STAKEHOLDER INVOLVEMENT IN DEVELOPING LNG AS A SHIP FUEL IN THE BALTIC SEA REGION

Jörg Albrecht

University of Jyväskylä

School of Business and Economics

2015

ABSTRACT

New environmental regulations require the shipping industry to reduce its sulphur emissions. The currently most environmentally friendly alternative for ship owners to comply with the regulations is the switch to LNG fuelled vessels which however also requires port developers to invest in the supply of LNG. In order to successfully implement the creation of an LNG infrastructure, various challenges have to be overcome.

This study looks at the challenges of LNG as a ship fuel from a stakeholder perspective by conducting a port screening with the aim to assess the current development status of LNG projects and the drivers and impediments behind it. Furthermore, a qualitative research with expert interviews of the most important stakeholder groups gives insight on how stakeholders are involved in the various aspects of LNG development.

While several challenges have impeded the introduction of LNG as ship fuel in the past years, by far the biggest issue in the soon future is the development of the oil price that lowers the feasibility of LNG ship fuel compared to oil-depending alternatives. The study also revealed that the potential of local industries and cargo owners to influence the implementation of LNG as ship fuel has been neglected so far. The successful creation of an LNG infrastructure relies on public funding programs. Therefore, policy makers need to have well-elaborated strategies and increase the general perception of LNG among local industries and legal authorities by pointing out the potential of LNG for the whole economy.

The results can support policy makers on EU level in their decision of composing an LNG strategy and give interesting insight to involved actors about the stakeholder network. The study was limited to the Baltic Sea region, specifically Finnish and Swedish stakeholders. These might vary from other geographical contexts.

Keywords: LNG, emission regulations, shipping industry, port projects, stakeholder theory

Author's address Jörg Albrecht
Corporate Environmental Management
School of Business and Economics
University of Jyväskylä
Albrecht-j@gmx.de

Supervisor Tiina Onkila, Ph.D.
Corporate Environmental Management
School of Business and Economics
University of Jyväskylä

Reviewer Hanna-Leena Pesonen, Professor
Dean, Corporate Environmental Management
School of Business and Economics
University of Jyväskylä

CONTENTS

ABSTRACT 3

CONTENTS 5

LIST OF FIGURES 7

LIST OF TABLES 7

LIST OF APPENDICES 7

1 INTRODUCTION 9

1.1 Background Information 9

1.2 Motivation for the Research 10

1.3 Research Problem 11

1.4 Thesis Outline 11

2 LITERATURE REVIEW 13

2.1 LNG in the Baltic Sea 13

2.1.1 Regulatory Background 13

2.1.2 Alternatives and Impact for the Shipping Industry 15

2.1.3 Evaluation of Alternatives 18

2.1.4 The Potential of LNG 18

2.1.5 Challenges 20

2.1.6 Summary 24

2.2 Stakeholder Theory 25

2.2.1 Introduction of Stakeholder Theory 25

2.2.2 Stakeholder Identification 29

2.2.3 Stakeholder Management in Port Projects 31

3 METHODOLOGY 35

3.1 Research Method 35

3.2 Limitations and Criticism 37

3.3 Data Collection 38

3.3.1 Port Screening 39

3.3.2 Interviews 40

3.3.3 Selection of Interviewees 40

3.3.4 Considerations Regarding the Selection of Interviews 42

3.4 Data Analysis 44

4 RESULTS 46
4.1 Stakeholder Involvement 46
4.2 Stakeholder Communication 48
4.3 Regulatory Framework 50
4.4 LNG Supply Chain 52
4.5 Economic Viability 54
4.5.1 Economic Dynamics 54
4.5.2 The Role of the Oil Price 55
4.6 Public Funding and Awareness 57
4.7 Current Development Status of LNG 58
4.8 Summary of Results 62
5 DISCUSSION 64
5.1 Stakeholder Involvement 66
5.2 Overcoming the Investment Dilemma 68
6 CONCLUSION 71
6.1 Contributions 72
6.2 Limitations and Future Research 73
7 REFERENCES 74

LIST OF FIGURES

FIGURE 1 MARPOL Annex VI Timeline for Adoption of Sulphur Content... 14
FIGURE 2 Pros and Cons of the Different Alternatives... 17
FIGURE 3 Chicken-Egg-Dilemma... 20
FIGURE 4 Power-Interest Grid... 30
FIGURE 5 Stakeholder Salience... 31
FIGURE 6 Map of LNG Development Status... 61
FIGURE 8 Solution of the Investment Dilemma... 70

LIST OF TABLES

TABLE 1 Contribution of Research Functions to the Research... 37
TABLE 2 Selection of Stakeholders... 43
TABLE 3 LNG Development Status in the Baltic Sea Region... 59
TABLE 4 Aspects of LNG Absence... 62

LIST OF APPENDICES

ANNEX 1 Interview Structure... 82
ANNEX 2 Port Screening Questionnaire... 84

1 INTRODUCTION

The topic of implementing LNG as a ship fuel is a very new phenomenon that has been triggered by new environmental regulations and the technical innovations in LNG fuelled vessel engines. While LNG offers notable economic and environmental opportunities, its successful implementation has some threats to face. Many different actors have a considerable interest in the topic, such as ship owners, ports, gas suppliers and policy makers. These stakeholders are very important in the development process, therefore this research is conducted from a stakeholder perspective. Research on the aspects of creating an LNG infrastructure for ships is scarce, although publications on the topic have tremendously increased in the past years which indicate the growing relevance and potential of LNG. This chapter will introduce the topic of LNG as ship fuel, explain the motivation for the research and present the research problem and outline of the thesis.

1.1 Background Information

Transportation by ship is a very important transportation method globally and regionally and its role is expected to increase even further, especially in the Baltic Sea region (Lindfors 2014; Kadin 2008). While shipping is a relative environmentally friendly means of transport compared to most other fossil fuelled transportation, it still contributes critically to climate change. The expected growth in volume and the slow rate of environmental improvement of the industry sector lead to stricter environmental emission regulations that target at a significant reduction of sulphur emissions which are typical for ships and cause a lot of negative environmental and health impacts (MARPOL 73/78 Annex VI 2005) . This new legislation poses considerable challenges for the shipping industry which require it to substantially alter their way of conduct (Kehoe 2010). In order to comply with the new regulations, ship owners have to choose between different abatement alternatives that all have their advantages and disadvantages (Nielsen & Schack 2012). The most environmentally friendly

solution and due to low operational costs most cost-efficient solution is the switch to LNG (Laugen 2013). This however necessitates high investments in the building and retrofitting of LNG vessel engines. Furthermore, LNG is currently not available at Finnish and Swedish ports. Port developers hence also have to build LNG bunkering facilities that are quite expensive to build. This results in an investment dilemma, as both ship owners and port developer have individual benefits incentives to wait for the other side to act first and hence have less investment risks (Semolinos et al. 2013). The potential of LNG is however also recognized by the European Commission that therefore composed an LNG strategy with the aim to have a core network of LNG available by 2025 (EU 2014). The most significant support is the provision of public funding programs that reduce the risks of investors and drive the further development process.

Currently, there are several LNG projects under planning and construction in the Baltic Sea region that in some cases have received considerable financial support that can partly help the overcoming the investment dilemma (TEM 2014). While these public funding schemes can support the process remarkably, they do not ultimately reduce the perceived uncertainties of investors (Wang & Notteboom 2013). The shipping and port sector is characterized by many different actors who are all involved in the development and have considerable influence on the development process (Acciaro & Gritsenko 2014).

1.2 Motivation for the Research

The shipping and port sector is characterized by numerous different actors, such as ports, ship owners, cargo owners, municipalities and a very complex network of regional and interregional policy makings with varying responsibilities. A lot of research points out the presence of numerous stakeholders and the importance of their proactive participation in order to create port projects (Weems & Hwang 2013). The topic of LNG as shipping fuel, while being a major challenge to the industry, also affects the interests of many different actors. The role of stakeholders is hence very important in the LNG development process which has been acknowledged by various previous studies (Danish Maritime Authority 2012a; Work & Lng 2013; Adamchak 2013). Previous research is also very aware of the investment dilemma concerning the introduction of LNG as ship fuel. However, no study has been made from the specific stakeholder perspective, by taking into account the contribution of stakeholder theorists. A study from this perspective could bring interesting insights from a theoretical perspective that eventually could also be the basis of considerations with practical impact.

The practical scope of the thesis is also a major motivation for the research. This study is part of a joint industry project co-funded by the European Commission between a cargo owner, a ship owner and an engine manufacturer with the aim to investigate the environmental and economic

impacts of operating an LNG vessel. This paper will therefore also be presented to decision makers on EU level which further stresses the high practical relevance of this research.

1.3 Research Problem

One major way of reducing the perceived investment risks of port developers and ship owners is the provision of financial support. The dynamics of the shipping and port sector however go beyond that. Port environments are very complex environments with numerous stakeholders being involved in the decision making process. Previous research mentions the importance of stakeholders, does however not address their role specifically. The task of this study is therefore to analyze how stakeholders are involved in the creation of a bunkering infrastructure. In that perspective, it is of particular interest to identify who the main stakeholders are and how they interact with each other. By focusing on the stakeholders of LNG development, this study will further be able to identify eventual neglected stakeholders in the development process. On that account, the role of stakeholders will be analyzed from a perspective considering the different aspects and challenges of LNG development.

Due to the complexity of port environments, which also differs from region to region, this paper will focus on the development of the Baltic Sea region, specifically the development in Finland and Sweden that have a very transport routes, business contracts/deals and comparable policy maker structures (Lindfors 2014).

1.4 Thesis Outline

Chapter 2 introduces the topic of LNG as ship fuel. A closer look on the legal developments on emission regulations is necessary to understand the ongoing changes in the industry. In this perspective, the different alternatives for ship owners to comply with the regulations have to be mentioned as well, as the LNG solution has to compete with them. There are several aspects and challenges of implementing LNG as ship fuel which are described thereafter. Since stakeholder theory is the theoretical framework of the research, the stakeholder concept will be presented in chapter 2.2. Stakeholder theory has become a very popular theory with various different contributions and criticisms. By looking at the most important contributions of science to the theory it will be justified why stakeholder theory was chosen as theoretical angle of this research. Chapter 3 presents the methodological approach. In order to answer the research question as best as possible, essential considerations about the most suitable approach are discussed in chapter 3 with a presentation of how the data collection and analysis was carried out. The results are presented in chapter 4 with special focus on challenges of LNG development and the involvement and communication of the various stakeholders. Ultimately, the results are being discussed in chapter 5 by

comparing them to the current development status in the Baltic Sea region and previous research findings. In that sense, an effort is also made to overcome the investment dilemma and evaluate and classify the importance of the involved stakeholders.

2 LITERATURE REVIEW

The literature review is divided into two parts. At first, the topic of LNG is introduced with a summary of legal developments and the various impacts and challenges for the implementation of LNG. Since stakeholder theory is the theoretical framework of this research, chapter 2.2 introduces the stakeholder concept. By looking at the various contributions and criticisms of stakeholder theory, it will also be argued why stakeholder theory was chosen as a theoretical ankle.

2.1 LNG in the Baltic Sea

In order to understand the complexes around the development of LNG as a ship fuel, it is important to take into account the legislative developments that affected the shipping industry which will be given at first. The new legislations require the ship owners to choose different abatement alternatives. These are also taken into account in this chapter before the different challenges of the implementation of LNG are described.

2.1.1 Regulatory Background

In the past decade, the global shipping industry has experienced several drastic changes concerning shipping emissions from their most important regulating authority, the International Maritime Organization (IMO). The IMO is a specialized agency of the United Nations with the agenda to develop a regulatory framework for shipping, including all aspects from ship design to operational security and environmental impacts. One of its conventions is the International Convention for the Prevention of the Pollution from Ships, also known as MARPOL which is the most important international agreement concerned with environmental issues of the maritime sector. All ships operating in the Baltic Sea have to comply with the regulations set by the MARPOL convention. Adopted in 1973, it has been amended several times since with the prevention of air pollution from ships being the latest amendment elucidated in Annex VI in 1997 which entered into force in 2005. In 2008, a revision of Annex

VI was adopted which entered into force on 1 July 2010. The revised Annex VI provides a reduction of sulphur emissions in three tiers:

- Maximal 4,5% SOx emissions prior to 1 January 2012 (Tier I)
- Maximal 3,5% SOx emission effective from 1 January 2012 (Tier II)
- Maximal 0,5% SOx emissions effective from 1 January 2020 (Tier III)

The MARPOL convention also determined special areas where air pollution protection measures are particularly important, based on high amount of ship traffic or their oceanographical and ecological condition. Annex VI defines these areas as Emission Control Areas (ECAs) (also known as Sulphur Emission Control Areas (SECAs) which include the North American Coasts, the US Caribbean Seas, the European North Sea and the Baltic Sea. The emission thresholds of sulphur oxides, nitrogen oxygens and particulate matter follow even stricter regulations in ECAs (MARPOL ANNEX VI) (FIGURE 1):

- Maximal 1,5% SOx emissions prior to 1 January 2010 (Tier I)
- Maximal 1% SOx emission effective from 1 January 2012 (Tier II)
- Maximal 0,1% SOx emissions effective from 1 January 2015 (Tier III)

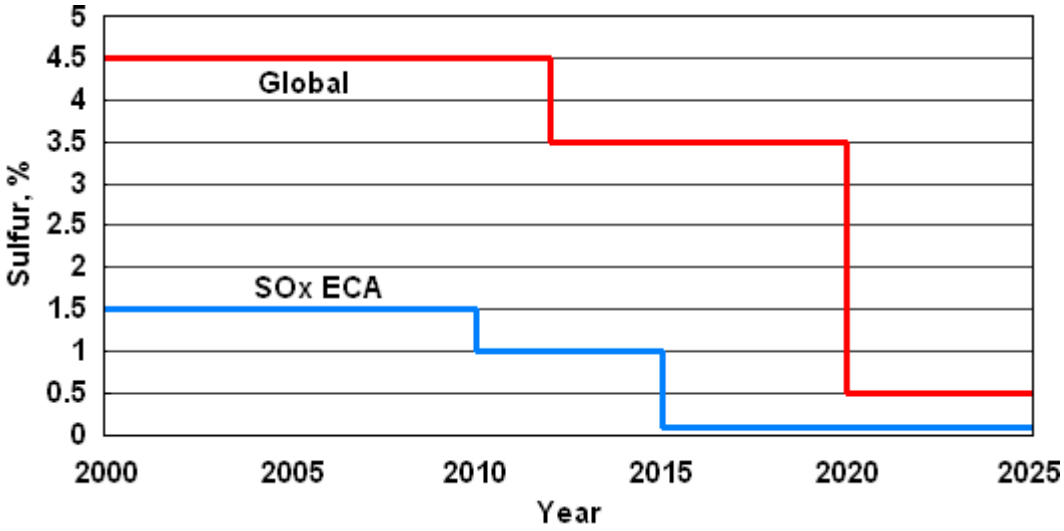

FIGURE 1 MARPOL Annex VI Timeline for Adoption of Sulphur Content

The regulations of the MARPOL Annex VI have been incorporated into the European Directive 2012/33/EU (EU 2012). The Baltic Sea is one of the biggest maritime traffic regions, therefore a huge sector is affected by the new regulations which pose great challenges for the shipping sector and its stakeholders. Adoption measures could take time and negatively influence the sectors economic efficiency by increased prices, for example. On the other hand, the new regulations also pose great opportunities for the shipping sector in the Baltic region in a longer perspective as actors' early adaption to legal requirements and more environmentally friendly products and services could enable competitive advantages. Consequently, the new emission regulations are a major topic for the shipping sector in these days that will shape and in some circumstances reallocate old structures and conducts.

The new regulations aim at significantly decreasing air pollution of the shipping industry. Ship emissions have a huge negative impact on the environment (Ng & Song 2010) and the economic development in the past decades has steadily increased ship traffic and hence also the emissions from the shipping industry (IMO 2009). The increased ship traffic has also resulted in increased air emissions in the Baltic Sea (Jalkanen et al. 2009). Compared to other sectors, the maritime sector lacks behind in environmental innovations (Lai et al. 2011). The air quality in port cities is highly affected by shipping with sulphate and nitrate concentrations of up to 50% ascribing to the shipping industry (Matthias et al. 2010). These high concentrations of SOx, NOx and particulate matter pose considerate negative impacts on the ecosystem and human health conditions in port cities. Ship emissions are estimated to contribute to 60 000 pre-mature deaths globally, a number which is expected to increase considering the growing industry (Corbett et al. 2007). The regulations of the IMO have been adopted by the European Union in the Maritime Strategy Framework Directive 2008/56/EC, where the reduction of emissions from ships is a specifically mentioned directive with the objective to improve the ecosystem and health conditions in port areas (Blasco et al. 2014).

2.1.2 Alternatives and Impact for the Shipping Industry

Currently, heavy fuel oil (HFO) is the most common used ship fuel. While being cost effective, it is also very damaging for the environment with high amounts of carbon dioxides (CO_2), sulphur dioxides (SO_2), nitrogen oxygens (NO_X) and particulate matter (PM). The concentrations exceed the requirements of the new emission regulations which hence necessitate a substantial shift of common practices in order reduce air pollution (Burel et al. 2013). Ship owners have three alternatives to comply with the new legislation (FIGURE 2):

2.1.2.1 Low Sulphur Fuels

The shift from HFO to marine grade oil (MGO) or marine diesel oil (MDO) is the most viable option for ship owners. Instead of combusting HFO, vessels could run on MGO with sufficiently low sulphur concentrations when trafficking through ECAs. The shift would require investments in a fuel cooler for the MGO and training of the ship crew in the safe operating of MGO as both fuels have different burning temperatures and viscosities that bear the risk of damaging the engine. These adaption costs amount to roughly 30,000-50,000 € and can therefore be considered neglectable (Nielsen & Schack 2012). The biggest financial impact derives from higher fuel prices for MGO that could negatively affect the economic efficiency in the long run. Since the switch to low sulphur fuel is the most attractive option in terms of initial investments, it can be expected that most ship owners choose this solution until the financial uncertainties of the other alternatives and price developments of MGO are sorted out (DNV 2014).

2.1.2.2 Scrubber Technology

A scrubber system could be installed on the vessel that removes most of the SOx emissions and depending on the scrubber technology also reduces particulate matter and NOx emissions to some extent. However, the scrubber solution creates other negative environmental impacts. The exhaust gases are absorbed by water which has to be discharged off as sludge at the ports. Furthermore, the scrubbing technology increases fuel consumption by 1-3%. The installation of a scrubber also requires training of the vessel crew in scrubber operation and new structure and equipment has to be installed on the ship which reduces storage capacity. In general, scrubbers are not installed on ships yet, so the installation would require considerate investment costs. The necessary investments amount to 2-4M €, depending on the applied scrubbing technology, the scrubber manufacturer and the ship type. The retrofitting of vessels is about 50% more expensive than the installation of a scrubber on a new build vessel, which is another crucial point the ship owners have to consider (EMSA 2010; Nielsen & Schack 2012).

2.1.2.3 LNG

The currently most environmentally friendly alternative is the shift to LNG fuelled vessels. LNG is natural gas that is removed from acid gases such as CO2 and H2S and cooled down to -162 °C at which it becomes liquid and reduces its volume by 600 times. Natural gas consists almost entirely out of methane and compared to other fuels generates very low amounts of sulphur oxides, nitrogen oxygens and particulate matter when combusted. LNG therefore not only easily complies with the sulphur emission caps but also meets the requirements for upcoming regulations on NOx reduction. The exact benefits of LNG compared to HFO are:

- SOx emission reduction by nearly 100%
- NOx emission reduction by 80-85%
- Particulate matter emission reduction by 98%
- CO2 emission reduction by 20-30%
- Increase in energy efficiency by circa 33% (Laugen 2013).

LNG is odorless and has no toxic or carcinogenic attributes and poses no health hazards. With a density of 0,4-0,5 kg/l in liquid form, it flows on top of water where it evaporates quickly. However, LNG spills should be avoided at all events as the evaporating methane is a critical greenhouse gas. Potential hazards also arise when LNG is ignited which in the event of handling large LNG amounts could lead to explosions and flash fires (Kumar, Kwon, Choi, Lim, et al. 2011). There are thus certain environmental and safety threats that have to be taken into account when handling LNG. The biggest safety concerns happen in the event of an LNG spill, whose risk should therefore be limited and monitored at all costs (Vandebroek & Berghmans 2012). LNG has been used since the 1960s, hence a lot of research on the safety risks of LNG has been done

in the past. Current literature is predominantly concerned about new usage methods for LNG as ship fuel and observes the operational safety of LNG ships and terminals (Bernatik et al. 2011; Licari & Weimer 2011). As a result, almost all potential hazards have been identified in order to guarantee a safe design, construction and operation of LNG equipment and handling. So far no major accidents can be recorded, although the extensive use of LNG in bunkers and ships requires still clear guidelines in the safe handling from authorities (Aneziris et al. 2014; Woodward & Pitblado 2010; Foss 2003; Cleaver et al. 2007). Concluding, safety aspects should be considered, but they do not influence the decision to switch to LNG as ship propellant.

