this is a technical specification, i.e. a guideline, published by ISO and not an international standard. This means that it is not mandatory on its own, and it has to be implemented or referenced to in other high-level standards or regulations to become mandatory.

7.1.2 Rules for Bunkering Gas-fuelled Seagoing Vessels

As explained in Chapter 6 of this report, it is clear that for LNG cargo transport, rigorous codes and standards exist for the design, construction and operation of both the cargo vessels and the terminals where they load and discharge their cargo. The effectiveness of these rules is demonstrated by the excellent safety record of marine cargo transport. With the introduction of small scale LNG, it is essential that the experience and knowledge of the large scale LNG world is used now in the small scale LNG industry.

Most important guidelines and standards applicable to transfer of LNG as cargo, which can be used in the future for rule development for small scale LNG bunkering, are:

- SIGTTO – LNG ship to ship transfer guideline (see § 6.5)
- ISGOTT – International safety guide for oil tankers & terminals (see § 6.5)
- SIGTTO – ESD Arrangements & linked ship/shore systems for liquefied gas carriers (see § 6.5)
- ISO 28460:2010 – Standard for installation and equipment for liquefied natural gas – Ship to shore interface and port operations (see § 5.3.1).

Furthermore, some general guidelines, rules and standards exist, which are also applicable to LNG bunkering:

- **EN 1160:1996 – Installations and equipment for liquefied natural gas – General characteristics of liquefied natural gas and cryogenic materials**

This international standard gives guidance on the characteristics of LNG and the cryogenic materials used in the LNG industry. Furthermore, it gives guidance on health and safety matters. It is intended to act as a reference document for the implementation of other standards in the liquefied natural gas field. It is intended as a reference for use by persons who design or operate LNG facilities.

- **SIGTTO – Liquefied Gas Fire Hazard Management**

This document discusses the principles of liquefied gas fire prevention and fire fighting.

- **SIGTTO – LNG Operations in Port Areas**

This document draws on the collective experience of the gas industry members in setting out guidance to best practice for managing gas shipping operations within ports. It also illuminates the profile of risks attaching to gas operations, for the information of those who administer ports and provide essential services in ports areas. This document is essential guidance to best practice for those involved with the design and operation of new LNG terminals and for existing terminals who wish to re-assess risk due to the dynamic nature of operating environments.

- **ATEX Directive 94/9/EC (ATEX 95)**

ATEX derives its name from the French title of the 94/9/EC directive "Appareils destinés à être utilisés en ATmosphères EXplosibles". ATEX 95 concerns the equipment and protective systems intended for use in potentially explosive atmospheres. ATEX 95, which is dedicated to the manufacturer, is applicable up to 19 April 2016 and will then be replaced by directive 2014/34/EU. The new directive aims to align at its origin 10 directives. Next to ATEX 95, these include also the Civil Explosives Directive, the Pressure Equipment Directive (as described above) and the Measuring Instruments Directive.

ATEX 95 is applicable to onshore LNG installations only. This directive is very commonly applied to onshore installations in the EU. The national implementation of ATEX does not contain specific features that will influence the development of LNG bunkering.

- **ATEX Directive 99/92/EC (ATEX 137)**

ATEX 137 requires that employers must classify areas where hazardous explosive atmospheres may occur into zones /16/. The classification given to a particular zone, and its size and location, depends on the likelihood of an explosive atmosphere occurring and its persistence if it does.

ATEX 137 is applicable to onshore LNG installations only. This directive is very commonly applied to onshore installations in the EU and does not contain specific features which will influence the development of LNG bunkering.

7.1.3 Rules for Bunkering Gas-fuelled Inland Vessels

Since gas-fuelled inland vessels were only allowed by exception in the past, specific rules for bunkering do not exist.

With the Rhine Vessel Inspection Regulations, gas-fuelled inland vessels will be allowed, but the main focus of these regulations is on the gas-fuelled ship and not on the bunkering interface.

ISO/TS 18683 also covers LNG bunkering for inland trading vessels, but as mentioned this will only be a technical specification and thus not mandatory.

7.2 Training

Besides training requirements related to LNG cargo transport and LNG fuelled vessels, covered in chapter 6 of this report, specific training requirements related to LNG bunkering are mentioned in the ISO/TS 18683 LNG bunkering guidelines, which puts training in a central role in managing the risks inherent to bunkering of LNG.

- Chapter 7 is dealing with risk assessment. "Training" is referred to in two places.

7.2.3.3.4 Action plan

... Safeguards to be considered in the HAZID should as a minimum include

a) Training of involved personnel;

...

7.3.7 QRA report

...

The level of detail in the report shall ensure that

...

b) Study assumption, operational safety measures, and key findings can be implemented in operational procedures, training programs and emergency plans.

...

- Chapter 8 is issuing functional requirements for LNG bunkering systems.

8.5.4 Emergency preparedness

[F23] A contingency plan shall be in place ...

[F24] Copies of the plan shall be communicated to all parties involved in the bunkering operation including the planned emergency response team and be part of the training program. This should be practiced at regular intervals both as "table top" and practical exercises. ...

- Chapter 10 is addressing Training in particular.

All personnel involved in LNG bunkering operations shall be adequately trained. Such training shall be appropriate for the purpose and a record of training shall be maintained.

Training shall be structured in accordance with written programs, including such methods and media of delivery, procedures, assessment and course material as are necessary to achieve the required standard of competence.


Training schemes should be independently verified at least every five years to secure that they fulfill the requirements set out below. Training according to other, recognized, standards maybe taken as equivalent to those outlined here as long as they fulfill the minimum requirements below.

Training shall be conducted by persons appropriately qualified and experienced.

If training or assessment is being carried out in the workplace this shall only be permitted if such training or assessment does not adversely affect normal operation, and time and attention can be safely dedicated to training or assessment.

Training for all personnel involved in the bunker operation shall as a minimum cover:

- a) properties and hazards of LNG relevant to the LNG bunkering operations;*
- b) potential effects of mixing L11IG with different properties;*
- c) risk reducing measures;*
- d) international or national regulations and guidelines regarding LNG fuel transfer operations;*
- e) first aid specific to frost- bite and asphyxiation;*
- f) safe operation of LNG fuel transfer equipment;*
- g) procedures to be followed during normal LNG bunkering operations:*
 - 1. pre-transfer procedures, tests and checks;*
 - 2. safe connection procedure;*
 - 3. checks and procedures during LNG bunkering operations,*

- 
4. *safe disconnection procedure;*
 5. *LNG fuel quantity and properties confirmation;*
 6. *management of operations other than LNG fuel transfer that can occur simultaneously with that transfer;*
 7. *routine maintenance and testing procedures;*
 8. *all other procedures applied for the specific operation*

h) understanding of non-standard operations and emergencies during LNG bunkering operations:

1. *immediate action to be taken in response to emergency situations that can occur during LNG fuel transfer operations including liquid and/or vapour leakage, fire, ore emergency breakaway;*
2. *management of vapour and/or liquid leaks to minimise risk to personnel and assets due to cryogenic temperatures and flammable atmospheres;*
3. *emergency response plans*

- *Chapter 11 formulates requirements on documentation.*

11.7 Training Documentation

The operator of the LNG bunkering facility and the receiving ship shall provide appropriate training of personnel who are responsible for the operation, maintenance, safety and emergency response associated with the bunkering facility to ensure that such personnel are adequately knowledgeable of such matters.

Documentation of the provided training and qualification of personnel shall be prepared and retained.

11.9 Retention of documentation

All technical, engineering, operational, maintenance and training documentation associated with the requirements of Clause 10 shall be prepared and retained for the life of the bunkering facility, or longer as appropriate.

8 PERMITTING PROCESSES

8.1 Introduction

Permitting is a key aspect in the development of LNG infrastructure. Long permitting processes may be showstoppers for (small scale) LNG infrastructure. The current average duration of permitting procedure for energy infrastructure projects, from submission of application document to issuing of the permit is typically 4 years /20/. Public opposition to the project (via the mandatory stakeholder dialogue) is the main reasons for delay/failure of the process. It is worth to mention that – except for Norway (and Sweden to a limited extent) – the main permit process experience with LNG infrastructure is linked with large scale infrastructure (import terminals).

The permitting process in the different European countries for (small scale) LNG infrastructure (i.e. LNG bunker station, LNG satellite plants, ...) differs regarding the number of permits/processes in the permitting procedure, number of authorities responsible to deliver the permitting procedures, documents to be produced and delivered, timing, etc.

This chapter focuses on the different permitting processes for building and operating small scale LNG terminals and to a larger extent LNG bunkering within a selection of (potential future) ECA countries in Europe. In addition to the permitting process itself, reference is made to the main regulatory framework and to specific (small and large scale) LNG developments.

Water side LNG bunkering operations (e.g. ship to ship bunkering) in harbour context are subjected to prior approval of the harbor masters (not formal permits). The latter is not specifically dealt with in this chapter.

8.2 European Frame

Two EU directives strongly influence the permit process for LNG bunkering facilities at national level, i.e. the EIA Directive and the Seveso Directive.

EIA Directive (85/337/EEC)¹⁶ (and its updates) defines the Environmental Impact Assessment (EIA) and minimum requirements for the public consultation procedure. The EIA Directive (85/337/EEC) is in force since 1985 and applies to a wide range of public and private projects, which are defined in Annexes I and II. Annex II specifies requirements for so called “Energy Industry” and more specific storage of gas. For projects listed in Annex II, the national authorities have to decide whether an EIA is needed. The EIA-directive specifies no threshold for ‘storage of gas’ (LNG) installations. In general this Directive and its implementation in national law by Member States applies to larger LNG installations (some exceptions exist) rather than to small scale terminals. The EIA also specifies the requirements on public participation in the process.

Seveso Directive (96/82/EC) concerns the prevention of onshore major accident hazards with dangerous substances involved. It covers both, industrial processes as well as the storage of dangerous chemicals. The purpose of this directive is to prevent major accidents and to limit the consequences of such accidents. The Directive has for each substance category two thresholds, for LNG >50 tonnes (low tier) and >200 tonnes (upper tier). Low tier Seveso companies are required to send a formal notification to the competent authority. Upper tier need to draft a formal safety report; establish a safety management system and an emergency plan.

¹⁶ The initial Directive of 1985 and its three amendments have been codified by DIRECTIVE 2011/92/EU of 13 December 2011. Directive 2011/92/EU has been amended in 2014 by DIRECTIVE 2014/52/EU

As from 50 tonnes LNG on, this Directive applies. The new Seveso III directive (2012/18/EU) will succeed the Seveso II directive as per June 2015, although this update will have no specific impact for LNG installations.

Member States have adopted the European EIA and Seveso Directive in their own national legislation. An overview is given for a selection of ECA countries in the table below.

Table 8-1: National implementation of EIA Directive and Seveso Directive

Country	EIA	Seveso
Belgium	<p><i>Decree MER/VR; EIA, i.e. milieu effectenrapport in Belgium</i></p> <p>Mandatory for energy companies & storage facilities of natural gas above ground with a capacity equal to or larger than 100,000 m³</p>	<i>Samenwerkingsakkoord, SWA</i>
Denmark	<p><i>BEK1654</i></p> <p>EIA screening by local municipality always obliged for LNG storage facilities, depending outcome eventually a full EIA examination is needed, for > 200t EIA needed by default</p>	<p><i>BEK1666</i></p> <p>Difference for low and high tier, facilities with < 50t are by default not considered to be risky operations and will only be obliged to follow local fire authority rules</p>
Finland	<ul style="list-style-type: none"> • <i>Finnish Act (468/1994)</i> • <i>Decree (713/2006)</i> <p>competent authority decides if EIA is required on a case-by-case basis, EIA is mandatory if LNG storage is above 50000 m³</p>	<i>Law 390/2005 & 59/1999</i>
France	<ul style="list-style-type: none"> • <i>77-393</i> <p>competent authority decides if EIA is required on a case-by-case basis, no strict link with amount of LNG</p>	<i>Order of 10 May 2000' & French Circular of 10 May 2000</i>
Germany	<ul style="list-style-type: none"> • <i>Environmental Impact Assessment Act (UVPG)</i> • <i>Federal Mining act (BBergG)</i> • <i>ordinance on EIA (UVP-V Bergbau)</i> • <i>building code (BauGB)</i> • <i>Federal Regional Planning Act (ROG)</i> • <i>law of the German Länder</i> <p>EIA is required for the spatial planning phase</p>	<i>Major Accident Ordinance (StörfallV)</i>
Netherlands	<ul style="list-style-type: none"> • <i>Decree for Environmental Impact</i> 	<i>Major Hazards Decree (BRZO) in 1999</i>

	<p><i>assessment (besluit m.e.r.) in 1994.</i></p> <p>For LNG facilities, an EIA screening must be executed (if >76t), based on the results, a decision is made as to whether an EIA is to be carried out or not</p>	
Poland	<ul style="list-style-type: none"> • <i>Polish Environmental Protection Law (Dz.U.1994 No. 25, pos 150)</i> • <i>Polish decree on Public Hearing and making of EIA (Dz.U.2002, No. 75, pos. 609)</i> • <i>Act of preparation of EIA (Dz.U.2008, No. 199, pos. 127)</i> <p>For LNG facilities, an EIA screening must be executed, based on the results, a decision is made as to whether an EIA is to be carried out or not</p>	<i>Polish Environmental protection Law (Dz. U. 1994, No. 25, pos 150)</i>
United Kingdom	<ul style="list-style-type: none"> • <i>Town and Country Planning (EIA) Regulations 2011</i> • <i>Marine Works (EIA) (Amendment) Regulations 2011</i> • <i>the Infrastructure Planning (EIA) Regulations 2009</i> 	<i>Control of Major Accident Hazards Regulations 1999 (COMAH)</i>

8.3 Permit types

The permitting process/requirements differ between countries, but there is strong similarity in the type of permits required at a national level. Often required permits are:

- Environmental permit;
- Permit to store dangerous goods;
- Handling of dangerous goods Permit;
- Building Permit.

Note that the above mentioned permits can be separate permits or integrated into overall (all-in-one) permits.

Table 8-2 gives an overview of the main permits required in the different ECA countries.

Table 8-2: Mandatory permit for LNG storage facilities in a selection of ECA countries

Country	Environmental permit	Storage Permit	Handling Permit	Building Permit	Note
Belgium	<input checked="" type="checkbox"/> ('All-in-one Permit for Physical Aspects')	<input checked="" type="checkbox"/> ('All-in-one Permit for Physical Aspects')	<input checked="" type="checkbox"/> ('All-in-one Permit for Physical Aspects')	<input checked="" type="checkbox"/> ('All-in-one Permit for Physical Aspects')	'All-in-one Permit for Physical Aspects' (<i>Omgevingsvergunning</i>)
Denmark	<input checked="" type="checkbox"/> (> 50t)		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	to be included in municipal planning (if EIA required)
Finland	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
France	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	
Germany	<input checked="" type="checkbox"/> (part of the building permit)	<input checked="" type="checkbox"/> (part of the building permit)	<input checked="" type="checkbox"/> (part of the building permit)	<input checked="" type="checkbox"/>	spatial planning process
Netherlands	<input checked="" type="checkbox"/> ('All-in-one Permit for Physical Aspects')	<input checked="" type="checkbox"/> ('All-in-one Permit for Physical Aspects')	<input checked="" type="checkbox"/> ('All-in-one Permit for Physical Aspects')	<input checked="" type="checkbox"/> ('All-in-one Permit for Physical Aspects')	'All-in-one Permit for Physical Aspects' (<i>Omgevingsvergunning</i>)
Poland	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
United Kingdom	<input checked="" type="checkbox"/> (part of the planning permit)	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	

8.4 Number of Processes

The average number of processes required in countries analysed to obtain all the required permits for the construction and operation of a project is 3 or more. In Belgium and The Netherlands there is one single permit process and one single authority for handling the permit process. The UK has a similar approach for projects from a certain size on. Other countries have two (Germany) or more permit processes (e.g. Poland with 4 processes, the EIA decision process, the planning Permission process, the Designation of Land process and the construction permit process) with two or more authorities involved. The creation of an all in one permit and one-stop-shop makes the permit process more lean.

A typical permit procedure consists of following steps /20/:

- Scoping: process of determining the content of the matters to be covered in the environmental information to be submitted to the competent authority
- Preparation of application documents: the developer prepares the application documents based on the list of requirements
- Verification of completeness of the application: ensure that application documents cover the scoping and enable a proper assessment of all potential impacts of the project
- Public consultation: formal dialogue is established between responsible authorities, stakeholders and project developers
- Decision phase: goal of this phase is to issue a permit
- Appeal and litigation: after a permit has been issued, stakeholders may appeal

The permit process and involved authorities in detailed for a selection of EU countries in § 8.6.

8.5 Public consultation

Public consultation is a key element in the EIA-directive. This directive requires that the public is informed in an early stage of the decision making process. Member states should be required to take the necessary measures to ensure that the public concerned are given 'early and effective opportunities' to participate in the procedure.

Most countries have clear public consultation as part of the permit procedure. Specific details on the organisation of public consultation, varies between countries.

8.6 Permitting processes in selection of EU countries

A selection of (relevant) EU countries is made taking into account those countries that already have an LNG infrastructure or where LNG installations or activities are expected to be developed respectively take place in the nearby future.

8.6.1 Belgium

Belgium has one import LNG terminal at Zeebrugge since 1987. In 2015, a second jetty will be operational and the port of Zeebrugge will then be able to handle almost all sizes of LNG vessels (incl. bunker vessels and feeder vessels). For truck to ship bunkering, a first truck loading station has been operational for several years and a second station is to be built in the near future. No small scale LNG terminals are yet operational, but one such terminal is planned in Antwerp port (EU TEN-T programme) and will be operational in 2016.

The three main local legislations in Belgium relevant for permitting of LNG terminals are the *Samenwerkingsakkoord*, i.e. the implementation of the Seveso II Directive in Belgian law, the Decree MER/VR (implementing the Seveso and EIA directives in regional law) and the Vlareem legislation: Title I & Title II of Vlareem (governing legislation for environmental affairs). Note that environmental obligations differ per region (Flanders, Brussels, Wallonia). In this chapter focus in on Flemish law as the main LNG small scale developments are to be expected in that region.

In Vlareem II, storage or transfer facilities for natural gas with a capacity exceeding 10.000 m³ are determined as class 1 facilities (most stringent class), between 1000 m³ and 10000 m³ class 2 and below 1000 m³ class 3 facilities. The environmental permits for class 1 facilities are treated by the Provincial Commission for Environmental Permitting (PMVC). This Commission will further ask relevant regional, provincial and federal official agencies for advice. Contrary to LPG-installations and storage and handling of gas recipients, LNG is not mentioned explicitly in Vlareem II for small scale applications, so no further guidance is given on technical requirements for materials & installations, firefighting requirements, ...

Table 8-3: Permitting process in Belgium

Subject / Question	Belgium
Currently LNG terminals operational?	Yes
Required Permits	'All-in-one Permit for Physical Aspects' (<i>Omgevingsvergunning</i>)
Local legislation related to permits	Samenwerkingsakkoord (SWA), i.e. implementation of Seveso II Directive; Vlarem Annex 2 (Flanders) Decree MER/VR (Flanders)
Authority responsible for permitting	PMVC (environmental permit) if class 1 Municipality if class 2 or 3
Other authorities involved in process	Yes for consultation/advice
Time frame permitting	12 months
Difference permitting per state/ province	Yes, differs for the Flemish, Walloon and Brussels Region. In case of LNG for maritime purposes, only the Flemish region is relevant, since this is the only region directly connected to the sea
Involvement of public	Yes, part of the environmental permitting process
Required studies	QRA, Environmental impact assessment
External risk criteria	Yes
Safety report / Safety management plan required?	Yes
Thresholds	>100,000 m ³ (NG storage above ground): submitted to EIA >50 tons: notification + prevention policy and internal emergency plan required >200tons: in addition, safety report (SWA-VR (before operations phase) & OVR (permit)), external emergency planning

Although a QRA study is strictly only mandatory for high tier (>200 tons LNG) companies, in practice a QRA study will also be requested by the permitting authorities in case of smaller storage capacities.

Recently, a small LPG bunker station for trucks started operating in Antwerp. Although the storage volume falls even below the low tier amount (i.e. 50 tons), a QRA study was requested by the authorities. It is expected that for LNG bunker stations, the same philosophy will be followed and a QRA study will be requested, even if their storage volume falls below the low tier amount.

8.6.2 Denmark

Although the regulatory system for permits to construct and operate an LNG bunkering terminal in Denmark is in principle in place, so far, only one such terminal is planned to be built in the country. Liquiline and Fjord Line have entered into a contract whereby Liquiline Europe AS will design, construct and commission an LNG bunkering terminal for Fjord Line AS at the Port of Hirtshals.

The relevant authorities to be contacted to obtain a permit in connection to LNG bunkering operations in Denmark are the Danish Maritime Authority and the municipality. The former will consider issues related to the ship, including ship-to-ship bunker operations. The latter will consider issues related to bunker operations and facilities ashore, including any cooperation with other authorities. Both must coordinate their work to ensure consistency and coherence and ideally one of them should serve the applicant as a single contact point to all public authorities.

Further authorities that must be consulted or grant permits with regard to specific activities/steps in the broader context of bunker operations are the Danish Emergency Management Agency, the Danish Energy Agency, the Ministry of Transport, the Danish Working Environment Authority (occupational safety) and the police (terror assessment and terror safety).

The approval process for environmental and building permit is governed by Municipality. Main legislation is:

- Order no. 1666 of 14 December 2006 (BEK 1666) on control of the risk of major accidents with dangerous substances issued by the Ministry of the Environment – requires a risk assessment and accident prevention for operations involving LNG >50 tonnes;
- The act on environmental protection no. 879 of 26 June 2010 and the Order no. 1654 of 27 December 2013 (BEK 1654) on assessment of the impact of certain public and private installations on the environment (environmental impact assessment) pursuant to the act on planning – requirements for EIA. Above ground LNG storage facilities will always be obliged for an EIA screening. Local municipality must assess whether the storage facility can be expected to have a significant effect on the environment. If positive, a full EIA examination and inclusion in the public municipal planning is needed before the construction can start. A facility with above 200 tonnes will per default be obliged for a full EIA examination.
- Consolidated Planning Act no. 937 of 24 September 2009 and the Construction Regulation of 1 January 2013 - both apply to all construction works ashore.

Table 8-4: Permitting process in Denmark

Subject / Question	Denmark
Currently LNG terminals operational?	No
Required Permits	Environmental Permit, building permit, handling of dangerous goods
Local legislation related to permits	BEK 1666 BEK 1654
Authority responsible for permitting	Municipality
Other authorities involved in process	Yes for consultation/advice
Time frame permitting	12-24 months
Difference permitting per state/ province	No
Involvement of public	Yes, part of the permitting process
Required studies	Environmental impact assessment
External risk criteria	Yes
Safety report / Safety management plan required?	Yes
Thresholds	>200 tonnes: submitted to EIA + safety report >50 tonnes: EIA screening <50 tons: local fire rules

8.6.3 Finland

Gasum's small scale production plant located in Porvoo has a production capacity of 20 000 tonnes/year (storage capacity is 2300m³). Several other terminals are being planned, including the construction of a large-scale LNG terminal.

The permitting process for LNG storage facilities in Finland requires building, environmental and operational (storage/handling) permit.

A permit for operating a terminal is to be obtained according to Chemicals Act (Act on industrial handling and storage of dangerous chemicals 390/2005 according to Seveso Directive) and Decree on natural gas (551/2009). The permission is to be applied for from the Finnish Safety and Chemicals Agency (Tukes). Note that there are ideas to integrate this operating permit into the environmental permit.

Finland has adopted a comprehensive regulatory framework on environmental issues. Although mostly regulated through national legislation, a large part of Finnish environmental legislation is from EU law

either as directly applicable law or through implementation of EU law. Finish Act (468/1994) and Decree (713/2006) (based on EIA directive) specify the requirements for EIA. An EIA is mandatory for all LNG storage above 50 000 m³, below the competent authority (regional Centres for Economic Development, Transport and the Environment) decides on a case-by-case basis. A project cannot be issued a permit without the EIA being completed. Environmental permit is needed in case of storage of gas or in case of fuel stations for the distribution of liquid fuels where the capacity of the storage tank is at least 10 m³, or other facilities for the storage of liquid fuels or dangerous chemicals in liquid form capable of holding at least 100 m³ of such chemicals (Environmental protection Act 86/2000 and Decree 169/2000). Permit is to be applied from the Regional State Administrative Agency (AVI). The permit procedure includes a public hearing during which the stakeholders (neighbors, affected citizens, NGO', ...) are invited to submit their comments/objections. In addition, municipalities affected by the environmental impacts of the project and specialized authorities are also requested to submit statements to the permit authority.

Building permit is applied from the local authority according to national Land use and building act (132/1999). Land use plan should allow for building the terminal.

Table 8-5: Permitting process in Finland

Subject / Question	Finland
Currently LNG terminals operational?	Yes
Required Permits	Environmental Permit, building permit, handling of dangerous goods
Local legislation related to permits	Act on industrial handling and storage of dangerous chemicals 390/2005 Decree on natural gas 551/2009 Finish Act (468/1994) Decree (713/2006) National Building code (132/1999)
Authority responsible for permitting	Finnish Safety Authority Regional State Administrative Agency (larger operations) and municipality (smaller operations)
Other authorities involved in process	Yes for consultation/advice
Time frame permitting	12 months
Difference permitting per state/ province	No
Involvement of public	Yes, part of the permitting process
Required studies	Environmental impact assessment
External risk criteria	No
Safety report / Safety management plan required?	Yes (above 200 tons)
Thresholds	>50 tons: EIA, notification < 50 tons: screening need EIA >200 tons: safety report

8.6.4 France

Already equipped with LNG terminals (3 LNG import terminals Fos Toskin, Fos Cavaou and Montoir and one LNG import terminal under construction in Dunkerque), the following maritime ports also have projects of construction of LNG bunkering facilities (for LNG as a shipping fuel):

- Dunkerque (North Sea): a call for expression of interest for the construction of a LNG terminal and a specialized ship (for ship-to-ship LNG bunkering operations) was launched in April 2014; a consortium composed of Dunkerque LNG, Air Liquide and Exmar has been selected for this project.

- Nantes Saint-Nazaire / Montoir-de-Bretagne (Atlantic): on 4 December 2014, Elengy (a subsidiary company of the GDF Suez Group) signed a MoU with the port of Nantes Saint-Nazaire towards the future development of small-scale LNG bunkering for ships.
- Marseille-Fos (Mediterranean)

In the French Ministry of Ecology, Sustainable Development and Energy (MEDDE), the relevant services in charge of LNG-related activities are the DGPR (Directorate-General for Risk Prevention) and DGITM (Directorate-General for Transport Infrastructure and Materials).

Although some existing Regulations would apply to small-scale LNG bunkering operations in France, there are no specific permitting procedures in place for the construction and operation of such infrastructure in French ports yet. However, the Bureau for the Security of Industrial Equipment (BSEI) – a department of the DGPR - is currently working on such a framework.

The Environmental Code (77-393) provides for EIAs. The procedure was modified by a Decree on the reform of environmental impact assessments dated 29 December 2011. The modifications apply to classified facilities for which the registration or the authorization application is submitted after 1 June 2012. The main change concerns classified facilities submitted to registration and other specifically listed infrastructures. For these the requirement for an EIA is determined on a case-by-case basis. France implemented the Seveso II Directive into its national legal framework through ‘the order of 10 May 2000 relative to the prevention of major accidents which involve substances or preparations present in certain categories of permit-holding classified installations for environmental protection’. The requirements that must be implemented by operators (for major accident prevention) are implemented through French Circular of 10 May 2000.

The environmental/operating permit is regulated by the law No. 76-663 of July 19, 1976 on classified installations for environmental protection and its related decree No. 77-1133 of September 21, 1977 (as amended in 2005). Article 3 of the 1976 law concerns specific classified installations with a major accident potential (subjected to Seveso Directive). The Prefect releases permits on the basis of the advice of DREAL (*Directions Regionales de l’Environnement, de l’Aménagement et du Logement*), the institutional body responsible both for the assessment of Safety Reports, the consultation of local authorities and other involved parties.

Industrial activities are classified according to their potential dangerousness and eventually to their potential impacts on the environment. The classification is listed in the following: Low dangerousness: declaration scheme “D”. A simplified declaration is required at the Prefecture; Medium dangerousness: authorization scheme “A”. A Safety Report and an environmental impact assessment (EIA) procedure are compulsory; High dangerousness: authorization scheme with land-use restrictions. Land use restrictions are possible in addition to A establishment requirements.

This procedure for obtaining permission to build and operate an LNG facility in France is a description of the tasks required by 2003-8 French law of 3 January 2003, which was modified and completed by law 2004-803 of 9 August 2004. This law is the key piece of legislation governing LNG infrastructure permitting in France, in accordance with the French Planning Code.

Table 8-6: Permitting process in France

Subject / Question	France
Currently LNG terminals operational?	Yes
Required Permits	Environmental permit, storage permit, handling permit, building permit
Local legislation related to permits	law No. 76-663 and decree No. 77-1133 French planning code
Authority responsible for permitting	Prefect
Other authorities involved in process	Dreal
Time frame permitting	12 months
Difference permitting per state/ province	No
Involvement of public	Yes, part of the environmental permitting process (for installations >200 tonnes LNG)
Required studies	Safety report, Environmental impact assessment
External risk criteria	Yes
Safety report / Safety management plan required?	Yes
Thresholds	>50 tons: notification required >200tons: safety report/EIA/H&S study/ on site emergency response plan

Example of the Fos Faster LNG terminal (Marseille): Technical impact assessment studies were carried out throughout 2012-2013, and in September 2013 the permit application for the building and operation of this LNG terminal was sent to the regional prefecture (Bouches-du-Rhône) and to the city Council of Fos-sur-Mer. On 7 July 2014, the Prefecture officially delivered the permit for exploitation of this LNG terminal. The dossier is currently being examined by the Council on Environment and Sustainable Development (CGEDD) for opinion.

8.6.5 Germany

Germany does not have any LNG terminals. A number of terminals have been planned but are postponed. In 2012 the German Federal Ministry for Transport published a feasibility study¹⁷ on the bunkering of LNG in German ports. The study summarizes the rules applicable for LNG installations and for the bunkering procedures for LNG in German maritime and inland ports.

According to the study, rules for LNG installations in both maritime and inland ports are set at Federal level, supplemented by specific rules at the Länder level. Applicable rules are set out in the Federal Building Code (*Baugesetzbuch*) and the Federal Pollution Control Act (*Bundes-Immissionsschutzgesetz*).

Moreover, according to the study, rules on LNG bunkering procedures in maritime ports are set at the level of the coastal Länder (Bremen, Niedersachsen, Hamburg, Schleswig-Holstein and Mecklenburg-Vorpommern). And, the bunkering of LNG is subject to general rules on the handling of fuels and/or dangerous goods as set by the relevant coastal Länder. General rules on LNG bunkering procedures in inland ports are set at the federal level. Applicable rules are set out in the Federal Product Safety Act (*Produktsicherheitsgesetz*) and the Operational Safety Ordinance (*Betriebssicherheitsverordnung*). In addition, specific rules are set at the federal level for federal waterways (all major rivers), and at local level for other waterways / ports. Applicable federal rules are in this context set out in the Federal Waterways Act (*Wasserstraßengesetz*).

¹⁷ The study (in German) can be accessed here: http://www.bsh.de/de/Das_BSH/Presse/Aktuelle_Meldungen/Studie-LNG.pdf

In Germany, the EIA Directive is transposed in the Environmental Impact Assessment Act (Gesetz über die Umweltverträglichkeitsprüfung) (UVPG), the Federal Mining Act (BBergG) and the relevant ordinance on EIA (UVP-V Bergbau), the Building Code (BauGB), the Federal Regional Planning Act (ROG), and the law of the German Länder. Environmental impact assessment is integrated into the procedures for the authorisation of projects.

The Federal Pollution Protection Act (§ 50 "Planning") (BImSchG) provides the rules for granting licenses for potentially polluting or hazardous installations or activities according to the Annex of the 4th Ordinance for the Implementation of the Federal Act. The competent authority is the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. The Major Accident Ordinance (StörfallV), which is referenced in the Federal Pollution Protection Act, implements the Seveso II Directive in federal legislation. Establishments which fall under the requirements of the Major Accident Ordinance are required to be designed and operated according to the "state of the art in safety technology. At this moment this state of the art safety technology relating to LNG bunkering facilities is not defined and best practice for small scale LNG bunkering facilities is not available in Germany.

Worth to mention are the following recent developments. In June 2013, the Federal Government adopted the Mobility and Fuels Strategy¹⁸, which aims to support the deployment of alternative fuels and the related infrastructure. One of its priorities is the deployment of LNG as maritime fuel, and the development of the relevant infrastructure. Specifically, the Strategy announces the development of an "LNG Action Plan", a "joint LNG infrastructure programme for shipping (maritime stakeholders, energy and port industry and public sector)". The Action Plan would importantly aim to "harmonize safety standards and approval procedures". It would also include a "communication strategy for public acceptance". In Germany the so called "Maritime LNG Platform e.V." was established. This is a national initiative aiming to support the deployment of LNG as maritime fuel. It brings together companies and ports.

Small scale LNG installation needs to comply with the planning and building regulation law (and environmental legislation) before being granted a building permit. The process for obtaining the building permit is based on two sub steps; selection of an appropriate location (spatial planning) and permit for construction.

Table 8-7: Permitting process in Germany

Subject / Question	Germany
Currently LNG terminals operational?	No
Required Permits	Environmental permit, storage permit, handling permit, building permit
Local legislation related to permits	Betriebssicherheitsverordnung (BetrSichV) Planning and Building law Environmental Impact Assessment Act (UVPG) Major Accident Ordinance (Störfall V)
Authority responsible for permitting	Regional organisations at State (Länder) level
Other authorities involved in process	Yes
Time frame permitting	Undefined
Difference permitting per state/ province	Difference per State
Involvement of public	Yes, after screening by competent authorities
Required studies	Safety report, Environmental impact assessment
External risk criteria	Yes
Safety report / Safety management plan required?	Yes

¹⁸ The Mobility and Fuels Strategy (in English) can be accessed here (for reference to the LNG Action Plan refer to page 35: http://www.bmvi.de/SharedDocs/EN/Anlagen/UI-MKS/mfs-strategy-final-en.pdf?__blob=publicationFile)

Subject / Question	Germany
Thresholds	>50 tons: notification and EIA required >200tons: safety report/EIA/ on site emergency response plan

8.6.6 The Netherlands

The Netherlands has one import terminal (Gate terminal) located in Rotterdam area. The terminal is being modified for supplying LNG to bunker vessel by 2016. Several small scale developments are being planned.

In the Netherlands the so called "Nationaal LNG Platform" was established to allow for introduction of LNG as clean fuel for road transport and transport per ship. The Platform brings together companies and authorities, working on introduction of LNG, by means of a so called Green Deal. The purpose of the group is to have at least 50 inland vessels, 50 sea vessels and 500 trucks fuelled via LNG. The group acts as a platform to share information and provide solutions to LNG issues. The state authorities are participating via Ministry of Economic Affairs (energy policy) and ministry of Infrastructure (environmental policy). The platform consists of 5 working groups:

- Regulatory and safety
- Road transport
- Shipping
- Strategic environmental management
- Bio-LNG

In the Netherlands, for all activities with regard to building, renovation, demolishing, construction, living, monuments, environment, nature and open space, a permit is needed. This so-called 'All-in-one Permit for Physical Aspects' (*Omgevingsvergunning*) was introduced 1 October 2010 to replace several individual permits. This included the building permit, environmental permit, operating permit, construction permit and the tree felling permit. This authorization may be requested from one box at the municipality. The environmental permit is regulated by the General Provisions Environmental Law (wet algemene bepalingen omgeving - Wabo). The permit requirements are not specifically regulated in this law, but in the law on environmental management (wet milieubeheer, WM), implemented on March 1, 1993. Companies with LNG terminal, LNG storage, LNG fuelling station and related operation have to comply with the General Provisions Environmental Law and require a permit. Regulations apply to, for instance, noise and vibration energy, waste materials, odour, air emissions, discharging liquids, transport management, soil protection and hazardous substances.

The environmental management decree ¹⁹forms the basis for the environmental regulations. Depending on the activities of a facility, it will be classified in one of three categories pursuant to the activities decree. Type A does not require an environmental management notification or an environmental permit; type B requires and environmental management notification; Type C requires an environmental permit. LNG stations and terminals are classified as Type C.

For facilities that contain hazardous substances the activities decree refers to the so-called PGS (Publicatiereeks Gevaarlijke Stoffen) guidelines which are formulated to provide design requirements for

¹⁹ Decree on general rules for environmental management of facilities, activities decree (*Besluit algemene regels voor inrichtingen milieubeheer, activiteitenbesluit*)

a safe installation. These guidelines are considered to represent Best Available Techniques (BAT). These guidelines are used by the authorities and industry to prove conformity to the regulation by complying with the requirements of PGS. PGS 33-2:2014 provides a consistent and transparent regulatory framework for shore-to-ship LNG bunker station design. The guideline includes harmonised risk analysis procedures for the siting of LNG bunker stations. For a detailed evaluation of technical guidelines and standards including PGS33-2 the reader is referred to "Sub-activity report 2.3 II LNG bunkering procedures".

The decree on risk of major accidents (Besluit risico zware ongevallen, Brzo) is a transposition of the Seveso II directive (96/82/EC, see section 3.2.1). Brzo integrates legislation on occupational safety, external safety and disaster relief in one legal framework. Like SEVESO II, all onshore establishments which hold more than 50 tonnes of LNG fall under the scope of Brzo and need to establish a major accident prevention policy. In addition, operators of high tier establishments holding more than 200 tonnes of LNG (equivalent to 440 m³) need to establish a safety report before construction is commenced. The safety report must include identification of major hazards, a quantitative risk assessment (QRA) and necessary measures to prevent such accidents, a safety management system and an emergency plan.

The decree on external safety of facilities (Besluit externe veiligheid inrichtingen, Bevi) sets safety requirements to companies that pose a threat to people outside of the premises of that company. The decree contains requirements for location bound risk (plaatsgebonden risico) and group risk (groepsrisico). It forces city councils and provinces to take into account these requirements in environmental permit procedures. The Bevi decree is applicable to all activities that fall under the previously mentioned Brzo (SEVESO II), e.g. for onshore establishments that hold more than 50 tonnes of LNG.

Table 8-8: Permitting process in the Netherlands

Subject / Question	The Netherlands
Currently LNG terminals operational?	Yes
Required Permits	'All-in-one Permit for Physical Aspects
Local legislation related to permits	General Provisions Environmental Law (Wabo)
Authority responsible for permitting	Province
Other authorities involved in process	Yes for consultation/advice
Time frame permitting	Unclear how new procedure will affect timing
Difference permitting per state/ province	No
Involvement of public	Yes
Required studies	Safety report, Environmental impact assessment
External risk criteria	Yes
Safety report / Safety management plan required?	Yes
Thresholds	>50 tons: notification and QRA required >76 tons EIA screening >200 tons: safety report/ on site emergency response plan

8.6.7 Poland

The LNG terminal in Świnoujście is the first infrastructure project of this kind in Poland. The terminal is to be operational as of early 2015. The terminal will have unloading jetty for large LNG tankers, two storage tanks and regasification train. The terminal's initial regasification capacity will be 5 billion m³ per annum, and with the construction of the third tank its capacity is due to expand to reach 7.5 billion m³ per annum satisfying approximately 50% of the annual Polish gas demand. Polskie LNG (a company established in 2007 with the aim to construct and operate the Świnoujście LNG terminal) and Polskie

Górnictwo Naftowe i Gazownictwo-PGNIG (the largest Polish oil and gas exploration and production company) have signed on 21 October 2014 a letter of intent in which both parties declared joint action aimed at expanding the plant and developing new services to be provided by Świnoujście LNG terminal. The objective of the letter of intent is to establish common understanding and the basis for further discussion aimed at agreeing the terms of cooperation towards the expansion of the LNG terminal with the third tank, development of services including reloading LNG onto smaller vessels and LNG bunkering.

An LNG facility would require following permits:

- Environmental permit according to Polish environmental protection law (implements the EIA and Seveso directive), this includes a screening process for EIA need and content. EIA is part of permit process
- Building permit according to Polish building law


Given that the Świnoujście terminal is a first of its kind in Poland, a resolution of the Council of Ministers (dated 3 January 2006) allowed for the construction of an LNG terminal on the Polish coast. On 31 May 2006 the Council of Ministers passed a resolution on the compliance of constructing an LNG Terminal on the Polish coast with the general concept of gas source diversification and the energy policies of the Polish government. In 2009 a special act facilitating the process of creation of the terminal was adopted. The Act of 24 April 2009 on investments related to the LNG regasification terminal in Świnoujście (commonly referred to as the Special Purpose Act) concerns the construction of the terminal and the accompanying investments (transmission pipelines and underground gas storage facilities). It stipulates the simplification and shortening of the administrative procedures connected with the preparation and completion of the investment. It facilitates the procurement of necessary permits (zoning permit, building permit, environmental license) and the investor's procurement of land. It prescribes clear and short deadlines for decision/advice by authorities on different permits.

Table 8-9: Permitting process in Poland

Subject / Question	Poland
Currently LNG terminals operational?	Yes
Required Permits	Environmental permit Building permit Operating permit
Local legislation related to permits	Polish Environmental Protection Law Polish Building law
Authority responsible for permitting	Regional environmental director for EIA process Local authorities for planning permission and land designation process County administrations for building permit
Other authorities involved in process	Yes for consultation/advice
Time frame permitting	18 months
Difference permitting per state/ province	No
Involvement of public	Yes
Required studies	Environmental impact assessment
External risk criteria	No
Safety report / Safety management plan required?	Yes
Thresholds	>200 tonnes: safety report EIA screening for all LNG developments

8.6.8 United Kingdom

The UK has four LNG import terminals (South Hook LNG, Dragon LNG, Isle of Grain LNG and Teeside Gasport LNG). No LNG bunkering facility is yet available in the UK. The country's first planned LNG



bunkering facility is to be completed by December 2015 in the Port of Teesport (near Middlesbrough). The project will demonstrate the high potential for LNG in short sea shipping in the UK and the North Sea. Its construction will be supported by the European Commission through its TEN-T Programme.

The construction and operation of LNG facilities must comply with relevant environmental, planning, health and safety requirements.

All establishments wishing to hold stocks of certain hazardous substances above a threshold quantity must apply to the Hazardous Substances Authority (HSA) - usually the local planning authority - for hazardous substances consent under the Planning (Hazardous Substances) Regulations 1992 (this includes the EIA). For LNG the threshold is 15 tonnes. HSE is one of eleven organizations that the HSA must consult as to the advisability or otherwise of locating a major hazard establishment in the location designated.

The principal legislation covering LNG establishments is the Control of Major Accident Hazards Regulations 1999 (COMAH). These regulations are enforced by the COMAH Competent Authority, comprising the Health and Safety Executive and the Environment Agency in England and Wales. An operator who plans to build a new LNG establishment has to submit information to the Competent Authority in advance of construction in the form of a pre-construction safety report (PCSR). Another similar report must be sent to the CA prior before dangerous substances are introduced into the plant - the pre-operations safety report (POSR). The operator has to ensure that the construction and operation of an establishment does not start until he has received from the competent authority the conclusions of its examination of the relevant report. Under COMAH, operators of LNG terminals are also required to produce an on-site emergency plan before the establishment starts to operate and must provide information to the local authority to assist them in their production of an off-site emergency plan. The plans' objectives are to contain and control incidents to minimize the effects and to limit damage to persons, the environment and property.

If the storage of LNG is offshore, there are no specific UK Government authorizations required to construct and operate LNG facilities, other than the offshore unloading license. Introduced under the Energy Act 2008²⁰, the offshore unloading license is intended to facilitate the future development of any offshore fixed or floating LNG receiving terminals. The Pollution Prevention and Control Act 1999 and Environmental Permitting (England and Wales) Regulations 2010 also apply to onshore operations.

The regulators and organizations in England and Wales (these may be different for operations in Scotland and Northern Ireland), from whom authorizations may need to be obtained or who may need to be consulted, include the Ministerial Department of Energy and Climate Change (DECC), the Health and Safety Executive (HSE), and their relevant departmental units, the Joint Nature Conservation Committee or coastal conservation bodies such as Natural England. Of key importance is also the Office of Gas and Electricity Markets (Ofgem), which is governed by the Gas and Electricity Markets Authority (GEMA), a non-ministerial government department and an independent National Regulatory Authority.

As regards safety measures, the Health and Safety Executive is responsible for ensuring safety during the design, construction and operation of LNG terminals.

Major energy projects (LNG facilities with storage capacity of 43 Mcm (million standard cubic meters) of gas are covered by the National Policy Statements for Energy (NPS) under the Planning Act (2008). This act was introduced to create a more efficient planning system for nationally significant infrastructure, including gas supply infrastructure (assessment at national level by the Infrastructure Planning

²⁰ <http://www.legislation.gov.uk/ukpga/2008/32/contents>

Commission). Development for small scale LNG will typically not be under scope and these types of projects are assessed locally for building permit purposes.

Table 8-10: Permitting process in UK

Subject / Question	UK
Currently LNG terminals operational?	Yes
Required Permits	Environmental permit Building permit Operating permit
Local legislation related to permits	Planning (Hazardous Substances) Regulations 1992 Planning Act (2008) Control of Major Accident Hazards Regulations 1999 (COMAH)
Authority responsible for permitting	Hazardous Substances Authority Local planning authority
Other authorities involved in process	Yes for consultation/advice
Time frame permitting	18 months
Difference permitting per state/ province	No
Involvement of public	Yes
Required studies	Environmental impact assessment COMAH safety study
External risk criteria	Yes
Safety report / Safety management plan required?	Yes
Thresholds	>15 tonnes: safety report


8.7 Conclusions

The design of the permit process and the related practices vary between the Member States. In some Member States permitting procedures are considerably more complex than in others. Past experience shows that the permit process for large scale LNG terminals in ports took an average of four years /27/. Most experience has been gained in permits for large-scale LNG import terminals. Today, Norway has by far the most experience with permit processes for small scale LNG facilities. Experience shows that in Norway it takes approximately 12 months to complete the permit process. Several factors are leading to slow and inefficient permit processes. Those 'bottlenecks' are discussed below.

In most EU member states, many authorities are involved in the LNG development decision process, leading to a long permit process. In addition project developers often do not know which authority to address to. There are several initiatives to speed up the overall permit process via 'one single permit' approaches (Belgium, The Netherlands) and via specific LNG guidance/practices (e.g. The Netherlands via PGS 33). All-in-one permits with one authority (one-stop-shop) having the full responsibility for the permit process or the coordination of the process should have a positive impact on the permit duration. In some countries specific laws/processes (e.g. Germany, Poland, UK) are in force to smoothen the permit process for selected critical/significant projects.

Although the permit processes are well enforced by law, the overall process is not fully transparent to all involved parties, this includes information on milestones/deadlines, authorities responsible, documents to be produced, Various Member States have no clear time targets for the different steps in the permitting procedure and/or no enforcement/consequences if the delays are not respected.

The Ministries and authorities are not familiar with LNG and its benefits and risks. This in combination with lack of LNG skilled people (specific knowledge on LNG and LNG installations) at authorities and clear standards might lead to an overkill of studies to be executed for LNG developments. Several countries (Netherlands and Germany) have created platforms to share best practices and information between all LNG stakeholders.



In addition to the permitting process from a legal perspective, project developers play a key role in the procedure for obtaining a permit, as they prepare the document and communicate with stakeholders. Project developer's primary focus is on technical and economically viability of a project rather than accounting for public acceptance (involvement of stakeholder early in the process) and environmental concerns in the overall planning process.

9 QRA APPROACH AND RISK ACCEPTANCE CRITERIA

The main purpose of this chapter is to illustrate risk assessment (e.g. QRA) practices and risk acceptance criteria to provide recommendations for harmonization and improvements for LNG bunkering risk assessment practices across EU ports in various countries.

In light of the EMSA study, identified gap number 9 is of particular relevance for this chapter (see highlighted text below). The current status of these gaps is given in Chapter 11.

EMSA Gap 9:

Despite various industry driven initiatives common guidelines for port rules on LNG bunkering procedures are not yet available.

*9.1 **A common risk assessment approach and risk acceptance criteria** for LNG bunker procedures are missing, which requires each port to develop its own standards with potential differences as a result;*

*9.2 Despite various applications of gas-fuelled cargo and passenger vessels **the definition of detailed safety requirements for simultaneous LNG bunkering and loading / unloading or passenger embarking / disembarking processes are missing;***

*9.3 **Indicators for determining common safety distances** and identification of LNG bunkering processes **are currently missing;***

9.4 Common safety accreditation criteria for LNG bunker companies are missing;

9.5 Additional measures for LNG bunker operations within emergency plans should be considered;


Different risk assessment approaches (e.g. quantitative risk assessment: QRA) and regulatory risk acceptance criteria for small scale LNG infrastructure (i.e. primarily those installations that fall under the Seveso directive) are adopted in the different EU countries. Various techniques, methodologies, guidelines and tools used for the general analysis of the risks of activities with hazardous substances were identified. These are commonly used to determine external safety distances between major hazard industrial facilities (or activities) and surrounding land-uses (e.g. vulnerable objects such as residential areas). This process is also commonly referred to as land-use planning (LUP).

Specific focus is on the different risk assessment approaches and criteria used in EU countries for LUP as per the national legislative implementation of the Seveso directive and to illustrate which (parts of) approaches and criteria have specific or general applicability.

Risk approaches and acceptance criteria related to the transport of dangerous goods on water, road or rail are not described. Reference is made to a previous study carried out by DNV GL for the European Commission DG-Move /34/, which provides an overview of applicable risk acceptance criteria in the EU (and suggestions for harmonization) for transport of dangerous goods in the EU.

Background information is provided on the various existing methodological approaches. In particular, the QRA approach is elaborated by describing its generic methodology, required tools and available guidelines for the risk analysis. With respect to guidelines, attention is given to industry best practices that supersede national or local regulations, e.g. global QRA best practices and methodologies used by major oil & gas companies or advisory companies.

Furthermore, many countries have established risk criteria for regulatory purposes. These are essential to assess the risk in a QRA (i.e. to determine whether the risks are acceptable or can be considered



tolerable). For this reason, the generic framework for risk criteria and the principles of (risk) threshold criteria are explained in more detail.

Next to the use of a QRA approach in LUP, various other potential applications of a QRA are discussed for the safe and secure operation of Small Scale LNG infrastructure or activities:

- Assessment of specific risks and mitigating measures for Simultaneous Operations
- Determination of safety zones
- Determination of internal safety distances (i.e. to prevent cascading effects).

Finally, based on the identified issues, concrete suggestions for harmonization of and improvements for risk assessment approaches (including methodologies, guidelines, tools and risk criteria) used for LNG small scale infrastructure and activities across European ports are provided.

The structure of this chapter is as follows:

- An overview of existing (categories of) methodological approaches used for LUP is provided in paragraph 9.1. The main principles and differences are explained. The QRA approach is only one of the approaches used for LUP;
- Paragraph 9.2 describes the generic methodology of a QRA approach, followed by an overview of leading consequence and QRA software tools required for a QRA (9.3) and QRA guidelines and best practices (9.3);
- A framework for risk criteria and principles of (risk) threshold criteria are detailed in paragraph 9.5;
- The application of LUP approaches in the different EU countries are described and compared in paragraph 9.6;
- Paragraph 9.7 elaborates on other potential applications of the QRA approach for assessment of safety in the operation of small scale LNG infrastructure or activities;

9.1 Methodological approaches


Existing methodological approaches for land-use planning in European countries have been summarized and described in literature. In general, the existing methodologies can be divided into the following four categories:

1. Consequence-based approaches

The consequence-based approach is based on the assessment of consequences of credible (or conceivable) accidents, without explicitly quantifying the likelihood of these accidents. The consequences of the accidents are mostly taken into consideration by calculating the distance in which the physical and/or human health impacts (e.g. heat radiation) reach, for a given exposure period and a threshold value (e.g. irreversible health effect/harm or fatality). The external safety zone is thus defined according to which LUP restriction is applied. The method has been generally used in Luxembourg and Austria.

