How to stimulate the sales of Liquefied Natural Gas-Vehicles

- A case study in the Belgian market

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Abstract

Liquefied Natural Gas is a clean and lower carbon alternative to diesel in the heavy road transport sector. It is established as a system in Netherlands and is in the preliminary phase in Belgium with three existing LNG filling stations. Belgium is one of the most heavily trafficked countries in Europe with poor air quality, making it an interesting market to establish an LNG system. However, truck manufacturers lack a sufficiently clear picture of the market in Belgium to formulate marketing strategies for Liquefied Natural Gas Vehicles. The aim of this work is to outline key leverage points for marketing strategies to stimulate the sales of L-NGV in Belgium. This work is accomplished via the generation of a case study. In order to formulate marketing strategies, the driving forces and barriers in LNG uptake are identified and examined. This is performed using interviews with Belgian transport companies with experience in LNG. Feedback and communication with relevant Scania employees are gathered to place barriers and drivers in the context of a manufacturer's perspective. While the study shows substantial evidence that there is a suite of drivers that have a great potential to drive a significant increase in L-NGV in Belgium. It also shows that there are several risk-related issues for the transport companies that need to be solved for substantial growth in the L-NGV market to take place. In particular, the transport customers sometimes perceive risks greater than they are in reality. Key risks areas found to be affecting perception and contributing to risk-averse behaviour were the uncertainty of Total Cost of Ownership, residual value and the performance of the technology. Marketing strategies can drive and change the risk-averse behaviour. Suggestion for future research is to compare the residual value for L-NGV and diesel-powered trucks.

List of Abbreviations

CNG – Compressed Natural Gas

GHG – Greenhouse gas

LBG = Liquefied Biogas

LNG – Liquefied Natural Gas

L-NGV – Liquefied Natural Gas Vehicle

LPG – Liquefied Petroleum Gas

NG – Natural Gas

NGV = Natural Gas Vehicle

RV – Residual Value

TCO – Total Cost of Ownership

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Introduction

The transport sector represents almost a quarter of Europe's greenhouse gas emission (EU, 2018), and within the transport sector, road transport accounts for more than 70% of the emissions. The EU-goal to have 40% lower greenhouse gas emissions in 2030 compared to 1990 is a great challenge (EU, 2018). Also, the awareness of health risks of traffic related air pollution (e.g increased risks of heart attacks, and the exacerbation of asthma among children but also expected life reductions) and noise (noise annoyance, sleep disturbance, hypertension and cardiovascular risks) have increased substantially the recent years (Istamto, T, et al, 2014). These health and environmental risks generate substantial costs for the society that are external to a large extent because they are not represented in the market price of the transportation.

Belgium, located in Western Europe, is suffering from heavy traffic and congestions despite its extensive road network (Meers, D, et al, 2016). Belgium is considered as one of the most heavily trafficked countries in Europe (Vermeersch, L, 2014). This poor air quality and high traffic noise is causing critical impact on human health (Belgian Interregional Environmental Agency, 2018).

Alternative fuel is one of the pathways to reduce harmful environmental and health emissions and make less noise. One of the alternative fuels that represents a promising alternative to diesel in short-term, within the heavy-duty road sector is LNG (Liquefied Natural Gas) (Arteconi, A & Polonara, F, 2013).

LNG is natural gas that is liquefied by cooling down below -161°C to reduce its volume to 1/600 compared to its gaseous state (Hahn, E, 2018). The environmental and social benefits of LNG compared to diesel are distinct (NGVA, 2014). LNG compared to diesel reduces the particulate matter and SO2 emissions up to 90% (Fluxys, 2018:b). It makes 50% less noise and but also lower CO_2-reductions but varies depending on well-to wheel analysis (Clean Energy Compression). L-NGV (Liqufied-Natural Gas Vehicles) also creates a great opportunity to make a transition into LBG (Liquefied Biogas) which makes a possible reduction of GHG emissions of up to 90 percent (NGVA, 2014).

It is also commercially proven that L-NGV is a valid replacement of diesel, as USA and China have a considerable amount of L-NGV and a developed infrastructure (South China Mornings Post, 2017, & NGVA, 2015). Also, the neighbouring country of Belgium to the north, The Netherlands, is a rather mature country in LNG with a country-wide coverage of filling stations (Owen. W. 2018, January).

At this time, Belgium does not have a commercially mature system for the utilisation of LNG for heavy road transports; however, it has entered the preliminary phase with three existing LNG filling stations situated Kallo, Veurne and Lokeren (Personal Communication, Frank Schoepen, 7/3-2018). The first was installed in 2014, while the newest one in 2017. The LNG Blue Corridor, financed by the Seventh Framework Programme, EU, was the project that installed the first LNG-fuelling stations in Belgium, Kallo, making L-NGV a viable option (Denys, T, 2014).

The Current LNG-filling stations in Belgium
Green is Kallo, Red is Lokeren and Blue is Veurne

Replacing diesel-powered trucks with L-NGV has great potential to increase the air quality significantly in Belgium, however, according to Browne, D (2012) the implementation of an alternative fuel in a new market is a rather slow and complex process. Saukkonen, N, et al (2017) concludes that AFV (Alternative fuel vehicles) investments in transport companies is a complex decision-making process guided by not only the number of filling stations, maintenance infrastructure or residual value of the vehicle, but also by subjective, non-rational elements such as personal interest in sustainable solutions or value for the environment. The driving forces to use NGV can be financial incentives or to improve air quality (Khan Imran, K, 2017). In the future of conventional fuels, it might not be able to enter cities, which create a great

opportunity for electrification and NGV. This is becoming a reality in Paris among other cities (Love, B, 2017).

LNG is an economically justifiable option that is cleaner and has lower greenhouse gas emission compared to diesel. Even though it is an attractive option for transport companies there are uncertainties and perceived risks in the system that are restraining them from investing in the technology. Thus, it makes it important to check on the areas that potential users consider particularly uncertain and risky to their business models.

This research is made in corporation with Scania. Scania is an international company active in more than 100 countries with a world leading provider of transport solutions and delivered 73,100 trucks and 8,300 buses in 2016 (Scania, 2018). Scania is a part of driving the shift towards a sustainable transport system and in 2017 they announced an L-NGV (Liquefied-Natural Gas Vehicle) with a 13-litre engine and 410 horsepower that are viable for long-distance transports and regional distribution (Scania, 2018).

Aim

Engine manufacturer lack a sufficiently clear picture of the market in Belgium to formulate marketing strategies. The aim of this work is to outline parameters for marketing strategies to stimulate the sales of L-NGV in Belgium.

Question Formulas:

1. What marketing strategies might be necessary to be provided from truck manufacturer to facilitate the sale of L-NGV in Belgium?
    a. What is the current situation of LNG for heavy truck transports in Belgium?
    b. How high is the potential to substitute diesel with LNG in the heavy transport sector in the coming future?
    c. What are the driving forces and barriers among the manufacturer and transport companies in Belgium to use L-NGV in the road freight transport?

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Method

The purpose for this research is to fill the knowledge gap for Scania in understanding what strategies and knowledge is needed to stimulate the sales of L-NGV vehicles in Belgium. One of the most important aspects to be able to formulate marketing strategies is to understand the driving forces and barriers in using L-NGV. This study is accomplished via the generation of a case study.

The decision to focus on LNG and Belgium was decided on a sustainability conference for Scania in Södertälje between 22/1-24/1 2018. It was highlighted that I was doing my thesis in Scania and I was available if a market needed additional support. Scania Benelux showed interest and in a meeting a few days after the conference we decided that the aim of the study is to focus on formulating marketing strategies for LNG.

Belgium and LNG were a viable option because of three things:

- Geographical aspect - the country is located in Europe and within the EU which makes it easy to travel and visit from Sweden.
- LNG situation – L-NGV in Belgium is commercially in the beginning phase.
- The size of the market - Belgium is a small-medium sized market.

To be able to formulate marketing strategies is to first identify the maturity of LNG market in Belgium, but also understanding the entire structure of the technology. This is also how the research questions were formulated. To be able to do this, a trip to Belgium was made between 5/3-2018 -8/3-2018. The trip was to interview and understand the mind-set of transport companies in L-NGV, but also to meet Frank Schoepen (Manager, Sustainable Solutions, Scania Benelux) and give me a brief view of LNG and Belgium. Three Belgian transport companies were interviewed, instead of mentioning the names; they will be named as Transport Company one, two and three in this work.

1. CEO of Transport Company one (Interview 6/3-2018)
2. CEO of Transport Company two (Interview 7/3-2018)
3. CTO of Transport Company three (Interview 7/3-2018)

Frank Schoepen organized these meetings. The decision to meet these companies were based on that they have a close relationship with Scania and they also have experience of using L-NGV. This could develop rewarding discussions as they are Scania customers and interested in explaining their concerns in L-NGV to one of their suppliers. The intention of the interviews was to gain information of

what the drivers for them were to go for L-NGV but also to understand what identified barriers they have experienced.

The interviews were semi-structured, as the questions were prepared before the interviews but only used as support for the discussion. The interviews were not recorded; mostly because of not make the interviewed persons to feel uncomfortable as some things were confidential. Instead notes were taken during the interview and then summarised afterwards.