Besides the significantly lower sulphur levels another advantage of LNG is its low price compared to other marine fuels. Depending on price developments, LNG has significant potential to increase the economic efficiency of shipping. The biggest impediment to this point is the absence of an extensive LNG infrastructure. Currently, LNG is still a niche sector with only a small number of LNG vessels operating in the Baltic Sea/global oceans. An intact LNG refueling infrastructure is however a basic prerequisite for ship owners to switch to LNG. Therefore, ports need to ensure sufficient supply of LNG and invest in LNG refueling stations. While ship owners need to make significant investments in the retrofitting of vessel engines, they also need to have the certainty that ports can provide LNG at their refueling stations. The ports on the other hand need to be sure of sufficient demand from the ship owners in order to invest in also rather costly LNG bunkering stations (Adamchak 2013). This circumstance poses a major challenge for LNG which will be addressed more thoroughly in chapter 2.1.5

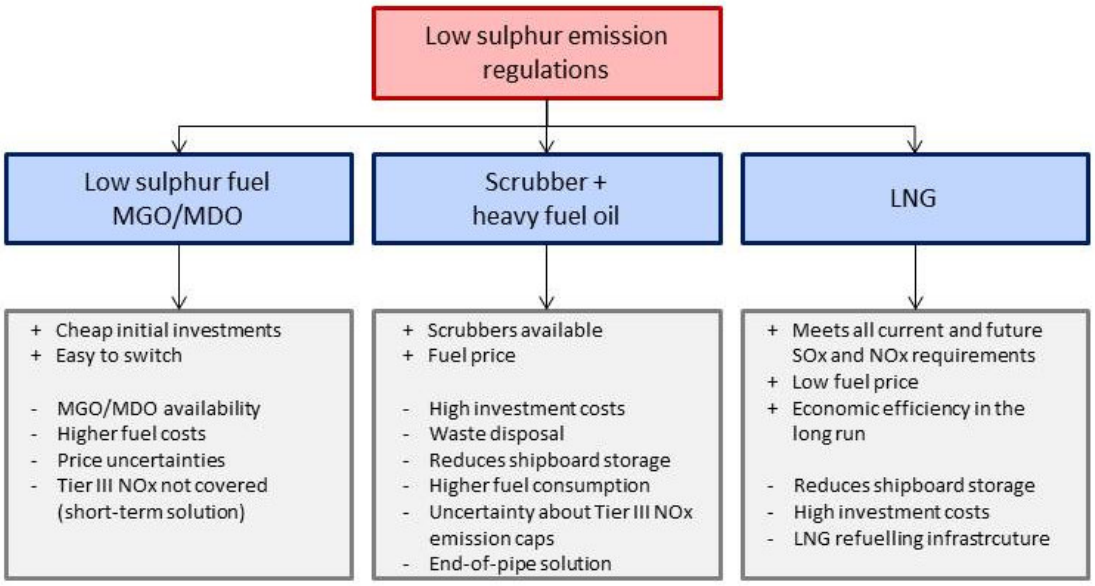

FIGURE 2 Pros and Cons of the Different Alternative

2.1.3 Evaluation of Alternatives

Several studies highlight the benefits of LNG over scrubbers and low sulphur oils (Burel et al. 2013). A life cycle assessment of marine fuels concluded that LNG has lower global warming potential and is contributing significantly less to acidification and eutrophication (Bengtsson et al. 2011). Furthermore, the technological prerequisites to equip vessels with LNG engines are available for most ship types. Their efficiency is guaranteed and will be supported even more by a presumable growing market in LNG engines that will most likely reduce prices for LNG engines and equipment in the future which will make the shift to LNG more affordable (Stenersen 2011). The costs for retrofitting an existing vessel with an LNG engine are significantly higher than the costs to build a new LNG vessel. This makes LNG especially attractive for new built ships. A new LNG vessel is however still 20-25% more expensive compared to an oil vessel, even though prices might decrease once the demand for LNG vessels increases (Baumgart & Olsen 2010). The economic efficiency is also ensured by a thorough study of the Danish Maritime Authority that estimated the average payback time of a new LNG vessel to two years more compared to the low initial investment alternative of MGO. The payback time depends on the LNG price, but even in the worst case scenario, it was found to be four years which still outcompetes the scrubber solution (Danish Maritime Authority 2012a). Another benefit of LNG as ship propellant is the more secure supply of natural gas. Natural gas reserves are more dispersed and their availability more ensured in the long run. Additionally, the availability of LNG benefits from decreasing investment costs in the creation of LNG supply chains (liquefaction of natural gas and shipping) which further promotes the creation of an LNG infrastructure (Maxwell & Zhu 2011).

From a scientific point of view, LNG appears to be the most favorable alternative to meet the new legal requirements for ship owners. However, the success of LNG is highly depending on the various factors such as actors' communication and commitment. Therefore the main challenge is to find concepts to encourage all stakeholder groups to promote LNG.

2.1.4 The Potential of LNG

Since low sulphur fuels do not require initial investments and are easy to adapt to it can be expected that most ship owners choose MGO in the early stages. Low sulphur fuels are more expensive than HFO and an increased demand for MGO is very likely to even increase this price gap. Higher prices for MGO in turn make the shift to LNG more attractive. The degree of adaption of LNG is hence not only depending on the price development of LNG, but also their relation to low sulphur fuels. Higher fuel prices on the other hand will increase the shipping costs which will result in a significant increase in freight prices (Ministry & Transport 2009). Several studies confirm the threat of increased prices for shipping due to the new emission regulations (EMSA 2010, Lemper 2010). This could be a threat for ship transport that is also competing with other

means of transport. A study of the German Baltic Sea ports estimated that depending on the increased fuel prices, up to 22% of transported shipped volume of German ports into the Baltic Sea could switch to land routes (Lemper 2010).

In the same study, the option of more subsidiaries for the shipping industry is addressed. The lack of availability of funds is discussed as a main cause for failure and it is also pointed out that subsidiaries would merely prevent a shift to other means of transport, thereby questioning their economic necessity (Lemper 2010). However, the study does not mention how a specific funding of an LNG infrastructure could not only prevent the shift of transport but also improve the environmental performance and long-term efficiency of the shipping industry. Specific funding programs that promote the expansion of LNG bunkering networks could have great potential to promote the environmental performance of the maritime transport sector along with ensuring its compliance to current and future regulations and guarantee cheap shipping costs especially in the medium to long run that prevents a major shift of transport from shipping to land routes.

While fuel prices of MGO are a determining factor in the ship owners decision to switch to LNG (Aagesen et al. 2012), the supply of LNG also plays a significant role. Currently, LNG fuel supply is marginal and it is estimated that LNG demand will triple from 2011 to 2030. According to natural gas supply studies, this increased demand can however be met by natural gas suppliers (Kumar, Kwon, Choi, Hyun Cho, et al., 2011 B) A comprehensive LNG bunkering infrastructure would also increase demand for natural gas (Aagesen et al. 2012). The critical issue is hence mainly to ensure the LNG availability at the ports. The success of LNG bunkering strategies is therefore depending on the developments of the LNG prices and the price dynamics of natural gas and also the price trends on the low sulphur fuel market.

A study on the ship owners' perspective concluded that most ship owners considered MGO as the best short-term solution while LNG was found to be the most promising long-term alternative. Many ship owners appeared to be unsure of how to deal with the emission regulations. The vague outline of goals and guidelines for LNG supply contributed to the uncertainty of some ship owners. This furthermore might show the necessity for thorough communication between the various actors in order to decrease the risk perceived by ship owners concerning LNG (Aagesen et al. 2012).

Even when the price developments encourage ship owners to switch to LNG, they have to be certain that their demand is met from the suppliers' side. An LNG fuelled vessel only makes sense if its fuel supply is ensured at the ports. Therefore, LNG refueling opportunities have to be in place along the ship's trade routes. On the other hand, ensuring the availability of LNG at ports is dependent on sufficient demand from the ship owners. The creation of a bunkering infrastructure requires high investments all along the value chain and can only be materialized with the participation and commitment of predominantly port authorities and gas suppliers but also the many stakeholder

groups that can either impede or facilitate the process. The demand from ship owners is therefore one of the main drivers for the decision to build an LNG bunkering facility.

A survey on the ports' drivers to provide LNG found that demand from ship owners is the most important driver, followed by LNG pricing compared to other fuels, positive public perception and inter-port competition. The price development of LNG is hence another key factor for the ports' decision on providing LNG (Aagesen et al. 2012).

2.1.5 Challenges

As discussed above, the switch to LNG is beneficial environmentally and from an economic perspective in the long run for both ship owners and ports. The main challenge is hence to overcome the investment dilemma and reduce the perceived risks for both sides. This can be achieved by extensive communication between all stakeholders involved and long term vision and commitment of all relevant stakeholders (Semolinos et al. 2013) Both ship owners and port actors have reason to hesitate with their investment decision until the other side to take action. This stalemate situation is commonly referred to by many authors as a "Chicken-and-Egg-Dilemma" (Semolinos et al. 2013; Wang & Notteboom 2013; Danish Maritime Authority 2012a) (FIGURE 3).

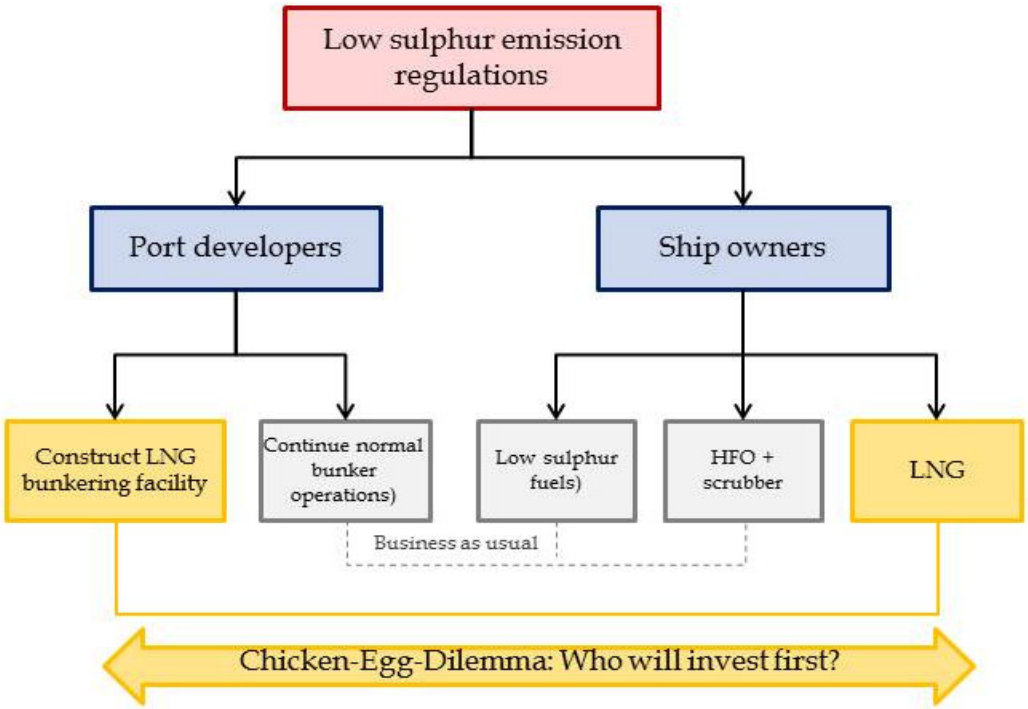

FIGURE 3 Chicken-Egg-Dilemma (Adamchak 2013)

Numerous studies have been conducted on LNG as a ship fuel whose results help to investigate the main aspects that have to be addressed in order to facilitate the creation of an LNG infrastructure and to overcome the investment

dilemma (Wang & Notteboom 2013). All the relevant aspects have been identified and classified into four categories, LNG supply chain, regulatory framework, economic viability and public perception and awareness. Understanding the features of each challenge is necessary in order to create measures of improvement for the LNG development.

2.1.5.1 LNG Supply

The availability of LNG has to be ensured by gas suppliers. Natural gas is abundant in the Baltic Sea region, a shortage of LNG can therefore most likely only occur if the liquefaction or LNG transport and storage capacities are exceeded. A study on Europe's LNG import terminal capacities revealed that in 2014, less than 20% of the LNG storage capacities in import terminal has been used. Considering that several new import terminals are planned along the Swedish Finnish coast line, for example in Pori, Tornio and Gothenburg it can be expected that the LNG capacities are sufficient (Standaert 2014). In order to get LNG available for ships in the form of LNG, a couple of issues have to be considered. The supply of LNG to the ports can be ensured by two different sources. Natural gas from national pipelines can be used and by liquefaction be converted to LNG. This method would require the creation of local small-scale liquefaction plants that are very costly and therefore only in some circumstances where access to the natural gas pipeline is close and sufficient demand would make on-site liquefaction feasible.

The second option is to supply bunkers from large import terminals. LNG is brought to the terminal in vast amounts by LNG carriers. The liquefaction of natural gas in these cases usually took place already on the natural gas extraction site. The import terminal then serves as a hub and provides other ports with LNG. In the past, natural gas was mainly converted to LNG in order to transport the natural gas by ship instead of land pipelines. Once the LNG arrives at the import terminal, it is regasified and fed into the national gas network (Foss 2003). The new possibility to use LNG as ship fuel requires the creation of a feeder distribution system that manages the refueling of ships with LNG. The refueling can take place by different methods. The ships can be refilled either directly from the LNG storage tank. This implies that an LNG storage tank is installed at the port with the specific task to refuel ships. Trucks can also be used to feed the ships, this option is attractive if LNG has to be transported from further away and direct shore-to-ship bunkering is not feasible. The third option is to use feeder vessels that take the LNG from the storage tank and then refill the ships. This option is the most viable due to its flexibility to access sites where jetties are not installed or at ports where LNG bunkering sites are not installed yet.

By using LNG as ship propellant a new market is emerging that has to be seen separated from the existing natural gas market. The LNG ship fuel market has its own infrastructure, new end users (ship owners) and will develop its own pricing mechanism. The new market can create opportunities and attract new players from existing gas and oil markets. Obviously, uncertainty

characterizes the initial phases in the LNG supply market that could pose an invest barrier, however once the dynamics settled down the market is likely to become more transparent which could contribute to steady price developments (PWC 2013).

2.1.5.2 Regulatory Framework

While there is a framework for the maritime transport of LNG cargo and the LNG on shore facilities, such as liquefaction, regasification and LNG storage operations, there have not been any clear existing regulations for the LNG bunkering operations (ship refueling) and the use of LNG as a ship fuel in general (Wang & Notteboom 2013). There are three different methods on how ships can be refueled. The tank-to-ship refueling takes place at the jetty with the vessel approaching the LNG tank and getting the LNG straight from there. The second method is by Truck-to-ship. LNG can be loaded on a truck and then this truck refuels the vessel. This method is more flexible as the vessel does not have to be next to the LNG tank but can be refueled further away, for example at ports where there is no LNG bunker terminal. The third method is by a bunker vessel. A specifically designed LNG bunker vessel takes the LNG from the storage tank and then refuels the ships. This method is also very flexible. The absence of clear established standards for bunkering procedures, requirements for equipment and staff training has been a key barrier in the past years. The IMO has meanwhile created a draft of a code that deals with the use of LNG for ships, however it still being further developed (IMO 2014). The International Standardization Organization (ISO) also created a working group to discuss the technical specifications of LNG bunkering operations. The working group is consisting of a technical committee that can set guidelines that even though not binding, could become mandatory if regulatory authorities implement them. In January 2015, the working group formulated guidelines, mentioned in ISO/TS 18683:2015 (ISO 2015). The guidelines include guidance to requirements on LNG bunkering design and operations and list recommendations for crew training. The recently published guidelines will certainly help decrease the absence of a regulatory framework and certainly support decision makers to invest in LNG, although it should be mentioned that the final legal implementation is still pending from legislative authorities. The exact impact of the lack of regulations on the development is however unclear. Stakeholder might be hesitant to go ahead with plans as long as a regulatory framework is missing.

2.1.5.3 Public Funding and Awareness

Although LNG has excellent safety records it is still perceived as dangerous. The public, media, local and regional authorities have been showing relatively low interest in LNG as a ship fuel. This circumstance could slow down the adoption of measures from public actors. Better communication of the project developers and port authorities could improve the image of LNG. A study of

TENT-T found that higher rates of public acceptance could shorten the permit process in the development of LNG projects (Danish Maritime Authority 2012) Public and government involvement play a crucial role in the promotion of LNG. A lot of studies agree that the investment dilemma can best be overcome if public funding schemes are in place. In an analysis of 33 studies on LNG as ship fuel, Notteboom and Wang concluded that the vast majority of studies identify a lack of public awareness on LNG and a lack of public financial support concerning the support of LNG infrastructure (Wang & Notteboom 2013). Currently, there is only a small amount of. local government funding programs that can be used to initiate the funding of an LNG bunkering infrastructure. The funding project of TENT-T can be mentioned at this point for example. Its aim is among others to increase public awareness of LNG. Once the public stakeholders such as media, local governments, municipalities and the general public become aware of LNG's better environmental performance and its economic potential it should eventually create incentives for further public financial support. The switch to LNG for example results in better health conditions at port cities which could be of interest for the local governments and municipalities (Work & Lng 2013). Furthermore, as mentioned above, the new market opportunities of LNG availability at different sites has other market potentials. An LNG bunkering facility could also serve the local demand for natural gas and thus contribute to the inland economy. So far there are several public funding programs in place from EU level for both ship owners and port developers.

2.1.5.4 Economic Viability

The fourth aspect that should be addressed is the economic viability. As mentioned earlier, LNG engines and LNG fuel tanks onboard the ships require significant financial investments for the ship owners. Although the payback time has been identified to be in reasonable periods even for the worse scenarios of higher LNG prices and retrofitting of vessels, ship owners might still be reluctant to invest in the initial phases. On the other hand, LNG fuel is cheaper so the operational costs are lower which in the long run amortizes the ship owners expenses. In general, ship owners spend 50% of their total costs on ship fuel (Lindstad et al. 2013), so cheaper bunkering prices significantly impact the ship owners' budgets. Potential incentive programs could be considered at this place. The port of Gothenburg for example announced a special tariff discount for LNG-fuelled vessels at their ports (Greenport 2014). These kind of incentives bear a huge potential to motivate ship owners to switch to LNG.

From the supply side perspective the LNG bunkering facility developers, namely the ports and gas supplying companies face similar problems. An LNG refueling station is estimated to cost 1 000 000 -1 500 000 EUR depending on the specific circumstances. Gas suppliers are the predominant investors since they can benefit the most from LNG sales. Port authorities however could also participate in the financing (PWC 2013). LNG availability after all ensures the ports' competitiveness and reputation. Municipalities and local governments

could theoretically also be a possible investor. Their investment drivers are among others improved health and environmental conditions and contribution to the local economic development. In this perspective certain local industries should also be considered. A specific industry with a lot of natural gas demand might use an LNG terminal for reliable and cost-efficient energy supply. The LNG terminal in Tornio for example is carried out mainly privately by a local company (Manga LNG 2014). The last possible investor group is public funding programs. As mentioned earlier, these have a huge potential to facilitate the creation of new LNG projects.

The recent drop of the oil price has resulted in a drop of shipping fuels to almost 50% which eliminates a lot of initial concerns about increased prices for shipping. The current low oil prices however pose a threat to LNG. Although natural gas prices are historically sort of attached to oil prices a drop in natural gas and hence LNG prices cannot be expected in this scale in the future. Eventually, most ship owners now switch to low sulphur fuels as this option does not necessitate any initial investments and with low fuel prices outcompetes LNG in the short to medium turn. The oil price drop therefore poses a considerate threat to the development of LNG. The speed of the creation of an LNG infrastructure could be slowed down but it is uncertain how the recent oil price will actually affect the various decision makers (Wang & Notteboom 2013).

2.1.6 Summary

Concluding, the creation of an extensive LNG infrastructure provides a lot of benefits for the shipping industry. It ensures the compliance with current and upcoming regulations and the competitiveness of the whole industry compared to other means of transport. Furthermore it improves the environmental performance of shipping and improves health conditions along ports and trade routes. Both ship owners and ports have thus interest in a shift to LNG as an alternative fuel. Its successful implementation is however depending on the regulative framework, secure LNG supply, the investment and operation costs of LNG compared to alternative fuels and public funding programs. In order to manage possible threats of these aspects it requires all involved actors to cooperate and communicate thoroughly. Regulatory authorities from local to international levels need to set clear guidelines for the creation of LNG shipping and bunkering operations. Ship owners need to invest in LNG fuelled ships and have the security to have LNG available for their fleet. Ports can facilitate the creation of bunkering terminals by participating in investments, and can with close communication with municipalities and local governments increase the public awareness of LNG. The local industry can benefit from local LNG availability and thus also be a driving force. National governments and the EU can promote development process significantly with public funding programs and gas supply companies develop the creation of LNG projects and thus have to interact with the other actors as well.

This complex environment is characterized by a remarkable number of different stakeholders. The successful creation of an LNG infrastructure requires the cooperation of all above mentioned actors. In order to identify how the creation of an LNG infrastructure can be improved, this paper therefore analyses the challenges of LNG from a stakeholder perspective. While many research articles address the various challenges of LNG as ship fuel and stress the complexity of the different stakeholders, no study has yet been done specifically from the stakeholder theory framework.

2.2 Stakeholder Theory

In chapter 2.1, the issues of implementing LNG as a ship fuel have been presented. It has been shown that the role of stakeholders is of great importance for the successful LNG development. Therefore, stakeholder theory was chosen as a theoretical framework of this research. The following chapter presents the stakeholder theory with its main ideas. The theory has also received criticisms from different theoretical considerations which are also addressed and by confronting them with previous literature and the specific issue of LNG serve as a further basis for the justification of this theory. Lastly, the role of stakeholders in port projects is presented.

2.2.1 Introduction of Stakeholder Theory

Stakeholder theory was elaborated as a new approach to strategic management in the 1980s. Existing management theories were not sufficient anymore to explain the complex business environment with various external actors and forces influencing the organization's performance. Freeman concluded that an organization needs to "take into account all of those groups and individuals that can affect, or are affected by, the accomplishment of the business enterprise"(Freeman, 1984:25). He then defined "any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984:46) as stakeholders. This is the classic definition that is most commonly agreed upon and served as a base for further interpretations on stakeholder theory. Accordingly, the realization of business objectives is only possible if the interests of stakeholders are taken into account and managed appropriately. The objective of the introduction of LNG as ship fuel is its successful implementation which depends on the actions of a wide range of different organizations that all fit into the definition of stakeholders. In 2.3 the identification of stakeholders are addressed in detail which enable a comprehensive overview of the stakeholders involved in LNG infrastructures.

The formulation of the stakeholder theory has opened a new management concept of organizations that has been discussed extensively in science. Different approaches to stakeholder theory and management have led to an unclear network of the theory that has caused a lot of contradictions, discrepancies and confusions (Jones & Wicks 1999; Stieb 2009) This controversy

can be explained by the many different scientific fields the theory became subject to over the course of years. While in the early stages stakeholder theory was particularly a concept of strategic management, it is meanwhile also discussed thoroughly in organizational theory, business ethics and sustainable development (Stieb 2009).