2. Deterministic approach with implicit judgment of risk

A simplified form of the consequence-based approach is the use of “generic” separation distances. These distances are usually derived from selected scenarios and developed on a conservative basis. In their most simple form, they are derived from expert judgement, including consideration of historical data or



experience from operation similar plants. The approach of generic separation distances has been established and used in Germany.

3. Risk-based (or “probabilistic”) approaches (i.e. QRA)

The risk-based approaches define the risk as a combination of the consequences derived from a range of possible accidents, and the likelihood of the accidents. The results are represented as individual risk and/or societal risk. LUP criteria are based on specific acceptability criteria with respect to the calculated risk. In general, the approach is similar to the QRA methodology described in the next paragraph. This approach is followed in e.g. the United Kingdom, Belgium (Flanders) and the Netherlands.

4. Hybrid approaches

Hybrid approaches (or semi-quantitative) combining risk and consequence-based approaches have been developed and extensively used in France and Italy. Under these methods, one of the elements (usually frequency) is assessed more qualitatively, i.e. using classes rather than continuous figures. The use of a risk matrix is a typical example. For instance, France adopted a hybrid approach that combines a consequence-based approach for the determination of the zones that correspond to damage thresholds and a risk-based approach for the determination of the considered accident scenarios. Respectively, Italy has adopted a hybrid criterion that takes into account the frequencies, as mitigation factor for the damaged zones, identified using a consequence-oriented approach.

The above described approaches often require the use of risk tools as described in paragraph 9.3. Next to these tools, (risk) threshold criteria are needed to determine the extent of the external safety zone in LUP (see 9.5).

9.2 QRA methodology

A quantitative risk assessment is a well-known and widely accepted methodology to quantify safety risks. It is an approach to determine risk levels associated with accidental Loss of Containment events (e.g. spills, gas releases).

A QRA can give insight into the risks to human life or property of a certain activity by calculating the potential hazardous effects of a variety of scenarios as well as considering the probability of occurrence of these scenarios. The QRA methodology is visualized in Figure 9-1.

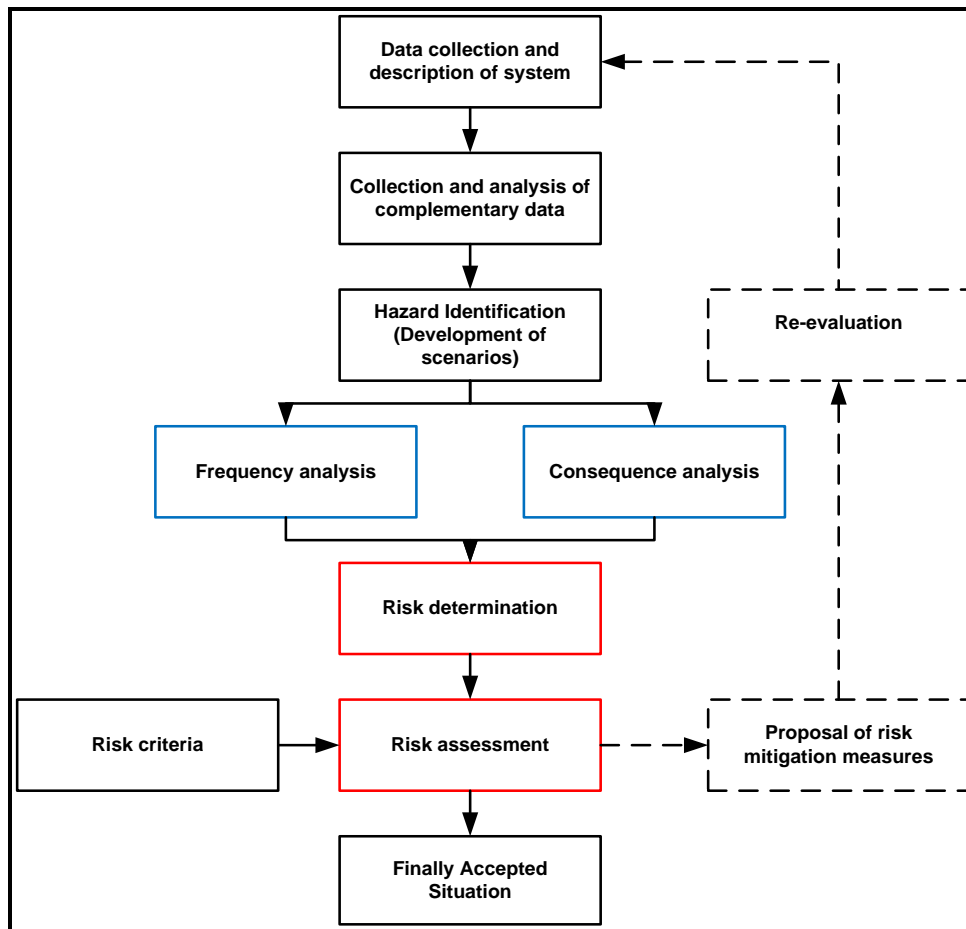


Figure 9-1: QRA methodology

Typical objectives of a QRA study are:

- Quantify the level of safety risks (to people or property) associated with the operation of a plant or activity with hazardous materials
- Demonstrate that the levels of risks are in compliance with risk acceptance criteria as agreed with authorities.
- Evaluate and select safeguards and risk reducing measures, if needed

In general, a QRA tries to answer five simple questions. Beside each question, the technical term is listed for that activity in the risk assessment process:

- | | |
|-----------------------|-----------------------|
| 1. What can go wrong? | Hazard Identification |
| 2. How bad? | Consequence Modelling |
| 3. How often? | Frequency Estimation |
| 4. So What? | Risk Assessment |
| 5. What do I do? | Risk Management |



These activities are explained in more detail underneath.

What can go wrong? - Hazard identification

The first part of the quantitative risk assessment is similar to the qualitative risk assessment, i.e. to establish the study basis and perform a Hazard Identification Session (HAZID) to identify and screen potential hazardous situations. Potential hazards to people or property can arise if a loss of containment occurs. A comprehensive identification of potential hazardous scenarios is critical. Typical accident and loss of containment scenarios based on historical incident data can be assessed on relevance and should be complemented with the outcomes of a site specific HAZID.

The current industry practice is to perform a HAZID for LNG activities, especially in case of special circumstances where the risks are not fully known, such as SIMOPS (see also 9.7.1) or in case of e.g. non-standard LNG bunkering scenarios. Some authorities also request a HAZID to be carried out as part of the permitting process, despite the fact that this is normally not specifically mandated in legislation.

Risk assessment guidelines may also prescribe accident scenarios for failure of various equipment types and piping based on historical incident data. These are, however, not LNG-specific. The ISO/DTS 16901 specifies types of accident scenarios to be considered for LNG import/export terminals. The specifics of the given accident scenarios (e.g. release size and associated base frequencies) are however not provided. There is a need for a complete and detailed definition of credible accident scenarios that can occur during the operation of Small Scale LNG installations and activities. It must be noted that there are currently developments²¹ in the Netherlands, with the purpose to fill this knowledge gap (reference is made to paragraph 9.4 for more information).

How bad? Consequence Modelling

In parallel with the frequency analysis, consequence modelling evaluates the resulting effects if the accidents occur, and their impact on people and property. Ignited flammable releases can result in various consequences such as jet-, pool-, or flash fire, fireball or vapour cloud explosions depending on the type of scenario and time and place of ignition. The consequence assessment shall be carried out using recognized consequence modelling tools that are capable of determining the resulting effects and their impact on personnel, equipment and structures. These tools are normally validated by experimental test data appropriate for the size and conditions of the hazard to be evaluated.


Reference is made to paragraph 9.3 for more information regarding leading consequence and risk assessment tools and their suitability to quantify consequences or risks of potential accidents occurring in LNG installations or during activities.

How often? Failure frequencies

After the hazards of a system or activity have been identified, the next step in performing the QRA is to estimate the frequency at which the hazardous events (or scenarios) may occur. The following are common techniques and tools available for frequency assessment:

- Analysis of historical incident data;
- Fault tree analysis;
- Event tree analysis;
- Simulations.

²¹ Projects and developments such as: Dutch Safety Program, LNG-specific risk calculation guidelines, research into failure frequencies for LNG equipment.



The selected technique will depend on the availability of historic data and statistics.

There are a few sources of data for failure frequency data for process equipment loss of containment: Netherlands and Belgium have issued two different onshore frequency datasets for use in Seveso Directive risk assessments, and some companies and consultants have their own data. It must also be stressed that nominated frequencies are tightly integrated with national risk criteria. For instance, the Dutch risk criteria appear up to 100x more strict than those stipulated by the UK HSE, but are matched with failure frequencies which are believed to be 80x lower. Hence, this would result in about the same assessment of risk. The Belgian nominated frequencies appear to be roughly a factor 10 lower compared to the HCRD dataset.

Unfortunately, there are currently no LNG specific failure frequencies due to the lack of available incident data. Risk analysts are forced to use release frequency data from generic sources. DNV GL recommends using data from the hydrocarbon from the Hydrocarbon Release Database (HCRD) from the UK HSE, which are based on historical data from oil platforms in the North Sea and are representative for equipment used in those installations. This is considered the most extensive dataset of its type and superior to current published datasets, which often have much smaller and older data which do not reflect current integrity management programs. The data forms the basis for onshore and offshore QRA's which, in the absence of LNG specific data, is also used in QRAs for LNG installations. There is currently no statistically sound basis for modifying the source failure data from the HCRD (or any other dataset for that matter) to account for onshore and cryogenic or LNG specific applications.

There is, however, a strong believe among owners and designers of LNG equipment that release frequencies from LNG-specific equipment and piping should have lower values than those from their equivalent in offshore platforms. Therefore, QRA results based on HCRD release frequencies are believed to be conservative for LNG applications. It is unknown to what extent this conservatism could potentially drive the calculated risk of LNG installations to high, thus requiring the implementation of (expensive) risk reduction measures or require large external safety distances.

So What? Risk Assessment


The next stage is to introduce criteria which are yardsticks to indicate whether the risks are "acceptable", "tolerable" or "negligible" or to make some other value-judgment about their significance. The most common criteria used in the industry for risk assessments when relating risk to people are individual and societal risk criteria (reference is made to paragraph 9.5.2 for more details). This step begins to introduce non-technical issues of risk acceptability and decision making, and the process is then known as risk assessment.

What do I do? Risk Management

In order to make the risks acceptable, risk reduction measures may be necessary. The benefits from these measures can be evaluated by recalculating the risk. Investigation of risk mitigation measures and their impact on the calculated risk can also be performed to demonstrate that the residual risk is As Low As Reasonably Practical (ALARP). For a risk to be ALARP it must be possible to demonstrate that the cost involved in reducing the risk further would be grossly disproportionate to the benefit gained (see also 9.5.1).

9.3 Consequence and risk analysis software tools

A comprehensive overview of leading software tools for undertaking consequence and risk (e.g. QRA) analysis is published in a paper by the American Society of Safety Engineers /35/. The key findings of this paper where that there is no single "best" consequence tool. What is important is the selection of



the appropriate tool for the specific situation being modelled, i.e. the tool should be proportionate to the magnitude of the hazard.

In addition, it is important that the software models are periodically maintained, verified and validated in order to establish that accurate results are generated. Model validation for LNG releases is of particular importance. For instance, an LNG release often results in a heavy gas dispersion despite the fact that methane is lighter than air. This mechanism is difficult to model and therefore the dispersion model should be properly validated to ensure that accurate results are predicted.

The HSE has also performed an extensive review of the state-of-the-art of various consequences models suitable for LNG hazard analyses /36/.

9.4 Risk assessment guidelines and best practices

Various guidelines and best practices to perform risk assessments (i.e. QRA) exist. The purpose of this paragraph is to outline and describe the main publications and to discuss LNG applicability in particular. It is not the intention to provide an exhaustive list.

Various guidelines and best practices are published by e.g. the following entities and are more detailed below:


- National authorities (e.g. UK HSE, National Institute for Public Health and the Environment, (RIVM, the Netherlands))
- Major oil and gas companies
- Advisory companies (e.g. DNV GL, Bureau Veritas)
- International guidelines (e.g. ISO)

National authorities

In countries that set requirement for a QRA, rather detailed information is needed for the design of the LNG small scale supply chain installations, the possible failure scenario's, the frequency of occurrence, the release consequences and how to model all these items. Not all countries are in that respect prescriptive (i.e. no specific guidelines are mandated). For instance, the Netherlands is the 'outer edge example' of prescribing complete guidelines (and software tools) to be used to execute QRA's. Belgium (Flanders) mandates only the use of specific failure frequencies, but not the use of specific software tools and accompanying model parameters. The UK HSE, on the other hand, provides only guidance on the evaluation of risk and risk tolerability (e.g. ALARP demonstrations), rather than the definition of failure cases, failure frequencies and how to model the latter. No specific onshore risk assessment guidelines are currently mandated (or published for that matter) by the UK HSE.

The most well-known and world-wide accepted guideline for the execution of quantitative risk assessment is the 'purple book'. Together with the other 'coloured books' (yellow, green and red) the guideline forms valuable reference material for safety studies²². The books are written by Dutch Government (RIVM) with support from the research institute TNO. The coloured books have become obsolete and are not kept up-to-date anymore since 2005. The successor is the Dutch Reference Manual Risk Assessments Bevi /37/, which is mandated in the Netherlands for the execution of QRA's (see also paragraph 9.6.5). Although these guidelines are not specifically written for LNG, they have generic applicability. However, the main limitation is that they do not specify LNG-specific failure frequencies.

²² The coloured books are freely available in electronic form and can be downloaded here: <https://www.tno.nl/en/focus-area/urbanisation/environment-sustainability/public-safety/the-coloured-books-yellow-green-purple-red/>, accessed on 05-01-2015



Therefore, the RIVM has recently initiated a project (start-up phase) into LNG-specific failure frequencies for LNG transfer systems and stationary (double walled) pressure vessels. This project is part of a larger two-yearly (national) LNG safety research program with the purpose to enhance and accelerate full development of LNG safety issues including the determination of external safety distances used in LUP²³.

Furthermore, separate guidelines have been developed by the RIVM for risk assessments of specific (LNG) installations. The most recent guideline (or risk calculation methodology) is the draft version: 'Risk methodology LNG delivery installations for road vehicles'²⁴. A similar guideline for LNG bunker stations is currently under development (final stage). These guidelines also contain case studies.

Other published or mandated risk assessment guidelines by national authorities of all EU countries are described in paragraph 9.6, if applicable.

Major oil and gas companies

Several major oil and gas companies have developed their own proprietary QRA guidelines. Most of them only contain risk criteria and are intended for internal use. The guidelines are strictly confidential, but risk criteria have been revealed in individual risk studies. The risk criteria are subject to change to a greater extent than the government criteria identified in paragraph 9.6. Only some companies also provide specific guidance on QRA related input data, such as failure frequencies, ignition data and failure cases.

Advisory companies

Some advisory companies have developed their own proprietary (LNG) QRA guidelines. These guidelines are bringing together most of the best industry practices and are used to conduct QRA's for projects worldwide, ensuring harmonization and global alignment.

International guidelines

An LNG-specific risk assessment guideline is recently published by the International Organization for Standardization. This is the ISO/DTS 16901 (OGP 116901) – Guidance on performing risk assessment in the design of onshore LNG installations including the Ship/Shore interface.

9.5 Risk criteria – framework and thresholds

9.5.1 Generic framework for risk criteria

A framework for risk criteria can be either two or three bands. The simplest framework for risk criteria is a single risk level which divides tolerable risks from intolerable ones (i.e. acceptable activities from unacceptable ones). This framework is based on two bands (implies a single risk criterion).

Another approach is to use two criteria; dividing risks into three bands:

- The upper band is where the risk are usually considered intolerable whatever benefits the activity may bring, and risk reduction measures are essential whatever their cost.
- The middle band is where risk reduction measures are desirable, but may not be implemented if their cost is high relative to the benefit gained (i.e. the ALARP principle should be demonstrated).

²³ The LNG Safety Program has started in the beginning of 2014 and is carried out as a joint cooperation between public and private stakeholders. The two-year (2014-2015) program has been initiated by the National (Dutch) LNG Platform after numerous requests from market parties and Dutch emergency response organisations to enhance and accelerate full development of LNG safety issues.

²⁴ Draft version can be downloaded here: http://www.rivm.nl/dsresource?objectid=rivmp:262836&type=org&disposition=inline&ns_nc=1 , accessed on 23-12-2014

- The lower band where risks are negligible, or so small that no risk reduction measures are needed.

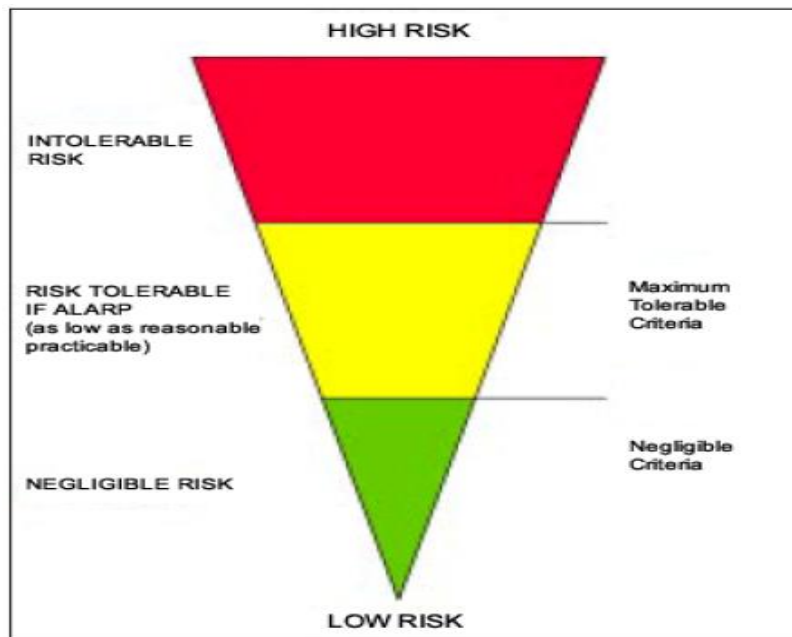


Figure 9-2: Framework for three band risk criteria

For example, risk criteria in the Netherlands and Belgium (Flanders) are based on a two band framework whereas France and the UK use a three band framework.

9.5.2 Threshold criteria

Threshold criteria are used to assess risks on acceptability and are needed to establish external safety distances in the land-use planning process. Threshold criteria can be used as either non-legal binding values (i.e. target values) or hard (statutory) limits. The type of criteria applied will depend on the type of methodological approach prescribed in an EU-member state. In general, the following type of criteria can be distinguished:

- Consequence-based criteria (effect distances)
- Risk-based criteria (often expressed in individual risk and/or societal risk)

Consequence-based

Effect distances to certain threshold values for damage are determined, in the event that the methodology requires the calculation of effect-based distances (i.e. for the consequence-based and hybrid approaches). Typically, the 'damage' effect in LUP is considered as lethality and major or moderate injuries. Threshold values are established for various hazardous effects, e.g.:

- Toxic vapours: LC1% (concentration for 1% lethality), IDLH values (Immediately Dangerous to Life or Health) or an equivalent dose for shorter exposure durations;
- Fires: heat radiation exposure for a given duration resulting in either major (3rd degree burns) or serious health effects (e.g. 1st degree burns);
- Overpressure: corresponding to collapsed ear drum as a result from an explosion.

Risk-based

Risk-based criteria as usually expressed in individual and/or societal risk. The difference between the two expressions of risk is that location specific individual risk is used to show the geographical distribution of risk, while societal risk assesses to what level areas with high population density are exposed to risk. For land-use planning purposes, the Location Specific Individual Risk (LSIR) is often used to determine the external safety distances to vulnerable objects and in some countries it should also be demonstrated that the societal risk meets the legal (guiding) criteria.

It must be stressed that it has become increasingly clear that risk-based criteria cannot be considered stand alone. They are tightly integrated with nominated frequencies (reference is made to paragraph 9.2).

Individual risk (IR)

LSIR is the risk of death for an individual who is present at a particular location, continuously all year (i.e., 24 hours a day, 7 days per week) without wearing personal protective equipment. Individual risk is the frequency at which an individual may be expected to sustain a given level of harm from the realization of specific hazards. Individual risk is often interpreted as an incident every X number of years and is often referred to as the risk of death.

Examples of how to interpret individual risk is as follows:

- 1×10^{-3} per year is equivalent to one incident every 1,000 years
- 1×10^{-4} per year is equivalent to one incident every 10,000 years
- 1×10^{-6} per year or one incident every 1,000,000 years

These numbers do not imply that no event will occur for the specified time period. These risk levels are statistical representations of risk. They predict that an incident might occur within this average timeframe. The incident could happen tomorrow or sometime during the next 1,000 years.

Individual Risk is presented as isopleths similar to elevation contours on a map. The inner contour is the highest risk (often 10^{-3} or 10^{-4} per annum), and normally contours are plotted in declining order of magnitude circles. Figure 9-3 provides an example of a visualization of IR contours.

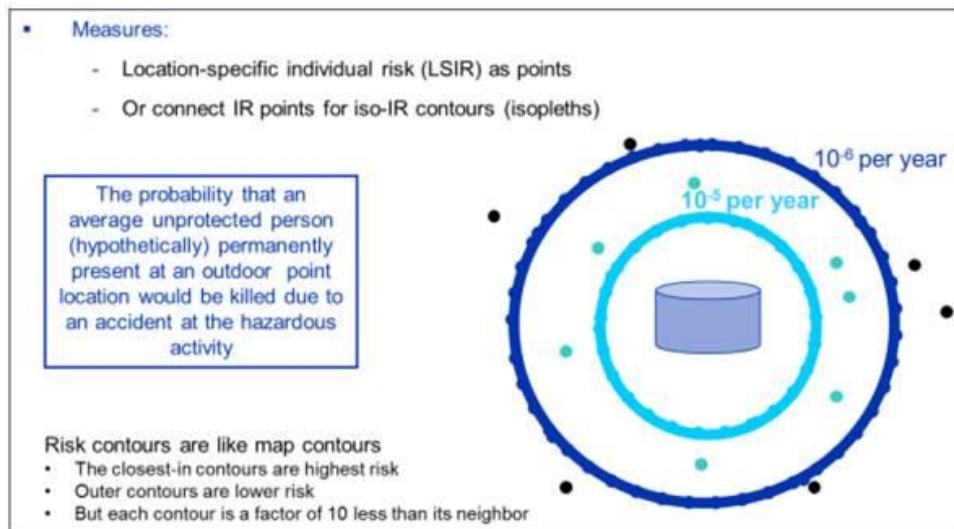


Figure 9-3: Individual risk presentation

Societal risk (SR)

Societal risk is defined as the (cumulative) frequency per year that a particular group of people dies concurrently as a result of accidents. Societal risk criteria have not been as widely used as individual risk criteria because the concepts and calculations involved are much more difficult. Societal risk is represented in an FN curve, which is a Log-log graph: the X-axis represents the number of deaths and the y-axis the cumulative frequency of the accidents, with the number of deaths equal to N or more.

An example of an FN curve including one criterion is given in Figure 9-4.

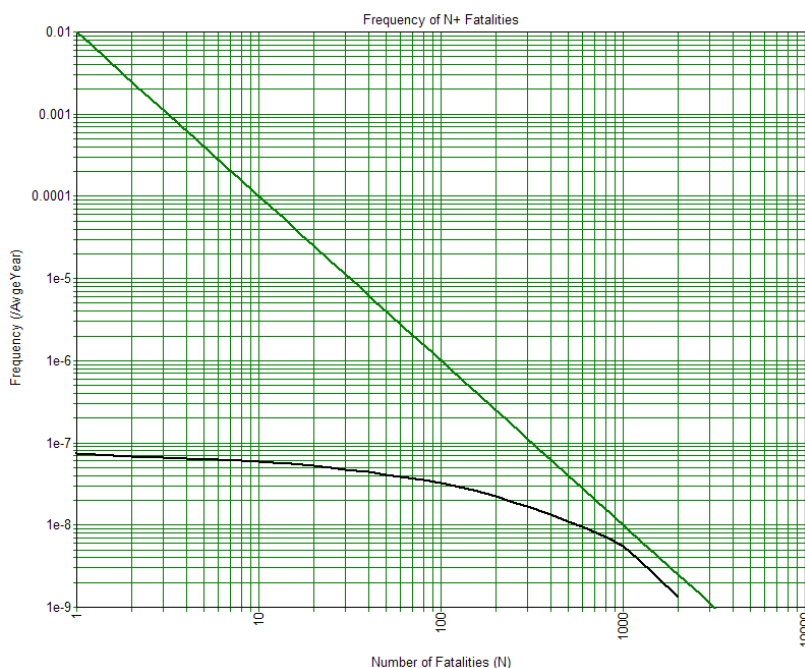


Figure 9-4: Example of an FN curve to express societal risk (black line is the societal risk, green line the intersection between the lower and upper band above which the risks could be considered intolerable).

Note: in the Netherlands the green line is used as a target value, it may be exceeded under certain conditions (see also the following paragraph).

9.6 Application of LUP approaches in EU countries

This paragraph identifies and discussed the use of (prescribed) risk tools, methodologies, guidelines and criteria in the EU countries in Europe, specifically focussing on the implementation of the Seveso directive and the application for land-use planning (external safety distances).

It is noted that not all EU countries are included in the analysis. A selection of (relevant) EU countries is made taking into account the following considerations:

- Not all EU countries have a fully developed risk assessment framework for LUP and are therefore not discussed as such. Focus is on the countries that have a mature LUP framework/methodological approach with generic applicability;
- Selection is based on those countries that show a diversity in adopted methodological approach (e.g. risk-based/deterministic/hybrid, see also 9.1) and as a whole can be seen representative for the other EU countries not discussed (i.e. although different criteria might be implemented, the methodological approach would be the same);

- Specific focus is on those countries that already have an LNG infrastructure or where LNG installations or activities are expected to be developed respectively take place in the nearby future.

Based on the above considerations, the following EU countries are selected to work out in detail:

- Belgium (Flanders);
- France;
- Germany;
- The Netherlands;
- Sweden
- United Kingdom;

9.6.1 Background

Major hazard industrial facilities or activities may pose a serious threat to human health and the environment, due to the possibility of accidents with severe consequences. Land-use planning aims to prevent and limit the consequences of possible major accidents and deals with the potential conflicts between sources of risk and surrounding land-uses /38/.

The European legislation for control of major accident hazards, the Seveso II directive (see also Chapter 8), includes provisions for land-use planning. In particular, article 12 of the directive requires member states to ensure that technical advice on the nature and magnitude of risks is available and is taking into consideration in land-use planning. This is to establish and maintain appropriate separation distances between sensitive areas and installations where dangerous substances are present in quantities above certain thresholds.

9.6.2 Belgium (Flanders)

The Government of the Flemish Region of Belgium has established quantitative risk acceptance criteria (for both individual and societal risk) for its implementation of the Seveso Directive. The criteria are applicable for both new and existing major hazard (Seveso) establishments. For high-tier (column 3) Seveso establishments a QRA is required to calculate and assess the risk. The low-tier (column-2) establishments are not obligated to perform a QRA, but Flemish local authorities may require a QRA as a basis for an environmental permit. If existing establishments fail to comply with the criteria, additional safety measures will be required. It might also be the case that the environmental permit is not issued or that the government prohibits the operation of (some parts of) the establishment.

The individual and societal risk criteria and their evaluation principles with respect to land use are well-described in the code risk criteria /39/. A summary is provided below. It is important to note that risk criteria in Belgium (Flanders) are not regarded as binding legal limits.

Individual risk

The following restrictions for various levels of the (location specific) individual risk (IR) per average year are applicable:

- $IR \geq 10^{-5}$ → An individual risk level of 10^{-5} should not exceed the plant boundary of an establishment. In case the individual risk is equal to or higher than 10^{-5} and exceeds the plant boundary of the establishment, a safety information plan is required to exchange information about risks with other establishments in the area. Hence, 10^{-5} is the risk criterion for the plant boundary.
- $IR \geq 10^{-6}$ → Residential areas (more than five residences) are *not* allowed. Isolated residences (including farms) are *not* regarded as residential areas. Hence, 10^{-6} is the risk criterion for residential areas.
- $IR \geq 10^{-7}$ → Vulnerable areas (defined as schools, hospitals, nursing homes, care centres) are *not* allowed. It is noted that the vulnerable area is defined as the vulnerable object (e.g. school, hospital) including the associated land around the object. Hence, 10^{-7} is the risk criterion for vulnerable areas.
- $IR < 10^{-7}$ → Risks below 10^{-7} are in effect treated as broadly tolerable and all types of land use are permitted /3/.

Societal risk

The maximum acceptable societal risk is expressed on an FN diagram as $F < 0.01/N^2$ for $10 \leq N \leq 1000$ fatalities. No societal risk criteria apply for $N < 10$ fatalities. No accidents are permitted with $N > 1000$ fatalities. People working at the establishment itself and external contractors are excluded from the societal risk calculations. The societal risk criterion is visualized in an FN curve displayed in Figure 9-5.

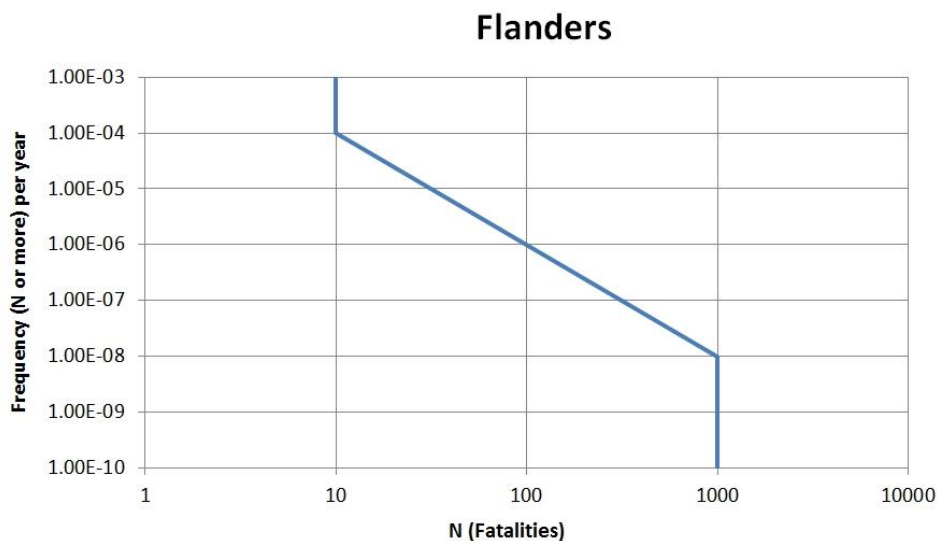


Figure 9-5: Criteria for societal risk in Belgium (Flanders).

Risk assessment tools and methodologies

Guidelines with respect to calculating the external risk is adopted in the guideline book for safety reports (*Richtlijnenboek voor veiligheidsrapportages*). No specific risk assessment (QRA) software tools (such as SAFETI-NL, which is mandatory to use in the Netherlands) are prescribed in Flanders for the calculation of risk. There are, however, other specific technical guidelines that are mandatory to use in the calculation of risk²⁵. These documents provide guidance in the methods, methodologies, models, failure

²⁵ For an overview of all technical guidelines, <http://www.lne.be/themas/veiligheidsrapportage/rlbvr/tr>, accessed on 23-12-2014

frequencies and assumptions for the calculation and analysis of external risk (for people and the environment). Specific technical guidance for a QRA is provided in the Handbook Failure Frequencies (*Handboek faalfrequenties, 2009*).

Guidelines specifically intended to conduct a risk assessment of a LNG installation or activity, have not been published nor are being currently developed.

9.6.3 France

France has adopted a semi-quantitative (hybrid) approach to manage the risks from hazardous installations. The risk from each hazard is described by its probability of occurrence and its consequences, expressed in function of the number of people exposed to lethal or irreversible effects.

The probability is assessed by class of probability according to a national scale of five categories of probability from A (> 10⁻²/year) tot E (<10⁻⁵/year). Within the probability assessment performances of risk control measures to reduce the probability of events occurring are taken into account.

The consequences of the events are determined based on the intensity and the gravity of the effects. The intensity is determined by calculating effect distances for Toxic, Thermal and Overpressure effects (Table 8-1). The gravity of the effects are established using intensities bay assessing the number of potential victims in the accident's effect envelopes. The gravity is categorized depending on the number of victims for each type of effect assessed.

The risk acceptance criteria are expressed in a matrix (Figure 9-6) where each combination of probability and consequence is characterized as acceptable or not:

- OK : acceptable area for which authorisation can be given;
- No: unacceptable area for which the risk is deemed too high: the installation cannot be authorized in its current state;
- ALARA: authorisation is given after verification that all risk control measures at an acceptable cost have been put in place.

Table 9-1: Intensity levels in France

Effects	Level of effects on human		
	Significant lethal effect threshold	Lethal effect threshold	Irreversible effect threshold
Toxic	Lethal concentration 5%	Lethal concentration 1%	Irreversible effect
Thermal	8kW/m ² or 1800 (kW/m ²) ^{4/3} .s	5kW/m ² or 1000 (kW/m ²) ^{4/3} .s	3kW/m ² or 600 (kW/m ²) ^{4/3} .s
Overpressure	200mbar	140mbar	50mbar (indirect: 20mbar)

Table 9-2: Gravity levels in France

Seriousness	Significant lethal effect threshold	Lethal effect threshold	Irreversible effect threshold
Disastrous	>10	>100	>1000
Catastrophic	1 to 10	10 to 100	100 to 1000
Major	<1	1 to 10	10 to 100
Serious	0	<1	1 to 10
Moderate	0	0	<1

<i>Seriousness</i>	<i>Moderate</i>	<i>Serious</i>	<i>Major</i>	<i>Very major</i>	<i>Disastrous</i>
<i>Frequency class</i>					
A	ALARA	No	No	No	No
B	OK	ALARA	No	No	No
C	OK	ALARA	ALARA	No	No
D	OK	OK	ALARA	ALARA	No
E	OK	OK	ALARA	ALARA	No

Figure 9-6: Risk matrix criteria France

Furthermore a risk management plan is prepared for LUP based on the probability and effect contour maps based on the intensity of the events. These maps combine the frequencies of the maximum consequence events to present the risk zones:

- TF/TF+ : new constructions are not allowed and potential compulsory expropriation of the land;
- F/F+ : new construction are not allowed though existing buildings/activities are tolerated (but land cannot be reused once vacated);
- M/M+ : new constructions are allowed but subject to special conditions;
- Fai : new constructions are allowed but subject to (minor) limitations.

<i>Maximum consequence</i>	<i>Very serious</i>	<i>Serious</i>	<i>Significant</i>	<i>Indirect</i>
<i>Frequency</i>				
>D	TF+	F+	M+	Fai
Between 5E and D	TF	F	M	Fai
<5E	F+	M+	Fai	Fai

Figure 9-7: Risk matrix for land use planning France

In March 2012, a joint working group between the DGPR and the French Gas Association (AFG) was established, with the participation of the Short Sea Promotion Centre (BP2S). The DGITM, the National Competence Centre for Industrial Safety and Environmental Protection (INERIS) and Bureau Veritas (BV) also joined the working group at a later stage. The working group focused on LNG bunkering installations from the perspective of the 'Seveso II' legislation and legislation on 'Installations Classified for Environmental Protection' (ICPE)^[1]. Based on a review of existing legislation and stocktaking exercise of relevant pilot projects in France, the group comprehensively addressed all questions linked to LNG bunkering (especially truck-to-ship) in ports.

French Gas Association AFG prepared safety guidelines for such installations, looking at all potential risks linked to LNG bunkering operations, including BLEVE (Boiling Liquid Expanding Vapor Explosion) phenomenon. While several EU Member States have ruled out this potential risk due to its very low probability, it has been considered in France due to the strict application of the precautionary principle. The AFG emphasised that the consideration of the BLEVE risk is a point of differentiation between the French methodology and those used by its neighbours.

9.6.4 Germany

The German 'Störfallkommission' prepared guidelines in 2005 for implementing article 12 of the Seveso II Directive on land use planning and ensuring the necessary distances between major hazard establishments and vulnerable objects /40/. The requirements of Seveso were transposed in the German law primarily through Article 50 of the Federal Immission Control Act (BImSchG) and by amending Article 9 of the Federal building code (Baugesetzbuch, BauBG).

Consequence-based thresholds (effect distances) for external safety distances (or separation distances)

Germany has adopted a simplified version of a consequence-based approach (the deterministic approach with implicit judgment of risk, see 9.1) to determine generic external separation distances. Distinction in the approach depends on two situations:

1. No detailed information about the establishment is available ('greenfield sites') → generic distance requirements are recommended based on the declared substances stored or used by the establishment. These requirements are divided into four classes, with distances of: 200, 500, 900 and 1500m. The latter distances are based on a consequence calculation of a release scenario with the following parameters:
 - Leakage of the dangerous substance from a 490mm² hole (corresponds to a rupture of a pipe with a nominal diameter of 25mm)
 - Flammable substances ignite immediately
 - Atmospheric parameters and the dispersion model are based on the VDI²⁶ guideline 3783
 - Effect distances are calculated for the following end-point (threshold) values and the maximum value is taken:
 - 1.6kW/m² for thermal radiation
 - 0.1 bar for overpressure
 - For toxic substances the EPRG-2 value²⁷ is calculated

^[1] ICPEs represent potential risks for the environment and are therefore subject to specific regulations in France.

²⁶ See <http://www.vdi.eu/guidelines/>

2. Detailed information is available: consequence calculations can be performed for specific release scenarios. Freedom is permitted in selecting the scenario (e.g. a specific hole size can be selected). Where dangerous substances are stored in tanks or cylinders, leakage from a single unit (tank or cylinder) is assumed. Mitigating measures can also be taken into account in the consequence assessment. Fire, explosion and toxic effects are assessed separately, with the same end-point values as specified above. The maximum calculated effect distance is taken as the external safety distance.

Table 9-3: Recommended external safety distances* to be used in Germany when no detailed information is available **

Class I, required distance: 200m	Class II, required distance: 500m	Class III, required distance: 900m	Class IV, required distance: 1500m
Ethylene oxide	Oleum 65% (Sulphur trioxide)	Sulphur dioxide	Phosgene
Acrylnitrile	Bromine	Hydrogen sulphide	Acrolein
Hydrogen chloride	Ammonia	Formaldehyde (>90%)	Chlorine
Methanol	Hydrogen fluoride	Hydrogen cyanide	
Propane (F-gas)	Fluorine	HCN	
Benzene			

*Note: LNG (or methane) is currently not yet categorized

** Adopted from: Acceptance criteria in Denmark and the EU, Nijs Jan Duijm (DTU Management Engineering, consultant and writer) and the Danish Emergency Management Agency, the Agency for Spatial and Environmental Planning and the Environmental Protection Agency, 2008

Application of the separation distances

The separation distances are intended to prevent, as far as possible, major accident in an establishment of having an effect on neighbouring sensitive areas. The separation distances are to be understood as consultation distances (i.e. not as a hard criterion). The separation distances apply for the following land use planning scenarios:

- Identification of new building zones for establishments
- Identification of site for extensions to existing establishments
- Sensitive land use (i.e. vulnerable objects) moving closer to existing establishments

The separation distances only apply to human risk receptors and not to other risk receptors under article 50 of the Federal Immission Control Act. Furthermore, the distances do not apply to: permitting individual projects inside the establishment, existing developments and external emergency planning.

The recommended separation distances can be exceeded under certain conditions. In that case it can be assumed that prevention at the planning level has been sufficient in order to limit as much as possible the effects of major accidents, and that the planning-related protection objective stipulated in Article 50 of the Federal Immission Control Act is met.

The zones resulting from the separation distances should not be understood as areas free of buildings. Within these zones less sensitive areas/usages than those described in article 50 (first sentence) of the

²⁷ EPRG: Emergency Response Planning Guidelines. Three concentrations are specified for each substance (EPRG 1 to EPRG 3). The EPRG 2 value for a substance is the airborne concentration that almost every person can be exposed to for one hour without experiencing permanent injury or effects that would prevent their escape.

Federal Immission Control Act may be planned. Specific guidance is developed (KAS-18, see below), which contains advice on which usages and/or objects are to be considered sensitive (i.e. vulnerable) within the meaning of article 50.

Consequence assessment tools, guidelines and methodologies

The guidance document KAS-18 /41/ offers guidance, assessment methods and recommendations with respect to the consequence-based separation distances. Key principles of this guideline are stipulated in this paragraph.

Guidelines specifically intended to conduct a consequence calculation for an LNG installation or activity, have not been published nor are being currently developed.

9.6.5 Netherlands

The Netherlands uses a risk-based approach (QRA) for the assessment of external risk similar to that of Belgium (Flanders). The prescribed risk methodology, tools and criteria are however different.

Criteria for individual and societal risk for fixed installations (so-called Bevi establishments) are implemented in the Decree External Safety Establishments (*Bevi, Besluit Externe Veiligheid Inrichtingen, 2009*). This decree applies to all establishments falling under the Decree concerning Major Accident Hazards (BRZO, *Besluit Risico's zware ongevallen, 1999*), which is the Dutch implementation of Seveso.

Individual risk

The maximum acceptable (location specific) individual risk is 10^{-6} per year. This is a statutory limit for "vulnerable objects" (e.g. housing, hospitals, schools etc.), and a target value for "objects with limited vulnerability" (e.g. offices (<1.500m² floor surface) and recreational facilities). As a first principle, the 10^{-6} /year contour should not overlap objects with limited vulnerability. When this is the case, the goal should be to lower the risk. A higher risk could be accepted with proper motivation and under certain conditions. An overview of all (limited) vulnerable objects as defined in Bevi is given in Table 9-4.

It must be noted that objects (such as office buildings) that are part of (other) Seveso II establishments are not taken into account in the risk evaluation to the legal individual risk criteria (Reference is made to 'Besluit externe veiligheid inrichtingen' article 1, section 2).

Table 9-4: Overview of vulnerable objects and object with limited vulnerability

Vulnerable objects (not allowed to be exposed to an individual risk level equal or higher than 10^{-6} /year)	Objects with limited vulnerability (less vulnerable objects). Individual Risk of 10^{-6} /year applies as target value.
Housing; Hospitals, elderly care centers and nursing centers; Schools and day care for minors; Office buildings and hotels with a gross floor area more than 1500 m ² ; Shopping malls (with more than five shops and a gross floor area of more than 1000 m ²) and shops with a total floor area of more than 2000 m ² ;	Isolated housing (maximum of 2 houses per hectare); Other* office buildings (<1500 m ²); Other* hotels and restaurants; Other* shops; Sporting places, sporting terrains, swimming pools and play grounds;

Vulnerable objects (not allowed to be exposed to an individual risk level equal or higher than 10^{-6} /year)	Objects with limited vulnerability (less vulnerable objects). Individual Risk of 10^{-6} /year applies as target value.
Camping- and other recreational terrains intended for the stay of more than 50 persons during multiple consecutive days.	Other* Camping- and other recreational terrains; Company/plant buildings; Equivalent objects; Objects with high infrastructural value

*Other means: other than defined in the first column as vulnerable object

Societal risk

The societal risk evaluation in the Netherlands is not based on a 'hard' limit value for acceptability for risk. Instead, there is a so-called 'justification' obligation. This implies primarily that the societal risk has to be compared against a target value. This means that the same principle as for individual risk for objects with limited vulnerability is valid: a higher risk could be accepted with proper motivation and under certain conditions. The target value is expressed for fixed installation on an FN curve as 10^{-5} per year for 10 fatalities, with $F=10^{-3}/N^2$ for higher fatalities (see Figure 9-8). It does not apply for fewer than 10 fatalities. The societal risk 'cut-off' criterion is 10^{-9} /year, below this value the societal risk is considered negligible for any number of fatalities.

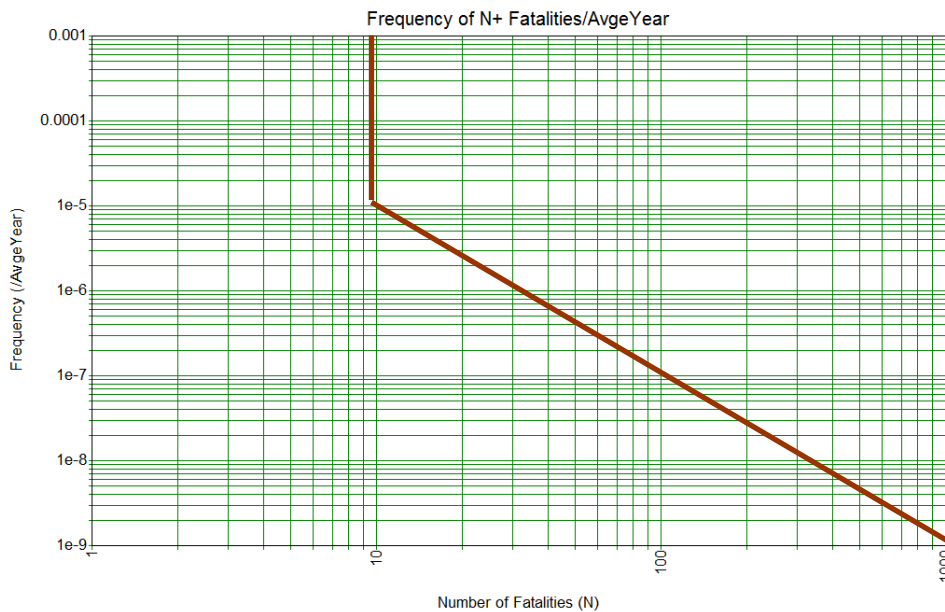


Figure 9-8: Criteria for societal risk in the Netherlands

Risk assessment tools, methodologies and guidelines

According to Dutch law (Bevi), a QRA has to be performed in accordance with the Dutch Reference Manual Risk Assessments Bevi /42/. Its predecessor is the Purple Book /43/, which is a world-wide accepted manual for the execution of QRA's. In addition, a QRA for Bevi establishments (fixed installations) must be modelled in the risk software tool SAFETI-NL (developed by DNV GL and support is provided by National Institute for Public Health and the Environment, RIVM). Fixed model parameters are incorporated in SAFETI-NL, which cannot be modified. This measure, in combination with the

prescribed reference manual for risk assessments, improves the consistency between QRA's conducted for Bevi establishments in the Netherlands.

A separate handbook is published by the Ministry of Infrastructure and Environment for the justification (and calculation) of the societal risk (*Handreiking verantwoordingsplicht groepsrisico, 2007*).

Separate guidelines have been developed by the RIVM for risk assessments of specific (LNG) installations. The most recent guideline (or risk calculation methodology) is the draft version: 'Risk methodology LNG delivery installations for road vehicles'²⁸. A similar guideline for LNG bunker stations is currently under development (final stage). These guidelines also contain case studies.

9.6.6 Sweden

A risk assessment and use of quantitative methods is an important part to the permitting documentation to the authorities in Sweden. Although a specific methodological approach for LUP is not embedded in legislation, authorities tend to ask for a QRA sometimes even accompanied by a semi-qualitative hazard identification study (HAZID).

Sweden has not developed legislative risk criteria for individual or societal risk.

The MSB has published a guideline for risk analysis (*Guide to risk and vulnerability analyses*) and the MSB is often involved in permitting processes or consulted by regional authorities. Also the IPS (the Swedish Association for Process Safety) guidelines²⁹ (also describing risk criteria) are sometimes used as guiding documents in permit applications. Those documents have no legal basis and should be considered as guidelines.

Guidelines specifically intended to conduct a risk assessment of a LNG installation or activity, have not been published nor are being currently developed.

9.6.7 United Kingdom

In the United Kingdom a risk based approach is applicable for companies to demonstrate that the risks are as low as reasonably practicable (ALARP). The type of risk based assessment (Qualitative, Semi-Quantitative or QRA) is determined by the general level of risk of the site.

In the UK the Health and Safety Executive (HSE) has published tolerability limits /44/ for use with the tolerability of risk framework (figure 8-11). The tolerability limits were originally created for Nuclear power stations but are now applicable to any industrial activity.

- Maximum tolerable risk for workers : 10^{-3} per year
- Maximum tolerable risk for the public : 10^{-4} per year
- Broadly acceptable risk : 10^{-6} per year

²⁸ Draft version can be downloaded here: http://www.rivm.nl/dsresource?objectid=rivmp:262836&type=org&disposition=inline&ns_nc=1 , accessed on 23-12-2014

²⁹ E.g.:

"Downsizing" - tools for risk analysis, Cutting down within the Industry - a Process Safety Risk? A guideline with tools for risk analysis Anders Jacobsson 2006.

"Downsizing" - en processsäkerhetsrisk, En handledning för riskanalys av större organisatoriska förändringar eller nedskärningar. Anders Jacobsson, 2011

Handledning om riskkriterier, Liane Haeffler, Ivan Mares, Scandpower 2012

Handledning för genomförande av riskanalyser inom processindustrin, Göran Davidsson, Magnus Karlsson, COWI 2012

More information: <http://www.ips.se/index.php?pageId=13>, accessed on 06-01-2015

Their applicability to Transport of dangerous goods was confirmed in a study by the Advisory Committee on Dangerous Substances (ACDS) /45/. These are considered to be guidelines, not rigid criteria to be complied with in all cases and may be adapted to take account of societal concerns. The criterion for workers refers to “any substantial category of workers for any large part of a working life”, and hence might be exceeded by “fairly exceptional groups”. The criterion for workers is based on the risk experienced by the highest risk groups of workers.

In the ALARP region between the maximum tolerable and negligible RAC, risks are kept as low as reasonably practicable (ALARP). Legal precedent established that, in order to make risks ALARP, risk reduction measures should be adopted unless their cost is “grossly disproportionate” to the benefit gained. HSE has not specified how this should be done, but indicated that it uses the valuation of statistical fatalities from road transport as a benchmark but regards “higher values as being appropriate for risks for which people appear to have a high aversion”.

HSE suggested a societal risk criterion for major industrial installations, such as an existing chemical plant near to a housing estate, as a maximum tolerable frequency of once in 5000 year for accidents causing 50 fatalities or more. This RAC does not appear to be used in practice, and subsequent efforts or develop societal risk criteria have not reached agreement. ACDS developed societal risk criteria for communities affected by TDG, e.g. people living near a port:

- Maximum tolerable risk: $F=0.1/N$
- Negligible risk: $F=10^{-4}/N$

With N the number of potential casualties and F the cumulative frequency of events with N potential casualties or more.

Risk assessment guidelines

Guidelines with respect to the methodology of calculating the risk are not prescribed although if a QRA approach is selected a specific database is recommended for the QRA (HCRD).

Guidelines specifically intended to conduct a risk assessment of a LNG installation or activity, have not been published nor are being currently developed.