The next step after the visit in Belgium and understanding the maturity in Belgian market was to look into other markets for inspiration and understanding what strategies can be implemented in Belgium. But also gather information within the technology, service & maintenance, secondary market and Total Cost of Ownership. This work is looks into Spain and Netherlands for inspiration in how they have been approaching the LNG system. The decision to look into those countries are based on that they are one of the most mature LNG countries in Europe.

The decision to interview following persons was based on snowball sampling, at first I was recommendations to contact Johan Mühlbach by my externally supervisor, Jonas Nordh. Here is a list of following persons I had personal communication with (Name, title, organisation, subject, date):

1. **Frank Schoepen**, Manager, Sustainable Solutions, Scania Benelux: Information of LNG and the maturity in Belgium (Continuous personal communication throughout the study).
2. **Johan Mühlbach**, Product Manager Gas Trucks: Technical and commercial aspect of L-NGV but also provided Scania TCO. (Continuous personal communication throughout the study)
3. **Johan Palmqvist**, Head of Sustainable Solutions, LOTS Group: Challenges in LNG and strategies that has been used in the Netherlands (Interview 14/3-2018)
4. **Thomas Björk**, Area Sales Manager EU: Residual value of used L-NGV and the secondary market of gas-powered trucks (Interview 4/4-2018)
5. **Jacob Thärnå**, Sustainability Director, Scania: LNG and Spain – examples of marketing strategies and challenges (Interview 9/4-2018)
6. **Niklas Olsson**, Head of Product Manager Scania Maintenance: How the secondary market works for alternative fuel and the challenges (Interview 24/4-2018)

Once having enough information of the technology and understanding the commercial part and the customer's mindset I formulated parameters to outline the marketing strategies that could be applied to the Belgian market. The analysis consists of a theoretical insight that builds from institutional theory to support the findings of this work. The personal communication that was presented earlier is complemented with empirical data from following searching engines:

Searching Engines
The Searching engines that was used for this work.

Science Direct	*Google*
Web of Science	*LUBsearch*
Google scholar	

The empirical data consists of sources from science articles, reports and websites. Google was primarily used for finding articles and websites to prepare for the interviews in Belgium but also to find basics and elementary information of the LNG system. The other searching engines were used to find scientific articles and reports relevant for this study.

Delimitations

The focus will be on LNG-powered heavy vehicles in the Belgian market, but also some examples of some mature markets in Europe for comparison and inspiration.

The study's focus is LNG for road transport in long-haulage- and distribution segments and the decision to focus in LNG was based on that it is the alternative fuel that has the good potential in short-term aspect. The transition to LNG also goes parallel with LBG which the alternative fuel in long-term aspect could be. There will also be some thorough check of fall cases when LNG has been supplemented by LBG, to see if yet is commercially possible.

The Interviews were only made with customers that have experience of using LNG and have a good collaboration with Scania. Having customers close to Scania could create a good discussion as they might also be interested in explaining their experienced barriers going for LNG as this paper is trying to solve it. The decision to interview these customers were made by Frank Schoepen (Manager, Sustainable Solutions in Scania Benelux).

This paper is not looking deep into the details of the technical aspects of L-NGV and the barriers, as this work is focusing on focusing on the commercial aspect. It is also not looking into the life cycle of LNG and the environmental impact of extracting it.

Limitations

The time limitation of the thesis is taking place 16th January to 23rd may. Also, in the visit in Belgium there was a meeting with the owner of the newest LNG-filling station that had to be cancelled due to lack of time.

Results

This part of the work will present; (a) overview of LNG situation in Belgium and the potential; (b) Technology and infrastructure; (c) Economics of LNG, TCO and the secondary market; (d) LNG commercially worldwide (e) LNG and LBG projects; (f) Summaries of key information from transport company interviews and then at last; (g) Features that make the system less robust.

LNG in Belgium

The first LNG-filling station in Belgium was introduced in 2014 in Kallo, the Antwerp port area (LNG World News, 2018). Before that, LNG had not been used as a fuel for trucks in Belgium. It is strategically located to provide LNG to several heavy-duty vehicles, connecting key logistical countries within European corridors (Denys, T, 2014). The filling station in Kallo was a part of the European project LNG Blue Corridor.

The second LNG-filling station was introduced in 2014 in Veurne by Fluxys and Mattheeuws Eric. The station is supplied by tanker truck from the Zeebrugge (LNG World News, 2014). Zeebrugge is an LNG terminal located in Belgium and serves as a gateway to supply LNG to Northwest Europe. LNG is stored there temporarily as a buffer in storage tanks and can be either regasified and injected into the grad for transmission or loaded into LNG vehicles or vessels (Fluxys, 2018:c). The main imports of LNG to EU member states are coming from vessels from Qatar, Algeria and Nigeria. But also, Southeast Asia including Malaysia, Vietnam and Singapore are big exports of LNG (Wilson, A-B, 2015). Meaning that LNG is already liquefied once it arrives to the terminal in Belgium.

The project in Veurne was selected for EU funding by an independent group of experts under the priority" Measures to promote innovation and new technologies for transport infrastructure" of the TEN-T Annual Call 2013 (LNG World News, 2014).

The newest LNG-filling station is located in Lokeren and is projected by Tankterminal N.V in cooperation with LIQAL (LNG World News, 2017). It opened in 2017 and is located alongside highway E17, the main corridor between the Netherlands and France. LIQAL is the one that designs the station and is responsible for technical operation and maintenance of the system (Tankterminal, 2017).

The decision for the location for these filling stations was based on (European Commission, 2016):

- Accessibility from highway
- Close to logistic hub (such as port or distribution centre)
- Presence of launching for base volume.
- Absence of other LNG station (not too hard, for the time being)
- LNG compatibility of site with respect to permit (environment, safety, noise)

There are also a lot of plans of installing new LNG-filling stations in Belgium. The Belgian transport company Remitrans just invested in nine new L-NGVs resulting in 15% of their fleet run on LNG with a future plan to change the entire fleet (LNG World News, 2018). Simultaneously, the company is investing in a new fuelling station expected to be in Ninove and operating in the second half of 2018, both available for its own and for third parties.

Emission Free Zones

In Paris there are plans to banish all petrol and diesel-fuelled cars by 2030 (Love, B, 2017). This is to tackle the pollution in the cities that is mainly caused by the transport sector and many other cities in the world are considering similar moves to reduce the emissions. In Belgium, Antwerp was the first in the country to implement a low emission zone in the city centre (A Typical Antwerp, 2018). If the vehicle doesn't meet the conditions for admission it is possible to buy an LEZ day pass. This is needed if your vehicle is Euro standard 3 without a DPF (diesel particulate filter) or older than 40 years (Smart Way to Antwerp, 2018).

Emission Free Zones, or known as Green Zones, have different restrictions within EU, but it is predicted that this will have a positive effect on purchasing alternative environmentally friendlier fuels, since conventional fuels might not be able to enter future green zones (Obrecht, M, et al, 2018).

LNG vs CNG & LPG

There is a well-established CNG infrastructure in Belgium and is a viable choice for road transports (Fluxys, 2018). LPG is also an alternative fuel used for road transport in Belgium (Mylpg, 2018). The purpose of this part is to briefly show a competitive comparison of LNG versus CNG & LPG which explains why this research focus is in LNG.

Natural Gas is a mixture of paraffinic hydrocarbons such as methane, ethane, propane and butane (Kumar, S, et al. 2011). Small amounts of higher hydrocarbons such as ethylene can be present apart from carbon dioxide, a trace amount of hydrogen sulphide and nitrogen. The removal of acid gases such as carbon dioxide and hydrogen sulphide before liquidation of the natural gas is an important process to generate LNG. LNG consists approximately of more than 98% methane, therefor it is considered as the cleanest form of 'natural gas'. LNG trucks can seamlessly fulfil the Euro VI standard without requiring after-treatment exhaust equipment, as required by diesel engine (Osorio-Tajeda J.L et al, 2017).

LNG is natural gas that is liquefied by chilling below -161°C which reduces its volume to 1/600 compared to its gaseous state (Hahn. E, 2018). This makes LNG transportable in cryogenic ships or trucks. As noted, LNG consists mainly of CH4 (Methane) which is an odourless, non-toxic and non-corrosive gas. Natural gas is flammable, but in liquefied form not (GIIGNL, 2018). The flammability of methane is such small that any leak of LNG vapour from a tank is likely to rapidly mix with the air and quickly dissipate.

CNG (Compressed Natural Gas) on the other hand is a mixture of hydrocarbons consisting of approximately 80-90% methane in gaseous phase (Kumar, S, et al, 2011). It is also colourless, non-carcinogenic, non-toxic, inflammable and lighter than air. Due to its low energy density, it is compressed to pressure of 200-250 kg/cm^2 .

The driving range of LNG is generally less than comparable conventional diesel-vehicles because of the lower energy density of natural gas (Alternative Fuel Data Center, 2017). Liquefying the gas increases the energy density significantly

which makes it 1.7 litre of LNG equivalent to one litre diesel, while it is equivalent to approximately 0,969 m^3 CNG (Alternative Fuel Data Center, 2017). Because of this CNG is more suitable for light-duty cars and distribution and not for heavy-duty trucks in the long-haulage sector. A L-NGV with the same fuel tank size could travel up to 2,4 times the distance compared with one fuelled by CNG (Osorio-Tajeda J.L et al, 2017). However, if looking into well-to-wheel phase, GHG reduction from CNG might be higher than LNG due to the additional energy requested for natural gas liquefaction and shipping for LNG (Arteconi, A & Polonara, F, 2013).