Donaldson therefore divided the stakeholder concept into three different aspects: descriptive/empirical -, instrumental – and normative stakeholder theory (Donaldson et al. 1995). The *descriptive/empirical* approach describes the structure and characteristics of the organization and aims at explaining the attitudes and behavior of managers from a stakeholder theory perspective. The objective is thereby to prove that the stakeholder concept can be used to describe the observed reality of how corporations are managed. The *instrumental* aspect on the other hand examines the relation between stakeholder management and traditional corporate objectives such as economic growth, competitiveness and profitability of the firm. In many cases the perspective even lies on those traditional management aspects and stakeholder management is considered as an instrument that contributes to an improvement of the business objectives (Jones 1995). Lastly, the *normative* stakeholder theory deals with the functioning of organizations within society. It comprehends the moral responsibilities and philosophical interpretations of how organizations should be operated and what ethical values should be regarded (Donaldson et al. 1995). The fact that the three approaches take different perspectives and have different focuses hence explains why there is such a variety of different definitions, interpretations and concepts in stakeholder theory. The authors however clarify that the normative justification is the underlining principle of the stakeholder theory as its presumption of the moral values and ethical responsibilities of organization and stakeholders forms the fundamental normative base for the instrumental and normative approaches.

Using Donaldson's findings, the perspective of this paper can be ascribed to the instrumental justification of stakeholder management. The main purpose of the study is to explain how stakeholder management can improve the business objective, which in this case is the successful creation of an LNG. In order to properly conduct this approach the core values of the stakeholder concept ascribed to the normative approach will nevertheless be acknowledged.

Usually, successful stakeholder management is considered essential for the organization's performance, so stakeholder theory explains how an organization, namely its top managers should deal with their stakeholders (Agle et al. 1999). As has been shown in 2.1, the creation of an LNG infrastructure is not managed and carried out by a single organization but a cooperating network of different organizations that all possess highly significant levels of legitimacy and influential power. While stakeholder theory is an instrument of strategic management that ultimately aims at increasing the prosperity of the organization, the goal of the LNG infrastructure is the success of its successful implementation. The performance of a single organization within the LNG network is not the field of attention of this study. The focal

point is therefore not on a single organization within the LNG network but a holistic perspective is taken where every actor is considered a stakeholder.

This approach is in line with published articles in the 2000s that shift the management perspective from the organization to the stakeholders themselves. The role of stakeholders is thus highlighted as they can decide on the organization's performance with their actions. This principle is known as the "stakeholder recourse" (Friedman & Miles, 2006:2) and also defines the *normative* perspective with the absence of one single organization that is managing its stakeholders but a network of stakeholders that all aim for the common objective which is the successful implementation of LNG as ship fuel (Donaldson et al. 1995).

Stakeholder theory has become a popular concept for the explanation of how organizations are or should be managed. However, the theory also receives some criticism, especially from some of the traditional business school of thoughts. Some of the critics are also dealt with as they help to further justify why the stakeholder approach is a valid perspective for LNG strategies. One of the most important critics is Jensen who argues that an organization that adopts stakeholder theory is likely to be less successful in the long run. The traditional goal of organizations is to create value maximization, which according to the general thinking in economics equaled social value and hence also maximized social welfare. Concluding, the conventional approach of focusing on value maximization of an organization accomplishes all the goals that stakeholder theory aims at (Jensen 2002).

The stakeholder framework on the other hand takes the perspective that the corporate objective is to satisfy and balance all stakeholder interests instead of aiming for value maximization which is the single corporate goal of traditional business models (Sundaram & Inkpen 2004). This approach impedes a proper performance measurement of the organization and leaves it to the managers to decide how the resources are used without any guidelines, which also empowers the managers to follow their own preferences. The author points out that there is no criterion for the managers to decide what stakeholder interests should be privileged or how the trade-off of any stakeholder group could be justified. However, they still acknowledge that stakeholders should be included in the considerations of business actions using a combination of the traditional value maximization and the stakeholder model (Jensen 2002). Concluding, organizations should aim for value maximization as their single corporate goal in the long run, however focusing on balancing the stakeholder interests in the short term. The consideration of stakeholders is however still acknowledged, although they should be put under the general principle of value maximization.

The main purpose of an LNG infrastructure is not predominantly to create more economic value for its key stakeholders. As has been shown in 2.1, environmental improvements and compliance with regulations (which are traditional stakeholder interests) were main drivers for LNG. Even if the creation of an LNG infrastructure focused on pure value maximization for its

developers, its realization still remains only possible if all necessary stakeholders are addressed and participating in the different development stages.

The criticism of the mislead objective of an organization is further carried out by Sternberg who points out that the definitions and identification models that have been developed in the past of stakeholder theorists do not allow for a successful operating of an organization (Sternberg 2001). In the early stages, a stakeholder was defined as any group that the organization has an economic interest in (Fassin 2009). Traditional stakeholders were consequently shareowners, employees, society or customers. Freeman expanded this definition by including all the groups and individuals that might not be of interest for the organization itself but in turn might have an interest in the organization and its operations (Freeman et al. 2004). This radically increased the number of stakeholders and also included more indirectly affected or even hostile groups such as terrorists, competitors, unborn generations or the environment. Aligning the corporate objective to also satisfy these groups would thus not be in the interest of the organization's long term prosperity that could even threaten its survival. Another critic is the assumption that the stakeholder groups themselves do not adjust their interests to stakeholder theory. An environmental NGO for example is not necessarily interested in the organization's other stakeholders and will hence not adjust their claims to them. As a result, all stakeholders have somehow more egoistic claims rather than adjusting them to other stakeholder groups (Sternberg 2001).

The barriers to implement LNG are not so much opposition from certain stakeholder groups. There are indeed a huge number of stakeholders involved in LNG as ship fuel but as has been shown earlier it is in the common interest of all key stakeholders to promote LNG. The main challenges for LNG are external and structural barriers not opposition from a certain stakeholder group. It has even been shown that including less significant stakeholders such as the media and general public in order to increase public awareness can trigger more important stakeholders such as governments to provide public financial support. The main criticisms to stakeholder theory hence do not hold ground for the application in this study.

The criticism and interpretations brought up against stakeholder theory have nevertheless resulted in a disputed reputation of its applicability in business and organization management. Freeman et al. addressed these issues and aimed at clarifying the concept of stakeholder theory and how it should be applied in organizations. Freeman referred the critics of Sternberg and Jensen and argues that if shareholder maximization is the core value of an organization rather than successful stakeholder management, the shareholder value maximization can still only be achieved by addressing the stakeholders. These approaches hence are merely using an instrumental theory perspective with shareholder value maximization as core business objective (Phillips et al. 2003).

2.2.2 Stakeholder Identification

This study focuses on how stakeholders are involved in the implementation of LNG as ship fuel and how their participation can be improved in order to promote the successful introduction of LNG. Therefore it is necessary to have a clear theoretical guideline on how stakeholders are identified. Furthermore, it has been shown that not all stakeholders have the same level of importance, hence, once the stakeholders have been identified, they also need to be classified. This step is necessary as not all stakeholders can be interviewed. By classifying the key stakeholders, it can be assured that the most relevant concerns and issues are addressed.

To analyze who should be involved in a stakeholder analysis is a key strategic concept which applies especially for the case of LNG with its expected vast amount of stakeholders. Identification of stakeholders is a central question of any stakeholder analysis (Parent & Deephouse 2007). As a general rule, Donaldson defined that all groups that possess information that makes their position unique in the organization's network should be included in an analysis. Logically, this is highly depending on the level of information that the stakeholder group possesses. This concept is very attractive for the stakeholder analysis of the creation of an LNG bunkering strategy where communication, and hence information sharing seems to be of exceptional relevance (Donaldson et al. 1995).

Bryson created a model for the identification of stakeholders. Accordingly, stakeholders are selected by the planning group or researcher in a preliminary stakeholder analysis. The stakeholders can then be mapped in a "Power-interest"- grid. This grid defines the level of power a stakeholder has on the organization and its level of interest. As a result, the matrix shows four categories of stakeholders: *players* that have high amounts of power and interest, *subjects* who have low power but high interest, *context setters* with little power but high interest and *crowds* who have low levels of power and influence (FIGURE 4) (Bryson 2004).

Once the stakeholders have been identified using the power-interest-grid they can be ranked according to their importance to the organization. Bryson therefore suggests complementing the matrix with Mitchell and Wood's model of stakeholder classification that allows for a distinction of stakeholders that is highly adhered to Freeman's definition of groups that affect or affected by the organization.

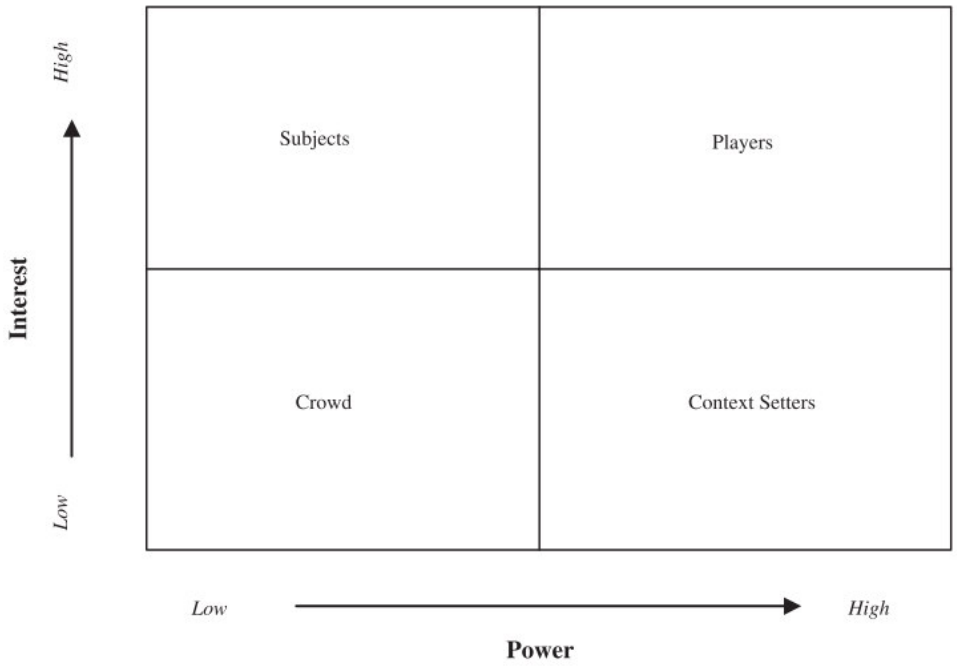

FIGURE 4 Power-Interest Grid

Mitchell and Wood also developed a stakeholder salience theory. Not every interest and claims of every identified stakeholder can be addressed by the organization, therefore the level of salience of the stakeholders needs to be analyzed which enables a concept of what stakeholder issues should actually receive attention. Therefore, the stakeholder groups are assessed in three different categories:

- The *legitimacy* of the stakeholder relationship which consists of the justified claims of the stakeholder bases on the cause's definition and commonly shared morals and values. The legitimacy is defined by the normative core of why a stakeholder has claim to clarify his concerns.
- The *power* of the stakeholder to exert influence: This comprehends the ability of one actor to bring about the outcome he desires and impose its will upon other actors either by using normative (symbolic) or material resources.
- The *urgency* of the stakeholder's claims defines the awareness of the stakeholders' interests in the organization and willingness to exert influence.

Based on the evaluation of these three categories, each stakeholder group can be classified and the ones with the highest level of salience can be selected. The stakeholder management between these identified stakeholders should then be the main focus on LNG developments and their claims and perspectives should be analyzed and coordinated in order to improve the stakeholder cooperation in LNG projects.

It is important to understand that the three different categories are variable and might change over the time, depending for example on the development stage of LNG projects. Furthermore, the evaluation of these attributes for each stakeholder group is done subjectively based on own socially constructed perceptions (Mitchell & Wood 1997). The different stakeholder types can subsequently be classified in a model (FIGURE 5).

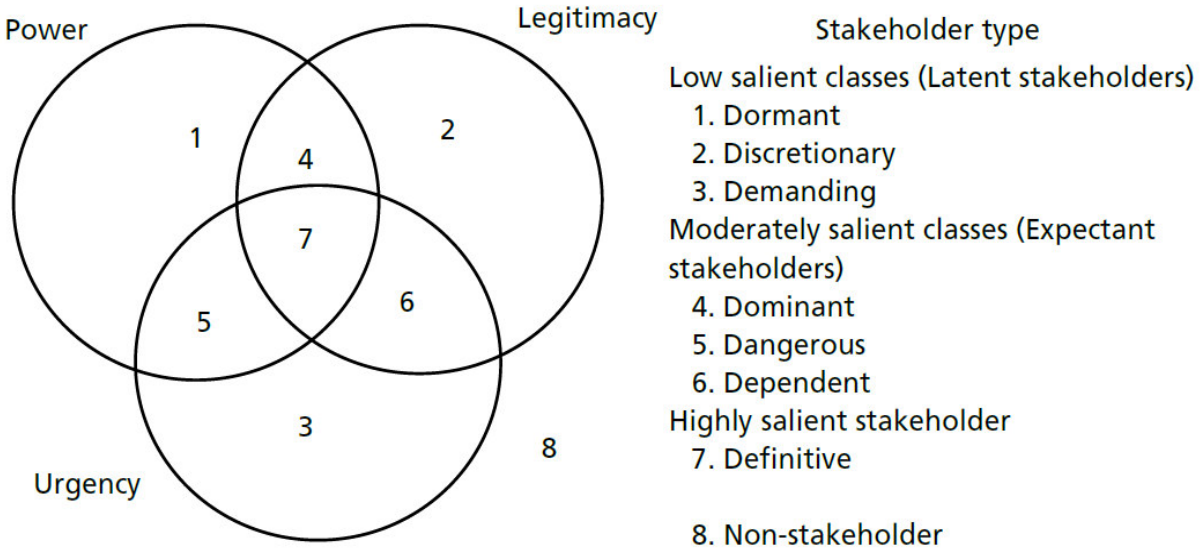

FIGURE 5 Stakeholder Salience (Friedman & Miles 2006; based on Mitchell et al. 2007)

Stakeholder groups that only have one attribute are defined as latent stakeholders (areas 1-3), stakeholder that possess two attributes but are missing the third are expectant stakeholders (areas 4-6) and stakeholders that fulfill all three categories are definitive stakeholders (area 7). (Friedman & Miles 2006) Obviously, there might be differences between the levels of one attribute, one stakeholder might for example have more power than another one. The determination of one attribute is hence slightly blurry; nevertheless this model gives a theoretical based assessment and justification of the key stakeholders that will be defined later on.

2.2.3 Stakeholder Management in Port Projects

The main feature of a managerial stakeholder theory is to acknowledge that an organization should do more than just maximizing shareholder wealth (Schmidt & Weiß 2009). In a joint industry project with different participants, this becomes obvious as the success of the shareholder maximization is directly linked to the success of the project which is only possible through extensive stakeholder participation and communication. Port construction projects are in most cases carried out by joint-industry projects. The specific ownership structure of ports often automatically involves a wide range of actors (de

Langen 2006). Usually, the municipality owns the port authority that manages the land and is in charge for the infrastructure development such as long term plans like access roads or berths. The cargo handling operations are carried out by private companies who either possess their own equipment or rent it from the port authority. The port authority in turn, although mostly financially independent, is accountable to the municipality, which means any major infrastructure project also involves decisions made by the municipality. Ports are also of great economic value for the municipal economic network, so the interest of municipalities in ports is usually exceptionally high (Nokkala 2011). Complex regulatory structures concerning land planning issues and maritime issues are often managed by different authorities which further increases the complexity of construction innovations. Hall et al. consequently underline the high importance of stakeholder involvement and collaboration in port innovation projects (Hall et al. 2013).

De Langen investigates port innovation projects by examining conflicting interests of stakeholders. He concludes that among others port development mainly clashes with interests of environmental protection, residence interests that concern safety and health issues and the overall economic development. As elaborated earlier, LNG projects are however promoting environmental protection issues, can improve the economic competitiveness of the port and reduce health hazards by less air pollution in the surrounding area. Stakeholders in LNG projects are thus expected to have less conflicting interest compared to other port development projects (de Langen 2006).

Special attention should also be paid to the public authority actors. Studies have shown that they are the most effective actor in terms of driving an innovation, especially in the early stages. Public policy actions can on the one hand side ease "soft dimensions" barriers such as regulatory obstacles and one the other hand side can substantially support the innovation by providing "hard dimension" support, in other words contribute to the materialization by financial funding programs (Arduino et al. 2013).

Concluding, the maritime transport section is characterized by a multi-stakeholder environment. Numerous actors at different places and jurisdictional levels with different positions and characteristics coexist and often possess significant decision-making power. For example, every port authority has to comply with a number of local, national and global guidelines represented by various institutions and is closely linked and affected by decisions made by port operators or the municipality. Gritsenko and Yliskylä-Peuralahti describe the governance of ports as interactive and stress its *polycentricity* (Gritsenko & Yliskylä-Peuralahti 2013; Aligica & Tarko 2012). This nested hierarchy poses complex problems for the implementation of environment-related projects that involve a great number of actors and institutions at many different hierarchical levels and hence complicate the creation of effective environmental policies. In many cases accountability of environmental topics is furthermore not allocated clearly which could reduce the commitment of actors to take measures (Marsden & Rye 2010). This effect

however might be contradicted by the shared interest of many stakeholders in the successful implementation of an LNG bunkering infrastructure.

Changing requirements and increased economic activity are the major challenges ports have to face. In many cases, adaption measures require new investments in the development of new infrastructures (Taneja et al. 2011). Due to the specific ownership and management characteristics of ports, any constructional changes to the infrastructure require the involvement of several concerned actors. The creation of an LNG bunkering infrastructure hence also requires the inclusion of several key groups/stakeholders to the planning and project management. These different groups, for example port operators, terminal operators, construction companies, LNG suppliers etc. have to be involved in the project planning. Referring to the stakeholder theory approach, all of these groups can be defined as stakeholders due to their ability to affect and being affected by the port authority's actions.

The actors involved in LNG planning phase are presented shortly in this section. They have been identified and characterized by Gritsenko and Yliskylä-Peuralahti. Accordingly, there is a distinction between intergovernmental organizations and EU-level (supranational) private and public organizations that often have overlapping but partly also contradicting agendas.

The complexity of policy makers goes up to the highest levels. The European Union enacts new laws and regulations that have to be implemented into national law by the member states. The directive to reduce sulphur emissions was legislated by the European Union according to the IMO regulations. This directive is the biggest driver for most LNG shipping/bunkering projects. There is a range of intergovernmental organizations in the European maritime transport sector that discuss and align their interests and actions and form recommendations on how to stay economically competitive while still complying with legal regulations. The International Maritime Organization (IMO) and the Helsinki Commission (HELCOM - Baltic Marine Environment Protection Commission) can be listed here. While the IMO is a specialized agency of the United Nations and operates globally, HELCOM is a governing body that only concerns the Baltic Sea region. Both organizations have regulatory functions but also develop new recommendations and measures and have coordination bodies to facilitate shipping procedures. However, the interests of the different nations often differ which makes it tough for the IGO (International Government Organization) to align the agendas of the states. (Knutsen & Hassler 2011). In this regard, it might helpful and more accurate that this study focuses on Finland and Sweden, rather than taking into account all countries in the Baltic Sea region. Both IGOs and the EU also interact with each other, in the creation of new laws for example. Typically, NGOs are a significant actor in legislative procedures. However, their presence and influence on environment-related issues in the European maritime sector is rather low, which can be explained by the general relative low interest in the shipping industry's environmental performance (Skovgaard 2012). Nation states hence are a crucial actor as they enact national

laws directed by the EU but also regulate the environmental and economic effects of the shipping industry through their participation in intergovernmental organizations. Hence they have enormous influence on the performance of their national maritime industry.

The private actors such as ship owners, cargo owners and ports are the ones who are mostly affected by the regulations. Their main concern regarding the new regulations is increased vessel operation costs due to the adaption measures of the ship owners who for example have to invest in retrofitting or purchasing new vessels However, not all reaction was negative. Some ship owners identified competitive advantages if they act early and adapt to the new legislation, for example by switching to LNG. The cargo and vessel owners align their interests by participating in the Clean Shipping Index (CSI) for example. This cooperation not only improves their environmental performance but facilitates innovation measures directed by policy makers.

All those actors have significant influence on the creation of an LNG bunkering project. The above analyses mentions some of the actors involved in the creation of an LNG bunkering project. However, a detailed analysis using Bryson's and Mitchell and Wood's models will give a detailed overview of the involved stakeholders. A mapping of stakeholders will justify what stakeholders should be interviewed based on their importance and interest on in the issue. This allows the validity and relevance of the stakeholder analysis that will enable the unfolding of potential improvement measures.

3 METHODOLOGY

In chapter 2, the topic of introducing LNG as a ship fuel in the Baltic Sea region has been explained and the various challenges concerning its successful implementation have been presented. It has been shown that numerous stakeholders are involved in the creation of an LNG infrastructure. This study examines how exactly these stakeholders are involved in this process by investigating how stakeholders evaluate their importance and mutual communication. It will also be of particular interest to find out how stakeholders are influencing the different challenges of introducing LNG as these determine the reason why stakeholders are that important. Therefore, the methodological tools have been chosen regarding their suitability to answer the research question.

This chapter presents the methodological choices for the study. At first, the research method is presented with an explanation of why this method was preferred compared to other approaches. Thereafter, the tools of data collection and data analysis are explained with an overview of how the method was used to answer the research question.

3.1 Research Method

Qualitative research has been found to be the best method to answer the research question as it "[…] examines events or experiences in context from the perspective of the individuals experiencing the phenomena" (Thompson & Walker 1998). One of the key motifs is to understand how people "[…] perceive and interpret their reality (Bryman 1988, p.8; Lewis & Ritchie 2003). This is especially true for research that addresses questions about events and experiences for which little is known. Qualitative research is in general the most appropriate approach to examine such events and contribute to the creation of a holistic picture with a better understanding of the complexity of the subject of the research and the relationship of its components (Lewis & Ritchie, 2003:32; Thompson & Walker, 1998). The creation of an LNG bunkering infrastructure fulfills these conditions as it is an unprecedented phenomenon for the shipping

industry that requires all actors to proactively cooperate in order to successfully introduce LNG as a ship fuel.