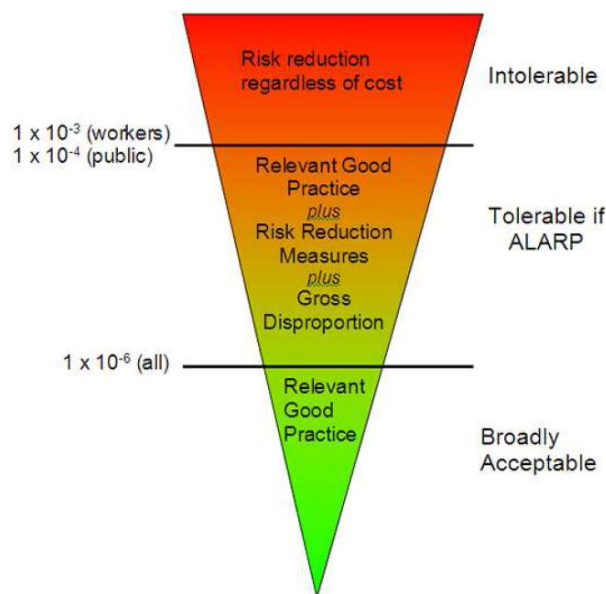


Figure 9-9: Criteria for individual risk in the UK

9.6.8 Summary and identified gaps for harmonization

An overview and comparison of risk assessment methodologies and criteria used in EU countries relating to land use planning for Seveso establishments (as per national legislation) is provided in Table 9-5.

Table 9-5: Overview and comparison of risk assessment methodologies and criteria used in EU countries relating to land use planning for Seveso establishments

Country	Methodology	IR	SR	Criteria
The Netherlands	Risk-based	Yes	Yes	IR: 10^{-6} (limit value for vulnerable objects, target value for objects with limited vulnerability). SR: FN curve start at 10^{-5} for 10 fatalities, with $F=10^{-3}/N^2$ for $N>10$. Societal risk criteria do not apply for $N<10$ fatalities.
Belgium (Flanders)	Risk-based	Yes	Yes	IR: 10^{-5} (plant boundary), 10^{-6} (residential areas), 10^{-7} (vulnerable areas). SR: FN diagram as $F<0.01/N^2$ for $10\leq N\leq 1000$ fatalities. No societal risk criteria apply for $N<10$ fatalities. No accidents are permitted with $N>1000$
France	Hybrid	No	No	Risk matrix
Germany	Deterministic*	No	No	Generic distances: 200, 500, 900 or 1500m based on dangerous good. Specific distances: based on maximum effect distances of a particular release scenario for fire ($1.6\text{kW}/\text{m}^2$), explosion (0.1 bar) or toxic effect (ERPG-2 value)
United Kingdom	Risk-based	Yes	Yes	IR: $10^{-3}/10^{-4}$ max tolerable limit for workers/public; 10^{-6} acceptability limit; SR: $10^{-1}/N$ tolerable limit; $10^{-4}/N$ acceptability limit
Sweden	None	No	No	No specific methodologies and criteria are mandated in legislation. Although previous LNG projects have shown that a QRA and HAZID is requested

* Simplified version of the consequence-based approach: deterministic approach with implicit judgment of risk, see also paragraph 9.1

As can be concluded from Table 9-5, several EU countries have different methodological approaches and criteria to determine and assess external safety (distances) in LUP. The EU countries that don't mandate a specific approach in national legislation can always refer to existing approaches from other countries or any other best practice that would ultimately meet the requirements in the Seveso directive. For each country that does have an approach, accompanying threshold (risk or consequence) criteria are developed. Some countries have developed guidelines and prescribe specific tools to ensure a nationwide harmonized approach. The approaches, tools, guidelines, and (risk) criteria have generic applicability and can in principle be used for the storage, handling of any dangerous good in Seveso establishments including LNG. There is no single best approach, guideline or tool as each has its own merits.

Nonetheless, for the purpose of EU-wide harmonization, it would be preferable to have one common LUP-approach including one set of risk assessment guidelines, tools and criteria for all EU countries. Therefore, the implementation of different methodological approaches and criteria in the various EU countries can be considered as a gap.

Although Seveso is a European directive, the problem of harmonization in LUP-approaches and criteria for Seveso establishments is not easily solved due to the fact that several European countries have incorporated in their legislation their own interpretation and implementation of the directive. The consequence is that different European countries may predispose different external safety distances for the same installation. This could potentially affect the development of an LNG infrastructure in certain countries, as the land-use planning safety requirements may be stricter compared to other countries. It

must be noted that the problem of harmonization is applicable for all dangerous goods, not specifically for LNG. With respect to harmonization of risk criteria, reference is made to a previous study carried out by DNV GL for the European Commission DG-Move /46/, which provides an overview of applicable risk acceptance criteria in the EU (and possible harmonization thereof) for transport of dangerous goods in the EU.

For non-Seveso (LNG) establishments and activities, i.e. storage of small quantities, transport and temporary storage of LNG including loading, unloading and bunkering (if it does not take place within a Seveso establishment), harmonization could be more attainable. Although these would not require a major accident prevention policy similar to those prescribed for Seveso establishments, a risk assessment (including criteria) according to an EU harmonized approach could be mandated. Alternatively, fixed (minimum) external safety distances could be prescribed for standard installations (e.g. LNG delivery installations for road vehicles³⁰) and activities (e.g. LNG bunkering), depending on the nature of the activity and other operational and design parameters (e.g. bunkering rate). This would ultimately depend on the expected risk they pose to the external environment. For non-standard installations and activities or upon request of the regulator, a risk assessment (e.g. QRA) could always be performed to determine whether the safety distance should be increased and if the total risk is acceptable.

9.7 Other applications of the QRA approach and criteria

Safety is of great importance for the use of LNG as bunker fuel. Therefore, operators in the Small Scale LNG infrastructure often conduct a risk assessment (QRA) apart from the legislative requirements in LUP based on the best practices in the oil and gas industry. It could also be the case that a QRA is specifically requested by authorities or in the event of specific operational circumstances, despite the fact that there is no specific requirement stipulated in national legislation or regulations. Typically, a QRA can be performed for the following applications:

- Assessment of specific risks and mitigating measures for Simultaneous Operations (SIMOPS)
- Determination of safety zones
- Determination of internal safety distances (i.e. to prevent cascading effects), usually performed by a consequence assessment with implicit judgement of risk.

Specific requirements for most of the abovementioned QRA applications are normally not covered in national legislation or regulations³¹, indicating less difficulty for EU-wide harmonization. The applications are discussed in more detail below.

9.7.1 SIMOPS

Simultaneous operations (SIMOPS) during for example LNG bunkering operations (as fuel to ships) shall normally be addressed in a risk assessment. This assessment could either be a qualitative or quantitative. The focus should be on the mitigation of risk and demonstrating the effectiveness of mitigating measures. The latter is normally demonstrated with means of a QRA.

Examples of simultaneous operations can be (not intended as an exhaustive list):

- Loading/unloading of cargo, provisions and other goods on the receiving vessel
- Activities in the vicinity of the bunker area (e.g. hoisting, maintenance activities or hot work)

³⁰ These installations have usually a standardized design and have a limited storage of LNG (<50 tonnes) and are therefore not subject to the Seveso directive.

³¹ Note that Port regulations may specify requirements for the need of a risk assessment to determine safety zones or to assess SIMOPS.

- Passenger embarking/disembarking during bunkering or bunkering with passengers on-board
- The simultaneous transfer of other bunker fuels (SIMBOPS)

Usually the (port) authorities will specify the requirements and limitations for simultaneous operations and are likely to ask for a risk assessment. The approved operational documentation of the bunker or receiving vessel should contain the risk mitigating measures for simultaneous activities. The limitations should be clearly understood by all parties and documented with means of e.g. a bunkering checklist, which should be completed before actual transfer operations start. The LNG bunker operations should be suspended when the limitations cannot be met. The local authorities will finally grant permission for simultaneous operations during LNG bunkering based on the outcomes of the risk assessment (and suggested mitigating measures/limitations).

The study should focus on the possible safety and operational issues associated with the concurrent operations and should take into account common operational use of e.g. vapour return, LNG transfer lines etc. It is strongly recommended to perform a QRA to evaluate the acceptability of the risk, in case of SIMOPS or non-standard bunkering scenarios.

A common and clear approach in guidelines or technical specifications (e.g. ISO/DTS 16901) to address SIMOPS in a risk assessment (QRA) is currently lacking. It is recommended that the approach should be based on the following principles:

- A QRA can be developed for two situations, where the risk is calculated for 1st, 2nd and 3rd party personnel:
 1. The LNG operation *without* taking into account SIMOPS
 2. The LNG operation *with* SIMOPS and defined mitigating measures

SIMOPS could be allowed in case it is demonstrated that the relative increase in risk is not significant (e.g. <10%), provided that the overall project risk criteria can be met.

- Furthermore, it should be demonstrated that the proposed mitigating measures are effective in reducing the risk by an ALARP demonstration, taking into account the costs and benefits of any further risk reduction by implementing more (or other) mitigating measures.
- The ultimate criterion for acceptability/tolerability is when it can be demonstrated that the project risk criteria are met. The criteria should be established in agreement with the relevant authorities;

9.7.2 Safety zone

Safety zone

A safety zone is the area around the bunkering station where only dedicated and essential personnel and activities are allowed during bunkering (definition as per ISO/TS 18683). Its purpose is two-fold:

1. To control ignition sources in order to reduce the likelihood of igniting a flammable gas cloud due to an accidental release of LNG or natural gas during bunkering
2. To limit the exposure to non-essential personnel in the event of potential hazardous effects (e.g. fire) during an incident when bunkering.

Some publications also refer to an 'exclusion zone' (e.g. the LNG Bunker checklist ship to ship, IAPH). The size of the safety zone depends on various bunkering parameters and also on the chosen method to

determine the size. The zone will normally be inside the security zone (see below) and encompass the hazardous areas (the EX-zones) as defined by IEC 60079-10-1 or other relevant regulations. ISO/TS 18683 provides detailed guidance for two methods that can be used to determine the safety zone:

- A conservative and simple (deterministic) approach based on a qualitative risk assessment (HAZID), or;
- By a risk based approach (QRA) relating to the overall safety requirements.

The more complex risk based approach may be used if the simplistic approach results in too large (and conservative) distances from a practical point of view. A smaller safety zone may be accepted provided that it can be demonstrated by the QRA that risk acceptance criteria can be met for 1st, 2nd, and 3rd party personnel. If the risk is acceptable in accordance with the acceptance criteria (as agreed with authorities) the smaller safety zone is acceptable. Examples of risk acceptance criteria are adopted in ISO/TS 18683 annex A and are shown in Table 9-6.


Table 9-6: Examples of risk acceptance criteria, adopted from ISO/TS 18683, annex A, table A.1

	Acceptance criteria	Comment
Individual risk 1 st party personnel	$IR < 10^{-5}$	Applies to crew and bunkering personnel directly involved in the activity.
Individual risk 2 nd party personnel	$IR < 5 \cdot 10^{-6}$	Port personnel and terminal personnel.
Individual risk 3 rd party personnel with intermittent risk exposure	Risk contour for $IR < 5 \cdot 10^{-6}$	3 rd party personnel should not have access for prolonged period.
Individual risk 3 rd party personnel with prolonged risk exposure	Risk contour for $IR < 10^{-6}$	General public without involvement in the activity. No residential areas, schools, hospitals etc. inside this risk contour.

Note that the safety distance shall never be zero and the safety zone shall never be less than the minimum distance as defined by national authorities and marine requirements for the receiving ship. The safety zone shall normally extend not less than 10 m around any point of the connected bunker system /47/. The IAPH recommends a minimum distance of 25 meters.

9.7.3 Internal Safety Distances

Internal safety distances are widely used for preventing incidents caused by unintended interference between two activities or for preventing harmful consequences from an incident to objects or people in the vicinity. In the European legislation there is no official definition of safety distance, but some guideline documents or codes do state a definition. The EIGA guideline/48/, for example, states the following definition: "Safety distances need to be considered as a generic means for mitigating the effect of a foreseeable incident and preventing a minor incident escalating into a larger incident." An internal safety distance is therefore defined as the minimum separation distance between a potential hazardous source and the 'hazard receiver' (e.g. other equipment or building) to prevent escalation to a larger incident (domino-effects).



Some countries have specific regulations, expressing required distances based on standard equipment, while others also allow a performance based approach using guidelines or codes on how to determine internal safety distances.

The EIGA guideline is a well-known document used to determine internal safety distances. For instance, the document is used by the Dutch government (RIVM) to determine safety distances for LNG delivery installations for road vehicles. These distances are adopted in the PGS-33-1 guideline as minimum separation distance between vulnerable objects within the establishment. The methodological approach used is a deterministic assessment with implicit risk judgement, meaning that consequence (effect) distances to certain threshold criteria (to prevent escalation) are calculated based on credible scenarios that occur within a certain frequency range.

A QRA can also be used to determine internal safety distances, with means of e.g. probabilistic simulation³² and the use of exceedance curves (for heat radiation/overpressure) in combination with vulnerability and risk criteria.

To conclude, with the exception of the Netherlands, none of the EU countries have adopted specific requirements (in e.g. guidelines or regulations) with respect to internal safety distances for small scale LNG installations.

³² See also paragraph 7.4.7 of ISO/DTS 16901 - Guidance on performing risk assessment in the design of onshore LNG installations including the Ship/Shore interface

10 INCIDENT REPORTING

10.1 Introduction

Incident reporting is legally enforced to inform the relevant authorities at international, national and local level about deaths, injuries, occupational diseases, spills and dangerous occurrences. This allows authorities to identify where and how risks arise, and whether they need to be investigated. Incident reporting serves multiple purposes, a.o. contribution to overall safety improvement by capturing the lessons learnt, continuous improvement of legislation, development of new technology/industry best practices, input to hazards identification (via statistical data – see GAP 26), monitoring of environmental impact, ...

For LNG bunkering activities, only limited experience has been gained from a few years of operation and thus only limited information for LNG bunkering related incidents is available today. One important LNG spillage during truck-to-ship bunkering happened in 2014, where approximately 100 kilograms of LNG leaked from the hose connection in the bunkering room on-board a passenger ship. In different media, this was referred to as a 'wake-up call' for the LNG bunkering sector, having a clean incident record before. Also SIGTTO identified two incidents involving LNG releases while draining and purging of the manifold. However, for LNG bunkering operations, clear and uniform requirements for incident reporting are missing, which makes current information on LNG bunkering incidents very limited.

Traditional marine fuel oil bunkering is mainly ship to ship bunkering, hence investigation of accidents is covered by Directive 2009/18/EC establishing the fundamental principles governing the investigation of accidents in the maritime sector. LNG as shipping fuel will involve other bunkering modes (i.e. terminal to ship and truck to ship), with a clear link with the shore side, where incident reporting requirements are partially in place via Seveso directive (if applicable), ADR requirements and specific port requirements.

This chapter gives an overview of the existing incident reporting requirements for LNG as fuel related activities at the shore side and water side (including shore/water interface), both for seagoing and inland waterway vessels, at an international, European and Member State level.

10.2 Shore Side


10.2.1 Onshore LNG installations

10.2.1.1 Seveso Directive

Land based small scale LNG installations (LNG fuel stations and small scale terminals) with storage above 50 tons of LNG - and thus the majority of small scale LNG installations - are subjected to the Seveso directive (2012/18/EU repealing Directive 96/82/EC). For the establishments in scope of this directive, two means of accidents reporting are in place (reporting by operators to competent authorities and the latter to the Commission).

Operators shall ensure that competent authorities are informed following a major accident³³. Operators need to provide as a minimum, following information as soon as it becomes available: the circumstances of the accident; the dangerous substances involved; the data available for assessing the effects of the accident on man and the environment and the emergency measures taken. Additionally they need to

³³ 'major accident' means an occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of an establishment, and leading to serious, danger to human health or the environment, immediate or delayed, inside or outside the establishment, and involving one or more dangerous substances;



inform competent authorities on the steps envisaged to alleviate the medium- and long-term effects of the accident and to prevent any recurrence of such an accident. Information is collected at Member State level by Competent Authorities.

Secondly, Member States need to formally report major accidents to the Commission according to Article 18 of the Seveso III Directive if the quantitative criteria of Annex VI are met. The quantitative criteria are specified for serious injury to persons, damage to environment, damage to property or cross border damage /49/. Accidents or 'near misses' which Member States regard as being of particular technical interest for preventing major accidents and limiting their consequences and which do not meet the quantitative criteria above should also be notified to the Commission.

This information from major accidents (meeting the criteria of Annex VI) is captured within a European database, i.e. the Major Accident Reporting System (eMARS, see § 10.2.1.2).

The transport of LNG and LNG loading/unloading/bunkering activities outside Seveso establishments (f.e. truck to ship bunkering) are not in scope of the Seveso Directive and thus do not have to be reported via eMARS.

Summarized, reporting to competent authorities is in place for LNG 'major accidents' (typically involving higher amounts of LNG). However, it is expected that the bulk of LNG leaks occurring during LNG bunkering activities will not be covered by the definition of major accident and thus clear incident reporting requirements for those incidents are missing. If criteria of Annex VI are met reporting by Member States to the commission is requested. For those incident types reporting structure is well established.

Worth to mention is that all high tier Seveso establishments (>200 tons of LNG) should have a safety management system in place which includes procedures for reporting major accidents and near misses, including their investigation and follow-up based on lessons learnt.

10.2.1.2 The Major Accident Reporting System (eMARS)

The Major Accident Reporting System (MARS and later renamed eMARS) was first established by the EU's Seveso Directive 82/501/EEC in 1982 and has remained in place with subsequent revisions to the Seveso Directive in effect today. The purpose of the eMARS is to facilitate the exchange of lessons learned from accidents and near misses involving dangerous substances in order to improve chemical accident prevention and mitigation of potential consequences /50/.

eMARS contains reports of chemical accidents and near misses provided to the Major Accident and Hazards Bureau (MAHB) of the European Commission's Joint Research Centre from EU, OECD and UNECE countries. Reporting an event into eMARS is compulsory for EU Member States when a Seveso establishment is involved and the event meets the criteria of a "major accident", as defined in Annex VI of the Seveso III Directive (explained in §10.2.1.1). For non-EU OECD and UNECE countries reporting accidents to the eMARS database is voluntary. The information of the reported event is entered into eMARS directly by the official reporting authority of the country in which the accident occurred.

The eMARS database is freely accessible³⁴. A search on LNG incidents in this database results in 4 major accidents, one accident took place at a peak shaving station, one at a liquefaction plant and two others were related to power supply and distribution. No LNG bunkering related incidents were found in this database.

³⁴ eMARS is accessible via this link : <https://emars.jrc.ec.europa.eu/?id=4>

10.2.2 LNG cargo transport via land

ADR, which regulates the transport of dangerous goods via road and railways and thus also covers LNG cargo transport via trucks, gives requirements for notification/reporting of incidents in § 1.8.5, 'Notifications of occurrences involving dangerous goods' of the ADR /51/. This paragraph mentions:

... 1.8.5.1 If a serious accident or incident takes place during loading, filling, carriage or unloading of dangerous goods on the territory of a Contracting Party, the loader, filler, carrier or consignee, respectively, shall ascertain that a report conforming to the model prescribed in 1.8.5.4 is made to the competent authority of the Contracting Party concerned at the latest one month after the occurrence....

The ADR model report requires the following information to be completed after an incident: Information on carrier; transport mode (rail / road); date & location of occurrence; topography (gradient/tunnel/bridge/...); particular weather conditions; description of occurrence; dangerous goods involved; cause of occurrence and consequences of occurrence.

If necessary, the Contracting Party has to make a report to the UNECE to inform other contracting parties.

Since incidents during loading and unloading of dangerous goods are in scope according to § 1.8.5.1 of ADR, it can be assumed that LNG bunkering from trucks resorts under this definition.

LNG incidents have to be reported if more than 50 kg of LNG is released or if there was an imminent risk³⁵ of loss of product, if personal injury, material or environmental damage occurred, or if the authorities were involved.

Reported incidents are collected at National level, currently no European database exists for road accidents and incidents, contrary to railway. Recently some Member States (a.o. UK, France, the Netherlands, Belgium, ...) have joined forces on a voluntary basis to develop a common database with incident reports (this database will include accidents and incidents by road, railway and inland shipping). This initiative is in a pilot phase and it is yet unclear what the final outcome will be and if these data will be publically available.


10.3 Water Side

10.3.1 International level

IMO Requirements

The *International Standards and Recommended Practices for a Safety Investigation into a Marine Casualty or Marine Incident (Casualty Investigation Code)* is adopted via resolution MSC.255(84) and became mandatory under SOLAS in 2010. Chapter 14 *Marine Safety Investigation Reports* requires that a marine safety investigation is conducted for every "very serious marine casualty", defined as a marine casualty involving the total loss of the ship or a death or severe damage to the environment. Furthermore, these reports have to be made available to the public and the shipping industry. The Code also recommends an investigation into other marine casualties and incidents, by the flag State of a ship involved, if it is considered likely that it would provide information that could be used to prevent future accidents.

³⁵ The imminent risk of loss of product is defined as 'if, owing to structural damage, the means of containment is no longer suitable for further carriage or if, for any other reason, a sufficient level of safety is no longer ensured (e.g. owing to distortion of tanks or containers, overturning of a tank or fire in the immediate vicinity)'.



Furthermore, in MSC-MEPC.3/circ. 4, IMO gives harmonized reporting procedures. This circular contains an overview of the data to be submitted into the IMO Global Integrated Shipping Information System (GISIS). The *'Marine Casualties and Incidents'* module of the GISIS database collects data on marine casualties and incidents. /54/.

Since 17 June 2011, EU Member States have been uploading marine casualty data to the European Marine Casualty Information Platform, EMCIP (see 11.3.2.1), to improve data collection and analysis. At the same time, at international level, countries are required to send accident investigation data and reports to the IMO's Global Integrated Shipping Information System, GISIS. To avoid the duplication of work entailed in reporting casualty data to two different systems, Member States proposed the development of a mechanism to enable the mandatory accident investigation data required by GISIS to be transferred to the IMO by EMCIP. This mechanism was developed at EMSA and, since April 2014, data has been transferred automatically from EMCIP to GISIS. EU Member States are now able to report to GISIS using EMCIP, without any additional workload.

10.3.2 European level

10.3.2.1 Seagoing vessels

European Marine Casualty Information Platform - EMCIP

Directive 2009/18/EC, establishing the fundamental principles governing the investigation of accidents in the maritime transport sector, requires member states to ensure safety-focused investigation systems, to investigate very serious marine casualties and decide on the investigation of others, as well as to send commonly structured investigation reports and to populate the European Marine Casualty Information Database (EMCIP). This means that data on marine casualties and incidents have to be stored in the European electronic database EMCIP.


EMCIP is a European electronic database for the storage, exchange and analysis of data on marine casualties and incidents. The investigative bodies of the Member States have to notify the Commission about marine casualties and incidents, and also have to provide the Commission with data resulting from safety investigations in accordance with the EMCIP database scheme.

EMCIP provides the means to store data and information related to marine casualties involving all types of ships and occupational accidents. It also enables the production of statistics and analysis of the technical, human, environmental and organisational factors involved in accidents at sea /53/.

The database taxonomy has been developed by EMSA in consultation with the Member States, on the basis of European research and international recommended practice and procedures. Within the scope of Directive 2009/18/EC, from 17 June 2011, EMCIP notification by Member States of information on marine casualties and incidents and data resulting from safety investigations is mandatory. This allows the Agency to assist the Commission and Member States with initial analysis of such data, the development of trend monitoring mechanisms, proposals for safety recommendations, the improvement of existing European legislation and promotion of new technical requirements.

The EMCIP database is populated by the national competent authorities of the Member States acting as data providers. EMSA manages the system and accepts the communicated data before they are finally stored.

LNG bunkering accidents and incidents (truck to ship, terminal to ship and ship to ship) are covered by this Directive. If a ship is involved, then it is possible to report, but pure shore operations are not in scope. Currently the EMCIP structure and taxonomy are being updated to allow for adequate reporting



on accident related to LNG as shipping fuel. It relates to taxonomy on propulsion types (BOG steam, BOG diesel electric, NOG dual fuel, dual fuel), LNG bunkering (ship to ship, truck to ship and terminal (shore) to ship). This update will go live in the near future allowing to register all water and water/shore interface related incidents.

SafeSeaNet – SSN

For the sake of completeness SafeSeaNet is mentioned. SafeSeaNet is a vessel traffic monitoring and information system. It is the Community maritime information exchange system developed by the Commission in cooperation with the Member States to ensure the implementation of Community legislation and enables the “receipt, storage, retrieval and exchange of information for the purpose of maritime safety, port and maritime security, marine environment protection and the efficiency of maritime traffic and maritime transport”. This information is received in AIS based position messages (sent by vessels and received by shore based installations) and notification messages (such as pre-arrival, estimated time of departure, actual time of arrival, and departure, dangerous or polluting goods – HAZMAT - and Incident Report notifications), which are sent by designated authorities in participating countries. Through SSN, this information is centralised in a single European platform.

EMSA also collects and manages risk and incident data through the SafeSeaNet, i.e.:

- positions of different types of accidents/incidents involving different types of ships throughout EU waters can be viewed and assessed, and this can be used as a key input to safety-related initiatives;
- high risk ships (e.g. carrying hazardous goods, notifying that they have a problem/emergency, banned from EU ports and single hulled tankers) can be selected and monitored individually or collectively;
- incident report notifications.

Although SafeSeaNet contains a lot of information, it focuses mainly on traffic monitoring and the location of incidents, rather than being an incident database.


10.3.2.2 Inland waterway vessels

Requirements for incident reporting for inland waterway vessels are described in ADN, § 1.8.5.1 – *Notifications of occurrences involving dangerous goods*. Similar to ADR, ADN requires the reporting of incidents if a certain amount of dangerous goods were released during loading, filling carriage or unloading of dangerous goods or if there was an imminent risk of loss of product, if personal injury, material or environmental damage occurred, or if the authorities were involved. This means that from a certain amount (i.e. ≥50 kg), LNG spills during LNG bunkering have to be reported.

ADN provides a model for report on occurrences during the carriage of dangerous goods, which is very similar to the ADR report model for transport via road/rail.

10.3.3 National level

In some countries, national incident reporting requirements exist for the reporting of maritime accidents in general, applicable for seagoing vessels, inland waterway vessels, or both. Some examples are:

- 
- Directive for registration of maritime accidents by the nautical administrator (*Richtlijn voor registratie van scheepsongevallen door de nautische beheerder (SOS formulier)*, The Netherlands)
 - Act to Prevent Against Accidents on the North Sea (*Wet bestrijding ongevallen Noordzee – Artikel 4 Meldplicht*)

The requirements can apply to the whole country, a specific region or a specific waterway. The key data collected by these procedures are more or less the same as the databases discussed above (e.g. vessel, location, damage, ...) however the way of detailing and the way of reporting strongly varies and thus a uniform way to collect incident data is lacking.

10.3.4 Port level

For incidents occurring within a port area, port specific incident reporting procedures exist for incidents involving dangerous goods. These incident reporting requirements are mostly part of the 'Dangerous Goods Codices' of the ports. Similar as with the incident reporting on a national level, the level of details required according to these port specific incident reporting procedures and the way of reporting differs between the ports.

11 IDENTIFIED REGULATORY GAPS RELATED TO LNG BUNKERING AND PRELIMINARY RECOMMENDATIONS

This chapter contains an overview of the previous gaps identified in the EMSA study and their current status. If the gaps are not yet solved, and no concrete actions are already planned to solve the gaps, a recommendation is written. For the previous EMSA gaps already solved, or which will be solved in the near future, an overview of the performed/planned actions to solve the gap is given. No further recommendation is drafted in those cases.

Some additional points for facilitation of LNG as fuel and the LNG infrastructure were identified during the execution of the study. These items are also addressed as "gaps", although these points are rather suggestions for improvement than strict gaps.

The "gaps" below are classified according to the 3 different types, explained below:

- **Type 1 – Legal Gap:**

Legal gaps are gaps for the use of LNG as fuel and the development of a small scale LNG infrastructure that severely limit or even block the use of LNG as fuel for ships. These gaps are typically gaps in legislation and regulations.

- **Type 2 – Harmonization Gap:**

Harmonization gaps are gaps in the EU-wide harmonization of methods, rules, guidelines, provisions and safety aspects for LNG as fuel and Small Scale LNG infrastructure. If EU-wide harmonization is considered as the ultimate goal to reach, all aspects that are currently not harmonized can be considered as a 'gap'. However their related recommendations are not strictly necessary for the use of LNG as fuel and the development of a small scale LNG infrastructure.

- **Type 3 – Knowledge Gap:**

Specific knowledge gaps are points where more research is needed in the implementation and development of a small scale LNG infrastructure and the use of LNG as fuel. Recommendations formulated for these gaps are suggestions for improvement, and so are not strictly necessary.

For each gap identified, the gap type will be indicated.

The (preliminary) recommendations have been discussed in several stakeholder meetings with amongst others representatives of national authorities, ports, equipment manufacturers, ship owners, terminal operators and several LNG platforms. In addition the (preliminary) recommendations have been circulated to selected experts for their reading, comments, feedback and additional input. The preliminary recommendations have been adapted based on comments and feedback received during this process.

The final recommendations will be presented together with the rationale behind it and how effective the recommendation would be in facilitating the uptake of LNG as shipping fuel.

The recommendations are structured as follows:

0) Title of the recommendation

The title of the recommendation is the header of each sub-section and is followed by a sentence or two that aim at capturing the essence of the recommendation.

1) Aim of the recommendation

This is the description of the main aim(s) of the recommendation that indicates the direction in which the Commission shall focus on when implementing it.

2) Scope of the recommendation

Scope of the recommendation indicates the range and breadth of the main areas covered by this recommendation.

3) Recommended actions

The main recommended actions are listed and described in order to give a better understanding of how to cover the scope and achieve the aims of the recommendation.

4) Justification for recommendation

The main reasons why this recommendation was developed and the most relevant reasons behind the formulation of this recommendation and recommended actions.

5) Consequences of non-implementation

The main consequences which can occur should the Authorities decide not to proceed with the implementation of the proposed recommendation and recommended actions.

6) Prioritisation

Prioritisation based on two axes: Impact on LNG small scale market development and Implementation effort (time, cost, legal): scale from ---, --, -, 0, +, ++, +++ (significant negative to significant positive)

In Table 11-1 an overview is presented of all gaps and recommendations discussed in this chapter. Table 11-2 refers to the list of recommendations that overlap with and/or integrate with the discussed recommendation.

Table 11-1: General overview of gaps and recommendations

nr	Recommendation
EMSA Gap 1	Establish a EU-wide guidance for the development of LNG bunkering procedures (EU LNG bunkering guidelines) in order to assist port authorities in the development of their port specific LNG bunkering procedures, to ensure consistency in LNG bunkering procedures between the ports of the different member states and promote EU wide (or global) harmonization of LNG bunkering procedures.
EMSA Gap 2	EU to monitor the progress of overall acceptance of the technical specification ISO/TS 18683 at international level and timely adoption in a standard.
EMSA Gap 3	Make sure that the responsibilities during the LNG bunkering process are clearly defined for all foreseen LNG bunkering configurations and locations. The bunkering procedures are the preferred instrument to document the responsibilities during LNG bunkering.
EMSA Gap 4	Establish a harmonized definition/clear delineation of transfer of LNG as cargo and LNG as fuel on European level, to be adopted in port laws and in national laws of the member states.
EMSA Gap 5	Guarantee that the aspects of connection/disconnection of portable tanks are covered in the bunkering procedures.

nr	Recommendation
EMSA Gap 6	-
EMSA Gap 7	Make sure that regulations for use of LNG as fuel as laid down in amendments of Rhine regulations will be adopted in future update of EU directive 2006/86/EC
EMSA Gap 8	Develop a European standard for small scale LNG bunkering stations, based on currently available local guidelines, e.g. the Dutch guideline PGS33-2.
EMSA Gap 9.1	Develop an EU harmonized approach for risk assessment (including criteria) for non-Seveso small scale LNG establishments and activities.
EMSA Gap 9.2	Make sure that a common and clear approach via guidelines or technical specifications (e.g. ISO/DTS 16901) is adopted and enforced for all EU countries to address SIMOPS in a risk assessment (QRA).
EMSA Gap 9.3a	The concept of safety zones and the approach to define the limits should be accounted for in bunker procedures.
EMSA Gap 9.3b	Specify a harmonized approach to determine internal safety distances (separation distances) for small scale LNG installations. The approach should be implemented or applied in relevant guidelines that specify minimum requirement for the operation and design of LNG installations.
EMSA Gap 9.4	Establish an agreed EU-wide approach for bunkering suppliers' accreditation scheme.
EMSA Gap 9.5	-
EMSA Gap 10.1	Guarantee that crew training requirements for LNG carrying or fuelled inland vessels and barges will exist for all EU inland waterways.
EMSA Gap 10.2	EU to closely monitor development at IMO-level with respect to specific training requirements for seafarers on ships using gases or other low-flashpoint fuels.
EMSA Gap 11	Continuously promote the developments on the effect of Methane Number over dual fuel engine operations.
EMSA Gap 12	-
EMSA Gap 13	Develop a standard for the safe sampling of LNG as fuel.
EMSA Gap 14	-
EMSA Gap 15	Develop a procedure and define the equipment necessary for fiscal metering of the LNG bunkered during truck-to-ship, ship-to-ship and terminal-to-ship bunkering of LNG.
EMSA Gap 16	Establish a comprehensive approach for methane slip management, i.e. boil-off gas, vapour management and emergency venting.
Gap 17	Create a level playing field with regard to harmonisation of fines related to non-compliance to the stricter sulphur limitations.
Gap 18	Potential lack of knowledge with regards to salvage of stranded LNG fuelled vessels/LNG carriers and lack of harmonised requirements for shipyards receiving LNG fuelled vessels/LNG carriers for emergency repairs.
Gap 19	Develop standards for small scale LNG equipment (incl. refuelling stations), in order to harmonize the equipment used for LNG as fuel.

nr	Recommendation
Gap 20-1	Increase knowledge/experience of permitting authorities by partnership in so called LNG platforms with participation of industry, and provide a digital information platform with LNG key information.
Gap 20-2	It is recommended to draft a list of rules, requirements, criteria and conditions that can be applied in permitting and supervision of small scale installations.
Gap 21	Initiate a process to ensure early involvement and cooperation between project developers, local and regional authorities, port authorities, NGO's, fire brigades and other stakeholders to get an idea on the suitability of locations for onshore LNG bunkering facilities, to guarantee a smooth permitting process and to identify potential showstoppers in an early stage.
Gap 22-1	Define clear legally binding target durations to each of the permit process steps and an effective intervention mechanism in case of delays.
Gap 22-2	Evaluate to define a list of 'strategic' small scale LNG developments and facilitate the permit process via specific laws.
Gap 23-1	Establish a single contact and coordination authority (one-stop-shop-principle) for permitting procedures of small scale LNG development.
Gap 23-2	Explore the idea of an all-in-one-permit to simplify the permit process of small scale LNG developments.
Gap 24	Clearly define on Member State level the (environmental) reports that need to be in place for (non Seveso) LNG small scale developments for obtaining an environmental permit
Gap 25	Develop a complete and detailed definition of credible accident scenarios that can occur during the operation of small scale LNG installations and activities.
Gap 26	It is recommended to develop LNG-specific failure frequencies (linked with incident reporting) for use in risk assessments.
Gap 27	It is proposed that a list of LNG-approved consequence and risk software tools is prepared and enforced for consequence and risk assessment. The approved models should be periodically maintained, verified and validated in order to establish that accurate results for LNG installations are generated. Model validation for LNG releases is of particular importance.
Gap 28	For the purpose of EU-wide (and national) harmonization, develop LNG-specific guidelines and case studies for (risk) assessments used for land use planning.
Gap 29-1	Ensure that existing databases of relevance for LNG as shipping fuel (ADR, eMARS and EMCIP) include reporting of near misses, incidents and minor spills and increase the awareness of the need for incident and near miss reporting.
Gap 29-2	Ensure that existing databases on incident reporting (marine and shore operations) will be linked via open data protocols to ensure that they can exchange data on LNG as shipping fuel related incidents. This should enhance LNG overall safety via lessons learnt, improve guidance and regulations and improve quality of risk assessments (failure frequencies).

Table 11-2: Links between identified Gaps and recommendations

nr	EMSA Gap 1	EMSA Gap 2	EMSA Gap 3	EMSA Gap 4	EMSA Gap 5	EMSA Gap 6	EMSA Gap 7	EMSA Gap 8	EMSA Gap 9.1	EMSA Gap 9.2	EMSA Gap 9.3a	EMSA Gap 9.3b	EMSA Gap 9.4	EMSA Gap 9.5	EMSA Gap 10.1	EMSA Gap 10.2	EMSA Gap 11	EMSA Gap 12	EMSA Gap 13	EMSA Gap 14	EMSA Gap 15	EMSA Gap 16	Gap 17	Gap 18	Gap 19	Gap 20-1	Gap 20-2	Gap 21	Gap 22-1	Gap 22-2	Gap 23-1	Gap 23-2	Gap 24	Gap 25	Gap 26	Gap 27	Gap 28	Gap 29-1	Gap 29-2		
EMSA Gap 1		x		x		x			x	x		x						x		x	x													x	x	x	x				
EMSA Gap 2									x							x										x									x	x	x	x			
EMSA Gap 3	x														x	x																									
EMSA Gap 4																																									
EMSA Gap 5	x																																								
EMSA Gap 6																																									
EMSA Gap 7	x									x	x																														
EMSA Gap 8												x															x	x													
EMSA Gap 9.1										x																										x	x	x	x		
EMSA Gap 9.2	x	x					x	x																												x	x	x	x		
EMSA Gap 9.3a	x						x																													x	x	x	x		
EMSA Gap 9.3b																																									
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11.1 Current status of EMSA Gaps and preliminary recommendations

11.1.1 Use of LNG as marine fuel & Bunker Procedures

EMSA Gap 1:		
<i>The entire use of LNG as marine fuel and LNG bunkering procedures are not regulated by IMO requirements and standards as LNG is formally not fully recognised as fuel for the time being.</i>		
Gap type:		
Legal gap - Use of LNG as marine fuel not regulated <input checked="" type="checkbox"/>	Harmonization gap - LNG bunkering procedures <input checked="" type="checkbox"/>	Knowledge gap

11.1.1.1 Current Status

Transport of LNG as cargo is regulated in the IGC-code. To enable the use of LNG as marine fuel, the IGF code is under development by IMO, which is applicable for the receiving vessel, i.e. the ship using LNG as fuel. The IGF code addresses all areas that need special consideration for the usage of low flashpoint fuels by seagoing vessels by providing mandatory provisions for the arrangement, installation, control and monitoring of machinery, equipment and systems using low-flashpoint fuels, focusing initially on liquefied natural gas (LNG), to minimize the risk to the ship, its crew and the environment, having regard to the nature of the fuels involved. The Code addresses all areas that need special consideration for the usage of low-flashpoint fuels, based on a goal-based approach, with goals and functional requirements specified for each section forming the basis for the design, construction and operation of ships using this type of fuel.

IMO's Maritime Safety Committee MSC 94 approved the IGF code in principle including amendments to make the IGF Code mandatory under SOLAS, with a view to adopting both the Code and the SOLAS amendments at MSC 95, scheduled for June 2015, to finally enter into force in January 2017. With this code, the use of LNG as marine fuel will be regulated by IMO, which solves this legal gap identified by EMSA.

LNG bunkering procedures and regulations for the bunkering interface and operation are not covered by the IGF code, since this code mainly focuses on the receiving vessel. However, the LNG bunkering interface is part of ISO/TS 18683 'Guidelines for Systems and Installations for Supply of LNG as Fuel to Ships', which is approved and has been published in January 2015.

LNG bunkering procedures are not regulated at an international/European level, although specific LNG bunkering procedures have been issued or are in a preparatory stage for several ports, IACS, IAPH, SGMF and SIGTTO. LNG bunkering procedures may differ between ports since they are to be adapted to the local port situation. However, EU wide guidance (or alternatively EU LNG bunkering guidelines) on how to develop these bunkering procedures and which topics should be covered in the procedures could be helpful for port authorities in developing their own LNG bunkering procedures.

Efforts with respect to the latter point are ongoing in 'ESSF (Marine) LNG subgroup³⁶' based on existing bunkering frameworks.

Reference can also be made to EMSA gap 3, 5, 9, 13, 15 and the related recommendations, which deal with relevant specific items to be addressed in these bunkering procedures.

11.1.1.2 Recommendation and action plan

Recommendation 1:

Establish a EU-wide guidance for the development of LNG bunkering procedures (EU LNG bunkering guidelines) in order to assist port authorities in the development of their port specific LNG bunkering procedures, to ensure consistency in LNG bunkering procedures between the ports of the different member states and promote EU wide (or global) harmonization of LNG bunkering procedures.

Aim of recommendation

By ensuring consistency in LNG bunkering procedures between the ports of the different member states and promoting EU wide harmonization of LNG bunkering procedures, this recommendation aims to avoid that vessels calling different EU ports would be confronted with significantly different bunker procedures, leading to confusion/unfair competition at best and potential unsafe operations and incidents at worst. The ambition level should be to have global harmonisation if possible, on EU-level as minimum.

Scope of recommendation

The implementation should be coordinated at EU level, the preferred channel is through EMSA or ESSF in a first stage, for ultimate adoption under the Directive 2014/94/EC on alternative fuels infrastructure.

Recommended actions

- 1) Study and analyse the current leading international initiatives (e.g. IACS, ISO, IAPH, SGMF, individual class societies' initiatives) related to LNG bunkering.
- 2) Prepare a GAP analysis of current initiatives and determine the areas to strengthen from an EU perspective (specific for the shipping case) for further EU wide (global) application. Note that this analysis has been initiated in the IACS study³⁷.
- 3) Based on the final outcome of the steps above, elaborate a set of guidelines for ensuring the safety of LNG bunkering operations by providing a unified framework in an attempt to harmonise and to reach an equivalent level of safety amongst EU Member States. Align with the work currently ongoing in ESSF Marine LNG subgroup.

³⁶ ESSF (European Sustainable Shipping Forum) was set up in 2013 to assist European Commission in implementing EU activities and programmes aimed at fostering sustainable shipping. The current focus is introduction of low sulphur norms in North European ECAs. ESSF is a platform for dialogue, exchange of knowledge, cooperation and coordination between Member States and stakeholders (ESSF Plenary: 60 members (28 Member States + 32 stakeholders)). ESSF consists currently of 7 subgroups:

1. Marine LNG
2. Exhaust gas cleaning systems
3. Implementation of the Sulphur Directive
4. Financing aspects
5. Research & innovation
6. Competitiveness of EU maritime transport
7. Port Reception Facilities

³⁷ In July 2014, IACS decided to launch a Project Team on development of Unified LNG Bunkering Guidelines

- 4) Consider to implement the results through the Directive 2014/94/EC on alternative fuels infrastructure
- 5) Consider a voluntary submission to IMO in view of adoption by the shipping industry.
- 6) EU – ESPO to enter negotiations with port organisations in view of early adoption by ports.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To guarantee **harmonized LNG bunkering operations** in different ports throughout the EU.
- 2) To promote **a level playing field**
- 3) To **simplify the requirements** for all parties involved in the bunkering supply process by making them uniform

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Different procedures in different ports, creating confusion and potentially leading to incidents.
- 2) Uncertainty for parties involved in the bunkering supply process about which requirements to comply with
- 3) Port authorities might impose (either excessive or poor) design and operational requirements based on their own judgement

Prioritisation

Impact on LNG small scale market development

This measure would improve take-up of LNG as fuel by reducing uncertainty and stimulating clarity and harmonisation. Overall this measure is expected to have a strong positive impact on LNG-as-fuel developments.

Evaluation impact small scale market development	++
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Implementation effort (time, cost, legal)

This step is considered as a time-critical step. Harmonized EU bunkering guidance (as per above suggested action plan) should be initiated as soon as possible to ensure timely publication. The LNG bunkering market is developing, hence the need to start immediately.

Most of the work is already initiated by ESSF initiatives and in this Study, the additional implementation effort is considered limited. Guidelines are voluntary which means that there is no automatic legal obligation to apply them. However, national laws and regulations may refer to the guidelines and hence enforce compliance. This means that minor adaptations to current EU and national legal framework might be needed.

Evaluation implementation effort	-
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11.1.2 Status of ISO Technical report on LNG bunkering

EMSA Gap 2:

The future status of the ISO Technical Report on LNG bunkering within the international rule framework will have to be reinforced through references in other common Standards and/or legal texts.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.1.2.1 Current Status

The work of ISO TC67 WG10, i.e. ISO/TS 18683 'Guidelines for Systems and Installations for Supply of LNG as Fuel to Ships', has been published as a technical specification (January 2015) , i.e. a guideline, and not as an international standard. This means that it is not mandatory on its own, and it has to be implemented or referenced to in other high-level standards or regulations to become mandatory.

However, technical specifications have to be reviewed at least every three years to decide either to confirm the technical specification for a further three years, revise the technical specification, process it further to become an International Standard or withdraw the technical specification. After six years, a technical specification should be either converted into an International Standard or withdrawn.

The technical specification is emerging as the de facto standard in the industry and it can hence be expected that this specification will become a standard. However the progress is to be monitored by regulators and the latter should be aware of possible opposition by the industry.

The fact whether or not this specification will become mandatory is not perceived as a bottleneck for the development of small scale LNG and the use of LNG as fuel. However, if it becomes a standard, this would contribute to the harmonization of the small scale LNG bunkering industry.

11.1.2.2 Recommendation and action plan

Recommendation 2:

EU to monitor the progress of overall acceptance of the technical specification ISO/TS 18683 at international level and timely adoption in a standard.

Aim of recommendation

The aim of this recommendation is for the Commission to monitor the ongoing initiatives at ISO level: technical specifications have to be reviewed at least every three years to decide either to confirm the technical specification for a further three years, revise the technical specification, process it further to become an International Standard or withdraw the technical specification. After six years, a technical specification should be either converted into an International Standard or withdrawn.

This recommendation aims at ensuring smooth and active collaboration between Competent Authorities (on EU, Member State, IMO, ISO, ... level), bringing together the insights from different experts and

actors. Authorities benefit from this setting as well, by having the possibility to build competence and in addition being able to draw on external expertise.

Scope of recommendation

The implementation is to be initiated at EU-level, the preferred channel is through requests from the European Commission to CEN. It is important to ensure alignment between CEN work and ISO work.

Recommended actions

- 1) Ensure active communication and collaboration between CEN and ISO initiatives
- 2) The European Commission will issue (at least) 2 standardisation requests related to Directive 2014/94/EC on the deployment of alternative fuels infrastructure. The first is for standards on refuelling points and connectors, including a European standard based on ISO/TS 18683 from ISO/TC 67. The Sector Forum Gas Infrastructure has been asked to coordinate work for natural gas in CEN/TC 301, CEN/TC 282, CEN/TC 326 and CEN/TC 408. The second is on labelling to address article 7. A dedicated CEN/Project Committee will be created during next CEN/BT meeting in March 2015. Ensure the timely progress of this work. This action is linked with PR19.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To **align efforts at CEN and ISO level**.
- 2) To **enhance harmonisation** in EU and in an international context

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Lack of standards for industry applications
- 2) Increased risk of delays for small scale installations if there remains doubt about which standards to comply with.
- 3) Proliferation of different non-standardized operations.
- 4) Uncertainties for industries on expectation of National and local authorities
- 5) Potential unsafe LNG bunkering operations by first movers on the LNG small scale market. This introduces risks of incidents that could harm the reputation of the entire small scale LNG value chain. This is one of the greatest concerns of the more established and experienced LNG industry today.

Prioritisation

Impact on LNG small scale market development

The fact whether or not this specification will become mandatory is not perceived as a bottleneck for the development of small scale LNG and the use of LNG as fuel. However, if it becomes a standard, this would contribute to the harmonization of the small scale LNG bunkering industry. This measure would overall improve take-up of LNG as fuel.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

This step is not considered as a time-critical step as the schedule is already fixed in the 3-6 year cycle.

The introduction of this would not require major adaptation of EU-legislation nor Member State legislation, other than already foreseen in the implementation of Directive 2014/94/EC. This measure seems to be cost neutral.

Evaluation implementation effort

0

11.1.3 Definition of bunkering process and responsibilities during LNG bunkering

EMSA Gap 3:

The definition of the bunkering process and the division of responsibilities for bunkering LNG as fuel is not covered by the Technical Report of the ISO TC 67 WG 10. Responsibilities mentioned in the current Draft IGF Code are limited to the Ship to Ship transfer.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.1.3.1 Current Status

A definition of bunkering is given in the IGF Code:

§ 2.2.4bis *Bunkering means the transfer of liquid or gaseous fuel from land based or floating facilities into a ship's permanent tanks [or connection of portable tanks to the fuel supply system.]*

Furthermore, ISO/TS 18683 describes different bunkering configurations (shore-to-ship, truck-to-ship and ship-to-ship) and gives a definition of the LNG bunkering interface:

§ Introduction *...The LNG bunkering interface comprises the area of LNG transfer and includes manifold, valves, safety and security systems and other equipment, and the personnel involved in the LNG bunkering operation...*

Regarding the responsibilities during truck-to-ship, ship-to-ship and terminal-to-ship bunkering, no clear industry best practice or standard has yet evolved that unambiguously describes these for all bunkering configurations. The IGF code only describes responsibilities during ship to ship transfer:

§ 18.3.1.1 *The responsibility and accountability for the safe conduct of the bunkering operation are jointly shared between the Master of the receiving vessel and the Master of the bunkering vessel or representative of the bunker station. Before the bunkering operation commences, the Master of the receiving vessel or his representative and the representative of the supplier shall:*

- 1. Agree in writing the transfer procedure, including cooling down and if necessary, gassing up; the maximum transfer rate at all stages and volume to be transferred.*
- 2. Agree in writing action to be taken in an emergency*
- 3. Complete and sign the bunker safety check-list.*

The Person in Charge (PIC) of bunkering operations shall have evidence of completion of training required by [Chapter 17.4.1.2 or 17.4.1.3 of the Code] [.....of the STCW Convention].

Also ISO/TS 18683 mentions that responsibilities should be described:

§ 8.5.2 *...g) [F10] An organizational plan shall be prepared and implemented in operational plans and reflected in qualification requirements. The plan shall describe... 2) roles and responsibilities for the ship crew and bunkering personnel...*

Terminal-to-ship bunkering will typically take place within the limits of a facility, with the facility being the final responsible for the bunkering process. Responsibilities for ship-to-ship bunkering are defined in

the IGF code. However, the responsibilities are not clear for all foreseen LNG bunkering configurations (e.g. truck to ship, mobile tank) and locations (e.g. inside port limits, inland waterways).

11.1.3.2 Recommendation and action plan

Recommendation 3:

Make sure that the responsibilities during the LNG bunkering process are clearly defined for all foreseen LNG bunkering configurations and locations. The bunkering procedures are the preferred instrument to document the responsibilities during LNG bunkering.

Aim of recommendation

The recommendation aims at ensuring that responsibilities for bunkering of LNG are clearly assigned to a unambiguously identified function, for example "Chief Engineer of the supplying vessel", in order to avoid misunderstanding and in order to avoid gaps in the chain of responsibilities. Note that it is recommended that this topic is fully integrated in recommendation 1.

Scope of recommendation

The implementation is suggested to be at EU level, via ESSF in a first stage, accounting at minimum for the following aspects:

- 1) The recommendation applies to all European ports where LNG may be bunkered including ports for seagoing vessels, ports on inland waterways and ports called by both type of vessels.
- 2) The recommendation applies to all modes of bunkering: truck to ship, fixed installation to ship and ship to ship.
- 3) The recommendation applies to both seagoing vessels on national, international and global trade and commercial vessels operating on European inland waterways.

Recommended actions

- 1) Assign the responsibilities for LNG bunkering by making use of the outcome of recommendation 1 (EU wide bunkering guidance).
- 2) EU – EMSA to enter negotiations with port organisations in view of early adoption by ports.