CNG is more established in the Belgian market compared to LNG. Today there are 90 locations where CNG-vehicles can be refuelled and additional stations to open (Fluxys, 2018). However, CNG is used by passenger cars meanwhile LNG is not; due to passenger cars stand idle much longer than duty-trucks, which would give rise to high evaporation losses (CTCN, 2018). It would neither be economically or environmentally sustainable.

LPG (Liquefied Petroleum Gas) consists of heavier molecules such as propane and butane unlike LNG/CNG (Diffen, 2018). LPG is generated from gas fields when natural gas is extracted from reservoirs but is also a by-product of cracking process during crude-oil refining. LPG gases can be compressed into liquid at relatively low pressure and is unlike LNG, broadly run on gasoline-engine (Diffen, 2018). However, even though LPG is a relatively clean fuel it has some disadvantages (Woodford, C, 2018). The two big disadvantages are safety and cost. To keep the gas pressurized at 74 less space than it normally occupies requires extremely sturdy metal tanks. The cost of LPG is also typically several times more expensive than ordinary natural gas (Woodford, C, 2018).

LNG has advantages over CNG and LPG in terms of easier transportation, storage and better density than gaseous methane (Kumar, S, et al. 2011). LNG also offers additional flexibility as liquefied to compressed natural gas. Furthermore, the LNG system has a role of contributing to the development of biogas-to-biomethane as a vehicle fuel, both for gas purification and transportation.

LNG vs Diesel

The fuel price is a significant important aspect when considering alternative fuel. Since LNG is relatively new on the Belgian market, there is a lack of regulations, but it is also tax-free (Personal Communication, Transport Company, March 8, 2018). It is common that L-NGV from Netherlands are filling up in Belgium because of the tax release. However, the interviewed transport companies (Personal Communication) believe that if there is a sufficiently great increase of L-NGV in Belgium it will result in a reduction of diesel-powered vehicles. This could result in a lower tax income for the government because diesel is taxed, but not LNG. This results in a high probability that LNG is going to be taxed as well. The EU Energy Taxation Directive is also implemented to "… avoid any distortions of trade and competition which could result from big differences in national tax systems" (EUR-Lex, 2016). This means that the tax loophole will be closed.

Since the purchasing price for an LNG-powered truck is more expensive than a diesel, the price for LNG needs to be approximately 20-30% cheaper per kg compared to gasoline per litre to have a long-term payback (Palmqvist, J, Personal Communication, March 15, 2018).

LBG - Liquefied Biogas

The chemical composition of LBG is almost the same as LNG; containing almost pure methane CH_4, with small traces of other substances (Wisdom, 2017). It is a renewable fuel and its sources come from animal manure, sewage sludge or green waste. As a renewable energy source, LBG has a competitive advantage over traditional liquefied natural gas. LBG offers about 80-85% CO_2- and NOx reduction and 100% reduction in SO_X and fine particles. However, it is commercially not mature, as today there is no significant bio-LNG production capacity available (Wisdom, 2017). However, since LBG can be mixed into LNG and might even completely replace it at some point, makes LBG benefit of the growing LNG infrastructure.

Driver Safety and Service stations

How safe is LNG? When looking into historical reality is that LNG has the best safety record of all common fuel types (Dodge, E, 2014).

Even though the product of CNG and LNG for vehicular applications is essentially the same, the general properties affecting safety are quite different (Federal Transit Administration, 2018). LNG is more refined and consistent product with no problems regarding corrosive effects on tank storage associated with water vapor and other contaminants. On the other hand, the cryogenic temperature makes it very difficult or impossible to add an odorant. Therefore, with no natural odour of its own, it is rather hard for personnel to detect leaks unless the leak is sufficiently large to create a visible condensation cloud or frost formation (Federal Transit Administration, 2018).

LNG is neither flammable nor explosive as a liquid (STI Group, 2018). But when it begins to vaporize it is potentially flammable and explosive, but only within the range of 5-15% natural gas in air. If it is less than 5% there is not enough natural gas to burn, while at more than 15% there is not enough oxygen.

The cryogenic temperature associated with LNG systems creates safety considerations for bulk and storage (Federal Transit Administration, 2018). LNG requires intensive monitoring and control because of the constant the fuel which takes place due to the extreme temperature differential between ambient and LNG fuel temperatures. Even in highly insulated tanks, there will always be a continuous build-up of internal pressure and a necessity to use the fuel vapor or safely vent it to the atmosphere. The constant vaporization of the fuel also might have a significant effect on the properties of the fuel. The methane in the fuel will boil off before some of the other hydrocarbon components. Therefore, if LNG is stored over a longer period of time without withdrawal and replenishment the methane content will continually decrease, and the actual physical characteristics of the fuel will change to some extent. However, this is not happening if the LNG is in highly purified form without containing other hydrocarbon components than pure methane (Federal Transit Administration, 2018).

LNG-stations are mainly built according to local regulations (Yanouch, B, 2013). Safety measures cannot be gathered in one document as these differ from one country to another or even by the individual supervising authorities (Yanouch, B, 2013). Despite the special cryogenic conditions in LNG stations, current technologies fulfil safety standards very well (Tarjeda-Osoriom, J-L et al, 2017). Even

LNG can be safer than diesel at stations due to the absence of boil-off gases released to the environment during the diesel refuelling procedure.

Technology

In general, the use of LNG in road freight transport is technologically optimal and shows the same or better performance and fuel efficiency than new diesel trucks (Tarjeda-Osoriom, J-L et al, 2017). The application of LNG in vehicles is supported by the same combustion technology as CNG; the fuel is always injected into the engine in gaseous form. The difference between the two types of vehicles is mainly the storage method. In an LNG vehicle with either SI (Spark Ignition) or CI (Compressed Ignition) the cryogenically stored natural gas is preheated and vaporized in a heat exchanger before being injected in a gaseous form to the cylinders.

Filling stations

LNG-filling stations is rather expensive, the cost of the first LNG-filling is estimated to €1 million (LNG World News, 2014:b). Due to its expensive cost it is important to ensure that vehicles will be using it regularly. The size of the station might differ, but it is needed that at least 20-30 vehicles will be fuelling from the station regularly, if not, there is a high risk that temperature in the tank will rise and the LNG will evaporate, according to Johan Palmqvist (Personal Communication, 15/4-2018). This safety issue overlaps with economic viability.

The knowledge of LNG technology is considered very high in Europe, however, it is still far from being commercially mature (Mariani, F, 2016).

LNG stations are mainly based on a tank that contains the LNG (Xavier, R, 2013). The tank delivers the LNG to the truck via a dispenser. Some stations have a cryogenic pump between the tank and dispenser for faster filling.

For LNG supply stations there are two options: first one is liquefaction “in situ”, namely small scale liquefication near to the services stations using NG from a pipeline (Tarjeda-Osoriom, J-L et al, 2017). The second option is LNG tanker trucks from a regasification terminal to the service station, which also has been considered to be the less expensive option in many studies.

LNG Technology and Infrastructure

LNG is essentially a fuel for niche market (McPherson, C, 1999). It is a rather expensive process liquefying and shipping natural gas making the LNG route most attractive in for areas where there is a shortage of indigenous gas supplies (CTCN, 2018). Additionally, the use of LNG requires large investments in terminal and fuelling infrastructure. In large quantities, LNG can only be transported by sea, so its large-scale use is confined only to places that are accessible via a port.

LNG also has potential in regions that doesn't have pipeline infrastructure since the fuel can be transported by road (Joeri J, 2015). But also countries for example in central Europe is lagging behind the current small scale LNG development because of being landlocked and causing complex and inconvenient supply (NGV Global, 2017). LNG transported long distances between import terminal and filling stations are not an economically or environmentally option. Meanwhile coastal countries have easy access to LNG due to presence of terminals and closer to filling stations (NGV Global, 2017).

Cost of Technology and LNG

For LNG use in heavy road freight transportation considering the low LNG fuel price, high annual mileage and current technology costs, fleet owners can recover their investments in attractive periods (Tarjeda-Osoriom, J-L et al, 2017). This was unthinkable a decade ago due to the higher price of the technology but also for maintenance costs.