Qualitative research methods are most commonly used in the field of social sciences. While traditionally very popular among sociology, its contribution specifically to business and management research has also been acknowledged by several authors (Cassell et al. 2006) among others especially its potential for market research is worth mentioning (Walker 1985). This poses a further justification of using the qualitative method since the creation of an LNG infrastructure is a very management oriented issue that leads to the creation of a new market of LNG as ship fuel that requires the understanding of future actors in the market and its dynamics.

Qualitative research is exploratory. It enables the gathering of information in areas where previous knowledge is scarce and therefore is part of the interpretive paradigm (Dickson-Swift et al. 2007). This interpretive and exploratory nature of the qualitative research is even considered "[…] highly appropriate in the case of business and management research" (Bahari 2010) due to its social structure that is governed by human behavior rather than law-like regularities (Lewis & Ritchie 2003, p.17; Bahari 2010).

While the theoretical justification of using the qualitative research methods is given, it is also important to acknowledge what kind of results a qualitative research can create and if those results are in line with the aim of the research. Lewis and Ritchie classify four different functions of qualitative research methods:

- *Contextual* - The contextual function seeks to describe and display a phenomenon (subject of the research) that is experienced by the study participants. This type of research allows a conclusion to describe *what* exists based on the understanding of the study participants. This aspect is also referred to as descriptive and exploratory
- *Explanatory* –The explanatory function is concerned with answering the *why* of a phenomenon and therefore investigates the forces and influences that lead to the existence of the phenomenon.
- *Evaluating* – The evaluating function explains the processes and outcomes of a phenomenon and therefore is looking at *how* it operates. This is rather complex as there is an almost endless number of possible questions that can target the evaluation of a phenomenon.
- *Generative* – This function is concerned with contributing an idea or solution to the problem of the phenomenon. It can develop a new understanding based on the research and produce a strategy with new ideas and recommendations for actions.

A qualitative research is expedient, if the research aims at answering at least one issue of a research function. As can be seen in TABLE 1, it is even possible to apply all four research functions in order to answer the research question of this paper. This circumstance can be affiliated to the complex topic of implementing LNG as a ship fuel and the absence of previous studies in the

field, especially concerning stakeholder involvement. This again shows that the use of qualitative research methods is the most suitable for this study.

TABLE 1 Contribution of Research Functions to the Research ((Own illustration based on Lewis & Ritchie 2003, p. 23)

Functions of research	*Qualitative methods to explore*
Contextual	*What* is the role of stakeholders in the creation of an LNG infrastructure?
Explanatory	*Why* is stakeholder involvement necessary?
Evaluative	*How* are stakeholders influencing the process?
Generative	Strategies / suggestions for improvement

3.2 Limitations and Criticism

Some problems of qualitative interviews are the artificiality of the interview situation, the intrusiveness of the interviewer or lack of trust between interviewer and interviewee, for example. All of these issues could influence the interview and alter the reliability and completeness of the data (Myers & Newman 2007). While most of those practical problems might be of importance for sensitive personal topics, their importance for this particular research is neglectable as the interviewees are not asked sensitive questions but merely about their professional perspective on LNG development. However, those limitations were still taken into account and efforts were taken to ensure that the interviewees felt comfortable during the interview.

A criticism of the qualitative approach could be its interpretive and exploratory nature (Mansourian, 2008; Gummesson, 2003). It relies on human behavior and their perception of reality as a social construct whose entities and processes are not experimentally examined and can usually not be measured in numbers (Denzin & Lincoln 2006). Therefore, qualitative research is often put in contrast to quantitative research which emphasizes the "[…]measurement and analysis of causal relationships between variables, not processes" (Denzin & Lincoln 2006). Researchers have been arguing a lot about the difference of qualitative and quantitative research (Bahari 2010; Mahoney & Goerts 2006). Qualitative research is interpretive (Fossey et al. 2002) and therefore considered "soft science" compared to the "hard science" of positivist quantitative research methods (Denzin & Lincoln 2006; Michell 2003). While the positivist perspective assumes that there is only one version of reality, the interpretivist perspective advocates the idea that there are multiple versions of reality (King

& Horrocks 2010, p.16). Therefore, qualitative research has often been considered "unscientific" (Denzin & Lincoln 2006; Lewis & Ritchie 2003, p.22). The debate between the interpretivist and positivist rationales is sometimes even referred to as the "paradigm war" (Bryman 2006). The critique of interpretivism has been countered by many authors, proving the value and importance of interpretivist qualitative research (Glaser & Strauss 1967; Taylor & Bogdan 1985; Guba & Lincoln 1994; Cohen & Crabtree 2006). In the case of a stakeholder analysis on the LNG development, where little knowledge is available, a quantitative research would not be able to answer the research question as profoundly. By interviewing different stakeholders and assessing their uniquely perceived reality, it is possible to create an understanding of the complexity of the topic, which is exactly the purpose of this paper. Considering the diversity of stakeholders and the complexity of the topic, stakeholder analyses are usually relying more on qualitative methods (Varvasovszky 2000).

A case study on one specific port project was also considered. Case studies offer a multiplicity of perspectives (Lewis & Ritchie 2003, p.52) which is among others what this stakeholder analysis contemplates. The approach is "[…] particularly useful to employ when there is a need to obtain an in-depth appreciation of an issue, event or phenomenon of interest, in its natural real-life context" (Crowe et al. 2011). While the in-depth and multi-faceted understanding of a case study would certainly be of benefit for this study, there are also some downsides of this approach. The focus of a case study is often on a small geographic area (Zainal 2007). The same would be the case if this research focused on only one specific LNG project. It would be difficult to give a broad overview of LNG development in the whole Baltic Sea region if only the project of one port was examined. This is further backed by the fact that little is known so far on how LNG projects are carried out. Every single port is unique in its geographical, strategic, economic and social context and it would be difficult to generalize the results that were gathered on only one single project. This problem is also acknowledged as one of the main misunderstandings of the case study approach to scientific development (Flyvbjerg 2006). Considering that part of this research is also to give an overview of the current development status on LNG in the region, a broader approach that included stakeholders of the whole region is more logical.

Concluding, it can be stated that while other approaches have their advantages in terms of in-depth analyses or scientific contribution, the qualitative research approach with individual interviews of the different stakeholders is the best method to answer the research question of this paper.

3.3 Data Collection

In order to interview the appropriate stakeholders and identify the main issues that needed to be addressed in the interviews, it was necessary to divide the data collection in two parts. The first part consisted of collecting general data on the development status of LNG projects in the Baltic Sea region and assessing

the ports' position on main drivers, impediments and the role of stakeholders by screening the ports. As mentioned earlier, the creation of an LNG bunkering infrastructure is a new phenomenon where previous experience is lacking. By identifying the current state of the art and the rough stakeholder dynamics in the field in a first step, it was ensured that the research not only has theoretical justification, but can also contribute to practical implementation of the research findings. The second part of the data collection consisted of qualitative interviews and was conducted after the initial data collection.

3.3.1 Port Screening

The current development status of LNG projects was assessed by sending out a questionnaire to all ports in Finland and Sweden. The questionnaire consisted of various multiple choice questions regarding measures of the development status and the scope of the project. Open questions were asked in the end concerning the role and communication of stakeholders, main drivers and impediments (ANNEX 2). It was made sure that the questionnaire fulfills all necessary scientific requirements in order to guarantee its accuracy (Baker 2003; Bowling 2005; Marshall 2005). Since the research is part of a joint industry project co-funded by the European Union, a list of all the relevant ports was provided for internally. The questionnaire was sent to the port authorities, whose addresses were either also provided for in advance or researched online.

The questionnaire was sent in October 2014 and two times later, in case the port hasn't replied. This approach lead to 8 ports filling out the questionnaire out of 24 contacted ports (33% response rate). In order to get a clear overview of the development status, it was decided to also contact the ports directly by phone. It seemed that ports that do not have LNG plans have less interest in filling out the questionnaire which might lead to incomplete results. Therefore, the ports were questioned spontaneously by phone. In the phone calls, the port authorities were asked the most important questions of the questionnaire and in case they did not have plans for LNG projects, they were asked for the specific reasons, main issues and opinions. The interviewees were hence asked mainly about the status of the port's LNG development process, the main drivers and inhibitors of its implementation and their opinion on which stakeholders are relevant in the process. Since the phone calls lasted only around five minutes, excessive preparation and focus on interview style was not needed, although the basic guidelines of phone interviews were taken into account (Burke & Miller 2001). All the remaining ports authorities have been interviewed in this manner which led to a complete analysis of the current state of the art. By addressing the first survey specifically to port authorities, the results are also able to give a good overview of the port authorities' perspective who after all are one of the main stakeholders. The data was completely collected and analyzed by January 2015 and could hence be used in the preparation for the in-depth interviews of the stakeholders.

3.3.2 Interviews

The individual interviews of the stakeholders were conducted using a semi-structured interview style. In semi-structured and unstructured interviews, the participation of the interviewee is increased. He is able to talk freely and can contribute with his expression of opinion (DiCicco-Bloom & Crabtree 2006). This technique is well suited for the exploration of perspectives regarding complex issues and it allows for the interviewees to clarify issues that are relevant for them (Barriball & While 1994). Furthermore, new unexpected information can be gathered, which is of interest especially for topics where little knowledge is yet available (Hohl 2000). The semi-structured technique was preferred to the unstructured technique as some degree of structure enhances the interview as it gives it guidance to what questions to ask and how to evaluate the responses (Campion et al. 1997).

Nevertheless, in the course of conducting the interviews, some questions ended up being more unstructured than planned, mainly due to the different background of the various stakeholders who had different levels of interest and knowledge concerning the questions. Also, in order to guarantee a smooth flow of the interview, the questions were sometimes asked in rather arbitrary order. The main asked in the interviews were how the creation of an LNG infrastructure can be improved, based on the interviewee's perspective and how they see the role of stakeholders in this process in general. Those main questions were elaborated further by questions concerning drivers, impediments and assessments of other stakeholders' participations (see ANNEX 1).

It has been tried to conduct every interview in a face-to-face meeting which is the dominant interview technique in qualitative research and allows the inclusion of social cues, such as body language, body language and intonation that can support the researcher's analysis. However, these social cues become less important if the interviewee is questioned about issues that have nothing to do with the interviewee himself (Opdenakker 2006). A total of eight interviews were held, consisting of representatives of the most important stakeholder groups. The preparation of the interviews was guided by the eight principles McNamara applies: (1) Choose a section with little distraction, (2) Explain the purpose of the interview, (3) Address terms of confidentiality, (4) Explain the format of the interview, (5) Indicate how long the interview usually takes, (6) Tell them how to get in touch later if they want to, (7) ask them if they have any questions prior to the interview and (8) Don't count on memory to recall the answers but use a recording tool (Turner 2010; McNamara 2009).

3.3.3 Selection of Interviewees

The interviewees were chosen based on the analysis of the literature review and stakeholder theory. In order to get a clear understanding of the issue of introducing LNG, stakeholders were chosen considering their importance and knowledge on the topic. As the importance and level of influence of each

stakeholder is not exactly known in advance, the selection of the stakeholder groups to be interviewed took place subjectively based on previous research. This approach of researchers selecting the stakeholders is very common for stakeholder analyses (Varvasovszky 2000; Parent & Deephouse 2007). As the aim of the paper is to identify the involvement of stakeholders in the LNG development, it can be expected that the results indicate an improved mapping of stakeholder groups around the issue. Accordingly the following stakeholders have been selected for interviews (The organizations have been anonymized due to confidentiality reasons):

1) *Port authority with a planned LNG bunkering project* (Port Authority 1): The port authority was represented by the vice president of operations. The port is one of the first to create an LNG bunkering project in the Baltic Sea region. The port therefore possesses a lot of experience and knowledge on project planning and implementation.
2) *Port authority* without a planned LNG bunkering project (Port Authority 2): The port authority is representing ports that do not have concrete projects planned considering LNG bunkering terminals. Their perspective concerning the competitiveness and eventual downsides of not being able to have LNG available will be of special interest. The interview was conducted by phone with the marketing manager. They are therefore not a main stakeholder in the sense that they actively plan a project, but their opinion is significant in comparison to the port authority with an LNG project in order to get a clear understanding of the ports' positions.
3) *Gas supply company* that develops several LNG bunkering terminals (Project Developer 1): This stakeholder represents gas suppliers that develop and carry out LNG projects. They have the technical knowledge of LNG bunkering operations and carry the majority of financial investments in bunkering facilities. The business development manager was interviewed by phone.
4) *Local energy company* that develops an LNG bunkering terminal (Project Developer 2): The local energy company was represented by the energy business director who could not only also present the perspective of the project developer, but also give insight on how the inland industry is affected by the LNG project.
5) *Municipality* of a planned LNG bunkering project (Municipality): The director of economic and business development was interviewed. The municipality owns the land on and around the port. In this interview, the perspective of the local community and general public is also taken into account.
6) *Governmental authority* (Governmental Authority): The government counsellor attended by the interview. The authority draws up policies for

the investment aids for LNG project and allocates financial resources. It will therefore represent the public authority and governmental perspective.

7) *Ship owner* (Ship Owner): The representative of the ship owner is a company that owns a fleet mainly running in the Baltic Sea and has already decided to order some LNG vessels. The interview was scheduled with the financial manager but was then spontaneously also attended by the vice chairman.

8) Cargo owner (Cargo Owner): The cargo owners were represented by the shipping manager of a company that charters vessels and transports their cargo mostly within the Baltic Sea region. Their contribution concerning the economic impact of the introduction of LNG on their operations will be of special interest.

All interviews were held in January and February of 2015. Six interviews were conducted face-to-face on site at the stakeholders' premises, while two interviews had to be made using phone calls due to geographic distances. The interviews lasted between 50 and 70 minutes, with the exception of the interview of the Port Authority 2 for which only 35 minutes were available due to another meeting of the participant. However, the limited time was known shortly in advance, therefore the most important questions could be answered nevertheless.

3.3.4 Considerations Regarding the Selection of Interviews

All eight stakeholders are representatives of their specific stakeholder group. As mentioned in chapter 2.2.3, many different stakeholders are involved in the creation of an LNG infrastructure. The selection of stakeholders for the interviews has therefore focused on the most important ones with regard to indirectly also including less relevant stakeholders. The local community for example is certainly a stakeholder that might partly have different interests than the administration of the municipality. However, the local community is not directly involved in LNG projects and the literature review has not led to the conclusion that the local community is a group with definite high interest in the issue. Therefore it was decided to not interview this stakeholder specifically but include it, along with the general public, to the municipality and consider their eventual concerns in that interview. Similar considerations concern the regulatory authorities. As mentioned previously, many different regulatory authorities with different responsibilities on local, regional, national and international level are included in LNG development. The governmental authority that was interviewed was therefore interviewed taking into account a broader perspective on how regulatory authorities are involved in general. Local industry enterprises are a further stakeholder group that could have been interviewed on its own. They are represented by the energy company that also develops an LNG project. Possibly, they could bring a slightly different insight as their interests and functions in the LNG development might vary from the

interviewed energy company. Finally, the shipping and port sector is characterized by a huge presence of industry cooperations, such as port and ship owner associations who possess significant levels of influence. They were however not specifically targeted as stakeholders in that sense as they are already represented by ship owners or port authorities. TABLE 2 gives an overview of all interviewed stakeholders and their main functions and interests concerning LNG development.

TABLE 2 Selection of Stakeholders

Stakeholder	*Function*	*Main concerns*
Port authority with an LNG project	○ Plan the project with municipality, ship owners and gas supplier ○ Providing external infrastructure	○ Port's competitiveness ○ Provide LNG to its customers
Port authority without LNG project	○ Check if LNG project is feasible ○ Develop a plan with project developer	○ Port's competitiveness ○ Attract investors in a project
Gas supplier	○ Develop and invest in the LNG project	○ Enter the market and sell LNG ○ Demand for LNG from customers ○ Public funding for the projects
Energy company	○ Develop and invest in the LNG project	○ Demand for LNG from customers ○ Energy security
Municipality	○ Owns the port ○ Approves and coordinates the LNG project	○ Local economic development ○ Contentment of local communities
Governmental authority	○ Allocates public funding programs ○ Coordinates and monitors LNG development financially	○ Economic development ○ Compliance with regulations
Ship owners	○ Purchase of LNG vessels ○ Customers of LNG	○ Compliance with regulations ○ Reliable LNG availability
Cargo owners	○ Chartering and Transport of cargo	○ Cheap transportation

3.4 Data Analysis

Both data collection measures were designed taking into account that the content of the questionnaires and interviews has to be in line with the research question. For the initial data collection of the port screening that gathered data on the development status of LNG projects, the ports were classified as either "having plans", "having no plans (yet)" or "internally discussing" the initiation of a project. The data on the drivers and concerns of the ports were combined with the in-depth interviews that were recorded and transcribed.

The researcher has to interpret the data and make "sense" out of what was uncovered (Turner 2010). Since the data is analyzed individually by the researcher, his judgement is very critical for the results (Varvasovszky 2000). Therefore, it is necessary to have a well-structured plan when analyzing the data. Based on Schwandt's suggestion, the data was reduced in an initial step, which means that all the relevant data of the transcripts and written notes during the interview were selected and abstracted. This step helps to exclude off-topic talks during the interview, for example. Afterwards the data was displayed, which means all relevant data from the transcripts and notes during the phone and in-depth interviews was assembled which allows for its profound analysis (Schwandt 1996, p.11). Considering that each interviewee had a different background in knowledge and perceptions about the topic, not all questions could be fully answered by every participant. Some interviewees can contribute a better input on some questions than others. These circumstances were considered already during the conduct of the interviews and should also be taken into account when analyzing the data. As a result, the collected data might show differences in patterns and structures and require a very intense analysis (Zhang & Wildemuth 2009).

Thematic Analysis was chosen as analytical method. It is a widely used approach in qualitative data analysis because it offers an accessible and theoretically flexible method to analyze qualitative data (Boyatzis 1998; Braun & Clark 2006). The focus of thematic analysis is on identifying and examining themes within the data (Daly et al. 2007). These themes or patterns are coded to better describe and explain the researched phenomenon. Braun and Clark distinguish six phases in which the data is coded: familiarization with data, generating initial codes, searching for themes among codes, reviewing themes, defining and naming themes, and producing the final report (Braun & Clark 2006). These six steps have served as a guideline for the data analysis of this paper. Constructivism was used as a research paradigm as it "denies the existence of an objective reality" (Mills et al. 2006) and concludes that knowledge is only created in a relative sense based on the formations of the individually socially constructed realities. Therefore, multiple social realities exist that are apprehended differently and sometimes even conflict with each other (Guba & Lincoln 1994) which can easily be combined with stakeholder theory and the differing interests of stakeholder groups (Mainardes et al. 2011). In order to support the data analysis, it was decided to use a computer-assisted

qualitative data analysis software (CAQDAS). Using a CAQDAS software can bring more rigour into the research (Rambaree 2007). The QDA Miner Lite software was chosen as CAQDAS to support the analysis.

4 RESULTS

This chapter presents the results made by the analysis of the port screening and the individual interviews. The port screening with the questionnaire and the phone calls allowed to create an overview of the current development status of LNG projects in Sweden and Finland (chapter 4.7) and also supported the findings on stakeholder involvement in LNG projects, which are predominantly based on the individual interviews. At first, the results of how stakeholders are generally involved in LNG projects and communicate with each other are presented. Thereafter, the findings are categorized based on their relevance for the four different aspect of LNG development, elaborated in chapter 2.1.5 before the results of the port screening show the current state of the art of LNG development in Finland and Sweden.

4.1 Stakeholder Involvement

Stakeholders play a crucial role in the creation of any LNG project. All interviewees agreed that without participation of all relevant stakeholders, the development of projects is not possible. In the analysis, a closer look was taken on how each stakeholder is participating in the creation of an LNG infrastructure.

The most important stakeholders identified are gas suppliers, port authorities and ship owners. Gas suppliers are usually the main initiator of a project; they possess the technical knowledge to build an LNG bunkering facility and are in charge of the actual LNG bunkering operations, unless they assign these responsibilities to a terminal operator. Gas suppliers are furthermore the main direct financial beneficiaries of LNG projects and hence usually also carry the main share of investments.

Every LNG project at a port requires profound cooperation with the port authority. Port authorities monitor the port operations and provide external infrastructure to the project. Therefore, they have to construct special infrastructure to enable the LNG operations by improving the jetties at the ports, for example. This external provision of all the installments around the project is also their main financial contribution. In general, they do not invest

themselves in any LNG projects. As a result, ports need the presence of a gas supplier who is willing to invest. Ports are rather powerless in initiating a bunkering facility all by themselves, but have a huge interest in getting LNG available at their port. *They are competing with other ports obviously and if they can offer a variety of fuel bunkering solutions […] that is a way of not steering away certain vessels from the ports*, as the Project Developer 1 acknowledged.

Ship owners have the biggest interest in having LNG available on all the ports, therefore they take a lot of effort in contacting ports and gas suppliers to investigate where LNG will be available and push the supply side to initiate plans. Their actual involvement in the creation of a bunkering facility is rather low, their role is mostly important considering their demand for LNG. Before a gas supplier invests in a project they need to be sure that there are enough customers that buy their product. Thus, customers such as ship owners have to be included in the planning stage relatively early.

Local land industry is the other main customer of LNG. The volume of LNG for the local economy is in fact significantly higher than the ship owners', especially in the first phase of LNG ships. In particular, industries with a high demand for energy might be interested in LNG available close by, as LNG can replace other energy sources or add to or replace natural gas from the gas grid. As the development of LNG as a ship fuel is rather uncertain in the next few years, the local industry will be the main customer in the beginning. For example, the LNG terminal in Tornio is even initiated only by local industry without any ship owner involvement. However, local industry seems to be a neglected stakeholder. An extensive LNG bunkering network is only possible if local industries are involved in the various projects and supplied with LNG. Their awareness of the potential that LNG availability has is relatively low so far. The creation of an LNG infrastructure could be improved a lot with higher awareness and demand for LNG from the local economies. *Industrial use of LNG is supporting the building of an LNG infrastructure because this is a volume business only and the bigger volumes the better for LNG*, as the Project Developer 2 mentions.