Justification for recommendation

The recommendation needs to be implemented in a harmonized way in different governmental structures and in different legislative regimes in Europe:

- 1) To guarantee **harmonized LNG bunkering operations** in different ports throughout the EU.
- 2) To guarantee **clearly defined roles and responsibilities** during LNG bunkering
- 3) To **avoid competition on unfair grounds**
- 4) To **simplify** the requirements for stakeholders involved in the bunkering process by making them uniform



Consequences of non-implementation

Non-implementation may lead to a number of issues:

- 1) Unclear or partially undefined responsibilities.
- 2) Adapting to change of responsibility from port to port or from state to state will not stimulate uptake of LNG as fuel.
- 3) Potential for commercial competition on relaxed responsibilities between ports or states.

Prioritisation

Impact on LNG small scale market development

This measure would improve take-up of LNG as fuel by reducing or removing legal uncertainty. Overall this measure is expected to have a positive impact on LNG-as-fuel developments. This step is considered as a time-critical step. Ensuring clarity for responsibilities in LNG bunkering is essential for a timely development of the industry.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

Most of the technical work serving as a basis for this recommendation is already initiated by ESSF initiatives and in this Study, the additional implementation effort is considered limited and could be fully integrated into the work performed under PR1.

Evaluation implementation effort	0
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11.1.4 Delineation between transfer of LNG as cargo and LNG bunkering

EMSA Gap 4:

A conceptual delineation between transfer of LNG as cargo and bunkering of LNG as fuel is missing.

Gap type:

Legal gap

Harmonization gap



Knowledge gap

11.1.4.1 Current Status

It is important that a clear difference is made between transfer of LNG as cargo and LNG bunkering, because some standards/regulations are only applicable for LNG cargo transfer and others only for LNG bunkering. Some (local) regulations state requirements on the transfer of dangerous goods without specifying cargo transfer or bunkering. Such (local) regulations could lead to misinterpretation. This delineation is also of specific importance for the situation of portable LNG tanks.

11.1.4.2 Recommendation and action plan

Recommendation 4:

Establish a harmonized definition/clear delineation of transfer of LNG as cargo and LNG as fuel on European level, to be adopted in port laws and in national laws of the member states.

Aim of recommendation

This recommendation aims at making clear distinction between using LNG as cargo and as fuel. The requirements for handling LNG as cargo and for handling LNG as fuel are different with regards to operation, legislation or regulation and partly differ with regards to taxation.

Scope of recommendation

This recommendation requires close involvement of and consultation with the industry. Delineation is to be consolidated on EU level. SGMF and SIGTTO work can be used as an example. The EU needs to enforce the adaptation of port laws and national laws where applicable.

Recommended actions

- 1) ESSF's subgroup on LNG to set an EU wide definition of delineation between LNG as cargo/fuel.
- 2) This definition to be disseminated to Member States for adoption in port bye laws via Alternative fuels Directive.

Justification for recommendation

The main reasons why this recommendation was developed is the following:

- 1) To guarantee **harmonized understanding of "LNG bunkering"** in different ports throughout the EU as a basis for **harmonized procedures and responsibilities**.
- 2) To ensure **consistent development** across ports and countries of industry best practice.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Stringent requirements pertinent to LNG cargo transfer being applied to LNG bunkering.
- 2) Different procedures in different ports, creating confusion, potentially leading to incidents.
- 3) Uncertainty for parties involved in LNG transfer processes whether an LNG transfer is considered cargo operations or bunkering.
- 4) The non-existence of a clear definition of LNG bunkering may allow for misinterpretations of LNG transfer that is not cargo transfer, in a result leading to a reduced level of safety.
- 5) Port authorities might impose (excessive) design and operational requirements, based on understanding "bunkering" as "cargo transfer".

Prioritisation

Impact on LNG small scale market development

This measure facilitates the success of LNG as fuel by providing a clear differentiation between LNG cargo transfer and LNG bunkering.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

The actions of this recommendation can be addressed in the ESSF subgroup meetings of LNG as fuel. Additional effort is considered as limited. This recommendation will result in minor changes to national an port laws.

Evaluation implementation effort	-
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11.1.5 Portable LNG fuel tanks

EMSA Gap 5:

The connection and disconnection process of portable LNG fuel tanks is not defined in the current draft of the IGF Code and the Technical Report of the ISO TC 67 WG 10.

Gap type:

Legal gap



Harmonization gap

Knowledge gap

11.1.5.1 Current Status

Portable tanks are indeed not in scope of the Technical Report of the ISO TC 67 WG 10. ISO/TS 18683 mentions:

§1 ... The use of containers, trailers or similar to load and store LNG to be used as fuel is not part of this Technical Specification...

However, the use of portable tanks is in scope of the IGF Code and is discussed in §6.5 *Non permanently fixed Portable tanks for liquefied gas fuel*. More specific regarding the connection and disconnection process of portable LNG fuel tanks, the IGF code mentions the following:

§8.5.1 For tanks not permanently installed in the vessel the connection of all necessary tank systems (piping, controls, safety system, relief system etc.) to the gas system of the vessel is part of the "bunkering" process and shall be finished prior to ship departure from the bunkering station. Connection of portable tanks during the sea voyage or manoeuvring is not permitted.

Portable tanks are covered within the IGF Code, but mainly from a design perspective. For aspects with respect to connection/disconnection reference is made to the bunkering procedures.

11.1.5.2 Recommendation

Recommendation 5:

Guarantee that the aspects of connection/disconnection of portable tanks are covered in the bunkering procedures.

This topic is to be fully integrated in recommendation 1 and therefore no further detailing of the recommendation is made.

11.1.6 Transport of LNG on European inland waterways

EMSA Gap 6:

The absence of appropriate rules relating to the transportation of LNG on European inland waterways affects the lack of construction requirements for LNG inland tankers, bunker barges and gas-fuelled inland waterway vessels.

Gap type:

Legal gap	<input checked="" type="checkbox"/>	Harmonization gap	Knowledge gap
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11.1.6.1 Current Status

Transportation of hazardous materials is already common practice along inland waterways, as for example on the Rhine corridor, both for liquids under atmospheric temperatures as well as liquefied gasses such as LPG. Under the previous regulatory framework, i.e. the ADN 2013, transport of LNG via inland waterways was not allowed (unless by specific exemption). This gap is now closed as the *European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN) 2015* contains requirements for inland tanker carrying LNG as cargo. The ADN was published by the *Central Commission for the Navigation of the Rhine (CCNR)* and is into force since 1st of January 2015. These regulations are expected to be included in next update of EU directive 2008/68/EC.

In comparison to the previous version ADN 2013 the actual ADN 2015 now contains in its table C "List of dangerous goods allowed to be carried by tankers, listed in numerical order" an additional row for "Methane, deep-frozen, liquid or Natural Gas, deep-frozen, liquid, with high Methane content" (compare ADN 2015, Chapter 3.2 "List of dangerous goods", 3.2.3 table C, UN-Number 1972).

Regarding table C of the ADN 2015 it is allowed to transport LNG with type G tankers, which are specified for the transport of pressurized or deep-frozen Gases. At the time being the ADN allows the use of pressurized tanks with fixed insulations. For the regulation of vacuum-isolated tanks and membrane tanks pilot projects are currently running aiming the single permit of the pilot vessel and also amendments to the ADN based on the results of these pilot projects. A timeframe for the amendment of regulations for other tank types than pressurized tanks is not known, yet but is expected within the next 2 years.

Therefore the gap on specific construction requirements for LNG inland tanker and bunker barges is considered to be closed in the near future.

The use of LNG as fuel on inland waterways in the EU is only allowed by exemption. Draft amendments to include LNG as fuel in RVIR (CCNR) regulation have been developed and are scheduled to enter into force June 2015. Chapter 8b and Annex T hold the requirements for gas fuelled inland vessels (see § 6.4.1) and specify amongst others construction requirements for LNG fuelled vessels. It is expected that EU directive 2006/87/EC will be updated accordingly.

With this action, the gap with respect to construction requirements for LNG fuelled vessels will be closed.

11.1.7 Use of LNG as fuel on inland waterways

EMSA Gap 7:

The use of LNG as fuel is not permitted on inland waterway vessels in general and is only possible by exemptions by the CCNR, which consequently does not stimulate the creation of larger LNG demand.

Gap type:

Legal gap	<input checked="" type="checkbox"/>	Harmonization gap	Knowledge gap
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11.1.7.1 Current Status

In order to facilitate and stimulate the development of LNG as fuel and cargo for the inland waterways the LNG Masterplan was created, a project that addresses Priority Project Nr. 18 "Waterway axis Rhine/Meuse/Danube" of the TEN-T network.

The main actions to close the EMSA gap 7 are initiated. Altogether three actions are in process by the CCNR:

- Definition of technical requirements for LNG powered vessels to be implemented in the Rhine Vessel Inspection Regulations (RVIR)
- Definition of requirements concerning operation of LNG powered vessels and traffic rules to be implemented in the Rhine Police Regulations (RPR)
- Definition of requirements concerning personnel of LNG powered vessels to be implemented in the Regulations for Rhine Navigation Personnel (RPN)

For all three actions the second hearing was performed in February 2015. The last third hearing will take place in March 2015.

In addition a bunker checklist for the bunkering and pre-/post-processing including a bunkering guideline is in discussion and will be finalized as an additional document of the CCNR.

The amendments of Rhine Regulations are to be expected to come into force end of 2015. This closes the gap for all 'Rhine' countries. In the future, Rhine and EU regulations will continue to evolve in tandem so as to remain identical. In order to make it applicable throughout EU, the Rhine regulation has to be adopted in the EU directive 2006/87/EC.

11.1.7.2 Recommendation and action plan

Recommendation 7:

Make sure that regulations for use of LNG as fuel as laid down in amendments of Rhine regulations will be adopted in future update of EU directive 2006/87/EC.

Aim of recommendation

By virtue of its stringent requirements, the Rhine regulations, which is only legally applicable on the Rhine itself, has become Europe's reference base, irrespective of whether they are intended for use on the Rhine or elsewhere. The aim of this recommendation is to ensure that the requirements as amended in Rhine regulations will result in an update of Directive 2006/87/EC.

Scope of recommendation

The implementation is at EU level for all LNG fuelled inland vessels and by means of updating Directive 2006/87/EC, specifying the technical, operational and personnel requirements for LNG fuelled inland waterway vessels. This would allow full harmonisation of these requirements not only on the Rhine itself, but throughout Europe.

Recommended actions

- 1) Monitor at EU level the progress of the 3 actions in process by the CCNR in order to update the Rhine regulations for use of LNG as propulsion for inland vessels.
- 2) EU to initiate the process of updating Directive 2006/87/EC based on the amendments of Rhine regulations
- 3) Ensure inclusion of inland waterways specific issues related to LNG bunkering in the EU wide guidance on bunkering as proposed in recommendation 1.

Justification for recommendation

The main reasons why this recommendation was developed is the following:

- 1) To guarantee **harmonized understanding of "LNG as fuel"** on inland waterways.
- 2) To ensure **consistent development** across inland waterways.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Different procedures on inland waterways, creating confusion, potentially leading to incidents.

Prioritisation

Impact on LNG small scale market development

Full harmonisation of the operational, personnel and technical requirements for LNG fuelled inland waterway vessels on all inland waterways would facilitate LNG as fuel on inland waterways.

Evaluation impact small scale market development	++
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Implementation effort (time, cost, legal)

This recommendation will result in an update of European legal framework. The efforts are expected to be minor as it only consists in aligning to Rhine Regulations.

Evaluation implementation effort	-
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11.1.8 Standards for small scale LNG bunkering stations

EMSA Gap 8:

Despite the large range of national legislation, further guidance or Standards for small scale LNG bunkering stations could be developed using current best practices

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.1.8.1 Current Status

For large and small onshore LNG installations, general frameworks like EN 1473 and EN 13645 can be used respectively. Bunker stations often have pressurized storage volumes larger than 200t. EN 13645 is intended for installations between 5 and 200 ton. EN 1473 accommodates for larger volumes and would be applicable, but is primarily written for large-scale LNG terminals (with atmospheric storage) rather than small scale LNG bunker stations (often with pressurized storage). This leads to lack of clarity on which standard to use in LNG projects, hence justifying the need for a dedicated standard.

For small scale LNG bunkering stations, the Dutch guideline PGS 33-2 was published in April 2014 and could set the example for other international standards. PGS 33-2:2014 provides a consistent and transparent regulatory framework for shore-to-ship LNG bunker station design. Similar initiatives are ongoing in other Member States, e.g. Flemish (Belgian) BREF on LNG fuel stations under construction.

11.1.8.2 Recommendation and current status

Recommendation 8:

Develop a European standard for small scale LNG bunkering stations, based on currently available local guidelines, e.g. the Dutch guideline PGS33-2.


Aim of recommendation

The aim of this recommendation is to provide a European standard, specifying (minimum) requirements for the design and operation of LNG bunker stations. The ultimate aim is to achieve an acceptable level of protection for people and the environment by providing requirements reflecting the current state-of-the-art. Additionally, it will provide regulators with a means to enforce requirements in permits (by e.g. referring to the standard).

Scope of recommendation

The EN standard to be developed, should be complementary to relevant existing European standards, e.g.:

- EN 13645: Installations and equipment for LNG - Design of onshore installations with a storage capacity between 5t and 200t
- EN 1473: Installation and equipment for liquefied natural gas. Design of onshore installations.



Relevant international guidelines and best practises should be considered in the development of the standard (e.g. ISO/TS 18683). The scope can be similar to that of Dutch guidelines such as the PGS 33 series, covering design requirements for various LNG bunkering configurations. PGS 33-2 covers LNG bunker stations and Truck-to-Ship bunkering operations.

Recommended actions

- 1) Initiate the development of a European standard for LNG bunker stations via CEN (European Standardisation Organization).
- 2) The standard is to be developed and defined through a process of sharing knowledge and building consensus among technical experts nominated by interested parties and other stakeholders. As a minimum, experts of the small scale LNG industry (operators and designers) should be included.
- 3) International and national developments regarding the best practices for the design and operation of LNG bunker stations should be reviewed and taken into account during the development of the standard in order to achieve alignment and consensus regarding the current state-of-the-art (or best practices).

Justification for recommendation

The main reasons why this recommendation was formulated are the following:

- 1) Specific guidelines for LNG bunkering installations are (being) developed by some EU member states (e.g. The Netherlands, Belgium) on own initiative. This clearly suggests **a need for a (European) standard** (also to ensure consistency) that can be implemented as national standard in all EU member states.
- 2) **Authorities are often unsure which standard is applicable for LNG bunker stations**, hence justifying the need for a dedicated standard.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Non state-of-the-art design and operation of LNG bunker stations by e.g. pioneers on the LNG small scale market. This introduces risks of incidents that could harm the reputation of the entire small scale LNG value chain.
- 2) National EU-member states will start initiatives to develop their own standards (as already has happened in the Netherlands), which is inefficient and potentially resulting in inconsistency and contradictive requirements.
- 3) Delays in permitting procedures caused by:
 - a. Authorities that potentially include excessive design and operational requirements in permits based on their own judgement.
 - b. Operators being required to demonstrate that their design and operation is safe, without being able to refer to existing applicable standards.



Prioritisation

Impact on LNG small scale market development

The development of a standard would improve overall acceptance of LNG projects and facilitate the permitting process. It is in addition expected to have a positive impact on the duration of the permit procedure. The standard would also allow first movers in the small scale LNG market to develop their initiatives more efficient, which could improve the LNG small scale infrastructure development in general. Achieving standardization in design and operation of bunker stations would also benefit the LNG fuelled shipping industry by ensuring compatibility and interoperability of components. Overall, the standard is expected to have a positive impact on safety, reducing cost and enhancing performance, which would ultimately benefit the LNG small scale market.

Evaluation impact small scale market development	++
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Implementation effort (time, cost, legal)

This step is considered as a time-critical step. Development of an EN standard should be initiated as soon as possible to ensure timely publication. The next step is for the national standardisation bodies to implement the EN standard as national standard. In total this process could easily take several years. By then the LNG small scale market will be in full development, hence the need to start as soon as possible.

The cost of developing a EN standard would be significant. EN standards automatically become national standards in each of the 33 CEN-CENELEC member countries.

Standards are voluntary which means that there is no automatic legal obligation to apply them. However, national laws and regulations may refer to the standards and make compliance compulsory. This might require adaptations to national laws.

Evaluation implementation effort	--
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11.1.9 Common guidelines for port rules on LNG bunkering procedures

EMSA Gap 9:

Despite various industry driven initiatives common guidelines for port rules on LNG bunkering procedures are not yet available.

9.1 A common risk assessment approach and risk acceptance criteria for LNG bunker procedures are missing, which requires each port to develop its own standards with potential differences as a result;

9.2 Despite various applications of gas-fuelled cargo and passenger vessels the definition of detailed safety requirements for simultaneous LNG bunkering and loading / unloading or passenger embarking / disembarking processes are missing;

9.3 Indicators for determining common safety distances and identification of LNG bunkering processes are currently missing;

9.4 Common safety accreditation criteria for LNG bunker companies are missing;

9.5 Additional measures for LNG bunker operations within emergency plans should be considered.

Gap type:

Legal gap

Harmonization gap

Knowledge gap

Several European ports have developed their own LNG bunkering procedures (e.g. Port of Antwerp, Port of Rotterdam, Port of Stockholm,...). Also the LNG Fuelled Vessels Working Group, established under the IAPH's World Ports Climate Initiative (WPCI), has developed guidelines on safe procedures for LNG bunkering operations, providing ports around the world with implementation guidelines to pursue this technology. Furthermore, several recommended practices and guidelines for the development of bunkering procedures have been published (e.g. ISO, SGMF, IAPH) or are being developed (e.g. IACS). However, there are no uniform European requirements for LNG bunker procedures (see EMSA Gap 01 & recommendation 1).

Regarding safety zones, ISO/TS 18683 contains a chapter on Determination of safety zones, however this is a guideline and until now not an international standard and thus not mandatory.

For risk assessment, a technical specification is recently published (March 2015), i.e. ISO/DTS 16901 'Guidance on performing risk assessment in the design of onshore LNG installations including the Ship/Shore interface'. This technical specification provides a common approach and guidance to those undertaking assessments of the major safety hazards as part of the planning, designing and operation of LNG facilities onshore and at shoreline using risk based methods and standards, to enable a safe design and operation of LNG facilities. The technical specification is aimed to be applied both to export and import terminals but can be applicable to other facilities as well.

Furthermore, in ISO/TS18683 'Guidelines for systems and installations for supply of LNG as fuel to ships', it is required that development of a bunkering facility is conducted in line with a risk assessment approach, which is further explained in chapter 7 of this technical specification.

EMSA Gap 9.1:

A common risk assessment approach and risk acceptance criteria for LNG bunker procedures are missing, which requires each port to develop its own standards with potential differences as a result;

Gap type:

Legal gap	<input checked="" type="checkbox"/>	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.1.9.1 Current status

A distinction is made between risk assessment approaches and criteria for Seveso LNG establishments and non-Seveso LNG establishments and activities (e.g. bunkering in ports):

Seveso LNG establishments

EU countries have adopted different methodological approaches, guidelines, tools and (risk) acceptance criteria in their legal framework to determine and assess external safety (distances) in land use planning. Some EU countries do not enforce a specific approach, but refer to existing approaches from other countries or any other best practice that would ultimately meet the requirements of the Seveso directive. The approaches and (risk) criteria have generic applicability and can in principle be used for the storage and handling of any dangerous good (including LNG) in Seveso establishments. There is no single best approach, guideline or tool.

The implementation of different methodological approaches and criteria in the various EU countries is considered as a gap in achieving EU-wide harmonization, hence resulting in different external safety distances for the same installation. Although this is a clear concern, specific EU wide harmonisation of risk methodologies/criteria for LNG installations covered by the Seveso directive seems not feasible given the current country specific approaches. Therefore no recommendation is drafted.

Non-Seveso LNG establishments and activities

For non-Seveso LNG establishments and activities, harmonization could be more easily achieved as no specific approaches/rules have been adopted in national legislation.

11.1.9.2 Recommendation and action plan

Recommendation 9-1:

Develop an EU harmonized approach for risk assessment (including criteria) for non-Seveso small scale LNG establishments and activities.

Aim of recommendation

The aim of this recommendation is to achieve an EU-wide consistent approach for risk assessment for (non-Seveso) small scale LNG establishments (or installations) and activities. Ideally establish specific EU-wide fixed safety distances for the same type of installation to serve as a simplified guide for full harmonised permitting of LNG as fuel related activities. This would enhance the permit procedure in terms of permit process duration, improve permit acceptance probability and would allow operators to select suitable locations more efficiently.

Scope of recommendation

The approach should be suitable for various non-Seveso small scale LNG installations and bunkering configurations, e.g.:

- Truck-to-Ship bunkering
- Ship-to-Ship bunkering
- Mobile tank-to-Ship
- Bunker stations

The approach should have generic applicability as well as specific guidance for (standardized) LNG installations and activities. Risk acceptance criteria should also be addressed.

This recommendation should not be treated separately from recommendations 25-28.

Recommended actions

- 1) Initiate a working group consisting of representative specialists of national authorities (e.g. environmental agencies) of various EU member states and risk assessment specialists from independent advisory companies. The mandate of the working group would be to develop the EU harmonized approach on risk assessment. The working group should take the following specific recommendations into account:
 - a. For the purpose of harmonization and consistency, it is suggested to consider one common approach including one risk assessment guideline (including frequencies, recommended software tool(s) and risk criteria). Note that even when applying this common approach, the assessment needs to be complemented to account for local considerations (f.e. port specifics, meteorological conditions).
 - b. Consider to define fixed recommended external safety distances for standardized LNG small scale installations and activities, based on the nature of the activity and operational and design parameters.

Consider the developments in the Netherlands regarding a newly developed interim policy on external safety for LNG delivery installations for LNG as fuel for trucks.

- 2) Perform a comprehensive impact assessment study by proof-testing the approach using various case-studies as input.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) The implementation of **different methodological approaches** and criteria for risk assessments in the various EU countries is considered as a gap in achieving EU-wide harmonization.
- 2) The **lack of a specific (national) regulatory approach** for non-Seveso LNG establishments and activities in national regulations.
- 3) To **achieve harmonization of external safety requirements** for same type of LNG installation or activity across the EU (i.e. equal safety distances and/or acceptance criteria).

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Different European countries imposing different external safety distances for the same installation.
- 2) The status of some Member States as 'preferred choice' for the LNG industry to develop their small scale LNG initiatives, as safety requirements might be less stringent and/or the approach to demonstrate acceptability of external safety is considerably less complex.

Prioritisation

Impact on LNG small scale market development

The harmonized approach would improve overall acceptance of LNG projects and facilitate the permitting process. It is expected to have a positive impact on the duration of the permit procedure.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

The initiation of a working group, review and validation of the approach by relevant stakeholders and finally the impact study would require a considerable amount of time and cost.

However, cost and time savings are possible, considering the work that has already been undertaken by some Member States (i.e. the Netherlands).

The introduction of an EU harmonized approach would require adaptation of EU legislation and Member State legislation.

Evaluation implementation effort	--
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EMSA Gap 9.2:

Despite various applications of gas-fuelled cargo and passenger vessels, the definition of detailed safety requirements for simultaneous LNG bunkering and loading / unloading or passenger embarking / disembarking processes are missing.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap	<input checked="" type="checkbox"/>
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11.1.9.3 Current status

This gap remains unchanged. Usually the (port) authorities will specify the requirements and limitations for simultaneous operations and are likely to ask for a risk assessment (type QRA). A common and clear approach in guidelines or technical specifications to address SIMOPS in a risk assessment (QRA) is currently lacking.

11.1.9.4 Recommendation and action plan

Recommendation 9-2:

Make sure that a common and clear approach via guidelines or technical specifications (e.g. ISO/DTS 16901) is adopted and enforced for all EU countries to address SIMOPS in a risk assessment (QRA).

Aim of recommendation

The aim of this recommendation is for the ship operators and authorities to have, respectively, a framework for conducting (study scope and outcome) and assessing (risk assessment criteria and resulting provisions) a detailed study on the safety of operations when LNG bunkering is conducted at the same time as other operations. The framework is to be harmonised in an EU wide context. The study shall include loading/unloading of containers, cargo, passengers, personnel and/or vehicles while LNG bunkering is taking place. These studies shall also take into account the transfer of personnel to/from the ship, including passengers, officers/crew and surveyors/auditors/inspectors.

The ultimate aim of the framework would be to have a common and clear approach to assess whether the SIMOPS can be allowed and if yes, under what conditions and provisions.

Scope of recommendation

The outcomes of the approach are clear requirements when (and if) simultaneous operations can be allowed during LNG bunkering.

Activities to address in the studies include:

- Transfer of personnel to/from the ship (passengers, officers/crew, surveyors, inspectors, etc.).
- Activities in the vicinity of the bunker area (e.g. hoisting, maintenance activities or hot work)
- Loading/Unloading of containers, cargo (liquid and solid), vehicles, etc.
- The simultaneous transfer of other bunker fuels (SIMBOPS, for dual fuel ships).

- Any use of cranes on the receiving vessel e.g. loading provisions, spares and other goods.

A framework – typically SIMOPS QRA - on how to conduct these risk assessments is to be set at EU level and further cascaded down to local level via adopting in relevant guidelines, procedures or (port) regulations.

This recommendation should not be treated separately from recommendations 25-28.

Recommended actions

The main action would be to initiate a working group consisting of representatives from the authorities, LNG industry, other industry types involved in SIMOPS activities (e.g. container terminals) and risk specialists from independent advisory companies. Their mandate would be to develop a common and clear approach to address SIMOPS (and how to assess the acceptability thereof) in a risk assessment.

The approach could comprise of the following aspects:

- 1) Clearly define what is intended by simultaneous operations; for example it could include bunkering and cargo/container (un)loading, but also bunkering from multiple sources.
- 2) Define an EU wide overall methodology to assess the risk of simultaneous operations. For standardised activities or for activities where risks are fully understood, fixed safety zone distances to the LNG bunker area may be specified. In all other situations, it is suggested that a case by case assessment is initiated. The suggested methodology is a combination of a (semi-)qualitative Hazard Identification Study (HAZID) and a quantitative methodology (SIMOPS QRA). The focus should be on the mitigation of risk and demonstrating the effectiveness of mitigating measures. The required safeguards are normally identified in a HAZID and their effectiveness can be quantitatively demonstrated with means of a QRA. General guidance on both methods is provided in ISO/DTS 16901 and/or ISO/TS 18683. Unfortunately, none of these guidelines provide clear details on how to address SIMOPS in a QRA.

Following principles are to be considered when defining a detailed approach:

The QRA need to account for two situations:

- 1) The LNG operation without taking into account SIMOPS
- 2) The LNG operation with SIMOPS and mitigating measures (as defined in the HAZID)

SIMOPS could be allowed in case it is demonstrated that the relative increase in risk is not significant (e.g. <10%), provided that the overall project risk criteria are met.

Furthermore, it should be demonstrated that the proposed mitigating measures are effective in reducing the risk by an ALARP demonstration, taking into account the cost and benefits of any further risk reduction by implementing more (or other) mitigating measures.

- 3) Verify and validate the framework with relevant stakeholders (e.g. port authorities, LNG industry, ISO working groups)
- 4) Implement the framework into harmonized risk assessment guidelines (see also recommendation 9-1 and recommendation 28) or bunkering procedures (recommendation 1), adopted and enforced for all EU countries.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) In order to **optimize the time spent in ports or at anchorage**, simultaneous operations as defined in the scope of the recommendation will take place. To maximize commercial interests while not compromising on safety, a risk assessment study is to be conducted to verify compatibility between simultaneous bunkering with other operations. Usually the (port) authorities will specify the requirements and limitations for simultaneous operations and grant permission based on the outcomes of the risk assessment.
- 2) How to address SIMOPS in a risk assessment is currently not specified in sufficient detail in available international guidelines (e.g. ISO/TS 18683 and ISO/DTS 16901). The EU ports do usually not specify a specific approach (qualitative and/or quantitative). Hence, this justifies the **need for a clear and common approach** to address SIMOPS in a risk assessment.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) a potential compromise of the safety of LNG bunkering and in particular to the safety of the passengers and second/third party workers involved in the simultaneous operations.
- 2) LNG not being commercially viable and ship owners (or e.g. cargo/container/ferry terminals) not switching to LNG as fuel.

Prioritisation

Impact on LNG small scale market development

This measure would harmonize the process of accepting SIMOPS operations by port authorities, encouraging equal developments/requirements in all European ports. This measure will facilitate the approval process. SIMOPS is important to make LNG bunkering commercially viable and the feasibility of SIMOPS may be an ultimate decision criterion for ship owners to switch to LNG as fuel. For this reason, the outcome of the recommendation is expected to be vital for the success of LNG as shipping fuel.

Evaluation impact small scale market development	+++
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Implementation effort (time, cost, legal)

The initiation of a working group, the development of the approach and the verification and validation of the approach by relevant stakeholders would require a reasonable amount of time and cost. The SIMOPS approach could be incorporated into the harmonized approaches for risk assessment (recommendation 9-1), guidelines (recommendation 28) or harmonized bunkering procedures (recommendation 1).

Cost and time savings may be achieved by further detailing the approach adopted in ISO/DTS 16901 and ISO/TS 18683 by the respective ISO working groups.

The introduction of this approach would not require adaptation of EU legislation and Member State legislation; because the approach can be included as part of other harmonized approaches (see above-referenced recommendations).

Evaluation implementation effort	-
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EMSA Gap 9.3:

Indicators for determining common safety distances and identification of LNG bunkering processes are currently missing

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap	<input checked="" type="checkbox"/>
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11.1.9.5 Current status

The LNG bunkering processes are covered in EMSA Gap 01 and recommendation 1. This paragraph focuses therefore on the aspect of safety distances (and the various definitions).

A distinction is made between external safety distances (used in the paragraph on Land use Planning, see Chapter 9), safety zones (as per definition in § 9.7.2) and internal safety distances (see § 9.7.3). Note that the recommendations described underneath are closely linked with GAP's 25-27 and the associated recommendations.

External safety distances

Reference is made to EMSA Gap 9.1 described above.

Safety zones

Safety zones should be established for LNG bunkering operations. The implementation of a safety zone during LNG bunkering should be specified as a minimum requirement in LNG bunker procedures. It is proposed to specify the common, harmonized approach to determine safety zones according to the methods and requirements in ISO/TS 18683, annex B. However specifications on failure frequencies, software models to be used, are not addressed in detail in this technical standard (see GAP's 25-27).

Internal safety distances (separation distances)

Separation distances need to be considered as a generic means for mitigating the effect of a foreseeable incident and preventing a minor incident escalating into a larger incident. An internal safety distance is therefore defined as the minimum separation distance between a potential hazardous source and the 'hazard receiver' (e.g. other equipment or building) to prevent escalation to a larger incident (domino-effects).

Some countries (e.g. The Netherlands, PGS33-1) have specific regulations, expressing required distances based on standard equipment, while others also allow a performance based approach using guidelines or codes on how to determine internal safety distances. There is no harmonized approach in determining internal safety distances.

11.1.9.6 Recommendation and action plan

Recommendation 9-3a:

The concept of safety zones and the approach to define the limits should be accounted for in bunker procedures.

Aim of recommendation

The aim of this recommendation is for the competent authority to define and enforce a fixed zone around the bunkering station where only essential activities and personnel are allowed during bunkering.

This recommendation further aims at providing a clear concept of safety zones. The concept should as a minimum include methods to determine safety zones. Preferably, minimum recommended distances to the perimeters of the zones should be proposed (as guidance value) depending on the bunker configuration (e.g. shore-to-ship, truck-to-ship and ship-to-ship) and possibly various operational parameters (e.g. bunker rate / pressure) and implemented safety systems (ESD etc.).

Scope of recommendation

The concept of safety zones (determination) should include the following as a minimum:

- Methods to determine the size including a justification of the (end-point) criteria to define the limits (criteria can be either consequence based or risk-based).
- Implementation requirements (e.g. placement of warning signs, fences, ...)

Reference is made to ISO/TS 18683 for detailed guidance. The concept should be applicable for all LNG bunkering operations as defined in ISO/TS 18683 such as shore-to-ship, truck-to-ship and ship-to-ship; but also for hoisting/placement of LNG mobile fuel tanks.

Recommended actions

The concept of safety zones and methods to determine these are well-described in ISO/TS 18683. The following actions are recommended on EU level with respect to implementing and developing the concept of safety zones in the harmonized bunkering procedure:

- 1) The implementation of a safety zone during LNG bunkering should be specified as a minimum requirement in LNG bunker procedures (recommendation 1)
- 2) Adapt the guidance and approach provided in ISO/TS 18683 with regard to safety zoning (annex B) into a quick and simplified guide.
- 3) It is recommended to enforce minimum safety distances for specific configurations. Reference can for example be made to IAPH guidance, specifying a minimum distance of 25 meters for truck-to-ship bunkering. The assumptions used to calculate these distances should be included in order to allow (port) authorities or operators to decide whether the distance is applicable for the specific LNG bunkering operation taking place.
- 4) The safety distance shall normally encompass the EX-zone and shall never be less than the minimum distance as recommended for the specific bunkering configuration (step 3) by national/port authorities and marine requirements for the ship.
- 5) Preferably this guideline is adopted via a guidance document associated with legislation (e.g. Alternative fuels directive).

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To **complement current (port) regulations on safety distances** since they are not specifically addressing LNG bunkering operations and to ensure harmonization in all EU ports/Member States.
- 2) To **reduce risk to assets and personnel** not involved in the LNG bunkering operation.
- 3) Enforcing minimum requirements (distances) would ensure a **minimum level of protection**

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Potential compromise on safety as personnel in the vicinity of the operation might be exposed to higher risk.
- 2) Higher risk perception of LNG bunkering leading to lower industry adoption (i.e. if larger distances than normally required would be mandated).
- 3) European regulators/authorities defining different safety zone distances for the same LNG bunkering operation.
- 4) The status of some Member States as 'preferred choice' for the LNG industry to develop their small scale LNG initiatives, as safety requirements with respect to safety zoning may be less stringent.

Prioritisation

Impact on LNG small scale market development

This recommendation would improve clarity in defining safety zones. It enhances overall acceptance of LNG bunkering and facilitates the approval process. It also enables (port) authorities to select suitable locations for LNG bunkering (in combination with the external safety distance requirements). The recommendation might contribute to the market driven LNG bunkering developments.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

Taking the recent and on-going developments regarding safety zoning (IAPH, ISO/TS 18683, ...) into consideration, the implementation effort in terms of time and cost is considered low. Modifications will be needed to port bye-laws.

Evaluation implementation effort	-
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Recommendation 9-3b :

Specify a harmonized approach to determine internal safety distances (separation distances) for small scale LNG installations. The approach should be implemented or applied in relevant guidelines that specify minimum requirement for the operation and design of LNG installations.

Aim of recommendation

The aim of this recommendation is to specify a harmonized approach to determine separation distances for small scale LNG installations. Separation distances need to be considered as a generic means for mitigating the effect of a foreseeable incident and preventing a minor incident escalating into a larger incident. The approach should be implemented or applied in relevant guidelines/standards that specify minimum requirement for the operation and design of LNG installations. Ideally this is fully integrated in the standard to be developed in recommendation 8.

The ultimate aim of this recommendation is to enhance the safe design of small scale LNG installations by optimizing the facility lay-out and so effectively managing the risk of escalation.

Scope of recommendation

The approach should be applicable for small scale LNG installations and harmonized with existing similar technical standards/guidelines.

Recommended actions

- 1) Initiate a working group, possibly via a European Standardization Organization, e.g. CEN. The group should consist of representatives of the LNG industry (operation), LNG equipment designers and engineering companies specialized in LNG projects.
- 2) Perform a review of existing approaches for the determination of separation distances in existing (international) guidelines and codes. For example, consider to adopt the EIGA guideline as a basis for the approach. This international guideline is a well-known document and widely used to determine separation distances.
- 3) Define the approach in detail and determine (if possible) fixed minimum separation distances for the design of LNG bunker stations (to be part of the standard, see recommendation 8).

Justification for recommendation

With the exception of the Netherlands, no EU countries have yet adopted specific requirements (in e.g. guidelines or regulations) with respect to internal safety distances for small scale LNG installations. An EU-wide harmonized approach would be preferable, in particular with respect to achieving consistency in safety (design) requirements.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Potentially unsafe (facility) design of LNG installations and risks of domino-incidents that could harm the reputation of the entire small scale LNG value chain.
- 2) EU-member states will start initiatives to develop their own guidelines, which is inefficient and could result in inconsistent and possibly contradictory requirements with respect to the design (lay-out) of LNG installations.

3) Delays in permitting procedures

Prioritisation

Impact on LNG small scale market development

A clear approach, preferably with fixed separation distances would facilitate the permitting procedure and improve the overall acceptance of LNG projects. In addition, it enables a safe and efficient (in terms of spacing requirements) design of any LNG installation.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

This recommendation should be implemented as part of the standard for LNG bunker stations (recommendation 8). These standards (procedures) are voluntary with no automatic legal obligation to apply them. However, national laws and regulations may refer to the standards. This might require minor adaptations to national laws.

Evaluation implementation effort	0
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EMSA Gap 9.4:

9.4 Common safety accreditation criteria for LNG bunker companies are missing.

Gap type:

Legal gap

Harmonization gap



Knowledge gap

11.1.9.7 Current status

Regarding safety accreditation criteria, today common safety accreditation criteria for LNG bunkering suppliers are missing. Because of this, an EU wide agreed approach for safety accreditation criteria for LNG bunkering companies should be developed. IAPH has already initiated a voluntary accreditation procedure that could serve as a basis for development of an EU-wide bunker supplier accreditation scheme.

11.1.9.8 Recommendation and action plan

Recommendation 9-4:

Establish an agreed EU-wide approach for bunkering suppliers' accreditation scheme.

Aim of recommendation

The aim of this recommendation is for the Commission to facilitate and harmonize market entrance conditions while safeguarding a minimum safety level. This recommendation aims at avoiding competition on unfair grounds between ports and between bunker suppliers.

Scope of recommendation

The implementation is at EU level, preferably to be coordinated by EMSA or port platforms (ESPO). Adoption of requirements is preferably via sector agreements rather than via regulation.

Recommended actions

- 1) Current voluntary accreditation procedures are to be analysed for their applicability
- 2) EU – EMSA to enter negotiations with port organisations to develop an approach for development of an EU-wide bunker supplier accreditation scheme

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To guarantee a **minimum safety level** for bunker operators
- 2) Equivalent requirements for operators regardless of whether the bunker vessel is a seagoing vessel or an inland barge
- 3) To **avoid competition on unfair grounds**.



Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Insufficiently trained or insufficiently equipped bunker suppliers entering the market, potentially leading to incidents.

Prioritisation

Impact on LNG small scale market development

This measure would improve take-up of LNG as fuel by stimulating harmonisation. Overall this measure is expected to have a positive impact on small scale LNG-development.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

The introduction of this would not require adaptation of EU nor Member State legislation, it could be introduced via port bye-laws; examples are already existing. This measure seems to be cost neutral.

Evaluation implementation effort	0
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EMSA Gap 9.5:

9.5 Additional measures for LNG bunker operations within emergency plans should be considered.

Gap type:

Legal gap

Harmonization gap



Knowledge gap

11.1.9.9 Current status

Emergency measures and emergency management needs to be fully addressed as part of bunkering procedures (see EMSA Gap 1 and related recommendation).

No additional recommendation is needed.

11.1.10 Crew training requirements for inland vessels

EMSA Gap 10:

Crew training requirements for LNG carrying or fuelled inland vessels and barges do not exist and have to be developed especially with a view on using inland barges as bunker barges.

Gap type:

Legal gap	Harmonization gap <input checked="" type="checkbox"/>	Knowledge gap <input checked="" type="checkbox"/>
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11.1.10.1 Current Status

For seagoing vessels, different international codes and guidelines exist that cover elements of crew training:

- IGC Code- International Code for construction and equipment of Ships carrying Liquefied Gases in bulk
- International Code for the Construction of Gas Fuelled Ships (IGF code) – Part D, Chapter 18
- ISO/TS 18683 – Guidelines for Systems and Installations for Supply of LNG as Fuel to Ships - Chapter 10 – Training & Chapter 11 – Requirements for documentation: § 11.7 Training documentation
- DNVGL-RP-0006:2014-01 – Development and Operation of Liquefied Natural Gas Bunkering Facilities - Section 6.2.10 – training
- Training issues are addressed within Working Group 4 ‘LNG Bunkering: Competence and Training’ of the SGMF.
- Norwegian Maritime Authority (NMA) – Regulation of 17 June 2002 No. 644 concerning cargo ships with natural gas fuelled combustion engines
- NMA – Regulation of 9 September 2005 No. 1218 concerning construction and operation of gas fuelled passenger ships.
- Society of International Gas Tanker & Terminal Operators (SIGTTO) – Ship to Ship Transfer Guide for Petroleum, Chemicals and Liquefied Gases, 2013 – 1.8 Training and familiarization of ship’s personnel
- SIGTTO Liquefied Gas Handling Principles, 3rd ed. 2000 – 5.5 Fire Fighting / 5.5.6 Inspection, maintenance and training, 6 The Ship/Shore Interface / 6.10 Training, 9 Personal Safety / 9.1 Cargo Hazards, 9.9 Personal Protection / 9.9.1 Breathing apparatus, 10 Emergency Procedures / 10.3.3 Training
- The Oil Companies’ International Maritime Forum (OCIMF) – International Safety Guide for Oil Tankers & Terminals (ISGOTT) – 7 Handling of Cargo and Ballast / 7.7.9 Training, 9 Tank Cleaning and Gas Freeing / 9.2.5 Washing in an over rich atmosphere, 11 Enclosed Space Entry / 11.5.8 Training, 14 Emergency Procedures / 14.2.9 Use of Municipality and Port Service, 14.2.17 Training and Drills, 14.3 Tanker Emergency Plan / 14.3.7 Training and Drills

The most comprehensive documents addressing competence requirements on LNG fuelled ships are:

- IMO Interim Guidance on Training for Seafarers on ships using gases or other low flashpoint fuels – STCW.7/Circ.23 (superseding training requirements laid down in MSC.285(86))
- DNV Standard for Certification No. 3.325 – Competence related to the On board Use of LNG as a Fuel

Despite the identified existing regulations and best practices a consolidated regulatory framework is not yet in force. Crew Training is on the Agenda of the IMO Convention for Standards of Training, Certification & Watchkeeping (STCW). 01. January 2017 is expected to be the date on which the parts of STCW pertinent to competence and training for crew on LNG fuelled vessels will enter into force.

Crew training requirements for LNG carrying or fuelled inland vessels do not yet exist, since LNG fuelled inland vessels are currently not yet allowed by RVIR. Also in the applicable chapters of the new draft RVIR (chapter 8b and annex T), no specific training requirements are mentioned.

Crew training requirements for LNG carrying or fuelled inland vessels and barges are being addressed in the LNG Masterplan study Su Ac 4.2 '*Education & Training*'. For this activity, an inventory is made of competence and training requirements suitable for working with LNG in inland waterway transport.

11.1.10.2 Recommendations and action plan

Recommendation 10.1:

Guarantee that crew training requirements for LNG carrying or fuelled inland vessels and barges will exist for all EU inland waterways.

Recommendation 10.2:

EU to closely monitor development at IMO-level with respect to specific training requirements for seafarers on ships using gases or other low-flashpoint fuels.

Aim of recommendation

These recommendations aim at defining specific training requirement for LNG fuelled vessels, seagoing as well as inland. By ensuring consistency in LNG training requirements with regards to seagoing ships and on ships on European inland waterways a uniform level of safety will be provided.

Scope of recommendation

The recommendation is to be initiated at EU level and coordinated with CCNR and IMO.

Recommended actions

- 1) Establish communication with CCNR.
- 2) Closely monitor the evolution of competence standards at IMO/STCW.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To guarantee **harmonized competence levels** on **all** ships using LNG as fuel throughout the EU.
- 2) To **avoid competition on unfair grounds**.
- 3) To ensure a **minimum safety standard**

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Different procedures and competence levels on seagoing ships as on inland vessels.
- 2) Safety issues in ports that are called frequently by seagoing ships and inland water vessels.

Prioritisation

Impact on LNG small scale market development

This measure would improve take-up of LNG as fuel by reducing need for provision of different training schemes. Uniformity in competence standards will accelerate and simplify development of procedures. Overall this measure is expected to have a positive impact on LNG as fuel developments.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

This step is not considered as a time-critical step. The uptake of LNG as fuel on inland waterways is lagging behind the uptake for seagoing vessels. STCW will publish competence requirements which will be made mandatory by IMO. These requirements may be adapted to the needs for inland waterways. Most of the work is already initiated by STCW, the additional implementation effort is considered limited.

Evaluation implementation effort	-
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11.1.11 Specification of LNG as marine fuel

EMSA Gap 11:

No International Standards for the specification of LNG as marine fuel are available.

Gap type:

Legal gap	Harmonization gap <input checked="" type="checkbox"/>	Knowledge gap <input checked="" type="checkbox"/>
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11.1.11.1 Current Status

ISO 8217:2012, *Petroleum Products – Fuels – specifications of marine fuels*, specifies the requirements for petroleum fuels for use in marine diesel engines and boilers, prior to appropriate treatment before use. For LNG as marine fuel, those specifications are not available in an international standard.

On-going work is performed within the ESSF on the gas quality and methane number issue and on the need for a harmonized standard which specifies the requirements for LNG for its use as a marine fuel. All properties of LNG relevant to the process of custody transfer and the assessment of safe and cost-effective use in marine engines have to be appropriately addressed. Currently research is ongoing to provide clarity on to what extent the quality of LNG affects safe engine operations. ESSF's main conclusion was that for this reason operators need to know the composition of the gas and the methane number (MN), leading to submission to IMO of a bunker delivery note (BDN)-template for LNG. However, it was concluded that strict regulations (a formal standard) are not recommended as it might limit the availability of LNG as marine fuel /31/.

Trading of LNG is a global market, with LNG qualities being produced/offered following the requirements/needs of large regional pipeline gas markets. The emerging use of LNG as a marine fuel is not expected to see a standard marine-spec LNG being offered in the short to medium term. Shipping is a global market too, with ships anchoring and bunkering in ports all over the world. Hence, LNG-fuelled ships will have to be able to accommodate different qualities of LNG. The consensus reached is that the further specification of LNG as fuel shouldn't be part of a standard, but part of the agreed delivery 'contract' between LNG supplier and receiver instead.

11.1.11.2 Recommendations and action plan

Recommendation 11:

Continuously promote the developments on the effect of Methane Number over dual fuel engine operations.

Aim of recommendation

Ships operators need to be informed on the gas composition and the methane number (MN) for safe engine operations. This has led to the development of the bunker delivery note (BDN)-template for LNG, rather than a formal standard, as this might limit the availability of LNG as marine fuel.

This recommendation aims at stimulating discussion and developments with regard to impact of Methane Number on safe engine operations.

Scope of recommendation

The recommendation is to be initiated at EU level, coordinated with a representation of stakeholders (e.g. ESSF subgroup Marine LNG) and further brought up to IMO level (MSC/MEPC).

Recommended actions

- 1) Establish a working group with representatives from engine manufacturers, ship owners and LNG suppliers to discuss impact of methane number on engine safety and operations, based on a technical summary note discussing e.g. knocking effects, engine resistance, fuel consumption, methane number calculation methods, ...
- 2) EU to support industry joint development projects aiming at better understanding of the combustion process and the operational limitations when engines are operated on different methane numbers.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) Ensure that the gas quality is **within the parameters** specified by the engine manufacturer
- 2) To ensure a **minimum standard** for safe engine operations

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Non compatibility of gas quality (including MN number) and the engine specifications leading to safety, environmental or operational problems.

Prioritisation

Impact on LNG small scale market development

This measure would enhance take-up of LNG as fuel by improving the understanding of impact of methane number on safe engine operations. Overall this measure is expected to have a positive impact on LNG as fuel developments.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

This step is not considered as a time-critical step. Several initiatives are ongoing and the main purpose is to have all discussions centrally coordinated.

Evaluation implementation effort	-
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11.1.12 Measurement of the sulphur content of LNG as fuel

EMSA Gap 12:		
<i>No requirements and guidelines are available for the measurement of the sulphur content of LNG as fuel.</i>		
Gap type:		
Legal gap	<input checked="" type="checkbox"/> Harmonization gap	Knowledge gap

11.1.12.1 Current Status

The basis for the 2009 guidelines for the sampling of fuel oil for determination of compliance with the revised MARPOL ANNEX VI Guidelines is regulation 18.5 of Annex VI to MARPOL 73/78, as amended by resolution MEPC.176(58), which provides that for each ship subject to regulations 5 and 6 of that Annex, details of fuel oil for combustion purposes delivered to, and used on board the ship, shall be recorded by means of a bunker delivery note which shall contain at least the information specified in appendix V to that Annex. In accordance with regulation 18.8.1 of Annex VI, the bunker delivery note shall be accompanied by a representative sample of the fuel oil delivered. This sample is to be used solely for determination of compliance with Annex VI of MARPOL 73/78.

Hence, regulation 18.8.1 and 18.8.2 of Annex VI are only applicable to fuel oils and not gases. The following was added to Regulation 18.4: "Paragraph 5.6, 7.1, 8.1, 8.2, 9.2, 9.3 and 9.4 of this regulation do not apply to gas fuels such as LNG, compressed natural gas."

Furthermore, in a European context, EMSA's January 2015 Sulphur Inspection Guidance for the Council Directive 1999/32/EC exempts LNG from the requirement to determine the sulphur content:

"The limitations on the sulphur content of certain fuels shall in principle not apply to e.g. fuels used by warships and other vessels under military service, and to fuels used on board vessels employing emission abatement methods (*Emission abatement methods (e.g. exhaust gas cleaning systems, mixtures of marine fuel and boil-off gas, LNG, fuel cells and biofuels) are permitted for ships of all flags in EU waters as long as they continuously achieve reductions of SO_x emissions which are at least equivalent to using compliant marine fuels*) in accordance with the Directive. Under some exceptional circumstances, the limitations on the sulphur content of fuels used by ships shall also not apply" (*E.g. in case of damage to the ship or its equipment, and in case of securing the safety of a ship or saving life at sea (Paragraphs 2f, 2g and 2h of Article 1 of the Directive).*)

Subsequently, this issue is not further considered a gap.

11.1.13 LNG sampling

EMSA Gap 13:

A Standard for the safe sampling of LNG as fuel is missing.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.1.13.1 Current Status

ISO 8943:2007, *Refrigerated light hydrocarbon fluids -- Sampling of liquefied natural gas -- Continuous and intermittent methods*, specifies methods for the continuous and the intermittent sampling of LNG while it is being transferred through an LNG transfer line. In this standard, an LNG transfer line is defined as a pipeline used for transferring LNG. However, this is a general standard and not made specific for marine transfer applications.

SIGTTO published Liquefied Petroleum Gas Sampling procedures in 2010. This book contains recommendations for taking liquefied petroleum gas samples and can be used as a starting point for a procedure / standard on the safe sampling of LNG as fuel.

Although a standard for the safe sampling of LNG as fuel is indeed missing, this standard should be seen as a suggestion for improvement. In addition the need for resampling on every bunkering operation is not deemed necessary.

11.1.13.2 Recommendation and action plan

Recommendation 13:

Develop a standard for the safe sampling of LNG as fuel.

Aim of recommendation

The aim of this recommendation is to develop suitable sampling procedures to determine the LNG quality during bunkering. The recommendation does not imply the need for sampling. The need for sampling and quality measurement procedures has been addressed in the Code of Safety for Ships using Gases or other Low flashpoint Fuels (IGF Code) and by the ISO TC 67 committee. For the LNG trade between LNG carriers and onshore terminals procedures and standards have been developed, but these lack to address LNG as a fuel. The principles developed may be applied to LNG bunkering, but other alternatives for sampling should also be considered. The final aim is to have a fit for purpose sampling procedure taking into account the cost for sampling and measuring the quality.

