THE ROLE OF LNG IN THE WADDENSEA

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Thesis M.Sc. Environmental & Infrastructure Planning

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Preface

This thesis for the Master Environmental and Infrastructure Planning originates from my personal interest in the energy sector. I think energy is a specially interesting topic because it concerns us all. In our current society, everybody is dependent on energy and energy sources. Developing countries are trying to close the gap and are producing and consuming more and more and need enormous amounts of energy for these developments. The developed countries have their own agenda and are in a stage where society also looks at energy use reduction for economic and ecological motives. These developments of global concern and influence have always interested me very much. Because of my study and residence in Groningen, also regional energy policy grabbed my attention. Via news articles and internet I came to the recent developments of LNG in the region and it immediately grabbed my attention. I examined the matter more in depth and decided that it would be a good topic for my master thesis. After a little bit of research I found that the shipping sector has the highest contribution to this sector and I decided that the Waddensea would be an ideal scope for my research. This is because it is an area of national concern which is located in the northern region of our country and the scale is accessible. This is how I started my research and I made a proposal for my supervisor, Ferry van Kann. Throughout the process he helped me with a lot of detailed feedback. He always gave me a good feeling about the direction I was going with my thesis and gave me helpful advice. I would like to thank him very much for that. Finally, I would like to thank all the interviewed stakeholders for their time and willingness to participate.

Abstract

This aim of this thesis is to identify the possible role for Liquefied Natural Gas in the Waddensea area, the Netherlands. The scope is the transport sector, and more specifically the fuel for the shipping sector. First, the background of LNG and the background of the Waddensea is described. The major drivers and obstacles for LNG implementation in the Waddensea are identified and categorized. Following, the background is put in an academic perspective of planning theory, complexity theory, scenario planning theory, transition theory, and innovation theory. Subsequently, stakeholders have been interviewed to gain insights in their perceptions of LNG and its developments. On basis of these interviews, different themes are distinguished, which are then linked with the drivers and blockers. This background, theoretical framework, and stakeholder interviews then form input for four different scenarios, which are split up in conditions and impacts. Concluding, it can be said that LNG can play different roles in the Waddensea area. Different conditions give LNG a role ranging from an abundant, transportable and cheap fuel up to a bridging fuel that is part of a transition towards an equilibrium where renewable energy supplies the ships in the Waddensea with fuel.

Table of Contents

1. Introduction

Energy is the backbone of our society. Energy is besides clean drinking water the key focus point of the coming decades. Energy is everywhere around us.

Currently, the energy market is on a crucial point. Do we keep relying on the conventional fossil fuels like oil and gas? Or do we switch to the renewable energy sources like solar-energy or wind-energy? And besides the usual suspects, biomass and hydroelectric power (which some years ago accounted for 16% of the global electricity consumption)[1] are also renewable sources which could provide us with energy. With the dramatic population growth of nowadays and in the future, the urge for new energy sources is key[2]. With our oil reserves declining, and the prices increasing over the last decades, the energy market is extremely dynamic[3]. If we are to believe in the common concept of 'peak oil', keeping this development line is not an option[4]. We have to either drill for more conventional fuels (where recently shale-gas gives us new perspectives)[5], or we have to differentiate our scope. This is possible by introducing more renewable energy sources in the market, or make a combination of renewables and conventional fuels. Shell publishes its scenarios every couple of years, in which its experts prospect the energy market for the coming years and decades. Although they are the biggest exploiter of oil worldwide, they too do not deny our current energy consumption and energy use has to change[6]. We can identify a shift from a situation where the big oil companies have all the power towards a different mindset. People and governments are aiming at more local and decentralized initiatives. Whether these are cooperatively building a windmill[7] or installing solar panels on your own roof[8], all the 'green' initiatives are hot topics. Energy is a topic that spatial planning and environmental planning are concerned with.

More stringent environmental norms and regulations are going to force the shipping sector in the UNESCO World Heritage site the Waddensea, the Netherlands, to use less polluting fuels. The International Maritime Organization has pointed the Waddensea as a SECA area (section 1.2), and the shipping sector is therefore looking for alternatives for their current fuel, because most current fuels do not comply to the upcoming rules of 2015. This makes the quest for alternatives (amongst other Liquefied Natural Gas) urgent and therefore this thesis will

[1] Renner, M. (2013). Climate change and displacements. In *State of the World 2013* (pp. 343-352). Island Press/Center for Resource Economics.
[2] Kaack, L. H., & Katul, G. G. (2013). Fifty years to prove Malthus right.*Proceedings of the National Academy of Sciences*, *110*(11), 4161-4162.
[3] Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *foresight*, *3*(1), 15-31.
[4] Bardi, U. (2009). Peak oil: The four stages of a new idea. *Energy*, *34*(3), 323-326.
[5] Lechtenböhmer, S., Altmann, M., Capito, S., Matra, Z., Weindrorf, W., & Zittel, W. (2011). Impacts of shale gas and shale oil extraction on the environment and on human health. *Wuppertal Institute for Climate, Environment and Energy and Ludwig-Bölkow-Systemtechnik GmbH, study requested by the European Parliament's Committee on Environment, Public Health and Food Safety, IP/A/ENVI/ST/2011-07, June*.
[6] Shell (2013) http://www.shell.com/global/future-energy/scenarios.html
[7] De Windcentrale (2013) https://www.windcentrale.nl/
[8] Grunneger Power (2013) http://www.grunnegerpower.nl/

highlight the possible roles LNG can play with regard to this urgency. Because LNG in the Netherlands and especially the Waddensea is a recent development, there is need for insights in the current driving and blocking forces for LNG in the Waddensea. This introducing chapter will describe the topics: emissions, the shipping sector, the upcoming norms with regard to emissions and Liquefied Natural Gas as fuel. This thesis will focus especially on the Waddensea area, because this is an area that has been appointed as one of the few SECA areas. This is, among others, because it is an particularly sensitive area (section 3.1.7) and it is on the World Heritage List of UNESCO. These characteristics of the area under research make this thesis valuable as comparative study for other SECA areas where LNG might or might not be playing a role in the future. The thesis will focus on specific local characteristics and input though, like interviews with local stakeholders and national and regional regulations. After an introduction of the topics of energy, shipping, emissions and LNG, the research questions will be elaborated on.

1.1 Energy and Emissions

One of the key topics of the energy market nowadays are emissions. Since nature, ecology and environment are moving up the political agenda, the pollutant natural resources are critically assessed. Stricter emission norms form binding restrictions for the majority of the sectors, which the Kyoto Protocol set in motion[9].

One of the sectors which faces huge challenges is the transport sector. Because not only do we need energy to keep our houses warm or cool, to grow our food and to produce the products we use in our everyday life, but we also need it for transport. To transport ourselves and our goods. The transport sector is roughly divided in: air, shipping, rail and road-traffic. If we look at these divisions in terms of energy and emissions, one can see the stricter norms in every modality. But not only the environmental norms put pressure on the transport sector[10], also an economical aspect is essential. Due to increasing energy demand, the prices of the conventional fuels like petrol and diesel are increasing over time. This seems unavoidable, since growing populations creates growing demand for goods, which forces the transport sector to scale up. Since the transport sector is one of the main contributors to air pollution worldwide[11], this thesis will focus on this sector. This thesis will now zoom in towards the main contributor within this polluting sector.

[9] Protocol, K. (1997). United Nations framework convention on climate change.*Kyoto Protocol, Kyoto*.
[10] Colvile, R. N., Hutchinson, E. J., Mindell, J. S., & Warren, R. F. (2001). The transport sector as a source of air pollution. *Atmospheric environment*, *35*(9), 1537-1565.
[11] Fuglestvedt, J., Berntsen, T., Myhre, G., Rypdal, K., & Skeie, R. B. (2008). Climate forcing from the transport sectors. *Proceedings of the National Academy of Sciences*, *105*(2), 454-458.

1.2 Shipping

The transport sector generally relies heavily on the fossil fuels. The maritime shipping industry is massively polluting by using Heavy Fuel Oil (from now on: HFO), with a high content of sulfur. The inland ships are relatively cleaner, because they are using the Marine Gas Oil, which is less polluting in terms of sulfur and nitrogen emissions. In comparison, the fifteen biggest cargo-ships worldwide account for as much pollution as all the cars worldwide[12]. Major impacts can be expected here. To force this, the IMO (International Maritime Organisation) has set rules to reduce the sulfur emissions. Worldwide, the sulfur-norm goes from 4,5% (up to 2012) to 3,5% (2012 onwards) to 0,5% (from 2020 or 2025).[13]

In Europe, even stricter norms are assigned to special areas. These SECA's, Sulfur Emission Control Areas (Figure 1)[14], should be free of fuels with more than 0,1% SO_x (SO_x is the collective term for all sulfur and oxygen containing compounds, but in this context mainly focused at SO, SO_2 and SO_3). HFO will not comply to these norms, so these ships will not be able to ship in these areas. Marine Gas Oil (from now on: MGO) could be an alternative, but the irony here is that the supply side is not sufficient for this future massive demand[15]. When all the enormous consumers of HFO will shift to MGO, the supply of MGO will decline so quick that the possibility rises that the prices increase and this will in turn affect the economic side of the shipping sector. Since solar power, wind energy and biomass are not yet developed enough for ships, the European shipping sector is looking for an alternative.[16]

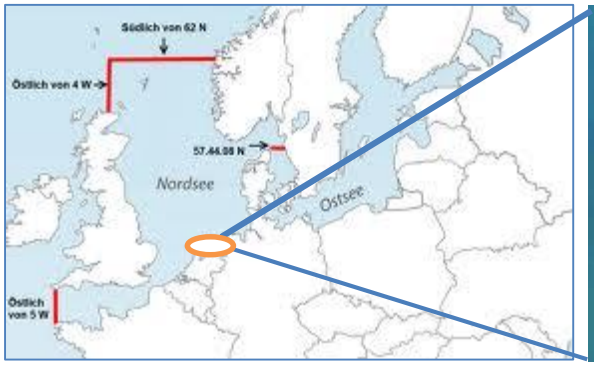


Figure 1 - SECA in Europe

Figure 2 - 'Energy Valley region' (in white), including the Waddensea

Besides the sulfur emissions, the nitrogen emissions deserve some attention. In 2016, stricter norms concerning the so-called NO_x will apply in the ECA areas. NO_x is meant as the collective term for the mono-nitrogen oxides: NO, NO_2 and NO_3. As seen in Figure 3, in 2016 the NO_x Tier

[12] The Guardian (2009). http://www.theguardian.com/environment/2009/apr/09/shipping-pollution
[13] IMO, (2013). http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-%E2%80%93-Regulation-14.aspx
[14] DNV, (2006). http://www.dnv.com.ar/binaries/flyer_marpol_seca_tcm158-278353.pdf.
[15] Energy Valley, (2012). "LNG als scheepsbrandstof. Kansen en uitdagingen voor een nieuwe markt."
[16] DNV, (2012). Shipping 2020. http://www.dnv.com/binaries/1shipping%202020%208%20pages%20summary%202012%2006%2004_tcm4-518883.pdf

III regulation will apply, which means the NO_x emission goes down from a maximum of 17 g/kWh to 3,4 g/kWh.

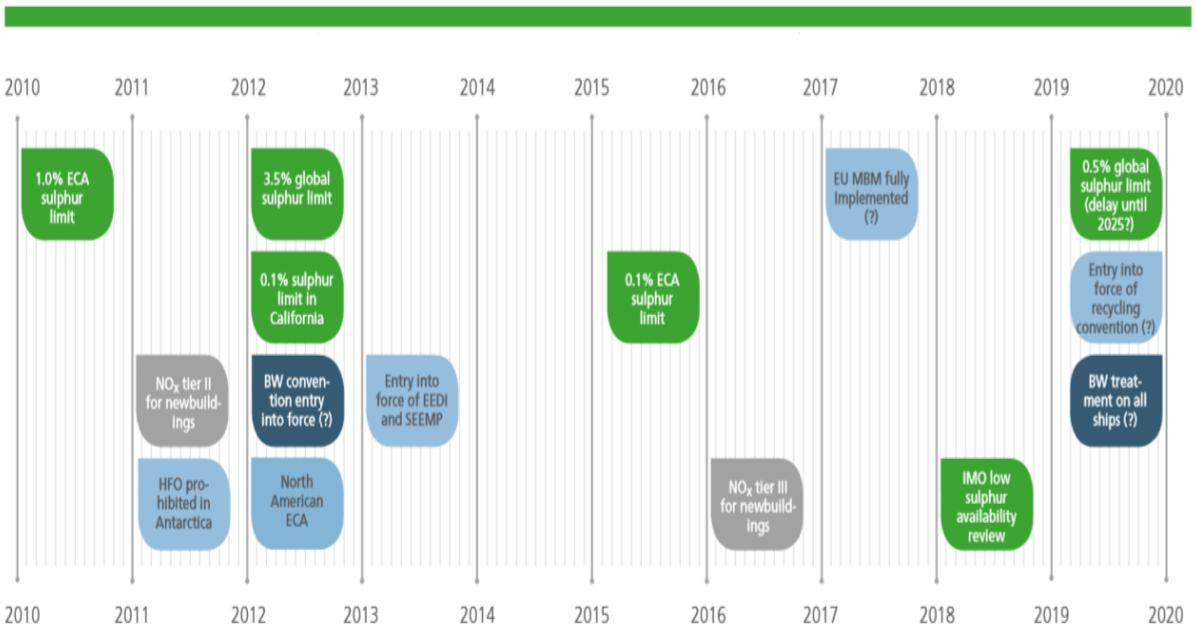


Figure 3 - Upcoming maritime regulations

1.3 LNG

An often mentioned alternative is the Liquefied Natural Gas (LNG). This fuel is made by cooling down natural gas in special liquefaction plants. By decreasing the temperature to minus 162 degrees Celsius, the gas becomes liquid and shrinks to 1/600th of its original size. Not only is this advantageous for the transport, because it is easier to transport in vast volumes, but also it is better for the environment with regard to air pollution. This is because by cooling and compressing the gas, the burning of the fuel is more efficient and cleaner. The emission of sulfur and nitrogen both decrease about 90% compared with MGO.[17]

All these advantages make that there are positive reactions all over the energy sector. Norway is currently the front-runner and this has several reasons. First, with the finding of North Sea oil in the Norwegian waters in the 1960's have given Norway good oil and gas reserves. This led to a situation where the country could export oil and gas instead of importing it. So the supply of gas is not an issue in Norway. Second, the geographical features of the country make it difficult to build pipelines all over the country. This is also in close relation with the population distribution, because there are a lot of people living in remote areas, where a gas pipeline would be too costly to build. Therefore, a lot of the transport goes via sea. The steepness and curves of the fjords also make road transport less attractive. But third, and for

[17] Authority, D. M., Bech, M. S., Gullberg, M., & Gahnström, J. (2011). North European LNG Infrastructure Project.

sure not least, is a political reason. Norway's image is not only environment friendly, they also have policies in harmony with this. They have introduced the so-called NO_x-fund. This is a fund where companies that emit more pollutants than a certain norm, have to pay to. From this collected money, NO_x-reducing initiatives are subsidized. With this mechanism, pollution-reducing investments are stimulated and polluting activities are discouraged without the government having to pay for it. This new policy instrument has contributed to the good LNG infrastructure in the country, which now makes Norway world leader in the sector.

In conclusion, it can be said that LNG has both economic and ecological advantages. Although it is hard to predict future prices, it is expected that the price for LNG will be lower than MGO, which gives it a price advantage. On the ecological side, it reduces the pollutants to a minimum, so there are also benefits on the environmental side. It is therefore that LNG is put on both the more environmental friendly side as the economic advantageous side of Marine Gas Oil in the spectrum between economy and ecology. This tension and the role of LNG between these forces, will form the basis of this thesis.

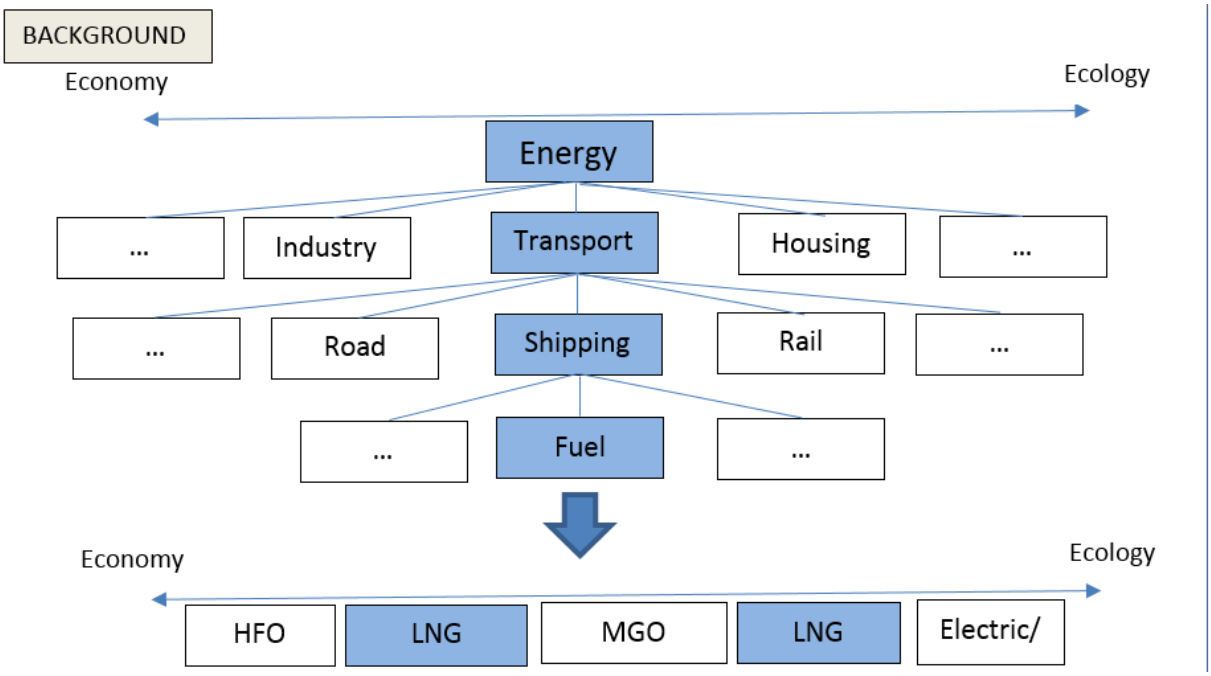


Figure 4 – Conceptual representation of the background

To put in a broader perspective, energy is a field where spatial planners can intervene in different ways. The planner has the possibility to facilitate, mediate, restrict, direct, steer and many more. But to do so effectively, the content and the context of the world we are living in should be clear. This is another role the planner can take: describe the current situation and think about where this will go in the future. This future is inherently concerned with many uncertainties. One of the tasks of a planner is to cope with these uncertainties in an effective way. This thesis will try to describe the emerging field of LNG in the Waddensea area, in order to provide context and information to base our image of the future on. Only when we have described, analyzed and structured the topic, we can try to understand it. And this

understanding will provide us with the many possibilities for decision-making and intervening. So the main goal of this thesis will be to provide a framework for understanding the topic of LNG in the Waddensea. To take it one step further, this thesis will use this understanding to produce possible futures. Although none of these futures will prove to be true in reality, it does give planners information to use for planning goals.

This described basis provides this thesis with a subject and goal. The dynamic character of energy and the uncertainties around the relatively new technology of LNG evokes a lot of questions. The main- and sub-questions will be described in the next chapter.

2. Research Questions

The main research question of this thesis is:

What are driving and blocking forces for future LNG adoption in the Waddensea area?

The following sub-questions are underlying this main question:

1. *What does LNG mean in a Dutch context?*
2. *In what way is the Waddensea area relevant for the topic LNG?*
3. *What are driving or blocking forces for LNG adoption?*
4. *How can LNG play a role in the Waddensea area?*
5. *What is the impact of a shift to LNG?*

2.1 Structure of the thesis

This thesis will consist out of the following six parts: background, theoretical framework, methodology, findings, conclusions and a discussion.

First, a background will be described, which is split up in two parts: one part describes the landscape for LNG in the context of the different geographical scales and the second part elaborates on different drivers and blockers for LNG implementation. In this chapter (3), sub questions 2 and 3 will be answered.

Second, in the theoretical framework, the concepts of scenario planning, transitions and complexity will be connected with LNG.

In the third part, the methodology of how to proceed from this theoretical framework onwards will be described. Interviews are used as a means to complement the theoretical framework.

Following, the findings will lead to conclusions and these will be used as input for four different scenarios about the developments of LNG in the Waddensea. The scenarios are extended with a description of the impact the scenario causes. This chapter (7) will provide answers for sub questions 4 and 5. Finally, overall conclusions will be drawn and a discussion shows the limitations and recommendations and puts the research in the academic perspective.

2.2 Conceptual Framework

The conceptual framework exist of five main parts. Chapter 3, 4 and 5 build up to a synthesis that will be described in Chapter 6. These will lead to four distinguished scenarios in Chapter 7.

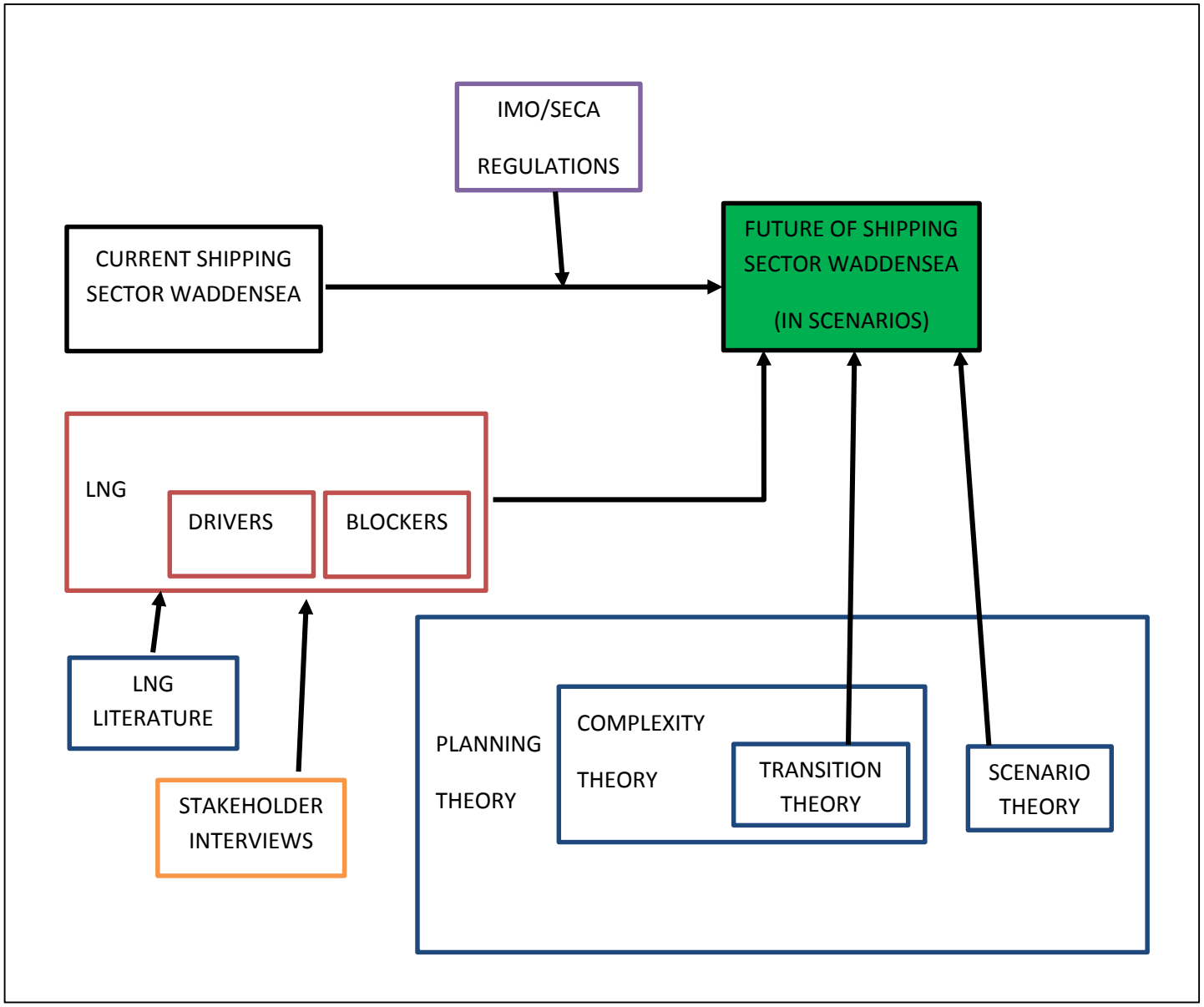
Chapter 3, titled 'Background', starts with a spectrum with the two extremes of *economy* and *ecology*. Energy is somewhere in between these two extremes. The tension is between the financial and the ecological aspects of energy. While diminishing the scope from energy, through transport, shipping and fuel, it will conclude with putting various fuels on the spectrum between economy and ecology.

Chapter 4 builds on the academic literature in the field. The framework is formed by complexity theory, scenario theory and transition theory. It uses the degree of complexity to distribute issues on a spectrum with the extremes of technical rational issues and communicative rational issues. Issues that form the middle of the spectrum because of their uncertainties, will be considered by different scenarios. Transitions then, are used to form parts of these scenarios to describe the fundamental changes that might occur within the playing field.

Chapter 5 contains the methodology for obtaining empirical data. Interviews with several stakeholders are conducted to identify the drivers, obstacles and trends within the LNG sector.

Chapter 6 categorizes the findings in multiple themes and draws conclusions on basis of the findings.

In Chapter 7, the synthesis of the background, theoretical framework and the stakeholders input is formed. Four scenarios and their impact are distinguished to compose possible futures for the role of LNG in the Waddensea area.



Model 1 – Conceptual Model

Model 1 schematizes the important inputs for this thesis. Figures 5, 6, 7, and 8 give a more in depth conceptual representation of important aspects of the conceptual model. The end-image where this thesis shines its light upon is the future of the shipping sector in the Waddensea. Take-off point is the current situation, taking the upcoming IMO/SECA regulations into account. Both literature and the conducted stakeholder interviews will be used to identify drivers and blockers for LNG in this future of the Waddensea. To theoretically structure and position LNG in the Waddensea, multiple theories are used. General planning theory is used for a background, in which complexity theory is examined in more depth. Then, this is linked with the transition theory that is linked with complexity theory. In addition, scenario planning/theory is used in combination with the other theories to provide tools for developing possible future images of the Waddensea and LNG herein. With this model the main research question "*What are driving and blocking forces for future LNG adoption in the Waddensea area?"* will be answered.

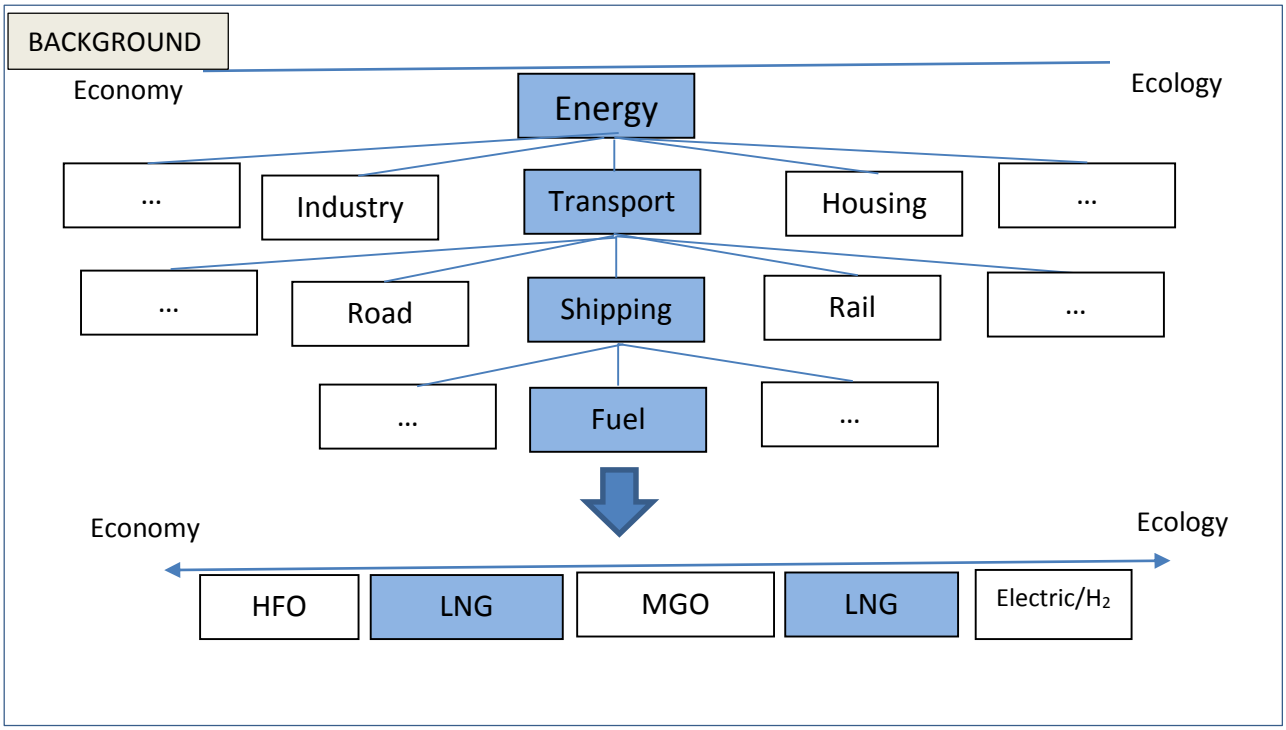


Figure 5 – Conceptual representation of the background

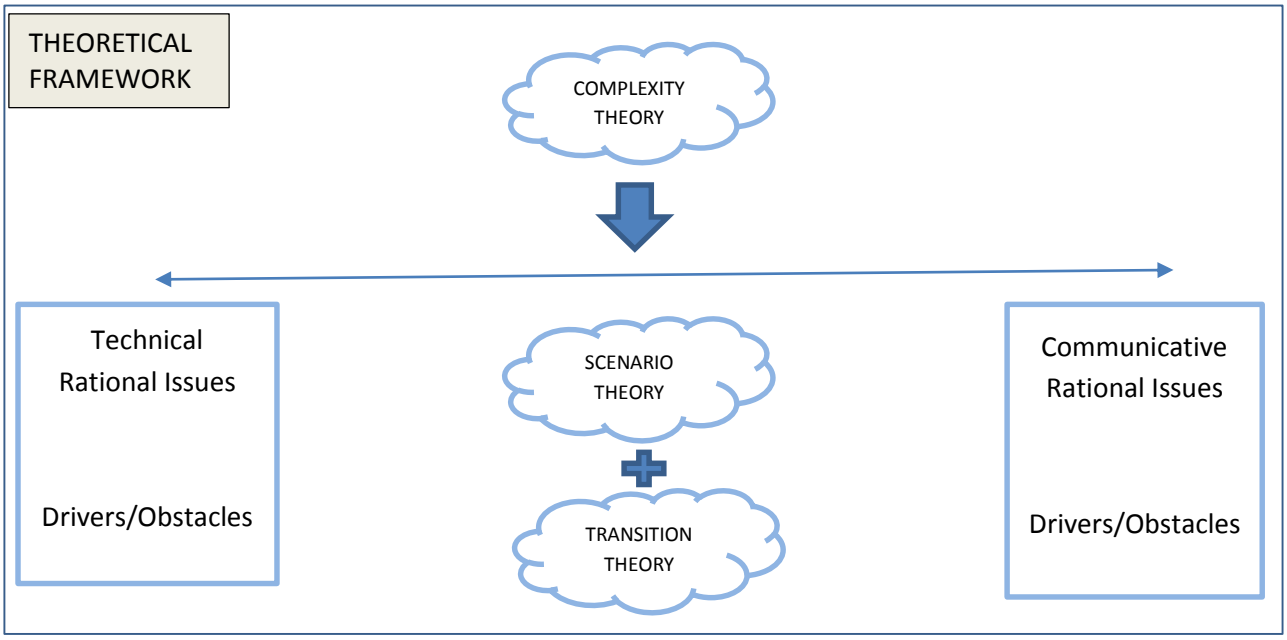


Figure 6 – Conceptual representation of the theoretical framework

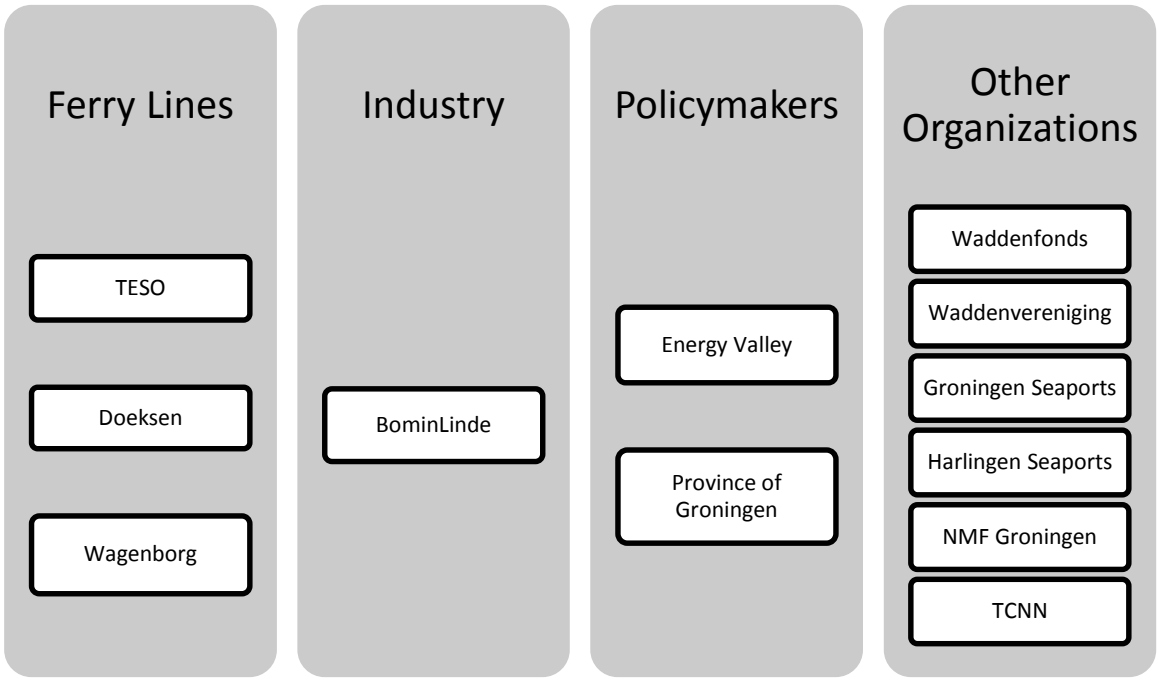


Figure 7 – Segmentation of interviewed stakeholders in sector and company

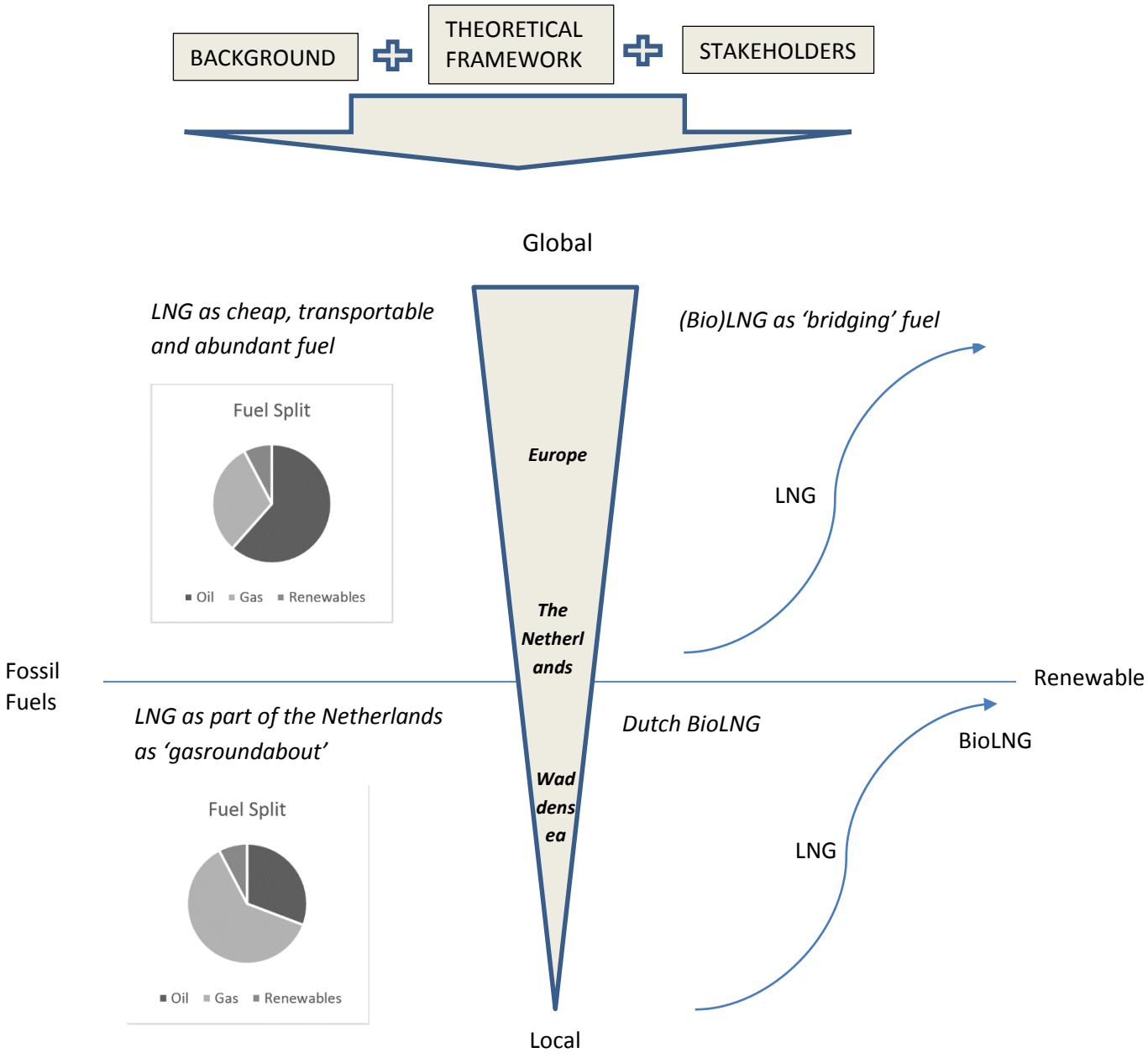


Figure 8 – Synthesis of background, theory and empirical data into scenarios

3. Background

This chapter comprises two parts. The first part (section 3.1) will give the different geographical scales in which LNG plays a role. From a global level, it is narrowed down to European level, towards the Dutch national level, towards the local/regional level of the Waddensea. By narrowing down to the level of the Waddensea, sub question 2 will be answered. The second part (section 3.2) will dwell on the multiple drivers and obstacles for LNG implementation in the Waddensea that can be identified. This will give an answer to sub question 3. Finally, the concept of innovation puts these drivers and obstacles in a time-perspective.