Municipalities play an important role in this perspective. They provide a lot of information to the project developer and infrastructure companies. In most cases they own the land at and around the port and therefore are involved in many legal procedures. They also have a lot of influence on the local industries, the public, governmental and legal authorities. Municipality for example stated that they think they should be included a bit more and *know what is happening next*. Due to the port ownership structure of most Finnish and Swedish ports, they are also directly or indirectly involved in the financial performance of the port and have an interest in its economic performance. Furthermore, they are the stakeholder who is in contact most with the general public, so their influence on creating awareness for LNG and managing its public reputation is important.

Governmental authorities monitor the development and, based on directives and strategies, plan the development of LNG. As Governmental Authority says: *A new government might make new decisions […] and the* (funding)

schemes are based on the priorities of the government. Governmental support is thus not static and depends a lot on energy-related strategic priorities. Ship Owner identified this stakeholder group as the one who slows down the development process most because *they would not see the big picture, […] do not provide sufficient public funding and have slow processes along with their agendas*. The role of public funding is also crucial for the creation of an LNG network. Investments are generally very high and barely possible for the businesses themselves to make on their own. Most LNG projects have received significant financial support, which is hence a very important factor.

Similar to the local industry, cargo owners are not fully aware yet of their potential to shift the shipping industry towards LNG. Cargo owners make charter contracts with ship owners, so they can decide what type of vessel they want their product to be transported. If the cargo owner pushes for more environmentally friendly transportation methods, they could chose an LNG vessel over a conventional fuelled vessel and enter a long term contract with the ship owner. Thus, the ship owners have the insurance that the LNG vessel they build is going to be used by its customers and therefore profitable for the ship owner. The interviewed cargo owner for example signed such a contract and agreed to ship its products on the LNG vessel, which reduced the risk of the ship owner and allowed him to urge ports and gas suppliers to guarantee LNG supply at the various locations.

Besides the main actors of LNG projects discussed above, some interviewees considered so far unmentioned stakeholders as important. Port Authority 1 for example stated that the upstream gas suppliers should *see the environmental side of the project and the new possibilities to convert the ship industry to gas*. If they were included more the price uncertainty concerning the LNG market which makes it difficult to estimate and plan the LNG fuel market could be diminished.

Port Authority 1 also mentioned classification societies could be considered who investigate the business and are usually included in a lot of regulatory processes. This opinion has however not been shared by the interviewed project developers who supposedly deal with the classification companies as well. Therefore, they are only mentioned here but are not considered a primary stakeholder.

4.2 Stakeholder Communication

Considering the importance of stakeholder participation in LNG projects, it is essential to have open and extensive communication between the various stakeholders. Every actor is depending on the contribution of other actors, accordingly mutual trust is an important issue. The analysis of the interviews and the port screening gives an overview of the communication between stakeholders and tries to find potential for improvement.

The general opinion of the interviewees is that communication is not impeding the development process, but in fact considered rather well. The

creation of an LNG network poses new challenges to all involved actors. In the early stages, the amount of LNG in the market will be very low. The main focus of all actors is therefore to increase the availability of LNG and increase the volume. During this first phase, LNG will only be profitable for one stakeholder if other stakeholders benefit from it as well. Gas suppliers for example will only profit from an LNG terminal if ship owners profit from LNG, too. Ship owners are the ones who are mostly affected by the new emission regulations. This circumstance puts them in a position that they are forced to act and enquire if LNG is the best solution to comply with the SECA regulations. Consequently, they are highly active in reaching out to all different stakeholders. They discuss with their customers if they would be interested in chartering LNG vessels, but also need to make sure LNG is available at the ports, thus reaching out to the ports and gas suppliers. Furthermore, ship owners communicate with governmental authorities to check for funding possibilities. In the interview, the ship owner also mentioned the importance to communicate with other ship owners. One single vessel is not creating sufficient demand to create an LNG terminal, but if the ship owners come together and accumulate their demand, they reach considerate amounts that can be a big driver for one port to ensure an LNG bunkering possibility.

Gas suppliers are also in extensive communication with ports, ship owners and local industries. Only if they are sure that there is enough demand will the investment in a project be reasonable. Project Developer 1 did not see communication as problem so far: *I think we communicate quite well in the Scandinavian region.* This perspective was shared by Cargo Owner who stated that *everything has been good so far, everybody knows what everybody is doing […] For the vessel owners it is quite nice, vessel owners they are competitors but they are still discussing what kind of plans they have.*

Communication channels seem to gather around the ports. Port Authority 1 stated that they have been very actively communicating with all different actors and made sure all stakeholders are well informed at all times. He also highlighted that the active communication substantially contributed to a smooth planning and implementation of the LNG project. The port held many conferences and meetings with all different stakeholder groups along with other European ports that carry out LNG projects. Information sharing seems to be the most important function of the communication. LNG is a new issue and by sharing experiences and information it can be ensured that the lack of knowledge can be overcome. Even though Port Authority 2 does not have any plans for LNG in the upcoming future, they have still been in contact with ship owners and gas suppliers, which demonstrates the general interest in LNG and the active communication of ship owners and gas suppliers.

While the communication between ports, gas suppliers and ship owners seems to present sufficiently, the communication with and between other stakeholders is not always flawless. The Municipality stated that the local LNG project is not really communicated to the public. It has not been assigned who is in charge of informing the public and the local economy, the municipality, the project developer or the port? This is in contradiction to the communication of

the project Port Authority 1 is involved in. They stated to be very active in communicating with the municipality and the public and inform them about the environmental and health improvements but also reassuring the safety of the product: *We have had a lot of discussions, risk analyses and safety precautions and the local communities have looked at it and said it was ok to get the application*. By actively communicating these concerns and openly discussing about the project, the awareness for LNG could be raised while also creating a positive image of LNG. Port Authority 2 stated that municipalities should be responsible for informing the local communities and the local economy about the features of LNG since they are the most eligible in that perspective. The strategy of the Municipality's and Project Developer 2's project did not include the public that much. It was considered that by informing about LNG – both benefits but also mentioning safety issues – opposition might arise that otherwise would not have to be dealt with. This attitude is risky as yet another project with a similar communication strategy had to face a public appeal that stopped the development process. Including the municipality and the public and actively informing them about LNG can thus guarantee a smooth creation and it should be made clear who is informing other stakeholders and how.

Furthermore, by increasing the general awareness of LNG, the local economy might also get more interested in the topic which could in another step increase local industrial demand for LNG. In general, it seems that the communication with local industries has the biggest potential for improvement. Port Authority 1 suggested that local industry should be included more often in their meetings.

Cargo owners are also not very actively communicating with other stakeholders, apart from ship owners. But the question from this point of view is whether communication between the cargo owners and other stakeholders is really necessary. Cargo Owner for example has not been in contact with any ports but stated that by communicating with them they could enforce the demand and drive ports to set incentives for LNG.

Summarizing, it was found that communication between the most important stakeholders is sufficient and smooth. All stakeholders recognize the importance of sharing information in order to drive the development process. Communication with public actors and the local economy is still important as the given example shows, but could at least in some projects be improved in order to avoid resistance to the projects and to increase local industry demand for LNG.

4.3 Regulatory Framework

The main stakeholders affected by the regulatory framework concerning LNG bunkering operations are port authorities, gas suppliers and ship owners. The LNG project developers need to ensure that the bunkering of vessels is feasible and complies with legal guidelines concerning environmental, health and safety issues, for example. Considering that several LNG projects have been planned

and entered the implementation phase before a clear legal framework has existed implies that the port authorities and gas suppliers had to align their plans on the project and its operations in advance and take into account their correspondence with the regulations once they will be created.

Port Authority 1 was one of the first ports to build an LNG bunkering facility, therefore they have contributed to the creation of bunkering standards in cooperation with other European ports with LNG projects. Accordingly, in the early stages, it was a big challenge to plan the bunkering operations and come up with instructions. The instructions that have been created by Port Authority 1 might serve as a recommendation for other ports, as the interviewee suggests.

Most responsibilities for implementing the guidelines affect the port authority, while the remaining issues are for ship pilots and national legal authorities to figure out. Port Authority 1 also argues that the creation of bunkering guidelines for their port is nearly completed. The experiences from this case show that it has been a hurdle to figure out how the bunkering should be managed and be organized by instructions.

Project Developer 2 thinks that *you have to plan more because if you have rules it is easier and now* (without regulations) *you have to discuss if this would be ok or not*. He furthermore pointed out that it is difficult to make European wide rules and that without clear planning from European and international level it is unlikely that coherent regulations will be designed throughout the different European ports.

Project Developer 1 also acknowledged the absence of regulations so far but stated that a lot can be learned from currently operating LNG test vessels and from conventional bunkering operations. The absence of regulations *is not a major impediment […] as long as we have an open dialog with the authorities. I don't think it is an issue right now. It was more an issue some time ago*, as he says.

The same opinion was shared by Ship Owner who additionally pointed out that the LNG bunkering regulations increase financial expenses. Bunkering vessels with LNG requires special training of the ship crew in order to avoid any kind of accidents, for example a spill of LNG. The training of the ship crew is a significant financial expenditure for Ship Owner because such schooling is so far only available in Fredericksham and Gothenburg, but the fleet of ship owners is often scattered around the globe which makes training them logistically challenging and expensive. Ship Owner also argued that since as long as there is no clear standardization of how to manage the bunkering instructions, each port can create its own guidelines. As a result, it is possible that ports have different regulations which means that ship owners might face different regulations from port to port.

The screening of the ports revealed that several ports that do not have LNG plans yet do not consider the absence of a regulatory framework an obstacle. No port specifically mentioned the unclear legal framework being a major impediment.

Governmental Authority pointed out that permitting agencies are confronted with the issue around a regulatory framework because they need to

figure out how to manage and monitor the bunkering processes, so their role in this particular aspect is important. It is therefore necessary that governmental permitting authorities on all relevant levels come together and issue clear guidelines for bunkering operations. An ISO document has been created just at the beginning of this year that will help as guidelines for port authorities to compile bunkering instructions, which will very likely be used as a frame for the definition of clear laws.

While the absence of a regulatory framework has been an issue in the past, it seems that it is not considered a major hurdle anymore. It might require more detailed planning of the project developer and leave them with a certain uncertainty, but it was not identified as an issue that will prevent or slow down the LNG development in the future. Nevertheless, legal authorities should make sure that a regulatory framework is created rather sooner than later in order to facilitate the planning of LNG projects.

4.4 LNG Supply Chain

The LNG supply chain starts with the extraction of natural gas. The majority of natural gas for the Finnish and Swedish markets comes from Norway and Russia. Natural gas is transported either via gas pipeline or via ship in the form of LNG carriers. The latter requires the liquefaction of natural gas and then, if fed to the national gas grid, regasification plants. The LNG projects at the investigated ports have mostly in common that they receive LNG from an LNG import terminal, which means LNG is transported by an LNG carrier. Once the LNG is at the port, it can be used to fuel ships or supply local inland energy demand. The capacities for LNG storage are sufficient and will not be utilized to capacity by the sudden demand from LNG vessels. The upstream gas companies are so far not aware that much of the potential of LNG as a ship fuel, as Port Authority 1 thinks. This could perhaps be explained considering the fact that natural gas is in general available sufficiently in the Baltic Sea region. Therefore, this fact was not considered that much of an issue, which was also shared by Project Developer 1. Project Developer 2 in turn was sure that the upstream gas suppliers see the potential of LNG in the future. Additionally, no stakeholder mentioned that there could be a shortage of natural gas or LNG that could threaten the security of supply in any way. The main challenge of the LNG supply chain is to make sure it is actually available at the ports, not if the ports or LNG projects can acquire enough LNG.

The LNG projects will not only supply the shipping industry with LNG, but also significantly contribute to the local and national energy grid. Governmental Authority for example estimated that the LNG terminals contribute to the energy security of the whole region. Therefore, the LNG projects were considered not only as being relevant for ship owners, but for the whole national energy strategy. Furthermore, LNG availability is a new phenomenon; an LNG terminal can therefore serve the whole area and even create new business opportunities. Project Developer 2 even argued that the

supply for all the local inland demand, from feeding the energy grid, supplying local businesses and fuelling gas fuelled vehicles is the main share of LNG and these volumes are expected to contribute to the profitability of the whole project. Serving only the ship owners is not that lucrative from the gas suppliers' perspective. On the other hand, as Project Developer 1 highlights, LNG terminals make less sense at locations where the natural gas grid is close by that can serve the industrial demand at lower costs. This is also one reason why LNG terminals are planned for example in Gävle, Pori or Gothenburg (see also 4.6).

Energy security was also one main driver for the LNG project Municipality is involved: *It will affect the availability of gas produced here locally […] it is important from an economic perspective because we wouldn't need to use Russian gas that much anymore*. The project is also connected to the national gas grid, so the LNG could fuel the local energy grid and hence be attractive not only from a strategic but also from a business perspective.

Referring to the availability of LNG at the ports, Governmental Authority stated that the priorities of public funding have been to specifically support bigger LNG projects at strategically important locations. The idea was to support those important ports and ensure that LNG is available in that region and then waiting if these large terminals trigger ship owners to buy vessels and thus trigger the LNG market with the creation of LNG projects in smaller ports. Governmental Authority further implied that the future development of the LNG market will show if further public funding is necessary for the smaller ports. This circumstance should be regarded concerning the directive of the EU that demands every port should ensure LNG bunkering opportunities by 2025.

Project Developer 1 highlighted how difficult it is for gas suppliers to ensure the LNG supply because they are the main investors in the projects while all the affected stakeholders benefit from LNG availability but are usually not investing themselves. The gas suppliers face high risk accordingly because demand for LNG is often too low to justify a project. And in order for them to invest they […] *want to make money of it, but then you need customers and you need throughput and that has been the biggest issue so far*, as he reckons. He furthermore points out that every supplier therefore creates more or less his own infrastructure which means the total investments aren't used optimally. One way to overcome this would be if stakeholders were included more and share the costs.

Ship Owner was concerned about the LNG prices. Since there is no real market for LNG yet, the ship owners are often forced to buy the LNG from one site. In this regard, he complained about high prices of LNG. Once LNG is available at different ports, this fact might become irrelevant. Several ports have already mentioned that they consider offering special port tariffs to make their port more attractive for LNG vessels.

It seems that bunkering by a bunker vessel or truck-to-ship will be the most common type of bunkering method in the early stages, as Project Developer 1 points out. A bunker vessel can ensure more flexible operations

and even serve vessels that are not located directly in the port. Also truck-to-ship refueling will probably be found a lot in the future. Even though the EU directive targets every port to have LNG available by 2025, it is very unlikely that every port will have its own LNG storage tank. More likely, smaller ports will supply LNG vessels with truck-to-ship or bunkering vessel methods.

The LNG supply chain is under a lot of development, especially in the downstream part. In general, there will not be a deficiency of LNG in the region; the challenge is more to have LNG present at all the ports. The biggest LNG terminals have capacities that are enough to serve the shipping industry in the area and it will be up to the market to see how LNG will be available at all ports, and not just the ones that build a terminal.

4.5 Economic Viability

This aspect turned out to be the biggest challenge for the development of LNG as a ship fuel. In order to overcome the previously mentioned "Chicken-Egg-Dilemma" it is important to reduce the financial risks and uncertainties of project developers and ship owners.

4.5.1 Economic Dynamics

Some ports that do not have LNG plans yet, named an absence of a gas supplier ready to invest as a reason for the absence of concrete LNG plans. From the project developer's side it can be stated that a port with an LNG infrastructure ensures the competitiveness of the port and improves its environmental performance and reputation. These factors have been explained as being the main drivers for the LNG project at Port Authority 1's port. Port Authority 2 admitted that not having LNG available at the port and not being considered a modern port would result in competitive disadvantages, even though he did not identify them as main issues. For the Municipality, the LNG project was driven to ensure the port's competitiveness and reputation and it was considered a main contributor to attract new businesses and improve the local economy. *[…] It will remarkably increase the competitiveness of the harbor, meaning that this will be the start of getting new businesses and volumes, and via that more economic prosperity and of course more jobs*.

Demand from ship owners for LNG was relatively low in Project Developer 2's calculations and not expected to be very high in the near future either. The supply for the local industries and the energy grid was considered as the main driver for the LNG project, thus overcoming the investment dilemma. The role of the industrial demand has been identified throughout the interviews as key driver for LNG. No LNG project is possible without the demand from local industries. Additionally a project becomes profitable only through the involvement of this stakeholder group, especially in the beginning, when LNG vessels are still rare in the Baltic Sea region.

From the demand side perspective, ship owners will switch to LNG if

they see it as the better alternative. Ship Owner clearly saw LNG as the favorable ship fuel for the future that not only has the better environmental performance but also is more efficient in terms of economic efficiency. He mentioned operational savings due to higher energy efficiencies of the new vessels for example. One way to ensure that ship owners see the potential of LNG is if they are pushed towards it by their stakeholders. Port Authority 1, Project Developer 1, Ship Owner and Cargo Owner identified a considerate potential of the cargo owners to influence the ship owners' decision. Cargo owners can put more emphasis on improving their environmental footprint of the supply chain and hence demand for more environmentally sound shipping such as LNG. But as Cargo Owner explains: *The cargo owners' decision inside the company is difficult to make*. Internal processes inside the company hence complicate the commitment to use LNG vessels. Of course in this perspective it is important to recognize that cargo owners have to compete as well and might favor cheaper transportation. Cargo Owner further elaborated on the relationship with the ship owners: *The vessel owners are forced to have some kind of relationship with the charterer to be able to make all the investments, that is why it has been important for the ship owner to have us onboard*. Cargo owners have thus a considerate influence on getting ship owners to switch to LNG as they can reduce their uncertainty concerning the building of an LNG vessel.

Port Authority 1 suggested that the shipping industry needs to share the prices: *The shipping industry needs to share the prices and of course […] companies who buy their transportation from [the ship owners], in some way everyone needs to take in the new costs*. The idea of distributing the costs was shared by several stakeholders. Everybody seems to agree that LNG is a favorable alternative that will be lucrative in the long run, but in the early stages, when the infrastructure still has to be constructed and a lot of investments are needed, everyone should carry a share of the costs. The interviewee therefore suggested that also port tariffs could play a major role and be the ports' part in sharing the costs. This idea was also welcomed by Ship Owner, who stressed that cheaper port tariffs could be a big incentive for an LNG vessel. Additionally, port tariffs improve the competitiveness of one port and can contribute to the port's economic performance in the long run. Therefore, it is likely that other ports might follow with such incentives.

The investment dilemma that makes ship owners as well as port developer hesitate is an issue perceived by many ports. However, with more involvement of cargo owners and local industries these hurdles can be overcome. The high investment costs of building an LNG network can further be managed by sharing costs among all stakeholders and focusing on the long-term benefits of having an LNG infrastructure rather than aiming for short term profits.

4.5.2 The Role of the Oil Price

The biggest uncertainty that all actors face is the development of the oil price. All interviewed stakeholders identified the current low oil price as the main

hurdle. Port Authority 1 stated that *it is not good for the business. In general, we like when the oil price goes down. But if we just focus on LNG, it is not good for the LNG business and the upcoming LNG market. Because if you as a ship owner see that the low sulphur diesel is available for a small amount of money, then it is not necessary to make any investments in other fuels*.

Project developer 2 also raised an interesting point in revealing that ship owners with dual fuel engines, might use their LNG engines for a lot of marketing purposes but in fact combusting MDO, particularly as long as LNG is not available broadly and less profitable as MDO. This should be considered in the future when the environmental footprint of vessels, especially dual-fuel vessels is calculated. On the other hand, this consideration shows the flexibility of the ship owners which makes it easier for them to choose LNG. They can use MDO as long as LNG is not available and then switch to LNG when it is present at the ports and cheaper than MDO. The Cargo Owner also confirmed this: *It looks like the prices are going to stay that way, […] we didn't see that coming but that is why we have the dual fuel vessel so we don't have to use LNG but MDO when it is cheaper.*

Most ships that have been ordered will operate with the dual fuel technology. Therefore, ship owners of LNG vessels are not affected that much by the low oil price. However, the ship owners' decision today might be a different one, due to the low oil prices. Project developer 1 explained that *if I were to start talking to a ship owner today […] it would be difficult for me to say you should chose LNG*. He also added: *But we know very well that things change rapidly and over time there is no doubt that LNG is a competitive solution*. This view was commonly shared. All interviewed stakeholders saw a problem in the current low oil price, but were confident that in the future the price relation between LNG and oil will be in LNG's favor and thus LNG will emerge as the most favorable ship propellant.

From another perspective, the low oil prices prevented the shipping industry from any major impacts. One concern of the sector was that the new regulations might increase costs for transportation and thus ship transport might shift to rail transport, for example. The sudden drop in oil price resulted in a business as usual conduct, with MDO being relatively as expensive as HFO one year ago. That is why Port Authority 2 noticed that the awareness of ship owners and interest in the port's LNG plans has decreased once oil prices dropped as well. He pointed out that interest for other alternatives than LNG has increased: *There is more interest for scrubbers and other marine oils than for LNG at the moment*. This circumstance shows again how the development of LNG is slowed down substantially by the oil prices. A vessel that has been refurbished with a scrubber for example is less likely to be retrofit with an LNG vessel, for example.

The development of the oil price has slowed down the LNG development considerably. Further developments will show if this trend will continue or if LNG emerges as a clearly economic viable solution. Most interviewees were confident that in the future the price relation between LNG and oil will develop in LNG's favor.

4.6 Public Funding and Awareness

All stakeholders agree that public funding is necessary in order to get the LNG market on its feet. Without support from public funds, LNG could probably not be enforced as viable alternative to other ship fuels, for example Ship Owner highlighted.

Port Authority 1 pointed to Norway to show how efficient and extensive public funding can support the LNG market. Norway has had a fund for a few years already that makes it very easy and feasible for ship owners to build an LNG vessel. Accordingly, Norway is a leading country concerning LNG fueled vessels. Governmental Authority however countered that such public funding as Norway does it would not be possible in Finland or Sweden due to constitutional differences. Nevertheless, similar funding schemes could be initiated from EU level that could learn from the experiences made in Norway.