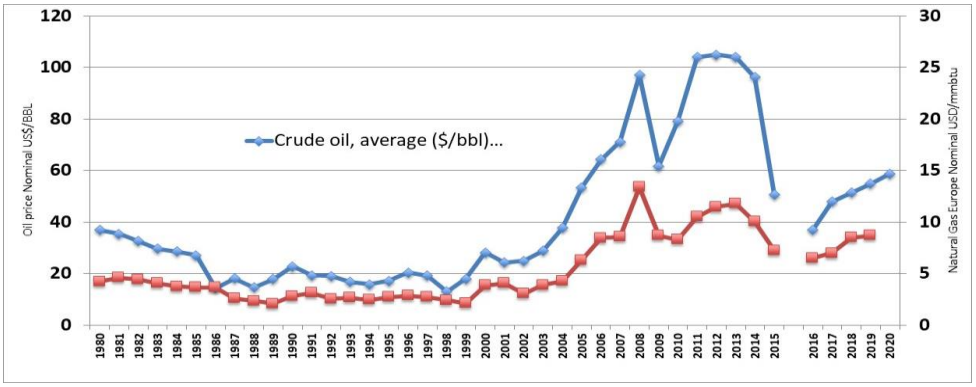
LNG is commonly sold in kilograms, being difficult to compare it with diesel pump prices directly (Tarjeda-Osoriom, J-L et al, 2017). Likewise, if both fuels are sold per litre, they could not be comparable because of energy density differences; LNG 21 MJ/L and diesel 35,8MJ/L.

Despite the current low oil price trend, the LNG price at fuelling stations can be found to be lower than that of diesel oil in most places (Tarjeda-Osoriom, J-L et al, 2017). There are several real-life comparative studies is in progress, one of them are a comparison between 161 LNG trucks and diesel Euro VI trucks run on Dutch roads. The preliminary results show that the average LNG consumption is 25.3 kg/100km per truck i.e. 26.31€ whereas the equivalent diesel truck consumes 32 L/100 km i.e, 39,34€, that is, a fuel saving about 30%.

In Netherlands, transport company that had a high amount LNG trucks reported a payback between 1 and 2 years, where the additional cost for LNG truck compared to diesel is approximately 15, 000 €. In the U.S, where there are more than 3500+ LNG trucks, a study showed that the payback would be less than 3 years, with shorter periods for the dual fuel trucks than for the dedicated ones due to better energy efficiency. In China, which is a big LNG market, the payback is less than 2 years, according to estimations made in 2013 (Tarjeda-Osoriom, J-L et al, 2017).

Although the oil price has dropped around 50% between 2012 and 2015, the price of imported LNG has also been reduced by approximately the same amount in the EU during the same period (Tarjeda-Osoriom, J-L et al, 2017).

The general LNG-diesel price gap at service stations in the EU has not been significantly affected due to the tax treatment, where taxes for diesel are higher than the baseline price, and taxes (excise duty) for natural gas are relatively much lower.



The average oil and gas price, 1980-2015.
The blue line/left side is the Crude Oil average, ($/bbl) and red line/right side is Natural Gas, Europe ($/mmbtu). One barrel of oil is equivalent of 5,8 mmBtu in calorific values. The price between LNG and diesel has been fairly consistent and robust even following the drop in oil prices.

The average LNG-diesel price gap in the EU is about 44%, while in the UK the gap increased from 50% in 2012 to 57% in 2015 due to the strong reduction of the LNG baseline price and the diesel tax increase.

Calculating and measuring the fuel consumption for gas-powered engines with the same precision as conventional vehicles is not possible, according to Jonas Nordh (Personal Communication, 2018-04-16). This is causing insecurity in how much the total fuel consumption and cost will be in the L-NGV's lifetime. Small changes in the fuel consumption can make a large difference in the TCO.

TCO - Total Cost of Ownership

TCO is an important key term when speaking of decision making and investments in a company (Christensen Douglas, K. 2016). A TCO includes;

"the total of the present value of all direct, indirect, recurring, and nonrecurring costs incurred or estimated to be incurred in the design, development, production, operation, maintenance, and renewal of a facility, structure, or asset over its anticipated life span"

This means that it is a financial management strategy that accounts for the complete life-cycle measurement and management of the product's useful life (Christensen Douglas, K. 2016). A TCO method allows consumers to directly compare all costs that are associated with the ownership of a product during its useful life. TCO can be applied in two different ways (Letmathe, P, & Suares, M, 2017). The first one, consumer-oriented, usually included the purchasing price as well as all costs related to actually receiving and using the item which are borne by the consumer. By contrast, the other one, society-oriented TCO considers, in additional to capital and operating expenditures, also environmental costs such as carbon dioxide (CO2) emissions costs (Christensen Douglas, K. 2016).

According to the interviewed customers they had received 2000 EUR/vehicle in governmental subsidies a few years ago when purchasing their LNG vehicles (Personal Communication, 8/3-2018 & 9/3-2018). However, according to Scania documents about Belgium, there are regional subsidies in Belgium. The biggest subsidies are in Flanders, up to 30 000 EUR per LNG vehicle, however, small ones in Wallonia and nothing in Brussels. Meaning that the TCO will differ depending on where in Belgium the companies are situated and how much of the subsidy they receive.

Scania TCO Example

When looking into a TCO for L-NGV, it might be necessary to compare it to diesel to understand the cost difference. Scania (2018) have examples of TCO of a single tank diesel-vehicle compared to an L-NGV with double tank. A double tank is more expensive than a single tank but increases the driving range. The assumed diesel price in this example is 0, 9 Euro /l and LNG 0, 6 Euro /kg and is looked into a 5 year-perspective and 100 000km yearly mileage. The total fuel cost for the period for LNG is 156k SEK while diesel is up to 266k. The cost of OPEX (operating expenses) for LNG is 250k SEK and Diesel 263k SEK, the primary difference is the cost of AdBlue, which is not needed for NGVs. Furthermore, the financial cost (Purchasing price, interest rate and residual value) is 207 k SEK for LNG and 109 k SEK for Diesel. The cost difference is because of higher purchase price for L-NVG, but also the residual value that is not included for LNG. The cost of Repair & maintenance is slightly higher in LNG than diesel, 23k compared to 16k SEK. The cost difference in this TCO where the residual value of the L-NGV is not included results in a 2, 5% lower total cost for LNG than diesel in a five year-period.

Case 1

Figure of Case 1, TCO.
In this case there is no residual value for LNG (numbers is KSEK for a five-year period when driving

	LNG	Diesel	**Details**
Other OPEX	250	263	Driver cost + Tyre cost + Adblue consumption and cost
Financial Cost	207	109	Purchase price + interest rate + residual value
Fuel Cost	156	266	Fuel consumption + Fuel cost
R&M	24	16	Maintenance cost
Total TCO	**637**	**654**	

100 000 km/year.

$$\textbf{\textit{LNG}}: 250k\ (OPEX) + 156k\ (Fuel\ Cost) + 207k\ (Financial\ Cost) + 24k\ (Research\ \&\ Development) = \mathbf{637k\ SEK}$$

$$\textbf{\textit{Diesel}}: 263k\ (OPEX) + 266k\ (Fuel\ Cost) + 109k\ (Financial\ Cost) + 16k\ (Research\ \&\ Development) = \mathbf{654k\ SEK}$$

$$\textbf{\textit{Difference in Cost}}: 653k/637k = 1{,}025 = 2{,}5\%$$

Case 2

However, if the residual value of the L-NGV is included and is approximately 15% (300 000SEK) of the purchase price after five years, it reduces the financial cost from 207k to 176k SEK. This would result in an 8% lower cost of L-NGV compared to a conventional vehicle in a five-year aspect.

Example of TCO with including 15% of the purchasing price as the residual value for LNG. Meaning this reduces the financial cost for LNG (numbers is KSEK for a five-year period when driving 100 000 km/year).

Figure of Case 2 TCO.
Example of TCO including 15% of the purchasing price as the residual value for the L-NGV. This reduces the financial cost for LNG-system (numbers is KSEK for a five-year period when driving 100 000 km/year.

	LNG	Diesel	Details
Other OPEX	250	263	Driver cost + Tyre cost + Adblue consumption and cost
Financial Cost	176	109	Purchase price + interest rate + residual value
Fuel Cost	156	266	Fuel consumption + Fuel cost
R&M	24	16	Maintenance cost
Total TCO	**607**	**654**	

$$\textbf{\textit{LNG}}: 250k\ (OPEX) + 156k\ (Fuel\ Cost) + 176k\ (Financial\ Cost) + 24k\ (Research\ \&\ Development) = \mathbf{607k\ SEK}$$

$$\textbf{\textit{Diesel}}: 263k\ (OPEX) + 266k\ (Fuel\ Cost) + 109k\ (Financial\ Cost) + 16\ (Research\ \&\ Development) = \mathbf{653k\ SEK}$$

$$\textbf{\textit{Difference in Cost}}: 653k/607k = 1{,}08 = 8\%$$

Furthermore, these TCOs is not society-oriented meaning it does not include the external costs for environmental- and social harmful emissions. This might have a positive indirect financial aspect in the TCO for LNG as in external marketing and customer relationship.

Residual Value of L-NGV

The global market for used L-NGV has a very low supply/demand today and is not commercially mature, according to Thomas Björk (Personal Communication 4/5-2017). Thomas means, the product is getting relatively mature to be able to predict its reliability and endurance, however, to predict the value of the truck after 5 years of usage is rather hard. To be able to predict the value is dependent on the supply and demand, but also heavily dependent on the development of infrastructure. To be able to understand the future volume, it is also important to take into consideration how many of the L-NGV that will be rebuilt to diesel or CNG. Additionally, it is also sometimes hard for the vehicle provider to achieve confidence from the customers regarding the residual value, due to historical overestimation.