3.1 Geographical Scales

3.1.1 Global LNG markets

Natural gas is seen as the 'bridging fuel' to a sustainable energy system, that we hope to reach somewhere after 2050. The advantages are that it is a clean, versatile and easily controllable fuel. Clean because it has less CO_2, NO_x and SO_x than fuels like diesel or heavy fuel oil. Versatile because it can be used for different purposes, like: generating power, heating or transport (in the case of LPG, CNG or LNG). And it is easily controllable because the technique of the gas infrastructure and consumption is already matured over the last decades. Gas is more and more used by end users, for example the majority of Dutch households are connected to the gas grid for cooking purposes.

But while gas demand is projected to increase drastically over the next decade[18], LNG demand is forecasted an even more steep increase (about 10% a year over the next 10 years), but important to note that this is on global scale. Since the focus of this thesis is on a lower, more regional scale, this 10% cannot be applied to this case one on one. The fact that this rising demand is projected though, can be partly due to the fact that LNG is the cleanest form of natural gas and it contains more than 90% of methane (CH_4). But, since natural gas is not traded on a global market (in contrast with oil for example), "price volatility remains as the Achilles' heel of natural gas, particularly when compared with coal"[19]

If we zoom in on Europe, one can identify at least three major factors that will force us to a higher dependency on gas. First factor is the restriction on CO_2 emissions. Since the Kyoto Protocol, governments have been applying stricter rules on greenhouse gases. Currently, one of the most polluting sectors, the shipping sector, is also subject to stricter norms. Not only for CO_2, but also NO_x and SO_x emissions will have to be diminished in certain areas (e.g. SECA areas). Secondly, high emissions from coal-based generation. Coal is the most polluting fossil fuel, and although not all the governments practically diminish the use of coal (e.g. the new coal-based power generation plant in the Eemshaven), public opinion about the pollution of coal will eventually force governments to look at cleaner alternatives. Finally, the obstacles

[18] Outlook, A. E. (2010). Energy Information Administration. *United States*.
[19] Rühl, C. (2008). BP statistical review of world energy.

for rapid development of renewable energy generation are in some degree blocking a total renewable energy-landscape. This is in the advantage of the 'clean' fossil fuel natural gas.[20]

If we now focus more on the future energy demand in Europe, the International Energy Agency[21] differentiates six factors: continued economic growth of more than 2% per year, hardly an increase in population, the remaining of oil prices at high level, gas prices that are determined by market forces, increased environmental awareness in both politics and among consumers, and growing trends to save energy and improving energy efficiency. If these determining factors are analyzed in relation to LNG, one can conclude that three factors are essential for the success of LNG in the future. First of all, if the oil prices remain as high as they are now, LNG can be an attractive cheaper alternative (dependent on the price development). Secondly, since the gas prices are determined by market forces, and not coupled with the global oil market, the price of LNG can positively develop in both relative and absolute sense compared with other fossil fuels. Thirdly, the increased environmental awareness in both politics and among consumers is a positive trend for LNG, since it is a less polluting energy source.

If we now zoom out again, there are some lessons that can be learned from other countries that might be applicable to the Dutch case. The following paragraph will now first look at China, followed by a paragraph about a comparison between the US and Europe and subsequently a comparison with some European countries is made.

3.1.2 Comparisons: LNG in China

China is already more developed concerning both LNG infrastructure and consumption.[22] China's energy demand will almost double of the coming century, and their current energy consumption relies for 90% on the conventional energy resources like coal, gas and oil. The fact that the LNG infrastructure is already way more developed in absolute terms does not necessarily mean that in relative terms LNG is well supplied in China. Because of the vast size of the country, it can in absolute terms not be compared with the Netherlands. Another important difference is the price in China. Because of different geographical location, but also political reasons (different import-markets and agendas), the price is a lot lower than in the Netherlands. What is important though, is that the demand of China will have a big impact on the global LNG market. When the demand rises, the price will go up and this will affect the European and US market. A less economical, but nonetheless important lesson from Chinese implementation is the extremely safe track-record of LNG, spanning over 40 years and over 35.000 ocean voyages. Finally, the Chinese public tends to be more open to accept new types

[20] Kumar, S., Kwon, H. T., Choi, K. H., Hyun Cho, J., Lim, W., & Moon, I. (2011). Current status and future projections of LNG demand and supplies: A global prospective. *Energy Policy*, *39*(7), 4097-4104.
[21] International Energy Agency (2013). http://www.worldenergyoutlook.org/
[22] Lin, W., Zhang, N., & Gu, A. (2010). LNG (liquefied natural gas): A necessary part in China's future energy infrastructure. *Energy*, *35*(11), 4383-4391.

of energy resources, despite a lack of knowledge, so severe resistant as in the US is not to be expected. This context will be elaborated on in the next paragraph.

3.1.3 Comparisons: US vs. European siting regulations

Licari & Weimer[23] have made a comparison between the regulations for LNG siting in the US and Europe. There are some key differences in the approach, though both focused on the risk of a possible facility. The US uses a more prescriptive approach based on a credible worse-case scenario, while the European approach is more a performance risk-based one. Regulations in the EU are expected to remain risk-based, so developers and operators have to meet performance standards and will be checked and monitored for these norms. Important side-note though, is that LNG has an excellent safe record, so regulations will be based on these records. This thus means that since LNG has proven to be a safe fuel, the standards will be set accordingly. The main emphasis in Europe will be on expansion and improvement of the current gas infrastructure, and regulations will have to provide the basis for this. More importantly, in the case of LNG, by setting regulations that will eliminate barriers for the construction of LNG infrastructure.

These comparisons show that there are not only economic, but also important social, political and historical aspects form the context in which LNG is evolving.

3.1.4 Comparisons: Denmark, Norway, Italy, Germany and Sweden

There are other comparisons in the rest of Europe. The Danish Ministry of Environment has conducted a research[24] focused on natural gas for ship propulsion in Denmark. They mapped a lot of different steps of the value chain and the Danish context. First, the benefits of using natural gas as a transport fuel are examined. The emissions(reduction) and the price competitiveness are analyzed for example. These main drivers are complemented by other drivers for LNG implementation, namely geography and politics. The typical geography of Denmark with its many islands, asks for inventive use of technology and water. Because of the many ferries and short sea ships, the shipping sector is highly developed in Denmark. Natural gas (whether compressed or liquefied) is one cost-effective and 'clean' alternative for the current ship's fuel. Politics form another opportunity for the development of LNG in Denmark. Stimulating measures, like funds to subsidize 'green' initiatives in the shipping sector, and stricter rules and regulations pushes the industry to look for 'cleaner' alternatives.

Moreover, the different practical possibilities of natural gas are described. Here a distinction is made between CNG (Compressed Natural Gas) and LNG. Since LNG has a higher energy density, CNG has some practical disadvantages over LNG. Besides, although CNG is more widely implemented in road transport, for ship propulsion the technology is underdeveloped. CNG is not attractive and/or applicable for the longer distances. On the other side, because of

[23] 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), 736-752.
[24] Stuer-Lauridsen, F., Odgaard, T., Winter Graugaard, C., Muro-Sun, N., & Andersen, M. (2010). Natural gas for ship propulsion in Denmark-Possibilities for using LNG and CNG on ferry and cargo routes.

the underdevelopment of LNG infrastructure, LNG should focus on long term contracts and fixed routes. Another disadvantage of CNG is that it requires, although stored at 200 bar, approximately 5 times the volume of oil, while LNG requires around 2 times the volume (while stored at 10 bar).

Nowhere in the Europe, the LNG infrastructure is as developed as in Norway. Not only does Norway have production plants, but also the small scale terminals and distribution channels are further developed than anywhere else in Europe. CNG though, is less prone to capital investments, since the natural gas network is quite far developed in most countries in Europe. Compression stations should be built to compress the gas from the conventional network into a usable pressure, but these infrastructure investments are significantly lower than the ones of LNG.

Summarizing the technical developments for CNG in the shipping sector, it has not so much progressed over the last decade, while LNG technology is experiencing much progression. Though widely implemented in road transport, CNG is not considered as a large scale solution for the shipping sector. Biogas could play a complementing role in the future, but for this fuel it is essential that it is cleaned before it is injected in the existing gas infrastructure.

If one now looks at the operational consequences of LNG implementation, the literature (see for example Stuer-Lauridsen et al.) identifies different possibilities in the supply chain. The bunkering operation can be done in three different ways: onshore infrastructure (for example a small scale LNG terminal in a port), truck to ship bunkering (a truck onshore that supplies LNG by a hose) or ship to ship bunkering. The latter concept is expected to face the least opposition, in the light of the NIMBY effect. The inhabitants of coastal regions will then not be confronted by onshore LNG installations. Overall, there are two issues that have to be addressed to further develop the bunkering operations of LNG: the first movers and international regulations (see also paragraph 3.1.3).

Apart from the technical and operational implications, the Danes have assessed the potential of LNG in their main ports. First, the large fuel consumers are identified by mapping the ferry routes and major ports. Within these major ports, a distinction is made between ferries and short sea shipping. The latter category is mainly impacted by (small) cargo shipping. Consequently, different scenarios for the identified ports are distinguished, while taking into account the both categories. One conclusion is that short sea shipping is contributing a lot smaller part to the total potential than the ferries. Moreover, because of the fixed and frequent routings of the ferries, this target group is more attractive for LNG. Main conclusion of the (four) scenarios is that the most feasible option for infrastructure (ships, ports and distribution networks) investments is a scenario with a limited amount of ports, with a focus on ferry ports. While focusing on only 24% of the possible ports, 83% of the total potential for LNG is accounted for. For emission reduction, the conclusion is similar. The scenario in which the lowest investment costs are required, relatively the highest reductions in fuel, SO_x, NO_x and PM is acquired.

The research also gives an overview of the experiences with natural gas in land transport in three other European countries. Italy has one of the largest numbers of natural gas (CNG) powered vehicles. Stimulating measures that attributed in accomplishing this are financial incentives (subsidies) and tax-advantages. In Germany, the growing number of CNG powered vehicles is due to the fact that German authorities have promised a low tax level for natural gas up to 2018. Moreover, local authorities have promoted natural gas fuelled taxis and school busses. Finally, in Sweden the success of natural gas is mainly attributed to governmental support to support local bio-gas facilities, combined with other incentives like free parking in many cities. Also in Sweden, in some cities the public bus transportation systems are operated by CNG fuelled busses. Overall, it can be concluded that the success of natural gas as a road transport fuel in several European countries is importantly attributed to political will, practically implemented as subsidies or tax reductions.With regard to supplying a certain country's market with LNG, there are two options. First possibility is to construct a liquefaction plant and feed the market by pipelines, ships or trucks. The other possibility is to import LNG from for example Middle Eastern (but possibly also from other European countries) suppliers, and then distribute it to local storage facilities, from where the end-consumers can be supplied.

Against this background, this thesis will now zoom in to a smaller geographical scale.

3.1.5 The Netherlands

When we zoom in on the Netherlands, we see that the country is lacking policy instruments à la Norway to influence the energy sector in such a positive way. Although energy is one of the 'Top-sectoren' of the Dutch government, there is no clear vision on basis of which the government acts. The targets of 16% of the energy generation to come from renewables, will not at all be met in 2020. The Dutch are currently around 4%, and one of the big contributors, wind energy, will be set aside in the coming years[25]. Where the Netherlands wants to profile itself as a pioneer of clean energy, the country is nowadays lagging behind and is one of the 'dirtiest' countries of Europe. Despite the targets, the Dutch government struggles with the dilemma between environment versus economy. The recently agreed 'Energieakkoord'[26] is one visionary step in the direction of a sustainable future for the Netherlands.

Visionary planning, both in economic and environmental sense, is especially crucial for the LNG sector. This is because LNG in the Dutch landscape struggles with one big problem: a so-called 'chicken-or-egg problem'. For a successful implementation of LNG in the market, a good balance between demand and supply is essential. The problem with LNG is that there is currently no demand nor supply. This is because there is not sufficient infrastructure yet to make companies decide to switch their transport means (whether these are ships, trucks or trains) to a LNG-applicable vehicle. On the supply-side, the companies who have to invest in

[25] Centraal Bureau voor Statistiek, (2010). http://www.cbs.nl/nl-NL/menu/themas/industrie-energie/publicaties/artikelen/archief/2010/2010-3105-wm.htm
[26] SER, (2013). Energieakkoord. http://www.energieakkoordser.nl/

the infrastructure are too dependent on their customers. When the potential of customers is so uncertain, the risk for the infrastructure companies is too high to invest in these projects. Gasunie did a step forward in 2011 by building the GATE (Gas Access To Europe)[27] terminal in Rotterdam. Eventually, this terminal is destined to supply the transport sector directly with fuel, but now the terminal is only used to re-gasify the LNG that is shipped from for example Qatar or Nigeria. After re-gasification it is pumped in the existing gas network. The capacity of the GATE-terminal is enormous, but this also means there has to be a high throughput. Since LNG evaporates under normal conditions, fuel will be lost if it is not used in a short time span. One can see that on the supply side of LNG, a lack of infrastructure can form a big obstacle for potential success of LNG in the Dutch landscape.

3.1.6 Northern Netherlands – Energy Valley

If we zoom in on the northeast of the Netherlands, and even the northeast of Groningen, we find the Eemshaven. This location near the German border has also examined the possibilities for a LNG terminal a couple of years ago. Eventually they 'lost' from Rotterdam, so the potential for a Large-scale LNG Terminal is gone now. A large-scale terminal has such a high capacity and scope of distribution, that a terminal of comparable size in the proximity of around 200 kilometers is not feasible. A small- or mid-scale terminal though is still one of the possibilities, but this project is not the main focus of this thesis. This paragraph will set the boundaries for this research and will show the current regulatory and governance frameworks.

The area under scope is the north of the Netherlands. Roughly said, this is the area of the provinces Groningen, Friesland and Drenthe. With a population of 1,7 million it is one of the less densely populated areas of the country, but still of significant importance. This is because there are big energy projects located in this area. The Eemshaven plans to accommodate 8000 MW in the coming years, enough to serve half of the households of the whole country. Among others, Eemshaven contributed to the term 'Energy Valley', which the north(east) of the country is sometimes called.

The Eemshaven is part of Groningen Seaports which is in turn part of the province of Groningen. The province has set up several programs to accomplish their ambitions. The comprehensive plan 'Economisch Actieprogramma Groningen 2012-2015'[28] elaborates on the province's economic goals and targets. It describes that the role of the province will be one of stimulating, facilitating and monitoring projects and overall development in economic perspective. To accomplish this, they set 4 policy priorities: energy, life sciences/health ageing, biobased economy/agribusiness and 'thrusting' MKB. Highest relevance for this thesis is the first priority: energy. The plan identifies several trends, of which two are of more importance for the energy sector. First, climate trends are showing that global warming is one of our major

[27] GATE, (2013). http://www.gate.nl/

[28] Province of Groningen, (2012). Economisch Actieprogramma Groningen 2012-2015. http://www.provinciegroningen.nl/fileadmin/user_upload/Documenten/Downloads/Economisch_Actieprogramma_Groningen_2012-2015.pdf

concerns, to which our policies on regional and local levels have to be adapted. The second trend, one of more political nature, is the decentralization of tasks. The provinces and municipalities are getting more and more responsibilities decentralized from the national and EU governments (this process is called 'subsidiary-principle'). This last trend makes it essential for regions and provinces to develop strong arguments and plans in order to gain sufficient financial means from the higher governments. Although complementarity rather than competitiveness is more a rising trend, the province identifies an unbalance in the distribution of money between the 'Randstad' and the Northern region.

To amplify the policy priority 'energy', the province of Groningen developed another policy document, called 'Programma Energie 2012-2015', which focusses on the energy related projects in the province. Two of the five key pillars within the realm of energy in Groningen are 'biobased energy' and 'groene gasrotonde'. These two themes are elaborated on by the energy programme, with as goal to support 40 energy related economic projects in 2015. Several trends form the background of this report, of which three are of relevance here. First of all, in 2011 the national government has assigned the Eemsdelta the title of 'energy port' of the Netherlands. Besides, the province is home to the biggest gas fields in the country and has the ambition to be the gasroundabout of Europe. Third trend is the rise of natural gas as a clean fossil fuel and the developments of the technologies of LNG and Power-to-gas.[29] The playing field within which this program operates, consists of two levels: national and regional. First, on national level, there are the 9 'Topsectoren'[30] of the Netherlands and the Foundation of Green Gas Netherlands[31]. These national ambitions are made more concrete on regional level, in the Green Gas Deal, the Green Deal North Netherlands[32] and Energy Valley phase IV.

The Energy Valley Foundation is the one of the key institutes in the area and the energy sector. It is a network organization whose goal is to stimulate energy initiatives in the region.[33] They do this by actively participating and coupling different stakeholders in the sector. One of the pillars of Energy Valley is the cluster Bio-energy & Gas, under which LNG is also a point of attention. The foundation actively tries to improve the dialogue between the public and the private sector. Especially in the chicken-or-egg situation of LNG this is crucial. In cooperation with the government, Energy Valley has agreed to the Green Deal LNG[34]. Its goal is to make shipping (inland, maritime and fishing) more sustainable. The target is to have 50 inland ships, 50 maritime ships and 500 trucks moving on LNG in the coming years. To meet these targets, Energy Valley is parallel looking with stakeholders of the supply-side for possibilities for the

[29] http://www.gasunie.nl/
[30] http://www.topsectoren.nl/
[31] Stichting Groen Gas Nederland. http://www.groengas.nl/
[32] Province of Groningen, Green Deal Noord Nederland, (2011). http://www.provinciegroningen.nl/fileadmin/user_upload/Documenten/Persberichten/11-089-avb-bijlage-Green_Deal_Noord-Nederland_oktober_2011.pdf
[33] http://www.energyvalley.nl/
[34] Green Deal LNG: Rijn en Wadden, (2012). http://www.ondernemendgroen.nl/SiteCollectionDocuments/OndernemendGroen/B124%20-%20Green%20Deal%20LNG%20Rijn%20en%20Wadden.pdf

infrastructure.[35] One of the focus areas Energy Valley is concerned with, is the Waddensea area. The next section will elaborate on this specific area and why it is an interesting area for LNG implementation.

3.1.7 The Waddensea

Since 2002, the Waddensea is marked as a Particularly Sensitive Sea Area (PSSA). This is an area that needs special protection through action by IMO (International Maritime Organization) because of its significance for recognized ecological or socio-economic or scientific reasons and which may be vulnerable to damage by international maritime activities.[36] Moreover, because this significance, UNESCO has put the area on their World Heritage list since 2009.[37] (Important to note here is that when we talk about the Waddensea in the context of this thesis, we focus on the Dutch part of the area, leaving the German and Danish parts out of the scope.) The Waddensea area is a place to live, work and recreate. The logistic-, trade-, fishing- and industry-ports in the Eemshaven, Harlingen and Den Helder are drivers for economic development and employment. The Eemshaven is the energy port, as described above, Harlingen is an important fishing and shipbuilding harbor, and Den Helder is the center for offshore logistics and maintenance for oil, gas and wind energy. On the other hand, the ferry terminals are used by millions of people yearly to visit the Wadden islands. Recreation and tourism form essential sectors for the area. But not only is the Waddensea important for economic development, but also ecologically seen it is an interesting case. Its status of World Heritage puts it amongst areas like the Great Barrier Reef and the Grand Canyon. Its specific ecologic value is that it is an essential stop for migrating birds between arctic areas and Africa. Moreover, it is the biggest tidal area in the world and moreover the biggest interconnected nature reserve of Western-Europe.

It is this combination of ecology and economy where major challenges emerge. For the Dutch part of the Waddensea, the involved provinces (Noord-Holland, Friesland and Groningen) developed the joint Waddenvision[38]. This vision comprises two main goals. The first is the enforcement and optimal usage of the physical and ecological qualities of the Wadden area. The second is stimulating and making space for (social-)economic development, housing, working, recreation and innovation. The overall goal is that the both main goals will be in balance in the whole Waddensea area. There is a difference within the whole area, since in the Waddensea, nature is leading (because of PKB Waddenzee), while on the Wadden islands an interweaving of nature and economy is leading, and on the Waddenshore the economic drivers will prevail. These sometimes conflicting agendas make it urgent to find a balance in this tension. This is where the Waddenvision aims for social, ecological and economic

[35] TNO persbericht. Green Deal LNG, (2012). http://www.tno.nl/content.cfm?context=overtno&content=nieuwsbericht&laag1=37&laag2=69&item_id=2012-06-15%2013:45:52.0

[36] Waddensea Secreteriat, (2013). http://www.waddensea-secretariat.org/

[37] Waddensea World Heritage, (2013). http://www.waddensea-worldheritage.org/nl

[38] Provinces of North-Holland, Friesland and Groningen, (2013). Wadden van allure! Gezamenlijke waddenvisie. http://www.waddenzee.nl/fileadmin/content/Dossiers/Overheid/pdf/Waddenvisie_v5juli2013.pdf

sustainability. Sustainable is herein defined as a good balance between the interests of people, planet and profit.

Recently (November 2013) the 'Algemene Rekenkamer' has conducted a research focused on the Waddensea area[39]. They examined whether the goal of recent policy change had the assumed effect. Generally said, a lot of nature preservation and spatial planning responsibilities have shifted to a lower governmental level. This decentralization builds upon the assumption that such policies can be best organized and operationalized on local level. The outcome of the research of the Rekenkamer suggests that this recent decentralization has not contributed to better management of the area. The nature aspect of the area has been preserved over the last couple of decades, but it has not improved. Also, the amount of stakeholders has increased dramatically, which has caused a jumble of interests and bureaucracies in the Waddensea. Take for example the responsible authorities: Rijkswaterstaat, Waddenunit of Economic Affairs, Rijksvastgoed en Ontwikkelbedrijf, Defensie, the provinces of North-Holland, Friesland and Groningen, Natuurmonumenten Association, Staatsbosbeheer, Provincial nature associations, the minister of Infrastructure and Environment, the minister of Economic Affairs, the minister of Finance and the minister of Defense. Amongst others, this abundance of stakeholders has brought the Rekenkamer to several conclusions. The first one is that nature and environment are under pressure and that there is too much bureaucracy for initiators of new initiatives. Another conclusion is that there is an abundance of responsible authorities (thirteen in total) and that there is inefficient allocation of money by the Waddenfunds. Third conclusion is that there is a lack of coordination and steering in the policies for the Waddensea, also after the decentralization. The main recommendation of the report is that the government should assign one nature manager, whether this will be the central government or the provinces.

It may be clear that the governance aspect in the Waddenarea is wide and dispersed. There are public and private stakeholders, all with their own tasks, responsibilities, competences and partnerships. Over the last years, the responsibility of the provinces has grown, due to strong decentralization of the central government. But the central government is still end responsible for integrated management of the Waddensea, and has to comply to the European targets of Natura2000. In international perspective, the Netherlands has to cooperate with Germany and Denmark to preserve and manage the Waddensea. This is done by the Trilateral Waddensea Governmental Council, but this scale is not within the scope of this thesis. On the national level again, we see another institution in the Waddensea. This is the Waddenfunds[40], founded in 2004 with an investment of around 800 million euros for the ecology and economy in the Waddenarea. The four main goals which the funds subsidizes are: augmenting and enforcing the nature-values of the Waddensea; reducing or alleviating external threats of the

[39] Algemene Rekenkamer, (2013). Waddengebied: natuurberscherming, natuurbeheer en ruimtelijke inrichting. http://www.rekenkamer.nl/Publicaties/Onderzoeksrapporten/Introducties/2013/11/Waddengebied_natuurbescherming_natuurbeheer_en_ruimtelijke_inrichting

[40] www.waddenfonds.nl

natural richness of the Waddensea; a sustainable economic development in the Waddenarea aimed at a substantial transition to a sustainable energy-system; the development of sustainable knowledge-systems. It is especially the second and the third goal of the Waddenfonds that can be coupled with LNG.

To come back to the Waddenvision, we will now look into the opportunities for LNG in this vision. The first one, the enforcement and optimal usage of the physical and ecological qualities of the Waddensea, does not find much overlap with the theme of LNG. While split up in nature, landscape, culture history and water, the main focus of this goal is not aimed on energy and/or fuel in specific. The second main goal though, stimulating economic development, adds a lot of potential for LNG. The economic drivers in the area are split up in five themes: agriculture, fishing, recreation, ports, and energy. Three of them are of interest for LNG: fishing, ports, and energy. First of all, the vision describes potential for liquefied natural gas in the fishing sector. The Blue Ports Noord-West Nederland are stimulating innovation and cooperation within the sector, of which LNG is a specific topic. One point of attention is the promotion of investments in research and development of sustainable fishing techniques and cleaner fuels. The second relevant theme in the vision, ports, describes the importance of the Eemshaven, Harlingen and port of Den Helder and their sustainability. In the vision for 2030 LNG will contribute to the image of the ships as figurehead of sustainability in the area. Another aim is to develop the Waddensea ports into UNESCO-worthy ports, within not only Eco-certification[41] is important, but also the implementation of LNG. The third theme, preservation of energy systems might be the most important one. This theme focusses especially on the energy transition to a sustainable energy system. The Waddenvision wants that in 2030 all the fishing-, cargo and ferry-ships are using LNG, or even bio-LNG. This will eventually contribute to the autonomy-principle of the Waddenislands, accomplished by a combination of energy reduction, effective usage of fuels and new forms of sustainable energy generation.

This section has provided the answer on the second sub question:

2. In what way is the Waddensea area relevant for the topic LNG?

We have defined the Waddensea area as an UNESCO World Heritage site, which is a very sensitive area that is recognized for its rich ecological and socio-economic value. The borders are set at national level, so the German and Danish part of the Waddensea is not included in the scope of this thesis. Furthermore, we have seen that the area is prone to many forces and interests. Many stakeholders (national government, 3 provinces, municipalities, port authorities, interest communities, etc.) form a political landscape for the Waddensea. We can see that a dynamic political landscape and the ecological and socio-economic values form the context for LNG.

[41] http://www.ecoports.com/

In the described policy documents and visions of the governmental institutions, we have seen that LNG is expected to enter the stage in the coming years. The following section will dive more deeply in the driving and blocking forces of the implementation of LNG in the Waddensea area.

3.2 Drivers and Blockers

Before we put the background on LNG in an academic perspective, we have to understand possible reasons for why LNG is not yet established in the Waddensea. These identified driving and blocking forces will provide a good background for the theoretical framework and the interviews that will be analyzed later on. These drivers and blockers can then be tested against theory and empirical data, and consequently gives a more overall understanding. This will provide us with the answer on sub question 4.

3.2.1 Drivers for a transition towards LNG – Why?

There are several reasons why stakeholders are aiming for LNG implementation in the region, of which four major ones will be described here.

First of all, the north of the Netherlands has a critical position in the energy landscape of the country. If the government wants to induce the transition to a more sustainable future, the Energy Valley is a critical area. Besides, this region is not enough developed in a couple of other energy initiatives. There are no collective solar-power parks in the region. The solar power that is generated, is done on private level at households. Grunneger Power is an initiative that offers households a lot of tools across the whole supply chain, but on basis of a conversation with one of the Board Members[42], it is concluded that this is not big enough to make a satisfying impact. Wind energy plays an important role in the region, but with the current plans of the government to decrease the funds designated for wind energy, this will not be a quick win. Wind mills are now only beneficial because they are heavily subsidized[43], but currently there is not enough money to continue this trend in our country. Therefore, LNG can play an important role in the energy innovations in the north. It is not capital intensive for the government, because companies like the Gasunie and Vopak will have to account for the building of the infrastructure. But the impact of a switch to LNG can give big positive spin-off for the environment, from which the national government will benefit also.

Second, the transport sector and especially the shipping sector are heavy polluters. Despite the described restrictions in the SECA-areas, the shipping sector contributes enormously to the emission of greenhouse gases. By switching to LNG the NO_x and SO_x emissions will decline around 90%, the CO_2 with 20% and also a noise reduction of around 50% is accomplished. This may not be an important factor in the shipping industry, but for road traffic this can give an

[42] Rob Aptroot, vice-chairman Grunneger Power, spoken on September 15th 2013
[43] Centraal Bureau voor Statistiek, (2011). http://www.cbs.nl/nl-NL/menu/themas/industrie-energie/publicaties/artikelen/archief/2011/2011-3497-wm.htm

extra advantage. For example the distributors of supermarkets use a lot of diesel trucks to supply their locations. One of the reasons they are not allowed to supply during evening-hours is the noise these engines generate. When engine-noise is reduced by 50%, this gives new opportunities for distributors like these.

Third driver for the implementation of LNG in northern Netherlands is the image of the region. Not only is it called the Energy valley; Groningen puts itself on the map as 'Gas Roundabout'. Because of the gas reserves in the region (Slochteren for example) and the headquarters of Gasterra and Gasunie located in the city, Groningen has a strong position in the gas market. Good connections with its Russian counterpart, Gazprom, gives us a central position in the European gas landscape. Since LNG is a product based on gas, this would reinforce this position of Gas Roundabout. Moreover, gas makes us less dependent on oil. Not only are the oil reserves quickly declining, but with this comes a high volatility of the oil prices. With the mentioned growing demand for energy, oil prices will keep rising, so a cheaper (and even cleaner) alternative is welcome. Important remark here is that the Netherlands are currently dependent on the import of LNG from countries like Nigeria and Qatar, because the Dutch do not have their own facilities to liquefy their gas. This makes us in certain amount still dependent on the reserves in other countries, but since the gas reserves are bigger and less uncertain than the oil market, this gives gas a stronger position in the energy market in the long term.[44] An estimated worldwide gas reserve of about 50 years is projected.