Cargo Owner pointed out that public funding might be important particularly in the shipping industry because the shipping sector is rather slow concerning innovation measures. Public funding could be an incentive that triggers actors in the shipping sector that are generally rather hesitant with innovation investments.

Project Developer 1 further argues that with public funding *you will lower the barrier for building the infrastructure and that will be beneficial also for the end user price of the LNG.* Not only can public funding thus support the building of LNG terminals, but it can also lower the price for LNG because gas suppliers have less investment costs they need to amortize by conveying the costs to the customers.

While public funding seems to be very important to create the LNG infrastructure, Port Authority 2 and the Governmental Authority also argued that public funding alone is not enough to trigger a project: *You cannot base a whole project on public funding because the project needs to be very mature* (to get the funding) *[…] you can perhaps add public funding on top, but you need to have decided to fulfill the project anyway, even without public funding*, as Port Authority 2 said. Governmental Authority explained that they do not pay for projects that are just planned on paper. Usually they pay once the actual costs have emerged and the project developer has paid them, then the public funding scheme can come in and take over the costs.

Governmental Authority explained the public funding strategy as such: *The whole idea of the government was that by providing funding this would trigger the market so that we do not need to fund every step in the supply distribution chain but by funding terminals, this would trigger that there will be LNG vessels*. The public funding therefore focused on certain strategically important ports. The main function of public funding is to reduce the risks for the market actors and increase the volume.

Informing the public about ongoing projects is also not flawless in every case. The project Municipality and Project Developer 2 are involved in has no

clear guidelines on how to inform the public. As a result, the public has not been informed at all so far. Municipality for example stated that *we will inform the public when the time is right and then explain the project and explain what it means. Right now it has been our policy that who is in charge of the project comes to the public.* He added that along with informing the public, local industries will also be approached, but according to him, only once the project has reached a certain stage. None of LNG projects the interview participants are involved in has had any issues with public concerns. However Municipality's and Project Developer 2 have both not informed the public. As mentioned earlier, this is rather risky because the public could at one point raise conflicting concerns as has been the case in one LNG project in Sweden as Port Authority 2 revealed. Informing the public and including them already in the early stages could ensure public opposition to the project will not emerge.

Municipality also explained that it is important to raise general awareness on LNG. Not only is the public not always informed about the LNG projects, but the general interest of the public in the LNG topic is also very low. Higher interest in LNG from all public actors, local communities, regional to national and international governmental bodies is prerequisite for policies that acknowledge the economic and environmental potential of LNG and prioritize public resources in the implementation of an extensive LNG market that will not only benefit the shipping industry, but also local economic development and energy security. From that perspective, the awareness of LNG for local industry and energy companies is also important. Governmental Authority backed this position by stating that a lot of future public funding schemes depend on the government's energy and transportation strategy. The provision of further public funding is hence also depending on the political developments. In this regard, Governmental Authority mentioned a lot of potential can be unfolded if stakeholders influenced policy makers and clarified and stress their interests. Raising general awareness on LNG by regularly informing all stakeholders and stressing the economic and environmental benefits of LNG would support the LNG market as it can result in more interest from new customers and market actors and eventually also result in further public funding incentives.

4.7 Current Development Status of LNG

The results on the current development status of LNG bunkering facilities are mainly based on the analysis of the port screening. The data gathered from the questionnaire and interviews was further added by information collected from the interviews. The LNG market is relatively overseeable so far and every stakeholder has knowledge on his own involved project as well as other projects. This information could further be added to the assessment of the development status. The contacted ports included the 21 ports that have been part of the internal project. Table 3 gives a detailed list of the contacted ports and their development status.

TABLE 3 LNG Development Status in the Baltic Sea Region

Port	*Status*	*Comments*
Lulea	No plans	A feasibility study is in progress
Örnsköldsvik	No plans	Small port with low customer demand, focus is on MDO until vessels retrofit
Södertälje	No plans	No plans, waiting for bigger ship demand There is an LNG plant close by in operation at Nynäshamn
Gävle	Planned to be in operation by 2018 30.000 m3 storing capacity 500.000t throughout /yr.	Considered an important terminal will make Gävle the most northerly LNG port Construction will begin in 2015
Kalmar	No plans	Waiting for the market development: more demand from ship owners would be needed Absence of actors at the port who are ready to invest and participate (stakeholders)
Göteborg	In operation by March 2015 Storage capacity in tiers to up to 30.000m³	Build in two phases, first phase only for ships, second phase also to supply national gas grid with regasification Most important LNG terminal in Sweden, project is a pioneer for the whole region
Brofjorden	Pilot bunker LNG supply project	Refinery close by in Lysekil Pilot project funded by TENT-T (23,1 million)
Stenungsund	No plans	
Norrköping	No plans	Has been discussed in management but no conclusion yet. No gas companies showed any initiative
Karlshamn	No plans	
Helsingborg	Planned 430 m³ storage capacity 18.500 m³ annual throughput	Located in an intense logistic traffic area Are now looking for a bunker partner
Stockholm	Planned Storage capacity unknown	Several permits and risk analyses have been concluded Bunker vessel in operation from Nynäshamn, another one is planned
Visby	No plans	The region is investigating the possibility of building a fuel platform to also be able to feed the energy grid
Kemi	No plans	Small port, LNG storage facilities are in discussion The LNG plant in Tornio

Oulu	No plans	Might become an issue in the future, if demand from ship owners is there
Kokkola	Proposed/Discussed	Local industry is involved in the plan, they push for it as it seems
Vaasa	Proposed/ Discussed	Lot of instances interested, many things currently happening and being discussed
Pori	In operation by 2016 30.000 m³ capacity	Is supposed to supply the west coast from Hanko to Kokkola; also includes energy supply for local industrial park
Naantali	No plans	Internal discussions are on going
Porvoo/Inkoo	Proposed/Discussed	Terminal is considered to be built either in Inkoo or Porvoo
Hamina	Planned In operation by 2018 25000 30.000 m³ storage capacity	Main driver is energy security (Hamina gets natural gas from Russia)
Turku	Planned In operation by 2017 7400 m³ storage capacity	
Helsinki	Proposed/Dicussed	No storage tank, but Truck-to-ship or feeder vessel is considered
Rauma	Planned to be in operation by 2016 Storage capacity 10.000 m³ capacity	Project had to be moved from Pori due to insufficient jetty infrastructure

Out of the 24 assessed ports, eleven had no plans for LNG yet, nine had LNG project planned (five in Sweden, four in Finland) and four were still in the decision making progress.

Of the ports with LNG plans, environmental performance, the port's competitiveness and demand from ship owners was mentioned as main drivers to provide LNG at the port. These findings are similar to the results of the interviews. Port Authority 1, Project Developer 1 and Municipality also mentioned those three factors as key incentives. All of the planned projects will be in operation by 2018 the latest, some already in 2016. In FIGURE 6, the allocation of the ports can be seen. The map demonstrates nicely how LNG terminals are so far centered around key strategic regions for shipping routes such as the Gothenburg area or at locations where there is no gas grid close by as is the case for Gävle on the East coast of Sweden or basically every port in Finland. The ports that are still internally discussing to take action might in the future do so. At the time of the data collection, the final decision has not been made; therefore the ports usually refrained from giving an insight on their drivers or concerns. The projects with no LNG projects usually stated the one or two main reasons for their status (TABLE 4). Two ports mentioned that there is a port close by that has already an LNG project in preparation. As a result, the attractiveness to also build a bunkering facility at this port is rather low. LNG

ships could take the fuel from the port close by. In this perspective, although the port does not have LNG available itself and loses some competitiveness to the nearby port with an LNG project, it might still benefit from the LNG availability in some way. The ports did not mention that the proximity to a port with LNG is an impediment for their own plans, but rather stressed that this circumstance is also of benefit to them. Two ports are currently assessing feasibility studies that check the possibility for an LNG project. The biggest reason why ports were hesitant to take any further action was that the development of the shipping industry was uncertain. Three ports answered that they wait until they see how ship owners react and how their demand develops. The absence of a gas supplier who will invest and operate a bunkering facility has been mentioned as the main problem by two ports. This result is in line with the previous finding that ports are not the most powerful decision makers when it comes to LNG projects, but gas suppliers who possess the technical and financial resources. Interestingly, one port mentioned that the local industry has raised interest to have LNG available. This circumstance constitutes a huge potential for a project, as inland demand is often crucial for the creation of a project.

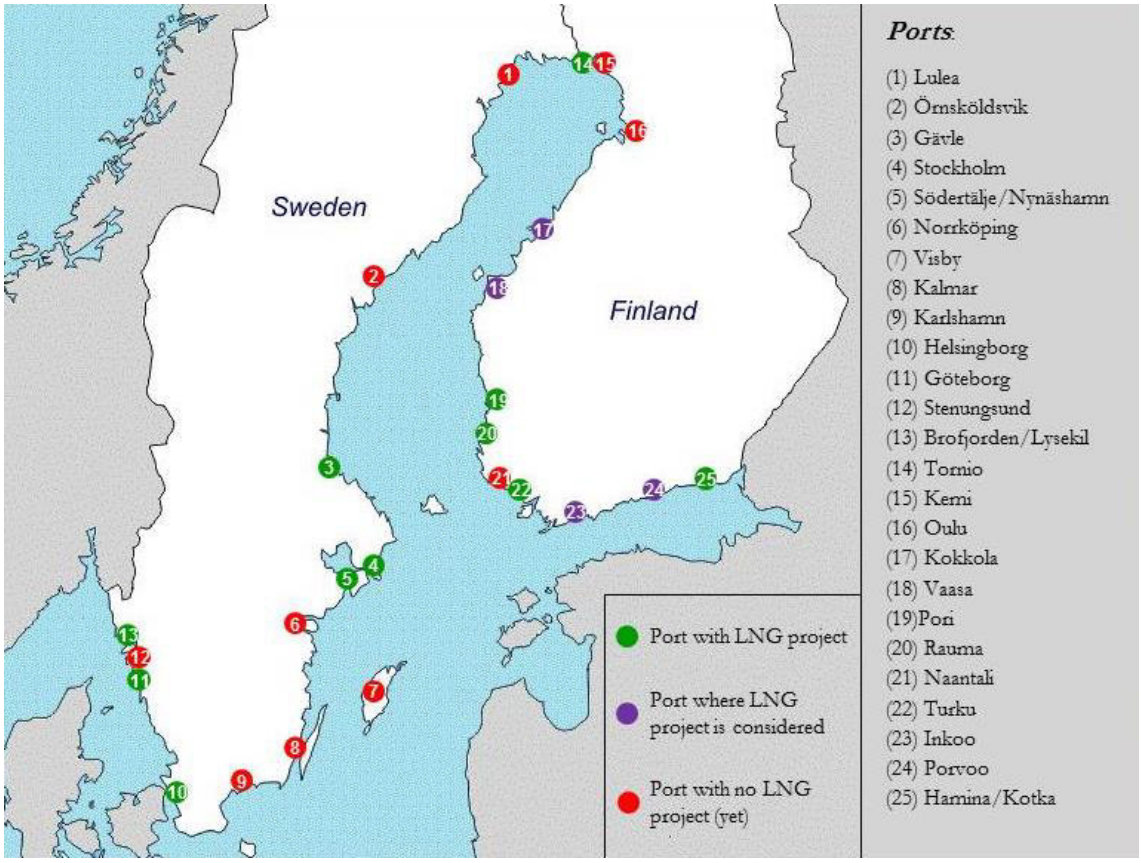

FIGURE 6 Map of LNG Development Status

TABLE 4 Aspects of LNG Absence

Aspect	*Frequency*
Use LNG from terminal close by	2
Waiting for bigger ship demand	3
Waiting for project developer	2
Inland demand is present	1
Feasibility study has been made	2
Has been discussed internally	3

4.8 Summary of Results

All interviewees, whether via questionnaire, phone calls or individual in-depth interviews agree that stakeholder participation is of exceptional importance for the successful creation of an LNG infrastructure. Furthermore, every stakeholder more or less acknowledges the potential and economic benefit of LNG compared to alternative fuels. This was especially the case for the ship owner and the gas suppliers who are additionally most interested and invested in LNG. Although a variety of stakeholders have been questioned, no clear conflicts between the interests of certain stakeholder groups have been identified which further militates for the potential of LNG.

Considering the themes that have been coded and examined in the data analysis, it has been shown that the different aspects and challenges concerning the implementation of LNG are often interrelated and should be addressed not from a single perspective, but with the general aim of improving the development process. The economic viability for example of a ship owner to invest in LNG is influenced by public funding programs or the LNG supply and its price. In turn, public funding programs are not only depending on the priorities of governmental authorities, but also on the development of the economic viability of LNG as a ship fuel in general. Public funding programs only make sense if they can actually promote the introduction of LNG. This in turn is affected by the development of the economic efficiency and viability of LNG shipping.

The coded themes of this chapter are nevertheless suitable to describe and examine the various challenges concerning LNG. It has been found that stakeholder involvement is highly important and communication is relatively well, especially among key stakeholders. While the regulatory framework has been an issue in the past, the general opinion of the interviewees is that it will not be an issue in the future. The supply of LNG is secure, no stakeholder identified LNG supply as a key inhibitor. Ensuring sufficient supply for the upcoming LNG market has also been mostly the agenda of public funding programs that have had an important role in the creation of LNG bunker terminals by financially supporting project developers. The biggest impediment of all aspects is clearly the low oil price that slows down the whole process and poses uncertainties for all investing stakeholders. The low oil price decreases the economic attractiveness of LNG ships, especially ship owners are currently hesitant to invest in projects. Considering the supply of LNG, it remains unclear whether gas suppliers and project developers also hesitate with investments. As has been shown, their main driver for LNG projects is the demand from local economies whose demand for LNG as energy source is not directly competing with oil, as oil is usually not used to feed the local energy grid, for example. The low oil price and its resulting slower development of LNG projects can also be expected to negatively influence the awareness for LNG. As long as oil is available relatively pricely, the need to find and switch to alternatives is rather low.

The port screening has shown that many ports have plans for LNG and ports without specific plans are still aware of LNG and might consider projects in the future. An extensive LNG infrastructure requires the presence of LNG projects in most or even all relevant ports. The decision for a port to switch to LNG is however highly depending on a gas supplier who carries out the project. This decision is in turn influenced by the various aspects around implementing LNG. When LNG shipping is economically efficient and public actors and local industries also see and support the potential of LNG, projects are more likely to be planned.

The results have shown that all relevant stakeholders have an interest and can benefit from LNG. The general opinion is also that stakeholders are very important in the development process. However, local industries and cargo owners have been identified as stakeholders that are relatively neglected so far. This circumstance should also be considered when examining the challenges of implementing LNG. Cargo owners for example have a huge influence on the economic viability of ship owners to switch to LNG. Local industries on the other hand can contribute to the LNG supply by communicating with ports and gas suppliers and creating a demand for LNG.

5 DISCUSSION

The literature review on LNG as ship fuel presented the key issues around the creation of an LNG infrastructure. LNG is just one solution for ship owners to comply with the low sulphur emission regulations and thus has to compete with the other alternatives. In this regard, several key challenges have been identified that influence the development process. The results have shown that some of these challenges are meanwhile more of an issue than a couple of years ago.

The absence of clear regulation has been identified as an issue in the past that however does not influence the further development that much anymore. Other studies also evaluate the absence of clear legal guidelines on the bunkering operations as negative, but do not really consider them as major challenges either (Wang & Notteboom 2013; PWC 2013).

The results indicated that low public awareness is low and hindering the development of a project. The low public perception is further connected to local political actors who are thus less inclined to take action. The results are in line with what several previous studies suggested. One study claims that the local political context is very important, especially in the early stages of a project (Acciaro & Gritsenko 2014). Low public perception along with rather underdeveloped public incentives have also been identified by Wang and Notteboom in 2013 (Wang & Notteboom 2014). Especially the role of local governments seems to be in need of improvement. A better public reputation among public actors and policy makers would hence certainly benefit the LNG market.

The drop in oil price in 2014 has also been identified as a main threat for LNG. There are no studies yet examining the oil price's influence on the shipping industry's behavior considering the emission regulation compliance, but the results from this research indicate that the development of LNG is significantly slowed down. On the other hand, the low oil prices made sure that the increased prices for shipping do not lead to a shift of transport to road or rail, as several studies predicted (Holmgren et al. 2014; Kehoe 2010)

The supply chain of LNG seems not to be a main issue. LNG is abundantly available in the Baltic Sea region and the main challenge is therefore to actually invest and build the terminals to increase the capacity. This fact has also been presented by previous research (Sonmez et al. 2013) The results have also shown that the demand from ship owners will be relatively low, especially in the early stages. Most bunkering will probably occur via bunker vessels that are allow for more flexible bunkering logistics. This way, not all ports necessarily have to build their own LNG bunkering facility but can engage in plans on how to offer refueling by bunker vessel or truck-to-ship. A study initiated by the EU has been completed just at the beginning of the year that also points out the benefits of LNG, yet also mentions some challenges of its successful implementation and further advocates the promotion of LNG projects in order to achieve an LNG core network by 2025 (EU 2015).

The port screening found that 55% of examined ports have started to discuss and plan LNG projects. This number coincides with the results of a port survey Lloyd's Register in 2014 that concluded that 59% of ports have specific plans for an LNG infrastructure (Lloyd's Register 2014). Furthermore, it was found in the port screening that the ports without LNG projects often mentioned that demand from ship owners was one important factor in the decision to take action, as well as the need to have a gas supplier present who is willing to invest. This is in line with a port survey of 2012 that showed that demand from ship owners and suppliers was the biggest driver for ports to become active (Aagesen et al. 2012). This circumstance leads to the conclusion that ship owners and gas suppliers have significant influence in ports' decisions to initiate a project. The relationship between gas suppliers, ship owners and port authorities is hence very complex. While port authorities need the demand from ship owners and gas suppliers to be assured that an LNG project is demanded, they are not the most influential stakeholder in actually making the decision, but the gas suppliers usually play the more powerful role.

Some studies see the port authorities in need to play a proactive role in promoting and encouraging the use of LNG. While the reasons for port authorities to push for LNG are certainly viable, such as the environmental and economic performance in regard to the port's connection to public actors (Wang & Notteboom 2013; Adams et al. 2009), their actual power to drive and initiate an LNG project is dependent on other actors, such as gas suppliers, local industry and ship owners. The results show that ship owners are very active in contacting ports, while gas suppliers are in general also aware and interested. The port authorities therefore do not have to excessively approach these stakeholders anymore. Their focus should be on pushing their local surrounding on supporting and promoting LNG projects by proactively communicating with the local governments, local businesses and the public.

5.1 Stakeholder Involvement

Whether an LNG project is planned depends not only on the various challenges of LNG development, but the actual role and involvement of stakeholders in this process. The study's aim was to examine how stakeholders are involved in creating an LNG infrastructure. The results have shown that stakeholders are influenced in every aspect of creating an LNG infrastructure, with certain stakeholders having more or less influence on each different aspect. In order to get the LNG market developed as quickly and effectively as possible, all relevant stakeholders need to work together. This theory has also been proclaimed by other studies on LNG development (Semolinos et al. 2013; Yun et al. 2014; Work & Lng 2013; Licari & Weimer 2011). While all of these studies mention ship owners, port authorities, gas suppliers, policy makers, authorities and occasionally public actors or local industries as stakeholders, they overall neglect the role of cargo owners and the local industry on LNG development. No study clearly takes into account how these actors can influence the development of LNG. This could be explained by the fact that none of these studies look at the creation of an LNG infrastructure specifically from stakeholder theory perspective. Appropriate methods to correctly identify stakeholders have been presented in chapter 2.2.2. Mitchell and Wood created a critically acclaimed model to identify and classify stakeholders based on their possession of *power*, *legitimacy* and *urgency.* In the case of an LNG infrastructure it is however difficult to clearly assign each group to the possession of the three attributes. The stakeholder environment in LNG development is very complex which makes it difficult to give a clear understanding by using this model. Ports for example certainly do possess power. They can decide to engage in planning a project and can influence other stakeholders. On the other hand, as has been shown, ports also tend to be less powerful in comparison to gas suppliers. The different degree of one attribute between different stakeholders is not the only issue, but also different degrees of one attribute might be possible internally within one stakeholder group. The difficulty to depict the stakeholders in Mitchell and Wood's diagram can be explained by the *polycentricity* of port environments (Gritsenko 2014) and the rather normative perspective on stakeholder theory of this research that does not look at stakeholders from an organization's but from a more holistic perspective (Donaldson et al. 1995; Friedman & Miles 2006). Nevertheless, using Mitchell's model, it can be found that port authorities, gas suppliers and ship owners are all *definite stakeholders* as they all possess certain amounts of *power*, *legitimacy* and *urgency*. The model is also suitable to assess the role of the cargo owners and local industries. Both stakeholders have *power* to exert their interest. Cargo owners can push ship owners in their decision to go for LNG and local industries' demand for LNG available at the port can drive project developers to become active. Furthermore, they both have the *legitimacy* to state their claim, as they act according to their morally justified business interest (Suchman, 1995). However, cargo owners and local industries do not have the *urgency* and willingness to

use their influence. For them, the issue of having an LNG network for ships is not a priority, hence the interest to really get involved is relatively low. According to Mitchell's model, they are classified as *dominant stakeholders*.

A more appropriate way to showcase how stakeholders are involved in LNG and what level of salience they actually have is to map the stakeholders in Bryson's Power-Interest grid that was also described in chapter 2.2.2. Accordingly, the identified stakeholders were mapped based on their level of interest and power in the LNG development (FIGURE 8). The evaluation was made using the results from the interviews and the port screening.