Scope of recommendation

The procedure to be developed should focus on safe and suitable sampling techniques during truck-to-ship, ship-to-ship and terminal-to-ship bunkering of LNG. The sampling techniques to be applied should be in-line with the quality measurement techniques. In principle two routes are available for LNG quality analyses. The first route is to sample the LNG, gasify this stream and collect it for further analysis. Alternatively the LNG quality is analysed in-line in its liquid state and doesn't need actual sampling but

only appropriate conditioning. To be able to develop a procedure the different quality measurement techniques should be evaluated (see also Gap 15). Parallel with this evaluation also the sampling techniques should be evaluated. At the evaluation the following should be addressed:

- The availability of commercial sampling techniques;
- The current known sampling practices;
- Safety and operability of available techniques;
- Accuracy & reliability of available methods
- Cost effectiveness of available methods

It is recommended that the procedures and requirements developed for sampling techniques are an enhancement for 'LNG custody transfer handbook' of the GIIGNL and ISO 8943 'Refrigerated light hydrocarbon fluids – sampling of Liquefied Natural Gas – continuous and intermittent method (published by ISO TC 28 SC5). Implementation is suggested via the marine equipment directive 96/98/EC (MED) or via an update to the IGF code. Additionally it is suggested that this topic is also addressed in the scope of recommendation 1.

Recommended actions

- 1) EU to identify and engage with **industry players** to establish a knowledge base of the **current LNG sampling practices**.
- 2) Identify recommendations to **enhance** current procedures, guidelines and standards.
- 3) Identify options for **improvement** of existing technology and possible innovation.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To translate **current** practices to LNG bunkering practices.
- 2) To **align** quality measurement with sampling techniques.
- 3) To share **knowledge** on sampling techniques.

Consequences of non-implementation

Non-implementation will potentially result in sampling systems which are overdesigned and engineered for LNG bunkering. Simplification and minimizing operation will reduce the risk of error and unsafe situations.

Prioritisation

Impact on LNG small scale market development

Suitable sampling procedures should further enable the introduction of LNG transportation fuel. Furthermore sampling procedures are strongly connected with the quality analysis techniques. In practice dedicated LNG bunkering sampling procedures will reduce the risk of error and unsafe situations.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

Developing suitable sampling procedures would require cooperation of the key players in LNG bunkering. Updating or creating new procedures or standards is expected to take some time. It is necessary to create a common understanding. As the sampling is strongly connected with the LNG quality measurement the whole system is likely to be subject to legal consultation. To support the process for knowledge sharing and building financial aid is anticipated to execute dedicated studies.

Evaluation implementation effort	-
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11.1.14 Standardisation of the Equipment for connection of communication devices

EMSA Gap 14:

No Standard is available for the Standardisation of the equipment for the connection of communication devices and process monitoring including Emergency Shut Down (ESD) between the LNG delivering facility and the receiving gas-fuelled vessel.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.1.14.1 Current Status

The SIGTTO publication *ESD arrangements & Linked Ship/Shore Systems for Liquefied Gas Carriers* has been produced due to members' concerns about the different interpretations of the functional requirements for ESD systems, particularly those differences between the needs of the LNG industry and those of the LPG industry and how these may interact with linked ship/shore shutdown systems. This guideline is applicable for LNG carriers, and needs to be adapted for small scale LNG. Furthermore, the connection of communication devices and process monitoring is addressed in recommended practices, various bunkering procedures (e.g. Port of Antwerp bunkering procedures) and the IAPH checklists. Also ISO/TS 18683 addresses the compatibility of ESD and communication systems.

Despite these recent evolutions, no international standard on communication devices and ESD exists. The development of standards for LNG bunkering equipment in general (including communication and ESD) is addressed in GAP 19.

11.1.15 Gas measurement

EMSA Gap 15:

Procedures and equipment for gas measurement are missing.

Gap type:

Legal gap

Harmonization gap



Knowledge gap

11.1.15.1 Current Status

ISO 10976, *Refrigerated light hydrocarbon fluids – Measurement of cargoes on board of LNG carriers*, establishes all of the steps needed to properly measure and account for the quantities of cargoes on LNG carriers. This includes, but is not limited to, the measurement of liquid volume, vapour volume, temperature and pressure, and accounting for the total quantity of the cargo on board. This International Standard describes the use of common measurement systems used on board LNG carriers, the aim of which is to improve the general knowledge and processes in the measurement of LNG for all parties concerned.

ISO is developing ISO/AWI 19970, *Refrigerated hydrocarbon and non-petroleum based liquefied gaseous fuels- Metering of gas as fuel on LNG carriers in ports*. This document is currently in preparatory stage.

However, a clear procedure and equipment for fiscal metering of LNG bunkered as fuel during a bunkering operation is missing. This is mainly important from a commercial point of view. Next to the fiscal metering flow rates also have to be monitored during bunkering from a safety perspective.

11.1.15.2 Recommendation and action plan

Recommendation 15:

Develop a procedure and define the equipment necessary for fiscal metering of the LNG bunkered during truck-to-ship, ship-to-ship and terminal-to-ship bunkering of LNG.

Aim of recommendation

The aim of this recommendation is to define equipment requirements, procedures and standards to determine in a safe way the quantity and quality of LNG transfer during truck-to-ship, ship-to-ship and terminal-to-ship bunkering. The protocol (equipment requirements, standards and procedures) should be a mandatory regulatory requirement for bunker suppliers to ensure a level playing field for the billing process of LNG gases and ensure documentation of gas quality (and its physical/chemical properties) at the same time. The set of equipment requirements and operating procedures to accommodate the "billing" and "fuel quality" demands for a "fair" bunkering should include LNG quality specifications as stated in for example the IMO bunker delivery note. The procedures shall also include reliability of the quality and quantity measurements and safety aspects regarding to persons, the environment or the ship during the LNG measurements.

Scope of recommendation

Clear and transparent equipment requirements, standards and procedures should be established to determine fuel quality and quantity during truck-to-ship, ship-to-ship and terminal-to-ship bunkering of LNG. To meet this objective an evaluation on various available measurements technologies and procedures to measure the quantity and quality of the LNG during the bunkering process should be performed. The technical evaluations should address:

- Commercial available equipment, standards & procedures for LNG quality measurements (LNG composition, heating value, knock propensity,..)
- Commercial available equipment, standards & procedures for LNG quantity (amount, V or kg)
- Safety of available methods
- Accuracy & reliability of available methods
- Cost effectiveness of available methods

It is recommended that the procedures and requirements for LNG can be easily combined with gas quality, physical & combustion requirements documentation as implied by MSC 94/11/1, in the IGF-code (IMO).


Potentially relevant guidelines that can be used as input are for example:

- GIIGNL Custody Transfer Handbook
- Directive 2004/22/EC of the European Parliament and of the Council of 31 March 2004 on measuring instruments (applicable from 2006-10-30), amended by Directive 2009/137/EC
- OJ L 135, 30 April 2004
- ISO 10976:2012 "Refrigerated light hydrocarbon fluids, Measurement of cargoes on board LNG carriers".
- NEN-ISO 89437 2007

Recommended actions

The following actions are recommended:

- 1) Define with the relevant stakeholders which species should be measured and which physical parameters (density, heating value, methane number,..) need to be determined (reference can be made to BDN) – alignment with the work of WG5 of SGMF
- 2) Define with the relevant stakeholders the sample frequency for the gas composition measurements (continuous- versus discontinuous measurements)
- 3) Define with the relevant stakeholders the accuracy & reliability for gas quality and quantity determination needed for billing and determination of the physical parameters of the gas, including determination of the optimal sample point in the header (accuracy & safety). See also gap 13.
- 4) Define the safety measures for equipment and personnel during the measurement, e.g.
 - a. Define material sampling probes

- 
- b. Define procedures to prevent explosion hazards for surroundings and equipment exposed to vaporised LNG.
 - c. ...
- 5) Evaluation on commercial available equipment & procedures for LNG quantity measurements
 - a. dynamic (real-time) measurement approaches such as commercially available ultra-sonic measurement devices
 - b. Static measurements (tank volume or mass measurements)
 - 6) Evaluation on available equipment & procedures for LNG quality measurements
 - a. In-situ gas composition measurements methods and equipment (infrared absorption, Raman spectroscopy)
 - b. Ex-situ gas composition measurement techniques using sample probes and composition analyses by using for example a Gas Chromatograph (GC), infrared absorption
 - 7) Perform a cost benefit analyses for the different gas measurement technologies available
 - 8) Agree on final equipment requirements, standards and procedures to determine fuel quality and quantity based on above process steps
 - 9) Integrate the findings in the EU bunkering guidance

Justification for recommendation

Depending on the origin the composition of LNG its heating value varies by about 10% and the density additional around 16%. As a consequence these variations results in substantially different total energy content bunkered and knock propensity among the different commercial available LNGs. To allow a fair trade and a level playing field for LNG suppliers and ship owners a world-wide common methodology to assess the density, amount, composition to determine the total energy content of LNG, knock propensity and calorific value of the LNG should be developed.

Consequences of non-implementation

Non-implementation will result in large uncertainty in the total energy content of the bunkered LNG. This can lead to negative economic consequences for ship owners when the gas has a low calorific value and results in uncertainty in the distance that can be travelled with the bunkered LNG. Moreover, non-implementation means that physical parameters such as the knock propensity (e.g. methane number) of the fuel is unknown what can result in performance loss or even damage of the ship engines.

Prioritisation

Impact on LNG small scale market development

Clear and transparent equipment requirements and procedures to determine the exact energy content and fuel quality enables transparent, "fair" and safe bunkering which is needed for the acceptance of LNG a transportation fuel. This step is considered as a time-critical step as the first LNG bunker vessels are currently being designed. This recommendation has a positive impact for LNG as a transportation fuel.



Evaluation impact small scale market development	++
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Implementation effort (time, cost, legal)

A common methodology and equipment necessary for determining the energy content and gas quality of LNG during bunkering needs to be defined and implemented. This is considered as a time intensive step, though considerable efforts have been performed by WG5 of SGMF on fuel quality and quantity.

Evaluation implementation effort	--
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11.1.16 Environmental impact

EMSA Gap 16:

Operational guidelines need to be developed to reduce potential negative environmental impacts related to the possible release of methane.

Gap type:

Legal gap	Harmonization gap <input checked="" type="checkbox"/>	Knowledge gap <input checked="" type="checkbox"/>
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11.1.16.1 Current Status

ISO/TS 18683, *Guidelines for systems and installations for supply of LNG as fuel to ships*, clearly states that releases of LNG or natural gas to the atmosphere should be prevented. Paragraph 8.4 states:

The system shall be designed and operated to prevent release of LNG or natural gas. This can lead to hazardous situations that can threaten safety of life, property or the environment. Further, the system shall be designed such that release due to accidents or abnormal conditions is minimized.

[F2] The system is arranged so that the system can be commissioned, decommissioned and operated (purged and inerted) without release of LNG or natural gas to the atmosphere. Operating procedures for these operations shall be established.

[F3] LNG transfer shall be carried out in closed systems where the components are connected and leak tested before LNG transfer is started.

Furthermore, a lot of authorities require zero emissions, and all equipment is developed according to this requirement.

Although this ISO technical specification and authorities require that release of LNG or natural gas to the atmosphere is prevented, a comprehensive approach for methane slip management, i.e. boil-off gas, vapour management and emergency venting, is missing at this moment.

11.1.16.2 Recommendation and action plan


Recommendation 16:

Establish a comprehensive approach for methane slip management, i.e. boil-off gas, vapour management and emergency venting.

Aim of recommendation

The aim of this recommendation is for Designer and Operator to increase awareness of negative environmental impact of methane release and to force them by prescriptive regulation to reduce methane discharge during normal operation by technical and operational measures.

Scope of recommendation



The implementation should at least be on EU level but it is recommended to have an international aim as e.g. ISO standards or IGF code.

Measures are already in force via the current rule framework to increase awareness of negative environmental impact of methane release and to force designer and operator to reduce methane discharge during normal operation by technical and operational measures.

Within the current IGF Code (IMO MSC 95/3/4: Development of International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code), Annex "Draft International Code of Safety for Ships using Gases or other low-flashpoint Fuels (IGF Code)") functional requirements for fuel supply, storage and bunkering arrangements are defined to prevent gas discharge under all normal operating conditions including idle periods. Settings of Pressure Relieve Valves of the tank are to be defined to minimize unnecessary release of vapour.

The ISO's Technical Specification 18683 defines within chapter "8.4 Prevention of release of LNG or natural gas to atmosphere" functional requirements for the design and operation of the system to prevent release of LNG or natural gas for safety and environmental reasons.

In addition design criteria for combustion engines are in discussion aiming at the prevention of release of unburnt gas (methane slip, crankcase emissions).

The above mentioned rules and guidelines demanding operational procedures within their functional requirements but do not define prescriptive guidance on that. Operational guidelines for e. g. boil-off gas handling, purging are still missing.

Recommended actions

- 1) EU to identify a (standardization) body to develop the requirements for a 'Methane Release Management (or Mitigation) Plan'.
- 2) EU to ensure enforcement of this Plan via a specific annex in a future revision of the IGF code in order to become part of the mandatory requirements for LNG fuelled ships
- 3) Evaluate to enforce certification of this Plan by a recognised body.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To give guidance on **current rule framework** as it already demands operational guidelines to reduce methane discharge.
- 2) To ensure **comprehensive procedures** covering all relevant operational modes where methane could be discharged to atmosphere.
- 3) To reduce the **lack of knowledge** by designer and operators regarding the environmental impact on methane discharge to the atmosphere

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Non-compliance with emission regulations/limits
- 2) More difficult acceptance process of LNG as environmental friendly solution
- 3) Violation of permits conditions due to environmental reasons



Prioritisation

Impact on LNG small scale market development

This measure would ensure the environmental advantages of gas-fuelled ship installations in comparison to oil-based systems. The introduction of further technical measures as e.g. catalytic burners for exhaust gas treatment could lead to higher investment and operational costs for specific systems. Overall this measure is expected to have a positive impact on the acceptance of the technology to be an environmental friendly solution. This step is not considered as a time-critical step.

This measure is seen as guidance for existing rules and standards. Until no common guidelines are available the operator and designer are obliged to develop their own guidelines and technical measures and to present this to the competent administration. Common guidelines will reduce in a first instance time and costs for the designer and operator by developing these guidelines.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

As efforts must be taken for the development of guidelines by a standardization body, the time investment is perceived to be significant.

Evaluation implementation effort	--
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11.2 Additional gaps and preliminary recommendations

11.2.1 Compliance with fuel sulphur limitations

Gap 17:		
<i>Clear instructions on how to control and follow-up the stricter sulphur regulations, valid as from January 2015, are missing.</i>		
Gap type:		
Legal gap	Harmonization gap <input checked="" type="checkbox"/>	Knowledge gap

11.2.1.1 Background

In 2015, shipping is taking a big step towards becoming greener. Stricter limitations on sulphur emissions in Emission Control Areas will significantly reduce the industry's footprint in terms of pollution from the 1st of January onwards. When ships pass through an ECA, their fuel oil will only be allowed to contain a maximum of 0.10% sulphur (MARPOL Annex VI).

The Implementing Act with the 2012/33/EU Directive as regards the sulphur content of marine fuels requires that as from January 2016, Member States shall carry out inspections of ship's log books and bunker delivery notes on board of at least 10% of the total number of individual ships calling in the relevant Member State per year.

EMSA published in January 2015 (in conjunction with this Act), Sulphur Inspection Guidelines to be used by Sulphur Inspectors to ensure harmonised and effective checks throughout Europe. The Sulphur Inspection Guidelines aim at guaranteeing that policing of sulphur emissions, administered by individual EU member states, would be consistent and well-coordinated. The guidelines state that proof of fuel's 0.1% sulphur content should be demonstrated by bunker suppliers before delivery of the fuel to the ship, as well as on board, to ensure that vessels will not be penalised because of unscrupulous fuel suppliers.

At this moment, it is not clear how the Penalty policies (strict enough to demotivate infraction) will be adopted by each Member State.

Proper enforcement of the obligations with regard to the sulphur content of marine fuels is necessary in order to achieve the aims of Directive. The experience from the implementation of Directive 1999/32/EC has shown that there is a need for a stronger monitoring and enforcement regime in order to ensure the proper implementation. To that end, it is necessary that Member States ensure sufficiently frequent and accurate sampling of marine fuel placed on the market or used on board ship as well as regular verification of ships' log books and bunker delivery notes. It is also necessary for Member States to establish a system of effective, proportionate and dissuasive penalties for non-compliance with the provisions of the Directive.

Currently, in Europe less than 1% of all commercial vessels are inspected annually for sulphur compliance. Half of these are found non-compliant. Fines for SECA non-compliance (varying between EU Member States and depending on the nature of non-compliance from 1500-85000€) do not match potential savings, leading to non-compliance as a competitive advantage. US, Denmark, Finland are, or will be, implementing more rigorous inspections with other countries likely to follow.

11.2.1.2 Recommendation and action plan

Recommendation 17:

Create a level playing field with regard to harmonisation of fines related to non-compliance to the stricter sulphur limitations.

Aim of recommendation

This recommendation aims at providing a framework for fair and equal level of fines in the different member states.

Scope of recommendation

Sanctions are within the Member State's competence, Member States should notify the provisions on penalties to the Commission which will monitor Penalties schemes in the EU Member States (the need for coordination between Member States is addressed in the ESSF sub-group on implementation)

Recommended actions

The recommended line of actions is:

- 1) Define and execute a project plan to harmonise the fine level between Member States, making sure that the fines for non-compliance are sufficiently dissuasive.
- 2) Identify and engage with EMSA and Member States the future inspection technologies under consideration:
 - a. Helicopters and/or drones for remote exhaust gas sampling / screening
 - b. Use of "sniffing" devices (test installation on Great Belt Bridge, Hamburg)
 - c. Combined AIS and "sniffing" devices on all vessels

Justification for recommendation

Penalties under Sulphur directive must be effective, proportionate and dissuasive, to include fines calculated to ensure that fines at least deprive those responsible of the economic benefits derived from their infringement, and gradually increase in case of repetition.

Consequences of non-implementation

Non-implementation of this recommendation will result in unfair competition and might lead to non-compliance adversely affecting the acceptance of LNG as a marine fuel.

Prioritisation

Impact on LNG small scale market development

Having an adequate enforcement scheme with proportional fines is a critical requirement for the business case of considering LNG as a marine fuel.



Evaluation impact small scale market development	++
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Implementation effort (time, cost, legal)

Developing a harmonized approach between Member States will be time-consuming and demanding careful stakeholder management.

Evaluation implementation effort	--
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11.2.2 Emergency repairs

Gap 18:

Potential lack of knowledge with regards to salvage of stranded LNG fuelled vessels/LNG carriers and lack of harmonised requirements for shipyards receiving LNG fuelled vessels/LNG carriers for emergency repairs.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap	<input checked="" type="checkbox"/>
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11.2.2.1 Background

As LNG is a dangerous substance, emergency repairs and salvage of stranded LNG fuelled vessels require special attention.

SALVAGE - General guidance on salvage of stranded vessels is governed by IMO regulations (IMO convention of salvage, 1989), although no specific guidance exists for LNG fuelled vessels. It needs to be mentioned that each ship casualty is unique and the challenges thrown at the salvor are always different and resulting from a case by case evaluation. However the common theme when salvaging a ship containing LNG (or by extension any form of gas or liquefied gas), is the understanding of the relevant containment systems and the associated risks. Specific guidance on salvage of LNG fuelled ships/LNG carriers is lacking, possibly because of the excellent safety track records of LNG ships. With the expected growth of the LNG fuelled fleet salvors need to be prepared for what may well occur in the future.

EMERGENCY REPAIRS - Specific requirements will be imposed by shipyards that want to give access to LNG fuelled vessels for emergency repairs, although a unified approach is absent. For personnel performing repair activities on LNG installations, specific harmonised requirements regarding knowledge and experience with LNG should be developed.


11.2.2.2 Recommendation and action plan

Recommendation 18:

Consider to harmonise the requirements for emergency repairs (including competence requirements of personnel performing these activities) of LNG fuelled vessels in shipyards and develop initiatives to build competence and knowledge with regard to salvation of LNG fuelled vessels.

Aim of recommendation

With an increasing number of LNG (fuelled) ships, the need for carrying out emergency repairs on these vessels or salvage of these vessels might rise. Industry best practice for gas tankers including LNG carriers is that most repair work, in particular "hot" work including welding, grinding and flame cutting, is prohibited for ships in gas condition. These best practices are pertinent to gas tankers globally and not harmonized across Europe.



Despite the fact that salvage of LNG (fuelled) vessels remains a case by case evaluation, LNG salvage procedures and processes needs to be developed to increase overall LNG knowhow of salvors that may be tasked with future LNG casualties.

This recommendation aims at

- 1) Enabling safe emergency repairs on gas fuelled ships, possibly including ships in gas condition (ie having gas in the fuel tank and gas system).
- 2) Enabling safe salvation of gas fuelled ships
- 3) Providing consistency in Europe.
- 4) Avoiding competition between yards and ports compromising on safety.
- 5) Developing a common framework for Search and Rescue (SAR) services

Scope of recommendation

Implementation at EU level – emergency repairs: the preferred channel is through CESA in a first stage; salvage: the preferred channel is through EMSA

Recommended actions

- 1) Develop an inventory of current practices on shipyards that are performing repairs on gas (fuelled) carriers. Undertake a GAP analysis in order to develop a consistent framework of safety management system, work permit system and worker competence to perform emergency repair on LNG fuelled ships.
- 2) Establish communication with CCNR for implementing similar requirements for LNG fuelled ships on inland waterways.
- 3) Identify specific knowledge gaps with regard to Marine Salvage of LNG (fuelled) stranded vessels, accounting for the different types of Marine Salvage: Towing, re-floating a sunken or grounded vessel, repairing (emergency/shipyard). Salvage classification (offshore salvage, harbour salvage, cargo and equipment salvage, wreck removal, afloat salvage and clearance salvage) needs to be considered.
- 4) Develop harmonised LNG salvage procedures and processes, with at minimum following topics to be addressed:
 - a. Safety, protection, isolation, containment, explosion/ignition prevention
 - b. Inerting
 - c. Damaged Stability of the LNG vessel
 - d. Operation of heavy lift equipment/ heavy-lift cranes
 - e. Considerations regarding containment system
 - f. Salvage procedures, safeguarding fuel tank integrity
 - g. Preparation procedures and other operational aspects
- 5) Develop a harmonized framework for Search and Rescue (SAR) services including emergency towing and first responders concerning LNG fuelled ships.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) The increasing number of ships using LNG as fuel will make it more and **more likely** that an **emergency repair** needs to be carried out.
- 2) **Not all emergency repairs will justify inerting** the ship. Some emergency repairs may be safely carried out provided management systems and competences are in place.
- 3) **Emergency repairs may be carried out at sea**. SAR services, provider of emergency towing services and first responders must know what repairs may be carried out on scene in gas condition and what require a gas free condition of the vessel.
- 4) To **increase LNG knowledge of salvors** that may be tasked with future LNG casualties

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) An increased potential for accidents.
- 2) An unnecessary cost disadvantage of emergency repair work on LNG (fuelled) ships (if inerting is per definition required).

Prioritisation

Impact on LNG small scale market development

This measure would improve transparency with regards to emergency repairs on and salvage of LNG fuelled ships. This measure will stimulate job creation and may pose an opportunity for European repair yards. The impact on LNG uptake is perceived to be neutral.

Evaluation impact small scale market development	0
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Implementation effort (time, cost, legal)

This step is not considered as a major time investment. Assessment needs to be done to what extent current IMO/EMSA procedures needs to be updated.

Evaluation implementation effort	-
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11.2.3 Equipment standardisation

Gap 19:

Standardisation of equipment requirements for small scale LNG (incl. refuelling stations) is lacking.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.2.3.1 Background

EU-wide introduction of LNG bunkering requires the need for standard and compatible solutions. For instance, standardization of safety systems/couplings and design requirements of (safety) equipment in LNG bunkering is preferable to ensure compatibility between the supplier and the receiving vessel. This will ultimately enhance the development of the small scale LNG supply chain.

Equipment requirements for small scale LNG are limited, although some of the existing standards for large scale LNG could be adapted to develop requirements for the equipment used during small scale LNG bunkering. In ISO/TS 18683, an overview of applicable standards to components of the LNG bunkering transfer system related to onshore installations is given.

However, Norway has built a small scale LNG supply network without the availability of such small scale standards. The development of these standards is thus not strictly necessary and has to be seen as a suggestion for improvement.

The European Commission will issue (at least) 2 standardisation requests related to Directive 2014/94/EC on the deployment of alternative fuels infrastructure.

The first is for standards on refueling points and connectors, including a European standard based on ISO/TS 18683 from ISO/TC 67. The Sector Forum Gas Infrastructure has been asked to coordinate work for natural gas in CEN/TC 301, CEN/TC 282, CEN/TC 326 and CEN/TC 408.

The second is on labelling to address article 7. A dedicated CEN/Project Committee will be created during next CEN/BT meeting in March.

11.2.3.2 Recommendation and action plan

Recommendation 19:

Develop standards for small scale LNG equipment (incl. refuelling stations), in order to harmonize the equipment used for LNG as fuel.

Aim of recommendation

The aim of this recommendation is to define standards for the equipment typically used for bunkering, in line with the scope of its application, for all dimensions including small scale LNG applications.

Scope of recommendation

Implementation at least on EU level but preferably at international level at aiming international publications e.g. ISO standards.

Recommended actions

- 1) Closely monitor the progress and activities of ISO's Technical Committee 8 (Ships and marine technology) WG8, who have just initiated work on LNG bunkering standards. The Working Group started its work in February 2015 and is expected to develop the standard within the next two years.
- 2) Closely monitor the progress and activities of ISO's Technical Committee 67 who will continue the work published in the ISO/TS18683 with a.o.t. an update of this TS within 3 years.
- 3) Establish/monitor a good liaison between ISO TC8WG8, ISO TC67SC9WG1 and TC28 in order to ensure alignment and effective cooperation between these groups.
- 4) Evaluate the need for a formal coordination in the form of joint TCs

Justification for recommendation

There is a need for a clear definition of the connecting points between the supplier and receiver (connectors, ESD link etc). ISO/TS18683 addresses functional requirements and informative examples with as main aim to release guidance asap in the form of a Technical specification to be updated within 3 years. But in order to establish an international practice for bunkering, standardised connectors are essential.

Consequences of non-implementation

This recommendation aims to avoid that vessels served by different LNG bunker suppliers across EU ports would be confronted with significantly different bunker connectors, leading to confusion or inability to connect at best and potential unsafe operations and incidents at worst.

Prioritisation

Impact on LNG small scale market development

This measure would significantly facilitate the widespread uptake of LNG as fuel by eliminating uncertainty. Overall this measure is expected to have a strong positive impact on LNG-as-fuel developments.

Evaluation impact small scale market development	+++
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Implementation effort (time, cost, legal)

This step is considered as a time-critical step. Standards for bunkering equipment should be in place as soon as possible to ensure smooth market development.

The effort is estimated as significant, however, as work is already initiated by ISO and CEN, the *additional* implementation effort is considered limited. For standards there is no automatic legal obligation to apply them. However, national laws and regulations may refer to them and hence enforce compliance.

Evaluation implementation effort	--
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11.2.4 Experience and knowledge of permitting authorities

Gap 20:

Lack of experience/knowledge of permitting authorities involved with small scale LNG developments in parallel with absence of standards, leading to long permitting processes/lots of extra studies.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap	<input checked="" type="checkbox"/>
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11.2.4.1 Background

The respective authorities (local, member state or European level) are not sufficiently familiar with LNG, in terms of LNG risks and potential benefits. Combined with a shortage of skilled people with specific knowledge on LNG and LNG installations at authorities, and lack of standards this might lead to an overkill of studies to be executed for LNG developments and result in long permit processes.

11.2.4.2 Recommendation and action plan

Recommendation 20-1:

Increase knowledge/experience of permitting authorities by partnership in so called LNG platforms with participation of industry, and provide a digital information platform with LNG key information.

Aim of recommendation

The aim of this recommendation is for the Regulator to increase overall knowledge and expertise in LNG related matters like LNG hazards, challenges, opportunities and best practices to ensure the safety of people, the protection of property and the safeguard of the environment.

This recommendation aims at ensuring smooth and transparent permit procedures via the enhancement of subject matter expertise of the authorities involved. This increased knowledge of Regulators in small scale LNG is best realized through active collaboration between industry and Regulators via so called LNG platforms. These LNG platforms should bring together permitting experts, technical experts and assessment experts.

Project developers would clearly benefit from this recommendation. Increased knowledge by Regulators will have a positive impact on the overall acceptance of LNG projects. Via these 'LNG platforms', Regulators -responsible for permitting- double benefit from this setting, by having the possibility to build competence and in addition being able to draw on external experts.

Scope of recommendation

Implementation at EU level - As LNG and LNG transportation is per definition transboundary and from a viewpoint that environmental legislation is governed at EU level (SECA's), it seems obvious that a European LNG Platform – initiated by EU – should be established to share expertise, best practices and define harmonized solutions for LNG-as-fuel permitting matters.

Implementation at Member State level - This European LNG platform should have a local anchorage in each Member State (via National LNG platforms) to deal with Member State specific issues.

These LNG platforms would group at minimum: Ports, permitting authorities, Ship owners, O&G companies, Terminal operators, Equipment manufacturers, consulting companies,

Recommended actions

- 1) EU to identify and engage with **industry players or sector groups** which will consider owning and/or operating these LNG-as-fuel installations into so called LNG platforms.
- 2) Provide a **digital information platform** with LNG key information to share amongst stakeholders

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To reduce the **lack of knowledge** by regulators, often leading to overkill of environmental studies
- 2) To reduce the **risk of delays** in permitting procedures.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Authorities not well staffed/lacking competence to handle permits
- 2) Increased risk of delays in permitting of LNG as fuel installations
- 3) Non acceptance of permits
- 4) Unnecessary overload of project justification study reports.

Prioritisation

Impact on LNG small scale market development

This measure would improve overall acceptance of LNG projects and facilitate the permitting process. Overall this measure is expected to have a positive impact on the effectiveness/duration of the permitting procedure and therefore on small scale LNG-developments

Evaluation impact small scale market development	++
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Implementation effort (time, cost, legal)

Several Member States have initiated or are in the phase of initiating such platforms (a.o. the Netherlands, Germany). As the introduction of this measure would not require adaptation of EU-legislation or Member State legislation, there is no legal impact by this measure. As participation into this network should be on a voluntary basis, this measure seems to be cost neutral. This step is not considered as a time-critical step.

Evaluation implementation effort	0
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Recommendation 20-2:

It is recommended to draft a list of rules, requirements, criteria and conditions that can be applied in permitting and supervision of small scale installations.

Aim of recommendation

The aim of this recommendation is to give guidance to LNG project developers and Authorities responsible for permitting via a framework of minimum requirements that can be applied in permitting and supervision of LNG as fuel installations. By adherence to these guidelines, project developers are supposed to have a strong position at authorities and a smooth permitting process.

Scope of recommendation

Based on the current state of the art, this guidance document should give a summary of regulations, requirements, criteria and conditions in order to design, construct and manage LNG as fuel installations.

It will be considered as the reference framework for granting licenses and permits, drawing up general rules and monitoring companies. These guidelines should be formulated such that should the case arise a company can choose other measures on an equivalence basis.

In order to allow for harmonization it is suggested that the EU defines a common standard, to be detailed on local level for legal compliance.

Recommended actions

- 1) EU to identify and engage with **industry players** which will consider owning and/or operating these installations or linked interfaces to define a set of minimum requirements.
- 2) Member States to draft a publication with minimum requirements for designing, constructing and operating a small scale LNG installation based on EU-input

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To complement **current permit regulations** as they are not LNG specific.
- 2) To **increase transparency** in the minimum requirements to construct, build and operate a small scale LNG terminal.
- 3) To reduce the **risk of delays** in permitting procedures.
- 4) To reduce the **lack of knowledge** by regulators

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Increased risk of delays in permitting of small scale installation.
- 2) Non acceptance of permits
- 3) Unnecessary overload of project justification study reports.



Prioritisation

Impact on LNG small scale market development

This measure would improve overall acceptance of LNG projects and facilitate the permitting process. This measure is expected to have a positive impact on the overall permitting process therefore on small scale LNG-developments

Evaluation impact small scale market development

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Implementation effort (time, cost, legal)

The Netherlands have initiated such guidance document (PGS 33.2) and a.o. Belgium is developing a similar framework.

The publication should be referred to as guidelines (a general framework) rather than as formal legislation. This means that the introduction of these guidelines would not require adaptation of EU-legislation or Member State legislation. Therefore no legal impact is foreseen by this measure. As there is already a framework developed in the Netherlands, this could serve as a stepping stone.

This recommendation is not considered as a time-critical, neither in the sense of time investment nor in the sense of timing to start implementation.

Evaluation implementation effort

0

11.2.5 Public acceptance and involvement of stakeholders

Gap 21:		
<i>Legal frameworks foresee late involvement of stakeholders in the permitting process which can lead to significant delays.</i>		
Gap type:		
Legal gap	Harmonization gap	<input checked="" type="checkbox"/> Knowledge gap

11.2.5.1 Background

Lack of public acceptance poses a major hindrance for the implementation of projects. LNG as fuel developments are typically located closely to the end customers, leading to potential safety and other conflicts. These aspects will result in involvement and consultation of a lot of stakeholders. In order to have as little delay as possible in the permitting process, early cooperation with and involvement of relevant parties is recommended.

It is essential that the project developer provides target-group specific information at an early stage of the project and shows willingness to engage in communication with local communities. The developer should seek the dialogue with stakeholders to learn about their concerns and to be able to address them effectively. Support from the responsible authorities during the mandatory stakeholder meetings/public hearings is crucial. Each party should play its role in communication with the public. Industry's representatives may help in detailing the technical features of the project and how it will be developed. Policy makers should help building an understanding of political local consensus around the project.

11.2.5.2 Recommendation and action plan

Recommendation 21:
Initiate a process to ensure early involvement and cooperation between project developers, local and regional authorities, port authorities, NGO's, fire brigades and other stakeholders to get an idea on the suitability of locations for onshore LNG bunkering facilities, to guarantee a smooth permitting process and to identify potential showstoppers in an early stage.

Aim of recommendation

The formal requirements of stakeholder involvement in the framework of permitting procedures differ strongly between the Member States. This has a major impact on the effectiveness of stakeholder involvement and the degree to which stakeholders participate in the dialogues between the project developer and the authority. With this measure project developers would be stimulated to conduct an extensive stakeholder dialogue before submitting permit application documents.

This recommendation ensures that project developers take responsibility for informing stakeholders and creating a dialogue with them early in the project and in an effective manner. This would contribute to overall public acceptance of projects and avoidance of delays in permitting procedure.

Scope of recommendation

The stakeholder dialogues would be the responsibility of the project developer but could be monitored by the permitting authority. It should not take the form of a formal public hearing, so the forum is about engaging rather than submission of formal comments. The main purpose of this early stakeholder involvement is to discuss on a high level on the project, discussing on alternatives and eventually adapt the project in line with stakeholders' concerns. It should be a fixed step in the permitting procedure and be approved by competent authority.

Recommended actions

- 1) Ensure that **early stakeholder involvement** is a mandatory step in permitting procedures for small scale LNG installations.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To reduce the **risk of delays** in permitting procedures.
- 2) To reduce the **risk of public opposition** in projects

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Potentially affected stakeholders feeling that their concerns are not taken into account
- 2) Public opposition to the project
- 3) Increased risk of delays in permitting procedure.
- 4) Non acceptance of permits

Prioritisation

Impact on LNG small scale market development

This measure would ensure that stakeholders are informed and that their concerns are taken seriously, improving the overall acceptance of LNG projects and facilitating the permitting process. Overall this measure is expected to have a positive impact on the effectiveness of the permitting procedure and therefore on small scale LNG-developments

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

Minor adaptation of Member States' legislation would be required. Cost and time effort from authorities is estimated low as the project developers shall be responsible for carrying out the stakeholder meetings. Timing is not perceived as critical.

Evaluation implementation effort	-
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11.2.6 Deadlines in the permitting procedure

Gap 22:

Lack of decision making time limits for each permit/ permit step or lack of enforcement of these timings leading to long permitting processes and difficult manageability of the permit procedure.

Gap type:

Legal gap	<input checked="" type="checkbox"/>	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.2.6.1 Background

Although the permit processes tend to be rather transparent, various Member States have no clear deadlines for the different steps in the permitting procedure and/or no enforcement/consequences if the delays are not respected.

Imposing an obligation to authorities to respond within the agreed deadlines would reduce the risks for delays and allow project developers to better manage their projects. Preferably one authority is accountable for respecting the delays or 'authority of last resort' is defined on a national level, which may take the decision if local authorities fail to respect the deadlines.

Harmonised national policy frameworks and the definition of a list of key strategic LNG locations can be stimulated via the Implementing Acts of the Alternative Fuels Directive.

11.2.6.2 Recommendation and action plan

Recommendation 22-1:

Define clear legally binding target durations to each of the permit process steps and an effective intervention mechanism in case of delays.

Aim of recommendation

This recommendation aims at defining legally binding maximum durations for permit processes and process steps. These maximum durations should be in combination with mechanisms for enforcing these maximum durations. The overall purpose is monitoring the permit process and controlling the maximum time to receive authorisation.

Scope of recommendation

This recommendation focuses on the overall duration of the permit procedure for land based LNG small scale developments (small scale terminals and LNG fuel stations). In several Member States defined durations are in place for permit processes and permit process steps. Enforcement mechanisms are the critical factor. The role of the EU is to set a target duration for each process step and for the overall length of the permit procedure. As the overall responsibility for the permit process is at Member State level, Member States should define legally binding target durations for each process step. In the definition of target durations the whole permit process should be accounted for (from submission of

complete application until issuing of the permit). The enforcement mechanism should be established on Member State level and might include financial and non-financial incentives.

Recommended actions

- 1) Impose a **target duration** on EU-level (via EU Regulation) for the overall permit procedure of LNG small scale installations.
- 2) Member States, competent authorities should define **legally binding durations** for each permit process step based on target duration set at EU level.
- 3) Definition of an **effective enforcement scheme** (with financial or non-financial incentives) in order to comply with the durations.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To reduce the **risk of delays** in permitting procedures.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Increased risk of delays in permitting procedure.

Prioritisation

Impact on LNG small scale market development

This measure will enhance means of monitoring and controlling the permit procedure's progress. Overall this measure is expected to have a positive impact on the effectiveness of the permitting procedure and therefore on small scale LNG-developments.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

Even if the introduction of a target duration is set at EU level (EU regulation, Recommendation, ...), (minor) adaptation would be required to legislation in the Member States. The impact on costs is perceived as neutral to slightly negative. Monitoring compliance to the defined target durations might be enforced via existing governmental bodies. Dependent on how this measure is introduced this might lead to a slight increase in fees paid by authorities to project developers. Timing is not perceived as critical.

Evaluation implementation effort	-
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Recommendation 22-2:

Evaluate to define a list of 'strategic' small scale LNG developments and facilitate the permit process via specific laws.

Aim of recommendation

This recommendation aims at identifying a list of small scale LNG developments of strategic interest on EU level. The implementation of this measure would ensure that these projects are prioritised in order to ensure the efficient, balanced build-up of an LNG fuel station network across Europe, aligned with the strategy adopted under the Alternative Fuels Directive.

Scope of recommendation

The Commission has proposed binding targets on Member States for a minimum level of infrastructure for clean fuels including natural gas. To that respect LNG refuelling stations are to be installed in all 139 maritime and inland ports on the Trans European Core Network by 2025 and respectively 2030.

Defining a list of priority projects is a key element in order to comply with this clean fuel strategy and for creating transparency of these projects at Member State and EU level. Projects of this list and therefore endorsed by EU and Member States could for instance benefit from a facilitated permit procedure. This should speed up the procedure and reduce uncertainty about the acceptance of the project justification by individual authorities.

Recommended actions

- 1) Define a set of **key projects** on EU-level
- 2) Develop a **time schedule for stepwise implementation** of these projects
- 3) Develop on EU level a '**standard permitting process**' for these key projects

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To allow for LNG refuelling stations in major ports within the delays.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Non respect of the EU ambitions on LNG fuelling stations.

Prioritisation

Impact on LNG small scale market development

This measure will enhance the development of critical small scale LNG infrastructure.

Evaluation impact small scale market development

+



Implementation effort (time, cost, legal)

The definition of key projects is to be defined on European level via input from the Member States. Those projects can be adopted by EU Regulation (e.g. implementing act), which is binding to the Member States. No adaptation would be required to legislation in the Member States.

The definition of measures to have this critical LNG-infrastructure in place has already been initiated. Defining a list of key projects seems to have a low impact on costs. Therefore this is perceived as neutral. Timing is not perceived as critical.

Evaluation implementation effort

0

11.2.7 Involvement of multiple authorities in permitting process

Gap 23:

Involvement of too many authorities in the permit process leading to delays and lack of clarity to which authority to address to.

Gap type:

Legal gap	<input checked="" type="checkbox"/>	Harmonization gap	Knowledge gap	<input checked="" type="checkbox"/>
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11.2.7.1 Background

In most EU member states, many different authorities are involved in the LNG development decision process, leading to a long permit process. In addition project developers often do not know which authority to address to.

A one-stop-shop for small scale LNG development should be installed with full responsibility for permit process or alternatively for the overall coordination of the permit process. Ideally the project developers should not go to the various municipalities, provinces, states to obtain the permits. The designated authority does the overall coordination and manages the whole process. This might impact the relevant legal frameworks in the Member States. EU might define the objectives, status and power of such a national coordination body, without of course compromising on the subsidiarity principle.

If several Member States would be affected by a development (seems more applicable to large scale development) a trans-border coordinator should be appointed.

11.2.7.2 Recommendation and action plan

Recommendation 23-1:

Establish a single contact and coordination authority (one-stop-shop-principle) for permitting procedures of small scale LNG development.

Recommendation 23-2:

Explore the idea of an all-in-one-permit to simplify the permit process of small scale LNG developments.

Aim of recommendation

This recommendation aims at having one authority responsible for handling the complete permitting process. If deployed to the full extent that competent authority would have full responsibility for the process and the final issuing of the (single) permit.

Scope of recommendation

This one-stop-shop should be established at Member State level. The specific situation of Member States should be accounted for (e.g. Federal States). The EU can play a facilitating role in transferring

knowledge and good practices from Member States where this one-stop-shop principle is already implemented to other Member States considering to introduce it.

Recommended actions

- 1) Define a **one-stop-shop** on Member State level with full responsibility for the permit process including issuing final permit
- 2) Definition of project types under responsibility of the one-stop-shop

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) Limit the complexity in permit processes
- 2) To reduce the **risk of delays** in permitting procedures.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Project developers need to go to various states, provinces, municipalities, ...
- 2) Delays in permits for projects.

Prioritisation

Impact on LNG small scale market development

The lower complexity of the process (reduced procedure) is believed to shorten the duration of the permitting process, having a positive impact on the permitting process and therefore on the development of small scale LNG infrastructure.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

Adaptation would be required to legislation in Member States where one stop shop principles are not yet in place. Depending on the permitting process complexity this might involve a serious effort.

The impact on costs is assessed as limited, being the establishment of a (new) administrative body.

In States with complex procedures (lot of authorities involved, Federal States, ...), time efforts to establish the legal frame might be significant.

Evaluation implementation effort	--
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11.2.8 Transparency in permit process

Gap 24:

Lack of transparency in documentation needs to obtain permits for (non Seveso) small scale LNG development

Gap type:

Legal gap	<input checked="" type="checkbox"/>	Harmonization gap	Knowledge gap	<input checked="" type="checkbox"/>
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11.2.8.1 Background

Although the permit processes are well enforced by law, the overall process is not fully transparent to all involved parties, including information on milestones/deadlines (see gap 22), authorities responsible (see gap 23), documents to be produced,

Specifically for small scale developments with LNG storage capacities below 50 tonnes a legal frame is absent in various Member States and therefore it is unclear which reports should be issued. Practices in several Member States show that e.g. safety assessments are demanded anyway. The lack of insufficient knowledge on the reports to be produced for permitting process carries the risk that a delay might become apparent only when it is too late to counteract it. It also makes it extremely difficult to steer the procedure to ensure high quality results within given timeframes.

11.2.8.2 Recommendation and action plan

Recommendation 24:

Clearly define on Member State level the (environmental) reports that need to be in place for (non Seveso) LNG small scale developments for obtaining an environmental permit.

Aim of recommendation

This recommendation aims at increasing transparency on the progress of permitting procedures with respect to environmental documentation. Today this is only partly enforced by a regulatory framework and partly up to an ad hoc assessment of the permitting authority.

Scope of recommendation

Defining a standard set of environmental reports to be drafted is a key element in order to create transparency for these projects at Member State and EU level. For projects covered by EIA-directive and Seveso-directive, the need for environmental documentation is set at EU-level. This recommendation mainly focuses to developments not in scope of both directives. It is suggested that a framework is set at EU level and that this is further implemented at Member State level.

Recommended actions

- 1) Develop on EU level a '**standard documentation requirements**' for small scale LNG projects
- 2) Transpose this EU guidance in formal document requirements at Member State level

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) Have a clear view on the environmental documentation needs at the start of project development
- 2) To limit the overload of environmental documentation.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Potential delays in permitting processes.

Prioritisation

Impact on LNG small scale market development

This measure will enhance clarity in the permit process and will have a neutral to slightly positive effect on the development of critical small scale LNG infrastructure.

Evaluation impact small scale market development	0
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Implementation effort (time, cost, legal)

The definition of key documentation is to be defined on European level, eventually via input from the Member States. Minor adaptation would be required to legislation in the Member States.

Defining a list of key environmental documentation has a low impact on costs. Therefore this is perceived as neutral. Timing is not perceived as critical.

Evaluation implementation effort	0
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11.2.9 Failure case definition

Gap 25:

A clear and detailed failure case (scenario) definition for small scale LNG infrastructure and activities is missing because of lack of operational experience.

Gap type:

Legal gap

Harmonization gap

Knowledge gap



11.2.9.1 Background

A comprehensive identification of potential hazardous scenarios is critical for many purposes (risk assessment, definition of safety zones, ...). Typical accident and loss of containment scenarios based on historical incident data can be assessed on relevance and should be complemented with the outcomes of a site specific HAZID. Due to the fact that there is lack of experience, there is a need for a complete and detailed definition of credible accident scenarios that can occur during the operation of small scale LNG installations and activities.

11.2.9.2 Recommendation and action plan

Recommendation 25

Develop a complete and detailed definition of credible accident scenarios that can occur during the operation of small scale LNG installations and activities.

Aim of recommendation

The aim of this recommendation is to provide a comprehensive identification of potential hazardous scenarios to improve the (quantitative) risk assessment process and to serve as a good basis for emergency response scenarios. This recommendation also allows for improved process of identification and assessment of mitigating measures.

This recommendation also aims at improving the risk assessment part in the permitting process and in particular the implementation of Member State specific land-use planning methodology (scenario definition is a critical part in any approach).

Scope of recommendation

The scenario definition should be developed for all potential bunker configurations. A complete and detailed definition of accident scenarios requires consideration of amongst others:

- a wide range of operating modes for each bunker configuration;
- common design and equipment list for LNG installations covering a wide range of possible configurations;

- causes leading to accident scenarios (visualisation by means of fault tree) based on historical incident data or expert judgement;
- consequences of such accidents (event tree).

Recommended actions

The following actions are proposed:

- 1) Initiate on EU level a working group of risk analysts and LNG experts/operators. Their task would be to perform a detailed HAZID identification study (scenario list) and to develop a fault and event tree, detailing respectively the causes of accident scenarios (Loss of Containment scenarios) and the consequences of such event and this for various bunkering configurations. Several LNG bunkering HAZID studies have been conducted elsewhere and could be taken into consideration for use as a basis or as example, e.g.:
 - a. HAZID examples/classification from Germany/Norway (DNV GL) joint submission to BLG17 (30NOV2012 – BLG17/INF.11)
 - b. North European LNG Infrastructure Project³⁸ – A feasibility study for an LNG filling station infrastructure and test of recommendations, Danish Maritime Authority, March 2012
 - c. HAZID of Small Scale LNG activities facilitated by DNV GL for the Dutch LNG Safety Program³⁹
 - d. Reference is also made to the current developments⁴⁰ in the Netherlands regarding scenario definition.
- 2) On the long term, review the quality of the above, based on operational experience via data from dedicated LNG accident/incident/near-miss database along (recommendation 29).
- 3) Initiate experimental test programs for LNG equipment to assess potential failure modes. Knowledge regarding failure modes contributes to the failure case definition.
- 4) Promote risk analysis – based on the above defined scenario list- as a standard EU-wide approach for LNG bunkering (see also recommendation 9-1).

Justification for recommendation

The main reasons why this recommendation was developed are the following:

A comprehensive identification of potential hazardous scenarios is critical in risk analysis. Accident and loss of containment scenarios are generally defined based on historical incident data and further assessed on relevance and completeness by means of a site specific HAZID. As limited historical data is available, there is a need for a complete and detailed definition of credible accident scenarios that can occur during the operation of small scale LNG installations and activities. The above set of 'credible' accident scenarios is additionally needed by authorities for land use planning purposes.

³⁸ Link to the project documentation can be found here:

<http://www.dma.dk/themes/LNGInfrastructureproject/Sider/Referencedocuments.aspx?RootFolder=%2fthemes%2fLNGInfrastructureproject%2fDocuments%2fFinal%20Report&FolderCTID=&View=%7b8CAC73ED-8773-4212-A313-95B58922F116%7d>

³⁹ DNV GL Report: HAZID Small Scale LNG activities, Report No.: PP099739-1, Rev. 2, 2014-11-17

⁴⁰ Projects and developments such as: Dutch Safety Program, LNG-specific risk calculation guidelines, research into failure frequencies for LNG transfer equipment and pressurized storage tanks.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Possible over- or underestimation of risk in LNG risk assessments by e.g. defining 'standard' accidental scenarios (due to lack of knowledge) that are not applicable, representative or suitable for LNG small scale activities.
- 2) Inconsistencies in scenario definition across the EU (for those countries who have adopted a risk analysis approach) potentially resulting in different safety requirements and (external) safety distances.
- 3) Development of parallel initiatives or research programs across the EU member states (e.g. safety programs: HAZID's and experimental testing) into the definition of credible accident scenarios for LNG activities. This would be inefficient in terms of time and cost and should be preferably coordinated on EU-level.

Prioritisation

Impact on LNG small scale market development

This recommendation would be beneficial for the permitting process as it enhances the uniformity/standardisation of the risk analysis process. The influence on small scale LNG developments is perceived to be neutral.

Evaluation impact small scale market development	0
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Implementation effort (time, cost, legal)

The total effort with regards to cost is considered high if all recommended actions would be implemented. It is worth to mention that the availability of existing information, studies and current research programs could reduce the total implementation effort considerably.

As the introduction of this recommendation would only require change in guidelines/standards, it is not expected to result in adaptation of EU-legislation nor Member State legislation. As such there is no legal impact by this measure.

Evaluation implementation effort	-
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11.2.10 LNG-specific failure frequencies

Gap 26:

Lack of qualitative LNG-specific failure frequencies for small scale applications.