Although energy is of global concern, economy plays on all levels. So the competitive aspect of a region also should be taken into account. Where Rotterdam and Schiphol profile themselves as the mainports of the country, and Eindhoven is the 'brainport', northern Netherlands should keep its strong position as energy hub of the Netherlands. By broadening the scope towards new technologies, the region is not only innovating, but also spreading the risk. As described, the volatility of the oil market and the uncertainties about the policies concerning the renewable energy sources demand for choices. Choosing for LNG could possibly be a choice with big impacts. It could boost the economic activity by creating job opportunities and shipbuilding activities. This could make the region economically stronger, which is also one of the main goals of Energy Valley Foundation.

In Figure 9, some of the current Dutch subsidies concerning LNG are shown.

[44] Kumar, S., Kwon, H. T., Choi, K. H., Hyun Cho, J., Lim, W., & Moon, I. (2011). Current status and future projections of LNG demand and supplies: A global prospective. *Energy Policy*, *39*(7), 4097-4104.

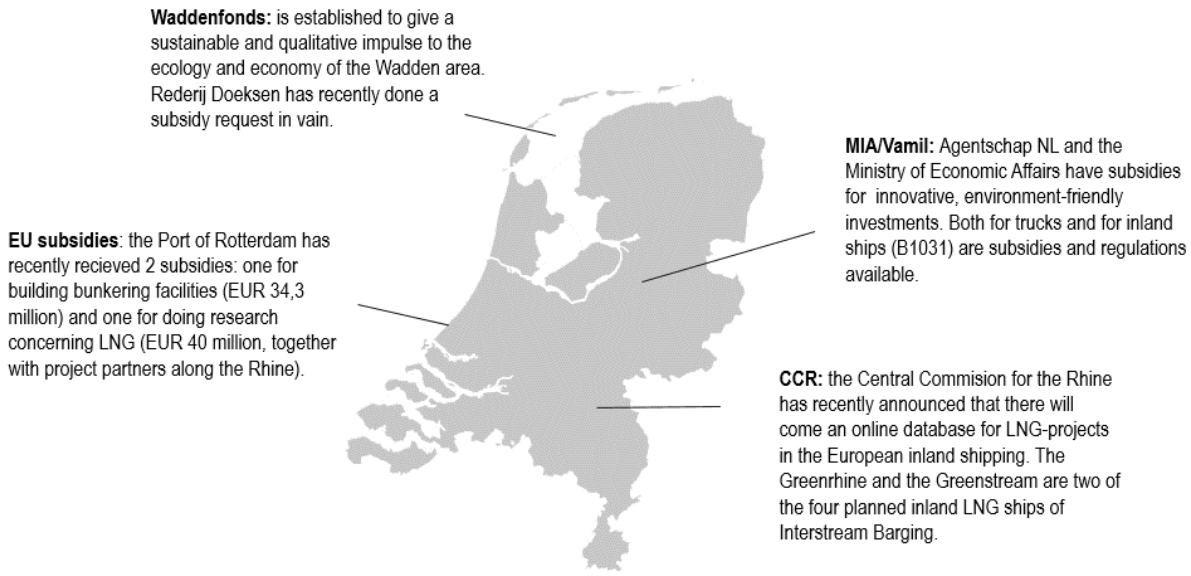


Figure 9 – Current subsidies for LNG in the Netherlands [45] [46] [47] [48]

3.2.2 Blockers for a transition towards LNG – Challenges

The major barrier for introduction of LNG is an economic one. The decision whether or not to implement LNG as a transport fuel is dependent on a couple of factors. A ship-owner has to make an initial investment which he wants to earn back over time. The time in which it is earned back is dependent on the price difference between the current fuel (now mostly MGO) and LNG. Since LNG is not yet implemented widely all over Europe, and the prices are very uncertain. Industry interviews confirm that the uncertainties of the future gas prices play a major role in the decision-making for the construction of gas facilities. Generally, importing LNG from the global market will in the beginning be the most attractive, since this will avoid high investment costs in local facilities. The importing and distribution costs can then be included in the fuel price. Whether or not the price of the fuel will be coupled on the oil or gas price is yet to be decided, so the uncertainty about the price is very high. To make the switch to LNG is thus a risky operation. On the one hand, it could be that the price gap between the current used fuel and LNG will decrease over time, and the initial investment will not be profitable after all. On the other hand, while currently the distribution costs are relatively high, these costs are expected to decrease over time, because of the maturing of the infrastructure. A transport company, for example, should be very positive about the potential of the fuel, and even then there are several other obstacles, besides the economic factor.

[45] Waddenfonds, (2013). http://www.waddenfonds.nl/
[46] Agentschap NL, (2013). http://www.agentschapnl.nl/subsidies-regelingen/miavamil
[47] CBRB, (2013). http://www.cbrb.nl/nieuws/nieuws/442-de-ccr-staat-lng-toe-als-brandstof-voor-de-binnenvaart
[48] Port of Rotterdam, (2013) http://www.portofrotterdam.com/nl/actueel/pers-en-nieuwsberichten/Pages/lng-subsidies-eu-rotterdamse-haven.aspx

The Danish Ministry of the Environment has identified four sorts of barriers for introduction of LNG: technical-, supply-, regulation- and political-administrative barriers.[49] Also possible actions to overcome these barriers are described.

The first one, from a technical perspective, is the more demanding footprint onboard. A LNG tank takes more space than a conventional tank, and therefore the capacity for commercial ends is reduced. New designs of the system and developments regarding the technology of the tanks could diminish or alleviate this problem.

The second barrier, focused on the supply-aspect, is the lack of infrastructure. More concrete, the short sea shipping filling stations in the key ports (in the Netherlands this would be Den Helder, Harlingen or Eemshaven) are lacking. Suggested solution from the Danes is to provide funds for pilot projects. This is to overcome the chicken-and-egg situation. For example, the construction of a supply facility could consequently generate a demand.

The third barrier that is identified, is concerning the regulations. This is then split up in two aspects. First, the ship-to-ship bunkering safety regulations are not in place, and second, the safety regulations for bunkering while the passengers are onboard are an issue. The government should develop and adapt the regulations to overcome this barrier.

The fourth category of obstacles are political-administrative ones. First, there are no rewards for the adoption of natural gas as a transport fuel, so to overcome this there should be innovation incentives available. Moreover, the concession periods might be too short for the demanded capital investments. If possible, the expansion of concession periods could attribute in the solution for this problem. Another barrier is that the rules and regulations for classification of ships are not developed sufficiently, but this expect to co-evolve with time.

Besides the described barriers that are seen in the Danish context, there are some specifically Dutch obstacles. Public perception always plays a key role in the adaptation of something new. Even when a nuclear plant complies to every safety norm and rule, it will always have the image of a dangerous facility. With LNG this is the same. It is new for most people who are not in the business, so it is burdened with skepticism. Most people know LPG from the transport sector, which is highly flammable. Though the name is quite similar, LNG is a significant different fuel. Besides, it has a relatively small ignition-range. To ignite LNG, the temperature should surpass 600 degrees Celsius and the mix with air should be of specific proportions (from 5%-15%)[50]. So in a liquid state, LNG cannot be ignited. These specifications make LNG safer than for example LPG. Whether correct or not, this negative public perception makes that the public support for the new fuel forms an obstacle. Education and instruction are solutions to

[49] Stuer-Lauridsen, F., Odgaard, T., Winter Graugaard, C., Muro-Sun, N., & Andersen, M. (2010). Natural gas for ship propulsion in Denmark-Possibilities for using LNG and CNG on ferry and cargo routes.
[50] Stuer-Lauridsen, F., Odgaard, T., Winter Graugaard, C., Muro-Sun, N., & Andersen, M. (2010). Natural gas for ship propulsion in Denmark-Possibilities for using LNG and CNG on ferry and cargo routes.

change this perception, and this is one of the first steps to be taken to let the consumers make the switch.

Another obstacle is an administrative one. The laws and regulations concerning LNG are not clear and complete yet. Currently, in the Netherlands LNG is under the PGS-regulation (Publicatiereeks Gevaarlijke Stoffen)[51]. This is in close relation with the described point of public perception. Even though LNG does in fact not qualify for the specifications mentioned in the Publicatiereeks Gevaarlijke Stoffen, the slow administrative apparatus is not planning to put in another segment. Moreover, companies are more or less passive in their attitude towards shifting to another fuel. This inertia follows out of another kind of uncertainty. Only the SECA-regulations form a direct incentive for some companies to look for alternatives, but in the rest of the sector these incentives are lacking. Here it is essential that the government takes measures to on the one side stimulate the investment in LNG infrastructure, and on the other side to discourage the continuation of the use of heavy polluting fuels. But, since the shift to LNG is indissoluble with capital investments, it is on the short term more beneficial to 'do nothing' and stay with the conventional fuels.

One other obstacle is again of technical nature. Although the technology around LNG is already applicable, as Norway, Denmark and the United States prove, there are still some small bugs. One very practical one that was mentioned by a truck-owner is that there is no specific engine oil for LNG trucks. You can use oil that is used for gasoline or diesel engines, but then the question raises how this will affect your LNG engine. Another problem is the tanking itself. The technology is ready, but for example the GATE terminal is not yet applicable as a tank station for trucks. A third technical aspect is the (economic) perfect mixture of LNG. (What is the best percentage/ratio methane?) Currently, professor van Dam (RuG) is doing research on this topic, but a lot remains to be done.[52]

All these obstacles lead to at least one conclusion: with the status quo the transition to LNG is not going to occur. A breakthrough in the chicken-or-egg impasse has to be forced so that the mentioned obstacles are set aside. In Figure 10, the identified drivers and blockers are summarized. This summary is the first step to answer sub question 3 (*What are the driving and blocking forces for LNG adoption?*). The second step will be taken after the literature and theory has been complemented with empirical findings in Chapter 7. This then gives us a more complete and area-specific answer.

[51] http://www.publicatiereeksgevaarlijkestoffen.nl/publicaties/PGS33.html
[52] Information on basis of conversation with P. Cnubben, Energy Valley

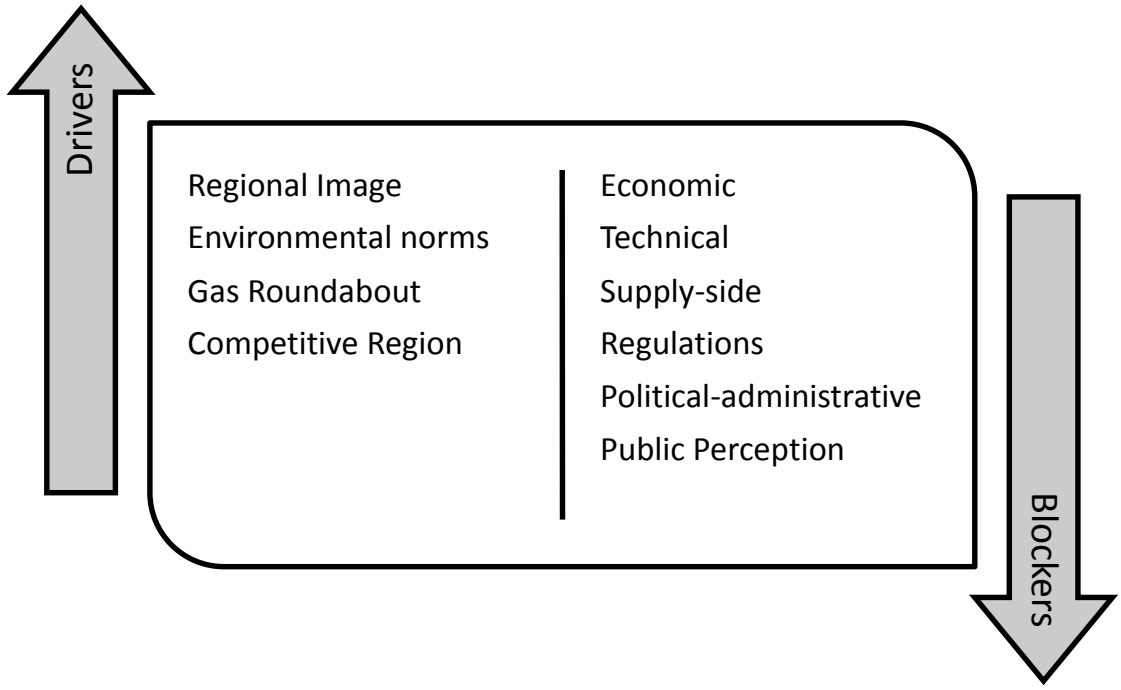


Figure 10 - Summary of driving and blocking forces

3.2.3 Future Developments - Innovation

How these drivers and blockers shape a landscape for different parties is closely related to the diffusion of innovation (Figure 11). The diffusion of innovation, as described by Rogers, is a theory that states that innovations follow a lifecycle that can be split up in five categories: innovators, early adopters, early majority, late majority, and laggards. The first three categories are interesting with regard to LNG in this thesis. The *innovators* are the ones that directly will shift to, in this case, LNG, even if the market and regulations are not very developed. They will be followed by the *early adopters* and then the *early majority* will follow the lead.[53] These adopters are not only needed for a successful development of the market for LNG, but also for a successful transition towards this new transport fuel. Moreover, the diffusion of innovation theory gives us reason to believe that the innovators/pioneers will encounter relatively higher extra investment costs for LNG ships, but that a lower level of investments can be expected as the market gets more mature and a larger number of vessels are equipped with tanks and engines for natural gas.[54] This would mean that because of the relatively high initial investments in the infrastructure, the start of the implementation of LNG in the Waddensea will be 'flatter' and then will steeply progress to come to a maximum. Eventually, in an ideal case, the late majority and the laggards will follow the innovators, early

[53] Rogers, E. M. (2010). *Diffusion of innovations*. Simon and Schuster.
[54] Stuer-Lauridsen, F., Odgaard, T., Winter Graugaard, C., Muro-Sun, N., & Andersen, M. (2010). Natural gas for ship propulsion in Denmark-Possibilities for using LNG and CNG on ferry and cargo routes.

adopters and early majority and the whole market for LNG in the Waddensea will be saturated.

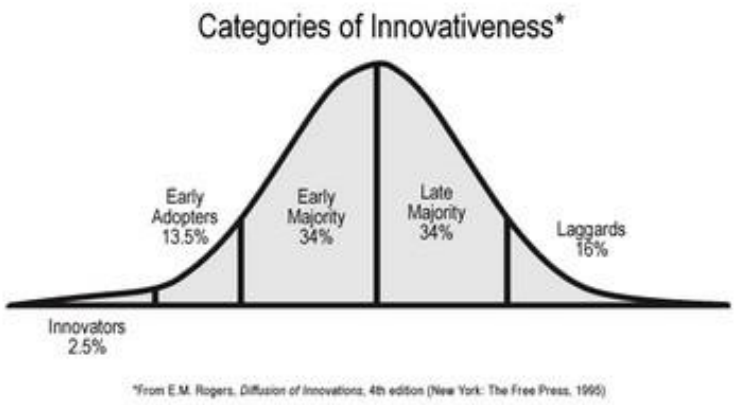


Figure 11 – Diffusion of innovation

3.3 Summary

The scope of this thesis can be divided in two parts. One is the subject of the thesis and the second one is the scale of the perspective.

The introduction has narrowed down to the subject. First, energy was put on a spectrum between economy and ecology. Following, we put the focus on 'transport' within the theme of energy. Subsequently, within the transport sector, we narrowed down to one of the most polluting modalities, shipping. Finally, we zoomed in to one of the most polluting aspects of shipping: the fuel. A recent development within the shipping fuels is LNG, which forms the subject of this thesis.

This chapter has set the background for the subject in a specific area, the Waddensea. First, we started with the highest geographical level, the global level, and described some trends and developments on this level concerning LNG. Then, the countries China and the United States were used to show some developments of LNG in other countries. Following, some geographically closer countries like Denmark, Sweden and Norway were described, to then zoom in on the Netherlands. Because the Northern Netherlands is the area where the Waddensea area is situated, these scales completed the geographical zooming in. When the scope was reduced, we dived deeper into the major driving and blocking forces in the area for LNG implementation. These drivers and blockers, put in the perspective of the diffusion of innovation, will form the basis for the rest of this thesis.

Previous chapters have shown that there are many questions surrounding the subject of the thesis and that there is quite some (inter)national literature and policy documents about it. However, there are two aspects that are not covered in an academic way. First of all, there is no Waddensea specific literature on LNG. This is probably because LNG is not implemented in the region yet. Secondly, the policy documents and other literature about LNG does not put it in academic concepts, like for example scenarios or transition perspective. Following out of these two shortcomings, there is no academic framework for LNG in the Waddensea. These knowledge gaps moves the author of this thesis to complement the current literature about LNG in the Waddensea. To put the findings from the previous chapters in planning perspective then, we have to develop a theoretical framework which will provide tools and a framework for empirical research. Next, the theoretical framework will be elaborated on and subsequently empirical data from several stakeholders will come together with the theory and background.

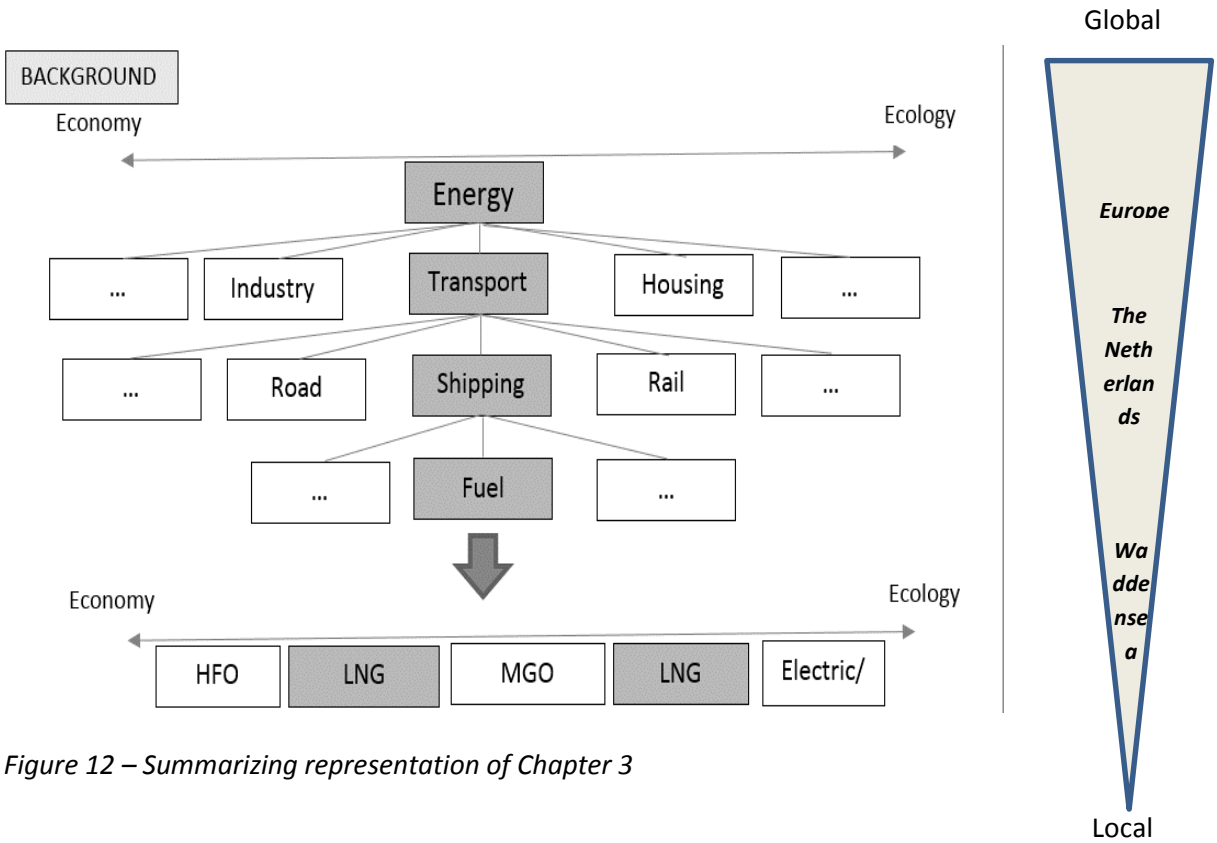


Figure 12 – Summarizing representation of Chapter 3

4 Theoretical Framework

This chapter will outline the theoretical framework. Paragraph 4.1 will describe planning theory and its roots. Paragraph 4.2 will introduce the concept of complexity, followed by scenario theory in paragraph 4.3. Finally, the use transition theory will be clarified and paragraph 4.5 will summarize this chapter.

4.1 Planning Theory

Planning theory is an ongoing discussion about thoughts in and of planning.[55] Planning has no endogenous body of theory and therefore draws upon a wide range of theories and practices from different disciplines. Emerging from theories in philosophy, science in general and sociology, planning theory uses aspects from all these fields. It is concerned with providing a framework based on which planners base their interventions in a wider perspective. In essence, it is about bridging the gap between modern and post-modern thinking within the realm of decision-making related to our physical environment. Modern thinking was based on several assumptions. First of all, it assumes that there is one factual world, which eventually we, humans, can understand completely if we have enough resources (time, money, knowledge). It is object-oriented and evidence-based. This way of thinking originated from Aristotle's philosophical thinking, which was later related to modernist thinking[56]. Opposite to modern thinking, there is post-modernism. Here de Roo identifies aspects from Plato's philosophy. This philosophy is more subject-oriented and based on ideas. Post-modernism sees reality as a construct from the ideas we as humans get. Reality is seen as an agreed reality of the subjects. This means, that due to our (creative) imagination, we can give different meanings to things and things can change of use. This is especially relevant as we have seen with the concept of innovation (see paragraph 3.2.2).

These different perspectives on reality provide us with a lot of theory to build on. To put the development of LNG in a theoretical perspective, this thesis will use different concepts as tools to frame it as a planning issue. One of the concepts often linked with post-modern thinking is complexity[57]. In the rest of this chapter, we will further look into the concepts of complexity,

[55] Allmendinger, P. (2009). *Planning theory*. Basingstoke: Palgrave MacMillan.
[56] de Roo, G., & Silva, E. A. (Eds.). (2012). *A planner's encounter with complexity*. Ashgate Publishing, Ltd..
[57] Cilliers, P. (2002). *Complexity and postmodernism: Understanding complex systems*. Routledge.

scenario's and finally transition theory. This will provide us with tools to develop a theoretical framework for LNG in the Waddensea.

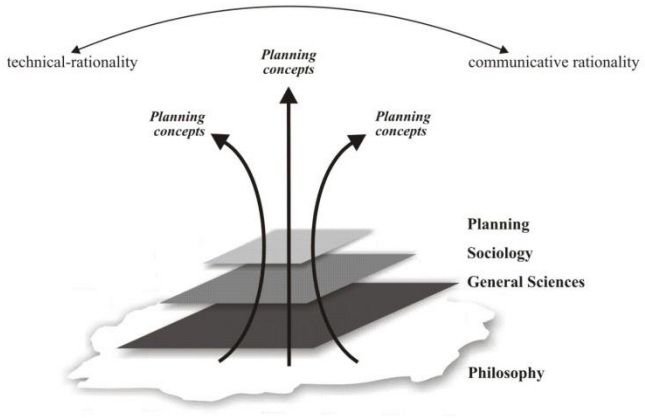


Figure 13 – Planning theory by G. de Roo ('Planning Theory', Lecture series 2013)

4.2 Complexity

In planning theory, the concept of complexity is rising in the last decades.[58] Complexity theory is built upon the principle that most planning problems are somewhere between the two extremes of order and chaos. At one extreme, order, a technical rational approach is appropriate. Consequences are *straightforward* and therefore easy to predict. A top-down planning approach, such as blueprint planning from the post-war era, is in these cases an effective tool. A planned intervention will eventually lead to the predicted outcome. At the other extreme, chaos, things are *very complex* and therefore uncertain and harder to predict. A clear distinction has to be made between complex systems and complicated systems. In the latter one, issues can be predicted when one knows what the linkages between entities, actions, and consequences are. In complex systems, this is per definition not possible. The systems develop in a non-linear way and linkages are not easy to identify, so a top-down planning approach is therefore not the most effective way to go. At this side of the spectrum, more communicative rationality is needed in the form of participatory approach. This bottom-up form of planning takes all stakeholders and their interests into account, and opts to form a consensus. The majority of planning problems though, are somewhere in between these extremes, in the so-called 'fuzzy' middle, where the issues are *complex*. In this fuzzy middle, both technical rationality and communicative rationality are not sufficient to deal with the issues in an effective way. A combination or synergy of the two approaches will be appropriate here. A new development with regard to complexity in planning theory is the aspect of time. In these problems in the fuzzy middle, most of the times, time is also an important aspect. What might be the 'right' thing to do now, might not be the solution in the future. In other words, the difference between 'being' and 'becoming'. This fuzzy middle and the aspect of

[58] de Roo, G., & Porter, G. (Eds.). (2012). *Fuzzy planning: the role of actors in a fuzzy governance environment*. Ashgate Publishing.

time will prove to be useful with regard to the concept of 'scenario planning' in the next section.

Intervening in the fuzzy middle thus has to cope not only with entities, actions and stakeholders, but also with time. Generally said, in the fuzzy middle, systems are not evolving linear, but are still in some way predictable. It is in this realm where the concept of bifurcation is also relevant.[59] A small difference in the starting situation can have major impacts at the end of the process. To give an example, if you would catch the starting point of a development in a value, say 0.0, the end outcome will be 10. In a complex system, with a lot of unpredictability and non-linearity, an input of 0.0001 can mean an outcome of 1.000. Although the starting point might be only relatively minimally different from another situation, the end situation is widely dispersed. And the essential aspect here is that it is not predictable at all. When this is applied to the energy transition and the role of LNG in this transition, this can have a major impact. For instance, if companies and end-users of LNG in the Waddensea area decide to shift to LNG, this has environmental and economic implications for the region. Consequently, this influences the Dutch energy landscape, and since the Netherlands is positioning itself as the Gas Roundabout in Europe, these alterations in energy use will have an impact on the European environmental and economic climate. This could lead to an European-wide increased demand for LNG and therefore steering the global LNG markets. The shift in the global LNG market could affect the national economy of big LNG importers, like Japan. When Japan shifts from using LNG towards nuclear energy again, this can have political and ecological consequences that will find their effects all over the world. This is an hypothetical and extreme example of how decisions and processes on the micro level have their impact on the macro level.

Another way to put LNG implementation in a planning context is in relation with what de Roo describes as the dynamic layer in a system. To find the right dynamics in a system (and a transition), the system should be both competitive as complementary. Regarding competitiveness, things can be said at different levels about LNG. First of all, it is a new fuel in the energy landscape of the Netherlands, so it can compete with the established fuel infrastructure. Another thing is that it can give the Netherlands a competitive advantage over other developed countries, which have not yet developed LNG implementation in their transport sector widely. With regard to complementarity, the northern region of the Netherlands can complement to the Rotterdam region. After all, this is the place where the main Dutch LNG hub, GATE terminal, is situated, but also where the majority of our maritime sector is active. A strong LNG infrastructure to support the supply in the Rotterdam harbor can in the end be a benefit for both regions. Another way in which the Waddensea area can complement the rest of the Netherlands is by stimulating the strong points of the region. Shipbuilding is one of the key strengths of the region, so (re)building ships to LNG-ships is a major opportunity for economic development and employment.

[59] de Roo, G., & Silva, E. A. (Eds.). (2012). *A planner's encounter with complexity*. Ashgate Publishing, Ltd.

Summarizing, when looking at planning problems as seen from a complexity perspective, the literature distinguishes different types of issues, ranging from straightforward to very complex. To effectively cope with these issues, different approaches are identified, ranging from technical rational towards communicative rational. Based on the background from the previous chapter, one can put the case of LNG somewhere in the middle of the spectrum. Some aspects are quite straightforward, other ones are significantly more complex. Moreover, time is also an important aspect in this respect. One of the (planning)tools for these kind of cases is scenario planning.

4.3 Scenario Planning

Scenario planning is increasingly been recommended as a tool for decision-making when dealing with uncertainty. Since the 1990's there has been a rise in the literature about scenario planning[60], though the publications are majorly made by just a handful scholars. Possible influence could be the rise of the scenario's published by the oil-company Shell every couple of years. These scenarios have been received very positively by practitioners and managers that use them as guidelines for their company's strategy.

But despite the positive implication scenario planning seems to have, there is a lack of research on the use and the effects of scenario planning in businesses. Varum & Melo therefore suggest that "the benefits gained in the decision making process from the use of scenario's reside mainly in rendering the process more flexible, more open to criticism and more transparent. The other benefits are not so directly related with what a scenario contains but rather with how it is carried out." We can see three aspects that we can apply in the LNG business as well. By keeping the process more flexible instead of static, keeping them open for critique and make them transparent, the uncertainties and fluctuations in for example the LNG price is decreased as much as possible.

By using scenarios the uncertain variables are projected and estimated in several ways. The low predictability of the factors that are apparent in a relatively new sector as LNG can be accounted by several factors. Wright & Goodwin[61] differentiate three different reasons for low predictability. First of all, inappropriate framing can be one of the causes. Since some planners and decision makers have a narrow frame of references, or ones that are too historically bounded, possible opportunities and threats are left out of reference. The way the problem will be framed is essential for the eventual predictions that are made in the case. If one for example thinks that the LNG market in the US is not of influence for the European market, because of the shale gas, the problem can be framed wrongly. The second reason for low predictability is cognitive and motivational biases. In some cases the motives of for

[60] Varum, C. A., & Melo, C. (2010). Directions in scenario planning literature–A review of the past decades. *Futures*, *42*(4), 355-369.
[61] Wright, G., & Goodwin, P. (2009). Decision making and planning under low levels of predictability: Enhancing the scenario method. *International Journal of Forecasting*, *25*(4), 813-825.

example managers can make that an event's probability of occurrence is underestimated. In the case of LNG, it might be argued that the probability of the collapse of the oil-market is underestimated, which in turn affects the market for LNG. Third reason is the inappropriate attributions of causality. Since in global markets, events and their interactions are very complex because of their high dynamics, a mistake is quickly made. In a chain of events that occur in say the global gas market, it will be very complex to attribute the exact cause for it in the whole chain. When for example the lowering gas price in the US is attributed to the rise in demand of gas instead of to the discovery and exploitation of shale gas, the assumptions and predictions that will follow over course can give problems. Another example of inappropriate causality is that the rising prices of LNG in Europe are attributed to higher distribution costs in the Middle East, while in reality it is because of the dramatic rising demand in Japan because of the nuclear disaster of Fukushima. Wright & Goodwin suggest an enhancement of the current scenario method. They propose four improvements, from which the main conclusion can be that conventional scenario planning operates with two dimensions, whereas a lot of complex problems ask for more dimensions to predict the future. In the light of this thesis, the author does not see concrete reasons to apply these extra dimensions to the scenarios. Main reason is that this research is maybe the first of its kind on this topic in this specific area, and should thus be seen as an introductory step. In the future, if more research will be done on this topic in this area, there will be more information available and it might then be more effective to add more dimensions.

Besides the perspective of dimensions, there are also other perspectives on scenarios. Chermack[62] analyzes scenario planning from the perspective of decision failure. He states that there are four contributors to decision failure: bounded rationality, a tendency to consider only external variables, the stickiness and friction of information and knowledge, and those mental models include decision premises or policies. These four factors are mostly in accord with Wright & Goodwin. Bounded rationality relates with inappropriate framing. Motivational biases have a link with the premised mental models and inappropriate attributions of causality has to do with information/knowledge. In order to reduce decision-failures, there are introduced four solutions concerning scenario planning. First, you can make events more memorable by including them in a scenario. People tend to memorize factors better when they are described story-like in a scenario. Secondly, scenario planning is based on systems view. This means both internal and external factors have to be differentiated and their interaction has to be analyzed. Third suggestion is providing a wider view. This is for example by providing more information from different kind of perspectives. This way, the risk of attributing causality in a wrong way will be reduced. Last solution is to alter the mental models of (leaders of) organizations. One example are the scenarios of Shell. Their planners realized that by just focusing on the scenarios themselves, they were overlooking the core of their work: changing the mental models of the teams they were designing scenarios for. For this thesis, the proposed solutions 1 and 3 will be applied. By summarizing the scenarios in a

[62] Chermack, T. J. (2004). Improving decision-making with scenario planning.*Futures*, *36*(3), 295-309.

scenario-title, a more memorable scenario is aimed for. To provide a wider view, there are many different perspectives taken into account in the methodology in chapter 5.

These decision-failures described by Chermack thus have to be avoided. To understand how we can do so, we have to look at the different approaches a scenario can have. Since a scenario can have different functions (providing insights, communicative function, mobilizing function), there are also different approaches in developing a scenario. There is a distinction made between a model approach and a design approach. The first one is closely related to technical planning, since the problem as it is now is taken as a starting point. It uses calculations to come to a factual based realism with a high explaining power, but with limited scope. The design approach is closer related to communicative planning, since desires for the future are taken as a point of reflection. It uses tools for designing based on values, opts for a large scope, but has therefore limited realism and a limited amount of explaining power. The different approaches can be used as a tool for the different purposes of scenarios. In the context of this thesis, a combination of the both approaches will be used. It seeks the middle between an explaining power with a highly realistic fundament, while using many value-based arguments and assumptions as input for the scenarios in Chapter 7.

While the above gives a brief overview of the advantages and the shortcomings of scenario planning, some further elaboration on the practical use in this thesis is needed. LNG is for several reasons pre-eminently a theme for which scenarios can be used. It is a theme that has an unpredictable nature. Even if one lets shock events like the financial crisis or nuclear disasters out of the equation, still human behavior concerned with big energy markets make the direction hard to predict. Moreover, time is an important aspect. Development in not only the market, but also regulations, rules, perceptions and technology are subject to fluctuations over time. Besides, planning is a field that explicitly intervenes in our surroundings with eye for the future, so it is inherently concerned with time. Another precondition for scenarios is that it has to cover the whole range of possible developments, but the spectrum should not be infinite. In the case of LNG, we can define the range quite clearly. Its position is somewhere between fossil and renewable fuels, it has aspects of economic development and ecological values and it is can develop in a global or a more local way. All these parameters sketch a range in which there are different combinations possible. These different combinations give an insight in the possible images where LNG can play a role in in the future. One image can be that LNG occupies a (small) share of the fuel division, besides conventional oil and gas and maybe renewables. This share can then grow or decline, but its impact is limited since the scale of its implementation is relatively small. On the other hand, the impact of LNG implementation can be so big, that it forces a fundamental change in the current (energy) system. This phenomenon is called a transition.