The secondary market for L-NGV is rather complicated and far away from being optimal. There are several reasons why, according to Thomas (Personal Communication, 4/5-2017):

1. Bureaucracy – There is no unified European regulation for LNG, for example, tank-size, meaning that an LNG-truck sold in one market, might not have the right certification to be sold in another one, compared to diesel-trucks that have a unified European regulation.
2. Limitations and regulations; the market is very local and limited, which makes it even harder to find the right customer.
3. Selling used L-NGV is a new market with customers that have very little experience of this; it is also a different kind of market and customers that buy used vehicles instead of new ones.
4. Today when an LNG-truck is sold to the first customer, they are dependent on subsidies or being part of a service, meanwhile, in the secondary market there is a lack of such thing.

Benefits with LNG

There are several benefits using LNG for heavy road transport. LNG compared to diesel reduces SO_x and particulate matter up to almost 100% (Osorio-Tajeda J.L et al, 2017) but also have a significant reduction of CO_2 and NO_x emissions. The noise is also 50% lower than diesel engine. Because of the poor air quality and high noise in many European cities there are plans to phase out diesel in several cities (Hockenos, P, 2018). This could result in that diesel-powered vehicles might not to be allowed to enter cities and instead change their routes which create great potential for LNG as a takeover.

Service & Maintenance

According to Niklas Olsson (Personal Communication, 27/4-2018) the cost differentiation for the manufacturer in repair & maintenance is generally lower for LNG compared to diesel. However, for the customer it might be more expensive, mostly because of the longer time spent in the workshop. The cleaning of the tanks in L-NGV is usually a time-consuming step but also environmental and technical challenging. It is necessary when repairing and maintaining L-NGV in the workshop that the tanks are empty, and it requires expensive a technique to transfer LNG from the tank to a container without leakage (Niklas Olsson, Personal Communication, 27/4-2018). Since LNG consists mainly of methane that is a greenhouse gas and more potent than CO_2 (Climate Change, 2016), it is rather important and challenging to not release the fuel to the air each time the vehicle is in the workshop.

LNG around the world

China is without any competition the country with highest amount of LNG stations (Sharafian, A, et al, 2017). In 2017 there were 3200 existing LNG stations compared to Europe that is reaching about one hundred. Spain, Netherlands, United Kingdom and Sweden are the leading countries in EU within LNG infrastructure (Sharafian, A, et al, 2017).

Germany

Meanwhile in some European countries, LNG has not received a legitimate introduction at all, one example is Germany, according to Lars Mårtensson (Eliott, S, 2018). At the same time, German Ministry of Transport and Digital Infrastructure (BMVI) indicates in a special report that the LNG drive is the best solution for long-distance transport. This applies both to short-term perspective, as to the next 10-15 years. According to the forecast in the BMVI study, by 2030 50 000 long-distance trucks with alternative fuel will be sold within Germany (Jurzak, M, 2017). Today there are no LNG Terminals in Germany, however, there are plans to open up the first one (Vopak, 2018). A joint venture called "German LNG Terminal GmbH". The purpose of it is to build, own and operate an LNG import in northern Germany. The terminal will also provide LNG distribution services and truck loading.

Netherlands

Due to the air quality and raising transport costs, Vos Logistics, took the initiative together with one Rolande LNG, to establish an LNG station on their site and to equip trucks with LNG installation (Verbeek, 2006). This was the first time using LNG as a fuel in traffic situations in Holland.

When establishing fuelling stations in a country, there were several drawbacks to take into considerations in Holland (Verbeek, 2006) that might be taken into consideration in Belgium as well:

- No legal base for safety and environmental regulations for allowances, both for stations and for truck.
- Lack of knowledge in LNG
- Replacing diesel oil at large quantities is not a popular message for the oil industry
- Missing dues on cheaper fuels is another unpopular issue for government.

Spain

Spain is the pioneer in Europe of LNG (Yanouch, B, 2013). By mid-2015, the EU only had 51 LNG stations, with 60% of them in Spain and the Netherlands. Spain has six LNG import terminals and new terminals are expected to come into operation in 2017 and 2018 in Gran Canaria and Tenerife (King & Spalding LLP). Spain has a high level of diversification, importing natural gas from 11 countries,

being the most diversified system in Europe (Ibarra-Diaz, R. 2015), making them less dependent of just one supplier.

One of the first Scania-trucks that were sold in Spain was to a customer with high interest in the technology, according to Jacob Thärnå (Personal Communication, 9/4-2018). The purchase of the LNG-trucks could be seen as a try-out of the performance of the trucks, that both the customer and Scania were interested in. The Scania trucks had a poor performance, including high boil-off, however, actions were made that solved the difficulties. The next customer that LNG-trucks were sold to was a customer that transported gas. The driving force for the customer to go for LNG-trucks was external marketing – you want to use gas-powered engines if you are also transporting to not lose credibility of the fuel. It is these kinds of niched customers that have a high potential.

The Spanish government have been supporting the LNG-market with purchasing subsidies but also a national fixed price on LNG. The fixed price has been based on diesel and is to create financial incentives and security for the customers to use NGV (Jacob Thärnå, Personal Communication, 9/4-2017. There are several reasons why the government are supporting this; (1) improve air quality and; (2) being less dependent on oil import.

LNG was at first used as regional distribution in Spain but is now also possible for long distance transports because of stronger gas-powered engine, according Jacob Thärnå (Personal Communications, 9/4-2018). The most important driving forces for LNG in heavy duty transports in Spain can be ranked in:

1. Financial incentives
2. Reduction of local emissions (NO_x, SO_x, particulate matter)
3. Noise reduction

In Spain the secondary market for LNG is pretty much non-existent (Jacob Thärnå, Personal Communications, 9/4-2018). It makes it rather difficult to guarantee a residual value of an LNG-truck, which might also be perceived as a negative impact of the credibility of the product.

Scania in Spain have used several strategies to sell LNG-powered vehicles. First one (I) is to have a successful case with a customer that has been driving on LNG, and then used the case as marketing for other customers; Second (II) is to lease out LNG-trucks for customer for just a few weeks to try out the product; Third (III) is to give a task to salesman to find a group of high potential customers in L-NGV and then visit them with a knowledgeable person within the topic as support.

One experienced barrier for LNG-powered trucks is that there is very little knowledge in fuel consumption (Zoran Stojanovic, Personal Communications, 9/4-2018). One of reason for this is because there is no automatic fuel consumption indicator. There is also very little knowledge in LNG among salesman, and the process of selling is rather complicated compared to selling a conventional truck.

Projects

There are a few projects that have been relevant in this research and that the interviewed customers have been a part of. Some LBG projects are also presented here, just to give a brief view that it is an on-going system. Here are they briefly explained:

LNG Blue Corridor

LNG Blue Corridor is a project funded by EU 'European Green Vehicles Initiative' and the aim is to establish LNG as a real alternative for medium & long-distance transports (EGVI, 2013). To accomplish its objective, it has defined a roadmap through Europe, connecting the Mediterranean region in south with North and West. As quoted from EU Directive 2014/94/EU about the TEN-T project (EUR-Lex, 2016):

..Should be the basis for the deployment of LNG infrastructure as it covers the main traffic flows and allows for network benefits. When establishing their networks for the supply of LNG to heavy-duty motor vehicles, Member States should ensure that refuelling points accessible to the public are put in place, at least along the existing TEN-T Core Network, within adequate distances taking into account the minimum range of LNG heavy-duty motor vehicles. As an indication, the necessary average distance between refuelling points should be approximately 400 km.

Powering Logistics 2020

Along with the Flemish institute for Logistics (VIL) and 13 Flemish companies (VITO, 2015) there is a study to investigate which sustainable, alternative fuel sources are available for the transport sector and which conditions need to be fulfilled before they can be used. Within the scope of the pilot project, they will create both a technical and economic analysis as a starting point for more focused research. One of the interviewed customers was a part of this project.

LBG-projects

There are some projects on-going in LBG, one of the is the EU's TEN-T Programme that will support with over €3,9 million for the development of alternative refuelling infrastructure on the main Dutch highways (INEA, 2015). The project's ambition is to pave the way to deployment of LNG/LB in the European roads for medium and long-haul road transport.

Some examples of LBG projects:

1. On-going project called BIOLNG4EU is a EU funded and a part of "Innovation and Networks Executive Agency" (EU, 2018:b). The overall objective is to contribute to greening the European road transport by the introducing bio-LNG in LNG infrastructure, by using proven technologies. The purpose of the project is to set-up and operate 2 bio-transformation stations from biogas to LBG and 4 refuelling stations (EU, 2018:b). The project is a part of a EU global plan of 50 LNG and Bio-LNG bio transformation stations that will be established gradually close to Distribution Centres or highways in Northern Europe.
2. The Swedish government subsidies a project run in Linköping to build a production facility for LBG (Tekniska Verken, 2017). This project is a part of "Klimatklivet", a national project to support fossil free projects (Regeringen, 2018).

Driving force for alternative fuel

The benefit of LNG makes it attractive to use it as a replacement of diesel (Vos Logistics, 2017). The driving force to use NG might come from several different stakeholders; transport providers, their customers and governments. However, the driving force to use alternative fuels might be different for each one. One of most common driving forces of using natural gas according to Sonia Yeh (2007) are:

(i) Environmental benefits for reducing local air pollution and greenhouse gas emissions.
(ii) Reduction of dependency on imported oil

One third aspect that is considered as an important driving force is the economic advantages of LNG compared to diesel (Arteconi, A & Polonara, F, 2013).