Gap type:

Legal gap	Harmonization gap	Knowledge gap	<input checked="" type="checkbox"/>
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11.2.10.1 Background

There are currently no LNG specific failure frequencies for small scale due to the lack of available incident data. Risk analysts are forced to use release frequency data from generic sources. There is, however, a strong believe among owners and designers of LNG equipment that release frequencies from LNG-specific equipment and piping should have lower values than those from generic sources. Therefore, QRA results based on generic release frequencies are believed to be conservative for LNG applications. It is unknown to what extent this conservatism could potentially drive the calculated risk of LNG installations to high, thus requiring the implementation of (expensive) risk reduction measures or require large external safety distances.

11.2.10.2 Recommendation and action plan

Recommendation 26

It is recommended to develop LNG-specific failure frequencies (linked with incident reporting) for use in risk assessments.

Aim of recommendation

The aim of this recommendation is to define LNG-specific failure frequencies to assure sufficient quality and more realistic risk assessments for small scale LNG installations and activities. The ultimate aim of this recommendation is to improve the risk assessment part as part of the permitting/approval process.

Scope of recommendation

LNG-specific failure frequencies should be determined for accident scenarios that could occur in various bunker configurations: truck-to-Ship bunkering; ship-to-Ship bunkering (also bunkering in transit); mobile tank-to-Ship; bunker stations.

The definition of LNG-specific failure frequencies requires consideration of, e.g.:

- The influence of various operating modes, bunker configurations and associated equipment counts.
- Differentiation in release sizes (e.g. ranging from leakages with varying sizes to catastrophic rupture).
- Linking a failure frequency with an accident scenario (the frequency assessment) based on e.g.:

- an in-depth analysis of failure modes (fault tree analysis) and event tree analysis;
- historical incident data (data from incident reports). In the absence of experience data information from comparable operations or equipment can be used possibly supplemented by theoretical modelling (simulations), or;
- expert judgement.

Recommended actions

The following actions are proposed:

- 1) Develop a dedicated LNG accident/incident/near-miss database (see recommendation 29), in order to extract LNG-specific failure frequencies. This is perceived as a long term solution as gathering sufficient data for statistical significance will require a significant time period
- 2) On short term: Initiate a working group of risk analysts and LNG experts/operators eventually in combination with the suggested working group from recommendation 25. Their task would be to define failure frequencies for LNG equipment based on the best available information and techniques for frequency assessment. Reference is made to a similar study recently initiated by the National Institute for Public Health and the Environment (RIVM, the Netherlands).

Justification for recommendation

The main reason why this recommendation was developed is the following:

There is a strong belief amongst owners and designers of LNG equipment that release frequencies from LNG-specific equipment and piping should have less conservative values than the current datasets (e.g. HCRD dataset). Therefore, QRA results based on published release frequencies (derived from relatively old accident data) are believed to be too conservative for LNG applications, potentially requiring the implementation of (expensive) risk reduction measures or leading to large external safety distances and/or safety zones.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Possible unrealistically high risk outcome in LNG risk assessments, which could have a negative impact on overall LNG project acceptance (too large distances, expensive safeguards, ...).
- 2) Possible development of parallel initiatives/studies across the EU member states into the definition of failure frequencies for LNG equipment. Reference is made to the previously mentioned developments in the Netherlands. This would be inefficient in terms of time and cost and should be preferably coordinated on EU-level.



Prioritisation

Impact on LNG small scale market development

This recommendation would facilitate the permitting as it improves the risk analysis process. The outcome would most likely result in a more realistic/lower risk profile. It could therefore open up more possibilities in terms of land-use planning and integration of LNG bunkering into existing terminals/energy ports. Moreover, it can potentially lower the (high) perceived risk towards LNG as fuel as well. Therefore, it could eventually increase the overall acceptance of LNG projects. Overall, the recommendation is expected to have a positive influence on small scale LNG developments.

Evaluation impact small scale market development	++
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Implementation effort (time, cost, legal)

The total implementation effort with regards to cost and time is considered to be 'medium'. The dedicated LNG accident/incident/near-miss database is suggested in a parallel recommendation (recommendation 29) as a solution on the long term.

Defining failure frequencies on the short term could be established via an expert group. This effort is to be considered as limited. The outcomes of the research initiative started by the RIVM could reduce the required cost and time for the research study to be conducted by the proposed working group.

As the introduction of this recommendation would not require adaptation of neither EU-legislation nor Member State legislation, therefore there is no legal impact by implementing this recommendation.

Evaluation implementation effort	-
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11.2.11 Software tools

Gap 27:

Harmonized and specific requirements for the use of software tools in consequence and risk calculations for LNG installation do not exist.

Gap type:

Legal gap

Harmonization gap



Knowledge gap

11.2.11.1 Background

Consequence and risk software model can produce different outcomes. When used to determine external safety distances in land use planning, different European countries may predispose different external safety distances for the same installation.

11.2.11.2 Recommendation and action plan

Recommendation 27

It is proposed that a list of LNG-approved consequence and risk software tools is prepared and enforced for consequence and risk assessment. The approved models should be periodically maintained, verified and validated in order to establish that accurate results for LNG installations are generated. Model validation for LNG releases is of particular importance.

Aim of recommendation

The aim of this recommendation is to ensure that appropriate software modelling tools are used in risk and consequence assessments for LNG (as fuel) applications. The tools should be validated against experimental data of LNG releases.

Scope of recommendation

It is proposed that a list of LNG-approved consequence and risk software tools is drafted and enforced on EU level for LNG as shipping fuel consequence and risk assessments.

All separate models (release models, dispersion models, fire models, ...) in consequence/risk assessment needs to be part of the approval process. It is important that the tools are periodically maintained and verified against other LNG validated tools.

Recommended actions

The following actions are recommended:

- 1) Perform a literature review to determine the tools suitable for LNG hazard analysis to allow for a preliminary list of LNG-approved consequence and risk software tools. Reference is made to a comprehensive overview of leading software tools for undertaking consequence analysis (and QRA) in a paper by the American Society of Safety Engineers /7/ and to a publication from the

UK HSE, which provides an extensive review of the state-of-the-art of various consequences models suitable for LNG hazard analysis⁴¹.

- 2) Initiate a working group of model experts and representatives from competent authorities (e.g. HSE/RIVM). The ultimate goal of the group would be to prepare an EU-list of LNG-approved consequence and risk software tools for LNG as fuel (i.e. small scale LNG applications).
- 3) The EU-list with LNG-approved software tools should be circulated amongst EU Member States.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) **Increase uniformity in consequence and risk calculations** (safety distances, land use planning zones, ...)

Consequences of non-implementation

The non-implementation of this recommendation could lead to possible over- or underestimation of risk in LNG risk assessments by e.g. use of software tools not suitable/validated for LNG. This can potentially result in different safety requirements and (external) safety distances.

Prioritisation

Impact on LNG small scale market development

This recommendation would stimulate harmonisation of consequence and risk results, increasing overall quality and transparency of the general risk analysis process. The impact on LNG as fuel uptake seems to be neutral.

Evaluation impact small scale market development	0
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Implementation effort (time, cost, legal)

As the introduction of this measure would not require adaptation of EU legislation nor Member State legislation, there is no legal impact by this measure.

The cost of the full process from initiating a working group, developing a Model Evaluation Protocol, associated experimental database and eventually maintaining the EU-list of LNG-approved tools would be considerable. Time and cost savings are considerable if existing publications are considered as basis.

Evaluation implementation effort	-
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⁴¹ HSE - LNG source term models for hazard analysis - A review of the state-of-the-art and an approach to model assessment, 2010.

11.2.12 Land use planning

Gap 28:

There is a need for LNG-specific guidelines and case studies for (risk) assessments used for land use planning.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.2.12.1 Background

Some countries have developed guidelines to ensure a nation-wide harmonized approach in land-use planning. Although these are not specifically written for LNG, they have generic applicability (with their limitations). Other countries do not mandate (specific) guidelines.

For the purpose of EU-wide (and national) harmonization it is recommended that LNG-specific guidelines and case studies for (risk) assessments used for land use planning are developed. Because each EU country has different land use planning approaches, the guidelines may have to be developed by each individual member state (or one common EU-wide LUP-approach should be established, see EMSA Gap 9.1). For those countries that do not mandate any guidelines or approach, a common LNG risk assessment guideline is recommended.

Reference is made to the current developments in the Netherlands who put a considerable amount of effort in harmonization of their QRA-approach and developing LNG-specific risk assessment guidelines⁴². Also reference is made to ISO/DTS 16901– Guidance on performing risk assessment in the design of onshore LNG installations including the Ship/Shore interface. Note that this guidance document provides generic guidance and not the specifics that would normally be required for a QRA (e.g. detailed scenario definition, frequencies, model parameters etc.).

11.2.12.2 Recommendation and action plan

Recommendation 28

For the purpose of EU-wide (and national) harmonization, develop LNG-specific guidelines and case studies for (risk) assessments used for land use planning.

Aim of recommendation

The aim of this recommendation is to improve the consistency of the implementation of the Member State specific land-use planning methodology for (Seveso) LNG establishments such as bunker stations by providing LNG-specific guidelines and case studies. This would ultimately contribute to the permitting procedure and improve the comparability and consistency of required external safety distances for the same installation.

⁴² Separate guidelines have been developed by the RIVM for risk assessments of specific (LNG) installations. The most recent guideline (or risk calculation methodology) is the draft version: 'Risk methodology LNG delivery installations for road vehicles'. A similar guideline for LNG bunker stations is currently under development (final stage). These guidelines also contain case studies.

Scope of recommendation

Risk assessment guidelines for (Seveso) LNG establishments should be developed on Member States level, although EU can propose general guidelines. The efforts can be coordinated with the work on recommendation 9-1.

Recommended actions

The following actions are recommended:

- 1) Develop general LNG guidelines on EU level
- 2) Promote the development of LNG-specific guidelines and case studies in the individual EU Member States for (risk) assessments to be used in the land-use planning process for LNG installations

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) Current country-specific risk assessment guidelines may **not fully take into account specific design and operational particulars of the LNG installation** under study. Specific guidance is needed by authorities/risk analysts.
- 2) Specific risk assessment guidelines contribute to the **consistent application of the land-use planning methodology** and therefore contribute positively to the permitting process and subsequent consistency in predisposed external safety distances for the same type of installation.

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Inconsistencies in risk assessments performed in EU Member States, as the risk analyst could have more 'degrees of freedom'.
- 2) A potentially slower and less efficient permitting procedure as the relevant authority would not have a guideline at its disposal to verify the correctness of the risk assessment more efficiently.

Prioritisation

Impact on LNG small scale market development


This measure would improve overall acceptance of LNG projects and facilitate the permitting process. This measure is expected to have a positive impact on the duration and efficiency of the permit procedure. Overall this measure is expected to have a positive impact on small scale LNG developments.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

The development of LNG-specific risk assessment guidelines for LNG establishments is the final responsibility of individual EU Member States (as it should fit the local context). Effort on EU level is limited to issuing general guidance and promotion and therefore considered to be limited.

As the development and introduction of risk assessment guidelines would not require adaptation of neither EU-legislation nor Member State legislation, there is no legal impact by this measure. The



guidelines should be considered as 'additions' to existing (mandated) guidelines and are in principle voluntary to follow unless the regulator would demand otherwise.

Evaluation implementation effort

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11.2.13 Incident reporting

Gap 29:

A European wide database, collecting incident data related to small scale LNG activities in a uniform manner, is missing.

Gap type:

Legal gap	Harmonization gap	<input checked="" type="checkbox"/>	Knowledge gap
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11.2.13.1 Background

Incident reporting serves multiple purposes, a.o. contribution to overall safety improvement by capturing the lessons learnt, continuous improvement of legislation, development of new technology/industry best practices, input to hazards identification (statistical data – see GAP 26), monitoring of environmental impact, ... This is of utmost importance for developments on LNG as shipping fuel as only limited experience has been gained from a few years of operation and thus only limited information for LNG bunkering related incidents is available today.

Directive 2009/18/EC, establishing the fundamental principles governing the investigation of accidents in the maritime transport sector, requires Member States to ensure safety-focused investigation systems, to investigate very serious marine casualties and decide on the investigation of others, as well as to send uniformly structured investigation reports and to populate the European Marine Casualty Information Database (EMCIP). LNG bunkering incidents (truck to ship, terminal to ship and ship to ship) are covered by this Directive, since a ship is involved. Therefore for these accidents a reporting structure is in place. Pure shore operations are not in scope. Currently the EMCIP structure and taxonomy are being updated to allow for adequate reporting on accident related to LNG as shipping fuel. It relates to taxonomy on propulsion types (BOG steam, BOG diesel electric, NOG dual fuel, dual fuel), LNG bunkering (ship to ship, truck to ship and terminal (shore) to ship). This update is expected in the near future.

Many port specific codices describe requirements for incident reporting in terms of structure of the report and criteria on when to report as far as the incident has happened in a port context. For land based installations covered by Seveso-directive, all 'major accidents' need to be reported to the competent authorities. In addition, a formal requirement to report major accidents to EU is in place if the accident meets the criteria of annex VI of the Directive. All high tier Seveso establishments should have a safety management system in place which includes procedures for reporting major accidents and near misses, including their investigation and follow-up on the basis of lessons learnt.

ADR, which regulates the transport of dangerous goods via road and railways and thus also covers LNG cargo transport via trucks, specifies requirements for notification/reporting of incidents. Reported incidents are collected at National level, currently no European database exists for road accidents and incidents, contrary to railway. Recently some Member States (a.o. UK, France, the Netherlands, Belgium, ...) have joined forces on a voluntary basis to develop a common database with incident reports (this database will include accidents and incidents by road, railway and inland shipping). This initiative is in a pilot phase and it is yet unclear what the final outcome will be and if these data will be publically available.

Major incidents are often preceded by multiple warning symptoms in the months, days, or hours before the incident. These symptoms may be occurrences that are called near misses. EMCIP and eMARS allow for near miss reporting, although records show that not many near misses are reported. It should be

mentioned that there are still barriers to report incidents and near misses, a.o. fear of disciplinary action, lack of understanding the differences between near miss versus non-incident, lack of management commitment, effort to report and investigate, disincentives for reporting, not knowing which reporting or investigation system to use, ...)

11.2.13.2 Recommendation and action plan

Recommendation 29-1

Ensure that existing databases of relevance for LNG as shipping fuel (ADR, eMARS and EMCIP) include reporting of near misses, incidents and minor spills and increase the awareness of the need for incident and near miss reporting.

Recommendation 29-2

Ensure that existing databases on incident reporting (marine and shore operations) will be linked via open data protocols to ensure that they can exchange data on LNG as shipping fuel related incidents. This should enhance LNG overall safety via lessons learnt, improve guidance and regulations and improve quality of risk assessments (failure frequencies).

Aim of recommendation

The above mentioned recommendations aim at capturing LNG specific incident data in a European database and to make these data accessible for all relevant stakeholders. The proposed database will combine data from existing databases / platforms (e.g. eMARS, EMCIP, ADR, port databases, ...). This necessitates that the mentioned existing databases are populated and thus implies that detailed incident reporting routines are in place and followed.

The ultimate goal of the database is to: contribute to overall safety by capturing the lessons learnt, input to continuous improvement of legislation, add to development of new technology/industry best practices, input to hazards identification (statistical data – see GAP 26), monitor environmental impact, ...

Scope of recommendation

The incident database should be implemented at EU level and should cover all incidents, accidents and near-misses with (potential) implications on safety and operations related to the small scale LNG value chain.

The incident database focuses in particular on:

- Injuries to personnel during the entire bunker operation
- Fire and explosion related occurrences
- LNG spills and leakages to the environment
- Damage to the vessel, bunkering infrastructure and equipment

Recommended actions

- 1) Evaluate the possibilities with the Competent Bodies to ensure that near misses, incidents and minor spills are reported in existing databases (eMARS, ADR and EMCIP)

- 2) Develop a European wide, public accessible database gathering small scale LNG incident data in a uniform way via open data protocols based on existing databases.
- 3) Define the minimum amount and taxonomy of information to be included in the database when entering an accident, incident or near miss.
- 4) Organise an awareness campaign/safety culture program for small scale LNG stakeholders (ship owners, ship operators, terminal operators, ...) to stimulate reporting of accidents and incidents with special focus on reporting of near misses.
- 5) Evaluate the need for having an incentives scheme in place to stimulate recording of near misses
- 6) Implement a yearly casualty report (EMSA) in order to compile LNG relevant casualty and near-miss data. This report might be drafted upon the input of multiple databases in order to build up a common small scale LNG report document
- 7) On a long term, deduct LNG specific failure frequencies from this database.

Justification for recommendation

The main reasons why this recommendation was developed are the following:

- 1) To **increase knowledge** related to LNG incidents for all stakeholders
- 2) To **collect lessons learned** and to **prevent similar incidents** due to lack of knowledge about LNG incidents
- 3) To be able to **create LNG specific failure frequencies**, as the failure frequencies used at this moment are not LNG specific
- 4) To serve as input **for legislation, guidelines and standards**

Consequences of non-implementation

The non-implementation of this recommendation could lead to:

- 1) Industry not learning from small scale LNG related incidents, hence recurrent similar accidents
- 2) Complexity in accessing and extracting small scale LNG incident information
- 3) Lack of a large dataset to create LNG specific failure frequencies, and possible overestimation of LNG related risks due to the use of generic failure frequencies.

Prioritisation

Impact on LNG small scale market development

This measure will improve the knowledge regarding LNG incidents and could therefore facilitate small scale LNG developments on a long term by preventing accidents from happening again. However, the short-term impact on small scale LNG market developments will not be significant. As it will improve safety on the long run, it is considered as an important driver to the overall viability of small scale LNG market.

Evaluation impact small scale market development	+
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Implementation effort (time, cost, legal)

Several European incident databases already exist, such as the Major Accident Reporting System (eMARS) for onshore installations, local port databases and country specific ADR databases and the European Marine Casualty Information Platform (EMCIP) for shipping activities. Hence, time efforts for implementation of an LNG incident database could be limited by making use of existing incident databases and LNG platforms.

On a regulatory level, the development of this database as such would not require adaptation of EU legislation nor national legislation.

Evaluation implementation effort

0

12 IMPACT ASSESSMENT

12.1 Introduction and background

12.1.1 Problem definition and underlying drivers of the problem

Seagoing and inland waterway transport is generally considered as a safe and efficient mode of transportation. A legal framework has been developed (see chapter 4) related to the topic of “greening the fleet”.

LNG is seen as one of the key solutions to reduce the environmental footprint of the shipping sector, at present mainly using HFO/MDO as fuel. With the exception of Norway, the uptake of LNG as ship fuel in Europe is still in an early stage, and key stakeholders typically identify three main barriers: the lack of adequate bunker facilities for LNG, the gaps in the legislative or regulatory framework, and the lack of harmonized standards.

The recently adopted Directive on the deployment of alternative fuels infrastructure 2014/94/EU aims to solve the first barrier by enforcing the Member States to ensure that an appropriate number of LNG refuelling points for maritime and inland waterway transport are provided in maritime ports of the TEN-T Core Network by 31 December 2025 and in inland ports by 31 December 2030.

In previous chapters, solutions (in the form of recommendations) were identified for the second and third barrier. The proposed measures aim at an EU-wide harmonization and cover the following key elements: legal and regulatory framework, the permitting process, quantitative risk assessment, incident reporting and other relevant remaining gaps. This is discussed in detail in previous chapters.

12.1.2 Scope and Methodology

The purpose of this chapter is to analyse the social, economic and environmental impact resulting from the adoption of measures to enhance the use of LNG as shipping fuel. The impact assessment is a key tool to ensure that Commission initiatives and EU legislation are prepared on the basis of transparent, comprehensive and balanced evidence. The overall approach is based on “Impact assessment guidelines, EU (2009)”, PwC and DNV GL best practices.

The assumptions in the report are based on a literature review and DNV GL’s and PwC’s in house libraries. The main assumptions to analyse the uptake of LNG, the fleet conversion rate from traditional fuel oils to LNG as fuel and the subsequent economic, social and environmental impact are detailed in the following chapters.

12.1.3 Impacted stakeholders

Major impacted stakeholder groups include: the general population, equipment and engine manufacturers, ship owners, terminal operators, shipyards and authorities.

- Shipping companies and ship owners will benefit from a harmonised policy framework and have incentives to invest in an eco-friendly fleet. Higher initial prices for LNG engines and equipment as compared to the traditional propulsion is compensated by lower fuel prices.
- Equipment and engine manufacturers are expected to benefit from higher LNG uptake leading to higher demand for their products. This will in addition stimulate R&D as innovation is seen as a competitive advantage.
- Shipyards will face opportunities in new build and retrofitted LNG fuelled vessels.
- EU population will benefit from emission reduction of harmful substances (NO_x, SO_x, PM, greenhouse gases), reducing risks to health and environment.

- EU, national and local authorities will be actively involved in implementing the different policy scenarios to address the identified problems and their drivers.

12.1.4 Limitations of the analysis

There is still considerable uncertainty with respect to the number of vessels that will use LNG as fuel and therefore the LNG uptake, amongst others driven by LNG price, investment costs, ... The outcome of this chapter is meant to show the impact of the different policy scenarios on the overall LNG uptake and should not be used for detailed investment decisions.

12.2 Policy objectives

12.2.1 General policy objective

As part of the Climate and Renewable Energy Package of 2009, the EU has agreed on a binding target on the share of renewable energy in the final energy use of transport (10% by 2020). The White Paper on Transport announced a reduction of 60% of CO₂ emissions by 2050 based amongst others on a significant uptake of alternative fuels.

The general objective of this initiative is to support the shipping sector in adopting environmentally sustainable alternative fuels by means of ensuring the resolution of identified gaps and of the remaining aspects for completing the EU framework on LNG-fuelled ships and its relevant fuel provision infrastructure.

12.2.2 Specific objectives

The general objective can be translated into more specific goals:

- To ensure that investment uncertainty is sufficiently reduced to break up the existing 'wait and see' attitude amongst market participants.
- To make sure that refuelling procedures and equipment are interoperable for all LNG fuelled vessels in EU;
- To ensure compliance with all international obligations with regard to Marpol annex VI and Directive 2012/33/EU

12.3 Setting the scenarios


12.3.1 Identification of key drivers

The use of LNG is expected to grow significantly driven by tougher emission regulations and positive fuel price spread (gas price as compared to oil prices). The following factors (key drivers) are influencing the LNG adoption rate:

POLICIES – EU, Member States and local authorities (e.g. ports) play a key role in developing the regulatory framework to facilitate the use of LNG as shipping fuel. In addition the governmental bodies can stimulate the use of LNG as shipping fuel via financial incentives.

FUEL PRICE SPREAD – An important driver for LNG adoption by shipping industry is the fuel price spread, i.e. the price of LNG compared to traditional fuel prices. This price will impact the success of LNG compared to other available 'clean' alternatives like using low sulphur fuels or other abatement technologies, ...

GROWTH OF SHIPPING SECTOR – A third driver is the growth of the shipping sector (seagoing and inland vessels).



LNG FUEL AVAILABILITY – A 4th driver is the LNG fuel availability; this involves production of the fuel as well as the bunker infrastructure. On the production side, the recent boom in non-traditional gas (shale) has had a huge effect on the market for gas, particularly in North America. The rate of development of new gas fields should assure an abundant supply for years. Next to the developments in United States, the discovery of enormous gas reserves overseas in areas like offshore East Africa and the Caspian Sea has made it obvious that fears about scarcity are not justified. As LNG is widely available in most parts of the world to which ships sail frequently, it has the potential to become the fuel of choice for all shipping segments, provided the infrastructure is in place.

The first factor is fully under responsibility of governmental bodies while the fuel price spread and the growth of the shipping sector are mainly influenced by market conditions. The 4th key aspect that needs to be accounted for is the availability of LNG bunkering infrastructure (e.g. LNG fuel stations, small scale terminals, bunker vessels, ...).

12.3.2 Why scenarios?

Scenarios describe likely outcomes on technology developments and associated investment levels and strategies in the (maritime) industry resulting from policy options.

A scenario is not a prediction of the future as such but rather a story of what the future might look like. With the scenario approach, we aim at spanning likely developments, at the same time as we want the scenarios to be sufficiently different to explore the effects of the identified trends and main drivers.

12.3.3 Identification of policy options

Our scenarios for the uptake of LNG are based on how the above identified drivers would possibly develop. There is a naturally strong link between economic growth and demand for sea transport, impacting the trade patterns, the required fleet composition with respect to type and size and the investment in new builds. In addition to the economic perspective, regulatory bodies have a set of tools they can use to influence the relative attractiveness of LNG compared to other fuels. Examples are emission regulations, harmonization of safety regulations, permitting procedures and financial incentives (tax/ subsidy regimes are under scope of the work in LOT 4 of this study).

The preceding work in LOT 1 of this study has resulted in a long list of potential interventions (via recommendations) that could help achieve the overall study objective, namely the reduction of emissions by shipping and to stimulate harmonisation across EU. The analysis was ultimately aimed at achieving insight into the (policy) ways of stimulating the use of LNG as clean shipping fuel.

These policy scenarios were developed by combining various recommendations, which could have an emission reduction potential, applied on a short to medium term and applied to a large part of the seagoing as well as inland fleet.

Policy scenarios - Following policy scenarios are considered:

1. Do nothing scenario (= Business as usual or baseline scenario);
2. Alternative policy options:
 - 2.1. No harmonisation across EU; (“Must haves”)
 - 2.2. Low/Moderate harmonisation across EU; (“low hanging fruits”)
 - 2.3. Full harmonisation across EU. (“Nice to haves”)

Each of the policy options above corresponds with a certain set of measures related to the full closure of any existing legal/regulatory gaps and knowledge gaps identified in the previous chapters (see Table 12-1).

The different policy options are assumed to influence two factors: the LNG adoption rate by shipping industry and the availability of critical LNG infrastructure.

In the business as usual (BAU-scenario) it is assumed that the gaps related to LNG market entrance will be closed (LNG fuelled ships can sail on inland waters and seas). The market will develop without additional regulatory framework enhancements. In this scenario ships are able to use LNG as fuel, but lack of standardisation/harmonisation discourages the use of LNG as safe fuel. Using LNG as fuel ensures compliance with SOx-ECA and helps in regional NOx regulated regimes (e.g. Norway). As the regulatory pressure is - in comparison with the other policy scenarios - low, shipping industry thrives in its traditional way. The rationale to shift to LNG is based purely on economic benefits. By 2020 some first movers are shifting to LNG. By 2025 LNG refuelling points will be available in TEN-T core sea ports and by 2030 in core inland ports.

In the 'no harmonisation across EU' scenario, it is assumed that the legal gaps will be closed but that no main actions are being executed with respect to harmonisation across EU. EU's plan for implementing ECA-like requirements in all EU waters is put on hold, resulting in different authorities acting independently and not coordinated. In this scenario proper enforcement of the emission regulations (ECA) can be expected. Furthermore an increased focus on LNG fuel quality and quantity measurement is assumed. Some increased regulatory awareness will lead to some major players shifting to LNG by 2020, branding themselves above the minimum standards.

In the 'low/moderate harmonisation across EU' scenario, it is assumed that the legal gaps are closed and that some further actions are being executed on EU level to harmonise the legal framework. Emerging regulations and standardisation support and facilitate the use of LNG. LNG fuel technology and bunkering operations are getting standardised. Compliance enforcement of emission regulations is harmonised on EU level. Yards and manufacturers see opportunities coming from the increased regulatory and stakeholder pressure and shipping companies will invest in innovation as a means to get competitive advantage.

The 'full harmonisation across EU' scenario ensures the implementation of harmonized processes and procedures across EU in a legally binding way, to fully support LNG uptake. All uncertainties related to requirements and level conditions of crewing and training of LNG fuelled ships and LNG providers, regulatory conditions and permitting have become obsolete. In addition stimuli regimes (e.g. permitting) are being developed in several countries/regions supporting LNG fuelled shipping. In this scenario shipping industry thrives through a process of innovation and technology development. There is an increased focus on environmental performance by charterers, forcing ship owners to implement environmentally friendly technology.

In the table underneath, the proposed recommendations are linked with the different policy scenarios.

Table 12-1 - Set of recommendations to be implemented in the different policy options.

GAP nr	BAU scenario	no harmonisation	moderate harmonisation	Full harmonisation
EMSA Gap 1			x	x
EMSA Gap 2		x	x	x
EMSA Gap 3			x	x
EMSA Gap 4	x	x	x	x
EMSA Gap 5			x	x
EMSA Gap 7	x	x	x	x

GAP nr	BAU scenario	no harmonisation	moderate harmonisation	Full harmonisation
EMSA Gap 8				x
EMSA Gap 9.1				x
EMSA Gap 9.2			x	x
EMSA Gap 9.3a			x	x
EMSA Gap 9.3b				x
EMSA Gap 9.4				x
EMSA Gap 10.1		x	x	x
EMSA Gap 10.2		x	x	x
EMSA GAP 11				x
EMSA Gap 13		x	x	x
EMSA Gap 15		x	x	x
EMSA Gap 16			x	x
Gap 17			x	x
Gap 18			x	x
Gap 19			x	x
Gap 20-1			x	x
Gap 20-2			x	x
Gap 21				x
Gap 22-1				x
Gap 22-2				x
Gap 23-1				x
Gap 23-2				x
Gap 24				x
Gap 25				x
Gap 26			x	x
Gap 27				x
Gap 28				x
Gap 29-1			x	x
Gap 29-2			x	x

TIMING - As the bulk of the recommendations still needs to be initiated and might take several years, the first measurable impact of the different policy options on the number of ships converting to LNG and the development of small scale infrastructure is expected only from 2019-2020. It is assumed that project developers anticipate regulatory requirements but only start with constructing activities once final regulation is in place.

RISKS – In this paragraph a description is given of risks connected with the implementation of different policy options:

- Time delays in implementing policy scenarios: this would imply that the effect of the concerned policy scenario is postponed.
- Over-regulation: where harmonised regulation is typically leading to more transparency, over-regulation could lead to long lead times, less flexibility for project developers and more complicated building and operational processes requiring special systems, connections, risk assessments, trainings, etc.

- Early technical standardisation: this might lead to market dominance by a major technology provider leading to a preferred technology/provider combination and limiting fair competition.

12.4 Approach to scenarios assessment

12.4.1 Introduction

The key purpose of this section is to understand the development of the LNG fleet, the LNG demand and the LNG infrastructure by 2030 in order to support the impact assessment analysis of the social, economic and environmental impact of the different policy options as compared to the base case (BAU) scenario.

12.4.2 LNG fuelled fleet

12.4.2.1 LNG fuelled fleet development towards 2030

Seagoing vessels

Since 2000, the number of vessels that have been designed or retrofitted to use LNG as fuel has been steadily increasing. Today (May 2015) about 60 vessels are using LNG as fuel, with the early adopters being Norwegian car/passenger ferry and offshore operators. Furthermore there are currently 78 confirmed LNG fuelled new builds.

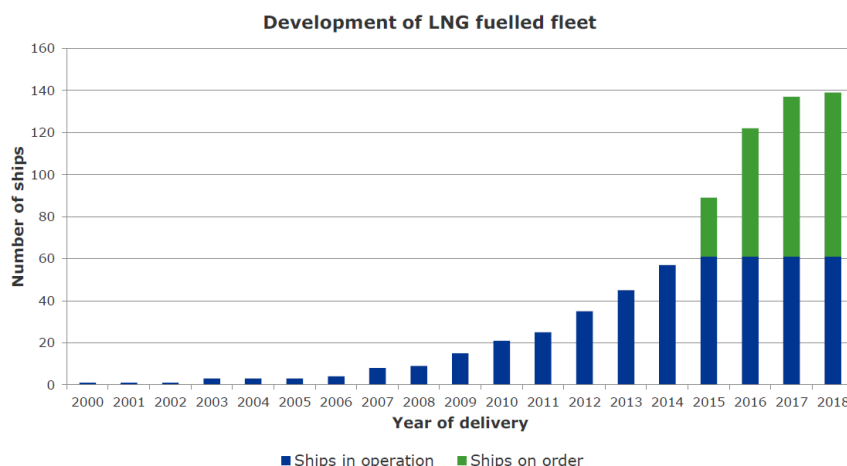


Figure 12-1 - Confirmed LNG fuelled ship projects (status May 2015)

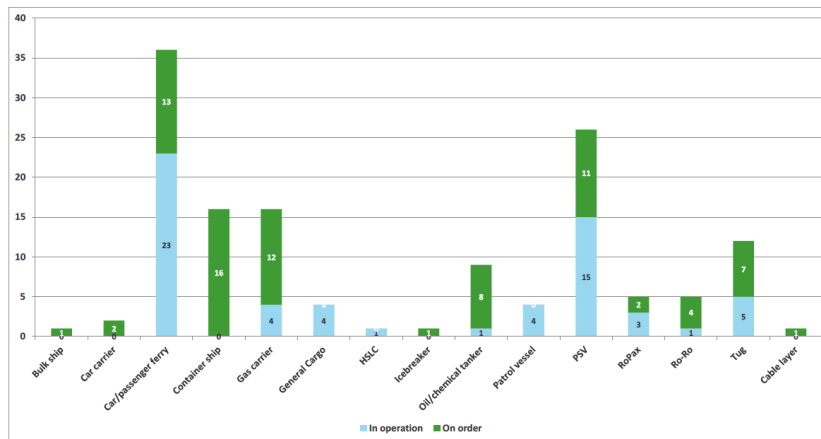


Figure 12-2 - Confirmed LNG fuelled ship projects - breakdown per ship type (status May 2015)

The number of seagoing vessels that will convert to LNG has been estimated for the time period 2015-2030 based on DNV GL in house data & expertise. The data are presented in Table 12-2 and Table 12-3 below.

On a short-term basis, MGO will compete with LNG in ECA as compliance solution. As LNG bunkers will become more available, it is envisaged that for the longer term, cargo-mile cost will be lower and this will drive the market and new build decisions towards LNG fuelled vessels.

In the BAU-scenario (business as usual or baseline scenario), it is anticipated that the uptake of LNG will be gradual per shipping segment with the current fleet of LNG-fuelled vessels concentrated in niche or high specification sectors. The RO-PAX and offshore vessel sector have been the first adopters of LNG as fuel. In the longer term more vessel types will be constructed or converted to use LNG as fuel. As the majority of passenger vessel and RoRo vessels sail on fixed routes, this allows for accurate planning of bunkering, which makes this segment very likely to shift to LNG. Offshore vessels are likely to continue moving to LNG as shipping fuel. In the cargo segment, there will be mostly tankers using LNG in 2030, but bulk and general cargo vessels will also embrace LNG as fuel towards 2030.

The greatest uncertain factor is when and to what extent deep sea shipping will start using LNG as fuel. It should be highlighted that using of LNG as fuel will negatively impact the carrying capacity⁴³ of a container vessel. Despite this fact, there is significant interest now for LNG fuel among some major container ship owners, their decision to move forward or not will affect the development towards 2030 and will be influenced significantly by the policy scenarios underneath.

Based on the discussion above, following growth factors have been accounted for compared to the baseline scenario:

- 'no harmonisation scenario': In this scenario, there is a strong belief in free market forces as the overriding principles for economic governance, and global regulations of trade and emission remain limited. Energy and other resources are not regarded as limitations and resource exploitation is based on the needs for economic growth. An additional conversion rate to LNG fuelled fleet of about 10% compared to the baseline scenario is assumed.
- 'low/moderate harmonisation scenario': Focus on climate change and sustainability results in many local and regional energy solutions employed. The result is a diverse introduction and

⁴³ Increased fuel storage space is required to carry the necessary volume of gas for similar ranges compared to a ship using oil fuel. When stored as LNG, the fuel takes up twice as much space as oil fuel.

application of new technologies. Although some actions are initiated on EU level to stimulate harmonisation. An additional conversion rate to LNG fuelled fleet of about 26% compared to the baseline scenario is assumed.

- 'full harmonisation scenario': The success of global agreements on climate change has created positive spill over effects and more goodwill towards international negotiations (IMO, UN, harmonisation across EU, ...). This in turn requires new investment in technology transformations to replace the 'old and dirty' alternatives. An additional conversion rate to LNG fuelled fleet of about 49% compared to the baseline scenario is assumed.

Table 12-2 - Number of LNG fuelled ships in European waters (source: DNV GL analysis)

Policy scenarios	2015	2020	2025	2030
Baseline	65	237	620	1541
no harmonisation	65	262	674	1688
low/moderate harmonisation	65	286	778	1945
full harmonisation	65	320	920	2294

Table 12-3 - LNG fuelled vessel – breakdown per ship type (source: DNV GL analysis)

Type of ship	2015	2030 base case	2030 no harmonisation	2030 low harmonisation	2030 full harmonisation
Tank	9	290	317	365	434
Bulk & General cargo	4	208	239	276	320
Container	3	241	267	307	368
RoRo	3	29	32	37	43
Passenger	25	247	272	313	369
Offshore service	21	525	561	647	760
Total	65	1541	1688	1945	2294

(*) The numbers shown in the above table represent the number of LNG fuelled ships in European waters (EU and non-EU), excluding inland vessels and LNG carriers.

Inland vessels

The size of the current and future inland fleet was taken from the Panteia 2013 study report 'Contribution to IA of Measures for Reducing of Emissions in Inland Navigation', EU, 2013. The evolution of the fleet from 2012 towards 2030 is presented for 10 representative vessel types.

Table 12-4 - Evolution of the inland vessel fleet for freight transport

CEMT class⁴⁴	length (m)	power (kW)	2012	2030
I	<38,5	189	3.461	1.666
II	55	274	1.235	836
III	70	363	711	456
III	67	447	1.118	689
III	85	547	1.260	814
IV	85	737	1.528	1090
V	110	1178	1.824	2.173
VI	135	2097	223	319
V - push boat	push boat 1000-2000 kW	1331	73	88
VI - Push boat	> 2000 kW	3264	27	31
			11.460	8.162

From the table an overall decrease in number of vessels can be concluded, but the number of larger vessel types is steadily growing.

In the same study an overview was presented of the engine renewal rate. These data are presented in Table 12-5. As larger vessels operate in a semi-continuous or full continuous mode and subsequently a high operation mode, they are reconditioned or have their engines replaced more frequently. Moreover the modern engines typically have a shorter lifetime than the older engines.

⁴⁴ CEMT refers to the classification of European Inland Waterways. It was created by the European Conference of Ministers of Transport (ECMT; French: Conférence européenne des ministres des Transports,CEMT) in 1992, hence the range of dimensions are also referred to as CEMT Class I-VII.

Table 12-5 - Number of inland vessels with new engines from 2018 to 2050

CEMT class	length (m)	Period 2018-2050	
		replacement of engine (nr)	new vessel (nr)
I	<38,5	220	198
II	55	553	31
III	70	271	19
III	67	355	92
III	85	522	39
IV	85	263	583
V	110	3164	1199
VI	135	992	228
V - push boat	push boat 1000-2000 kW	178	28
VI - Push boat	> 2000 kW	76	9

The Dutch Green Deal initiative's goal is to have 50 LNG inland vessels deployed by 2015. With less than a year to go and only 6 vessels in service (Argonon, Greenstream, GreenRhine, Eiger Nordwand, Sirroco and Ecoliner), this goal will not be reached. It is assumed that by end 2015 only 10 inland vessels will be in operation. However, new more stringent emission regulations will force the inland shipping industry to reduce their emissions in the coming years. Since a large part of the fleet is very old or has no compliant engines, this creates a huge potential for greener new-builds or retrofitting.

For vessels larger than 110m, LNG is perceived as a win-win situation with benefits for both society and operator or owner of the vessel. With the right incentives (e.g. full harmonization), almost all new-builds could be LNG-fuelled. Therefore it is assumed that in 2030, 100% of these vessels will sail on LNG for the full harmonisation case. In the baseline scenario it is assumed that only the tanker vessels would move to LNG. These vessels are expected to have the lowest threshold to convert to LNG since these vessels are able to install the tank on deck (e.g similar to Argonon) and since tanker vessels have high utilisation in terms of sailing hours. The share of tankers in vessel classes 110m and 135m is 38% and 24% respectively.

New build vessels smaller than 85m will be less and less common. Retrofitting these vessels to LNG is not economically feasible and other compliance options will be more likely. Therefore, no LNG fuelled vessels are expected in this category by 2030. This applies to all policy scenarios.

Table 12-6 - Number of inland vessel converted to LNG

	2015	2020	2025	2030
Baseline	10	186	489	689
no harmonisation	10	240	732	1055
low/moderate harmonisation	10	322	1096	1605
full harmonisation	10	368	1299	1911

12.4.2.2 Share of new building versus retrofitting vessels by 2030

Only part of the existing ship fleet is eligible to retrofitting. Ships have an average lifetime of 20 to 30 years, which means that only part of the fleet will be replaced by a new ship during the given time period. Alternatively ships can be retrofitted (diesel engine replaced by an LNG engine), although this is not possible for a large part of the fleet due to space and other practical restrictions. For ships where (cargo) space is no key hurdle, the choice whether or not to retrofit is mainly influenced by economic factors rather than by regulatory environment, therefore fixed – independent from policy scenario – factors are being suggested.

The current share of new build seagoing vessels versus retrofit seagoing vessels is 96% versus 4% (based on a number of 6 retrofitted vessels on a total fleet + order book of 139). It is not expected that this figure will significantly change in the coming years. LNG is an interesting option for newbuilds. Exhaust gas cleaning systems or other abatement options are typically preferred as cost-effective options for a retrofit.

Based on the current LNG fuelled fleet (ships in operation & order book combined) it can be deduced that European yards have a share of about 65% - 70%, although it is expected that the future picture will change. The share of European yards will drop in favour of Asian yards that are increasing their competence and will become more and more competitive. In addition the current European share is high due to the vessels in operation in the period 2001-2011 being mainly built in Norway. Therefore it is perceived as more realistic to use the geographic share of order book by main shipbuilding areas. Based on the order book (status October 2014 – source The European Ships and Maritime Equipment Association (SEA Europe)) the market share of European shipyards is about 12%, the bulk of the ships are being built in Korea (32%) and China (29%). The ships ordered in Europe are mainly passenger and offshore vessels. Based on the above data of European share in the overall market, and bearing in mind the importance of passenger and offshore vessel in LNG conversion, it is assumed that about 25% of the LNG fuelled fleet will be built in Europe during the timespan of this assessment.

The current share of new build inland vessels versus retrofit inland vessels is 90% versus 10% (based on 1 retrofitted vessel on a total fleet + order book of 10). From the 6 vessels in operation 4 were built in the Netherlands, 1 in Romania and 1 in China (and completed in the Netherlands). Based on this value it is expected that 80% of the LNG fuelled inland vessels will be built in EU shipyards.

12.4.2.3 Small scale LNG demand

This paragraph provides demand figures for LNG as bunker fuel. These amounts are based on the development of the current fleet and represent the amount of LNG needed by all LNG fuelled ships when operating in European waters. The figures presented in the table underneath are deduced based on the

installed engine power, average engine load, and number of sailing days in European waters for each ship type.

Table 12-7 - Amount of LNG bunkered by Seagoing vessels (kton/y)

(kton LNG/y)	2015	2020	2025	2030
Baseline	242	990	2545	6253
no harmonisation	242	1095	2767	6853
low/moderate harmonisation	242	1206	3215	7931
full harmonisation	242	1357	3828	9404

Table 12-8 - Amount of LNG bunkered by Inland vessels (kton/y)

(kton LNG/y)	2015	2020	2025	2030
Baseline	5	96	255	360
no harmonisation	5	125	381	551
low/moderate harmonisation	5	167	571	839
full harmonisation	5	191	677	998

12.4.3 On-shore infrastructure

The assessment of the on-shore infrastructure considers the type, size and capacity of facilities and equipment required to supply the expected amount of LNG for shipping (see § 12.4.2.3) under the different scenarios at EU level. Three different types of bunkering solutions have been considered: ship-to-ship (STS), truck-to-ship (TTS), and bunkering of ship from the terminal using a pipeline (TPS). There is no contradiction in using more than one method per port. Different bunkering solutions can complement one another if various types of vessels have to be served or if there is peak demand for LNG fuel at a terminal.

The assessment proposed hereafter is based on the outcome of the study on *North European LNG Infrastructure Project*⁴⁵ by the Danish Maritime Authority (DMA). The DMA Study provides an analysis of the infrastructure needs to meet LNG demand in Baltic Sea, North Sea and English Channel (including Norway). Furthermore, the study suggests that LNG demand for shipping can be satisfied with a mix of facilities of different capacities and a number of additional vessels and trucks for supporting additional refuelling points. More in detail, three different LNG terminal sizes have been considered⁴⁶: "large scale"

⁴⁵ EU co-financed feasibility study for an LNG filling station network in north Europe: "North European LNG Infrastructure Project – A Feasibility study for an LNG filling station infrastructure and test of recommendation".

⁴⁶ This approach reflects the one adopted by Danish Maritime Authority in an EU co-financed feasibility study for an LNG filling station network in north Europe: "North European LNG Infrastructure Project – A Feasibility study for an LNG filling station infrastructure and test of recommendation".

terminal is defined as a facility that could be incremental to an existing LNG import terminal which already serves other land-based end users (e.g. industry); "medium" and "small scale" terminals would be "purpose built" installations with a storage capacity aimed at serving the shipping sector.

The table below details the number and size of equipment assumed under each case.

Table 12-9 - Equipment assumed for the three terminal cases

Terminal Equipment	Large scale terminal	Medium scale terminal	Small scale terminal
<i>Land based tanks and handling equipment</i>			
700 m ³ Tank			2
20,000 m ³ Tank		1	
Tank trucks (capacity: 50 m ³)	2	1	1
Pipeline and manifold connected to tank		1	1
LNG infrastructure on jetty	1	1	
<i>Bunkering vessels</i>			
Vessel/barges	1	2	
<i>Port facilities</i>			
Jetty/quay	1	1	

Source: DMA - Feasibility study for an LNG filling station network in north Europe: "North European LNG Infrastructure Project".

The DMA Study provides an estimation of the number of small, medium and large terminals along with supplementary equipment (e.g. bunkering vessels/barges, trucks) which will be required to satisfy expected demand for LNG bunkering in North European seas. Therefore, considering ratios between capacity to be installed and LNG demand from the DMA Study, we have calculated the number of LNG terminals and supplementary equipment to be installed and put in operation under the different scenarios for the whole EU.

For the year 2015, we have assumed that there are three small scale LNG terminals and one bunkering vessel. Indeed, according to GIE⁴⁷, in 2015 there are three LNG bunkering stations and one LNG bunkering vessel operational in Europe. Two of the three stations are in Norway⁴⁸ and one in Sweden⁴⁹.

The Seagas bunkership is operational in the Port of Stockholm in Sweden. Table 12-10 shows the number of terminals and supplementary equipment to be provided over time under the baseline scenario in order to meet the LNG demand for seagoing and inland navigation.

⁴⁷ Small Scale LNG Map, available at: <http://www.gie.eu/index.php/maps-data/gle-sslng-map>

⁴⁸ Mosjøen LNG terminal and Øra LNG, Fredrikstad LNG Terminal

⁴⁹ Lysekil LNG Terminal

Table 12-10 – Infrastructure needs to meet LNG demand (Baseline Scenario)

Infrastructure/equipment	2015	2020	2025	2030
Large scale terminals		3	7	13
Medium scale terminals		2	5	10
Small scale terminals	3	6	15	36
Bunkering vessels/barges (capacity <1,000 m ³)	1	5	12	26
Bunkering vessels/barges (capacity <4,000 m ³)		8	20	39
Bunkering vessels/barges (capacity <10,000 m ³)			1	1
Additional Tank trucks (capacity: 50 m ³)	1	9	23	43

Source: PwC elaboration on DMA - Feasibility study for an LNG filling station network in north Europe: "North European LNG Infrastructure Project".

In case of no action by the EU, in 2030, we expect the availability of 59 LNG terminals, 66 bunkering vessels and 43 tank trucks. According to the Alternative Fuels Infrastructure Directive, by 2025 and 2030 respectively the TEN-T core sea ports and inland ports should meet the requirement of availability of alternative clean fuels. Potentially, one bunkering vessel or barge can serve several refuelling points, still, the TEN-T objective of availability of alternative clean fuel in all core ports might not be fully met in case of "no action" by the EU.

The three following tables present the number of terminals and supplementary equipment to be provided over time under the three alternative scenarios. The estimated increase in both infrastructure, bunkering vessels and tank truck is driven by the increase in LNG demand for shipping.

Table 12-11 - Infrastructure needs to meet LNG demand (no harmonisation Scenario)

Infrastructure/equipment	2015	2020	2025	2030
Large scale terminals		4	8	15
Medium scale terminals		2	6	12
Small scale terminals	3	6	17	40
Bunkering vessels/barges (capacity <1,000 m ³)	1	5	13	29
Bunkering vessels/barges (capacity <4,000 m ³)		9	23	45
Bunkering vessels/barges (capacity <10,000 m ³)			1	1
Additional Tank trucks (capacity: 50 m ³)	1	12	26	50

Source: PwC elaboration on results of DMA - Feasibility study for an LNG filling station network in north Europe: "North European LNG Infrastructure Project".

Table 12-12 - Infrastructure needs to meet LNG demand (low/moderate harmonisation scenario)

Infrastructure/equipment	2015	2020	2025	2030
Large scale terminals		4	10	17
Medium scale terminals		2	7	14
Small scale terminals	3	7	20	47
Bunkering vessels/barges (capacity <1,000 m ³)	1	6	16	35
Bunkering vessels/barges (capacity <4,000 m ³)		9	28	52
Bunkering vessels/barges (capacity <10,000 m ³)			1	1
Additional Tank trucks (capacity: 50 m ³)	1	12	32	58

Source: PwC elaboration on results of DMA - Feasibility study for an LNG filling station network in north Europe: "North European LNG Infrastructure Project".

Table 12-13 - Infrastructure needs to meet LNG demand (full harmonisation scenario)

Infrastructure/equipment	2015	2020	2025	2030
Large scale terminals		5	11	21
Medium scale terminals		2	8	16
Small scale terminals	3	8	24	56
Bunkering vessels/barges (capacity <1,000 m ³)	1	7	19	41
Bunkering vessels/barges (capacity <4,000 m ³)		10	31	61
Bunkering vessels/barges (capacity <10,000 m ³)			1	1
Additional Tank trucks (capacity: 50 m ³)	1	14	36	70

Source: DNV GL/PwC elaboration on results of DMA - Feasibility study for an LNG filling station network in north Europe: "North European LNG Infrastructure Project".

In case of "no harmonisation scenario" across EU, in 2030, we expect the availability of 67 LNG terminals and 75 bunker vessels. Under the "low/moderate harmonisation scenario" we expect the availability, in 2030, of 78 terminals and 88 bunker vessels. Finally, the implementation of the "full harmonisation scenario" is expected to result in 2030 in the development of 93 LNG terminals along with over 103 bunker vessels.

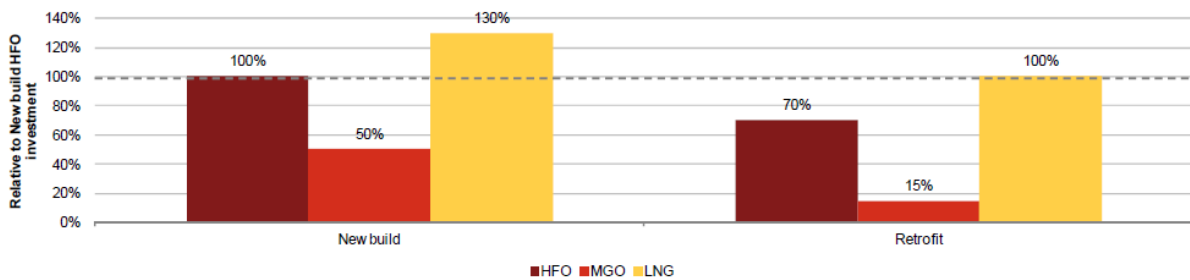
12.5 Economic Impact

12.5.1 Investments in LNG-fuelled vessels

12.5.1.1 New builds - retrofits

Paragraph 12.4.2.2 provides figures concerning investments in new builds and retrofits of LNG-fuelled vessels.