4.4 Transitions

A transition is defined as: a gradual, continuous process of structural change. It moves from one equilibrium to another, in this case within the energy sector. It is divided in four phases. First, the pre-development phase where the status quo does not visibly change. Second is the take-off phase, where the process of change starts because the state of the system begins to shift. In the acceleration phase the visible structural changes take place through an accumulation of socio-cultural, economic, ecological and institutional changes that react to each other. During the acceleration phase, there are collective learning processes, diffusion and embedding processes. Finally, in the stabilization phase, the speed of social change decreases and the new dynamic equilibrium is reached.[63] It follows the idea that during a transition several different developments reinforce each other, which can also be described as a process of the co-evolution of markets, networks, institutions, technologies, policies, individual behavior and autonomous trends from one relatively stable system state to another.[64]

Transitions can differ in: speed of change, size of change and time period of change. The shift in the energy market is for example a typical transition. It involves all the levels of society; from the macro-level (landscape) to the regimes of the meso-level to the niches in the micro-level. All these levels have to shift in harmony to come to an successful transition. This shift concerning energy is a particular gradual, continuous, but also slow process. Because the conventional fuels are so deeply rooted in every aspect of our society (from gasoline in our cars to oil-based products in manufacturing), the take-off towards another equilibrium is hard to affect.

One of the essential factors in a transition is recognizing and exploiting windows of opportunity.[65] It is a particular moment in time that offers an opportunity for frontrunners to set up an innovation network, a small but open network of visionary people, frontrunners, who are willing to put considerable effort in conducting joint transition experiments.[66] In the case of LNG in the Waddensea, the upcoming IMO regulation with concern to emission reduction is a clear window of opportunity. It forces stakeholders to overthink their current systems and to adapt it to the altered (policy) environment. Frontrunners can make use of this to start the transition. Networks like Energy Valley form platforms for experiments to kick-start the implementation of LNG in practice. So a window of opportunity can lead to a transition in the energy landscape of the Waddensea. But let us put an energy transition in a wider perspective.

[63] Rotmans, J., Kemp, R., & Van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *foresight*, *3*(1), 15-31.

[64] Van der Brugge, R., Rotmans, J., & Loorbach, D. (2005). The transition in Dutch water management. *Regional Environmental Change*, *5*(4), 164-176..

[65] Kingdon, J.W., (1984). *Agendas, Alternatives and Public Policies.* Harper Collins, New York, New York, USA.

[66] Van der Brugge, R., & Van Raak, R. (2007). Facing the adaptive management challenge: insights from transition management. *Ecology and Society*, *12*(2), 33.

Transitions to cleaner and more sustainable energy are at the heart of policies in many countries. Energy transitions replace dominant energy sources by new ones and introduce better, more efficient or cleaner uses of energy. LNG implementation in the Waddensea can also be framed as a transition because it will be a transformation process in which the energy landscape and society will change fundamentally.[67] It is a process of long-term thinking to guide short-term development. It is useful to frame it as a transition because by back- and forecasting, and setting short term goals based on a long term vision, the energy transition can be generated.[68] Energy transitions are approached from a complexity perspective for two reasons: energy transitions are gradual, continuous processes that structurally change the composition of energy sources instead of sudden revolutions. These transitions are typically spanning over at least one generation. The second reason is that it is considered as a societal change, because it affects the macro-level. Not only concerns on local level are apparent, but also global societal concerns and debates. There are a lot of different stakeholders on different levels that participate in their own way in energy transitions. These general characteristics concerned with energy transitions are partly applicable to LNG in the Waddensea. It is a gradual, continuous process and it might take a generation to complete the transition, but the specific impact of LNG in the Waddensea might not have the macro-level impacts all energy transitions have. It might be part of a global energy transition, but it is not so in itself. But also a transition on a smaller scale is not initiated solely by a policy change. The transition can only take place with the support of the public and economic sector. Just changing the rules of the game is not sufficient for a successful transition.

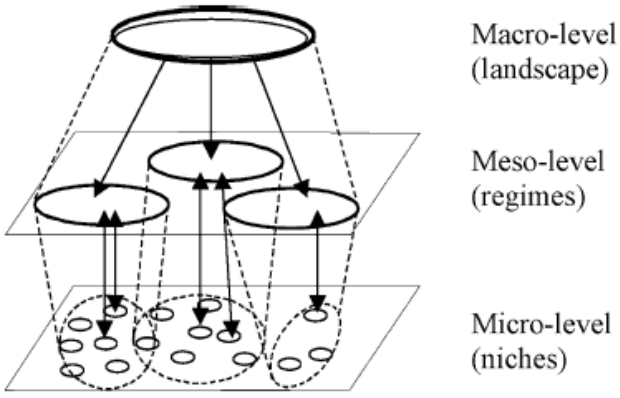


Figure 14 – Multilevel concept

For a successful transition, Loorbach distinguishes three levels: macro-level, meso-level and micro-level. This dividing is called the multilevel concept. The macro-level comprises the highest level, which consists of nations, international organizations and cultures and is related

[67] Rotmans, J., Kemp, R., & van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *Foresight*, *3*(1), 1-31.

[68] Loorbach, D. (2010). Transition management for sustainable development: a prescriptive, complexity-based governance framework. *Governance*, 23(1), pp. 161-183.

to strategic activities. This level is also called the 'landscape'. The meso-level exists of governments, networks and institutions and they are responsible for tactical activities. Another name for this level is the 'regimes'. The smallest scale, micro-level, consists of individuals or individual actors like energy companies. They relate to the operational activities and are operating on the level also known as 'niches'.[69] Within these three levels, the stakeholders have to be in line, but also between the different levels there should be a synergy. Only when the conditions within and between the different levels accord, a successful transition can take place.

Part of transition theory is transition management. A transition management cycle gives four different phases of activities in the process of steering towards an effective transition. Since the complexity of the system makes clear that uncertainty and non-linear processes are involved in the transition, it is unlikely that the steps take place sequential. Therefore, the model is a cyclical one, which takes place on the multiple levels. One step is the problem assessment and organizing a multi-actor network. A second one is developing sustainability visions and transition-agendas. Third one is mobilizing actors and executing projects and experiments. And the last one is evaluating, monitoring and learning. Throughout the sequential phases of pre-development, take-off, acceleration and stabilization, this transition management cycle is of importance to steer the transition in the right direction. Sometimes it is not possible to steer complex systems, but sometimes it is possible for the planner to facilitate or compose conditions for a transition and to 'steer' towards a succesful transition.

Another aspect to take into account for a successful transition is the structure of the system. In order to maximize the benefits of stability while retaining the capacity to change, a system should be both robust and flexible. The combination of this robustness and flexibility differs over the different stages of the transition. While in a stable state the system should be mainly robust with a certain degree of flexibility, this will be the other way around in the acceleration phase. In this phase, the system must be highly flexible in order to adapt to all the changing (external) factors like policy change, developing technologies, influencing stakeholders, fluctuating markets, et cetera. When approaching the stabilization phase of the transition, where another equilibrium is reached, the system should have a solid base of robustness again, and the dynamic capacity can be decreased. The combination of the different phases of a transition, the transition management cycle, and the robustness and flexibility are all put together in Figure 15.

[69] Loorbach, D. (2010). Transition management for sustainable development: a prescriptive, complexity-based governance framework. *Governance*, 23(1), pp. 161-183.

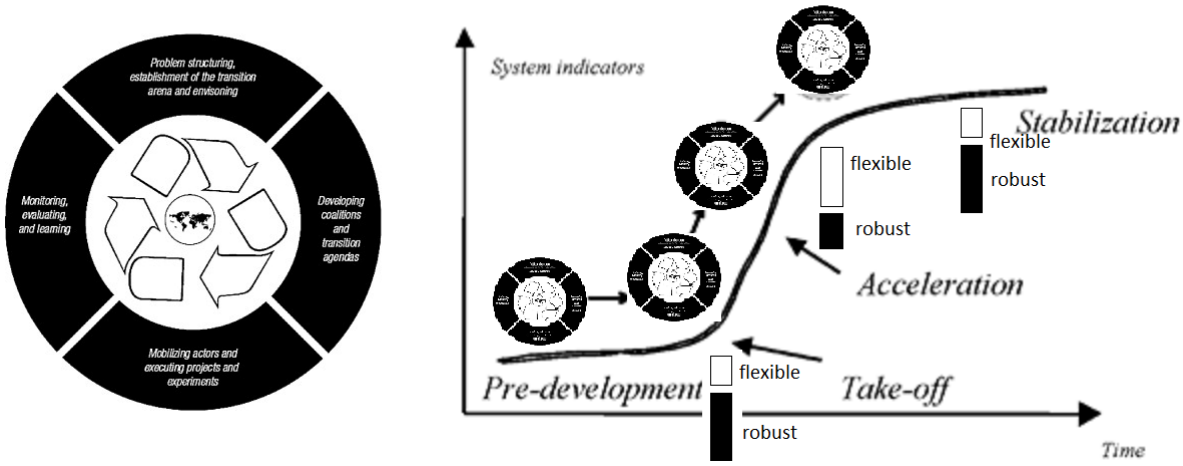


Figure 15 – Transition management cycle in a transition

Two different perspectives on how to look at shifts in our energy landscape have been shown. On the one hand there is the complexity perspective which builds on the multi-phase, multi-level and multi-actor principles. On the other hand, there are transitions from a policy perspective, which argues more that windows of opportunities have to be identified and the lead should be taken by frontrunners or policy entrepreneurs. A common understanding of both perspectives is that the fundamental change in the system is subject to a dynamic interplay between robustness and flexibility. Both perspectives and their common characteristics will be used further in this thesis to put LNG in a planning perspective.

4.5 Summary

In this chapter, the theoretical framework has been defined. Planning theory was used as starting point. Its fundaments in other fields of study like philosophy and social sciences are made clear. In paragraph 4.2, we dove into complexity theory. It is described how the concept of complexity can be used as a determinant for the planning approach. The spectrum of technical rationality to communicative rationality was explained, and the difference in complexity of planning issues was clarified. In the 'fuzzy' middle, where uncertainty and time come into play, we introduced scenario theory. Scenarios have proven to be an effective tool for distinguishing possible images of the future. In this thesis, scenarios will be used in both modernist and postmodernist sense. Although the goal of scenario planning is to comprehend all possible futures in one model, this thesis will describe several possible future, while acknowledging none of them will turn out to become reality. The modernist thinking of understanding and predicting the future on basis of a lot of information is complemented with the post-modernist mindset that complexity inhibits us from total understanding. Besides scenarios, the concept of transitions is elaborated on. This understanding proved useful to explain fundamental change in structure from one stable state to another. Different aspects

of transitions (levels, phases, actors) and different perspectives on transitions (policy entrepreneurs, complexity perspective) are explained and provide the framework in which the empirical data will fit in.

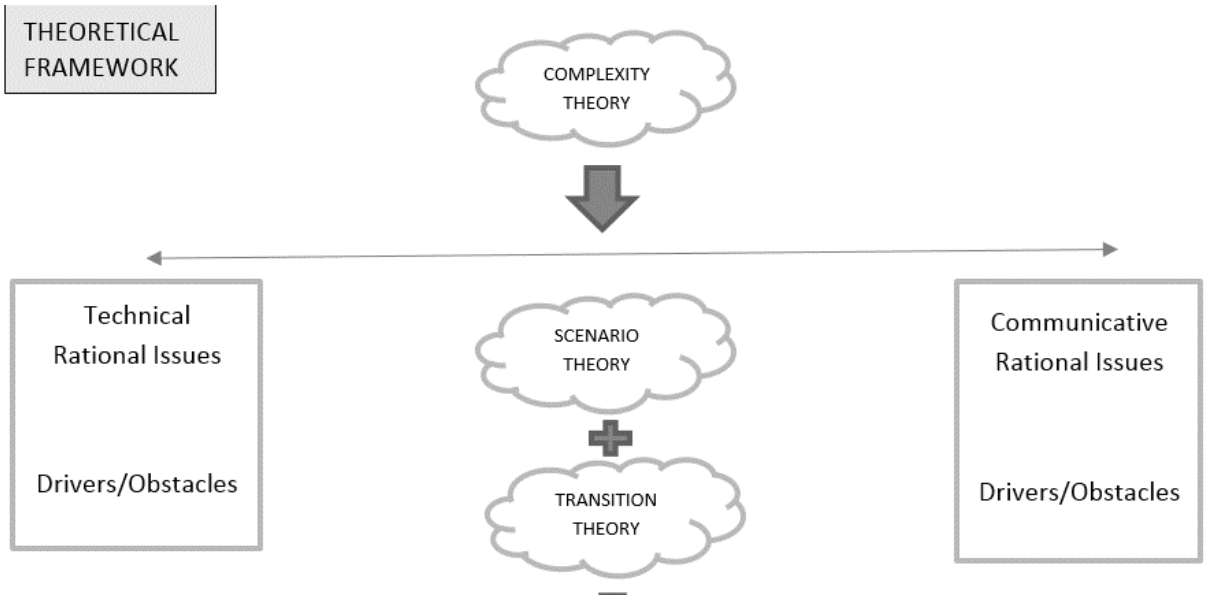


Figure 16 – Conceptual representation of theoretical framework

While the background literature of chapter 3 and the theoretical framework of chapter 4 provide us with general understanding of the subject and the problems at stake, there is one important part of information missing. Waddensea specific characteristics and stakeholder specific information are needed to fill in the framework set by the previous chapters. The following chapter will describe the methodology of the data gathering, and chapter 7 elaborates on the most important findings.

5 Methodology

To be able to answer the research question of this thesis, a specific research strategy has been used. The answer to the research question is concerned with different research methods. As seen in Model 1 (conceptual model), specific LNG literature is needed to provide a background on the matter. Complementary, primary data from stakeholder interviews will add input and will be converted to the driving and blocking forces for LNG in the Waddensea. This chapter will describe the strategy that is used to answer the research question and the choices that have been made in this process.

5.1 Research Strategy – Chosen Alternative

To come to a satisfying result, namely an insight in the driving and blocking forces for LNG in the Waddensea, several options were considered. One option is to search for literature of a similar kind of phenomenon. This could be the adoption of LNG in other (successful) cases, like Norway, Denmark or United States. Here are two problems though. First, no sufficient literature was found which describes the trajectory taken to come to the current state. Multiple reports are written about the current state of LNG in these countries and also some reports about potential for the market, but none specific about the shift to the current situation. Secondly, these areas are significantly different than the area under scope of this research. Many contextual factors make the Waddensea explicitly different than the mentioned other areas. In Norway, the geography and the resources make a big difference, while in the US the total network of infrastructure and relative smaller amount of sensitive coastline form differences. In all comparable areas, UNESCO World Heritage factor does not is apparent, so this already makes the Waddensea unique.

Another consideration was to look at the same scope, but at a different technology. Here we face the problem that there are not many comparable fuels in the Waddensea. CNG is not adopted yet, and electrical sailing is not yet a realistic option. The adoption of MGO is not only so long ago that the literature is not sufficient about this subject, but it is also a total different story. Nowadays, the public perception of a new fuel/technology is very important, while decades ago the fact that the Waddensea could be used for transport was a main driver. Moreover, the current environmental awareness is too important to make it comparable with the oil-era of decades ago. Thus it can be said that comparison of literature of other technologies or areas is not a feasible option. The option left is to gather new primary data. Surveys would be a good option with tens or hundreds of respondents needed and available, but in the case of LNG in the Waddensea, the amount of involved stakeholders is significantly less. Since the groups of respondents can be split up as done in Figure 7 and the number of different perspectives was relatively small, it was chosen to do interviews. These interviews then gave a thorough insight in the perspective of the stakeholder, and can then be compared with the other stakeholders. Later in this chapter, the step from interviews to useful information will be explained. Now, we will first look into the process up to the interviews.

5.2 Process – Background and Theory

First of all, background information on the topic was collected. This was done by visiting websites and reading reports, news articles, and policy documents. After this thorough desk research on the matter, the background was set up and written down in the structure that can be found in Chapter 3. Then the planning theories were linked with the topic and the background matter. During the process, the theories and the links were adjusted several times. These theories came from books, articles and lectures and were applied to the specific matter of the development of LNG in the Waddensea area. The choices with regard to the theoretical framework had to be made on basis of the desk-research and the background information. Because of the many uncertainties around the new developments in the Waddensea, complexity theory came to the front. This would account for the complex linkages between stakeholders and issues. Also linked with complexity theory, is transition theory. Upcoming regulations from the IMO will push the current state of the system to a new form. Whether this will be a fundamental shift towards a new equilibrium or just a re-shuffling of the cards, remained to be seen, but this is where transition theory provides a framework for. Now the background and the theoretical framework have been set, it was chosen to conduct interviews to fill in the gaps. Not only because there is not enough literature to base a research on, but also because this gives the opportunity to analyze the situation from multiple perspectives. Policy documents and academic literature can give ambitions and theoretical perspectives on the matter, but an interview with a ferry company, gas supplier, or nature federation gives another view on the matter. By combining all these perspectives and positions, the aim is to develop an as complete as possible Waddensea-specific image of LNG and its future developments.

5.3 Empirical Data – Interviews

When the theoretical framework was developed and the background of the issues was sketched, primary data had to be obtained to fill in the questions and issues that came forth out of the theory and background. To put the potential of LNG in perspective, several interviews were conducted. On the one side, there are stakeholders that will function as end-consumer of LNG. These are the ferry companies. These are interesting to interview because they are major shipping companies in the Waddensea, with high frequency movements and one home-base. This means they will always come back at their own harbor, which makes the needed infrastructure investments probably more comprehensible. Therefore, interviews are conducted with:

- TESO (Texel ferry line; Bert de Jonge)
  - Interviewed on: 15-11-2013
- Doeksen (Vlieland, Terschelling ferry line; Paul Melles)
  - Interviewed on: 25-11-2013
- Wagenborg (Ameland, Schiermonnikoog ferry line; Pieter Dibbits)
  - Consultation by phone on: 17-12-2013

On the other side, there can be distinguished several parties: political/network oriented organizations, port authorities, technological institutions, ecological institutions and suppliers of LNG. They all have their own specific interest in the Waddensea. Their exact interests and perspectives will follow in the results, but the expectation beforehand will be described at the different interviewed parties. Interviews are conducted with:

- Waddenfonds (Henk Staghouwer)
  - Spoken on Waddenzeehavens conference on: 20-11-2013
    - The Waddenfonds is an interesting party since they are an institution that subsidizes projects in the Waddensea. As the background study has shown, subsidies or incentives like the NO_x-fund have pushed LNG development in Norway.
- Waddenvereniging (Arjan Berkhuysen)
  - Spoken on Waddenzeehavens conference on: 20-11-2013
    - The Waddenvereniging is a party concerned with the environmental side of the Waddensea. They do not provide subsidies, but are more of an interest group, and have some political power since they are stakeholder in many plans.
- Natuur en Milieufederatie Groningen (Siegbert van der Velde)
  - Interviewed on: 17-12-2013
    - The NMF Groningen is also a nature concerned interest group, but more focussed on the on-shore side of the Waddensea. But although the shipping takes place on the Waddensea, the potential bunkering has to take place on-shore, so also NMF is concerned with the overall developments.
- Technologie Centrum Noord-Nederland (Leo van der Burg)
  - Spoken on Waddenzeehavens conference on: 20-11-2013
    - TCNN has specific technological knowledge concerning LNG. They are project-partner in many LNG-related projects, like Passenger Vessel and international projects with MariTim. Because of their expertise in the field and the area, their perspective is interesting.
- Energy Valley Foundation (Patrick Cnubben)
  - Spoken on Waddenzeehavens conference on: 20-11-2013
    - Energy Valley is a major player concerned with energy in the northern provinces, but also with LNG in specific. They have a special ‘cluster’ or taskforce on LNG development, so their knowledge, expertise and experiences are relevant for this research.
- Groningen Seaports (Theo Smit)
  - Interviewed on: 4-12-2013

- Groningen Seaports manages the port area of Eemshaven and Delfzijl. When we look at LNG development in the Waddensea, we also have to look at the port-sides, since this will be where the ships moor and bunker.

- BominLinde GmbH (Ruben Benders)
  - Consultation by phone on: 26-11-2013
    - BominLinde is one of the potential parties that can deliver LNG to the end-consumers. They are interesting to speak to, since they are expected to have a clear supply-side commercial perspective.
- Province of Groningen (Dirk Koppert)
  - Interviewed on: 5-12-2013
    - The province has developed many policy documents about energy in the province and also about visions for the Waddensea. Therefore it is an interesting party to interview, since explicit visions concerning LNG are not widely elaborated on in the documents.
- Harlingen Seaports (Jeroen van der Ende)
  - Spoken on: 12-12-2013
    - Harlingen Seaports is interesting to speak to for the same reason as Groningen Seaports. In Harlingen are other companies active (Doeksen's ferry line, fishermen from Urk), so a different harbor-context for LNG will be apparent.

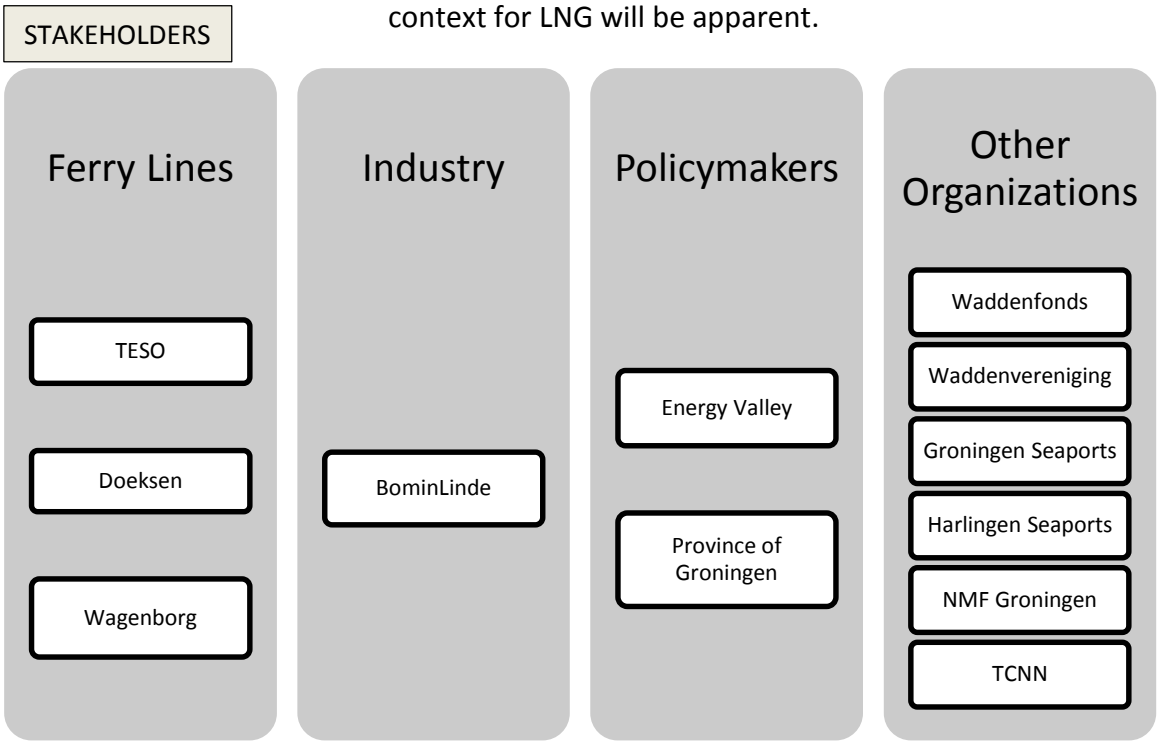


Figure 17 – Interviewed stakeholders structured by category and company

5.4 Interview Method and Questions

The method used were semi-structured interviews (TESO, Doeksen, Groningen Seaports, Province of Groningen, NMF Groningen), conference meetings (Energy Valley, TCNN, Waddenfonds, Waddenvereniging) and consultations by phone (Wagenborg, BominLinde, Harlingen Seaports). The minutes of all of the information gathering can be found in Appendix II to IX.

As a start of the semi-structured interviews, the following questions were used:

- What is your company currently busy with?
- What does 'sustainability' mean to your company?
- What role does LNG has in relation to this?
- What other stakeholders are concerned with the LNG process?
- Which alternatives are there?
- What is your vision on the Waddensea?
- What are your expectations with regard to LNG in the future?
- To what degree do you identify the following drivers and blockers for LNG implementation:
    - Drivers:
        - Green image
        - Positive business-case
        - Innovative incentives
        - Comply to new regulations
        - Additional advantages
    - Blockers
        - Lack of infrastructure
        - Financing obstacles
        - Inertia
        - Unclear regulations
        - Insufficient knowledge about LNG

The drivers and blockers are chosen because of the following reasons:

Green image: Corporate Social Responsibility (Dutch: Maatschappelijk Verantwoord Ondernemen) is becoming more and more a hot topic. Do the interviewed companies want to have an environmental-friendly image to their customers?

Positive business-case: How important are the financials behind the project? A high initial investment will be earned back by reductions in fuel costs.

Innovative incentives: are there financial or political incentives that stimulate to switch to LNG? For example subsidies from the national government.

Comply to new regulations: Are the upcoming regulations and stricter norms of the SECA areas a driver to look at LNG as an alternative?

Additional advantages: Here, one can think of cooling advantages because of the low temperature of the LNG fuel tank.

Lack of infrastructure: the described chicken-or-egg problem. Is the fact that there is no extensive LNG infrastructure network up to now a blocker for LNG implementation

Financing obstacles: are there not enough financial means to make the initial investment?

Inertia: the resistance to change from the current state to another. Is it easier to leave things just the way it is? Are there now not urgent reasons to change the status quo?

Unclear regulations: currently, there are so many uncertainties about regulations and legislations around LNG. Mainly because it is a relatively new transport fuel.

Insufficient knowledge about LNG: Do the companies or entrepreneurs actually know what LNG is and how it can be used as transport fuel? Do they know the regulations and risks?

5.5 Data Processing

To analyze qualitative data there are two methods: deductive and inductive. The deductive method is, amongst others, characterized by setting themes before the interviews are conducted. This is done based on the theory, in this case the background of Chapter 3 (and theory from Chapter 4). On the other hand is the inductive method, where the data will be explored without a set of predetermined themes[70]. Here the goal is to find themes emerging from the data. In this thesis, the deductive and inductive methods are used in a cyclical way. Out of the background literature study, there follow a couple of themes, which also formed the basis for the questions of the semi-structured interviews. But these themes are defined a bit more sharp by the outcomes of the interviews. So both information beforehand and data from the interviews give input to form the themes from Chapter 6 (Findings).

To come to the findings of the following chapter, there were several steps taken. While the interviews were conducted, they were recorded. Afterwards they were typed out. After all the interviews were conducted, they were read and the relevant parts were highlighted (see Appendices). The basis for what is relevant and what is not is based on prior knowledge of the researcher and keeping the research questions and goals in mind. The background literature gives handles to base these assumptions on. Out of these highlights then, overlap between subjects or themes was looked for. After these themes were identified, the similarities and differences in perspective from the different stakeholders were arranged.

After this is done per theme, the themes will be placed in the theoretical framework of transition theory. As mentioned in Chapter 4, transition theory is partly based on the multi-

[70] O'Leary, Z. (2010). *The essential guide to doing your research project.* (3th edition). London, England: Sage Publications Ltd.

level concept. The themes of Chapter 6 are therefore analyzed for their multiple levels and how these are in line. Following the theory, this is essential for a successful transition.

5.5 Conclusion and Outcomes

Following, the agreed and conflicting information leads to general conclusions. These conclusions are then assigned to the different interviewees. Finally, these conclusions are used as input for the different scenarios in Chapter 7. Besides the input from the empirical data analysis, also the different concepts from the theoretical framework come together in the scenarios. The scenarios should be seen as an outcome that follows out of these two inputs, not as an answer to the main research question. It gives an insight in the possible futures for LNG in the Waddensea, but is not scientifically proven on basis of the findings.

6 Findings

This chapter splits (based on the interviews, conversations and workshops) the information and perspectives from the multiple interviewees into nine themes:

- Green Image
- Economic Advantages
- Innovation Incentives
- Regulations
- Additional Advantages
- Lack of Infrastructure
- Cooperation
- Price Uncertainty
- Technology

For every theme, an overview of the most important findings will be discussed, and will be acknowledged to the different interviewees. This is done by linking with the actual citation of the interview in the footnote. In paragraph 6.2, the different themes will be put in the multilevel perspective of the theoretical framework. Finally, the main findings will be summarized and put into an overview.

6.1 Themes

Green Image

All the respondents have emphasized the ecological advantages of LNG. First, in terms of emission reduction, since it will reduce the NO_x and SO_x that will be emitted. Secondly, because the 'cleaner' image of LNG and natural gas in general fits with the profile of the Waddensea as a World Heritage site. Both TESO and Doeksen have said that they see it as their responsibility to respect the area they are operating in and that also a cleaner fuel can contribute to the strengths of the Waddensea[71]. Groningen Seaports has indicated the green image of LNG contributes to a green image for the port in general and consequently can attract new businesses[72]. In this way, the green image can support economic development in the port area. Harlingen Seaport has always been busy being a 'green' port, of which the Eco-certification is a concrete example. LNG does fit in this profile of the port. The province of Groningen has a lot of interests to represent, of which environment or sustainability is also one. They see it as a good development for the image of the region and the profile of Energy Valley. On the side of the Waddenfonds, we see that they are concerned with the type of activities they are sponsoring[73]. The goal of the initiatives they are subsidizing should be in line with the focus area, so in this case the green image of LNG fits in with the green image of the Waddensea. For the Waddenvereniging, not only a green image, but also real green

[71] Appendix II, p. 85 "All…'green'." & Appendix III, p. 88 "Since…possible."
[72] Appendix V, p. 93 "Uiteindelijk…liggen"
[73] Appendix IV, p. 91 "The fund…Waddensea area"

activities are of utmost importance[74]. Since LNG has proven to be more environmental friendly, the Waddenvereniging supports this development.

Overall, it can be said that all the interviewed stakeholders pointed to the environmental benefits of LNG and saw this as an evident advantage for the Waddensea.

Economic Advantages

The economic benefits of LNG can be split up in two. On the one hand, there is the financial benefit of cost reduction in fuel of ship owners. On the other hand, there is economic benefit in terms of employment and economic development. The benefits of the cost reduction has been emphasized by both TESO and Doeksen, though both valued their green ideology higher than money[75]. The benefit of employment was mentioned by the province of Groningen and by Energy Valley. The implementation of LNG in the Waddensea would create a lot of jobs in both the supply of LNG and the shipbuilding sector. Ships that would need to be retrofitted or newly build, can generate economic advantages for the region. For the seaports of Harlingen[76] and Eemshaven[77], the development of LNG means an added value to their port facilities. This could attract new businesses to the area. That can be suppliers of LNG, but also end-users, like companies that have a lot of transportation activities and that can use LNG as a new fuel. For the Waddenfonds, LNG is an interesting case, because it concerns investments which can be earned back over time because of the cost reductions. This gives them reason to think that subsidies may not be the only solution, but that providing credit as a loan might also be a feasible option[78]. Moreover, Energy Valley has emphasized the fact that also the big investments in infrastructure will give an economic boost to the region. Companies like Gasunie and BominLinde will earn money because of the potential new market in the Waddensea[79]. They will have to invest in some infrastructure, but can earn their investments back by the earnings of supplying LNG.

In conclusion, the economic benefits of LNG implementation are pointed out by most stakeholders. If LNG remains to be cheaper than conventional fuels, it will generate cost reductions for the end consumers. Furthermore, the region will benefit in terms of employment and economic activity. Important to note here is that there can be indirect negative effect on the current oil-/gas-markets and the regional economic activity concerned. It could be that the market for LNG in the Waddensea will grow at the expense of current fuel suppliers and infrastructure connected with them.

Innovation Incentives

For the ferry companies, LNG provides the opportunity to be innovative. Although LNG is widely implemented in the Scandinavian transport sector, it is not yet as mature in the

[74] Appendix IV, p. 91 “The Waddenvereniging…developments.”
[75] Appendix II, p. 85 “All…’green’.” ; Appendix III, p. 88 “Doeksen…possible.”
[76] Appendix VII, p. 97 “Van…constructies”
[77] Appendix V, p. 92 “GS…speler”
[78] Appendix V, p. 91 “What…rising”
[79] Appendix VI, p 96 “Koppert…(gasaanbieders)”

Netherlands. TESO has pointed out that they want to do as much as possible to be sustainable[80]. A lot of projects prove this fact, from sensor-based lighting to special antifouling paint. A gas engine is one of the projects to reach their goal to be sustainable. Because of their company targets, they opt to have a new ship operating by the end of 2015. They decided to fuel this ship by gas, but for the short term chose for CNG instead of LNG (because of other reasons highlighted in this chapter). However, they will equip the ship with a gas engine, which means it will be adaptable for LNG use in the future. Moreover, they could function as a role model or example for the rest of the port[81]. The same counts for Doeksen. They have said that other parties are looking at Doeksen to make the first step[82]. This could mean that whenever Doeksen implements LNG successfully, this consequently gives a kick-start in the whole port region. Corporate Social Responsibility is also one of the key pillars of Doeksen[83]. They try to act conform these principles throughout the whole company, from the paperwork at the offices to the fuel in the ships. Doeksen is therefore already looking at LNG for almost a decade, but has encountered some major obstacles, which has led to the current situation that they are still not using LNG. Their request for subsidy to the Waddenfonds has been rejected, so the lack of this stimulation for their innovations is a major obstacle for Doeksen[84]. But their pioneering attitude still gives them an exemplary role for the Harlingen region. The flipside of this slow development is that technology has progressed so much that the option of dual fuel (a combination of gas and oil engines together in one ship, to increase reliability and flexibility in fuel use) can be skipped, and Doeksen is now looking at total lean burn (gas engine)[85].