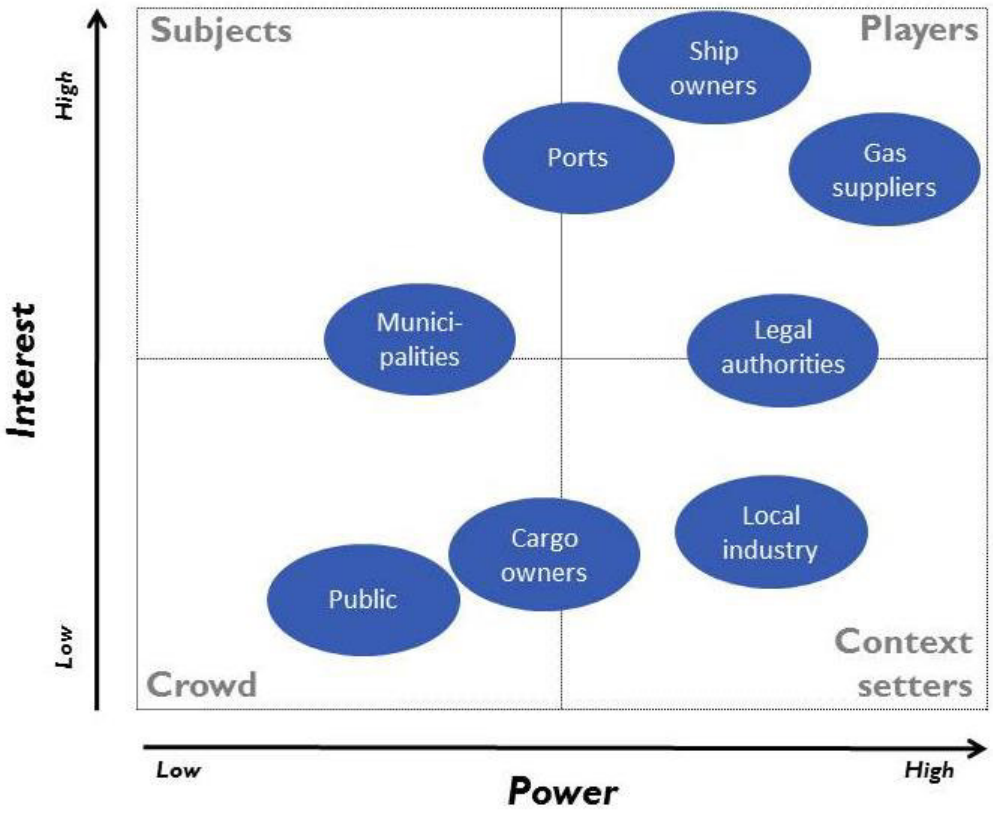

FIGURE 7 Power-Interest Ratio of Involved Stakeholders

Ship owners have the highest amount of interest. This makes sense, considering they are the ones who are mostly affected by the new emission regulations and hence forced to act. Gas suppliers however possess more power as the ship owners. While ship owners can exert influence on decision makers and stress their interests, nothing would happen without gas suppliers actually investing in and implementing a project. The next most important stakeholder involved are ports in the form of port authorities. Their interest in LNG is also very high as has been shown. However, their level of influence is ultimately lower than

that of gas suppliers or even ship owners. It should also be mentioned that it depends of course from port to port. Some ports clearly have more power than others. This is also been the case between Port Authority 1 and Port Authority 2 who both had significant different levels of influence on their stakeholders. Legal authorities have a lot of power in terms of making guidelines, monitoring and directing the LNG development and also issuing public funding. Their interest on the other hand has to be regarded a bit more cautiously. While they naturally show interest in how the development goes and direct the further projects with strategies for incentives, it also is not at a level that is ultimately driving the creation of an infrastructure. The awareness of local governments and authorities for example is not that high as has been found out in the interviews. Therefore, municipalities were allocated on the same level of interest. Obviously they have concerns about the economic and environmental impact of LNG available locally, but the interest is not that overwhelming in the end. No further actions are usually taken to inform other stakeholders of the benefits of LNG and hence the full potential of LNG remains unrevealed. As mentioned before, local industries are the most neglected stakeholder because their interest is relatively low. The results show however that they have a lot of power with several interviewees highlighting their role in LNG development. Similar justification applies to cargo owners who have also been named several times as considerable stakeholders. Their power on ship owners' decision to switch to LNG is so far unexplored. However, their interest in the whole issue is in general also relatively low. Being concerned mainly about reliable cheap transportation of their products, their willingness to promote LNG is not their first priority. Lastly, the public was also considered a stakeholder worth adding to the model. Both interest and power of the public are relatively low, higher public awareness of LNG on the other hand would be of benefit for the creation of an LNG infrastructure as a whole.

The model gives a clear overview of the stakeholders involved in LNG development. The absence of cargo owners and local industries in previous studies indicates that future research should consider including these stakeholder groups when assessing the market development of LNG.

5.2 Overcoming the Investment Dilemma

The classic problem of developing an LNG infrastructure for the shipping industry is the investment dilemma of who invests first, the ship owners from the demand side, or the project developer from the supply side. This phenomenon is acknowledged throughout almost every research paper on LNG development and commonly referred to as the Chicken-Egg dilemma (Wold 2014; Semolinos et al. 2013; Acciaro & Gritsenko 2014; Danish Maritime Authority 2012a; Adamchak 2013; Wang & Notteboom 2013). While this study has shown that the investment dilemma is still a prevailing obstacle for LNG development, some aspects have been revealed that might help to overcome this stalemate situation. For instance, the actual demand from ship owners for

LNG is very low compared to the volumes of LNG that will serve the local energy or business demand. The results show that an LNG project is not profitable if only targeted at the demand from LNG vessels. Participation of the local industry and/or the energy sector is indispensable in order to initiate an LNG project. The debate about the investment dilemma should hence be shifted away from the opposed perspectives of "project developer vs. ship owner". An LNG terminal is not a facility that is restricted to the shipping industry. This misunderstanding leads to the limited perception that an LNG terminal only serves the customers from the shipping industry, neglecting the potential for local economy demand (Semolinos et al. 2013; Adamchak 2013). A better inclusion of and focus on the local industries can help overcome the supply side of the investment dilemma. The LNG plant constructed in Tornio is a perfect example of this. It has been created regardless of any demand from ship owners.

From the demand side, another factor seems to be neglected in research. Ship owners have basically three alternatives to comply with the new emission regulations as FIGURE 3 illustrates. From this perspective, it appears that ship owners make their ship fuel decision only based on the evaluation of the various alternatives. It is not considered how the ship owners' stakeholders can influence this decision. In this regard, the customers of ship owners, the cargo owners have a considerable, yet so far unexplored potential to urge the ship owner to choose LNG. The cargo owners buy the transportation from the ship owner and are hence mostly concerned about reliable and cheap services. If the cargo owners however acknowledge the positive impacts of LNG in terms of environmental improvement and long-term economic efficiency for their products' supply chain, they could push ship owners to switch to LNG by increasingly demanding this type of transport. The main challenge thereby is that cargo owners would actually have to be willing to improve their supply chain, even if this could result in eventual higher costs for transportation, but these issues are part of green supply chain management which exceeds the scope of this paper (see for example Beamon, 1999; Lo, 2014; Srivastava, 2007). Concluding, it can be stated that cargo owners should be considered as more relevant than they have been so far by other studies. One way to increase the cargo owners' interest in LNG shipping is in turn related again with higher public awareness and an improved reputation of LNG. FIGURE 9 shows an adopted version of Adamchak's Chicken-and-Egg model, including cargo owners and local industry.

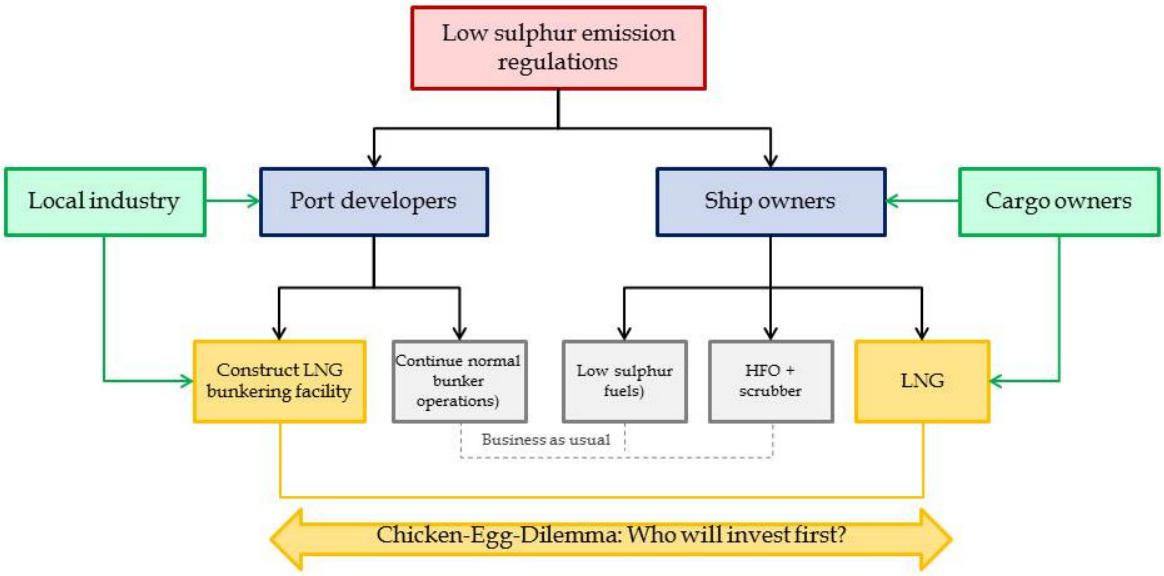

FIGURE 8 Solution of the Investment Dilemma

6 CONCLUSION

The shipping industry is undergoing significant changes. The issue of LNG is a relatively new phenomenon with recently high awareness in science and real life. A lot of articles have been published and practical implications been made in the past years and it can be assumed that the LNG market is going to increase substantially in the near future. There seems to be a shift in the perspective of LNG. While early research focused on considerations *if* LNG can become a viable environmental innovation for the shipping industry, the question meanwhile is *how big* the whole LNG market and its impact are going to be. The results of the port screening show that a remarkable number of ports will have LNG available in the future and that ports are aware of the potential of LNG and consider projects in the future. The successful implementation of an extensive and well-functioning LNG network nevertheless requires further measures to facilitate the creation of these LNG projects.

The proactive cooperation between all involved actors plays a crucial role in the development process. This idea has been found by a lot of previous research and the results of this study also highlight the importance of stakeholders in the process.

New insights could be made by looking at LNG development from a stakeholder theory perspective. Local industries and cargo owners have considerable influence in the development. Most stakeholders saw great room for improvement of the process by including these two actors more thoroughly. The role of local industries and cargo owners is also neglected by science so far. The analysis of the different challenges of LNG has shown that the development of the oil price is a major factor that currently slows down the transition of ships to LNG. The current low prices make it less profitable for stakeholders to proactively promote LNG. Competing alternatives to meet the emission regulations become more attractive with cheaper oil prices. In this regard, it is also important how policy makers will handle the LNG as ship fuel issue. The successful implementation of LNG-fuelled shipping requires well elaborated strategies from international to regional levels of legal authorities. Public funding programs are their major tool to support the LNG development and their provision should be aligned in future LNG strategies and programs.

From this perspective, the role of LNG awareness has to be considered as well. Currently, LNG is barely perceived in a public context. A better awareness of the environmental and economic potential of LNG, especially among local industries and local policy makers could trigger better coordination of LNG projects.

While this research pointed out the environmental and economic benefits of LNG as a ship fuel compared to oil-based fuel solutions, some considerations have to be taken into account from an environmental perspective. It has been argued that the awareness of LNG and its potential should be promoted in a public and governmental context. In this regard, it should be acknowledged that policy makers decide on what energy sources to promote based on similar considerations that relate to LNG as ship fuel, which is in the first place environmental benefits, but also economic efficiency considerations. On a public policy level, LNG is however not only competing against oil products, but also other energy sources, namely renewables such as wind energy, solar energy and biogas, for example. After all, LNG is a fossil fuel with a more negative environmental impact than other energy sources. These aspects could be considered by policy makers and hence from an environmental perspective argue against the promotion of LNG. It is therefore challenging to define which energy sources should be promoted in order to achieve environmental improvement for the shipping industry, but also as a whole.

6.1 Contributions

Using stakeholder theory as the theoretical perspective to answer the research question proved to be an excellent choice. All major ideas of the theory could be retrieved and applied to the topic of LNG. The theoretical tools to identify and classify stakeholders not only enabled an overview of the most important stakeholders involved, but also revealed what other relevant stakeholders have not received that much attention yet. The identification and classification of stakeholders is furthermore in line with the aspects and challenges of LNG development. The approach therefore leads to theoretical as well as practical contributions. The results of this research provide an interesting new angle on research on LNG as ship fuel. The specific perspective of stakeholders is new on the issue and can hence contribute to the current state of the art. The research might also be of interest for other studies on port projects as these show similar complex environments with many different stakeholders involved.

This paper is supporting a joint industry project co-funded by the EU. It will therefore also be presented to decision makers on an EU level. The results are a valuable contribution to their analysis on the current development status of LNG projects in the Baltic Sea region and the stakeholder dynamics of the LNG issue as a whole. This research can support the alignment of future strategies and studies on LNG. As this research focused on the Baltic Sea region, Sweden and Finland in particular, the findings of this paper can be also be considered for the analyses of other regions.

6.2 Limitations and Future Research

The port screening focused on all ports that are involved in the joint industry project and several other, strategically important ports. However, not every port in Finland and Sweden is covered in this analysis. The results give an interesting insight to the current state of the art, indeed, however it cannot give a full reliable evaluation of which ports actually have LNG plans. While it is unlikely that other smaller ports have some plans, that have gone unnoticed in the literature review and data collection phase, it should still be acknowledged at this point.

The main findings were collected by conducting individual interviews with subjectively defined stakeholder groups. Even though the selection of stakeholders was made based on commonly approved stakeholder identification tools and previous literature on LNG, it is not possible to fully confirm that the identification and classification is not missing out a certain stakeholder group. An additional limitation of the individual interviews is its reliance on the individual perceptions of each stakeholder. It was considered that every interviewed stakeholder is a representative of its respective stakeholder group. However, one interviewed stakeholder might have differing opinions than the general stakeholder perspective. The analysis focused on the Baltic Sea region, especially Finland and Sweden. It is hence not possible to make fully reliable interpretations about other geographic regions.

Since the specific focus on stakeholders offers an interesting and promising perspective, but is a novelty in LNG project literature, future research could redefine their perception of stakeholders in the development process and future studies could focus more on the considerations and implications of involved stakeholders. By revealing that certain stakeholders have been neglected by previous research on LNG development, future research could be directed at more in-depth analyses on those stakeholders. Studies on how local industries are affected by the new shipping emission regulations could for example provide interesting insights on how the planning of LNG projects could be improved. Other research could be addressed at the relations between ship owners and cargo owners and their corresponding influence on the LNG processes, taking into account for example the cargo owners' supply chain management. Other research could be concerned with the promotion of LNG as energy source in general and how its public role impacts the creation of an LNG infrastructure.

7 REFERENCES

Aagesen, J. et al., 2012. Lloyd ' s Register LNG Bunkering Infrastructure Study. , (February), pp.1–10.

Acciaro, M. & Gritsenko, D., 2014. Energy innovation in ports: the role of local contexts in LNG bunkering terminal development. In *IAME 2014 Conference Norfolk*.

Adamchak, F., 2013. LNG AS MARINE FUEL. Poten & Partners, pp.1–10. Available at: http://www.gastechnology.org/Training/Documents/LNG17-proceedings/7-1-Frederick_Adamchak.pdf.

Adams, M. et al., 2009. Environmental issues in port competitiveness. Dalhousie University, Centre for International Trade and Transportation, p.21. Available at: http://www.researchgate.net/publication/228410996_Environmental_Issues_in_Port_Competitiveness/file/72e7e51c0ccd28f143.pdf.

Agle, B.R., Mitchell, R.K. & Sonnenfeld, J.A., 1999. Who matters to CEOs? An investigation of stakeholder attributes and salience, corporate performance, and CEO values. Academy of Management Journal, 42, pp.507–525.

Aligica, P.D. & Tarko, V., 2012. Polycentricity: From Polanyi to Ostrom, and Beyond. Governance, 25, pp.237–262.

Aneziris, O.N. et al., 2014. Integrated risk assessment for LNG terminals. Journal of Loss Prevention in the Process Industries, 28, pp.23–35. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0950423013001526 [Accessed August 7, 2014].

Arduino, G. et al., 2013. How to turn an innovative concept into a success? An application to seaport-related innovation. Research in Transportation Economics, 42(1), pp.97–107. Available at: http://dx.doi.org/10.1016/j.retrec.2012.11.002.

Bahari, S.F., 2010. Qualitative Versus Quantitative Research Strategies: Contrasting Epistemological and Ontological Assumptions. Jurnal Teknologi, pp.17–28.

Baker, M.J., 2003. Data Collection -- Questionnaire Design. Marketing Review, 3, pp.343–370. Available at: http://ezproxy.library.nyu.edu:9454/ContentServer.asp?T=P&P=AN&K=11013140&S=R&D=bth&EbscoContent=dGJyMMvl7ESeprQ4xNvgOLCmr0qep65Ssqq4S66WxWXS&ContentCustomer=dGJyMPGutlCyqbVOuePfgeyx44Dt6fIA\nhttp://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=11.

Baumgart M., Olsen, J.; 2010. LNG-fuelled Vessels in the Norway Short-Sea Market; A Cost-Effective Response to Environmental Regulation (Published Master Thesis). University of Bergen. Norway

Barriball, K.L. & While, a, 1994. Collecting data using a semi-structured interview: a discussion paper. Journal of advanced nursing, 19(Williamson 1981), pp.328–335.

Beamon, B.M., 1999. Designing the green supply chain. Logistics Information Management, 12(4), pp.332–342.

Bengtsson, S., Andersson, K. & Fridell, E., 2011. Life cycle assessment of marine fuels - A comparative study of four fossil fuels for marine propulsion. , (11), p.183. Available at: http://www.dma.dk/themes/LNGinfrastructureproject/Documents/Fuels and environment/LCA of four possible marine fuels.pdf.

Bernatik, a., Senovsky, P. & Pitt, M., 2011. LNG as a potential alternative fuel – Safety and security of storage facilities. Journal of Loss Prevention in the Process

Industries, 24(1), pp.19–24. Available at: http://linkinghub.elsevier.com /retrieve/pii/S0950423010001014 [Accessed August 7, 2014].

Blasco, J. et al., 2014. Towards an integrated environmental risk assessment of emissions from ships' propulsion systems. Environment International, 66, pp.44–47.

Bowling, A., 2005. Mode of questionnaire administration can have serious effects on data quality. Journal of Public Health, 27, pp.281–291.

Boyatzis, R., 1998. Transforming qualitative information: Thematic analysis and code development. Thousand Oaks, CA: Sage.

Braun, V., Clark, V., 2006. Using thematic analysis in psychology. Qualitative Research in Psychology 3 (2): 83.

Bryman, A., 2006. Paradigm Peace and the Implications for Quality. International Journal of Social Research Methodology, 9, pp.111–126.

Bryman, A., 1988. Quantity and Quality in Social Research, Available at: http://books.google.nl/books?id=7pyt0yqQAcQC.

Bryson, J.M., 2004. What to do when Stakeholders matter. Public Management Review, 6(1), pp.21–53. Available at: http://www.tandfonline.com/doi/abs/10.1080/14719030410001675722 [Accessed August 9, 2014].

Burel, F., Taccani, R. & Zuliani, N., 2013. Improving sustainability of maritime transport through utilization of Liquefied Natural Gas (LNG) for propulsion. Energy, 57(December 2005), pp.412–420. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0360544213003861 [Accessed August 4, 2014].

Burke, L.A. & Miller, M.K., 2001. Phone Interviewing as a Means of Data Collection: Lessons Learned and Practical Recommendations. Forum Qualitative Sozialforschung/Forum: Qualitative Social Research, 2.

Campion, M., Palmer, D. & Campion, J., 1997. A Review of Structure in the Selection Interview.pdf. Personnel Psychology, 50, pp.655 – 702.

Cassell, C. et al., 2006. The role and status of qualitative methods in management research: an empirical account. Management Decision, 44(2), pp.290–303. Available at: http://hdl.handle.net/2173/3665.

Cleaver, P., Johnson, M. & Ho, B., 2007. A summary of some experimental data on LNG safety. Journal of Hazardous Materials, 140, pp.429–438.

Cohen, D. & Crabtree, B., 2006. The Interpretivist Paradigm. Qualitative Research Guidelines Project. Available at: http://www.qualres.org/HomeInte-3516.html.

Corbett, J.J. et al., 2007. Mortality from ship emissions: A global assessment. Environmental Science and Technology, 41, pp.8512–8518.

Crowe, S. et al., 2011. The case study approach. BMC medical research methodology, 11, p.100.

Daly, J., Kellehear, A., Gliksman, M., 1997. The public health researcher: A methodological approach. Melbourne, Australia: Oxford University Press. 611–618.

Danish Maritime Authority, 2012a. Full Report North European LNG Infrastructure Project.

Danish Maritime Authority, 2012b. TEN-T Motorways of the Sea The North Europe LNG Infrastructure Project - Finalizing Conference Copenhagen 14 June 2012, Available at: http://www.dma.dk/themes/LNGinfrastructureproject/Documents/Presentations Finalizing Conference 14 June 2012/Mogens Bech The LNG Infrastructure Project.pdf.

De Langen, P.W., 2006. Chapter 20 Stakeholders, Conflicting Interests and Governance in Port Clusters. Research in Transportation Economics, 17(06), pp.457–477. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0739885906170201 [Accessed August 7, 2014].

Denzin, N.K. & Lincoln, Y.S., 2006. Introduction The Discipline and Practice of Qualitative Research. Handbook of Qualitative Research, pp.1–20. Available at: http://www.sagepub.com/upm-data/40425_Chapter1.pdf.

DiCicco-Bloom, B. & Crabtree, B.F., 2006. The qualitative research interview. Medical Education, 40, pp.314–321.

Dickson-Swift, V. et al., 2007. Doing sensitive research: what challenges do qualitative researchers face? Qualitative Research, 7, pp.327–353.

Donaldson, T., Preston, L.E. & Preston, L.E.E.E., 1995. Theory the Stakeholder of the Concepts , Evidence , Corporation : and Implications. Management, 20, pp.65–91. Available at: http://www.jstor.org/stable/258887.

DNV, 2014. DNV GL – PREPARING FOR LOW APPENDIX SULPHUR LIMITS 2015 Guidelines to ensure compliance.