SEAGOING VESSELS – Figure 12-3 and Table 12-14 underneath (DMA, 2012) show that machinery costs (short sea vessel) are around 30% larger than for new build HFO ship (including scrubber). Cost for retrofitting are 40-45% higher for LNG as compared to MGO.



Source: DMA 2012, PwC analysis

Figure 12-3 - Comparison of estimated machinery-related investments costs for a short sea ship.

Table 12-14 - Overview of machinery related investments costs for different ship types (thousand EUR)

Type of ship	Fuel	Retrofit	New Build
Containership	HFO	3.400	4.800
	LNG	4.800	6.400
RoRo	HFO	2.300	3.300
	LNG	3.200	4.300
Coastal tanker	HFO	3.700	5.100
	LNG	5.100	6.800

(Source DMA, 2012)

The capex cost for machinery-related costs (since choice of fuel is focus) is generally 20 to 30% higher (MEC analysis 2015, DMA 2012, PwC and DNV GL internal databases) for new build LNG fuelled vessels compared with HFO fuelled vessels. The price difference between diesel engines and gas engines is small. The extra cost is due to increased piping and fuel tank costs. The machinery related cost account for 10-15% of the total ships costs (exact percentage depends on the ship type).

The machinery-related costs for retrofitting are generally 40 to 45% higher (DMA 2012, PwC and DNV GL internal databases) for LNG fuelled vessels compared with HFO fuelled vessels.

This additional machinery related costs (Δ) of LNG fuelled vessels compared with HFO fuelled vessels is expected to be fixed over the time period and independent of the policy scenario. Note that with increased LNG uptake the additional machinery related costs of LNG fuelled vessels might decrease due to economies of scale. This has not been accounted for in this study.

Table 12-15 - Overview of additional investment costs (Δ) compared to diesel fuelled seaships for some representative years (million EUR)

Policy scenario	Representative year						
	2017	2020	2022	2025	2027	2030	
Baseline	Retrofit	1,4	1,7	2,9	5,3	6,5	11,9
	new build	39,0	48,5	81,3	148,4	180,3	331,4
no harmonisation	Retrofit	1,4	2,9	3,5	4,5	7,2	13,2
	new build	39,0	81,0	96,6	126,4	199,7	366,0
low/moderate harmonisation	Retrofit	1,4	4,0	3,8	6,8	8,3	15,1
	new build	39,0	112,4	105,9	188,6	230,1	420,7
full harmonisation	Retrofit	1,4	5,6	4,3	9,8	9,8	17,8
	new build	39,0	155,4	118,5	273,4	271,8	494,5

In case of “no harmonisation scenario” across EU, in 2030, an extra investment of 35,9 million euro compared to the baseline scenario is expected. Under the “low/moderate harmonisation scenario”, in 2030, this extra investment adds up to 92,5 million euro. Finally, the implementation of the “full harmonisation scenario” is expected to result in 2030 an extra investment of 169 million euro.

INLAND VESSELS - A new build ship costs 4-20 million euro depending on size and complexity. The machinery cost accounts for about 10-15% of the overall cost of an inland ship. In Table 12-16 an overview is presented of additional investments cost of LNG fuelled inland ships compared to a diesel fuelled inland ship.

Table 12-16 - Overview of *additional investment costs (Δ)* compared to diesel engine per inland ship type (Source Panteia, 2013)

Inland ship type – CEMT class	LNG additional investment costs (Δ) (thousand euro)
V	591
VI	961
V - push boat	947
VI - Push boat	141

In case of “no harmonisation scenario” across EU (see Table 12-17), in 2030, an extra investment of 18 million euro compared to the baseline scenario is expected. Under the “low/moderate harmonisation scenario”, in 2030, this extra investment adds up to 44,9 million euro. Finally, the implementation of the “full harmonisation scenario” is expected to result in 2030 an extra investment of 59,9 million euro.

Table 12-17 - Overview of *additional investment costs (Δ)* compared to diesel fuelled inland ships for some representative years (million EUR)

Policy scenario	Representative year					
	2017	2020	2022	2025	2027	2030
Baseline	30,8	53,8	69,0	63,5	52,5	29,0
no harmonisation	30,8	87,2	111,8	102,9	85,0	47,0
low/moderate harmonisation	30,8	137,2	175,9	161,8	133,7	73,9
full harmonisation	30,8	165,0	211,6	194,7	160,8	88,9

In Figure 12-4 an overview is presented of the cumulative additional (Δ) investment cost generated by investments in LNG fuelled vessels (inland and seagoing) compared to traditional fuels. From the figure it can be identified that by 2030 the cumulative investments cost is 2695 million euro. In the “no harmonisation scenario” across EU, this value adds up to 3300 million euro or 22% more compared to the baseline scenario. Under the “low/moderate harmonisation scenario”, by 2030, this extra investment adds up to 4243 million euro (57% extra compared to the baseline scenario). Finally, the implementation of the “full harmonisation scenario” is expected to result by 2030 in an 87% increase compared to the baseline scenario.

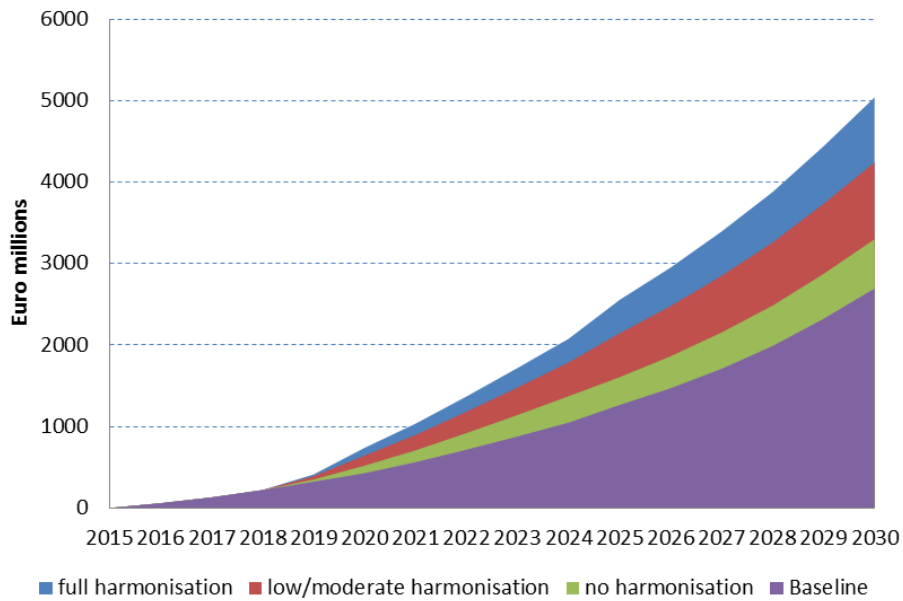


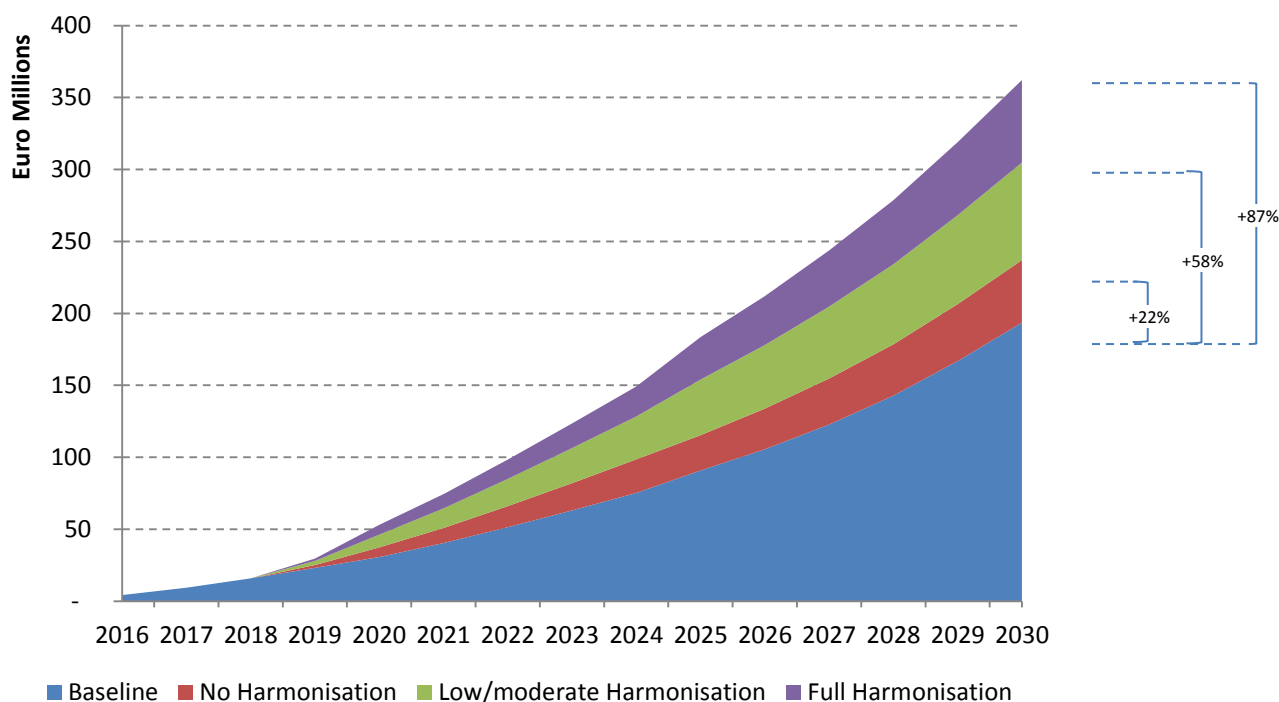
Figure 12-4 - Cumulative additional (Δ) investment cost generated by investments in LNG-fuelled (inland and seagoing) vessels over the period 2016-2030

12.5.1.2 Value added generated by investments in LNG-fuelled vessels

Investments in new builds and retrofits of maritime and inland vessels generate business opportunities for the European shipyards which contribute to the creation of added value. However, as discussed earlier, only about 25% of the LNG fuelled seagoing vessels orders and the 80% of the LNG fuelled inland vessels are expected to be built in EU shipyards.

According to Eurostat, in 2012, the ratio between value added and turnover of the shipbuilding sector⁵⁰ was about 0,27. In other words, each euro spent in shipbuilding generates a direct added value of about 0,27 Euro. Given the expected level of increase on capital expenditure, Figure 12-5 shows the trend of cumulated value added, over the period 2016-2030, for different policy scenarios.

⁵⁰ code 30.11 of NACE classification rev. 2



Source: PwC elaboration on Eurostat data

Figure 12-5 - Cumulative added value generated by investments in LNG-fuelled vessels over the period 2016-2030

Under the “no harmonisation” scenario the cumulative value added for the 2016-2030 period is expected to be 43 Million Euro higher compared to the baseline scenario (+22%). In the case of “low/moderate harmonisation” scenario the cumulated value added will be 111 Million Euro higher than in the baseline scenario (+58%). Finally if the “full harmonisation” policy option is implemented, the additional cumulated value added is expected to be in the region of 169 Million Euro (+87%).

These figures do not account for value added which can be generated indirectly by European suppliers of both European and extra European shipyards (engines, mechanical components, parts etc.). Hence the total value added generated in Europe is somewhat higher.

12.5.2 Cost savings of LNG-fuelled vessels

The paragraph provides figures concerning aspects with respect to cost savings of LNG-fuelled vessels compared with HFO and MGO fuelled vessels. These data are independent of the policy options under consideration. To enable the calculation of the economic benefits of utilizing LNG, assumptions have been made which are detailed hereunder.

One of the key cost items in ship operations are fuel costs. The Figure underneath shows a graph indicating the relative share of fuel costs in daily ship operating costs. It is not surprising then that for the shipping industry fuel costs, and consequently oil prices, are among the main drivers of the implementation of new technologies in shipping and determine to a large extent ship management and operation strategies.

The LNG price is assumed to be 80% of HFO price. DNV GL’s in house library mentions that contracts are offered by suppliers with LNG retail prices fixed at 60-80% of the diesel price. Note that the recent drop in oil price has resulted in a general drop in prices for energy from natural gas. But there is still a significant price advantage using gas compared to traditional liquid fuels and the energy price history indicates that a price drop will have limited duration.

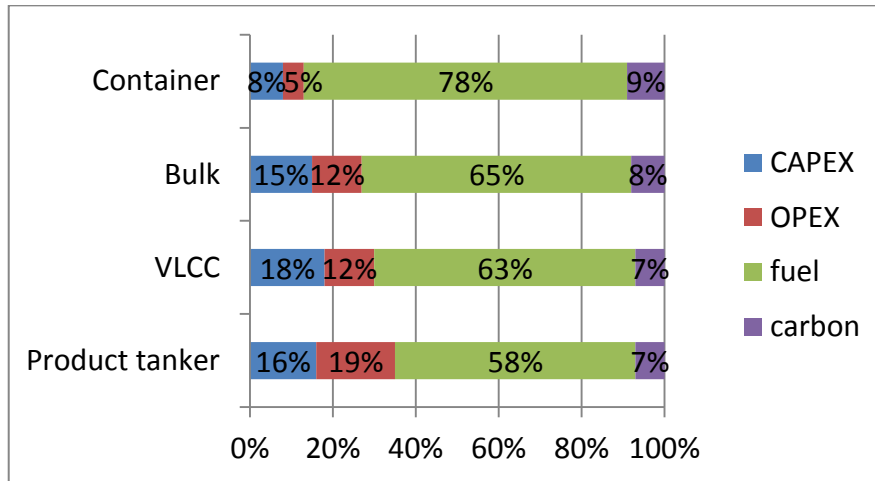
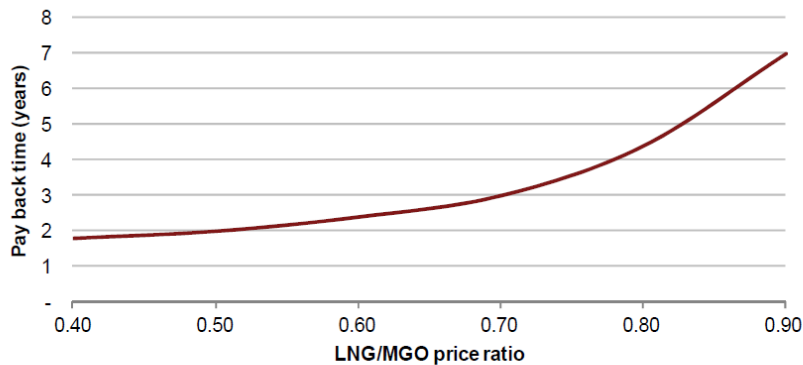


Figure 12-6 - Shares of daily ship operating costs (source: DNV GL analysis)

The length of the payback period depends on a set of factors, of which the LNG price spread is the most important one as presented in the figure below.



Source: DMA 2012

Figure 12-7 - Payback time for a big roll-on/roll-off (RoRo) shipowner as function of LNG/MGO-price ratio

The higher the LNG uptake, the higher the fuel cost savings will be. The impact on European economy will therefore be the highest in the full harmonisation scenario. A quantitative overall assessment of cost savings for the shipping industry per policy scenario has not been performed. On the short term (before 2030) the fuel cost saving will be used to pay back the initial investment and therefore not having a significant impact on European economy.

12.5.3 Other economic impacts concerning the fleet

Other factors might apply when making a detailed assessment (these factors have not been accounted for):

- Lower maintenance costs

- Higher operating costs (increased monitoring equipment required and possibly increased manning costs for newer systems).
- Higher insurance costs (as new build prices are higher)

12.5.4 Investments in LNG infrastructure

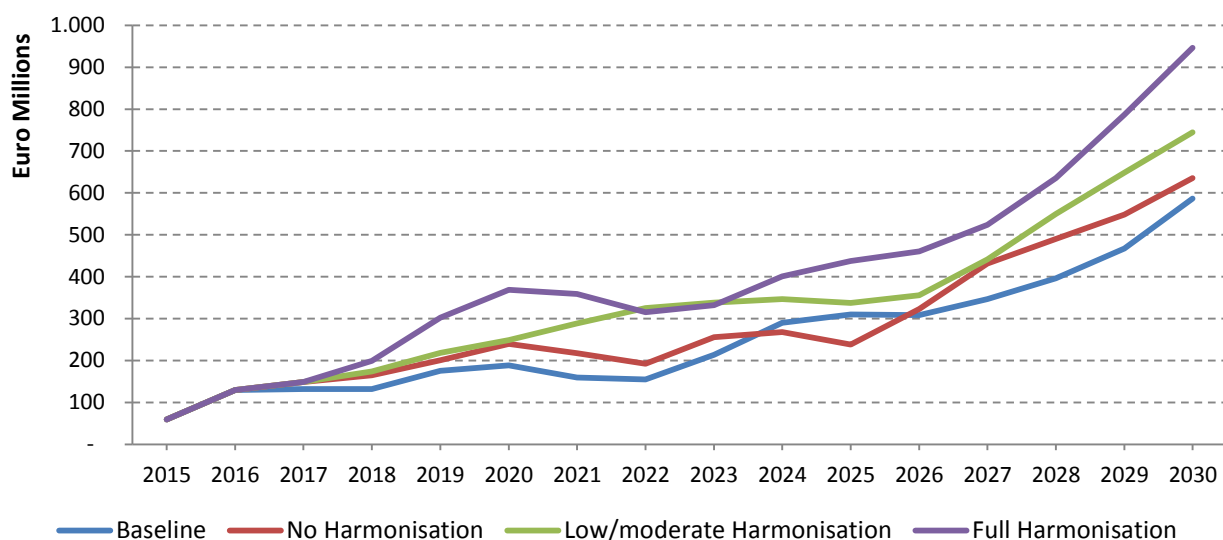
The development of the LNG infrastructure network in the period 2015-2030 implies an allocation of capital expenditure over such period by ports and bunkering operators. The DMA Study provides for an estimation of investment costs for different types of land based facilities, equipment and bunkering vessels. In addition also administrative costs for setting up LNG terminals have been considered (see Table 12-18).

Table 12-18 - Estimation of costs of equipment items from DMA study

Equipment item	Item Cost [€]
<i>Land-based tanks</i>	
700 m ³ Tank	7.000.000
20,000 m ³ Tank	40.000.000
50,000 m ³ Tank	80.000.000
Tank trucks (capacity: 50 m ³)	800.000
Pipeline and manifold connected to tank	500.000
LNG infrastructure on jetty	15.000.000
<i>Bunkering vessels</i>	
Vessel (capacity: 1,000 m ³)	20.296.296
Vessel (capacity: 3,000 m ³)	28.222.222
Vessel (capacity: 10,000 m ³)	40.888.889
<i>Port facilities</i>	
Jetty/quay	20.000.000
<i>Administrative costs: permission to set up an LNG terminal</i>	
Application for the activities	270.000
Licence costs	100.000

Source: DMA - Feasibility study for an LNG filling station network in north Europe: "North European LNG Infrastructure Project".

The LNG infrastructure and equipment needs, over the period 2015-2030, have been estimated in paragraph 12.4.3 according to different LNG demand scenarios (baseline, no harmonisation, low/moderate harmonisation, full harmonisation). Finally, capital expenditures have been estimated by multiplying the number of infrastructures and the related cost by item (see Figure 12-8).

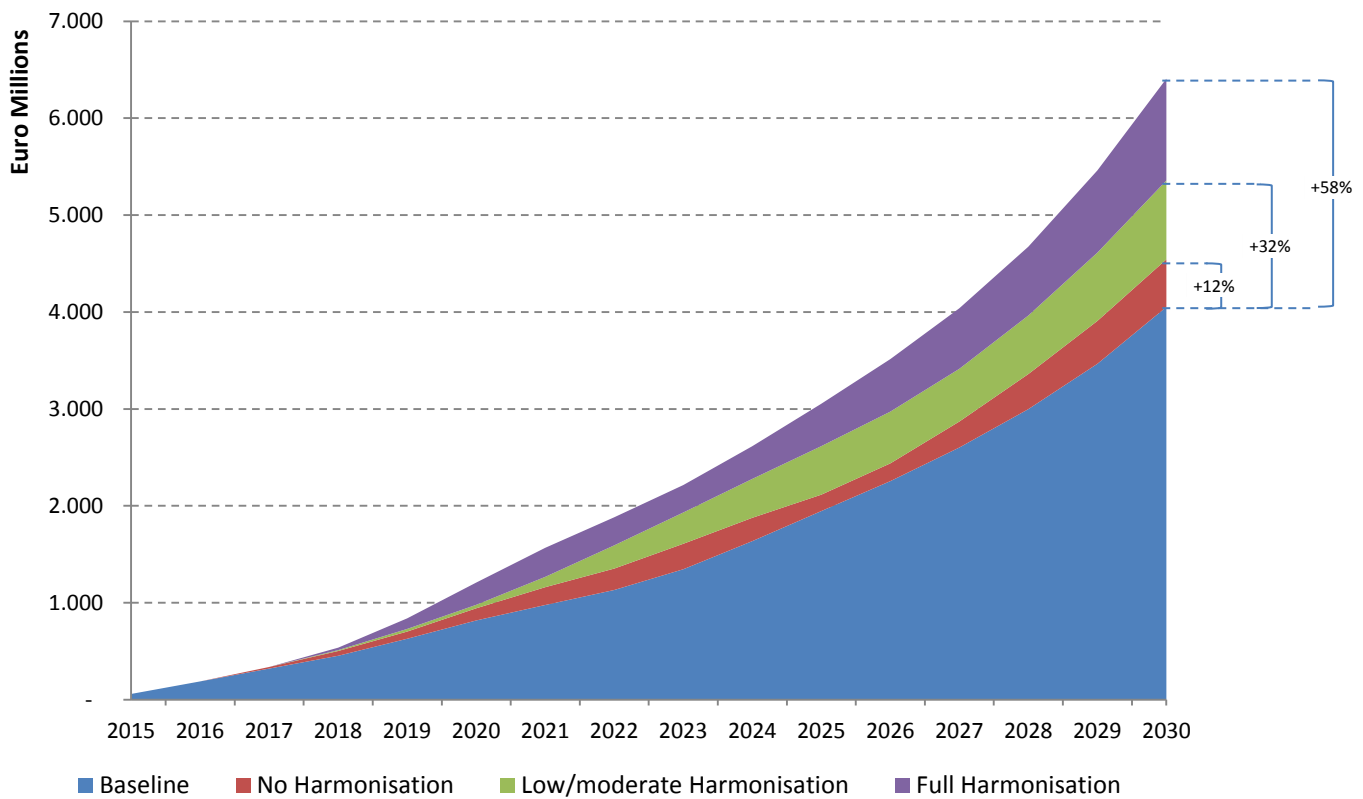


Source: PwC elaboration on DMA data

Figure 12-8 - Capital expenditure over the period 2015-2030

As effect of different policy options, the level of development of LNG infrastructure network will start to diverge from the year 2019 onwards. However capital expenditures to develop additional investment will be deployed as early as 2017. For calculation purposes, we have assumed that capital expenditures for development of a terminal or for the manufacturing of an equipment item is distributed over the 24 months period preceding the time of entering into operation (i.e. 25% in year t_{-2} , 50% in year t_{-1} and 25% in year t_0). As an example, if a new terminal enters into operation in mid-2019, we assume that 25% of capital expenditures is made in 2017, 50% in 2018 and 25% in 2019.

In general, a greater level of harmonisation of procedures among Member States should result in an anticipation of the investments over the period. As shown in Figure 12-9, cumulative capital expenditures under the baseline scenario will top 4.000 million Euro by 2030. Under the "no harmonisation" scenario the capital expenditures will be 492 million Euro higher than in the baseline (+12%). If the "low/moderate harmonisation" policy option will be pursued, the cumulative capital expenditure is expected to be 1.305 million Euro higher than in the baseline scenario (+32%). Finally, the highest cumulative capital expenditures are expected under the "full harmonisation" scenario: in this case the capital expenditure will be 2.355 million Euro higher compared to the baseline scenario (+58%).



Source: PwC elaboration on DMA data

Figure 12-9 - Cumulative capital expenditure over the period 2015-2030

12.5.4.1 Value added generated by investments in LNG bunkering infrastructure

The investments required for the development of the LNG bunkering network in Europe will generate several business opportunity for different European industries. New orders for European enterprises will result in value added for the European economy. Table 12-19 provides an estimation of ratios between value added and turnover for a list of economic sectors which are regarded as representative of the investments to be carried out.

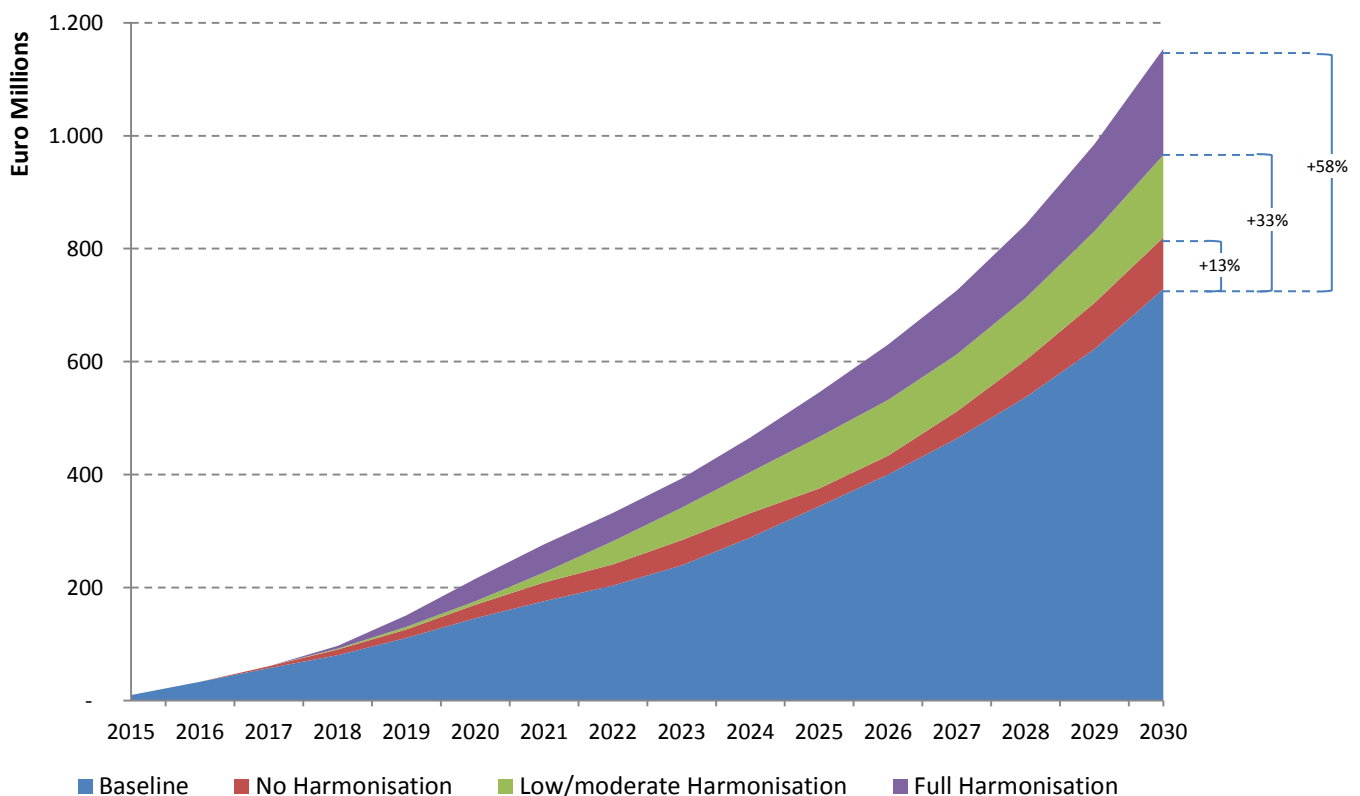
Table 12-19 - Ratios between value added and turnover (2012)

Economic sector (Nace Rev 2)	Value added at factor cost/Turnover or gross premiums written
Manufacture of motor vehicles, trailers and semi-trailers	17,7%
Building of ships and floating structures	26,6%
Construction of utility projects for fluids	31,7%
Construction of water projects	31,0%
Architectural and engineering activities and related technical consultancy	48,0%

Source: PwC elaboration on Eurostat data

We have further assumed that only 27% of bunkering vessels will be actually built in Europe, therefore only 27% of capital expenditures in bunkering vessels will generate value added in the EU. Construction activities as well as architectural and engineering activities will all take place in Europe, therefore we assume that 100% of these investments will generate value added in the EU. Finally, the share of tank trucks that will be actually produced in Europe or imported from above are unknown, however, since the European truck manufacturing industry is well established we have reasonable assumed that 100% of the investment will generate value added in Europe. Based on these assumptions, Figure 12-10 provides the expected cumulative value added generated under the four scenarios.

Compared to the baseline scenario, the “no harmonisation” scenario presents an increase in cumulative value added in the region of 91 million Euro by 2030 (+13%). Under the “low/moderate harmonisation” scenario the benefits in terms of cumulative value added will be 237 million Euro compared to baseline scenario (+33%). Finally the highest cumulative value added is observed under the “full harmonisation” scenario: 425 million Euro in addition to baseline scenario (+58%).



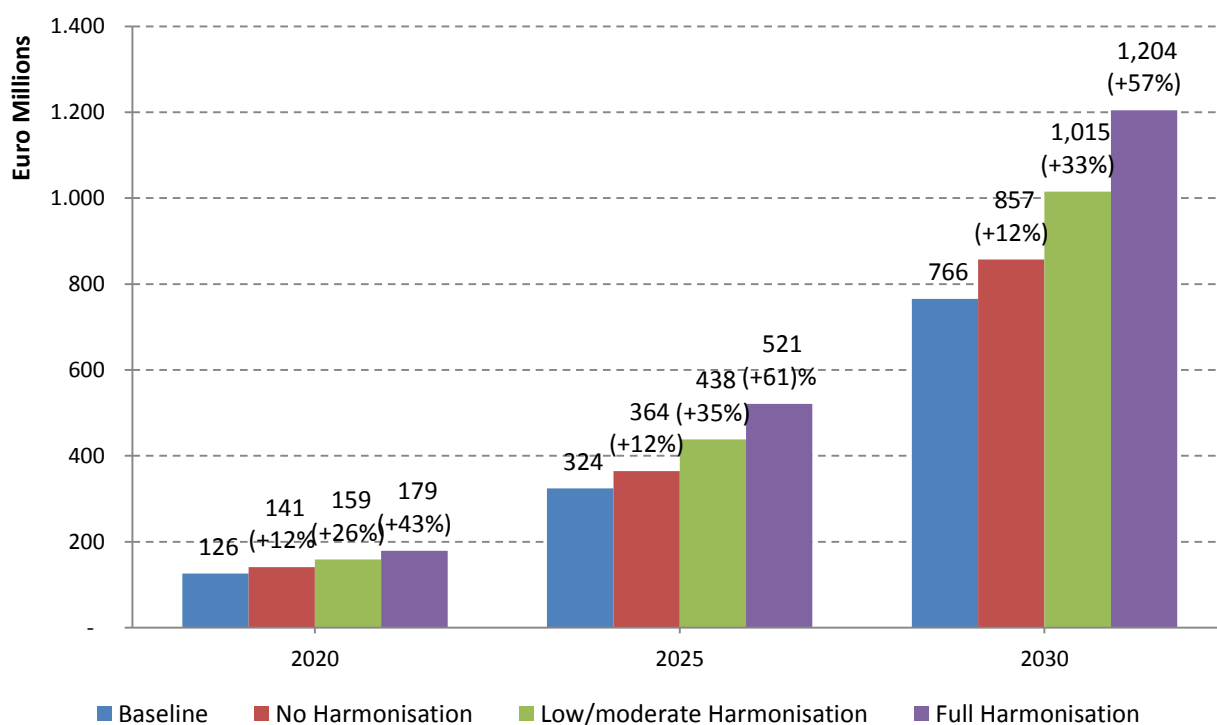
Source: PwC elaboration on DMA data

Figure 12-10 - Cumulative added value over the period 2015-2030

12.5.5 Operational Costs of LNG infrastructure

Operational costs of the LNG bunkering infrastructure are directly connected with the expected overall annual LNG throughput and the types of facilities and equipment employed to refuelling ships. Operational costs exclude LNG cost and consider labour cost, maintenance of equipment and infrastructure, energy cost and other raw material, depreciation and other costs.

The DMA Study⁵¹ provides an analysis of infrastructure needs to meet LNG demand in Baltic Sea, North Sea and the English Channel. The study assumes that LNG demand for shipping can be satisfied by a mix of facilities of different types and capacities. DMA analyses three cases of LNG terminals which vary in sizes and types of equipment employed⁵². Depending on the considered LNG terminal case, DMA estimates the annual LNG throughput to be in the range of 23.000 to 150.000 tonnes/year and the annual operational costs, excluding LNG, to vary from between 3 million and 17 million Euro. Based on these assumptions, DMA estimates the average operational cost for the European LNG infrastructure network to be about 120 Euro per ton of LNG bunkered. Given the estimated LNG demand under the baseline and the three alternative policy options, the Figure below provides the expected total operational costs connected with LNG bunkering operations.



Source: PwC elaboration on DMA data

Figure 12-11- Operational costs in 2020, 2025 and 2030

In 2030, the increase in LNG demand under the “no harmonisation” scenario will generate 91 million Euro of additional operational costs. In the same reference year, under the “low/moderate harmonisation” scenario additional cost to the bunkering industry are expected to be in the region of 249 Million Euro. Finally, in case of “full harmonisation” additional operational costs for bunkering operations are estimated to be 438 Million Euro.

⁵¹ EU co-financed feasibility study for an LNG filling station network in north Europe: “North European LNG Infrastructure Project – A Feasibility study for an LNG filling station infrastructure and test of recommendation”.

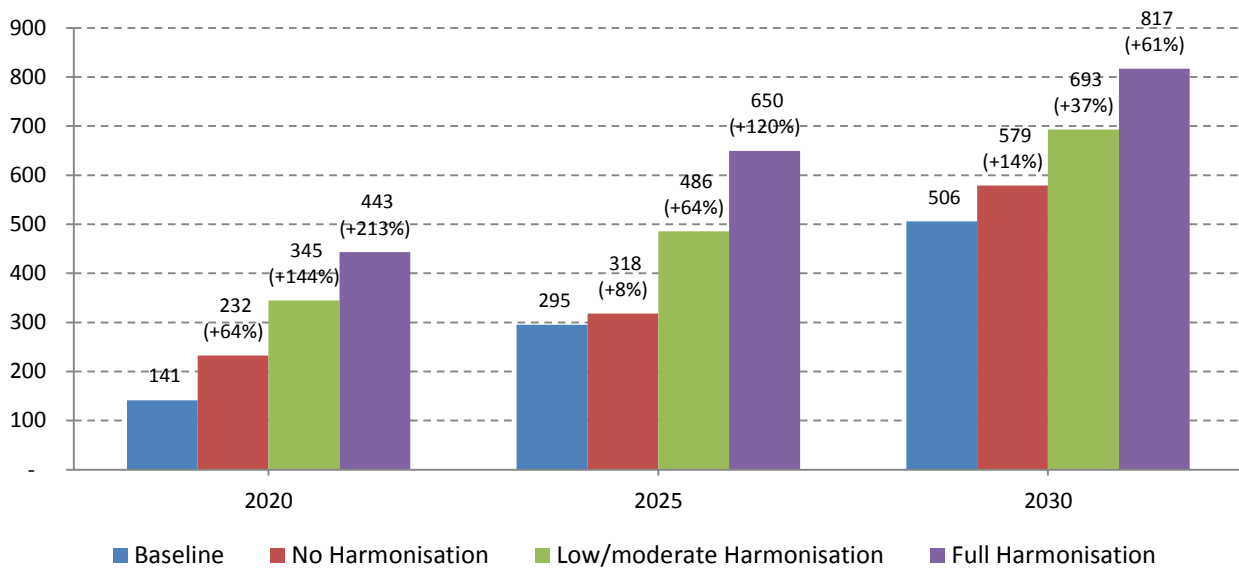
⁵² Large scale terminal is defined as a facility that could be incremental to an existing LNG import terminal which already serves other land-based end users (e.g. industry); Medium and Small scale terminals would be “purpose built” installations with a storage capacity aimed at serving shipping sector.

12.6 Social Impacts

12.6.1 Employment related to new building and retrofitting of vessels

Investments in new buildings and retrofitting of maritime and inland vessels will generate job opportunities in the European shipyards. However, as discussed earlier, only about 25% of the LNG fuelled seagoing vessels orders and the 80% of the LNG fuelled inland vessels are expected to be built in EU shipyards.

According to Eurostat, in 2012, the European shipbuilding sector⁵³ employed about 5 workers per million euro of turnover. Given the expected capital expenditures under the different policy scenarios, Figure 12-12 provides the estimation of annual levels of employment in 2020, 2025 and 2030.



Source: PwC elaboration on Eurostat data

Figure 12-12 - Estimation of annual levels of employment in 2020, 2025 and 2030

The greatest impact in terms of employment is expected under the “full harmonisation” scenario with about 300 additional annual jobs in 2030 compared to the baseline scenario. In 2030, the “low/moderate scenario” is expected to result into about 190 additional employees compared to the baseline. Finally, in case the “no harmonisation” policy option is implemented, the additional annual employment is calculated to be 73 units in 2030.

These figures do not account for the employment generated indirectly by European suppliers of both European and extra European shipyards (engines, mechanical components, parts etc.). Hence the total number of jobs created in Europe can be assumed to be somewhat larger.

12.6.2 Employment related to development of LNG bunkering infrastructure

The development of a European network for LNG infrastructure will generate business opportunities for several sectors of the European economic system. As discussed under § 12.5.4.1, these investments will result in additional value added and job opportunities.

⁵³ code 30.11 of NACE classification rev. 2

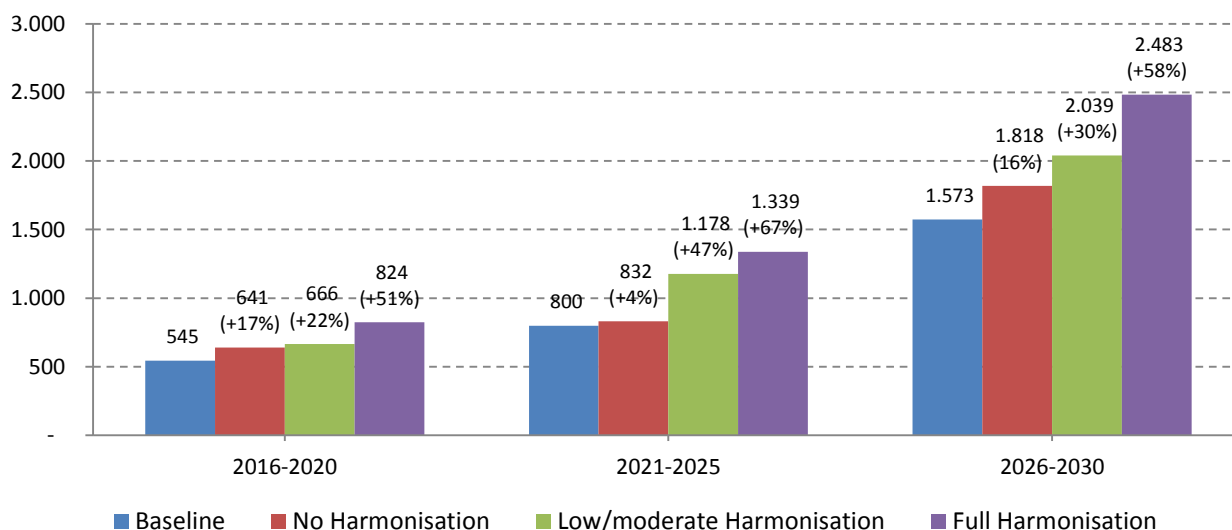
Table 12-20 provides an estimation of the average turnover generated by one employee for a list of economic sectors which are regarded as representative of the investments to be carried out. As for the assessment of the value added (see § 1.4.4.1), we assume that a share of the investment will result in import from outside EU, thus not affecting the European employment.

Table 12-20 – EU28 Turnover per employee by economic sector (€, 2012)

Economic sector (Nace Rev 2)	Turnover per employee (€, 2012)
Manufacture of motor vehicles, trailers and semi-trailers	372.106,00
Building of ships and floating structures	198.661,00
Construction of utility projects for fluids	132.444,00
Construction of water projects	167.316,00
Architectural and engineering activities and related technical consultancy	152.304,00

Source: PwC elaboration on Eurostat data

Based on the assumption described above, Figure 12-13 provides an estimation of average annual levels of employment in three periods (2016-2020; 2021-2025; 2026-2030) as effect of capital expenditures for the development of the European LNG bunkering network. Figures are broken down by policy scenario.



Source: PwC elaboration on Eurostat data

Figure 12-13 – Expected average annual employment in EU supported by investments in LNG bunkering infrastructure over the periods 2016-2020, 2021-2025, 2026-2030

As shown in the figure above, under all policy scenarios, the number of people directly employed in activities connected with the development of the LNG infrastructure network tends to increase over time.

Under the “full harmonisation” scenario, the development of the LNG infrastructure is expected to result into the creation of 910 annual additional jobs as average for the period 2026-2030. This means an increase of about 58% compared to the baseline scenario. For the same period, in the case of “low/moderate harmonisation” scenario, the average of additional annual jobs supported by infrastructure investment is about 466 (+30% against baseline). Finally, if the “low/moderate harmonisation” policy option is implemented, the average annual number of additional employees over the period 2025-2030 is expected to be in the region of 245 (+16% against baseline).

12.6.3 Employment related to operation of LNG bunkering infrastructure

The provision of LNG bunkering services is expected to generate new employment opportunity in Europe. According to a benchmark analysis carried out on a sample⁵⁴ of 5 HFO bunkering operators, about 34% of the operational costs, excluding raw material, are related to labour cost. The average labour cost per employee including salary and social cost is about € 52.000. Hence, assuming 120€/ton⁵⁵ as total operational cost for bunkering services, salaries and personnel costs accounts for about 40€/ton. Out of these findings we have calculated the expected amount of labour costs to be incurred by LNG bunkering operators under the different policy scenarios. Furthermore, given the amount of labour costs to be incurred, we have assessed the number of salaries (and other social costs) which can be paid. The latter is a proxy of the number jobs created in the sector. Results are summarised in Table 12-21.

Table 12-21 – Employment increases compared to the Baseline Scenario

DNV GL/PWC scenarios	2020	2025	2030
No Harmonisation	100 (+12,3%)	261 (+12,5%)	593 (+12,0%)
Low/moderate Harmonisation	215 (+26,4%)	739 (+35,3%)	1,616 (+32,6%)
Full Harmonisation	346 (+42,5%)	1,278 (+60,9%)	2,840 (+57,3%)

Source: PwC elaboration on DMA and Avention

The implementation of the “no harmonisation” policy option is expected to result in the creation by 2030 of almost 600 additional job positions in the LNG bunkering sector compared to the baseline. Under the “low/moderate harmonisation” scenario the LNG bunkering sector is expected to require, by 2030, about 1.600 additional employees compared to the baseline scenario. Finally, if the “full harmonisation” policy option is implemented the LNG bunkering sector will generate 2.840 additional employment opportunities compared to the baseline.

12.6.4 Other social Impacts

The uptake of LNG as fuel for ship will result in the need of new skills and competences by workers involved in different sectors. In 2013 the STX Canada Marine⁵⁶ provided an overview of the competencies required for personnel who are responsible for the safe use of marine LNG. The outcome of this analysis is briefly reported below. The following categories of human resources will require additional specialised skills and competences:

⁵⁴ Analysis of Profit & Loss sheets as reported by Avention Database (2015). The sample covers any EU company –available in the database– providing bunkering services as core activity (excluding those providing bunkering trading services). The following companies are included: Agaat Bunkering BV, Giuliana Bunkeraggi SpA, Friedrich G. Frommann (GmbH & Co. KG), Hans Rinck GmbH & Co. KG, Riccardo Sanges E C. SRL, Shell Marine Products Ltd.

⁵⁵ Source PwC elaboration on data provided by DMA study

⁵⁶ STX Canada Marine (2013) Transport Canada report, TP 15248 E, Canadian Marine Liquefied Natural Gas (LNG) Supply Chain Project, Phase 1 – West Coast

- Shipyard personnel, vessel designers and original equipment manufacturers (OEM) personnel: about 25% of the order book for LNG fuelled seagoing vessels and 80% of the order book for LNG fuelled inland vessels are expected to be retrofitted or built in European shipyards. This will require adequately trained personnel.
- Bunkering personnel; Safe bunkering of an LNG-fuelled vessel will require skills and knowledge that are to be acquired by following dedicated training programs for bunkering LNG.
- Seafarers: the operation of an LNG-fuelled vessel differs from that of an oil-fuelled vessel. Hence, officers and crew need to be properly trained in order to ensure the safe operation of the vessel.

The number of workers to train will depend on the number of workers involved in the LNG shipping sector. Therefore, the highest impacts in terms of training needs are expected under the “full harmonisation” scenario. On the other side, the baseline scenario will present the lowest number of workers to train.

12.7 Environmental impact

12.7.1 Introduction

While environmental legislation in the maritime industry has historically been lagging behind those of other industries, the situation is now changing. Key environmental regulation has come into force to address emissions of sulphur oxides (SO_x), nitrous oxides (NO_x), particulate matter (PM) and greenhouse gases (in particular CO₂) – see previous chapters.

SO_x, NO_x and PM are all emissions to air resulting from the combustion of marine fuels. These emissions have potentially severe ecosystem impact and negative health effects on exposed populations. Marpol Annex VI states a combination of general maximum global emission levels and more stringent levels applying to designated sea areas, generally known as Emission Control Areas (ECAs). The regulations allow emissions to be mitigated by either changing the fuel specification/type or by exhaust gas cleaning. The use of LNG in ECA-areas is one of the legally allowed options to reduce sulphur emissions to the atmosphere.

In this chapter, the environmental impact of the use of LNG on the marine environment compared to traditional fuels is examined.

12.7.2 Adverse effects of pollutants

This chapter addresses in brief the main environmental and health effects of Particulate Matter, NO_x, SO_x and CO₂.

PARTICULATE MATTER (PM) – Small particles have the ability to deeply diffuse within the lungs and to be absorbed in the bloodstream, with severe impact on health (decrease of lung capacity and negatively affect blood vessel function). For instance, in 2010 more than 400.000 premature mortalities annually are linked to exposure to fine particulate matter (EC 2013a)⁵⁷.

In 2000, 250.000 tons of PM was emitted by ships in Europe. Globally, 1,8 million tons of PM was released in 2007, representing a 50% increase from 1997 levels. The amount of PM released by ships is

⁵⁷ Impact Assessment accompanying the Communication from the Commission to the Council, the European parliament, the European Economic and Social Committee and the Committee of the Regions on a Clean Air Programme for Europe. European Commission (EC), Brussels, Belgium

much lower than that of SO_x or NO_x emissions. Note that PM and SO_x emissions are correlated: a decrease in SO_x emissions reduces emissions of PM.⁵⁸

NO_x - Increased nitrogen loading in water bodies upsets the chemical balance of nutrients used by aquatic plants and animals and accelerates "eutrophication," which leads to oxygen depletion and reduces fish and shellfish populations.

Exposure to NO_x may cause respiratory effects including airway inflammation and respiratory symptoms. NO_x react with ammonia, moisture, and other compounds to form small particles. These small particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease, such as emphysema and bronchitis, and can aggravate existing heart disease, leading to increased hospital admissions and premature death.

Shipping also accounts for a significant portion of the world's NO_x emissions.⁵⁹ A total of 3,3 million tons of NO_x was emitted by ships in the seas surrounding Europe in the year 2000. Globally, 25 million tons of NO_x were emitted by shipping in 2007, representing a 39% increase from 1997 levels. NO_x emissions from shipping represent around 15% of the world's total NO_x emissions.

SO_x - Emission of SO_x leads to acidification of ecosystems and water quality deterioration, causing a loss of biodiversity.

Additionally it may cause adverse health effects. Short term exposure may lead to an array of adverse respiratory effects including bronchoconstriction and increased asthma symptoms. SO_x can react with other compounds in the atmosphere to form small particles. These particles penetrate deeply into sensitive parts of the lungs and can cause or worsen respiratory disease, such as emphysema and bronchitis. The shipping industry is among the top emitters of SO_x. A total of 2,3 million tons of SO₂ (the most common sulphur oxide) was emitted by ships in the seas surrounding Europe in the year 2000. Globally, 15 million tons of SO_x were emitted by shipping in 2007, representing a 50% increase from 1997 levels. SO_x emissions from shipping represent between 5% and 8% of the world's total SO_x emissions.

CO₂ AND CH₄ - Under the GHG (greenhouse gasses) Protocol, six gases are categorized as greenhouse gases: carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), hydrofluorocarbons (HFCs), perfluorooctane sulphonate (PFCs), and sulphur hexafluoride (SF₆). Greenhouse gasses such as CO₂ and CH₄ are the primary mechanism for antropogenic warming of the atmosphere. The greenhouse gas effect of methane is between 20 to 25 times higher than for CO₂. CO₂ is the GHG most relevant to the shipping industry. Globally, 1.050 million tons of CO₂ were emitted by shipping in 2007, doubling 1990 levels. CO₂ emissions from shipping represent approximately 3% of the world's total CO₂ emissions⁶⁰.

12.7.3 Reduction of pollutants from exhaust gases

LNG has a number of environmental advantages over conventional fuels, such as reduction of SO_x, NO_x, PM and CO₂ from engine exhaust emissions.

SEAGOING SHIPS - The IMO emissions legislation for sea shipping is focussed on reduction of SO_x and NO_x. Sea ships are traditionally sailing on MDO (marine diesel oil) or HFO (heavy fuel oil). The ratio MDO/HFO is estimated to be at 30% (based on IMO (2009) Second IMO GHG Study). From 2020 on, it is assumed that the global sulphur cap of 0,5% is in force (in SECA's 0.1% sulphur cap).

⁵⁸ International Maritime Organisation, "International Shipping Facts and Figures - Information Resources on Trade, Safety, Security, Environment", released 6 March 2012

⁵⁹ Air Clim, "Air pollution from ships", November 2011

⁶⁰ International Maritime Organisation, "International Shipping Facts and Figures - Information Resources on Trade, Safety, Security, Environment", released 6 March 2012

Use of LNG as fuel (as compared to traditional fuels) will reduce the NO_x emissions by approximately 85-90% on a lean burn gas fuelled engine and the SO₂ and particulate matters emissions are eliminated. The CO₂ emissions are about 25% lower (because of the lower carbon content of LNG). However, the release of unburned methane from engines (so called methane slip) is a challenge. Note that next to the methane slip issues, methane release can also occur during LNG production, processing, storage, transport and bunkering, this has not been accounted for in this study. The environmental benefits are summarised in below table.

Table 12-22 – Environmental benefits from LNG as compared to traditional fuels for seagoing ships

Pollutant	reduction
SO _x	Almost 100%
PM	95%
CO ₂	20% ^(see note below)
NO _x	85 %

Note: The average GHG reduction from LNG as fuel is a complex area. Stoichiometrically the CO₂ reduction should be about 25%, but due to potential methane slip (engine related) issues only 20% reduction is accounted for. This varies from engine type to engine type: 2 stroke engines don't have any methane slip and new 4 strokes gas only engines have very low methane slip. Most LNG fuelled ships today have dual fuel 4 strokes and they do have some methane slip (3-5% of fuel into engine is lost). The highest methane slip values are found for the older engines. In these calculations potential methane releases during LNG production, processing, storage, transport and bunkering has not been accounted for. Based on the latter, the overall net CO₂ saving is set at 20%.