On the port side, there are other incentives that stimulate the use of LNG. Groningen Seaports has a tool to support the adoption of LNG. They give a reduction on the standard port fee if a ship that operates on LNG comes in the harbour. On shore-side, they stimulate LNG infrastructure development by being willing to co-invest in certain infrastructure projects. Up to today, no concrete plans are made to invest in LNG related infrastructure in the Eemshaven, but the possibilities for cooperation were emphasized by the port authority[86]. For both Harlingen and Groningen Seaports, another incentive to innovate is that the development of LNG facilities will fortify the port's position in the market[87]. A unique selling point like LNG can give the ports a stronger position compared with competitors. The province also has stimulating incentives for LNG. This has two sides. They feel the pressure of the central government and their visions, agreements and agendas (for example: Green Deal LNG, Topsector 'Energy') which forces the province to stimulate initiatives that contribute to these targets. To act upon these set targets, they subsidize innovative projects in different themes.

[80] Appendix II, p. 85 "green initiatives…own ideals"
[81] Appendix II, p. 85 "For example…design)."
[82] Appendix III, p.89 "Other…eventually"
[83] Appendix III, p. 90 "Main driver…things first'."
[84] Appendix III, p.88 "Doeksen…Waddenfonds"
[85] Appendix III, p. 89 "Doeksen…possible."
[86] Appendix V, p. 92 "Schone…speler"
[87] Appendix VII, p. 97 "Er zijn…voegen"

Green Gas is one of these themes, and LNG initiatives are covered by this topic. The province has to make sure though that they do not commit state support, so they have to choose the projects carefully. Besides direct subsidizing in innovative projects, the province is indirectly supporting LNG development by participating (financially) in for example Energy Valley and Groningen Seaports. Finally, the Waddenfonds[88] is a party that is busy with financially supporting projects through which the Waddensea benefits. Subsidies (or credits) from this funds could give different LNG related parties opportunities to develop their projects.

Summarizing, we can conclude that there are multiple incentives on different levels. On the level of the end-consumers, we saw that mainly ideology gives incentives to look at LNG. Within the port authorities, competitiveness is reinforced by LNG developments, so this gives incentives to for example co-invest or reduce port fees. On the governmental side, the province and the Waddenfonds have allocated money to subsidize innovative initiatives like LNG investments.

Regulations

The regulations concerning LNG are both clear and unclear. On one side, it is very clear that the emission norms will become stricter starting in 2015, and they are expected to become even more stricter in the following years. Also, when you look at global environmental policies, and the Dutch policies like the Energie-akkoord, one could expect the environmental regulations to become stricter over time[89]. On the other side, parties like TESO and Doeksen have pointed out that the development of regulations is not consistent and reliable. Although the government is publicly promoting LNG for years, they lack real steps to stimulate this, according to Doeksen[90]. TESO acknowledges that they expect the regulations to be in place for wide LNG adoption in 2017. They have done a lot of lobbying, but are frustrated by the way EU regulations work. Mostly, these regulations come afterwards. So they are more like a test after plans are already made. Instead, TESO would like to see that they help parties like themselves to develop their plans in line with EU targets. Doeksen also questions the attitude of the government. It is not clear how they stimulate pioneers like Doeksen. They see two obstacles that are accounted for by the government. The first one is the subsidy request, which was rejected by the Waddenfonds[91]. The second one is a lawsuit about the concession for their activities. Currently, it is not clear whether Doeksen will get the monopoly to ship to the islands of Vlieland and Terschelling. If the EU decides that their competitor (Eigen Veerdienst Terschelling) may continue to compete, the capital investments for a shift to LNG will be too costly to earn back in due time[92]. Doeksen is currently waiting for the decision in this lawsuit, and expects this to finish in about 1,5 years. With concern to existing regulations about emissions, Doeksen is already complying to these and also to the upcoming SECA

[88] Appendix IV, p. 91 “The fund…system.”
[89] Appendix VI, p. 97 “Beleidsvoornemens…vurgunningen).”
[90] Appendix III, p. 92 “But…counteracts.”
[91] Appendix III, p. 90 “A year…the fund.”
[92] Appendix III, p. 90 “This cargo…are taken.”

regulations of 2015. Their current fuel, low-sulfur MGO, is already 'clean' enough for the norms. So there Doeksen does not expect any difficulties in the near future[93]. For the port authorities, regulations are twofold. They are tied directly to regulations from the central government, and therefore have no possibilities to diverge from these directions[94]. Harlingen Seaport sees the ideal role of the government as a facilitating one. They should not hinder market developments, and facilitate where possible. Regulatory freedom is one of the aspects how this can be achieved[95]. They should not restrict or bureaucratize everything. Where the port authorities do have influence, is in the locating process. When a company wants to build a LNG facility for example, the ports can facilitate or hinder the developments. They do not make the rules though, since this is appointed to the provinces[96]. The province issues the permits for specific activities. This is what the province has pointed out as their main influence. One other possibility is to lobby as a province in the national politics. This is also where parties like the Waddenvereniging can influence the process. Although they cannot make rules, they have a major impact in the politics and therefore can indirectly influence the regulations. One possibility both the Waddenvereniging[97] and Doeksen[98] named, was that in the future the concessions for the Waddensea could contain specific directives to sail on LNG for example.

To sum up, five issues can be distinguished in the field of regulations. First, the upcoming regulations about emissions are clear to all the stakeholders. In second place, because of inconsistencies between the words and the deeds of the politics, there is still some uncertainty about future developments. In third place, the process of international regulations is not satisfactory. The EU uses policies afterwards, instead of as directive. Fourth issue is the power of the provinces. In general, they are constricted by national policies and regulations and they have only influence in the permitting process. Finally, the role of interest-parties is not one of making rules, but of high influence in the political lobby.

Additional Advantages

Two other advantages are discussed by the interviewed stakeholders. A very practical one is the fact that the risk of an oil spill will be reduced when implementing LNG in the Waddensea. Doeksen[99], the Waddenvereniging[100], and the province of Groningen[101] all have explained the evident advantage. In case of an accident with a ship propelled by oil, it would have disastrous impacts. Because of the structure of oil, it will not mix with water and there will emerge a puddle of oil on top of the water. Since the Waddensea is a tidal area, the oil will spread relatively fast and be extremely difficult and costly to clean up. This will affect the fauna and flora of the whole area and might even deplete certain species. In case of an accident with a

[93] Appendix III, p. 90 "Doeksen…though."
[94] Appendix V, p. 95 "Restricties…veel invloed"
[95] Appendix VII, p.98 "Van den Ende…deze constructies."
[96] Appendix V, p. 95 "Conflicterende belangen…het gebied"
[97] Appendix IV, p. 93 "The Waddenvereniging…a whole"
[98] Appendix III, p. 91 "Maybe…fuel"
[99] Appendix III, p.91 "Another…apart"
[100] Appendix IV, p. 93 "An example…Waddenvereniging"
[101] Appendix VI, p. 96 "Koppert…het Wad"

LNG ship, this would mean a spill of liquid gas, but when it is exposed to outside temperature, it will immediately evaporate and not mix with the water. In this way, it will not affect the ecosystem through the water. One important negative effect though is that the evaporation of LNG means that large amounts of CH_4 (methane) will go into the atmosphere, and since methane is one of the most polluting greenhouse gases, the environmental impact on a global scale will be bigger than an oil spill. The second advantage that the stakeholders identify is the synergy between economy and ecology. Doeksen [102], Province of Groningen [103], the Waddenvereniging[104], Groningen Seaports, Energy Valley and TCNN[105] all emphasize the positive combination of a cheaper and more environmental friendly fuel. The province used the example of Power-to-gas to explain the strong benefits of LNG[106]. The new technology of converting power to gas is also an economic interesting case, since it will reduce energy losses and therefore cause benefits from the extra energy resources. Although the technology itself is interesting for parties in the region, it would also mean the attraction of more companies to the region, which eventually will lead to more environmental impact in the province. LNG does not have this compromise. It has both the economic benefits and is besides that a cleaner option for replacing conventional fuels.

By way of conclusion, besides the advantages already distilled from the background literature, two major advantages are pointed out by the interviewed parties: the avoidance of an oil spill and the synergy between economy and ecology.

Lack of infrastructure

Lack of infrastructure is one of the main parts of the chicken-and-egg impasse. The idea that there will come no infrastructure if there is no demand and that there is no demand if there is no infrastructure, is partly true and partly dated. TESO does see this obstacle, since they encountered this problem with their potential suppliers[107]. TESO was willing to build their new ship on LNG, but was looking for supply of the fuel in a cost-effective way. But because they are currently the only interested party in the port of Den Helder and on Texel, the suppliers saw only delivery by truck as an option. This will give high transportation/distribution costs, and therefore makes the business case for TESO less attractive. It can be said that the lack of infrastructure is one main blocker for LNG adoption for TESO. Doeksen[108] on the other hand acknowledges that this was a problem a couple of years ago, but that it nowadays is not really a problem anymore. They pointed out that LNG can be brought to Harlingen tomorrow, if necessary. The seaports are open to the advent of LNG in their harbours, and combine their forces and knowledge in for example co-operations like the Waddenzeehavens. Here they all declared their willingness to stimulate LNG and the infrastructure necessary. As already said,

[102] Appendix III, p. 92 “Main driver…take action”
[103] Appendix VI, p. 98 “LNG…minder”
[104] Appendix IV, p. 93 “The Waddenvereniging…association”
[105] Appendix IV, p. 93 “First…bigger”
[106] Appendix VI, p. 98 “Verder…minder”
[107] Appendix II, p. 87 “The supply…built though”
[108] Appendix III, p. 91 “The infrastructure…as possible”

Groningen Seaports is also up to co-invest in the infrastructure[109]. The provinces and Energy Valley are more the mediators in the process and are stimulating the dialogue between end-users and suppliers[110]. Harlingen Seaports has a particular interesting view on this aspect. They think that market forces will work the most effectively. By letting the gas companies negotiate with the ship owners, the most cost-effective solutions arise. The gas companies can for example subsidize or invest in the retrofitting or new building of ships, in return for a secured contract for delivery of LNG for about 15 years. In this way, the risk for the ship owner is reduced by the investment of the gas company, and the gas company is secured of a long term customer[111]. TCNN sees cooperation and communication between the multiple harbours as a positive development since this could cause integrated infrastructure contracts to emerge. By combining the harbours, the infrastructure can be coupled smartly for example[112].

Summarizing, some parties see the lack of infrastructure as a major obstacle, while other parties don't see this problem anymore. The perspective of a couple of the stakeholders is that market forces will overcome the impasse and provide the best solution for both supplier and consumer.

Cooperation

All the interviewed stakeholders described the presence and importance of cooperation and communication. Cooperation takes place on different levels. First, the multiple ferry lines (TESO, Doeksen and Wagenborg) collaborate and communicate about their knowledge of LNG[113]. They do so also internationally, for example in the project iTransfer[114], where multiple ferry lines across Germany and Denmark also are active. The second level where stakeholders collaborate, is on the level of the seaports. The seaports of Den Helder, Den Oever, Harlingen, Lauwersoog and Eemshaven/Delfzijl collaborate in initiatives like 'Waddenzeehavens'[115]. Frequently, debates and conferences take place in which these seaports participate. Third level of collaboration is on provincial level. The provinces concerned with the Waddensea are North-Holland, Friesland and Groningen. Together they formed a partnership and together developed policy documents like the described 'Waddenvisie'[116]. Also internationally there are collaborations, for example the partnership between Energy Valley and Mariko, Germany. TCNN emphasizes the importance of the collaborations, because of three reasons[117]. First of all, the message to national and international politics is stronger if all ports act upon the same vision. Second, it can have economic benefits in the sense that integrated infrastructure contracts can be negotiated over the whole Waddensea. And last, but certainly not least, the environmental impact will naturally be much bigger when all stakeholders participate and

[109] Appendix V, p. 94 "Bereidheid…structuur"
[110] Appendix VI, p. 97 "Beleidsvoornemens…milieu"
[111] Appendix VII, p. 98 "Van den Ende…constructies"
[112] Appendix IV, p. 94 "The representatives…sustainability"
[113] Appendix II, p. 88 "Because…knowledge sharing"
[114] Appendix II, p. 86 "One…iTransfer"
[115] Appendix IV, p. 93 "Netelenbos…goal"
[116] Appendix VI, p. 97 "De Waddenvisie…aan"
[117] Appendix IV, p. 94 "The representatives…sustainability"

make the shift to LNG. The flipside of all these interactive links between stakeholders is pointed at by the province[118]. The density of stakeholders and activities also makes the process less effective. This is because of reduced responsibility and vagueness about tasks. The Algemene Rekenkamer has therefore suggested to appoint one central managing stakeholder for the whole Waddensea, in order to make the whole more understandable and clear. Overall, many stakeholders acknowledged that there are many gatherings, conferences, meetings and institutions about LNG, but the concrete steps are still missing. There is a lot of talking about the subject, but really implementing it is not happening. TESO indicated that they are still very busy with LNG but do not attend all the meetings because of the described objections[119].

In conclusion, it can be said there are many partnerships and collaborations over the whole Waddensea. Though this has many positive effects, the consequence is also that there are many stakeholders and interests and the management of all these is hampered by all the activity. A lot of conferences and knowledge-sharing platforms exist, but practical steps are missing.

Price Uncertainty

Energy is a dynamic sector because of the constantly changing resource reserves and market and political forces connected with these resources. Fossil fuels in specific are subject to price fluctuations that are influenced globally. This is the case with kerosene, LPG, coal, heavy fuel oil, marine gasoil and also LNG. Liquid fuels can be traded at world markets, whereas with natural gas this more difficult. It is feasible to transport it through pipelines, but only for a limited distance. It might be that after a certain distance, the transport costs will be higher than the price difference of gas in the two connected areas. By liquefying natural gas, the transport possibilities increase, and that makes it possible for a global LNG market to exist. Due to global influences on global markets, price fluctuations exist. These fluctuations are the cause of a lot of uncertainty. Although the price of for example one tonne of MGO on this very moment is quite certain, the price of the same oil tomorrow is already subject to predictions, and the same oil in a month or a year is only as predictable as the weather. This uncertainty linked with fuel makes investments in new ships especially risky. Both TESO[120] and Doeksen[121] acknowledge that despite their 'green' ideology, the businesses have to account for economic benefits and that uncertainty is essential in this aspect. LNG is a feasible alternative for MGO as long as it is (significantly) cheaper. But it also has to remain cheaper for quite some time to be feasible. Capital investments in the ships have to be earned back, and the only way to do this is by the gap in the prices of the fuels. When there is not enough certainty about the price of LNG, the investments are too risky. Both ferry companies declared that this is of course an essential parameter in a private company. The seaports are less concerned with this price

[118] Appendix VI, p. 96 "Er zijn…gebied" & p. 97 "Hoe…spelen nu"
[119] Appendix II, p. 89 "Back to…the goals"
[120] Appendix II, p. 87 "All the…connected"
[121] Appendix III, p. 92 "Main driver…aspect" & "Maatschappelijk…first things first"

uncertainty. Simply said, they do not really care which fuel is distributed and used in their port, as long as it is according the rules and it is good for the economic activity[122]. The governments (national and provincial) though, have a key role in the issue of fuel prices. Taxes can play an essential role in the attractiveness of a fuel. Doeksen saw the danger of the government misusing their power to increase the taxes on LNG when the market is maturing[123]. This will benefit the state, but makes the fuel more costly for the end consumers. Recently though, the announced tax increase on LNG was not put through in the Netherlands, so the prices remain relatively low in comparison with HFO and MGO. Another obstacle, which also results in price uncertainty, is the supply chain. TESO[124] and the province[125] has put the problem of not-closed supply chain forward. Where in the oil industry the whole chain is closed, from upstream into the ship's tank, LNG lacks this complete chain. There are several parties that pump the gas up and liquefy it (for example Shell in the Middle East). Sometimes the same parties transport the fuel all over the world, but then the storage is done by another party. After the storage, the distribution has to be done by another party, especially in the Netherlands, where LNG at GATE is mainly used for the gas network. Independent fuel distributors have to transport it to end-consumers then. Due to inefficiencies and possible gaps within the chain, security of both price and supply are uncertain.

In summary, liquefying natural gas makes it possible to make the gas market global, whereas it is now mostly regional. This can have different impacts on the price the end consumer will pay for it, but it is certain that uncertainty about the price will rise. Also the underdeveloped supply chain of LNG reinforces this uncertainty.

Technology

Although LNG in the Netherlands is a recent development, LNG technology in general is not, respondents pointed out. Already a couple of decades under development, LNG is a proven technique in the shipping sector, following Doeksen[126]. TESO[127] and TCNN[128] agree with this point, pointing at the LNG history in Norway. Only because it is new in the ears of a lot of people, they conclude that there must be increased risks concerned. Doeksen[129] bases its confidence in LNG on the professional literature and research in the United States. One misunderstanding is that LNG on board is very explosive. First of all, only in a highly improbable situation (because of the safe track record of LNG) of a crash, the tank will crack. Even if this tank cracks, the consequences aren't that dangerous. The liquid will drip out of the tank and will then evaporate. Because of the specific fuel characteristics, LNG is also not easily flammable. The ratio gas/air should be between 5/100 and 15/100, and the temperature

[122] Appendix V, p. 94 "GS…naar LNG."
[123] Appendix III, p. 92 "Taxes…example"
[124] Appendix II, p. 89 "Main problem…option" & "
[125] Appendix VI, p. 98 "Grote belemmeringen…leveringszekerheid"
[126] Appendix III, p. 91 "it is…the shelve'"
[127] Appendix II, p. 89 "When…Sweden"
[128] Appendix IV, p. 94 "It was…the Netherlands"
[129] Appendix III, p . 91 "For policymakers…the shelve'" & p. 92 "Also the…in LNG"

should be at least 600 degrees Celsius. Doeksen thinks LNG just has to be implemented, and the public should not be scared because it is a new development. TESO also touches upon the safety of CNG. This technology is already applied in a lot of public transport busses around the Netherlands, and is not very different from the application on ships. TESO therefore sees even less technical barriers for CNG adoption than for LNG[130]. The gas is pumped into the tank after it is compressed and this is done by a normal hose like also cars tank LPG. In respect of the engine, TESO also has an adaptable solution. They are planning to build in a lean burn (gas) engine, which can be fuelled by both CNG and LNG. Only the preceding process, so before it comes into the engine, is different for both fuels[131]. TESO does this because they expect LNG to be implemented also in their ships in a couple of years from now[132]. Besides LNG and CNG, BioLNG is a slightly different technology. The application as a fuel is the same as LNG, but the production is the difference between fossil and renewables. BioLNG is produced out of biomass and is therefore a renewable solution. Energy Valley is also busy stimulating projects concerned with BioLNG, but the province of Groningen pointed out that there aren't a lot of activities in the province currently[133]. Many of the interviewed parties acknowledged though that this will be the goal where LNG should ideally eventually lead to[134]. This is because it is then an even 'cleaner' fuel than LNG. Although the Waddenvereniging [135] is not really concerned with the technology around LNG, there is one thing that takes their interest: spatial and visual impact. They stated that they support LNG, as long as the spatial and visual impacts in the Waddensea are reduced to a minimum. Developing technology in storage facilities will contribute to this, but also factors within the ship itself. With LNG, there will not be a black cloud of particulate matter blown into the air out of the ship. This is one important visual advantage of LNG, which deserves the appreciation of the Waddenvereniging.

It can be concluded that LNG is an already proven technology. Based on experiences in for example Norway and the US, the safety and efficiency of LNG is proven. A more recent development linked with LNG is BioLNG, which makes the fuel renewable instead of fossil. Multiple stakeholders see BioLNG as the ideal fuel and as a goal for the future.

[130] Appendix II, p. 87 "CNG has…the island"
[131] Appendix II, p. 88 "Engine system…in the future"
[132] Appendix II, p. 87 "TESO expects…the expectation"
[133] Appendix VI, p 98 "BioLNG…stap zijn"
[134] Appendix III, p. 91 "A good…sustainable" & Appendix VI, p. 98 "BioLNG…stap zijn" & Appendix IX, p. 101 "Wat is…transport"
[135] Appendix IV, p. 93 "Key question…Waddensea" & "Furthermore…opposing"

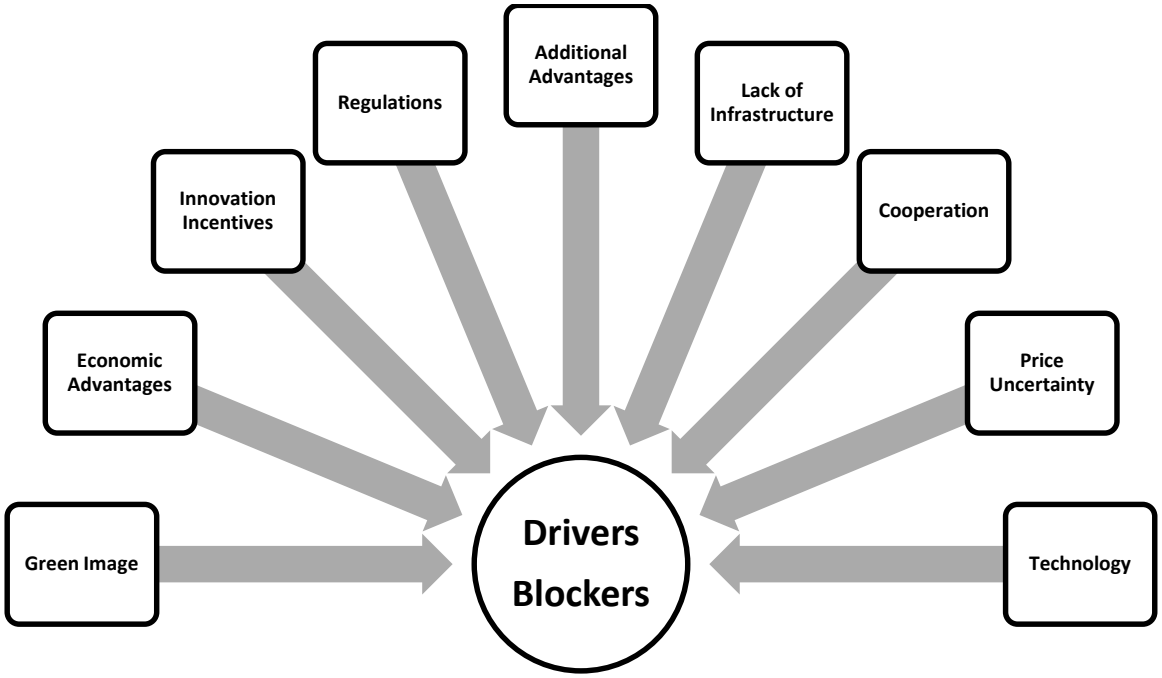


Figure 18 – Themes of drivers and blockers

Figure 18 summarizes the different driving and blocking forces for LNG adoption based on interviews. The nine themes together give an area-specific answer on sub question 3 (*What are the driving and blocking forces for LNG adoption?*). A further elaboration on the multilevel character of the themes will be made in the next section. In chapter 7, the drivers and blockers will be summed up once more and will be linked with conclusions made in section 6.3.

6.2 Multilevel concept in themes

Green image

On macro level, the stakeholders acknowledge that a green image is both on national level and regional level of importance. Public interest in green initiatives and the environment, and especially in a sensitive area like the Waddensea, is a rising trend.

On meso level, the norms and regulations concerning NO_x and SO_x are getting stricter. The stakeholders identify compliance to emission standards as an important aspect of LNG.

On micro level, the end consumers see the ecological advantages of LNG. Not only the emission reductions, but also the green image LNG will give the company are mentioned benefits.

Economic Advantages

On macro level, the economic development of the Waddensea as a whole is in line with national interests. The Waddenfonds, established by the national government, is there to preserve ecology and stimulate economic development. LNG is serving the latter goal in the way that it generates shipbuilding activities in the region as well as LNG storage and distribution facilities. This will generate jobs and economic activity in the area.

On meso level, the regulations and policies are in line with the development of LNG. Energy Valley's goal is to facilitate and stimulate economic activity and employment, and LNG is one of the developments in this vision.

On micro level, the end consumers like the ferry companies will benefit from the economic advantages by the cost reductions related to their fuel consumption. Gascompanies like Gasunie and BominLinde can gain economic advantage from the potential new market that emerges in the region.

Innovation Incentives

On macro level, the opinions about the innovation incentives is not unequivocal. Although the Waddenfonds proclaims to stimulate LNG related investments, the individual companies like Doeksen do not agree with this. Their request for subsidy was rejected multiple times.

On meso level, the port authorities and provinces are promoting LNG use by decreasing port fees and giving subsidies for LNG related projects. This is in accord with their visions and strategy for the region, namely facilitating and stimulating 'green' initiatives.

On micro level, the ferry companies are mainly driven by ideology. Their main incentive is to get a greener image, although economic aspects always play a role. They acknowledge that image is important, but at the expense of everything.

Regulations

On macro level, the regulations are very clear. In 2015 the SECA will apply their new norms concerning SO_x and a couple of years later, the IMO will further decrease the NO_x norms.

On meso level, the policies and regulations by the provinces have to be in accord with the national government's policies and rules. On provincial and local level there is not the freedom to diverge from these rules.

On micro level, there is a lot of uncertainty with the ferry companies. TESO and Doeksen do not know what to expect. They know the international norms of SECA and IMO, but say that the national government is not clear about their strategy. What will be the consequences for not complying to the norms and what does the government do to stimulate a shift to LNG? These questions are concerning the individual companies at micro level. For Doeksen in special, the uncertainty surrounding the concession of their ferry line is an extra blocker for a shift to LNG.

Additional Advantages

On macro level, the position of the Waddensea area as a UNESCO World Heritage Site is a very important aspect. By implementing LNG as a fuel in the Waddensea, the risk of an oil spill is significantly reduced. This is advantageous for the Waddensea's position as sensitive area.

On meso level, this risk-reducing benefit is acknowledged by stakeholders like the Waddenvereniging and NMF Groningen. Moreover, the synergy between ecology and economy is highlighted by all stakeholders.

On micro level, especially this synergy is emphasized. While reducing the environmental impact, the companies do not have to increase their costs, but even reduce them.

Lack of Infrastructure

On macro level, the national government does acknowledge the chicken-and-egg impasse, but do not take concrete steps to break it. Many conferences, meetings and information sharing takes place, but stakeholders argue that this does not solve the practical problems.

On meso level, the rules and regulations are not yet in place for developing the necessary infrastructure. Permits have not been issued, and it is not even allowed to ship on LNG currently. Despite this situation, several stakeholders expect these obstacles to vanish in the near future.

On micro level, the lack of infrastructure plays a major role. All ferry companies identified this as an important blocker, though all in different ways. TESO identifies the consequence of too high distribution costs because of a lack of infrastructure, while Doeksen does not encounter this problem. Wagenborg argues there is the practical impossibility to obtain LNG at their bunker location.

Cooperation

On macro level, there is international cooperation between the Netherlands, Germany and Denmark about their Waddensea. Moreover, international institutions like IMO have partnerships with all countries to support their policies.

On meso level, parties like Energy Valley are participating in many partnerships. Both internationally, with the German Waddensea, and regionally, by linking the Waddenzeehavens.

On micro level, also the ferry companies unite themselves in a cooperation. Also the port authorities have a cooperation. Furthermore, many individual parties participate in institutions like NMF or Energy Valley to promote their interests in collaborations.

Price Uncertainty

On macro level, price uncertainty is a trend of all times. The fluctuating prices of oil over the last decades will also apply to a global LNG market. The worldwide liberalization of bulk markets means that prices in the Netherland are dependent on developments worldwide.

On meso level, the national government can influence the prices by taxing LNG. They can do this both positively and negatively, but it is currently still uncertain which way the government's policy will go.

On micro level, the individual companies are very dependent on both macro and meso-level. While price uncertainty plays a role in day to day operational costs, the individual companies have little or no influence on this. One of the options to overcome this uncertainty is by making contracts with gascompanies, but currently none of the ferry companies has taken this step.

Technology

On macro level, public perception about a new technology is of utmost importance. Although LNG has proven to be a safe fuel in worldwide examples (Scandinavia, United States), the image to the public is not yet clear. Despite the many gatherings, meetings and conferences, only a small group of interested people and companies know the ins and outs of LNG in the Netherlands.

On meso level, the rules and regulations have to be in accord with the technology. Safety is an important aspect both on-shore and off-shore. Although the technology has been proven, not all the regulatory frameworks are in place to build a LNG facility on shore or to fuel your ship by LNG.

On micro level, the ferry companies do believe in the possibilities of LNG. The examples from other countries and companies have shown the Dutch ferries that there are many advantages and possibilities for their fleet. TCNN and the Rijksuniversiteit Groningen are busy with the technological developments surrounding the fuel.

***Theme/*Level**	**Macro**	**Meso**	**Micro**	**Remarks**
Green Image	Yes	Yes	Yes	In line
Economic Advantages	Yes	Yes	Yes	In line
Innovation Incentives	No	Yes	Yes	Not in line
Regulations	Yes	No	Yes	Not in line
Additional Advantages	Yes	Yes	Yes	In line
Lack of Infrastructure	No	No	Yes	Not in line
Cooperation	Yes	Yes	Yes	In line
Price Uncertainty	Yes	No	Yes	Not in line
Technology	Yes	No	Yes	Not in line

Table 1 – Themes in a multilevel context

On basis of section 6.2, Table 1 splits the nine different themes up in different levels (macro, meso, micro). A 'Yes' indicates that the theme is playing a relatively big role on that level, while 'No' indicates it is relatively playing a small role. It does not say whether it plays a positive or negative role, but this is clarified in the previous section. Under *Remarks*, the title 'in line' means the three different levels are in line with each other with regard to the theme. For Green Image for instance, both macro, meso and micro have the theme of green image on their agenda and are perceiving this theme in the same way. Lack of Infrastructure is a theme where the levels are not in line for example. Here the micro level identifies the lack of infrastructure as a major obstacle, while the regional policies and national government's actions do not stimulate the infrastructure development the way the end consumers prefer.

6.3 Summary

On basis of the input from the interviewees, nine themes were distinguished in the field of LNG in the Waddensea. The themes are described in the previous section and, in short, this leads in the following conclusions:

I. Emission reductions make LNG a relative environmental friendly fossil fuel.
II. The price gap between LNG and current marine fuels makes the fuel economic attractive.
III. LNG implementation in the Waddensea results in more employment and economic activity.
IV. Ideology, competitiveness and innovation form incentives for respectively ferry companies, port authorities and the government.
V. The field of regulations is dispersed in terms of clarity and consistency.
VI. By using LNG in the Waddensea, the risk for an oil spill is reduced dramatically.
VII. LNG combines economy and ecology.
VIII. The problem of a lack of infrastructure is acknowledged, but market forces are proposed to alleviate this problem.
IX. Many partnerships, collaborations and knowledge-sharing is present.
X. The dispersion of power and responsibility makes the Waddensea hard to manage.
XI. There is a lot of uncertainty in future prices of LNG.
XII. The supply-chain of LNG up to the potential end-consumers in the Waddensea is not completely closed.
XIII. LNG has proven to be an effective and safe fuel.
XIV. BioLNG is seen as a natural and 'better' successor of LNG.

Stakeholder|Conclusion	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**XIII**	**XIV**
TESO	X	X		X	X		X	X	X		X	X	X	X
Doeksen	X	X	X	X	X	X	X	X	X		X		X	X
Wagenborg	X	X						X	X		X	X		
Waddenfonds	X	X					X							
Waddenvereniging	X					X	X						X	X
Natuur Milieufederatie	X				X	X	X		X	X			X	
TCNN	X								X		X		X	
Energy Valley	X	X	X				X	X	X		X		X	X
Groningen Seaports	X	X	X	X			X		X					
Harlingen Seaport	X	X	X	X			X	X	X					
Province of Groningen	X	X	X	X	X	X	X		X	X		X	X	X
BominLinde	X	X					X				X		X	

Table 2 - Overview of the conclusions and the stakeholder responsible for input of the conclusion

7. Scenarios

The findings and the conclusions on basis of these findings from the previous chapter give a general image of the current and expected state of LNG in the Waddensea. What it does not give, though, is a concrete insight in possible future images. This chapter will try to do so by using the input from the previous chapters to develop different Scenarios that give different future roles of LNG in the Waddensea. To do so, the different findings will be combined and checked for similarities and differences. Then, some parameters will be defined as *agreed*, while others are defined as *uncertain*. These parameters will be the foundation for the different scenarios and their impact of section 7.2.

7.1 Synthesis of data

In order to structure the data (literature and interviews) in an effective manner, overlaps and discrepancies in both sources are searched for. The drivers and blockers from Chapter 3 are compared with the fourteen conclusions from section 6.2.

Motive |Conclusion	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Driver - Regional Image and energy targets	+					+	+							+
Driver - Environmental norms	+			+			+						+	+
Driver - Region of Gas-roundabout														
Driver - Competitive region and economic growth			+			+		+	+					
Economic driver – price difference		+									-	-		
Technical obstacle – more space on board				-									-	
Supply obstacle – lack of sufficient infrastructure								+				+		
Regulation obstacle – bunkering and safety regulations not in place					+									
Political-administrative obstacle – no innovation incentives; uncertainty of concessions				-	+	-	-			+				
Public perception obstacle – not enough knowledge and afraid of 'new' fuel				-					-				-	
Regulation obstacle – unclear which and when restricting rules apply					+					+				
Technical obstacle – safety and efficiency of LNG not sufficient	-					-	-						-	

Table 3 - Similarities (+) and differences (-) between drivers/blockers from chapter 3 and conclusions from chapter 6

On basis of Table 3, we can categorize the motives for or against LNG in the Waddensea in two categories: agreed and uncertain. Agreed motives are the ones that both the literature and the stakeholders brought forward as driver or blocker. These motives have relatively many plus-signs (+) in Table 3. Uncertain motives are the ones where there are different perspectives on by the literature and the stakeholders. These motives have relatively many disagreements, so many minus-signs (-) in Table 3. In Figure 19, the most important 'agreed' and 'uncertain' motives are imaged. The motives with only one or less (dis)agreements, were not identified as driver or blocker by the stakeholders, so are theoretical assumptions that are not confirmed by practice. They are used as input variables in the scenarios though.