Stakeholder pressure can be a high motivation for firms to take more consideration of environmental issues and could encourage them to incorporate environmental practice into their managemental strategies (Yu, W, et al. 2017). Stakeholder pressures have the capacity to affect a firm's decision to go for environmental innovation strategies. Also, the better a firm manages its relationship with various stakeholders; the better will be the performance outcomes. Firms that aim to react to stakeholder's pressure by implementing various environmental innovation strategies and practice can promote a good TCO while reducing negative environmental impact. Environmental innovation strategy mediates the relationship between environmental performance and stakeholder pressure, but also between financial performance and stakeholder pressure (Yu, W, et al. 2017).

As the response to growing environmental pressures from markets and state regulations, implementing sustainable development in the business requires new ways of thinking and acting (Yu, W, et al. 2017).

In the study by Yu Wantao, et al (2017) showed that government regulation does represent the most important source of pressure on firms to implement environmental management initiatives. Furthermore, the result suggests that marketing capability moderates the relationship between environmental pressure and innovation. Hence, it is crucial for a firm to engage in marketing campaigns to highlight the environmental initiatives and communicate it to the stakeholders. It is common that many firms miss the win-win opportunities to improve business performance (Yu, W, et al. 2017).

Today EU-28 has very high energy import dependence (European Parliament, 2017). A modest recovery of EU gas demand is expected in 2017-2021, partly because of coal and nuclear plant retirements. As EU domestic production is declining (down to 41% over the past 10 years) and as the decline is to continue, gas imports will further increase. LNG imports accounted for 13% of EU consumption in 2015, but the EU has the ability to import a lot more LNG. According to Mrs Yafimava, global LNG and Russian pipeline gas will remain the two main sources to meet EU demand up to 2030.

EU have a high dependency in energy imports, especially in crude oil (90%) and natural gas (69%) and the total import bill is more than €1 billion per day (European Commission, 2018:b). Many countries are also heavily dependent on a single supplier, including some that rely entirely on Russia for their natural gas. This

dependence leaves them vulnerable to supply disruptions, whether by political or commercial disputes, or infrastructure failure (European Commission, 2018:b).

EU has long-term measures to address the energy independence and safety, one of the goals are (European Commission, 2018:b) expressed as:

Increasing energy production in the EU and diversifying supplier countries and routes. This includes further deployment of renewables, sustainable production of fossil fuels, and safe nuclear energy where this option is chosen. It also entails negotiating effectively with current major energy partners such as Russia, Norway, and Saudi Arabia, as well as new partners like countries in the Caspian Basin region, but also Completing the internal energy market and building missing infrastructure links to respond quickly to supply disruptions and redirect energy across the EU to where it is needed

LNG imported to Europe through LNG terminals is a source of diversification that contributes to competition in gas market and security of supply (European Commission, 2018:c). New LNG supplies from North America, Australia, Qatar and East Africa are likely to increase the size of the global LNG market.

Even though a diversification of gas suppliers is to prefer, and it is a low carbon energy source it still remains a fossil fuel. Fossil fuel needs to be phased out to be able to reach the medium long-term climate goals of having 40% cuts in greenhouse gas emissions in 2030 from 1990 levels (EU, 2018).

Interviews in Belgium

This will provide a summary of each interview from the Belgian transport companies. Then a summation and general result of the interviews will be presented.

Interview Transport Company 1

This interview was made 7/3-2018 with the CEO of the company.

Information of the company:
Operating Vehicles: 150 vehicles
Focus & Segmentation: Distribution, Refrigerated, air freights and more.
Operating in Western Europe
Amount of L-NGV: 1

They received their first L-NGV in December 2014 as being a part of the LNG Blue Corridor Project. The L-NGV is operating for a customer within Belgium. The decision to use LNG was based on pressure from the customer to lower their CO2-emissions. The internal driving force in the company is to have a 'sustainable partnership'. Investing in L-NGV was a strategic choice to have a stronger PR and to follow their motto. The company decided to have a fuel contract that was based on a discount on the diesel price. They decided to not sign up for a maintenance contract as they considered it would be more expensive

Most of companies' customers are requesting CO_2 reductions, but they are not ready to pay a higher price for the transport services, which will happen if the company invests in alternative fuel, according to the CEO. The LNG Blue Corridor seems to have been an important part of going for their first L-NGV. This investment has increased their knowledge and reliability of the technology but has not been enough convincing for further investments in the product. Uncertainty of the TCO was expressed as it must be economically sustainable and reliable. The purchasing price is too high compared to diesel. Also, the lack of fuelling stations and infrastructure is a considerable problem.

Interview Transport Company 2

This interview was made 8/3-2018 with CEO of the company.

Information of the company:
Operating vehicles: 450 vehicles
Focus & Segmentation: Retail industry, distribution and warehouses.
Operating in Western Europe
Amount of LNG-trucks: 3

The company invested in a leasing-contract for three L-NGVs in 2015. The vehicles are operating in the Belgium-Dutch region with fuelling station close to Amsterdam. There is a high pressure from the transport buyers to reduce CO_2, primarily from one customer with business in spa with environmental focus. The decision to invest in LNG was based on that they wanted to be innovative and it is a strategic choice against competitors. In the beginning they had fuel contract based on a discount of the diesel price, but not anymore because the price would be more profitable without fuel contract. The opening of the new refuelling station in Lokeren last year has created new opportunities for them in the LNG system and they are considering upgrading their fleet with new L-NGV. There is a high interest in innovations and sustainability in the company.

One of the most major barrier is the lack LNG-refuelling stations. But there are also other things to take into consideration such as driver training and governmental policies, but they are not considered as significant barriers.

Interview Transport Company 3

This interview was made 8/3-2018 with CTO of the company.

Information of the company:
Operating vehicles: 300 vehicles divided into 3 departments; large volume transport, temperature-controlled transports, and conventional transports.
Focus & Segmentation: FMCG, food, pharmaceuticals, chemicals, construction and packaging.
Operating in Belgium, Slovakia, Spain, France, and Netherlands.
Amount of LNG-trucks: 2 (operating since April 2018, have also experience of leasing one LNG truck since earlier project).

The two L-NGV are being used for a customer in Warehouse business and the refuelling station is in Kallo. The decision to invest in two L-NGVs instead of one was to have one extra to switch to a different customer for competitive advantages if necessary. The company has been a part of the project Powering Logistics 2020 and trying out different alternative fuels; LNG, BEV among others. Their experience of L-NGV from this project were rather poor because of the 9-litre engine was not strong enough for their business. The internally interest for alternative solutions is high.

Their customer operating in the Warehouse business does appreciate the use of LNG instead of diesel. However, it was not really any compulsion from the customer. The primary reason going for L-NGV was to try the performance of the technology since they believe it might be a viable option in the future. They also believed that investing in L-NGV is a strategic decision and good against competitors that are using diesel-powered-vehicles.

One major barrier for the company to upgrade their fleet to L-NGV is the long distances between borders that are causing problems with fuelling stations. Even if there are investments and installations of fuelling stations within Belgium it also needs to be have strategically placed LNG-fuelled stations in the transit countries. There were also expressed some uncertainty about new technology and its reliability and the performance.

Summation of the interviews

So far, the interviewed customers have showed very little commitment to the technology. The lack of infrastructure is still a dominant barrier when using L-NGV, meaning that the flexibility decreases significantly when choosing the alternative solution. The financial incentive is a big drive in the transformation in LNG, however, it seemed like the financial reward seems far away because high-risk perceptions and uncertainties in the system. Furthermore, the performance and reliability of the technology have also been an important part for each customer when investing in L-NGV.

Furthermore, one thing in common for the transport companies are that they only invest in alternative solutions for the large and essential transport buyers, as they consider it important to keep a good customer relationship with them. The interviewed companies had a very little drive in form of regulations or governance to reduce noise or local emissions, as the drive are mainly coming from the private sector.

Knowledge and Insecurity

Two out of the three customers had also been using a fuel contract that was based on the diesel price. They had been offered the fuel contract by the fuel supplier once purchasing the L-NGV. The decision to have a fuel contract was to have a payback safety that the gas price will be lower than diesel. The fuel contract had only been used for the first years; however, there were no longer any interest of having fuel contract since it was more profitable of not having one. The third customer, that could be considered having the most knowledge about LNG and the highest devotion to the technology, did not get a fuel contract since they were confident enough that it would be more profitable without the contract – which turned out to be right. All of the transport companies had experience of leasing L-NGV as it removes the uncertainty and risk of the residual value of the vehicle.

In the interviews there was a rather divergent knowledge regarding L-NGV between the transport companies. In overall, the knowledge and attitude are presumably one of the most important factors in the process of buying and selling L-NGV. A good knowledge most often creates a positive attitude to the technology; furthermore, a lack of knowledge instead creates insecurity and precariousness of investing in it. Some of the insecurities might only be because of lack of knowledge, such as perceive LNG as something hazardous, while the literature tells the opposite.