EMSA, 2010. Report_Sulphur_Requirement. European Maritime Safety Agency, (January), pp.1–30. Available at: papers2://publication/uuid/3BC730E5-36EB-4874-B280-C61EEBC09E31.

EU- European Union, 2012. Directive 2012/33/EU of the European Parliament and the Council of 21 November 2012 amending Council Directive 1999/32/EC as Regards the Sulphur Content of Marine Fuels. Official Journal of the European Union

EU – European Union, 2014. Directive 2014/94/EU of the European Parliament and the Council of 22 October 2014 on the deployment of alternative fuels infrastructure. Official Journal of the European Union

EU – European Union, 2015. European Commissions' study on LNG as a shipping fuel shows industry's support, 03.03.2015 in EU Maritime News. Available at: http://ec.europa.eu/transport/modes/maritime/news/2015-03-03-lng_en.htm

Fassin, Y., 2009. The stakeholder model refined. Journal of Business Ethics, 84, pp.113–135.

Flyvbjerg, B., 2006. Five Misunderstandings About Case-Study Research. Qualitative Inquiry, 12, pp.219–245.

Foss, M.M., 2003. LNG SAFETY AND SECURITY, Available at: http://laohamutuk.org/Oil/LNG/Refs/024FossLNGSafetySecurity.pdf\npapers2://publication/uuid/18911941-3C72-418D-AF84-4FE783982684.

Fossey, E. et al., 2002. Understanding and evaluating qualitative research. Australian and New Zealand Journal of Psychiatry, 36, pp.717–732.

Freeman, R.E., 1984. Strategic Management: A Stakeholder Approach, Available at: http://www.mendeley.com/research/strategic-management-a-stakeholder-approach-2/.

Freeman, R.E., Wicks, A.C. & Parmar, B., 2004. Stakeholder Theory and ?The Corporate Objective Revisited? Organization Science, 15, pp.364–369.

Friedman, A.L. & Miles, S., 2006. Stakeholders : Theory and Practice: Theory and Practice, Oxford University Press. Available at: http://books.google.com/books?id=ITD8VWJGOYYC&pgis=1 [Accessed February 8, 2015].

Greenport, 2014. Gothenburg Incentive Encourages Cleaner Fuel. 30.06.2014 in Greenport News. Available at: http://www.greenport.com/news101/lng/gothenburg-incentive-encourage-cleaner-fuel

Gritsenko, D., 2014. ON GOVERNANCE OF QUALITY SHIPPING IN THE BALTIC SEA Exploring Collective Action in Polycentric Contexts,

Gritsenko, D. & Yliskylä-Peuralahti, J., 2013. Governing shipping externalities: Baltic ports in the process of SOx emission reduction. Maritime Studies, 12(1), p.10. Available at: http://www.maritimestudiesjournal.com/content/12/1/10 [Accessed January 13, 2015].

Guba, E.G. & Lincoln, Y.S., 1994. Competing Paradigms in Qualitative Research. Handbook of qualitative research, pp.pp. 105–117.

Gummesson, E., 2003. All research is interpretive! Journal of Business & Industrial Marketing, 18, pp.482–492. Available at: http://www.emeraldinsight.com/10.1108/08858620310492365.

Hall, P. V., O'Brien, T. & Woudsma, C., 2013. Environmental innovation and the role of stakeholder collaboration in West Coast port gateways. Research in Transportation Economics, 42(1), pp.87–96. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0739885912001655 [Accessed July 16, 2014].

Hohl, J., 2000. Das qualitative Interview. Journal of Public Health, 8, pp.142–148.

Holmgren, J. et al., 2014. Modelling modal choice effects of regulation on low-sulphur marine fuels in Northern Europe. Transportation Research Part D: Transport and Environment, 28, pp.62–73.

ISO- International Organization of Standardization. 2015. ISO/TS 18683:2015 Guidelines for systems and installations for supply of LNG as fuel to ships. Available at: http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=63190&commid=49506

IMO, 2009. Second IMO GHG study, 2009. International Maritime Organization (IMO). Available at: http://www.imo.org/ blast/blastDataHelper.asp?data_id=27795.

IMO – International Maritime Organization. 2014. New Code of Safety for Ships using Gases or other Low flashpoint Fuels (IGF Code) agreed in draft form by IMO Sub-Committee. Available at: http://www.imo.org/MediaCentre/PressBriefings/Pages/28-CCC1IGF.aspx

Jalkanen, J.-P. et al., 2009. A modelling system for the exhaust emissions of marine traffic and its application in the Baltic Sea area. Atmospheric Chemistry and Physics Discussions, 9, pp.15339–15373.

Jensen, M.C., 2002. Value Maximization, Stakeholder Theory, and the Corporate Objective Function. Business Ethics Quarterly, 12(01), pp.235–256.

Jones, T.M., 1995. Instrumental Stakeholder Theory: A Synthesis of Ethics and Economics. The Academy of Management Review 20 (2) 404-437.

Jones, T.M., Wicks. A.C., 1999. Convergent Stakeholder Theory. The Academy of Management Review. 24 (2) 206-221.

Kadin, M., 2008. Trends and scenarios exemplifying the future of the Baltic Sea and Skagerrak Trends and scenarios examplifying the future of the Baltic Sea and Skagerrak. Swedish Agency for Marine and Water Management, 46(December 2008).

Kehoe, J., 2010. Deliverables : Task-2 : Impact Study of the Future Requirements of Annex VI of the MARPOL Convention on Short Sea Shipping.

King, N. & Horrocks, C., 2010. Interviews in Qualitative Research, Available at: http://books.google.com/books?id=iOsnITKC48gC&pgis=1.

Knutsen, O., Hassler B., 2011. IMO Legislation and its Implementation: Accident Risk, Vessel Deficiencies and Administrative Practices. Marine Policy 35(2): 201-207

Kumar, S., Kwon, H.T., Choi, K.H., Hyun Cho, J., et al., 2011 (A). Current status and future projections of LNG demand and supplies: A global prospective. Energy

Policy, 39(7), pp.4097–4104. Available at: http://dx.doi.org/10.1016/j.enpol.2011.03.067.

Kumar, S., Kwon, H.T., Choi, K.H., Lim, W., et al., 2011 (B). LNG: An eco-friendly cryogenic fuel for sustainable development. Applied Energy, 88(12), pp.4264–4273. Available at: http://dx.doi.org/10.1016/j.apenergy.2011.06.035.

Lai, K.H. et al., 2011. Green shipping practices in the shipping industry: Conceptualization, adoption, and implications. Resources, Conservation and Recycling, 55(6), pp.631–638.

Laugen, L., 2013. An Environmental Life Cycle Assessment of LNG and HFO as Marine Fuels. Trondheim. Norwegian University of Science and Technology, (June). Available at: http://www.diva-portal.org/smash/get/diva2:648752/FULLTEXT01.pdf.

Lemper, P.D.B., 2010. Reducing the sulphur content of shipping fuels further to 0.1 % in the North Sea and Baltic Sea in 2015: Consequences for shipping in this shipping area. , (September 2010). Available at: www.isl.org.

Lewis, J. & Ritchie, J., 2003. Qualitative Research Practice - A Guide for Students, London, Sage Publications. London.

Licari, F. a. & Weimer, C.D., 2011. Risk-based siting considerations for LNG terminals – Comparative perspectives of United States & Europe. Journal of Loss Prevention in the Process Industries, 24(6), pp.736–752. Available at: http://linkinghub.elsevier.com/retrieve/pii/S0950423011000532 [Accessed August 7, 2014].

Lindfors, J., 2014. Future Strategic Freight Transport Nodes in the Bothnian Corridor. Bothnian Green Logistics Corridor.

Lindstad, H., Asbjørnslett, B.E. & Jullumstrø, E., 2013. Assessment of profit, cost and emissions by varying speed as a function of sea conditions and freight market. Transportation Research Part D: Transport and Environment, 19, pp.5–12.

Lloyd's Register, 2014. Lloyd's Register LNG Bunkering Infrastructure Survey 2014. Lloyd's Register. Available at: http://www.lr.org/en/_images/12-9203_Lloyd_s_Register_LNG_Bunkering_Infrastructure_Survey_2014.pdf.

Lo, S.M., 2014. Effects of supply chain position on the motivation and practices of firms going green. International Journal of Operations & Production Management, 34(1), pp.93–114. Available at: http://www.emeraldinsight.com/10.1108/IJOPM-04-2012-0133.

Mahoney, J. & Goerts, G., 2006. A tale of two cultures: Contrasting quantitative and qualitative research. Political Analysis, 14, pp.227–249.

Mainardes, E.W., Alves, H. & Raposo, M., 2011. Stakeholder theory: issues to resolve. Management Decision, 49, pp.226–252.

MANGA LNG. 2014. Tornio LNG –project development company established. Available at: http://www.torniomangalng.fi/en/tornio-lng-hankkeen-kehitysyhtio-perustettu/

Mansourian, Y., 2008. Exploratory nature of, and uncertainty tolerance in, qualitative research. New Library World, 109, pp.273–286.

MARPOL 73/78 Annex VI, 2005. Marpol 73/78 Annex VI.

Marsden, G. & Rye, T., 2010. Universities of Leeds , Sheffield and York. , 18.

Marshall, G., 2005. The purpose, design and administration of a questionnaire for data collection. Radiography, 11, pp.131–136.

Matthias, V. et al., 2010. The contribution of ship emissions to air pollution in the North Sea regions. Environmental Pollution, 158, pp.2241–2250.

Maxwell, D. & Zhu, Z., 2011. Natural gas prices, LNG transport costs, and the dynamics of LNG imports. Energy Economics, 33(2), pp.217–226.

McNamara, C., 2009. General Guidelines for Conducting Research Interviews. General guidelines for conducting interviews. Available at: http://managementhelp.org/businessresearch/interviews.htm.

Michell, J., 2003. Pragmatism, Positivism and the Quantitative Imperative. Theory & Psychology, 13, pp.45–52.

Mills, J., Bonner, A. & Francis, K., 2006. The Development of Constructivist Grounded Theory. International Journal of Qualitative Methods, 5, pp.25–35.

Ministry, T.H.E. & Transport, O.F., 2009. Sulphur Content in Ships Bunker Fuel in 2015 A Study on the Impacts of the New IMO,

Mitchell, R.K. & Wood, D.J., 1997. Toward a theory of stakholder identifications and salience: defininf the principle of who and what really counts. Academy of Management Review, 22(4), pp.853–886.

Myers, M.D. & Newman, M., 2007. The qualitative interview in IS research: Examining the craft. Information and Organization, 17, pp.2–26.

Ng, A.K.Y. & Song, S., 2010. The environmental impacts of pollutants generated by routine shipping operations on ports. Ocean and Coastal Management, 53, pp.301–311.

Nielsen, C.K. & Schack, C., 2012. VESSEL EMISSION STUDY: COMPARISON OF VARIOUS ABATEMENT TECHNOLOGIES TO MEET EMISSION LEVELS FOR ECA's. 9th annual Green Ship Technology Conference, p.13.

Nokkala, M., Port Ownership and Governance Models in Finland Development Needs & Future Challenges,

Opdenakker, R., 2006. Advantages and Disadvantages of Four Interview Techniques in Qualitative Research. Forum Qualitative Sozialforschung/Forum: Qualitative Social Research, 7.

Parent, M.M. & Deephouse, D.L., 2007. A case study of stakeholder identification and prioritization by managers. Journal of Business Ethics, 75, pp.1–23.

Phillips, R., Freeman, R.E. & Wicks, A.C., 2003. WHAT STAKEHOLDER THEORY IS NOT Robert Phillips, R. Edward Freeman, and Andrew C. Wicks. Business Ethics Quaterly, 13(4), pp.479–502.

PWC, 2013. Ökonomische Auswirkungen von LNG im Transportbereich.

Rambaree, K., 2007. Bringing rigour in qualitative social research: The use of a CAQDAS. University Mauritius Research Journal, 13A, pp.1–16. Available at: http://david.hcuge.ch/gfmer/GFMER_members/pdf/CAQDAS_Rambaree_2007.pdf.

Schmidt, R.H. & Weiß, M., 2009. Shareholder vs. Stakeholder: Ökonomische Fragen. In *Handbuch Corporate Governance*. pp. 161–184.

Schwandt, T. a., 1996. Qualitative data analysis: An expanded sourcebook. Evaluation and Program Planning, 19, pp.106–107.

Semolinos, P., Olsen, G. & Giacosa, A., 2013. LNG As Marine Fuel: Challenges To Be Overcome. In *17th International Conference & Exhibition on Liquified Natural Gas*.

Skovgaard, J., 2012. Corporate Social Responsibility in the Danish shipping industry. Cambride, University of Cambridge.

Sonmez, E.. et al., 2013. Strategic analysis of technology and capacity investments in the liquefied natural gas industry. European Journal of Operational Research, 226, pp.100–114. Available at: http://www.scopus.com/inward/record.url?eid=2-s2.0-84873061053&partnerID=40&md5=0507ccffd5eb265ab53a2655fa975732.

Srivastava, S.K., 2007. Green supply-chain management: A state-of-the-art literature review. International Journal of Management Reviews, 9(1), pp.53–80.

Standaert, K., 2014. LNG Outlook in EU and Baltic. , (December).

Stenersen, 2011. Gas fuelled ships. Cimac, pp.1–38.
Sternberg, E., 2001. The Stakeholder Concept : A Mistaken Doctrine. Foundation for Business Responsibilities (UK), (November 1999), p.57.
Stieb, J.A., 2009. Assessing Freeman ' s Stakeholder Theory. , pp.401–414.,
Suchman M.C., 1995. Managing Legitimacy: Strategic and Institutional Approaches. Academy of Management Review. 20 571-610
Sundaram, A.K. & Inkpen, A.C., 2004. The Corporate Objective Revisited. Organization Science, 15, pp.350–363.
Taneja, P., Ligteringen, H. & Walker, W.E., 2011. Flexibility in port planning and design. European Journal of Transport and Infrastructure Research, 12, pp.66–87.
Taylor, S.J. & Bogdan, R., 1985. Introduction to Qualitative Research Methods: The Search for Meaning. Nursing Research, 34, p.266. Available at: http://journals.lww.com/nursingresearchonline/Abstract/1985/07000/Introduction_to_Qualitative_Research_Methods__The.18.aspx.
TEM - Työ- ja Elinkeintoministeriö, 2014. Press Release: Hamina Energia Receives Nearly 28 Million Euro for Construction of LNG Terminal. Available at: https://www.tem.fi/en/energy/press_releases_energy?89521_m=116897
Thompson, C.B. & Walker, B.L., 1998. Basics of research (Part 12): Qualitative research. Air medical journal, 17(June 1998), pp.65–70.
Turner, D.W., 2010. Qualitative Interview Design : A Practical Guide for Novice Investigators. The Qualitative Report, 15, pp.754–760. Available at: http://www.nova.edu/ssss/QR/QR15-3/qid.pdf.
Vandebroek, L. & Berghmans, J., 2012. Safety Aspects of the use of LNG for Marine Propulsion. Procedia Engineering, 45, pp.21–26. Available at: http://linkinghub.elsevier.com/retrieve/pii/S1877705812031268 [Accessed August 7, 2014].
Varvasovszky, Z., 2000. How to do (or not to do) . . . A stakeholder analysis. , 15(3), pp.338–345.
Walker,R., 1985. Applied Qualitive Research, Aldershot: Gower
Wang, S. & Notteboom, T., 2014. The development of LNG bunkering facilities in North- European ports. World Maritime University.
Wang, S. & Notteboom, T., 2013. The Perspectives and Challenges of the Adoption of Liquefied Natural Gas as a Ship Fuel : Conducting a Systematic Review and Research Synthesis. Transport Reviews: A Transnational Transdisciplinary Joiurnal, (January 2015), pp.37–41.
Weems, P.R. & Hwang, M., 2013. Overview of issues common to structuring, negotiating and documenting LNG projects. The Journal of World Energy Law & Business, 6(4), pp.267–299. Available at: http://jwelb.oxfordjournals.org/cgi/doi/10.1093/jwelb/jwt016 [Accessed August 13, 2014].
Wold, M., 2014. Commercial terms for the development of LNG infrastructure. , pp.1–10.
Woodward, J.L. & Pitblado, R.M., 2010. LNG Risk Based Safety: Modeling and Consequence Analysis,
Work, C. & Lng, S., 2013. LNG fuelled ships as a contribution to clean air in harbours. , (May). Available at: http://cnss.no/wp-content/uploads/2013/08/CNSS-LNG-report-4mb.pdf.
Yun, S. et al., 2014. Conceptual design of an offshore LNG bunkering terminal: a case study of Busan Port. Journal of Marine Science and Technology.
Zainal, Z., 2007. Case study as a research method. Jurnal Kemanusiaan, 9, pp.1–6. Available at: http://www.gslis.utexas.edu/~ssoy/usesusers/l391d1b.htm.

Zhang, Y. & Wildemuth, B.M., 2009. Unstructured interviews. Applications of Social Research Methods to Questions in Information and Library Science, (1998), pp.222–231. Available at: http://hsmi.psu.ac.th/upload/forum/Unstructured_interviews.pdf.

APPENDIX

ANNEX 1 Interview Structure

Main questions	Additional questions	Clarifying questions
<u>Introduction</u>	- What is your occupation at XYZ? - How is XYZ involved in LNG bunkering projects?	
- How can the creation of an LNG infrastructure (more bunkering facilities) be improved?	- What are your main concerns/incentives/impediments? - What is the main driver for the introduction of an LNG project? - How could ports that do not have LNG bunkering plans yet be motivated to do so? - What kind of support/subsidiaries is needed? - How does LNG impact your competitiveness? - How are eventual increased prices for shipping impacting the progress? - What role do incentives for ship owners play?/How could they be promoted? - How could new regulations/standards impact the process? - How do the current low oil prices affect your motivation/the process? What is your opinion/forecast?	- Could you give an example? - Can you expand a little on this? - Can you tell me anything else?
- What role do stakeholders play in the creation of an LNG bunkering facility?	- What stakeholders are involved/play the most important role? (Customers or inland businesses) - What stakeholder drives / slows down the process? - How have you participated? /Would you like to participate more? - How did you clarify your concerns? - How/what could you/other stakeholders improve?	- Could you give an example? - Can you expand a little on this? - Can you tell me anything else?

- How could stakeholder participation be improved?	- At what stage of the planning phase have you been contacted? - How has the communication been? - How could the communication improve? - What other stakeholders could/should be included?	- Could you give an example? - Can you expand a little on this? - Can you tell me anything else?
<u>Conclusion</u>	- Is there anything you would you like to add?	

NEOT North European Oil Trade

Co-financed by the European Union
Trans-European Transport Network (TEN-T)

29.09.2014

Questionnaire on LNG Bunkering Strategies

This questionnaire is part of the Action funded by the European Commission which is in charge of promoting LNG as an alternative ship fuel. The aim of the questionnaire is to assess the current development status of Finnish and Swedish ports concerning LNG availability and unfold investment needs. The results will be presented to decision makers on EU level and will help in the alignment of further actions and financial incentives. Therefore, returning the questionnaire is highly recommended even if LNG projects are not planned at your port at this point. The data collected in this survey will be treated confidentially and will not be conveyed to any third parties.

---

1. An LNG bunkering strategy is

   ☐ Planned and expected to be in operation by Click here to enter text.

   ☐ Proposed

   ☐ Not yet considered. → *(End of questionnaire)*

2. What fuelling solutions are intended?

   ☐ Ship-to-ship

   ☐ Truck-to-ship

   ☐ Terminal-to-ship via pipeline

3. What is the planned on-shore storage capacity of LNG (in m³)? Click here to enter text.

4. What is the estimated annual throughput of LNG (in m³)? Click here to enter text.

---

5. A business case or plan for the project is

   ☐ Created

   ☐ Planned and expected to be completed by Click here to enter text.

   ☐ Proposed → *(Skip to Question 6)*

   ☐ Not yet considered. → *(Skip to Question 6)*

   a. The business plan or case includes

      ☐ Demand analysis

      ☐ Planning of terminal capacity, design and site

      ☐ Planning of terminal operation

      ☐ Integration with land-based LNG/conventional natural gas demand

      ☐ Rough financial and economical calculations.

North European Oil Trade Oy
PL 55, 00088 S-Ryhmä
Urho Kekkosen Katu 5C, 5.krs
00100 Helsinki

Puhelin:
010 76 80850
Sähköposti:
Albrecht-j@gmx.de

Y-tunnus: 1801056-5
ALV rek. / VAT FI18010565
Kotipaikka: Helsinki
www.neot.fi

6. A Feasibility study or similar is

   ☐ Concluded

   ☐ In progress and expected to be completed by Click here to enter text.

   ☐ Planned and expected to be completed by Click here to enter text.

   ☐ Not yet considered. → *(Skip to Question 7)*

   a. The feasibility study confirms the

      ☐ Economic feasibility

      ☐ Legal feasibility

      ☐ Operational feasibility

      ☐ Concludes that an LNG infrastructure is not feasible.

      Please specify in brief why: Click here to enter text.

7. The legal permit process is

   ☐ Concluded

   ☐ In progress and expected to be completed by

   ☐ Pending

   ☐ Impedes a further development at this point.

8. The cooperation in a port cluster or a similar network on the development of LNG infrastructure is

   ☐ Existing (if applicable, name:) Click here to enter text.

   ☐ Planned

   ☐ Not yet considered.

   a. An analysis of demand potentials for maritime and inland LNG usage at the involved ports in the cluster is

      ☐ Concluded

      ☐ Planned

      ☐ Not yet considered.

---

9. What kind of incentives are planned/considered to ensure LNG demand from ship-owners?

Click here to enter text.

10. What are the main drivers for an LNG bunkering strategy?

Click here to enter text.

11. What stakeholders are included in the project development planning?

Click here to enter text.

12. How is communication with the stakeholders managed?

Click here to enter text.

---

13. What are the total initial investment costs (in M€)? Click here to enter text.
14. What is the estimated payback time of the investment (in years)? Click here to enter text.

Name of the port: Click here to enter text.

Name of interviewee: Click here to enter text.

Job description: Click here to enter text.

☐ I agree to be contacted for further information:

E-mail: Click here to enter text.

Phone: Click here to enter text.