The arrows in Figure 19 visualize preferred steps. Arrow 1 shows that an agreed blocker like lack of infrastructure should be converted towards an agreed driver. This can be done by a technical rational approach, namely developing and building the infrastructure. When there is an extensive infrastructure network, this could become an important driver for LNG implementation. Arrow 2 shows the step from a disagreed blocker to an agreed blocker. Currently, unclear regulations are not identified by all stakeholders as blocking force. To alleviate the problem of unclear regulations, there are two options. One option is that it is not a blocker at all, and it will develop over time, as some stakeholders indicated. The other option is to push it to agree about what aspects of the regulations are unclear. Following, it can then follow the track of arrow 1. The step indicated by arrow 2 asks for a more communicative approach, while arrow 1 asks for a technical-rational approach. Finally, the uncertain drivers can make the leap to agreed drivers. This can be done by proving the strength of innovation incentives, by for example implementing a NO_x fund. The price differences can be stimulated top-down by the government by decreasing the taxes on LNG. In this way, stakeholders will agree that these aspects are drivers for LNG adoption.

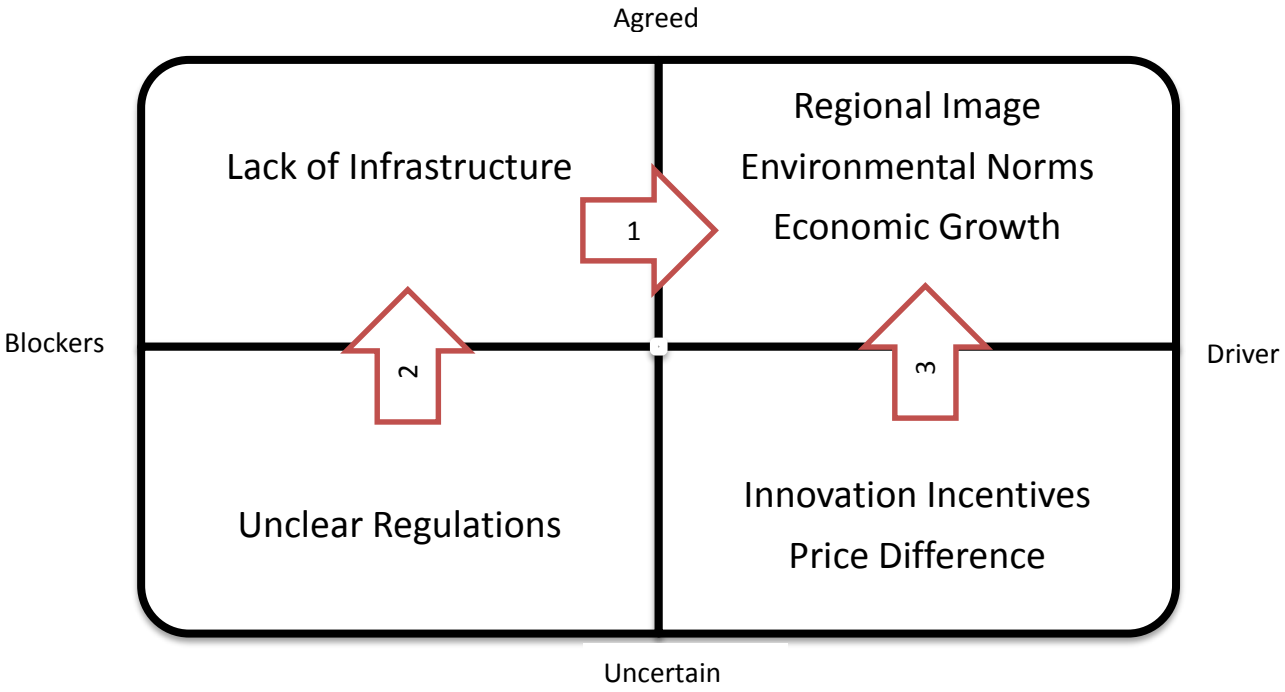


Figure 19 – Agreed and uncertain drivers and blockers

But not every driver or obstacle is subject to the same degree uncertainty and complexity. Therefore, a segmentation with regard to complexity is made, on basis of uncertainty. The degree of uncertainty is based on the literature (chapter 3) and empirical data (chapter 6). The following section elaborates on the reasons why the drivers and obstacles are placed in straightforward, complex or very complex issues.

Straightforward	Complex	Very Complex
Regional image	Price uncertainty	Innovation incentives
Environmental norms	Unclear regulations	
Economic growth		
Lack of infrastructure		

Table 4 – Drivers and blockers categorized on complexity

Straightforward

Regional image is influenced mainly by the visions and policies that are developed by the central government and the provinces. Composition of visions on a central level and implementing it on local or regional level is an issue of top-down planning.

Environmental norms are another tool for top-down planning. By setting maximum emissions, stakeholders on all levels will be forced to comply to these restrictions. This is a strong governmental tool which can be used for technical rational planning.

Economic growth can be predicted through quantitative research. By analysing how many jobs, facilities and ships will be created, an indication can be made of the economic growth. Causal relations are fairly straightforward, since input will generate certain economic output.

Although *lack of infrastructure* has been pointed out by both the literature and the empirical data as being of essential influence, its causal relations are also fairly straightforward. By constructing infrastructure in the sense of a distribution network and storage facilities, the infrastructural obstacles can be broken down. The question who has to take account for the infrastructure development, is not as straightforward though. This is also part of the (very complex) innovation incentives.

Complex

One of the most mentioned motive for shifting to LNG is *price uncertainty*. Though the price itself is subject to many factors (social, economic, political, legal) and therefore is of complex matter, there are possibilities to alleviate price uncertainty. By market forces like (long-term) price contracts, a lot of uncertainty over time can be taken away. Consequently, the complexity of the parameter 'price uncertainty' can be decreased.

Unclear regulations seem like an issue that is easy to solve by for example the government, but is still a complex matter. First of all, because it is subject to very many political influences, both global and local. What can be appropriate environmental policy today, can be outdated tomorrow and be fundamentally changed the day after. Moreover, it is not only the laws and regulations itself, but the perception of the people that counts. Even though the direction of regulations might be clear for the government, a shipping company can still have the feeling that he does not know what will be the rules of tomorrow.

Very complex

Innovative incentives are the most complex motives identified. This is because it is both dependent on the subject and the object. The incentives are hard to quantify, like ideology of the ferry companies. Or for example the incentive to avoid an oil spill. On the one hand a gas spill is relatively good for the ecosystem of the Waddensea, on the other hand it is dramatic for the global environment because of the methane going into the air. For some parties market forces will stimulate a shift to LNG, while other parties have said to wait for subsidies. Moreover, the power relations and the abundance of stakeholders and interests in the Waddensea have caused a lot of bureaucracy and political vagueness in the region. Different incentives for adopting LNG are dependent on ship owners, gas suppliers, port authorities, nature interest communities, local, regional and central government, global energy trends, financial resources, and more. Overall, this gives a very complex playing field with a lot of uncertainties.

7.2 Scenarios

This section uses the information from the previous section (7.1) and the previous chapter (6) as input for four different scenarios (see Section 2.2, page 14). The four scenarios are chosen because of their position on the axes along global to local and fossil to renewable. These two axes divide the total spectrum into four possible futures. The scenarios are given a title, in order to make them more memorable (as recommended by the literature in 4.2). The content of each scenario is split up in four parts: straightforward issues, complex issues, very complex issues (all based on the differentiation made in section 7.2) and an overall impact of these developments. The issues form the conditions under which the scenario takes place and the role of LNG will be as described in the scenario-title and the impact as described. Together, these four scenarios and their impact answer sub questions 4 & 5 (*How can LNG play a role in the Waddensea?* & *What is the impact of a shift to LNG?*).

Scenario 1:

LNG as cheap, transportable and abundant fuel

Straightforward	*Complex*	*Very Complex*
Regional image: Waddensea area remains a World Heritage area and has to cope with strong environmental policies that are set by UNESCO and global politics. **Environmental norms**: The environmental norms become stricter over time, due to rising global climate problems. **Economic growth**: the building of new (LNG) ships takes place in countries with cheap labor, like Asia. **Lack of infrastructure**: multinational parties like Shell take over the market for LNG in the Waddensea and import the fuel from cheap production locations like the Middle East. They have enough global revenues to invest in infrastructure.	**Price uncertainty:** the price of LNG stabilizes over time, while the market is maturing. Because of the relatively big global gas reserves, the prices of LNG can remain below the current price of MGO. Long term contracts provide the end consumers with price certainty and the supplier with constant revenues. **Unclear regulations:** Globally, the regulations like IMO and SECA find their way through. NO_x and SO_x norms are dependent on global politics and international agreements.	**Innovation incentives:** LNG becomes the fuel of the future. Companies and especially ship-owners follow the global trend of this new fuel and massively adopt LNG. Social pressure and political pressure from the region are amongst the many incentives to make the switch.

The impact of LNG will be one of global scale. Although LNG is still a fossil fuel, the significant emission reductions will push LNG as the new fuel in the Waddensea. The cheap production in the Middle-East and the developing infrastructure keep the prices low. The fuel can be easily shipped and distributed through the whole Waddensea, to supply the ferries and other ships of LNG.

Figure 20 – Scenario 1

Scenario 2:
LNG as a bridging fuel

Straightforward **Regional image**: Waddensea area remains a World Heritage area and has to cope with strong environmental policies that are set by UNESCO and global politics aimed at 'renewable-based' economies. **Environmental norms**: The environmental norms become stricter over time, due to rising global climate problems. Eventually, even LNG is not 'clean' enough to comply to regulations. **Economic growth**: The LNG related newbuilding and retrofitting takes place in the cheapest locations, mostly the Asian market. The revenues from LNG as fuel are taken by big gascompanies who want to make quick money before people go for renewable fuels. **Lack of infrastructure**: (Multinational) Gascompanies invest in the infrastructure to boost the LNG market and make money before LNG is out of scope and renewable energy sources are the new fuels.	*Complex* **Price uncertainty:** End-users are looking for short-term contracts to improve price certainty, but still keep the flexibility of shifting to renewable energy sources in the near future. Global LNG markets force the prices to be highly dynamic. **Unclear regulations:** Regulations for LNG will develop over time, but keep the goal of renewables in mind. LNG regulations will follow global trends and develop quickly based on examples like the United States and Scandinavia.	*Very Complex* **Innovation incentives:** LNG will bridge the gap between current fuels like MGO and HFO towards renewable fuels like sun-, wind- or biomass-energy. National government will stimulate LNG heavily for the period to come, by keeping the taxes low. Subsidies for LNG-related investments will be offered by government both directly and indirectly (by government-linked port authorities or Waddenfonds)

The impact of LNG will be one of global scale. It will be of temporary nature. Eventually, global markets will shift to renewable energy sources. This shift from fossil fuels to the renewables is the transition. LNG is forming the transition period between the two equilibria. In this period the context is highly dynamic, like uncertain prices, changing regulations and tax changes.

Figure 21 – Scenario 2

Scenario 3:

LNG as part of the Netherlands as 'Gasroundabout'

Straightforward **Regional image**: Waddensea area remains a World Heritage area, but is mostly formed and restricted by national and local governments. They fortify their Waddenvisie by concrete operational actions to stimulate the green image of the Waddensea. **Environmental norms**: Besides the environmental norms set at global level, the Netherlands stresses these norms further to meet national ambitions. **Economic growth**: The LNG related newbuilding and retrofitting is done by local shipbuilding companies, which have a good international reputation. Local institutions like the Gasunie are developing networks to profit from the revenues of LNG in the future. **Lack of infrastructure**: Dutch companies like Gasunie and Vopak invest in the infrastructure to boost the adoption of LNG. The goal is to liquefy Dutch Groningen gas to use it as LNG. The gas reserves and the image of the Netherlands as Gasroundabout of Europe drive these actions.	*Complex* **Price uncertainty:** In the initial stage, the prices will be subject to global price dynamics, because the fuel is coming from abroad. Later, when the Netherlands is producing its own LNG, (inter)regional and local contracts are closed to add to the Dutch Treasury. **Unclear regulations:** Regulations for LNG will quickly develop, because the Netherlands wants to remain the position of gas-country and therefore adopts a pioneering attitude. With this attitude comes fast implementation of new LNG related rules.	*Very Complex* **Innovation incentives:** The example of the NO_x fund of Norway is also adapted in the Netherlands. A system set up by the national and local governments, but preserved by the individual companies. Norms are set and companies that emit more than this norm have to pay, and from this money emission-reducing measures will be subsidized. Furthermore, companies will follow the trend of being a pioneering region in LNG adoption and will have to follow their competitors. Moreover, public perception plays a key role. The earthquakes in the Groningen region are a trending topic, so the image of gas as a appropriate fuel is stressed to its limits. Eventually, the safe track record of LNG will provide prove for the public to go along with LNG.

The impact of LNG will be mostly regional and local. The local economy gets a boost by the shipbuilding sector, but the economic benefits are not maximum because only the local market is served. The strong position of the Netherlands as the Gasroundabout of Europe is fortified by the pioneering role with LNG. Regulations are developing quickly to support a quick adoption of LNG in the Waddensea.

Figure 22 – Scenario 3

Scenario 4:
Dutch Bio-LNG

Straightforward **Regional image**: Waddensea area is one of the focus areas in national policies. In order to meet the 20-20-20 targets, a lot of measures need to be taken. A vulnerable UNESCO Heritage site like the Waddensea will be one of the first areas that will be looked upon. **Environmental norms**: Environmental norms are pushed more and more. Ever stricter norms cause that eventually LNG will be environmentally seen not sufficient anymore. Besides renewable sources like wind- and solar-energy, biomass is also a rising fuel. BioLNG is the cleanest form of LNG that will comply to the environmental norms. **Economic growth**: The LNG related newbuilding and retrofitting is done by local shipbuilding companies, which have a good international reputation. Local institutions like the Gasunie are developing networks to profit from the revenues of LNG in the future. **Lack of infrastructure**: Dutch companies like Gasunie and Vopak invest in the infrastructure to boost the adoption of LNG. Although worldwide adoption of BioLNG is practically not possible (there is not have enough land to plant sufficient biomass), BioLNG on a regional scale in the Waddensea is an option.	*Complex* **Price uncertainty:** LNG prices will be subject to the local Dutch market. Biomass producing companies in the region are able to set the price and compete with each other. **Unclear regulations:** Regulations for LNG will quickly develop, but with the end goal of the renewable alternative of BioLNG in mind. For the biggest part, this is almost the same, but rules around the generation of the gas will differ.	*Very Complex* **Innovation incentives:** Financial incentives will not suffice in making the shift to BioLNG. Inherent 'green' motivations within the companies will have to force them to shift to the renewable alternative. With only subsidies from the example of the NO_x fund of Norway, the end equilibrium will not be reached. Also the biomass producing companies in the region will have to be (financially) stimulated to make this transition successful.

Figure 23 – Scenario 4

7.3 Summary

Chapter 3 has provided us with the background of LNG. We've seen the tension between economy and ecology in the way our surroundings and environment is used.

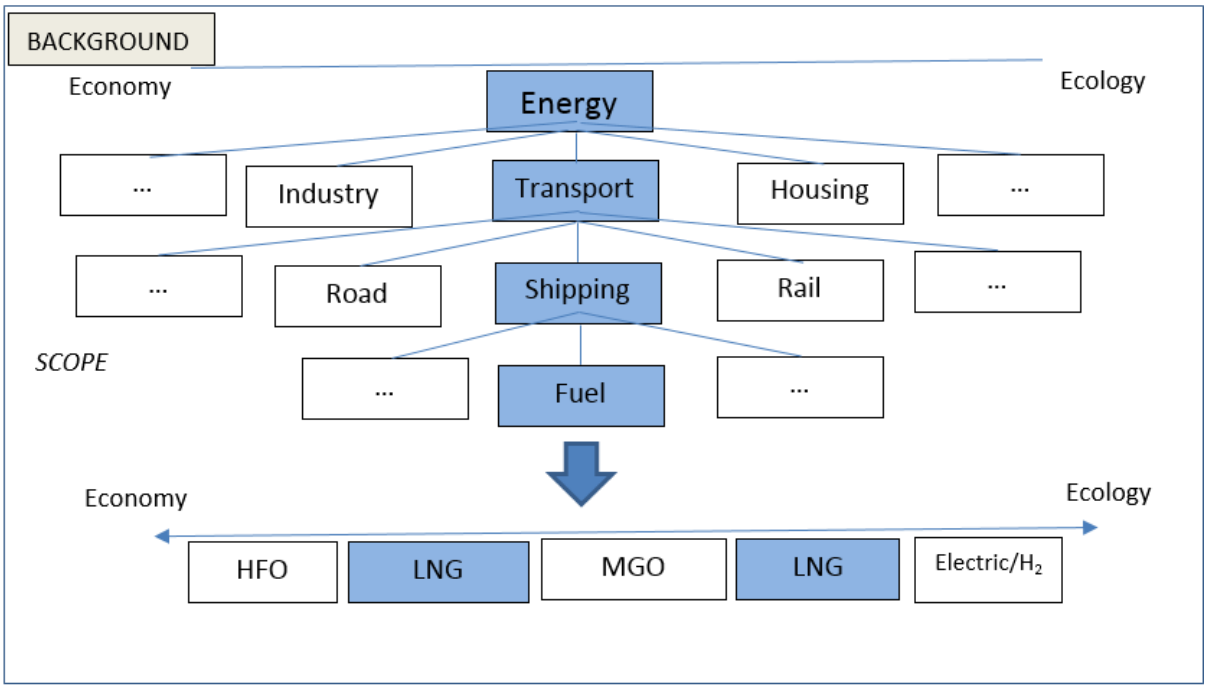


Figure 24 – Conceptual representation of background

In Chapter 4, a theoretical framework has been developed to put the background in perspective. The issues concerned with LNG can be divided in two extreme categories of technical rational issues and communicative rational issues. The bulk of the issues though, are somewhere in between these two extremes. To find an appropriate approach for these issues, scenario theory is added to the theoretical framework. This gives us a tool to cope with uncertainties, while accounting for the certainties. Within these scenarios, transitions play a prominent role.

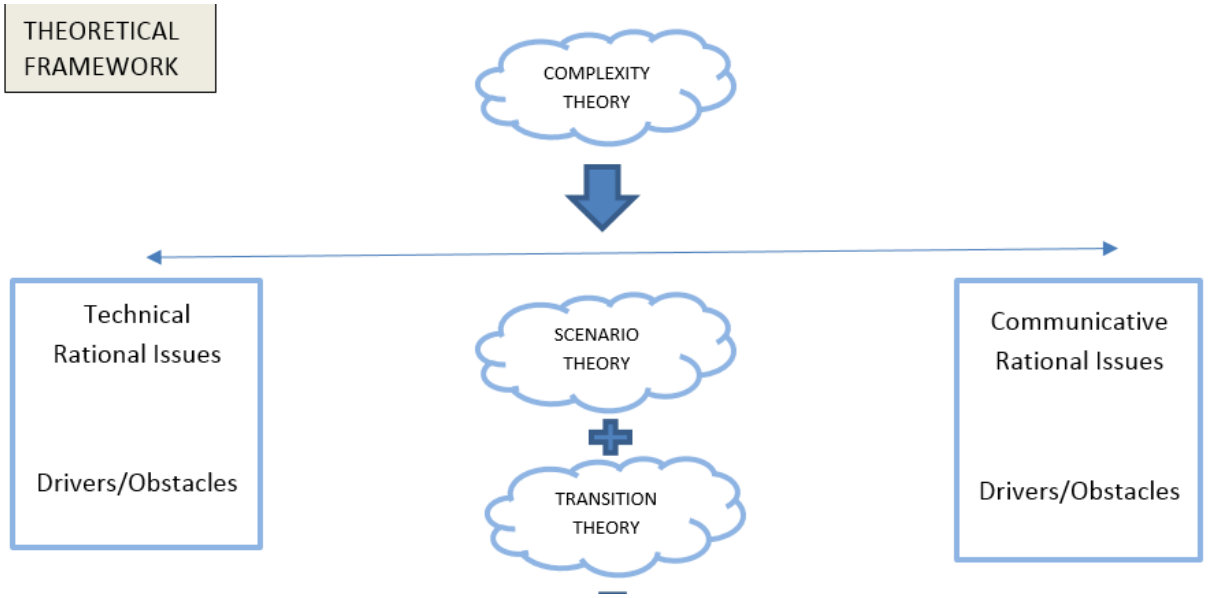


Figure 25 – Conceptual representation of the theoretical framework

To fill this background and theoretical framework with empirical data, interviews were conducted, which are described in chapter 5. This was done by several stakeholders in multiple arenas. The end-consumers (ferry lines) on the demand side, the industry on the other side and policymakers and other stakeholders as third and fourth perspective.

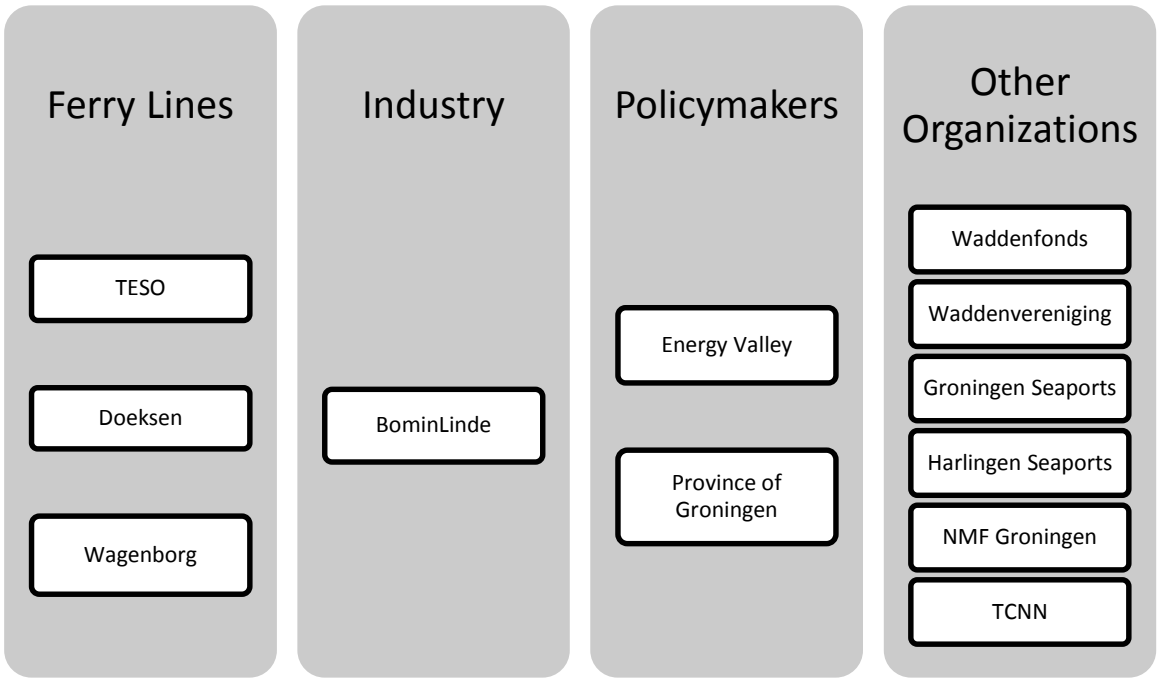


Figure 26 – Interviewed stakeholders structured by category and company

To come to a synthesis, the different inputs (background, theory and empirical data) are put together in a framework that describes the situation. This was done in Figure 27, which shows the different scenarios that were developed on basis of the input from the background (Figure 24), the theory (Figure 25), and the stakeholders (Figure 26).

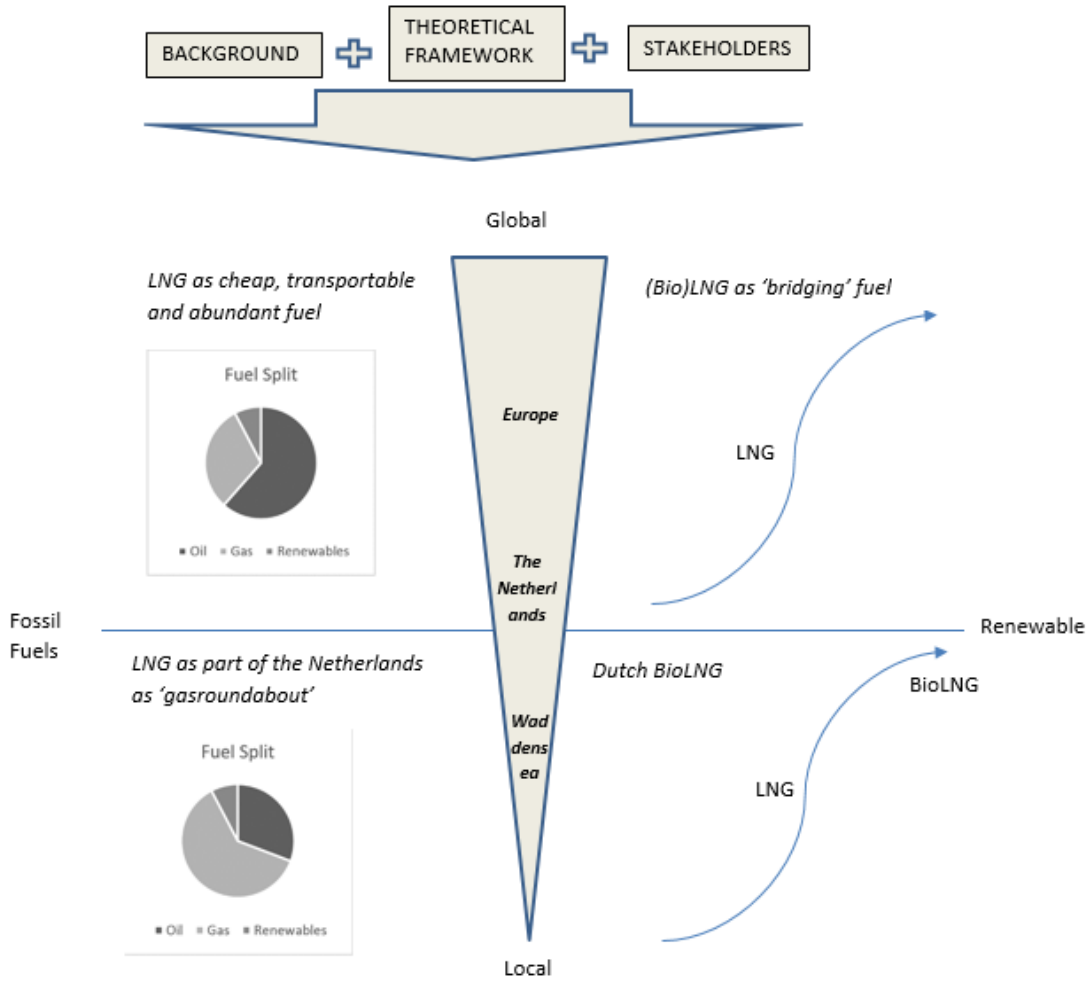


Figure 27 – Conceptual representation of synthesis of background, theory and stakeholders into scenarios

In Figure 27, the different scenarios are visualized. Scenario 1 (top-left) and Scenario 3 (bottom-left) are visualized as different fuel splits. This fuel split shows which fuels will be used as shipping fuel in the Waddensea. This visualization is mainly meant to show the relative difference between the fuels. In Scenario 1 oil still has the lion's share of the fuel usage, while in Scenario 3, (locally produced) gas adopts a big share of the total fuel usage. In both scenarios, renewables cover only a small piece of the total. It has been clarified in the different scenarios why there is relatively more gas or oil in the two fuel splits. Scenario 2 (top-right) and Scenario 4 (bottom-right) visualize the transitions that can be induced if the conditions described in the scenarios apply. Scenario 4 clearly moves towards a new equilibrium where BioLNG plays the major role, while Scenario 2 also moves towards a 'renewable' future, but the new equilibrium is not certain and not specified.

8. Conclusion and Discussion

8.1 Conclusions

Technological developments have made it possible for us to liquefy our natural gas and use it as a transport fuel. After successful adoption in the transport sector in countries like Norway and Denmark, LNG now also advances in the Netherlands. Since the developments in the Netherlands are still in an initial stage, many questions remain to be answered. This was the motive to research this topic and to draw up the following main research question:

What are driving and blocking forces for future LNG adoption in the Waddensea area?

To be able to draw a conclusion on the main research question, the sub questions will be answered first.

8.1.1 Sub questions

Sub question 1 "*What does LNG mean in a Dutch context?"* is answered in Chapter 1. LNG stands for Liquefied Natural Gas. It is a fuel made by liquefying natural gas to minus 162 degrees Celsius to shrink it to 1/600th of its original volume. By this, pollutants like sulfur and nitrogen are reduced, so after burning the fuel the polluting emissions will be heavily reduced. Furthermore, LNG is currently a cheaper fuel than a comparable fuel, MGO. LNG is already implemented with a safe track record in several countries across the world, of which Norway and the United States are two examples. The Dutch context described in Chapter 3 is that the Netherlands is struggling with both economic and environmental forces. This is also the struggle where LNG can act as a bridge between the two extremes.

Sub question 2 "*In what way is the Waddensea area relevant for the topic LNG?"* is answered in Chapter 3. The Waddensea area is a part of the northern Dutch territory and an UNESCO World Heritage site. It is a very sensitive area that is recognized for its rich ecological and socio-economic value. It comprises not only the water of the Waddensea, but also the Wadden-islands lying in it. Moreover, it is an area prone to many forces and interests of many stakeholders. These specific characteristics of sensitivity, ecological and socio-economic value and many stakeholders all form a specific context for LNG.

Sub question 3 *"What are driving or blocking forces for LNG adoption?"* is answered in the chapters 3, 6 and 7. The main drivers exist of improving regional image, complying to environmental norms, stimulating economic growth, innovation incentives and the price difference between LNG and alternative fuels. Main blockers consist of the lack of infrastructure and unclear regulations. Besides these two main blockers also other blockers are mentioned by some stakeholders: the safety and efficiency of LNG is not sufficient, no clarity about when restricting rules apply, not enough knowledge about LNG, uncertainty of concessions in the Waddensea and reduction of space on board.

Sub question 4 "*How can LNG play a role in the Waddensea area?"* is answered in Chapter 7. Four scenarios based on input from previous chapters describe possible futures for the

Waddensea and the role of LNG herein. The spectrum ranges from fossil to renewable and from local to global. The role of LNG varies from a cheap, transportable and abundant fuel to a bridging fuel towards renewable fuels. And from a part of the Dutch gas-roundabout to a part of the transition towards Bio-LNG that is locally generated.

Sub question 5 *"What is the impact of a shift to LNG?"* is also answered in Chapter 7. The four scenarios all give different impacts. This changes from a global impact where the Waddensea is a part of the growing global LNG market, towards an impact of a more temporary nature. In the latter one, LNG will impact in highly dynamic circumstances of uncertain prices, changing regulations and altering tax levels, which eventually leads to an equilibrium in which renewables will be the transport fuel. Another scenario causes a more local impact, where the local economy gets a boost by the shipbuilding sector and the regional image of the north as gas-roundabout is fortified. Finally, the impact of LNG can be one of a contribution to a transition towards renewables that are locally generated.

8.1.2 General conclusion

Now the sub questions are answered, the main research question can be answered. As has been concluded in sub question 3, there are several drivers and blockers that influence the adoption of LNG in the Waddensea. There are main drivers identified. The first one is the improvement of the regional image. By implementing LNG in the region, a 'greener' image is stimulated, since LNG is a cleaner fuel than the conventional MGO and HFO. The second one is compliance to environmental norms. The main norm here is the upcoming SECA-norm implemented by the IMO. From 2015 ships are forced to ship on defined 'clean' fuels. This forces the region to look at LNG as an alternative fuel. The third driver is the stimulation of economic growth. Not only follows economic development from the construction of LNG storage facilities and networks, but also from the ship-building activities that are needed for the new LNG-fuelled ships. Innovation incentives are the fourth driver. By implementing funds like NO_x fund as in Norway, or subsidies from the Waddenfonds, parties can be pushed by incentives to innovate and take the step to LNG. The final driver is an economic one: price difference between LNG and alternative fuels. Since currently the ships propelled by LNG are more expensive than conventional propelled ships, the ship owners want to earn back the extra investment. If the LNG price is lower than other fuels, this cost reduction in fuel costs can form another driver to shift to LNG.

On the blocking side, there are two main blockers: lack of infrastructure and unclear regulations. The lack of infrastructure is the fundament of the chicken-or-egg impasse that is currently apparent in the Waddensea. As long as there is no demand on the one side and there is no infrastructure on the other side, parties are looking at each other to take the first leap. The unclear regulations form a blocker because of different reasons. First of all, unclear regulations can give parties enough uncertainty to decide not to invest in long-term projects, like a retrofit/newbuilt ship on LNG. Secondly, it is less attractive to invest in a LNG ship if it is not yet clear whether there is permission to build bunker facilities in your harbor. Thirdly, when regulations about shipping on LNG (safety for example) are not clear for ship-owners,

they will see this as a blocking force. Fourthly, the uncertainty around concessions (Doeksen for example) is so big that it will stop stakeholders from investing in long-term projects like a LNG ship, while it is not certain that they are allowed to ship their ferry routes over the next decade(s). Other blockers are the safety and efficiency of LNG. Currently, many people percept LNG as a new and dangerous fuel, even though it has a safe track record for decades. The efficiency is not in an optimum state, and researchers are still looking for the most optimal mixture to use it in the shipping sector. Another blocker is the lacking clarity about when the restricting rules will apply. Though the IMO mentions 1 January 2015, many parties argued that it is not possible for all ships to convert to LNG in this time scope, and it is yet to be awaited which steps the IMO will take then. One more blocking force is the lack of knowledge about LNG. Most of the interviewed parties were known with the matter, but this is because it is one of their daily concerns. They pointed out that there are many other companies that still lack sufficient knowledge about LNG to make an argued choice for a shift or not. Final blocker is the argument that a LNG tank will reduce the space onboard. Because LNG needs more room than a diesel tank, the capacity within the ship will decrease and this can have negative economic effects (like decreasing storage room).

Besides the driving and blocking forces, one of the goals of this research is to look at the different roles LNG can play in the Waddensea. What we have seen in chapter 7 (Scenarios), is that LNG in the Waddensea can be a part of a global trend of LNG adoption. In this role, the Waddensea area will play a small part of the whole picture and the impact will be limited, but on the other hand it can benefit from scale advantages, like developing infrastructure, lower prices and international knowledge-sharing. LNG could also be the bridge from conventional fossil fuels towards renewable energy sources as transport fuel. It will be a temporary role in the future then, but the impact will be big, because it is a necessary step in the transition towards renewables. A similar role is also possible when the future of the Waddensea area will develop in a way that renewables are locally produced and Bio-LNG will be the transport fuel in the end equilibrium of the transition. The fourth identified role is LNG as a part of the regional image of gas-roundabout. This role means that LNG will increasingly be locally produced. The local gas from the Groningen gas fields will then be liquefied to keep the transportation and distribution costs lower. This means more independence from global gas market fluctuations, but might also mean higher prices when the local gas reserves decline.