Features that affect the LNG system

There are several features that affect the LNG system and they can be perceived as making it less robust than the conventional alternative. Consequently, it is logical for market actors to be precautious and more conservative and perceive risks to be greater than they are in reality. Here is a list of 14 identified items that affect the system:

LNG System
Fourteen features that affect the LNG system.

14 Features that affect the LNG system			
1	Coordination	8	Driving Range of LNG
2	Psychology and Perception	9	Fuel Properties
3	Technology	10	Fuel Price
4	Manufacturing	11	Driver Training
5	Infrastructure	12	Regulation
6	Distribution of fuel	13	Repair & Maintenance
7	Infrastructure	14	Residual Value of L-NGV

1. Coordination

According to von Rosentiel et al (2015) a most prominent factor leading to the failure of the NGV functioning market are complementary market coordination failures. However, the coordination barrier can be considered as one of the most important in the aspect of developing refuelling stations for NGV (Khan Imran, K, 2017). Example of coordination is to install/maintain fuelling stations and introduce vehicles in the market, at the same time as adapting governmental policies, such as taxes or regulations.

2. Psychology and Perception

One critical aspect when developing alternative fuel vehicles and the infrastructure is to have public acceptability (Khan Imran, M, 2017). In a study made by Italian NGV from 2002 (Khan Imran, K, 2017) about why natural gas is not considered as an attractive fuel, the most common answer was “I am not enough informed about it”. The study also shows that the general knowledge of NGV is low and often inaccurate and many are waiting to see large numbers of NGVs on road before they will consider purchasing one.

Even if the Italian study from 2002 might be out-dated, it still might be relevant for L-NGV as the interviews gave a similar result.

Emotional aspects have a big impact in the investment outcomes through personal experiences and contacts (Saukkonen, N et al, 2017). Emotional aspects also influence companies' tendency to avoid making the investment decision through negative feelings caused by the difficulty of making the choice.

A barrier explained by Flynn (2002) is when industry included excessive parts mark-up by conversion dealers, exaggerating claims for environmental and economic benefits, and poor design of promotional programs, that might cause the opposite effect.

3. Technology

When making the investment decisions on the new technology, the performance of the technology has a high importance (Saukkonen, N et al, 2017). The technological performance includes engine power, efficiency, and durability. These aspects are important as they affect the company's operations, financial performance and ecological footprint.

Generally, five different factors influence the technology acceptability of NGVs (Saukkonen, N et al, 2017): (1) AFV technology must offer higher and improved performance when compared to conventional fuels and vehicle technology. (2) access to maintenance, refuelling stations, and other necessary infrastructure to overcome the range limitation, must be there. (3) the higher affordability the greater market demand. (4) It must be safe option and should not have flammability concerns associated and the last one (5); perception of the offering should be of a favourable product.

4. Manufacturing

It is rather common that manufacturers of heavy-duty engines and vehicles - even those producing NGVs - have not adapted their production for LNG (Kumar, S, et al. 2011). There can be too few products, in particular, for the heavy truck-duty trucks where LNG could provide economic benefit. This could result in longer deliver times and higher production costs.

5. Refuelling stations

One of the considered main barriers for L-NGV in the European Union is the lack of refuelling stations (Arteconi, A & Polonara, F, 2013). Also, according to Zoran Stojanovic (Personal Communication, 16/4-2018) there is a variation of the pressure in LNG filling stations which is causing problems. Since the filling pressures sometimes are different between regions; a Dutch truck might damage the vehicle if it is being refilled in Belgium due to different infrastructure and filling pressures.

6. Distribution of Fuel

The distribution of LNG in landlocked countries is challenging (NGV Global, 2017). In case of using LNG as a fuel for heavy duty vehicles, it will not be regasified and fed into the local pipelines after the import terminals, but it will rather be kept in liquid state and distributed by trucks. Truck transports are environmentally and economically feasible only for limited distance (NGV Global, 2017).

7. The introduction process

A study performed by Garling and Thogersen (2001) saw a company's energy source as a rather rational and analytical decision, as the barriers to adoption are related to governmental subsidiaries, perceived promotional value with price, and then expected improvements in the technology (Saukkonen, N et al, 2017).

Meanwhile, investors might be reluctant to make what can be expensive and risky investments if there is an absence of clear policy signals or political attention (Browne, D, et al. 2012). The introduction of new fuels is an infrequent, uncertain and rather slow process, very much caused by the time required for diffusion between policy development and technological change. This can be identified as a risk among transport companies as the development of regulations and taxes can be uncertain in LNG. Meanwhile, as there are national and regional subsidies, the transport companies might expect

8. Driving range

The driving range is based on how much energy can be carried on the vehicle (Go with Natural Gas, 2014). LNG has less energy by volume than diesel meaning that LNG needs more space for the same amount of energy. The driving range for a typical Scania LNG semi-trailer on a flat road is up to 1,100 kilometres (Scania,

2017). With twin LNG rigid trucks, a range of up to 1,600 km is possible. Fuel properties
A disadvantage of LNG is the need for a consistent vehicle use because of LNG in the tank is getting warmer despite the insulation. Thus, a part of the LNG vaporizes and the pressure in the tank increases (Simmer, L, et al, 2014). Vaporization of LNG and released into the air has both negative financial and environmental consequences.

9. Fuel price

The price difference between NG and diesel is one of the most important factors in attracting users (Arteconi, A & Polonara, F, 2013). A low gas price is one of the highest driving forces; meanwhile, a high gas price is one of the main barriers in investing in gas-powered vehicles. A fuel contract based on the diesel price might create safety and reduce perceived risks but might not be as profitable as not having a contract.

10. Driver training

Drivers need to go through a special training to be able to refuel cryogenic LNG (Lockridge, D. 2012). Safety precautions during LNG fuelling include the need to wear safety goggles or mask, hardhat and gloves, and hooking a ground cable to tank. One of the interviewed transport companies expressed that a potential problem is when a driver with this education gets sick or can't drive, it can be hard to find a replacement. However, it was expressed as an insignificant barrier.

11. Regulation

A possible barrier is the lack of few global regulations for L-NGV applications and remaining gaps in the existing international standards. Lack of harmonized standards impedes opportunities to reduce the cost of manufacturing and purchasing different LNG equipment (Kumar, S, et al. 2011).

Regulatory barriers can also include: (a) regulatory gaps; (b) trade barriers; (c) potential legal challenges; and (d) planning restrictions (Browne, D, et al. 2012). This can be identified in the LNG system as there are regional technical regulations, creating difficulties in the secondary market.

12. Repair and Maintenance

According to Niklas Olsson (Personal Communication, 27/4-2018) the cost differentiation for the manufacturer in repair & maintenance is generally lower for LNG compared to diesel. However, for the customer it might be more expensive, mostly because of the longer time spent in the workshop. The cleaning of the tanks in L-NGV is usually a time-consuming step but also environmental and technical challenging. When repairing and maintaining L-NGV in the workshop the fuel tanks need to be empty, and it requires expensive a technique to shift LNG from the tank to a container without no leakage (Niklas Olsson, Personal Communication, 27/4-2018). Since LNG consists mainly of methane that is a greenhouse gas and is stronger than CO_2 (Climate Change, 2016) it has environmental consequences when released to the air.

13. Used L-NGV

LNG is a relatively new product in the market and highly dependent on infrastructure investments makes it is hard to predict its residual value, according Thomas Björk (Personal Communication, 4/4-2018). The secondary market for L-NGV is also close to non-existent.

Discussion

The first part of this section identifies the potential and drivers in LNG in Belgium to establish an LNG system. Then the results and the risk-based perceptions are compared to theoretical insights building from institutional theory. The theory is to support the finding of this work and back up the arguments. Furthermore, the ending of this section will have a reflection in the reliability and method of this work, but also why it is important in the aspect of environmental science and sustainability.

The current LNG system in Belgium

LNG as fuel for heavy duty vehicles is still in the early commercially stage in the Belgian market. Even if an introduction of a new fuel is a considered as a rather slow process, the material throughout this report provides substantial evidence that there are a suite of drivers that are likely to drive a significant increase in LNG the coming years. Importantly, LNG-fuelled logistic systems are already relatively large in some markets, for example in Netherlands, China and USA. This provides strong evidence that it is a commercially viable and functioning fuel for the heavy-duty vehicle sector.

Informants and planned activities also indicate that a function LNG infrastructure should be in place during the next decade. Furthermore, it is proven that a transition to LBG from LNG is commercially possible, as countries such as Sweden and Netherlands have successful cases doing it; however, it is a great challenge to reach the commercially required LBG quantity as it is heavily constrained by the production capacity. The establishment of an LNG system could have a significant positive impact in improving the air quality in Belgium, but also reducing GHG emissions, notably if LBG is mixed into the system.

From this work it two essential sparkles ignited the LNG development in Belgium; (1) growing public and political awareness of health- and environmental related issues with emissions; (2) the solution of the "chicken and egg-problem" as a result of EU funded projects. Also, some of the existing LNG infrastructure in Belgium either built or maintenance by companies outside of the borders with experience in LNG.