The emission factors for the different pollutants (per ton consumed fuel) are taken from the 2009 Second IMO GHG Study which compiled information in line with recognized standards (IPCC, UNECE/EMEP CORINAIR). The values are summarised in Table 12-23 below.

Table 12-23 – Emission factors per ton fuel consumed seagoing ships

Emission factors (tons per fuel ton)	HFO	MDO
SO _x	0,054	0,01
PM	0,0067	0,0011
CO ₂	3,130	3,190
NO _x	0,060	0,060

Source: DNV GL elaboration on IMO (2009) GHG study

INLAND SHIPS – Inland ship are traditionally sailing on diesel engines (reference fuel diesel EN590). For those diesel engines it is expected that NO_x and particulates emissions are just below the emission limits of the applicable legislation.

Use of LNG as fuel will reduce the NO_x emissions by approximately 5% and the SO₂ and particulate matters emissions are reduced with respectively 55% and 10%. The CO₂ emissions (GHG emissions) are about 20% lower (because of the lower carbon content of LNG).

Table 12-24 – Environmental benefits from LNG compared to diesel EN590

Pollutant	reduction
SO _x	55%
PM	10%
CO ₂	20%
NO _x	5%

The emission factor for the different pollutants (per ton consumed fuel) is based data provided by Winnes and Fridel in Journal of the Air & Waste Management Association (2009). These data were processed and summarised in table below.

Table 12-25 – Emission factors per ton fuel consumed

Emission factors (tons per fuel ton)	Diesel EN590
SO _x	0,0006
PM	0,0014
CO ₂	3,1800
NO _x	0,0450

Source: DNV GL assessment of Winnes and Fridel (2009)

12.7.4 Emission reduction by shipping for different policy scenarios

The next step in the analysis, is an estimate of the environmental emissions (CO₂, NO_x, SO_x and PM), produced by the use of fuel. The analysis focuses on the reduction of emissions by use of LNG compared to traditional fuels. As a basis for the analysis the uptake of LNG for the different policy years is being used (Table 12-8 for inland shipping and Table 12-7 for seagoing vessels).

SEAGOING FLEET – In Table 12-26, the yearly emission reduction for NO_x, SO_x, CO₂ and PM is presented for some selected years in the period 2015-2030 for the seagoing fleet. These data are further addressed in Figure 12-14 to Figure 12-17.

Table 12-26 – Emission reduction seagoing fleet for NO_x, SO_x, CO₂ and PM (in kton/y) for the different policy options

SO_x (kton/y)	2015	2020	2025	2030
Baseline	-10	-10	-25	-63
no harmonisation	-10	-11 (+11%)	-28 (9%)	-69 (10%)
low/moderate harmonisation	-10	-12 (+22%)	-32 (26%)	-79 (27%)
full harmonisation	-10	-14 (+37%)	-38 (50%)	-94 (+50%)

NO_x (kton/y)	2015	2020	2025	2030
Baseline	-12	-50	-130	-319
no harmonisation	-12	-56 (+11%)	-141 (+9%)	-349 (+10%)
low/moderate harmonisation	-12	-61 (+22%)	-164 (+26%)	-404 (+27%)
full harmonisation	-12	-69 (+37%)	-195 (+50%)	-480 (+50%)

PM (kton/y)	2015	2020	2025	2030
Baseline	-1	-5	-12	-30
no harmonisation	-1	-5 (+11%)	-13 (+9%)	-33 (+10%)
low/moderate harmonisation	-1	-6 (+22%)	-15 (+26%)	-38 (+27%)
full harmonisation	-1	-6 (+37%)	-18 (+50%)	-45 (+50%)

CO₂ (kton/y)	2015	2020	2025	2030
Baseline	-152	-623	-1602	-3937
no harmonisation	-152	-689 (+11%)	-1742 (+9%)	-4313 (+10%)
low/moderate harmonisation	-152	-759 (+22%)	-2024 (+26%)	-4993 (+27%)
full harmonisation	-152	-855 (+37%)	-2410 (+50%)	-5921 (+50%)

In 2030, the reduction in SO_x emission under the “no harmonisation” scenario adds up to -69 kton/y, or 6 kton extra reduction of SO_x emissions (circa 10%) compared to the baseline scenario. In the same reference year, under the “low/moderate harmonisation” scenario reduction of emissions of SO_x is expected to be -79 kton/y (or 27% additional reduction compared to the baseline scenario). Finally, in case of “full harmonisation” this reduction adds up to -94 kton/y (50% more reduction than the baseline scenario).

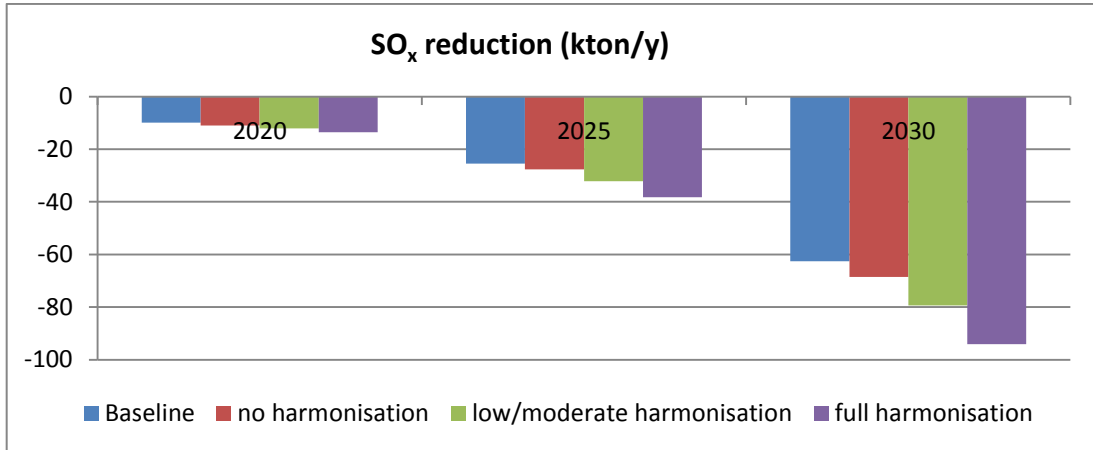


Figure 12-14 – SO_x emission reduction seagoing vessels for the selected policy scenarios (kton/y)

Similarly, for NO_x, the implementation of the “no harmonisation” policy option is expected to result in a reduction of NO_x emission of -349 kton/y by 2030 compared to the baseline of -319 kton/y. Under the “low/moderate harmonisation” scenario the LNG shipping sector is expected to reduce the NO_x emissions with -404 kton/y. Finally, if the “full harmonisation” policy option is implemented the NO_x emissions will reduce with -480 kton/y.

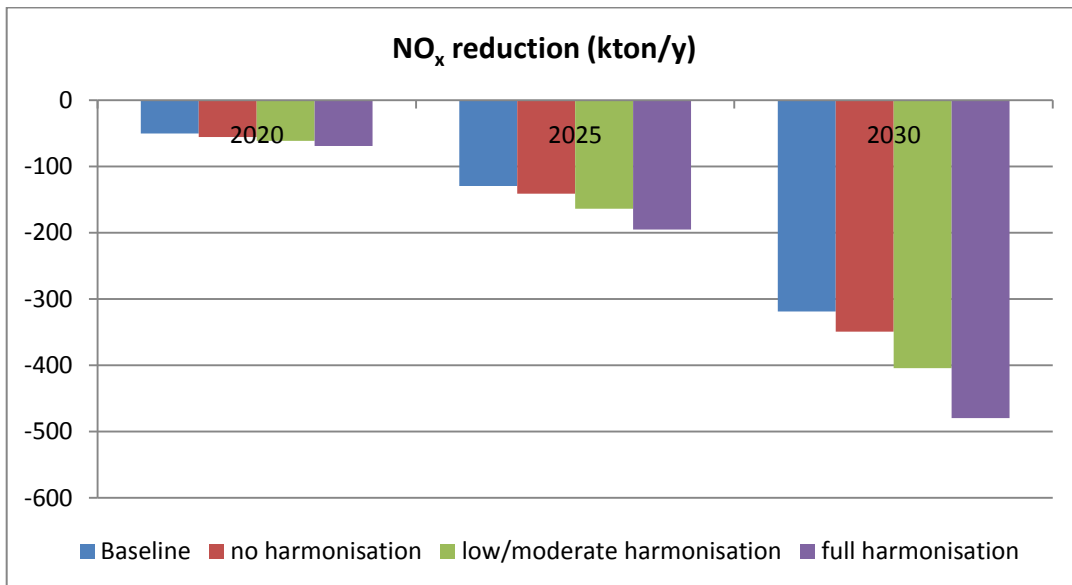


Figure 12-15- NO_x emission reduction seagoing vessels for the selected policy scenarios (kton/y)

In the baseline scenario PM emissions are yearly reduced with -30 kton by 2030. The 'no harmonisation', 'low harmonisation' and 'full harmonisation' scenarios add respectively, 10%, 27% and 50% of extra PM reduction compared to the baseline scenario.

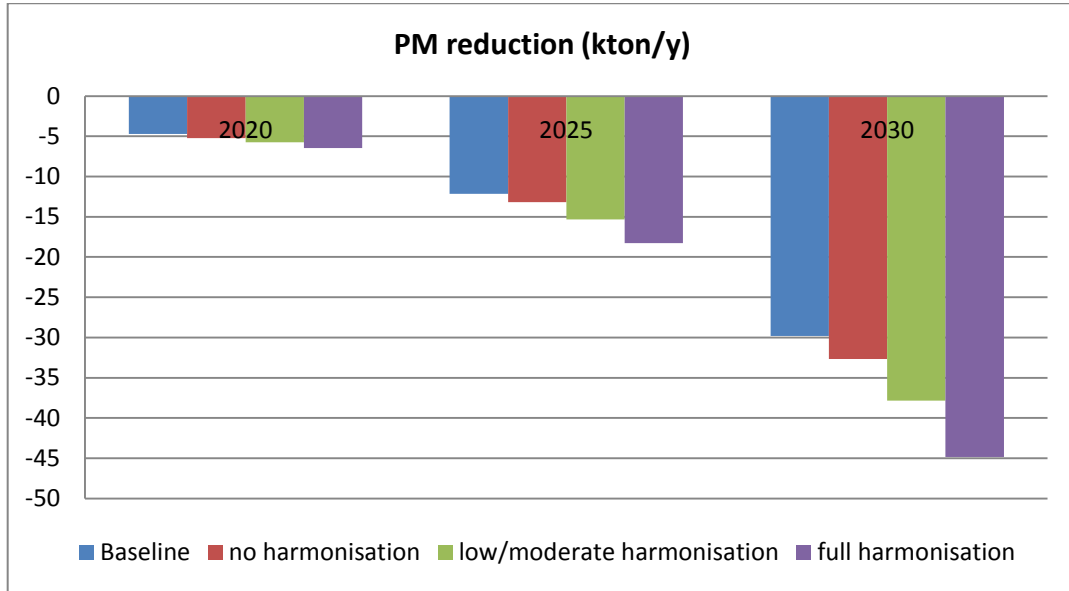


Figure 12-16 - PM emission reduction seagoing vessels for the selected policy scenarios (kton/y)

The CO₂ emissions are yearly reduced with -3937 kton by 2030 in the baseline scenario. The 'no harmonisation', 'low harmonisation' and 'full harmonisation' scenarios add respectively, 10%, 27% and 50% of extra CO₂ reduction compared to the baseline scenario.

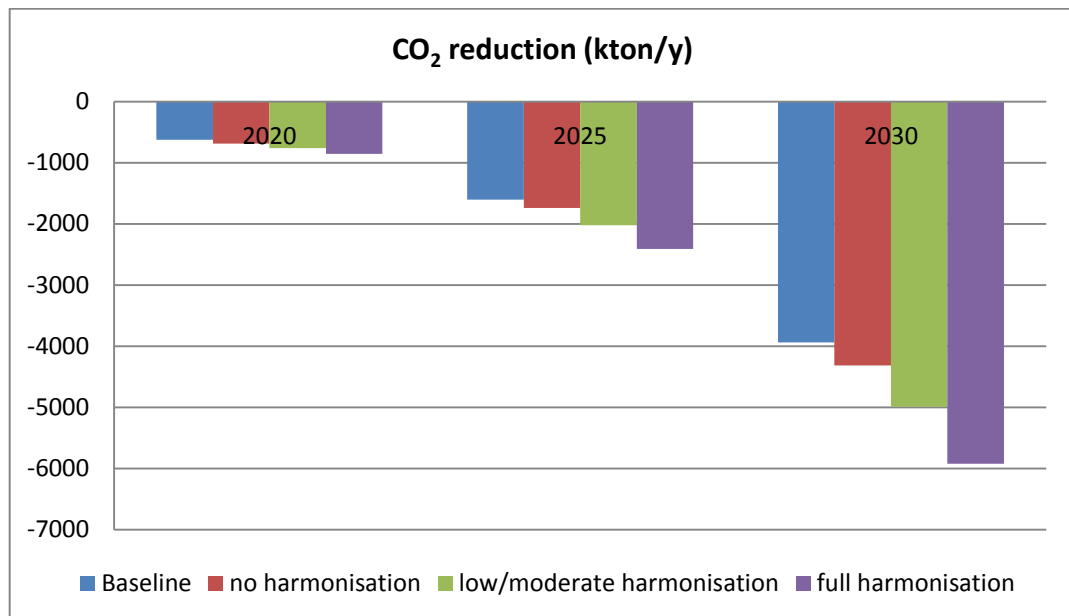


Figure 12-17 - CO₂ emission reduction seagoing vessels for the selected policy scenarios (kton/y)

In Table 12-27 the cumulative emission reduction is presented for the total period 2015-2030 (in kton). Shifting to LNG would lead to a cumulative emission reduction of -431 kton SO_x, -1.785 kton NO_x, -22.037 kton CO₂ and -167 kton PM under the baseline scenario in the period 2015 to 2030.

The main reduction benefit is found in the 'full harmonisation scenario' with a global emission reduction adding up to -587 kton SO_x, -2.579 kton NO_x, -31.841 CO₂ and -241 kton PM in the period 2015 to 2030

Table 12-27 – Global emission reduction (kton) over the period 2015-2030 for the seagoing fleet

kton	SO_x	NO_x	PM	CO₂
Baseline	-431	-1.785	-167	-22.037
no harmonisation	-464	-1.953	-183	-24.106
low/moderate	(+8%)	(+9%)	(+9%)	(+9%)
harmonisation	-516	-2.217	-207	-27.375
	(+20%)	(+24%)	(+24%)	(+24%)
full harmonisation	-587	-2.579	-241	-31.841
	(+36%)	(+44%)	(+44%)	(+44%)

INLAND FLEET - In Table 12-28 the emission reduction for NO_x, SO_x, CO₂ and PM for inland shipping is presented. From the calculated emission reduction it can be concluded that by 2030, the SO_x and PM emission is less than 1000 ton/y. The NO_x emission reduction is by 2030 ranging from -1 to -2 kton/y, the CO₂ reduction by 2030 from -229 to -635 kton/y depending on the policy scenario considered.

Table 12-28 - Emission reduction inland fleet for CO₂, NO_x, SO_x and PM (in kTon/y) for the different policy options

SO_x (kTon/y)	2015	2020	2025	2030
Baseline	0	0,0	-0,1	-0,1
no harmonisation	0	0,0	-0,1	-0,2
low/moderate harmonisation	0	-0,1	-0,2	-0,3
full harmonisation	0	-0,1	-0,2	-0,3

NO_x (kTon/y)	2015	2020	2025	2030
Baseline	0	-0,2	-0,6	-0,8
no harmonisation	0	-0,3	-0,9	-1,2
low/moderate harmonisation	0	-0,4	-1,3	-1,9
full harmonisation	0	-0,4	-1,5	-2,2

PM (kTon/y)	2015	2020	2025	2030
Baseline	0	0,0	0,0	-0,1
no harmonisation	0	0,0	-0,1	-0,1
low/moderate harmonisation	0	0,0	-0,1	-0,1
full harmonisation	0	0,0	-0,1	-0,1

CO₂ (kTon/y)	2015	2020	2025	2030
Baseline	-3,3	-61,3	-162,1	-229,0
no harmonisation	-3,3	-79,3	-242,5	-350,7
low/moderate harmonisation	-3,3	-106,4	-363,2	-533,3
full harmonisation	-3,3	-121,5	-430,3	-635,0

In Table 12-29 the cumulative emission reduction from inland shipping is presented for the total period 2015-2030 (in kton). Shifting to LNG would lead to a global emission reduction of -0,9 kton SO_x, -6,4 kton NO_x, -1813 kton CO₂ and -0,4 kton PM under the baseline scenario in the period 2015 to 2030.

The main reduction benefit is found in the 'full harmonisation scenario' with a cumulative emission reduction adding up to -2,4 kton SO_x, -16,3 kton NO_x, -4.620,8 kton CO₂ and -1 kton PM in the period 2015 to 2030.

Table 12-29 - Global emission reduction (kton) over the period 2015-2030 for the inland fleet

(kton)	SOX	NOX	PM	CO ₂
Baseline	-0,9	-6,4	-0,4	-1813,7
no harmonisation	-1,3 (+46%)	-9,4 (+46%)	-0,6 (+46%)	-2654,9 (+46%)
low/moderate harmonisation	-2,0 (+116%)	-13,9 (+116%)	-0,9 (+116%)	-3917,7 (+116%)
full harmonisation	-2,4 (+151%)	-16,3 (+151%)	-1,0 (+151%)	-4620,8 (+151%)

For seagoing ships, a substantial reduction of NO_x, PM, CO₂ and SO_x emissions can be achieved by shifting to LNG as fuel. This is mainly related to the highly polluting profile of the traditional fuels used in seagoing fleet. The overall reduction of NO_x, PM, CO₂ and SO_x of the inland fleet shifting to LNG is low compared to the seagoing fleet.

12.8 Impact on human health from emission reduction

The 2014 Impact Assessment related to the implementation of Directive 2012/33/EU asks Member States to quantify and monetize health effects of sulphur emission reduction. For EU-27 the cumulative impacts are reported to be:

- A reduction of the current global annual 60 000 premature deaths caused by burning high sulphur marine fuels
- € 15 to 34 billion of annual health benefits

The methodology to quantify mortality attributed to air pollution is a complex matter but several studies have unambiguously shown that people living in less polluted cities live longer than those living in more polluted cities; COMEAP (2009) "Long-term exposure to air pollution: effects on mortality" states a 10 µg_m-3 increase in fine particles is associated with a 6% increase in risk of death.

In the Second IMO GHG study it is argued that at local and regional scales, ocean-going ships impact human health through the formation and transport of ground-level ozone and emissions of sulphur and particulate matter (Corbett *et al.*, 2007). In many harbour cities, ship emissions are a dominant source of urban pollution. Furthermore, emissions of NO_x, CO, VOC, particles and sulphur (and their derivative species) from ships may be transported in the atmosphere over several hundred kilometres, and can contribute to air-quality problems further inland, even if they are emitted at sea. Corbett *et al.* (2007) demonstrated that emissions of PM from ocean-going ships could cause approximately 60,000 premature mortalities annually from cardiopulmonary disease and lung cancer, with impacts concentrated in coastal regions on major trade routes. Most mortality effects are seen in Asia and Europe where high populations and high shipping-related PM concentrations coincide. For the Europe/Mediterranean region an annual cardiopulmonary and lung cancer mortality attributable to ship PM emissions of 26710 is reported.

Based on this figure, the projected reduction in mortality due to a shift to LNG as ship fuel is calculated as follows. Based on the current amount of fuel oil bunkered in EU (40377 kton/year; Source: IEA

International Energy Statistics) and on the forecasted amount of bunkered LNG (Table 12-7 and Table 12-8), the percentage of fuel oil substituted is calculated (ceteris paribus):

Table 12-30 - Percentage of fuel oil bunkered substituted by LNG

	2015	2020	2025	2030
Baseline	1%	3%	8%	20%
no harmonisation	1%	4%	10%	22%
low/moderate harmonisation	1%	4%	11%	26%
full harmonisation	1%	5%	14%	31%

Using these percentages, the following projected reduction in mortality due to a shift to LNG as ship fuel is obtained:

Table 12-31 - Projected reduction in premature mortality (persons)

	2015	2020	2025	2030
Baseline	199	876	2260	5337
no harmonisation	199	985	2541	5975
low/moderate harmonisation	199	1108	3056	7078
full harmonisation	199	1249	3636	8395

In the baseline scenario, by 2030, more than 5000 premature mortalities will be avoided. Compared to the baseline scenario, the “no harmonisation” scenario presents an increase in avoided premature mortalities to almost 6000 by 2030 (+12%). Under the “low/moderate harmonisation” scenario the benefits in terms of premature mortalities avoided will be about 7000 or 33% extra compared to baseline scenario. Finally the highest value is observed under the “full harmonisation” scenario: about 3000 additional premature mortalities avoided compared to the baseline scenario (+57%).


12.9 Safety impact

12.9.1 Introduction

A key difference of LNG compared to traditional marine fuels are the low flashpoint and the cryogenic temperature and also that the supply of LNG is not carried out on a routine basis widely yet. It is also important to understand the different behavior and risks of operating with LNG as opposed to conventional fuel to ensure and maintain safety for people and the environment. The hazard control focusses primarily on fire and damage prevention and only in second priority on environmental pollution. In the text below a general overview is presented of LNG specific aspects followed by a detailed summary of safety considerations per policy scenario.

12.9.2 Overview of hazards involved when handling LNG

At atmospheric pressure, depending on composition, LNG will boil at approximately -160°C and represent a cryogenic hazard causing embrittlement of carbon steel structures and potential frost burns to exposed personnel. The natural gas is non-toxic, but can threaten personnel through asphyxiation due



to depletion of oxygen (reduction of O₂-concentrations). When the natural gas is mixed with air it will gradually become flammable (when it reaches its flammable concentrations).

Natural gas is only flammable within a narrow range of concentrations in the air (typically between 5% and 15% for pure methane). Less air does not contain enough oxygen to sustain a flame, while more air dilutes the gas too much for it to ignite. In the event of a spill, LNG vapours will disperse with the prevailing wind. Cold LNG vapour will appear as a white cloud.

The flammable concentrations of gas could be ignited, which can result in a pool fire, jet fire, flash fire, or confined explosions, depending on the release scenario and time of ignition. The probability of explosion could be limited by a good design of the LNG Bunker Vessel. This means that the vessel should have an open design where confinement is limited, so no significant overpressures can be built up after ignition.

A special type of hazard is a fireball, which is a very rapid combustion process most often associated with a Boiling Liquid Expanding Vapour Explosion (BLEVE). These are only associated with pressurized liquids. The normal mechanism for BLEVE is a pressure vessel containing pressurized liquefied gas (e.g. a pressurized LNG tank) subjected to external fire impingement or catastrophically failing due to other causes. Insulation of a pressurised tank generally contributes to reducing the risk of escalation from impacting fire. Also physical barriers prevent direct fire impingement and mechanical impact and reduce the likelihood of a BLEVE. For example, in case an LNG fuel tank is placed below deck, the ship's hull will act as physical barrier.

LNG is neither carcinogenic nor toxic. It is however an asphyxiant which dilutes or displaces the oxygen containing atmosphere, leading to death by asphyxiation if exposed long enough. Since natural gas in its pure form is colourless and odourless, confined spaces are subject to special attention. With large uncontrolled release quantities, personnel in direct surroundings may be suffering from low oxygen concentrations (<6-15 V%), which should be counteracted by technical and procedural solutions.

The cryogenic nature of LNG poses the risk of potentially injurious low temperature exposure of personnel, structural steel, equipment, instrumentation, control and power cabling. Cryogenic exposure of personnel causes frost burns; cryogenic exposure of carbon steel causes embrittlement, possibly resulting in structural failure. Consequently, protection from cryogenic exposure, as well as from fire exposure, is needed.

In case of an LNG release into water a rapid phase transformation (RPT) will occur. This is a very rapid physical phase transformation of LNG liquid to methane vapour mainly due to submersion in water. RPT does not involve any combustion and cannot be characterised as a detonation. The pressure pulse created by small pockets of LNG that evaporates instantaneously when superheated by mixing in water, will travel by the speed of sound and decay as any other pressure pulse. The hazard potential of rapid phase transitions can be severe, but is highly localized within or in the immediate vicinity of the spill area. It will not cause ignition but can be potentially damaging for the ship or equipment. However, RPT is unlikely to damage large structural elements of a ship.

To conclude, the main hazards associated with LNG are:

- fire, deflagration or confined explosion from ignited natural gas evaporating from spilled LNG;
- vapour dispersion and remote flash fire;
- brittle fracture of the steel structure exposed to LNG spills;
- frostbite from liquid or cold vapour spills;

- asphyxiation from vapour release;
- over-pressure of transfer systems caused by thermal expansion or vaporization of trapped LNG;
- possible RPT caused by LNG spilled into water;
- possible BLEVE of pressurized tanks subjected to a fire.

The planning, design, and operation should focus on preventing release of LNG and vapour, and avoiding occupational accidents related to the handling of equipment. The risk and hazards related to the LNG bunkering are closely linked to the potential rate of release in accidental situations, and factors such as transfer rates, inventories in hoses and piping, protective systems such as detection systems, ESD and spill protection are essential.

12.9.3 Qualitative assessment of safety issues by policy option

In this paragraph the implications with respect to safety for the different policy options are qualitatively assessed. Attention is paid to the three main elements for safe development and operations of LNG bunker facilities and ships:

- Safe design and operation
- Safety Management System.
- Risk Assessment

The stakeholder's role and involvements is presented in Figure below.

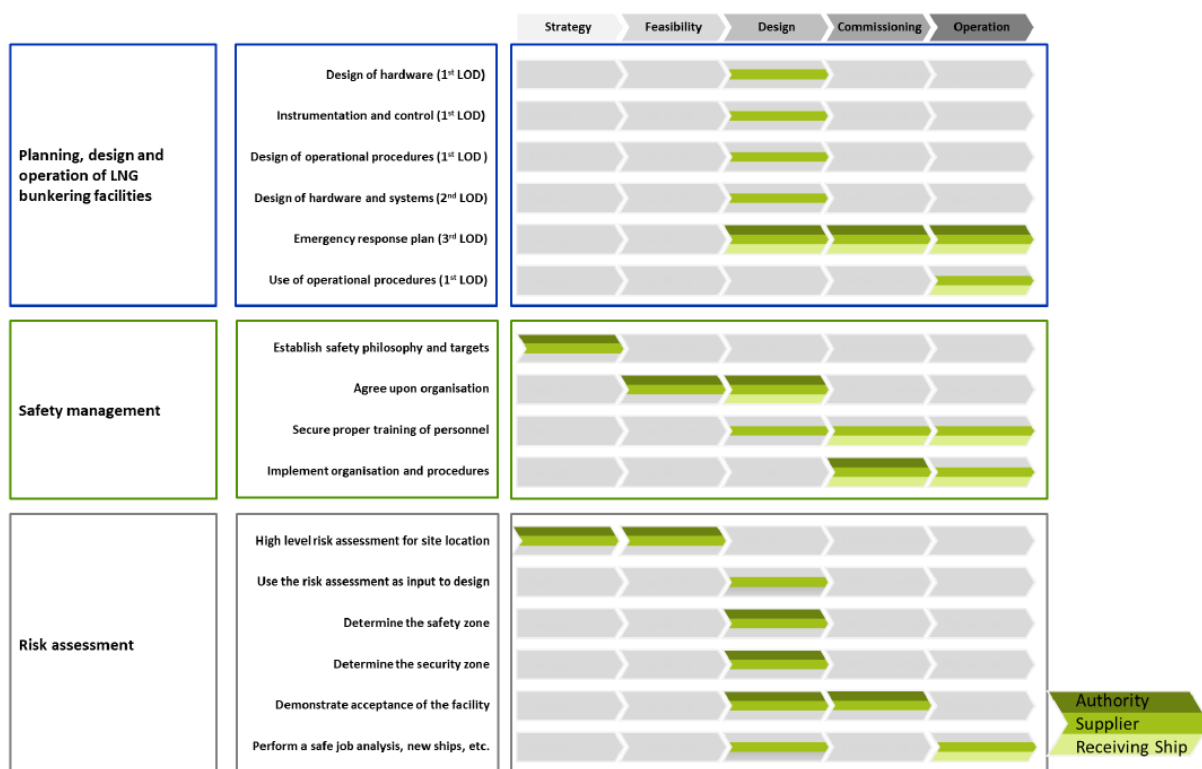



Figure 12-18 - Stakeholders' involvement in developing and operating of LNG bunkering facilities (Source DNV GL recommended Practice DNVGL-RP-0006:2014-01)



In the business as usual (BAU-scenario) the LNG market will develop without additional regulatory framework enhancements, leading to uncertainties for industries on expectations of National and local authorities. In the scenario LNG infrastructure is built and operated according to operator's best practices. The contribution from organisations involved in bunkering is dependent on the risk acceptance of the organisations involved and their maturity with regard to safety management system and risk management. Overall a proliferation of different non-standardized operations is expected. Whereas the traditional large scale LNG market is governed by a small set of traditional 'specialist companies', non-specialist companies are expected to enter the small scale market (bunkering and operation of LNG refuelling stations). The latter might lead to safety targets not being met for all involved in or potentially affected by LNG bunker operations. Potential unsafe LNG bunkering or unsafe operations by first movers on the LNG small scale market might introduce risks of incidents that could harm the reputation of the entire LNG value chain.

In the 'no harmonisation across EU' scenario, it is assumed that the legal gaps will be closed but that no main actions are being executed with respect to harmonisation across EU. In this scenario there is a lack of standards for industry applications. Port authorities/national authorities act independently and not coordinated in their decision making process with respect to minimum risk acceptance criteria, acceptability of the location of bunkering facilities, restrictions on bunkering operations such as simultaneous bunkering and loading, unloading, passenger presence, embarking, disembarking, portable tanks loading; overall contingency plans and arrangements; traffic control/restrictions, ... This might lead to authorities imposing different safety requirements for the same installation potentially resulting in the status of some Member States as 'preferred choice' for the LNG industry to develop their small scale LNG initiatives, as safety requirements might be less stringent and/or the approach to demonstrate acceptability of external safety is considerably less complex. Lack of equipment standardisation potentially might lead to vessels served by different LNG bunker suppliers across EU ports being confronted with significantly different bunker connectors, leading to confusion or inability to connect at best and potential unsafe operations and incidents at worst. Although some increased awareness will lead to some major players and 'experienced' authorities, branding themselves above the minimum standards.

In the 'low/moderate harmonisation across EU' scenario, it is assumed that the legal gaps are closed and that some further actions are being executed on EU level to harmonise the legal framework. Emerging regulations and standardisation support and facilitate the safe use of LNG. Actions are initiated to have a harmonized understanding of "LNG bunkering" in different ports throughout the EU as a basis for harmonized procedures and responsibilities. LNG fuel technology and bunkering operations are in the phase of getting standardised. Requirements and roles for all parties involved in the bunkering supply process are simplified and made uniform.

The 'full harmonisation across EU' scenario ensures the implementation of harmonized processes and procedures across EU in a legally binding way, to fully support safe LNG uptake. The harmonisation process is aligned with the international context. All uncertainties related to requirements and level conditions of crewing and training of LNG fuelled ships and LNG providers, regulatory conditions and permitting have been resolved. Authorities are well staffed and competent to assess LNG operations. All LNG involved parties share expertise and LNG incident reporting is well established to contribute to overall safety improvement by capturing the lessons learnt and is a leading tool for continuous improvement of legislation and development of new technology/industry best practices.

12.10 How do the policy options compare

In previous paragraphs the social, economic, environmental and safety impact is assessed and costs and benefits are quantified and monetised where possible. The ultimate question to be answered is which policy scenario (varying between minimum and maximum harmonisation) is most suitable to achieve the objectives of the European Union, i.e. stimulating the uptake of LNG in order to reduce the environmental footprint of the shipping sector. In all cases the business as usual scenario will be used as reference.

12.10.1 Criteria to assess the policy options

The economic criteria are covered quantitatively whereas the other parameters are described qualitatively on a scale from ---, --, -, 0, +, ++, +++ (significant negative to significant positive). Following indicators will be assessed.

Table 12-32 Parameters for scoring the options

	Parameter
Economic impact	Additional investment for LNG fuelled vessels Value added by investment in LNG fuelled vessels Investments in LNG infrastructure Value added by investment in LNG fuelled vessels Operational cost for the shipping industry Operational cost of LNG infrastructure
Social impact	Labour effect related to investments in LNG ships Labour effects related to investments of LNG infrastructure Labour effects related to operation of LNG infrastructure
Environmental impact	Reduction of SO _x Reduction of NO _x Reduction of PM Reduction of GHG (CO ₂)
Other impact	Premature mortalities avoided by emission reduction Safety impact Administrative burden Flexibility Implementation effort

12.10.2 Overview of scores per criterion

This section presents an overview of how the scores per criterion are determined for the policy options under consideration, based on the information presented in previous chapters.

Economic impact

LNG FUELLED VESSELS – By 2030, the number of LNG fuelled vessel (inland + seagoing) will generate a cumulative additional investment cost of 2695 million Euro under the baseline scenario. The increase in LNG vessels under the “no harmonisation” scenario will generate 605 million Euro of additional investments cost (22% extra). In the same period, under the “low/moderate harmonisation” scenario additional cumulative investment cost to the shipping industry are expected to be in the region of 1584 Million Euro (57% extra). Finally, in case of “full harmonisation” additional investments for building LNG fuelled vessels are estimated to be 2347 Million Euro (87% extra).

Under the “no harmonisation” scenario the cumulative value added for the 2016-2030 period is expected to be 43 Million Euro higher compared to the baseline scenario (+22%). In the case of “low/moderate harmonisation” scenario the cumulated value added will be 111 Million Euro higher than in the baseline scenario (+58%). Finally if the “full harmonisation” policy option is implemented, the additional cumulated value added is expected to be in the region of 169 Million Euro (+87%).

LNG INFRASTRUCTURE - In general, a greater level of harmonisation of procedures among Member States should result in an anticipation of the investment costs in LNG infrastructure over the period. Cumulative capital expenditures under the baseline scenario will top 4.000 million Euro by 2030. Under the “no harmonisation” scenario the capital expenditures will be 492 million Euro higher than in the baseline (+12%). If the “low/moderate harmonisation” policy option will be pursued, the cumulative capital expenditure is expected to be 1.305 million Euro higher than in the baseline scenario (+32%). Finally, the highest cumulative capital expenditures are expected under the “full harmonisation” scenario: in this case the capital expenditure will be 2.355 million Euro higher compared to the baseline scenario (+58%).

Compared to the baseline scenario, the “no harmonisation” scenario presents an increase in cumulative value added in the region of 91 million Euro by 2030 (+13%). Under the “low/moderate harmonisation” scenario the benefits in terms of cumulative value added will be 237 million Euro compared to baseline scenario (+33%). Finally the highest cumulative value added is observed under the “full harmonisation” scenario: 425 million Euro in addition to baseline scenario (+58%).

In 2030, the increase in LNG demand under the “no harmonisation” scenario will generate 91 million Euro of additional operational costs. In the same reference year, under the “low/moderate harmonisation” scenario additional cost to the bunkering industry are expected to be in the region of 249 Million Euro. Finally, in case of “full harmonisation” additional operational costs for bunkering operations are estimated to be 438 Million Euro.

Table 12-33: Scoring of the policy scenario with respect to economic benefits

	No harmonisation	Low/moderate harmonisation	Full harmonisation
Economic effects			
Additional investment costs (Δ) compared to diesel engine for LNG fuelled vessels over the period 2015-2030	+22% (-)	+58% (--)	+87% (---)
Value added by investment in LNG fuelled vessels over the period 2015-2030	+22% (+)	+58% (++)	+87% (+++)
Investments in LNG infrastructure (cumulative capital expenditure) over the period 2015-2030	+12% (-)	+32% (--)	+58% (---)
Value added by investment in LNG fuelled vessels over the period 2015-2030	+13% (+)	+32% (++)	+58% (+++)
Operational cost saving for the Shipping industry	(+)	(++)	(+++)
Operational cost of LNG infrastructure in 2030	+12% (-)	+33% (--)	+57% (---)

Social impact

LNG FUELLED VESSELS - The greatest impact in terms of employment is expected under the “full harmonisation” scenario with about 300 additional annual jobs in 2030 compared to the baseline scenario (506 extra employment). In 2030, the “low/moderate scenario” is expected to result into about 190 additional employees compared to the baseline. Finally, in case the “no harmonisation” policy option is implemented, the additional annual employment is calculated to be 73 units in 2030.

LNG INFRASTRUCTURE - Under the “full harmonisation” scenario, the development of the LNG infrastructure is expected to result into the creation of 910 annual additional jobs as average for the period 2026-2030. This means an increase of about 58% compared to the baseline scenario. For the same period, in the case of “low/moderate harmonisation” scenario, the average of additional annual jobs supported by infrastructure investment is about 466 (+30% against baseline). Finally, if the “low/moderate harmonisation” policy option is implemented, the average annual number of additional employees over the period 2025-2030 is expected to be in the region of 245 (+16% against baseline).

The implementation of the “no harmonisation” policy option is expected to result in the creation by 2030 of almost 600 additional job positions in the LNG bunkering sector compared to the baseline. Under the “low/moderate harmonisation” scenario the LNG bunkering sector is expected to require, by 2030, about 1,600 additional employees compared to the baseline scenario. Finally, if the “full harmonisation” policy option is implemented the LNG bunkering sector will generate 2,840 additional employment opportunities compared to the baseline.

Table 12-34: Scoring of the policy scenario with respect to social benefits

	No harmonisation	Low/moderate harmonisation	Full harmonisation
Social effects			
Labour effect related to investments in LNG ships by 2030	+14% (+)	+37% (++)	+61% (+++)
Labour effects related to investments of LNG infrastructure average period 2026-2030	+16% (+)	+30% (++)	+58% (+++)
Labour effects related to operation of LNG infrastructure	+12% (+)	+32,6% (++)	+58% (+++)

Environmental impact

LNG has a number of environmental advantages over conventional fuels, such as reduction of SO_x, NO_x, PM and CO₂ (greenhouse gas) from engine exhaust emissions. From the results presented in Table 12-35 can be concluded that the full harmonization policy scenario has the highest environmental benefit. In this scenario the LNG fuel uptake is the highest.

Table 12-35: Scoring of the policy scenario with respect to environmental benefits

	No harmonisation	Low/moderate harmonisation	Full harmonisation
Environmental effects (inland + seagoing shipping)			
Global SO_x reduction in time period 2015-2030	+8% (+)	+20% (++)	+36% (+++)
Global NO_x reduction in time period 2015-2030	+9% (+)	+24% (++)	+44% (+++)
Global PM reduction in time period 2015-2030	+9% (+)	+24% (++)	+44% (+++)
Global CO₂ reduction in time period 2015-2030	+12% (+)	+31% (++)	+53% (+++)

Other impacts

HUMAN HEALTH - The higher the level of harmonisation across EU, the lower the number of premature mortalities due to PM emissions. In the baseline scenario, by 2030, more than 5000 premature mortalities will be avoided. Compared to the baseline scenario, the "no harmonisation" scenario presents an increase in avoided premature mortalities to almost 6000 by 2030 (+12%). Under the "low/moderate harmonisation" scenario the benefits in terms of premature mortalities avoided will be about 7000 or 33% extra compared to baseline scenario. Finally the highest value is observed under the "full harmonisation" scenario: about 3000 additional premature mortalities avoided compared to the baseline scenario (+57%).

SAFETY - The higher the level of harmonisation across EU, the more harmonized processes and procedures are implemented across EU. The lower uncertainties related to requirements and level conditions of crewing and training of LNG fuelled ships and LNG providers, regulatory conditions and permitting.

A low level of harmonisation might lead to authorities imposing different safety requirements for the same installation potentially resulting in less stringent safety requirements and/or considerably less complex approaches to demonstrate acceptability of safety by authorities. Lack of equipment standardisation in the baseline or low harmonisation scenario potentially might lead to vessels served by different LNG bunker suppliers across EU ports being confronted with significantly different bunker connectors, leading to confusion or inability to connect at best and potential unsafe operations and incidents at worst.

Overall it is expected that higher harmonisation with clear roles and responsibilities for all involved stakeholders and a clear framework to refer will positively impact safety with a lower amount of accidental releases and absence of major accidents.

ADMINISTRATIVE BURDEN - Under the low/moderate and full harmonisation scenario considerable efforts will need to be spent to compliance and enforcement for both authorities and operators. The compliance cost will increase similarly. The scores of the options are negatively related with the level of harmonisation.

FLEXIBILITY - Minimum harmonisation allows a Member State to enforce stricter rules on top of EU legislation, but disables more lenient measures in a given area. The relative ease of implementation (less political compromise) and practicality favours minimum harmonisation.

Where full harmonised regulation is typically leading to more transparency and allows for unity in a diversified framework, it may lead to rigidity. Full harmonisation further implies that once EU has set legislation in a certain area, it is not open to Member States to enforce stricter rules.

IMPLEMENTATION EFFORT - Full harmonised legislation has a high cost and could lead to long lead times, less flexibility for project developers and more complicated building and operational processes requiring special systems, connections, risk assessments, trainings, etc.

Table 12-36: Scoring of the policy scenarios with respect to other benefits

	No harmonisation	Low/moderate harmonisation	Full harmonisation
other effects			
Premature mortalities avoided by 2030 due to emission reduction	+12% (+)	+33% (++)	+57% (+++)
Safety impact	(+)	(++)	(+++)
Administrative burden	(+)	(-)	(---)
Flexibility	(-)	(--)	(---)
Implementation effort	(-)	(--)	(---)

Summary for all options

A summary of the scores for all studied policy scenarios is presented in below table.

Table 12-37: Scoring of the policy scenarios with respect to other benefits

	No harmonisation	Low/moderate harmonisation	Full harmonisation
Economic effects			
Additional investment costs (Δ) compared to diesel engine for LNG fuelled vessels over the period 2015-2030	-	--	---
Value added by investment in LNG fuelled vessels over the period 2015-2030	+	++	+++
Investments in LNG infrastructure (cumulative capital expenditure) over the period 2015-2030	-	--	---
Value added by investment in LNG fuelled vessels over the period 2015-2030	+	++	+++
Operational cost saving for shipping industry	+	++	+++
Operational cost of LNG infrastructure in 2030	+	++	+++
Social effects			
Labour effect related to investments in LNG ships by 2030	+	++	+++
Labour effects related to investments of LNG infrastructure average period 2026-2030	+	++	+++
Labour effects related to operation of LNG infrastructure	+	++	+++
environmental effects			
Global SO _x reduction in time period 2015-2030	+	++	+++
Global NO _x reduction in time period 2015-2030	+	++	+++
Global PM reduction in time period 2015-2030	+	++	+++
Global CO ₂ reduction in time period 2015-2030	+	++	+++
other effects			
Premature mortalities avoided by emission reduction by 2030	+	++	+++
Safety impact	+	++	+++
Administrative burden	+	-	---
Flexibility	-	--	---
Implementation effort	-	--	---

12.10.3 Conclusion

Based on the above it can be concluded that:

- All options have positive economic, social and environmental effects
- The full harmonisation has overall the highest impact on economic, social and environmental aspects, this since in this scenario the highest LNG uptake is considered.
- The full harmonisation scenario has a significant better score for safety aspects, but has a significant negative score for administrative burden, flexibility and implementation efforts.

As can be concluded from the foregoing, both maximum and minimum harmonisation entails demerits. Notwithstanding the full harmonisation has the best overall score for environmental, safety and social criteria, this is strongly counterbalanced by a significantly higher implementation effort, more rigidity and higher risks of delays (administrative burden). Full harmonisation may result in complex compromises to be made at EU level, resulting in the policy objective not reached or reached at a much slower pace than anticipated.

Based on the above analysis we therefore consider the low/moderate harmonisation scenario as most workable policy option in terms of the efforts versus impact ratio to meet the foregoing defined policy objectives. With the choice for this policy option, Member States can transpose the Directive on Alternative Fuels with a 'light-touch' while retaining the benefits. With this policy option EU can remain confident that all Member States apply minimum and somehow harmonised standards.

It needs to be mentioned that final ranking of the options depends on how the different parameters are being weighted. This requires a judgement by decision makers in order to make a final assessment of the preferred policy option.

It further needs to be highlighted that one of the specific aims of this study was to identify harmonisation opportunities with respect to following focus areas: permitting, quantitative risk assessment and incident reporting. To that extent Chapter 11 gives an overview of the comprehensive set of recommendations. Each and every individual recommendation encapsulates an assessment whether harmonisation is at all desirable and if so, whether maximal or minimal harmonisation is suggested.

13 MONITORING AND EVALUATION

The Impact Assessment guidelines of the Commission provide that monitoring systems have as main function to enable policymakers to verify to what extent the policy is achieving its set objectives. For this purpose a set of core indicators need to be identified for the key objectives of the intervention. Such indicators must be checked against the purpose they are supposed to serve.

A proposed list of the above-mentioned set of indicators is given in the following paragraphs.

13.1 Proposed set of core indicators

The definition of a monitoring and evaluating system starts with the identification of the key indicators. An indicator can be defined as the measurement of an objective to be met, a resource mobilised, an effect obtained, a level of quality or a context variable. Within the framework of the present analysis, an attempt has been made to define some core indicators for the main policy objectives and to outline the monitoring system envisaged.

At this stage, it does not appear relevant to lay down detailed indicators and the monitoring systems for all the options identified as part of this study. This is more appropriately done after a choice of the most appropriate policy option has been made, as this is the last step in the policy design process.

Nonetheless, some core indicators for the key policy objectives have been identified, as it is fair to assume that these specific objectives are reasonably stable across the various alternative policy options.

The evaluation of the implementation of the new policy initiative should be carried out within five years from its adoption. The table below provides a preliminary set of core indicators.

Table 13-1 Monitoring indicators for specific objective

Specific objective	Indicators	Source of data
To ensure that investment uncertainty is sufficiently reduced to break up the existing 'wait and see' attitude amongst market participants	Share of LNG fuelled vessels (maritime and inland waterways)	IHS Fairplay (for seagoing vessels) and RVIR (inland vessels)
	Nr of ports providing LNG refuelling services (maritime and inland)	Gas Infrastructure Europe http://www.gie.eu/
	LNG demand as fuel for ship (maritime and inland waterways)	IEA: International Energy Agency (or bunkerworld.com)
To make sure that refuelling procedures and equipment among EU are interoperable for all LNG fuelled vessels	Level of consistency in LNG bunkering procedures between the ports of the different member states	Direct survey
To ensure compliance with all international obligations with regard to Marpol annex VI and Directive 2012/33/EU	Nr of non-compliant ships	THETIS database EMSA

13.2 Additional monitoring elements

The proposed policy is intended to contribute to the improvement of the quality of air and the human health in coastal regions and the hinterland. However, other policies and other exogenous factors are

also likely to influence these aspects. With this in mind, the evaluation analysis should be enriched with the assessment of environment and health oriented indicators as specified in the table below.

Table 13-2 Impact of measures on air quality and human health indicators

Topic	Indicators	Source of data
Air Quality	SO _x	European Environmental Agency
	NO _x	European Environmental Agency
	PM	European Environmental Agency
	GHG	European Environmental Agency
Human health	Cardiovascular and/or respiratory mortality	See note (*)
	Cardiovascular and/or respiratory morbidity	See note (*)

Note: Data on pollutant exposure and health quality is available from several European agencies and institutions (e.g. European Environment Agency, DG Health and Food Safety, Joint Research Centre, HEIDI data tool, etc.)

14 CONCLUSION

The uptake of LNG as ship fuel in Europe is still in an early stage, and key stakeholders typically identify three main barriers: the lack of adequate bunker facilities for LNG, the gaps in the legislative or regulatory framework, and the lack of harmonized standards.

The aim of this study was to propose solutions for the second and third barrier (The recently adopted Directive on the deployment of alternative fuels infrastructure 2014/94/EU aims to solve the first barrier).

In a previous study commissioned by EMSA and published in February 2013 (/1/), a detailed description of the existing rule framework related to LNG bunkering was made and through a gap analysis missing rules for bunkering LNG and related aspects were identified. The overall objective of the current study was to analyse, further evaluate and propose solutions to the identified gaps and barriers based on the findings of the EMSA study and the evolutions since.

The study thereto covers the following key elements: an update of the legal and regulatory framework analysis, identification of remaining gaps and possible recommendations how to solve these gaps and finally an impact assessment for main policy options defined as sets of recommendations.

The assessment of the existing rules, standards and guidelines shows that from a legal point of view, there are no remaining major showstoppers blocking the use of LNG as fuel – for both seagoing vessels and inland waterway vessels – nor for the deployment of LNG bunkering infrastructure. However, a comprehensive set of 35 recommendations is presented; the bulk of the proposed recommendations mainly address issues where further harmonisation is possible.

An important harmonisation opportunity is the bunkering activity itself, which is today not harmonised throughout EU ports. The possible outline for EU wide bunker procedures has been specifically addressed in a position paper, given its importance.

One of the specific aims of this study was to identify harmonisation opportunities with respect to following focus areas: permitting, quantitative risk assessment and incident reporting. 17 recommendations are linked to these focus areas and the respective action plans suggest a number of improvement opportunities at EU and Member State level.


The recommendations on the permitting process aim at speeding up the overall permit process via e.g. all-in-one permits with only one authority coordinating, and via specific LNG guidance documents. Furthermore clarification is suggested on the process and time schedule for the overall permit process in order to make it fully transparent to all involved parties, this includes information on milestones and deliverables, authorities responsible, documents to be produced. An important additional element is to educate/inform responsible authorities to familiarize them with LNG and its benefits, to create platforms to share best practices and information between all LNG stakeholders.

In the report a set of recommendations has been put forward to make efforts towards harmonization of risk assessment practices and risk acceptance criteria.

Recommendations are suggested to adapt the current incident reporting structure to be able to efficiently capture data from LNG bunkering incidents and the lessons learned. The aim of such an updated reporting structure is to capture LNG specific incident data in a European database and to make these data accessible for all relevant stakeholders.

In the last part of the study, a list is presented of potential policy interventions that could help achieve the general policy objective, namely to support the shipping sector in adopting environmentally sustainable alternative fuels. A scenario approach has been used with following policy scenarios:

1. Do nothing scenario (= Business as usual or baseline scenario);



2. Alternative policy options:

- 2.1. No harmonisation across EU; (“Must haves”)
- 2.2. Low/Moderate harmonisation across EU; (“low hanging fruits”)
- 2.3. Full harmonisation across EU. (“Nice to haves”)

From the impact assessment it can be concluded that all options have positive economic, social and environmental effects. The full harmonisation has overall the highest impact on economic, social and environmental aspects, since in this scenario the highest LNG uptake is considered. Notwithstanding the full harmonisation has the best overall score for environmental, safety and social criteria, this is strongly counterbalanced by a significantly higher implementation effort, more rigidity and higher risks of delays (administrative burden). Full harmonisation may result in complex compromises to be made at EU level, resulting in the policy objective not reached or reached at a much slower pace than anticipated.

Based on the analysis the low/moderate harmonisation scenario is considered to be the most workable policy option in terms of the efforts versus impact ratio to meet the policy objectives. With the choice for this policy option, Member States can transpose the Directive on Alternative Fuels with a ‘light-touch’ while retaining the benefits. With this policy option EU can remain confident that all Member States apply minimum and somehow harmonised standards.

A final and conclusive assessment of the preferred policy option remains with the policy makers depending on how the different parameters are being weighted.

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