All these different roles show that there is much potential for LNG in the Waddensea area and the impact can be of varying nature. Although the exact role will most probably be not exactly what was been described in the scenarios, the future has to point out whether the scenarios come close to reality and the real role of LNG is covered in this thesis. The scenarios have shown that there are some robust aspects though. Some aspects are apparent in every scenario and are therefore expected to play a role in ‘every possible’ future. These are that the Waddensea will remain an UNESCO World Heritage Site and that therefore the environmental norms and policies linked with this status play an important role. Moreover, the lack of infrastructure will eventually have to be overcome by investments in infrastructure

to shape conditions for a successful LNG implementation. Who initiates these investments is different in several scenarios. Finally, the regulations have to be shaped in the right way. Which level of authority and what specific rules and regulations will emerge, is not clear yet. But there is no doubt that a regulatory framework has to be developed to facilitate LNG adoption in the Waddensea. The described robust elements within the scenarios form a foundation for each scenario, where the flexible aspects form the rest of the conditions of the scenarios.

8.2 Discussion

This section will discuss the thesis as a whole. It will discuss the shortcomings of the literature and the validity and reliability of the empirical data, findings and conclusions.

8.1.2 Literature

To start with, there are several shortcomings of the literature. The literature has to be split up in policy documents/reports and academic literature. Concerning the policy documents, there are three major flaws. First, the focus is mostly sector-specific. Most of the times, it is economy focused and thus mostly discussing financial and employment related impacts. This means that while a lot of the attractiveness of LNG lies in the combination of sectors, these will be missed and wrongly assessed. For example, while subsidizing LNG might cost the government significant amounts of money, the ecological benefits of the LNG related impacts are not weighted similarly. This could be done with an Social Cost Benefit Analysis for instance. These kind of analyses are still lacking in the field of LNG in the Netherlands. Secondly, the policy documents are mainly expressing ambitions and visions, but do not discuss expectations or prospects. This makes it hard to analyze the expectations of the authors or institutions behind the documents. Thirdly, some reports are very concrete (DMA, DNV), but they are especially area-specific. While they have a high explanatory power for the area under research (Denmark and Norway respectively), many general conclusions that are of value for this thesis are lacking.

The academic literature also raises some issues to discuss. We will here make a distinction between LNG specific academic literature and planning specific academic literature. To begin with the LNG literature, the most important finding that there is not an abundance of literature. Chapter 3 has described multiple comparisons with countries all over the world about LNG, but there was not much more to find. Even in a country like the United States, where LNG is already been implemented for a couple of decades, the most relevant literature was about siting regulations. The most relevant comparisons were with Scandinavian countries, but this literature belongs in the category of policy documents/reports. The academic literature about planning is very extensive though. With regard to planning theory in general, there is one important point of discussion. It is the discussion between modern and post-modern thinking. There are many perceptions about the difference between these concepts, and this leads to many different linkages. Some would say that scenario planning is a form of planning based on modernist views and complexity is a concept unavoidably linked

with post-modernism. This thesis would like to argue that at least scenario planning is linked with both –isms. The understanding of our current complex world asks for different tools to help us with decision making and intervening in our physical environment. Complexity thinking is based on the same conclusion as post-modernism, namely that we cannot fully understand the world around us. Though conventional scenarios assume that we can include reality in a certain amount of possible futures, this thesis does not claim to do so. This thesis acknowledges that the scenarios described are quite likely to turn out to be no reality in the future, and the truth will be somewhere in between. This thesis does claim to provide a reflection of the future based on the interviewed stakeholders and the possible developments they brought up. Another critique on scenario theory is that it does not dwell on how to value the impact of the different scenarios. This thesis has described the impact on basis of the input for the scenarios, but it would be helpful if the theory about scenarios would also provide tools for impact assessment.

Finally, three points of discussion concerning transition theory will be raised here. First of all, the theory about the multilevel concept is not clear about the way the three levels should be in line with each other. It is explained that the three levels should be in accord with each other, but a concrete clarification about what criteria are for assessing whether they are in line, is lacking. Another critique on the transition theory used is the question what happens when a transition fails. The literature is extensive about what is necessary for a successful transition (though not complete, see previous critique), but does not dive deep into the consequences of a failed transition. Especially in the light of the topic of this thesis this is interesting, since LNG has been identified as one of the alternatives, but not the one and only option. This means that it could well be that LNG starts to be part of a transition, but is 'taken over' by other aspects of the transition. For instance, the LNG adoption in the Waddensea takes off with implementation of all the ferry lines, but inland shipping and sea-going cargo shipping do not follow the lead. They will continue to use MGO and will eventually shift to renewable sources without the step of using LNG. Third critique is that the terms of 'flexibility' and 'robustness' are not always applicable. Is uncertainty about the price part of the robust or the flexible part of the system? The prices itself are flexible, but the fact that the prices are flexible is of structural nature. Same counts for innovation incentives. The flexibility of the incentives is time and context-dependent, but innovation incentives itself should be a structural/robust part of the transition.

8.2.2 Empirical Data

The data collected for this thesis are subject to five shortcomings that will be described here.

First of all, the interviewees were only one per institution. This means that where this thesis talks about a specific stakeholder, it is actually talking about one person. Of course, the interviewed person was expected to represent the whole company/institution and did his best to do so. But unavoidably, there would be differences in answers if another person in the company was interviewed. More time and resources would give the opportunity to interview multiple persons per stakeholder.

Secondly, a major shortcoming of the data input is that there was not a policy maker from the national government interviewed. This was due to a lack of interest to support this research from the national government's side. Moreover, it is a very big and bureaucratic institution, so it was hard to find the right person with enough time. The interviewed stakeholders at a different level (province, port authorities) pointed at the national government several times as the institution that makes the rules.

Thirdly, this thesis has a lack of input from the supply side of the issue. Only one stakeholder from the industry is consulted by phone. To give a more complete perspective from the supply-side of LNG, more industry stakeholders have to be interviewed.

Fourth shortcoming is out-datedness of information. Because LNG is a relatively new issue in the region and developments are going fast, information is out-dated quickly. The perspective and the views of the stakeholders today, will be different next week or month. For example, while this thesis was written, the law suit about the concession of Doeksen has developed and this probably influenced the opinion of the company. Longitudinal research could provide a solution for this shortcoming, but this will be time-costly and the benefits are hard to predict.

Finally, there is a difference in knowledge about the matter. Some stakeholders are quite progressed in their knowledge about LNG, while others do not. This influences the fact that the opinion of certain stakeholders without enough knowledge will change when they know more about the matter. In this thesis, it is not taken into account if stakeholders are basing their opinion and visions on wrong information. This is so, because it is simply not possible to trace this, since the stakeholders themselves probably even do not know their information or knowledge is wrong.

Then there are some shortcomings about the processing of the data. First of all, the categorization in themes is rather subjective. There are nine themes identified, but it might also be five or fifteen. The nine identified in this thesis are chosen with the knowledge and experience of the author, but would probably be different for another author. The same counts for the conclusions that are made on basis of the findings. They are not infallible, but are drawn as objective as possible by the author. Moreover, the tool chosen for categorization after the themes were distinguished was by checking them in tables with drivers and blockers from chapter 3. Also this method is not infallible and subject to the fact that converting qualitative data into quantitative information is sensitive for errors.

8.3 Contribution to theory and planning

This section will elaborate on how this thesis can contribute to the academic field and planning theory and practice. As described in section 3.1.2, there are several shortcomings in the literature used. One of the critiques mentioned is that scenario planning is both connected with modernist and post-modernist view on planning. What this thesis does though, is to use complexity and transition theory to shape conditions under which a certain scenario occurs or develops. Academic literature has not yet shown that transitions can also be used in

combination with scenarios. By using the axes from the scenarios as input for the transition, a new sort of model is developed. The themes, explained in the findings, combined with the spectrum of complexity have formed the input for the scenarios. These scenarios then are used as a framework in which a transition can take place. This combination of these theories is especially valuable and useful in situations where a lot of uncertainties surround a potential transition. In the subject of energy, there are a lot of these kind of problems. This is also where the concept of scenario planning is widely used, but not in combination with complexity and transitions. But the combination with transition theory has another advantage. When for example this thesis had only used scenario planning, it would be very hard to determine the parameters that could be influenced and the ones that are more or less fixed/robust. By combining it with complexity and transitions, the factors/parameters are divided in straightforward, complex, and very complex issues, so that it clearer which approach should be used when one of the conditions for a transition should be reached. It is therefore not only useful to *identify* the multiple levels (from transition theory) and the degree of complexity, but this also provides tools to choose the right *approach* to *steer* towards a transition, if desirable. It thus also gives practical holds besides just a descriptive function. Critical questions that can be placed at the used theories are then: is scenario planning just a descriptive tool, or can it also be used as prescriptive or normative tool? Why does transition theory uses three levels to comprehend a successful transition? Shouldn't the degree of complexity and scale determine how many levels have to be in line for a successful transition? Does complexity theory imply that the world around us is not guidable or can we use complexity theory in a smart way combined with transitions and scenarios to build a better scientifically-based image of the future?

When we look at the implications this thesis has for the planning field, we can distinguish two main contributions: one for the Waddensea in specific, and one for a more wider field. In the scope of the Waddensea in specific, this thesis contributes to our general knowledge about the current situation of LNG in the area, and the perspectives and the drivers and blockers of many of the stakeholders active in the area. This information and the conclusions that follow from the interviews and the background study can form a new start-off point for further research on the topic in this area. Moreover, it gives an overview of the perspectives of the different groups of stakeholders, so proponents or opponents of certain statements, developments or expectations can be identified more easily. In a broader context, this thesis also contributes to an international field of planning practice. Generalizations that can be made out of this case study can be used in other areas and contexts. For example other maritime areas where the IMO might introduce their restricting norms or other World Heritage sensitive maritime areas where there is still shipped on MGO or HFO. It can also help other areas that consider LNG in their region to map their area. They can look for similarities and differences with the Waddensea, and how this influences their situation. Moreover, in the future, the practices from the Waddensea and LNG will provide other areas with useful information, just like Norway, Denmark and the US have provided background information for this research. Hopefully though, in the Waddensea case, the process will be recorded better,

so that real lessons learned can be derived. Overall, it can be said this research contributes to the planning field in the way that it shapes conditions under which a transition towards a new future of the Waddensea in which LNG plays a role. These conditions and contextual factors can be used to describe, but also to influence and intervene by the planner.

8.4 Reflection

This section will reflect on the different aspects of writing this thesis. From personal feelings on the subject to an evaluation on the process and the final product.

My personal interest in the topic has been enlarged by writing this thesis. I learned a lot about the day-to-day practices of the interviewed stakeholders. This ranges from the frustrations of companies about the inertia of the national government to the enthusiasm of the interviewees about LNG. Over the course of the process of this thesis, I gained more and more knowledge about the perceptions and developments of LNG. I started off with enormous enthusiasm and confidence in the value of LNG. After some literature analysis and interviews this was slowed down, because I got the feeling it is such a slow process. Although almost all stakeholders have confidence in the success of LNG, it is still a development of years. This can be frustrating, but it is unavoidable. Furthermore, I enjoyed doing the interviews, although it was not as easy as I expected beforehand. Keeping the flow in the interviews was harder than expected. Overall, I very much enjoyed doing this research.

The depth of the thesis was an aspect where I see many improvements if I had more time. Many aspects could be analysed in more depth, like specific characteristics of the Waddensea or more technical details about the ships and the LNG technology. Quite surprising is that even after writing this thesis I have not seen LNG in real life and I do not fully understand the technology behind it.

The literature about the topic was quite disappointing to me. I hoped there was more academic literature written about it. But on the contrary, I saw it as a challenge to explore a relatively unexplored topic. Policy documents and reports may not be official academic literature, but they are easier to read. Furthermore, I found it rather difficult to fit the topic in a theoretical framework. I had a lot of ideas and concepts of planning theory, but it was hard to fit LNG and the Waddensea in it.

Just as I expected before I started writing this thesis, the direction of my research changed multiple times. Only the topic has not changed along the process. My process endured a slow start, since I found it really hard to make a beginning. The structuring of my ideas and the feelings about the directions took a lot of times. The feedback of my supervisor really helped me a lot. One tip in special: ‘just start writing, you can always throw it away later’. I experienced that when you start writing, you get in the flow and it is even easy to write several thousand words a day. To find the right format for a theoretical framework was also quite hard. I had some theories in mind, but to link them together while also keeping the relation with your topic was hard. The method of data gathering is something I am satisfied with. With

this topic and under these circumstances (very initial stage in the developments and not a lot of literature), I think interviews were the most effective tools to get an insight in the matter. The stakeholders I approached for my research were also very willing to cooperate, and I am thankful for that.

As an evaluation of my final product, I can say that I am really satisfied about what I have produced, but I see many, many shortcomings. It proved to be a hard challenge to set up your own research in a new topic with many uncertainties and I still think there is a lot to be improved. I do think though that this research comprises enough for one thesis, and further research should help the academic world.

8.4 Suggestions for further research

For further research, I have four suggestions. First, interviews with the central government should also be included in the stakeholder interviews. The central government is an often mentioned stakeholder for essential aspects of the topic. Taxes, innovation incentives and regulations are just some of the drivers and blockers the central government is held responsible for. By conducting interviews with this stakeholder, the different perspectives on the matter will be represented better. Secondly, as brought up in the discussion earlier, there should be more interviews with every stakeholder. This gives a stronger foundation of information on which the analysis is based. Thirdly, in the future, there should be success stories of LNG implementation included. Currently, these are not yet present in the region, but there probably will be in the near future. Finally, I would suggest further research would also look for practical actions that can be made on basis of the information we now have. This thesis stops by developing scenarios for possible futures, but does not designate concrete steps to take for the planner to intervene in the landscape that is analysed.

9. Bibliography

Agentschap NL (2013). http://www.agentschapnl.nl/subsidies-regelingen/miavamil

Algemene Rekenkamer (2013). Waddengebied: natuurberscherming, natuurbeheer en ruimtelijke inrichting. http://www.rekenkamer.nl/Publicaties/Onderzoeksrapporten/Introducties/2013/11/Waddengebied_natuurbescherming_natuurbeheer_en_ruimtelijke_inrichting

Allmendinger, P. (2009). *Planning theory*. Basingstoke: Palgrave MacMillan.

Authority, D. M., Bech, M. S., Gullberg, M., & Gahnström, J. (2011). North European LNG Infrastructure Project.

Bardi, U. (2009). Peak oil: The four stages of a new idea. *Energy*, *34*(3), 323-326.

CBRB (2013). http://www.cbrb.nl/nieuws/nieuws/442-de-ccr-staat-lng-toe-als-brandstof-voor-de-binnenvaart

Centraal Bureau voor Statistiek (2010). http://www.cbs.nl/nl-NL/menu/themas/industrie-energie/publicaties/artikelen/archief/2010/2010-3105-wm.htm

Centraal Bureau voor Statistiek (2011). http://www.cbs.nl/nl-NL/menu/themas/industrie-energie/publicaties/artikelen/archief/2011/2011-3497-wm.htm

Chermack, T. J. (2004). Improving decision-making with scenario planning.*Futures*, *36*(3), 295-309.

Cilliers, P. (2002). *Complexity and postmodernism: Understanding complex systems*. Routledge.

Colvile, R. N., Hutchinson, E. J., Mindell, J. S., & Warren, R. F. (2001). The transport sector as a source of air pollution. *Atmospheric environment*, *35*(9), 1537-1565.

de Roo, G., & Porter, G. (Eds.). (2012). *Fuzzy planning: the role of actors in a fuzzy governance environment*. Ashgate Publishing.

de Roo, G., & Silva, E. A. (Eds.). (2012). *A planner's encounter with complexity*. Ashgate Publishing, Ltd.

De Windcentrale (2013) https://www.windcentrale.nl/

DNV (2006). http://www.dnv.com.ar/binaries/flyer_marpol_seca_tcm158-278353.pdf

DNV (2012). Shipping 2020. http://www.dnv.com/binaries/1shipping%202020%208%20pages%20summary%202012%2006%2004_tcm4-518883.pdf

Energy Valley (2012). “LNG als scheepsbrandstof. Kansen en uitdagingen voor een nieuwe markt.”

Fuglestvedt, J., Berntsen, T., Myhre, G., Rypdal, K., & Skeie, R. B. (2008). Climate forcing from the transport sectors. *Proceedings of the National Academy of Sciences*, *105*(2), 454-458.

GATE (2013). http://www.gate.nl/

Green Deal LNG: Rijn en Wadden (2012). http://www.ondernemendgroen.nl/SiteCollectionDocuments/OndernemendGroen/B124%20-%20Green%20Deal%20LNG%20Rijn%20en%20Wadden.pdf

Grunneger Power (2013) http://www.grunnegerpower.nl/

The Guardian (2009). http://www.theguardian.com/environment/2009/apr/09/shipping-pollution

International Energy Agency (2013). http://www.worldenergyoutlook.org/

IMO (2013). http://www.imo.org/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Sulphur-oxides-(SOx)-%E2%80%93-Regulation-14.aspx

Kaack, L. H., & Katul, G. G. (2013). Fifty years to prove Malthus right.*Proceedings of the National Academy of Sciences*, *110*(11), 4161-4162.

Kingdon, J.W. (1984). *Agendas, Alternatives and Public Policies.* Harper Collins, New York, New York, USA.

Kumar, S., Kwon, H. T., Choi, K. H., Hyun Cho, J., Lim, W., & Moon, I. (2011). Current status and future projections of LNG demand and supplies: A global prospective. *Energy Policy*, *39*(7), 4097-4104.

Lechtenböhmer, S., Altmann, M., Capito, S., Matra, Z., Weindrorf, W., & Zittel, W. (2011). Impacts of shale gas and shale oil extraction on the environment and on human health. *Wuppertal Institute for Climate, Environment and Energy and Ludwig-Bölkow-Systemtechnik GmbH, study requested by the European Parliament’s Committee on Environment, Public Health and Food Safety, IP/A/ENVI/ST/2011-07, June*.

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), 736-752.

Lin, W., Zhang, N., & Gu, A. (2010). LNG (liquefied natural gas): A necessary part in China's future energy infrastructure. *Energy*, *35*(11), 4383-4391.

Loorbach, D. (2010). Transition management for sustainable development: a prescriptive, complexity-based governance framework. *Governance*, *23*(1), 161-183.

O'Leary, Z. (2010). *The essential guide to doing your research project.* (3th edition). London, England: Sage Publications Ltd.

Outlook, A. E. (2010). Energy Information Administration. *United States*.

Port of Rotterdam (2013) http://www.portofrotterdam.com/nl/actueel/pers-en-nieuwsberichten/Pages/lng-subsidies-eu-rotterdamse-haven.aspx

Protocol, K. (1997). United Nations framework convention on climate change.*Kyoto Protocol, Kyoto*.

Province of Groningen (2012). Economisch Actieprogramma Groningen 2012-2015. http://www.provinciegroningen.nl/fileadmin/user_upload/Documenten/Downloads/Economisch_Actieprogramma_Groningen_2012-2015.pdf

Province of Groningen (2011). Green Deal Noord Nederland. http://www.provinciegroningen.nl/fileadmin/user_upload/Documenten/Persberichten/11-089-avb-bijlage-Green_Deal_Noord-Nederland_oktober_2011.pdf

Provinces of North-Holland, Friesland and Groningen, (2013). Wadden van allure! Gezamenlijke Waddenvisie. http://www.waddenzee.nl/fileadmin/content/Dossiers/Overheid/pdf/Waddenvisie_v5juli2013.pdf

Renner, M. (2013). Climate change and displacements. In *State of the World 2013* (pp. 343-352). Island Press/Center for Resource Economics.

Rogers, E. M. (2010). *Diffusion of innovations*. Simon and Schuster.

Rotmans, J., Kemp, R., & van Asselt, M. (2001). More evolution than revolution: transition management in public policy. *Foresight*, *3*(1), 1-31.

Rühl, C. (2008). BP statistical review of world energy.

SER (2013). Energieakkoord. http://www.energieakkoordser.nl/

Shell (2013) http://www.shell.com/global/future-energy/scenarios.html

Stichting Groen Gas Nederland. http://www.groengas.nl/

Stuer-Lauridsen, F., Odgaard, T., Winter Graugaard, C., Muro-Sun, N., & Andersen, M. (2010). Natural gas for ship propulsion in Denmark-Possibilities for using LNG and CNG on ferry and cargo routes. TNO persbericht. Green Deal LNG, (2012). http://www.tno.nl/content.cfm?context=overtno&content=nieuwsbericht&laag1=37&laag2=69&item_id=2012-06-15%2013:45:52.0

Van der Brugge, R., & Van Raak, R. (2007). Facing the adaptive management challenge: insights from transition management. *Ecology and Society*, *12*(2), 33.

Van der Brugge, R., Rotmans, J., & Loorbach, D. (2005). The transition in Dutch water management. *Regional Environmental Change*, *5*(4), 164-176.

Varum, C. A., & Melo, C. (2010). Directions in scenario planning literature–A review of the past decades. *Futures*, *42*(4), 355-369.

Waddenfonds (2013). http://www.waddenfonds.nl/

Waddensea Secreteriat (2013). http://www.waddensea-secretariat.org/

Waddensea World Heritage (2013). http://www.waddensea-worldheritage.org/nl

Wright, G., & Goodwin, P. (2009). Decision making and planning under low levels of predictability: Enhancing the scenario method. *International Journal of Forecasting*, *25*(4), 813-825.

Used Websites:
http://www.ecoports.com/
http://www.energyvalley.nl/
http://www.gasunie.nl/
http://www.publicatiereeksgevaarlijkestoffen.nl/publicaties/PGS33.html
http://www.topsectoren.nl/
http://www.waddenfonds.nl/

10. Appendices

APPENDIX I – Interview Questions

As a start of the semi-structured interviews, the following questions were used:

- What is your company currently busy with?
- What does 'sustainability' mean to your company?
- What role does LNG has in relation to this?
- What other stakeholders are concerned with the LNG process?
- Which alternatives are there?
- What is your vision on the Waddensea?
- What are your expectations with regard to LNG in the future?
- To what degree do you identify the following drivers and blockers for LNG implementation:
    - Drivers:
        - Green image
        - Positive business-case
        - Innovative incentives
        - Comply to new regulations
        - Additional advantages
    - Blockers
        - Lack of infrastructure
        - Financing obstacles
        - Inertia
        - Unclear regulations
        - Insufficient knowledge about LNG

The drivers are chosen because of the following reasons

Green image: Corporate Social Responsibility (Dutch: Maatschappelijk Verantwoord Ondernemen) is becoming more and more a hot topic. Do the interviewed companies want to have an environmental-friendly image to their customers?

Positive business-case: How important are the financials behind the project? A high initial investment will be earned back by reductions in fuel costs.

Innovative incentives: are there financial or political incentives that stimulate to switch to LNG? For example subsidies from the national government.

Comply to new regulations: Are the upcoming regulations and stricter norms of the SECA areas a driver to look at LNG as an alternative?

Additional advantages: Here, one can think of cooling advantages because of the low temperature of the LNG fuel tank.

Lack of infrastructure: the described chicken-or-egg problem. Is the fact that there is no extensive LNG infrastructure network up to now a blocker for LNG implementation

Financing obstacles: are there not enough financial means to make the initial investment?

Inertia: the resistance to change from the current state to another. Is it easier to leave things just the way it is? Are there now not urgent reasons to change the status quo?

Unclear regulations: currently, there are so many uncertainties about regulations and legislations around LNG. Mainly because it is a relatively new transport fuel.

Insufficient knowledge about LNG: Do the companies or entrepreneurs actually know what LNG is and how it can be used as transport fuel? Do they know the regulations and risks?

APPENDIX II – Interview TESO

Minutes interview Bert de Jonge (TESO) – 15/11/2013 13:00h; van der Valk, Drachten

TESO (Texels Eigen Scheepvaart Onderneming) is the ferry line that connects Den Helder with the Waddenisland Texel. It was founded It is owned in 1907 by doctor Wagenmaker. Nowadays, it is owned by shareholders (mainly islanders) and its headquarter is based on Texel. Benefits are kept inside the firm and will be used to invest in new ships. One of the important aspects in the strategy of TESO is a green image. In this perspective, the firm is part of the organization 'iTransfer'[136]. This is a fund destined for research for making ferry lines more sustainable. It is formed by shipping companies from the UK, Germany Belgium and the Netherlands. This is one of the initiatives TESO supports in their preservation principles. End 2015, TESO plans to have a new ship in operation, and the plan is to design and build this ship as sustainable as possible. There are several aspects that support this vision.

For example, the engine chosen for the new ship is operating on gas and batteries. Dual fuel (oil + gas) was one of the options, but there were no suitable engines for the opted capacity needed (2000kW). Another 'green' initiative is an innovative 'Automooring System'. These are some sort of suckers that will attach the ferry to the quay. Currently, because of time issues, in case of (un)loading, the ships engines keep rotating and push the ship against the quay. There is no time for anchoring the ship and turning the engines off. With this 'automooring system', TESO expects to save about 180.000 liter MGO on a yearly basis. Another new technology is antifouling paint, Ecospeed. This will reduce the amount of paint that will end up in the water of the Waddensea. Moreover, an ultrasonic-system will be implemented to

[136] http://www.itransferproject.eu

prevent the growth of small organisms on the ships surface. Another energy-saving project are the toilets. Nowadays, they are flushed with drinking water. The plan is to sanitize used toilet water and capture it on board. Around eight cubic metres is used daily, of which 90% is used for flushing the toilets. Next energy-saving project is everything that is not in the propulsion (for example: lighting, pumping, ventilation, etc.). LED lights with sensors and heat-coupling are some examples to save energy. Separation of waste is another green initiative on board that needs more attention. But besides energy savings, TESO also is looking at energy generation aboard. Plans for the new ship is 750 square metres of solar cells on the deck. On a sunny day, this could generate 150 kW per day and the payback time will be 10 years. Also the option of wind energy on the boat was considered, but there were too many practical obstacles for this technology (a.o.: height, wind direction, design).

All the above mentioned green initiatives are coming from TESOs own ideals, because there are no directives for most of the above. They see the fact that they operate in a 'green' area as an important driver to make their ships 'green'.

LNG was also considered as a fuel for the new ship. The pros and cons were weighed in depth, but eventually TESO chose for CNG. There were several reasons for this. First of all, the infrastructure of LNG is not developed enough. The supply chain is not completely connected. To make a parallel with oil, here Shell controls the whole chain. With gas this is a whole other story. It is pumped up by oil-companies, but at for example GATE in Rotterdam, the ownership is transferred to the energy companies. These do not have much interest in distribution of small amounts of LNG. It would be only interesting for these kind of companies to ship LNG around the country/seas with a bunker ship. TESOs demand though, is in a sort of vacuum. As long as TESO is the only customer around Texel and Den Helder, their demand is too small for a bunker ship. But the other option, supply by trucks, would mean very high distribution costs. Moreover, the trucks would need to be transported by the ferries of TESO itself, and would be hazardous materials. This would mean extra movements or movements without passengers. Either way, the movement pattern would be negatively influenced. A third option for supply would be a terminal for LNG storage. On Texel is not an option, because this would give the same problems with the supply of the terminal. Den Helder though, is also not an option, because when TESO is the only customer, building and operating a terminal is too costly. Another practical problem here is that there is no space for the terminal in their home port, and the adjacent port is not deep enough for the bunker ships. TESO expects that eventually there will be enough demand in Den Helder and the terminal will be built though. A lot of lobbying has taken place over the last period, and regulations are supposed to be developed in the near future. Around 2017 all this will be settled, is the expectation. But TESO has a tight schedule (their new ship should sail end 2015), so for the short term there is chosen to implement CNG (Compressed Natural Gas). CNG has the benefits of sailing on gas, since it is cleaner than conventional oil. The supply of CNG is also relatively easy. On Texel, there is a compressing station which compresses the natural gas from the net. The fuelling technology is similar to tanking LPG with your car. A hose is attached to the ship when all the passengers

have left the ship. In this way, in five hours the ship can be fuelled with the technology of pressure differences. Moreover, it is an already proven technology. For example, public transport busses are already driving around with CNG on their roof. In TESOs case, it is not necessary to convert all the four engines to a gas motor, because of the feasibility that is related with operating hours per engine. For the infrastructure, this is something TESO will not account for. A private company named BallastNedam will built this compressor station plus a pipeline of 14 kilometres. This will be done with a pressure of 8 bar, since the housing gas network is operating on 3 bar. To maximally benefit from this station, the plan is to also use the gas for other modes of transport on the island. (Footnote is that there are only three buses on the island.)

CNG is a little different than LNG. For example the calorific value of pure methane (CH_4) is 48 MJ/kg. In the CNG TESO is going to use, the calorific value is 35 MJ/kg, because there is much more nitrogen in it. Similar to LNG, it contains almost no sulfur, less CO_2 and no particulate matter. The supplier, BallastNedam is working in both CNG and LNG sectors and via this channel, TESO has found the alternative of CNG. Engine system is also the same in both technologies, the only difference is the process before, since CNG will be compressed, while LNG will be liquefied. The engine is therefore adaptable if TESO wants to shift to LNG in the future.

The regulatory framework is special for the Dutch ferry lines in the Waddensea area. The regulation is called 'zoute veren' and it is part of 'Binnenvaart' (inland) regulations. The reason for these inland regulations is that the staff is different for inland and seagoing vessels and also evacuation plans are different. Because of the same area and regulations, a lot of cooperation exists between TESO, Doeksen and Wagenborg ferry lines. For example in knowledge sharing.

The role of the government is one that needs special attention. They say a lot, but don't do enough in practice. The set goal was 50 inland ships, but now there are only 2 driven by LNG. The Norwegian NO_x fund is an example of innovative incentives that are lacking in the Netherlands. Main problem is that we mostly rely on European regulations, but they are always very late. So first the plans are made and then they have to be tested on the rules. This is a difficult process and situation. In regulatory terms, TESO has also asked for help. Not financial, but a sort of risk prevention. Because in case of the emission restricting rules not coming in 2017, the investments in new technology are unnecessary with hindsight. Also with the plans for the new ship, some flexibility is built in, in case the regulations will or will not change in 2017. So the government is saying that they really want to change something, like implementing LNG widely, but is leaving the initiative in the industry. TESO is really willing to pioneer, but some help of the government is needed. They have agreed upon the GreenDeal, but it just an agreement. Nothing concrete happens. Norway again is a role model in this.

There is now even sailing an electric ferry[137] there. In the future they are looking at induction-technology. Just like an electric toothbrush, the ferry could be charged while at the quay.

Price uncertainty is one of the key sensitivities with LNG. They are really fluctuating, and because it is not yet a big market in the Netherlands, the price ranges are uncertain. For CNG though, there are simple time-contracts, which are very predictable. TESO is not looking for the biggest cost reduction in the fuel, just the green image is enough, but are of course not going to pay more than current MGO. TESO has seen that fuel price is getting a bigger part of the total operational costs, so they have to look at the future. Gas might be cheaper and cleaner than oil, but in the future we also have to look at batteries.

Main problem TESO identifies remains the unclosed LNG supply chain. And since TESO is currently the only (potential) customer for LNG, it is not attractive enough to invest in infrastructure. Maybe in two years things have changed and LNG is a more feasible option. Possible other stakeholders that would consider LNG then, would be the royal Marine and a lot of off-shore parties. The chicken-and-egg problem remains.

In the slightly bigger picture than TESO alone, Texel is also busy with sustainable ideals. Their ambition is to be energy-neutral in 2020. Initiatives to accomplish this are a sun-park, power generation from the tidal waves and biomass. There are also organisations busy with looking for possibilities of Biogas on Texel.

Other alternatives TESO has examined are a fletner-rotor. This is a sort of chimney which catches wind from all directions. Another project was a kite-generator, but this system needs kite-lines of 800 metres to function properly, so this gave practical problems.

Back to LNG, TESO acknowledges that there are enough conferences and meetings about LNG. But it is a repeating concept. Every time the same things are being said, but not enough is put in practice to reach the goals. When we look at other countries, we see a couple of big LNG projects. The Viking Grace in Sweden, a big boat but based on subsidies. A boat on the island of Samso in Denmark is adopting LNG next year. And Scanlines is operating a shipping line on LNG between Norway and Sweden.

This leads to the conclusion that there is certainly a lot of potential for LNG and that eventually it will be rolled out in the Netherlands also. De Jonge expects that first in the inland shipping sector ships are shifting to LNG. Not only new built, but also retrofit. Another driver that will force this development is the forces of the charterer. If the charterer demands a cleaner fuel, shipbuilders and shipping companies are forces to convert their fleet.

[137] www.fjellstrand.no

APPENDIX III – Interview Doeksen

Minutes interview Paul Melles (Doeksen) – 25/11/2013 13:00; Doeksen, Harlingen

Doeksen is the company that operates the ferry line between Harlingen and Vlieland and Terschelling. They are already busy trying to implement LNG in their fleet since 2003. A year ago, they sent in a request for a subsidy at the Waddenfonds. This was rejected on the ground that there was not enough money left in the fund. The request was based on the retrofitting of 1 cargo ship and the new building of 2 ships, in order to contribute to a transition as big as possible. Now the request has been diminished to only 1 ship, as to obtain the subsidy for the cargo ship.

This cargo ship is not linked with the concession Doeksen is also busy with. The concession is about the 'gunning' of the transport between Harlingen and the islands. There are now competitors, which makes the certainty of a monopoly on the ferry line smaller. If this 'gunning' is done for 15 years, this will give some certainty for Doeksen, based on which investments in new ships can be made. Also for the financing of new ships this is needed. It is now pending for answers and decisions by the European counsel, and Doeksen expects this to take less than 1,5 years to be clear. This is short enough though, to make the decision not to take the risk to take further steps in LNG. The shareholders are willing to wait some more time, before further steps in LNG implementation are taken.

Doeksen has no conflicts with the upcoming SECA regulations. They are already shipping on low-sulfur MGO. But image is very important though. Since Doeksen is operating in World Heritage, and the people that are transported are looking for serenity, silence and nature, Doeksen sees this as a responsibility to be as 'clean' as possible. A practical is the cloud of smog that is produced when mooring at the quays. This simply doesn't fit in the image and

the surroundings of the Wadden area. But, Doeksen mentions, we should be careful to be too optimistic about fossil LNG. Emission reductions may decrease, but it is still a fossil fuel. A good target would be BioLNG, since that is totally sustainable.

Another driver for conversion to LNG is the prevention of an oil spill. When operating with gas, the risk of a nature disaster is diminished. Leaking LNG will evaporate relatively quickly, so the cleaning up would be not as disastrous as it would be with an oil spill. On the other hand though, the evaporation of gas will have relatively worse effects on the greenhouse effect, since CH_4 is damaging for our atmosphere. An oil spill would have a smaller impact on the greenhouse effect, but will be very hard to clean up, especially in a vulnerable area like the Waddensea. A spill with either fuels is not quite likely though, since the fuel tanks are so strong they will easier fall over than be ripped apart.

For policymakers also wariness is a problem. LNG is a gas that you transport aboard, so the coupling with LPG is easily made. This readily provides an image of danger. But the Norwegians already use LNG since 2000 and no disaster has occurred to date. This shows that it is a proven technique, which can be delivered 'off the shelve'.

Doeksen thinks the decision of TESO to go for CNG understandable. It is also a cleaner solution. Melles is a bit wary about the fact the gas is under pressure, and this is not the case with LNG. So the risk of explosion is one disadvantage of CNG. In 2003, a Rotterdam party has also looked at the possibilities to compress natural gas from the net. Doeksen let this option go quite soon, because LNG then entered the floor.

The infrastructure for LNG was a major problem two years ago, but is now solved. The possibilities to supply Harlingen by trucks is possible. You have to design your bunkering operations for these supply intervals, since the supplier would like to drop the LNG as efficiently as possible.

Other potential LNG customers in the harbour are also coping with a chicken-and-egg problem. They do not have a frame of reference or an example of a successful case. This is where Doeksen could be the example. When other parties that the implementation is successful and fruitful with a big party as Doeksen, they will make the step easier. For example fishing boats and 'Rijksvaartuigendienst' (ships owned and operated by the central government). And of course Wagenborg (see other interview). They currently do not have the focus on a shift to LNG, but Doeksen expects they have to, eventually. Maybe one of the boundary conditions of the new concession will be that your ferries have to use LNG as a fuel.

Doeksen now wants to skip the step of gas-electric engines, but wants to adopt full gas engines with a direct coupling (lean burn). In this way, you do not lose a lot of energy in the conversion of the fuel and you keep the energy footprint as low as possible.

Eventually electric sailing is the best, in case the electricity is obtained in a clean way of course. But this electric sailing is mainly focussed on peak-shaving. So with a sailing-profile with high

peaks it is profitable. But because Doeksens profile is relatively flat (because it is about 2 hours from shore to island), it is a lot less interesting.

The future of LNG and Doeksen is valued positively by Melles. Since 2003 they are busy with LNG, but are now surpassed by other parties. Examples in other countries show that LNG implementation will eventually come. Natural gas will be the fuel of the future. The question though is how the government will play a stimulating and facilitating role in this. But when LNG adoption is started, there is no way back. The rest will follow.

Taxes were an obstacle in the past, but eventually weren't put through. Also laws and regulations were an issue, but the government has shown to be willingly to cooperate, so this won't be a showstopper either. Doeksen foresees a danger in the price difference between LNG and other fuels. Now the gap is significant, but it could be that the government closes this gap in the future with additional taxes for example.

Main driver for LNG adoption for Doeksen is ideology. Economy is not the most important aspect. Experts have shown that tornados are becoming stronger and Greenland is melting. To stop this we have to take action. But the government is not consistent in this, but retracts or counteracts. What Melles appreciates, are the housing projects in which the owner gets full autonomy. He has to build and act on basis of a couple of boundary conditions, but therein he can experiment what he wants. Besides, he has to organise his own utilities. This is one good example of innovativeness by the government, but they should be consistent.

Maatschappelijk Verantwoord Ondernemen (Corporate Social Responsibility) is an important pillar within Doeksen. They focus on this in several projects: waste disposals, current consumption, lighting, 'horeca'disposal, paper use in the offices. Melles emphasizes that this needs a lot of attention in an organisation and is of high priority within Doeksen, but it is something for which money is needed. Currently the financials are not sufficient, so 'first things first'.

Other alternatives to make the ships more eco-friendly are wind sails. But because of the route that Doeksen sails, this is not practical. Batteries are another alternatives, but are currently too heavy and not strong enough to implement successfully.

Final remark is that within 2 years, Doeksen has a (cargo)ship fuelled by LNG. Also the professional literature is full of LNG articles, so also the experts and the engine manufacturers see a lot of potential in LNG.

APPENDIX IV – Waddenzeehavendebat

Minutes Waddenzeehavendebat – 20-11-2013, Remonstrantse Kerk, Groningen

Henk Staghouwer – Board Member of Waddenfonds

The fund may have 400 million, but in essence this is only some 30 million per year, so it is very crucial which goals the fund will sponsor. The fund operates on a 'first come, first served' base. What has been learned the last few years is that the industry does not only ask for subsidies, but the need for credit is rising. This means that for example half of the fund, 200 million euros, could be spent as lending credit to green initiatives in the Waddensea area. Eventually, these credits will flow back into the fund, and the resources can be distributed again. This will lead to a more durable financial system.

Arjan Berkhuysen – Director of Waddenvereniging

The Waddenvereniging is not only looking at the most 'sustainable' solution, but also at the image and the spatial impact of certain developments. Key question is whether the development fits in the picture of the Waddensea. So not every 'green' initiative is immediately supported by the association. LNG though is one of the developments the Waddenvereniging is keen to support. It has been widely accepted that the comparative advantages will benefit the area as a whole. An example that was mentioned is that the biggest disaster for the Waddensea would be an oil-spill somewhere in the area. It would be extremely costly (both in economic and ecological terms) to clean it up and it will probably kill some biodiversity. The switch to gas as a fuel will be a positive development in the sense that in case of an accident with a gas motor, the gas will immediately disappear. Since it is lighter than water, it will not mix with the water and when it is liquefied (like in LNG), it will immediately evaporate when exposed to the outside air. Overall a switch from oil to gas is thus a preferable option in the eyes of the Waddenvereniging. Furthermore, the association does not have a very strong opinion, since the visual implications of LNG implementation will not be very big. In perspective, the building of a coal-based power station in the Eemshaven is one of the developments the association is fiercely opposing.

Tieneke Netelenbos – Former Minister and current chairman of Waddenzeehavendebat

Netelenbos was very satisfied with the developments since the last debate. The harbours do not opt to compete with each other, but now want to complement each other. Den Helder is the main hub for off-shore activities like drilling platforms or wind energy developed at sea. Moreover, it is the headquarters of the Royal Marine. Eemshaven/Delfzijl has developed itself as the energy-harbour. The large amount of windmills shape this image, but more recently the construction of huge power plants give form to the ambitions of the Eemshaven to generate 8000 MW very soon. It is therefore thé Energy Port of the Netherlands, and maybe even North-Western Europe. Harlingen is looking for a distinct image, since it does not have one unique characteristic. Fishing is represented in Harlingen, the ferry-lines to Vlieland and Ameland are based there, and some shipping-trade takes place here. But especially to have both a positive economic and positive environmental impact, the harbours should cooperate

and complement eachother. Conferences and conventions like the Waddenzeehavendebat are good examples of this goal.

Leo van der Burg – Technologie Centrum Noord-Nederland

One of the workshops in the program was LNG. How can LNG play a role in the Waddensea. It was not the question íf LNG is going to play a role, but hów. It was therefore questioned whether a NO_x-fund, like the Norwegians have, could be implemented in the Netherlands.

The representatives of the municipalities of the harbours all articulated their statement about the future for the area. The main overlap of these statements was cooperation and communication. LNG came forward as an extremely potential development, but cooperation is essential in this. To roll out the implementation of LNG, it is necessary that the harbours and the municipalities make agreements on how to take steps in this. When they all decide to pave the way for LNG, there are three major benefits. First, the impact (both economic and environmental) will be much bigger. Second, cooperative contracts or agreements about the necessary infrastructure can be made. Third, the message that will follow will be a lot stronger. When all the (Dutch) Waddensea harbours work together to preserve their area, it will be a role-model for Dutch politics and sustainability.

APPENDIX V – Interview Groningen Seaports

Notulen interview Theo Smit – 04/12/2013 13:45; Groningen Seaports, Delfzijl

GS is op aarde om bedrijven in ons havengebied te faciliteren, nieuwe bedrijven aan te trekken, met het oog op economische ontwikkeling en werkgelegenheid en tot slot het begeleiden van de schepen in de haven. Schone scheepvaart wordt gestimuleerd: wanneer er aantoonbaar 'schoner' gevaren wordt, of minder emissies, dan zijn hier incentives voor. Bijvoorbeeld minder belasting/havengeld betalen. Daarnaast de leveranciers van LNG hierheen krijgen en aangeven aan de bedrijven dat ze eens moeten kijken naar LNG. Dus ook een communicatieve rol. Hoe? Een commercieel speerpunt van maken. Bereidheid om mee te investeren, wanneer dat nodig is. Daarnaast oplopen organiseren, partijen met elkaar in contact brengen. Deze rol wordt steeds actiever. Het krijgt steeds meer structuur. Door de groei in het gebied wordt GS ook een steeds belangrijkere speler.

Ook een natuur en milieurol weggelegd voor GS. Stimuleren van groenstroken, ecologische stroken in het gebied. Ook de bedrijven in het gebied moeten soms compenserende maatregelen treffen voor hun vervuilende en overlast gevende activiteiten. GS heeft hierin een coördinerende rol, om deze pakketten te bundelen en effectief in te zetten. Is overigens niet door GS opgelegd, maar algemene regels vanuit de overheid.

De groei van de regio; welke trends? Vooral energiebedrijven sinds 2006. Daarnaast offshore-windenergie. Die zorgen ook voor veel transportbewegingen. Uiteindelijk is het vestigingsklimaat, het aantrekken en faciliteren van de bedrijven vooral van belang voor GS. Welke activiteiten zij uitvoeren en op welke manier, is weer de verantwoordelijkheid van de eigen bedrijven. Vooral op economie gericht vanuit GS, maar toch is dit een gebied waarin ecologie en economie dichtbij elkaar liggen.

Restricties: er zijn grenzen aangegeven. Deze situaties zijn niet star, je kunt ze wel veranderen, maar er zijn kaders. Een voorbeeld is het uitdiepen van een vaarweg naar de haven toe. Hier kan er niet zomaar even een drempeltje weggehaald worden, zo werkt het niet. Voor RWS, maar daarnaast ook andere stakeholders zoals milieufederatie, Europese organisaties, etc. Veel onderlinge communicatie tussen deze spelers. Vooral bij een nieuwe case, is er actieve communicatie op projectbasis. Daarnaast zit GS ook in vele gremia vanuit eigen doelstelling. Om te participeren en doelen na te streven. De kaders worden door de overheid vastgesteld door middel van wetten, milieuorganisaties zijn meer de belanghebbenden, dus hebben wel veel invloed. Dit zijn dingen waar je als bedrijf mee moet omgaan.

GS sinds deze zomer een overheids NV. Gemeente Eemsmond en Delfzijl en provincie Groningen zijn de 3 onderdelen van de Gemeenschappelijke regeling, dat is de enige aandeelhouder van GS.

Samenwerkingen over uiteenlopende thema's. Met de haven van Emden, aan de overkant; delen ook de Eems. RWS coördineert alles wat buiten de havens gebeurt. Daarnaast Waddenzeehavens.

Duurzaamheidsaspecten voor GS: schone scheepvaart, en voor de rest zit alles wel bij de industrie. Aan de ene kant zijn deze bedrijven hier zelf voor verantwoordelijk (wat ze doen en hoe ze dat doen), maar aan de andere kant stimuleert GS wel groenere initiatieven (bijvoorbeeld het investeren in infrastructuur). Inkomstenstromen GS: ton lading die op de kade gaat, ieder schip dat aanmeert, de huur/koop van de grond, het gebruik van de infrastructuur.

Conflicterende belangen: GS is geen uitvoeringsorgaan van de provincie. Verschil is wel: een overheid heeft een veel breder spectrum waar ze zich over druk moeten maken. Ambities op alle verschillende vlakken, terwijl GS zich alleen op de economische ontwikkeling hoeft te richten. Stel een energiecentrale klopt aan bij GS, dan is de grondhouding: oké, laten we dat gaan doen. Mocht het niet stroken met de provinciale/landelijke visies, dan wordt er geen vergunning uitgegeven. GS is geen controleur of handhaver van de wet. Betekent niet dat ze er niet over nadenken wat wenselijke activiteiten zijn in het gebied.

Toekomst: havenvisie 2030. In scenario's opgedeeld, wat zijn de mogelijke toekomsten die ons te wachten staan. Ook geconcretiseerd (soort uitvoeringsagenda) tot de stappen die moeten genomen worden om hier te komen. De scenario's echt beïnvloeden zit er niet echt in. Visie staat dus vastgelegd.

Verwachtingen voor de toekomst: op korte termijn (binnen 5 jaar) is dat veel van de dingen die GS wilde bereiken (investeringen in schone scheepvaart o.a.) nu niet meer zo haalbaar zijn. De vraag is of dit binnen 5 jaar nu gerealiseerd kan worden. Een ander aspect is de verduurzamingen van de industrie. Realiteit echter is dat ze nu moeite hebben het hoofd boven water te houden, dus dat richt zich nu meer op korte termijn denken en minder structurele veranderingen. Veel verder wordt er niet gekeken, niet door de industrie, dus waarom zou GS zich hierover druk maken?

Stel het Waddengebied zal in de toekomst wegvallen uit het werelderfgoed, wat voor gevolgen zou dit hebben voor GS? Anders gezegd, heeft het Waddengebied een positieve of een negatieve invloed op het vestigingsklimaat in GS? Niet per se een zwakte, niet veel meer moeilijkheden met de partijen omdat het in deze gevoelige omgeving ligt. Het wegvallen van het natuur en toerisme functie van het Wad, zal niet direct GS aantasten. Echter het woon- en leefklimaat speelt natuurlijk wel mee.

APPENDIX VI – Interview Province of Groningen

Notulen interview Dirk Koppert – 05/12/2013 10:00; Provinciehuis, Groningen

Dirk Koppert werkt voor ECP: economische zaken, cultuur en projectfinanciering. Vooral Economisch actieprogramma van Groningen. Bedrijven accommoderen, binnenhalen laten groeien. Om mensen aan het werk te houden. Strategie is om te zoeken naar de sterke punten als provincie. Energie is een van deze punten. Zitten op het gas, hebben onze havens, hebben een groen achterland voor biobased activities. Wil je dingen aanjagen, dan zijn er veel middelen, subsidies ed voor. Dit mag geen staatssteun zijn, dus je moet altijd op zoek naar nieuwe ontwikkelingen, innovaties. Kijken naar verschillende initiatieven die onder energie vallen. Er is een energieprogramma vizier waarbinnen 5 punten de aandacht genieten: oa. Groengasrotonde en biobased energy. Het vergroenen van de energievoorziening. Hiervoor ook een projectplan opgesteld.

Daarnaast zit de provincie ook in het Waddenfonds. Grote financieringsbron voor projecten die in bovenstaand vallen. In principe de provincies (N-H, Friesland, Groningen) vormen het bestuur. Gedeputeerde zit in het dagelijks bestuur, wordt weer aangestuurd door algemeen bestuur, provinciale statenleden zit daar in om te controleren. DB neemt besluiten en dan heb je nog een uitvoerend orgaan. Deze bevinden zich in een enorm krachtenveld van de Wadden. Er zijn zoveel belanghebbenden in dit gebied. Milieufederatie, Waddenvereniging, gemeenten, havenbedrijven, provincies, et cetera. De rol van de provincie hierin is dat zij projecten aandragen waarvan zij denken dat het gestimuleerd moet worden, en dat wordt dan voorgelegd aan het DB. Torgas is hier een voorbeeld van (torrificeren van hout en daarna vergassen, daarna gebruiken in het Oosterhorn bedrijvenpark). Ander project met potentie om te gaan ondersteunen is een algenproject. En vooral LNG specifiek. Daar ziet de provincie

veel kansen voor het Waddengebied. Waddenfonds is afgelopen jaren verschoven van Rijk naar provincies. Laatste tijd komt er een hele stroom van projecten binnen, waarvan de provincie niet zo goed weet welke ze nou precies moeten subsidiëren. In het geval van Doeksen bijvoorbeeld is het de vraag of zo'n grote aanvraag wel de bedoeling is. Moet er misschien breder en programmatischer aangepakt worden, door veel verschillende initiatieven te steunen. Energieprojecten verdienen zichzelf wel weer terug, dus moet je dit wel subsidiëren. Maar daar zijn ze ook nog niet uit, er zijn zoveel belangen dat het nog even een weg hierin zoeken is.

Beleidsvoornemens van deze specifieke afdeling van de provincie (energie) bestaan dus uit Economisch actieprogramma, energieprogramma en het Waddenfonds. Daarnaast zijn er binnen de provincie ook afdelingen die zich bezighouden met het milieu (EHS, Natura 2000, vergunningen).

Van oudsher is de provincie betrokken/verantwoordelijk voor vele nutsvoorzieningen. Deze eeuw veel geprivatiseerd, maar nu ook juist bedrijven opgezet om deze nutsfuncties toch nog te stimuleren (zo is bv Groningen Seaports opgezet). Provincie blijft nog steeds betrokken bij vele bedrijven, om die publieke taak te borgen (energievoorzieningen, waterbedrijf Groningen, luchthaven Eelde, netwerk Enexis, afvalverwerking Attero). Discussie of dit niet publiek weggezet moet worden, of juist geprivatiseerd om marktconforme prijzen te krijgen door concurrentie. Provincie heeft vele belangen, niet alleen economische belangen, maar ook milieuoverwegingen. Spanning tussen werkgelegenheid en wat levert het op en aan de andere kant de overlast die het veroorzaakt.

Hoe past het waddengebied in deze bezigheden van de provincie? Is echt een meerkoppig monster. Er zijn zoveel instellingen die belangenhebben en die graag mee willen praten over het gebied. Provincies hebben een orgaan: bestuurlijk overleg Wadden. Hier wordt het beleid afgestemd. Er zijn natuurlijk ook kaders vanuit het Rijk. Denk aan natura 2000, werelderfgoed. Zie ook waddenzee.nl. Onlangs een rapport van de Algemene Rekenkamer uitgekomen, dat ingaat op de Wadden. De Rekenkamer gaf een advies om weer naar 1 beheerder te gaan voor het gehele gebied. Er zijn nu zo veel krachten die hierin spelen nu.

De Waddenvisie, opgesteld door de provincies. Geeft de visie weer van wat de provincies graag willen bereiken, dit dient als handvat voor meer uitvoeringsprogramma's waar de concrete stappen uit voort komen. Is niet als regelgeving als richtlijn gegeven, maar geeft goed de ambitie aan.

Koppert geeft aan dat LNG Waddenbreed wel een warm hart toegedragen wordt. Erg interessant, om vooral 3 redenen: je vermijd transport van olie op het Wad, emissiereducties en economische ontwikkeling (scheepswerven, gasaanbieders). 18.000 werkplaatsen in Noord-Nederland in de scheepsbouw.

Verder is provincie bezig met een roadmap samen te stellen om te kijken naar de mogelijkheden voor Power2Gas. Een schets van wat de opportuniteiten in de provincie zijn.

Dit kan bijvoorbeeld weer bedrijven aantrekken, maar dit zal ook weer extra uitstoot geven. LNG heeft deze spagaat tussen ecologie en economie veel minder. Grote bedrijven als GDF Suez en Shell zijn ook veel met LNG bezig.

Wet en regelgeving bij de provincie zijn niet heel erg ter sprake. Deze worden opgesteld door de centrale overheid (ministerie I&M), de provincie kan slechts aangeven en lobbyen voor bepaalde ontwikkelingen. Wel als er bijvoorbeeld een terminal of LNG faciliteit voorgesteld wordt, dan moet de gemeente of de provincie de vergunning afgeven.

Welke obstakels voor LNG? Provincie heeft de taskforce LNG Noord-Nederland in het leven geroepen. Hier worden niet per se de belemmeringen besproken, maar vooral gekeken hoe we het beste LNG kunnen stimuleren. Welke dingen spelen er, en hoe kunnen we hierin helpen? Via die weg komen de 'geluiden' bij de provincie terecht en kunnen drempels weggenomen worden. Grote belemmeringen: hoe krijg je nou de keten gesloten, kip-ei probleem, prijsstelling en leveringszekerheid.

Verwachtingen: LNG gaat zeker een transportbrandstof worden. Hoe lang en wanneer dit overgenomen wordt door andere brandstoffen, heeft hij nog niet duidelijk.

BioLNG? Zeker in geïnteresseerd. Momenteel niet heel veel initiatieven, nog niet tegengekomen in subsidieaanvragen. Zit er wel aan te komen, maar zal een volgende stap zijn.

APPENDIX VII – Interview Harlingen Seaport

Jeroen van den Ende (Harlingen Seaport) – 12/12/2013 12:00; Assen

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Betrokken bij de haven van Harlingen als zelfstandig adviseur. Ziet in Harlingen veel mogelijkheden voor LNG. De interessantste partijen zijn rederij Doeksen, de vissers uit Urk die een thuisbasis in Harlingen hebben en de HCL lijn van HOV. Dit zijn allemaal partijen die van A naar A varen.

Daarnaast is het feit dat het Waddengebied op de UNESCO Werelderfgoed-lijst staat een belangrijke reden dat er gekeken wordt naar schonere alternatieven voor de scheepvaart. LNG is hier de meest interessante vorm van. Grote partijen als Shell zijn hier al tientallen jaren mee bezig en zijn altijd op zoek om hun markt uit te breiden. Nu voorzien zij vooral de Amerikaanse en Aziatische markt van LNG, maar Europa zal in de toekomst ook een grote afnemer worden. Hierin is het Waddengebied een ideaal gebied voor een eerste uitrol.

Van den Ende ziet vooral mogelijkheden in een marktwerking. Niet de betreffende reders of scheepseigenaren laten wachten op concessies of subsidies, maar de markt haar werk laten doen. Laat grote gasmaatschappijen door middel van een tender een aanbod doen. Kijk naar de potentie van de schepen en wat voor investeringen er zijn gemoeid met de ombouw van

die schepen. Laat de gasmaatschappijen dan mee-investeren met deze nieuw- en ombouwprojecten, tegen de voorwaarde dat zij de komende 15 jaar gegarandeerd gas mogen leveren aan deze partijen. Zo hef je financiële obstakels op voor de scheepseigenaren en zijn ook de leveranciers verzekerd van hun aandeel in de markt. Op die manier hoeft de politiek geen financiële bijdragen te leveren, maar slechts mogelijkheden te bieden tot deze constructies.

Er zijn in Harlingen partijen bezig met het kijken naar LNG. Ze zien er economische en ecologische voordelen in. Er wordt echter veel over gepraat, maar te weinig gedaan. Het moet gewoon gebeuren en er zijn partijen die stappen moeten zetten. Van den Ende houdt niet zo van een afwachtende houding, maar ziet graag dat er slagen gemaakt worden en dat partijen daad bij woord voegen.

Wat betreft de verwachtingen voor de toekomst, ziet van den Ende het positief in. LNG wordt de brandstof van de toekomst. Overal ter wereld zijn ontwikkelingen met betrekking tot LNG. Als de grote partijen als Shell er zoveel in investeren, dan zal het uiteindelijk die kant op gaan. De vraag is niet óf het gebeurt, maar wanneer het gebeurt. In Nederland zijn genoeg mogelijkheden voor een uitrol, maar dan moet de markt er met elkaar uitkomen en de politiek meewerken.

APPENDIX VIII – Interview Wagenborg

Notulen gesprek Pieter Dibbits – 17/12/2013 15:00; telefonisch

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Duurzaamheid is best een belangrijk aspect voor wagenborg. Aantal jaren geleden heeft Wagenborg de GreenAward gewonnen voor milieuvriendelijkheid. Ecologie is belangrijk, maar dit mag niet ten koste van alles gaan. Wagenborg is een bedrijf dat omzet moet maken, en daarin gaat economie vaak boven ecologie.

Visie op Wadden: respect voor de omgeving, maar niet ten koste van alles. Opereren in het Waddengebied betekent opereren in een glazen stolp. Iedereen (overheden, publiek, belangenverenigingen) kijkt mee en wil overal wat van zeggen.

Samenwerkingen zijn er wel, bijvoorbeeld met TESO en Doeksen.

LNG: Er vindt veel gepraat in de ruimte plaats, maar er gebeurt weinig concreets. Laat eerst maar eens een voorbeeldproject zien. Er wordt veel gepraat, maar niets wordt echt bewezen. Dibbits gelooft er wel in, maar wil eerst eens in de praktijk zien dat het ook echt kan. Wil dat er een sluitende business-case is, anders gaat Wagenborg niet over. Om aan de CCR normering te voldoen is alleen een katalysator een alternatief. Regelgeving zal rond 2017/2018 rond zijn. Wagenborg zal een afwachtende houding hebben, tot er een concreet voorstel is. Grootste

probleem is dat LNG niet geleverd kan worden. Met moeite kan er wellicht een kleine tanker in de buurt van Ameland komen, maar dit is nu nog veel te kostbaar.

APPENDIX IX – Interview Natuur- en Milieufederatie Groningen

Notulen interview Siegbert van der Velde – 17/12/2013 16:00; Natuur en Milieufederatie, Groningen

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Rol van NMG: koepelorganisatie van allerlei natuur en milieuorganisaties. Gericht op lobby, milieu landschap, klimaat en energie. Vertegenwoordigd in overleggen. Steeds meer trekt overheid zich terug uit bepaalde organen, dus sluit NMG ook overeenkomsten. Vroeger waren milieubewegingen alleen om wat te vinden, maar niet veel inspraak. Niet alleen maar de politiek, maar nu ook milieufederaties en bedrijven die met elkaar afspraken maken.

NMG is niet per se bezig met duurzame mobiliteit. Hoe met LNG in aanraking gekomen? Door de bescherming van het waddengebied. Estuarium van Eems-Dollard in het specifiek. Waddenvereniging doet alles buitendijks, NMG binnendijks. Het is een gevoelig, maar ook vervuild gebied. Het is onderdeel van het UNESCO Werelderfgoed. Verder is het een getijdengebied, dus in het geval van een olieramp is het desastreus. Morele verplichting om zaken die van wereldbelang zijn, zoals werelderfgoed, wordt op nationaal belang niet voldoende gezien. Het ecologische aspect is ondergeschikt aan het economisch aspect. Verder is er onduidelijkheid wie waarvoor verantwoordelijk is. Er zijn zoveel stakeholders, dat het veel te lang kan duren in het geval van een calamiteit, voordat iedereen weet waar hij voor verantwoordelijk is en wat hij moet doen. NMG heeft met Vopak afspraken gemaakt om een soort spoorboekje te maken, om de veiligheid in geval of ter voorkoming van een olieramp in te kaderen.

Verder is NMG betrokken bij de havenvisie van Groningen Seaports. Verduurzaming van scheepvaart is een van de elementen waar zij invulling in proberen te geven. Emissies spelen hier ook een rol. Met vergunningen kan dit een probleem gaan vormen. De stikstofwaarden kunnen te hoog zijn. Dit komt omdat de achtergrondwaarde van stikstof al hoog is. Wanneer er bijvoorbeeld een kolencentrale neergezet wordt, dan wordt de aanvoer daarbij opgeteld en overstijgen zij de maximale stikstofwaarden. Dat stikstof slaat namelijk op een andere plek neer, en in het geval van Eemshaven slaat het neer op de eilanden of de veengebieden in Drenthe. Er zijn twee oplossingen om de natuur te beschermen tegen de stikstof. Twee mogelijkheden: het afplaggen of aanpakken van de consequenties van stikstof op de duinen bijvoorbeeld. Of het aanpakken van uitstoot in de schepen, dan is de stikstofuitstoot er in de eerste plaats niet.

Deze twee redenen zijn voldoende voor de NMG om zich in te zetten voor een integrale aanpak voor het Waddengebied en om te lobbyen voor een LNG-only regio. Ook NMG zet, naast EV, zich in voor de dialoog bevordering tussen afnemers en leveranciers om een

launching customer coalition tot stand te brengen. Waddenfonds is ooit opgezet om te kijken hoe ecologische gevolgen van boren naar gas te compenseren. Door de tijd heen is het echter verschoven ook naar economische activiteit. Nu is het ook zoekende naar welke projecten wel en niet steunen. Als je Doeksen subsidieert, waarom dan een kolencentrale van RWE niet?

Verder is NMG ook met EV bezig om te kijken of er mogelijkheden zijn voor een soort stikstof-fonds. Zoals het NO_x fund uit Noorwegen. Zo kunnen LNG activiteiten vormgegeven worden. Echter, er is hier een wettelijke basis voor nodig, nu zijn die regels er nog niet voor. Politiek draagvlak is voor zo'n fonds dus essentieel. Verhandelbare systemen zoals ETS zijn mislukt in Nederland, dus dit is lastig op te zetten. Hoe zit het? Milieuwet is gericht op individuele bedrijf, maar niet op het totale plaatje. Dus ieder individueel bedrijf kan wel zo schoon mogelijk zijn, maar als er steeds meer bedrijven bij komen, gaat in absolute zin bijvoorbeeld de stikstofuitstoot omhoog. Hier zijn geen middelen voor om dit tegen te gaan. Door middel van zo'n fonds is dat het fonds kan kiezen waar het geld aan wordt besteed om zo effectief de stikstofuitstoot aan te pakken. Varkensboeren uitkopen is bijvoorbeeld een veel effectievere aanpak. Één megastal stoot evenveel uit als de grootste kolencentrale van Nederland (RWE centrale). Dus effectievere aanpak is: schaf geen scrubber bij elk bedrijf aan, maar stort het bedrag in het fonds en dan besteden wij dat wel aan LNG in de scheepvaart of het uitkopen van varkensboeren bijvoorbeeld.

NMG wordt gesubsidieerd door de provincie om zo onafhankelijk mogelijk te zijn van de provincie. Op onafhankelijke wijze milieu en natuuragenda's naar voren brengen in de politiek.

Verder is NMG ook uitgenodigd voor Nationaal Platform LNG om deel te nemen in de dialoog. Hieruit hebben zij zich teruggetrokken, waarom: het gaat over wegverkeer niet over scheepvaart, het gaat over CO2 footprint maar veel minder over stikstof en gaat vooral over de vraag hoe positioneert LNG zich in de visie van ministerie van I&M. Er zit bijvoorbeeld een brandstofvisie aan te komen, dus welke brandstof wordt gestimuleerd en welke brandstoffen worden uit gefaseerd. Maar dit heeft allemaal veel te weinig te maken met de bescherming van het Waddengebied, dus zitten daar met een hele agenda in.

Wat is het eindbeeld: elektrisch varen, BioLNG? Elektrisch varen, misschien wel, maar denk het niet. BioLNG gelooft van der Velde niet in. Voor 1% van de consumentenvraag van Nederland is het gehele oppervlak van Nederland nodig. Het is dus haast niet mogelijk om de hele gasvraag te vervangen door biogas. Bovendien zal het biogas wat geproduceerd wordt, zal in eerste instantie voor de industrie bestemd zijn, dus er blijft niets over als vervanging van aardgas in het transport. De vraag zal dus te groot worden voor biogas, maar het zou dus kunnen dat er gevraagd zal worden naar schalie-gas. Dus dat er in de toekomst gevaren wordt op schalie-gas is niet uit te sluiten. Maar de vraag is dus ook hoe serieus de overheid is om naar die 95% duurzame energie te komen en bepaalde brandstoffen als kolen helemaal uit te faseren.

Verwachtingen voor komende 10 jaar: nieuwe emissienormen voor de scheepvaart betekent dat rederijen in ieder geval moeten nadenken over wat ze gaan doen. Verschillende opties: scrubber, laagzwavelige diesel, of LNG. Overheid moet hier meer stappen in zetten. Bijvoorbeeld het financieel ondersteunen van reders door te betalen voor de ombouw van de motoren op LNG ook. Daarnaast ook de wettelijke kaders hier op aanpassen. Niet via Waddenfonds, want dat is geen belastinggeld, maar er moet gewoon belastinggeld in worden gestoken. Vooral het meefinancieren vanuit de overheid zal veel reders net over het randje tillen, omdat LNG wel de beste optie is. Differentiatie van havengelden is ook een optie, maar hier zal wel een balans in gezocht moeten worden, want als er na een tijdje geen boten meer komen houdt het op.

Verder is van der Velde ook niet per se voor Doeksen als eerste overstapper. Publieke perceptie is een heel belangrijk aspect van het geheel. Mensen moeten uitgelegd krijgen en geloven dat het veilig is. Als Doeksen begint met een passagiersboot en men heeft het beeld van een 'varende bom' dan kan dit funest zijn. Bijvoorbeeld een vrachtschip zou een beter proefproject zijn.

APPENDIX X – Figures Sources

Cover Page	http://www.lngworldnews.com
Figure 1	http://commons.wikimedia.org/wiki/File:SECA_NORD%26OSTSEE.jpg
Figure 2	http://www.energyvalley.nl
Figure 3	DNV, 2012. "Shipping 2020"
Figure 4	Author
Figure 5	Author
Figure 6	Author
Figure 7	Author
Figure 8	Author
Figure 9	Author
Figure 10	Author
Figure 11	Rogers, E.M., 1995. Diffusion of Innovations, 4th edition
Figure 12	Author

Figure 13	De Roo, G., Porter, G., 2012. Fuzzy planning: the role of actors in a fuzzy governance environment
Figure 14	Loorbach, D. (2010). Transition management for sustainable development: a prescriptive complexity-based governance framework.
Figure 15	Author, adapted from Loorbach (2010) & de Roo (2012)
Figure 16	Author
Figure 17	Author
Figure 18	Author
Figure 19	Author
Figure 20	Author
Figure 21	Author
Figure 22	Author
Figure 23	Author
Figure 24	Author
Figure 25	Author
Figure 26	Author
Figure 27	Author
Table 1	Author
Table 2	Author
Table 3	Author
Table 4	Author