The Potential in Belgium

There are several identified factors in this paper that support a view that Belgium has a great potential in LNG:

(1) The Belgian port of Zeebrugge is Europe's major LNG transhipping terminal (NASA, 2017). It is important to have the LNG infrastructure/refuelling stations close to the terminal to reduce the transport distance; too long transport distance is not environmental or economically viable.
(2) Geographically, Belgium is a relatively small country. It makes it easier to have a sufficient amount of fuelling stations internally in the country.
(3) Belgium is a transit country for many European transport countries resulting in heavy traffic. This is causing bad air quality but leads to a health- and environmental awareness among the population.
(4) LNG Blue Corridor is an EU project that is supporting LNG infrastructure investments in Western Europe, and Belgium is a part of the corridor. A lot of transport companies are not only operating within the country, but in neighbouring countries, which makes it important to establish a network outside of the borders as well.
(5) The interviewed customers received 2000 EUR/vehicle in subsidies from the government when purchasing L-NGV; this is not very sufficient, but there are more regional subsidies present that the companies had not been part of, primarily in Flanders.
(6) The gas price is more favourable than diesel in Belgium.

There are several drivers that do currently not exist in Belgium, but that might have significant impact in the near future in the transition to an LNG system:

(1) Belgium does have low emissions zones, however, only for Euro 3 or lower and only in urban centres. Tighter regulations for local emissions or noise reductions could drive the change to gas-powered engines faster. Today, the regulations are not enough to force drivers to go for alternative fuels in Belgium but might be in the future as in many European cities.
(2) A great barrier is if Belgian transport companies are operating outside of the borders. Belgium shares borders with both France and Germany, countries with a current insufficient infrastructure.

Knowledge and risk-based perceptions

There are clear indications that the financial incentive is the biggest drive in LNG. However, in the interviews in Belgium the interpretation is that the risk-aversion and uncertainty is too high to take the financial risk. As one of the transport companies even expressed as if they were going to invest in the technology, the cost of their services would increase, and transport buyers are not to pay for the higher cost. Even if every TCO case is unique, Scania calculations shows that even in a rather bad case it still is profitable in a long-term perspective to invest in L-NGV. The reason for the transport customers to have this impression can be explained:

Economic variables are the major determinants of technological change and adoption of innovations (Marra, M, et al, 2002). But the risk, uncertainty and learning in the adoption of technologies have been shown that adoption processes are strongly affected by risk-related issues according to Marra (2002). As this study shows and is confirmed by Marra (2002), the financial incentives are the absolute highest driving force when adapting to a new technology. But when there are too many uncertainties and risk-related issues that might be perceived higher than they actually are, makes the alternative option less attractive and the financial incentives appear to look further away than it is in reality.

As Aldrich, H & Fiol, C.M (2007) explains that the less information or evidence we have, the more we need trust. Trust is a critical first-level determinant of the success of actors trying to establish a new technology or business in the system because by definition, there is an absence of information and evidence regarding their new activity. The perception and evaluation of risk are also highly subjective. As this work shows that the knowledge might differ among the customers which make the trust to manufacturers and fuel suppliers even more important. As this work indicates, if the customers are uncertain about the financial risks, they need trust in the provided TCO from supplier. Mishra, S et al (2017) explains that there are numerical examples that describes the key variables that serve as cost-benefit inputs for risk taking: (a) probability of success, (b) probability of failure, (c) payoff if one succeeds, (d) payoff if one fails. Since L-NGV is a relatively expensive investment, this work indicates that the high-risk needs to result in high reward among the transport companies. If the investment is a failure, it is hard to fall back as the investment is already made. Thus, it is important that if the investment is not as profitable as it was expected, it still needs to have a decent payoff.

Because of limiting infrastructure in LNG there is a reduced flexibility for the transport companies' operations for L-NGVs. But looking in the long-term aspect, LNG might in the soon future instead have higher flexibility than diesel. Because of regulations of banning diesel in cities such as in Paris, (Love, B, 2017) makes diesel-powered engines not being able to enter cities and also taking detours. L-NGV won't have these regulations, as the harmful emissions and noise are much lower in LNG compared to diesel.

The financial flexibility and risk-related issues is a concern for the residual value of L-NGV, but it is also becoming a risk for diesel-powered engines. The out phasing of diesel is causing uncertainties about the residual value, as for example German lease industries are abandoning diesel because of its uncertainties in regulations (FleetEurope, 2018). Because of the expanding LNG-market and the increasing uncertain future for diesel, the technologies might switch in the aspect of risk-related issues in the secondary market.

One of the central motives from the transport companies when investing in L-NGV was to try out the reliability and performance of the technology; including engine power, efficiency and durability. The results of the interviews show that the alternative solutions need to have the same performance as the conventional or even better, to be somewhat attractive. This corresponds to the study by Marra (2002), as the technology is new and has high uncertainty and risks about the reliability, which needs first be solved before the financial incentive is attractive. One other central motive to invest in L-NGV is to build competitive advantage on the market. However, it is hard to decide how much of a competitive value it has in the market because of the challenge to translate it into numbers and include it in TCO.

In contrast of buying L-NGV in the secondary market, the first owner of the vehicle are usually the ones with access to subsidies, fuel or service & maintenance contracts. As it might be hard to find a suitable customer as the secondary market for LNG is very limited because of technical regulations, meaning that most often a L-NGV must be sold in the same market as it is made for, or rebuilt. The secondary customers do also not have the same access to the service contracts or benefits as when buying a new vehicle. However, because of the cheaper vehicles in the secondary market it might open up possibilities for many transport companies to invest in the technology to "get to know it", as this has been considered an important aspect before investing in L-NGV fleet. This might otherwise not happen because of the high purchase price of the technology that has been considered as a significant barrier. Otherwise leasing is an option for customers to try out technology, as many other European markets have done as well.

Internal Marketing

This work does not only observe the importance of external marketing, but also emphasises the internal marketing. Internal marketing involves the pollination of environmental values across the organization to embed a wider corporate green culture (Papadas, K-K, et al, 2017). Such actions could include employee training or efforts to promote the functional values of LNG (quiet, clean, cost, performance etc) inside the organization. As this work shows that trust and clarity is one of the most important aspects selling an alternative technology; the knowledge and environmental values potency might be needed to exist within the organisation before promoting it externally. As the dealers have the best relationship with customers, their knowledge of the technology and system could play a fundamental part. This could be provided as Papadas K-K, et al (2017) suggests, by employee training to convince customers of the functional values of the technology.

Reflection

This is a largely qualitative study with rather general results. However, it is also considered that these can also be applied in other markets that are in the preliminary phase within LNG. As this work has been resource and time limited to a period of four months makes it difficult to go deeply into each barrier and also formulate detailed marketing strategies. The interviews were made in the beginning of this research, but as my knowledge increased during this study I might have had better discussions and interview questions if such discussions had also been conducted in the of this work. However, doing the interviews in Belgium was an important step to proceed with the research. Meaning there are both advantages and disadvantages in doing the interviews in the beginning or in the later part of the work.

The decision to use to use snowball effect as the method for the interviews was probably the only viable option as I otherwise would be uncertain of who would be relevant to contact within the organization. The disadvantage of using this method has been that is has nevertheless been difficult hard to reach the recommended person or one has continuously been redirected. A deeper investigation in mature LNG markets could be desirable to outline the parameters for marketing strategies but was not possible because of time and data limitations. This work also provides valuable results as the findings of this work are also supported by insights from theories that enfold new areas of business.

Instead of stating direct directions of what is needed to do to stimulate the sales of L-NGV, this work outlines the parameters for marketing strategies and what might be necessary to be taken into consideration when formulating them. The results highlight the importance of reducing the risk-based perceptions among transport companies to stimulate the sales of L-NGVs; however, the approach of doing it may differ, but there are several strategies that might be applicable in the Belgian market and that are suggested in this paper.

The importance of this research is also the focus within social- and ecological sustainability. LNG has great potential in reducing the harmful local emissions (NO_x, SO_x, particulate matters) and noise reduction in the heavy traffic. How much the greenhouse gas emission is reduced by using LNG instead of diesel is uncertain, as the logistics, production, cooling system and leakage of methane play a significant part and differ. The transition to LBG is important to have a critical and certain reduction in GHG emissions and to be able to reach short- to medium long targets.

Conclusion

The material throughout this report provides substantial evidence that there are a suite of drivers that have a great potential to drive a significant increase in LNG the coming years. A LNG system has the potential to improve air quality and to reduce GHG emission from the transport sector in Belgium. But as long as LNG doesn't heavily outperform the conventional alternative for the transport companies, or if they perceive the risk-related issues as being too high, there are strong evidence from this work that the increase of LNG will be rather constrained. However, the transport companies' decision making is not always rational, as they sometimes perceive risks greater than they are in reality. There is considerable room to ameliorate these challenges via application of knowledge and marketing strategies.

There are several strategies to overcome the barriers or perceptions that makes LNG less robust: (1) Marketing successful cases – based on the findings of this work, it might be necessary to reach out to the bigger audience of the performance and reliability of the product to gain trust and a good reputation. As the results and earlier theoretical data confirms that trust and information is an important factor for companies to invest in new technology. Marketing successful cases creates trust from an independent part that tells that the system is a profitable investment; (2) Leasing – This strategy have potential in giving customers experience in L-NGV. Because of the high purchase price, leasing might be a viable option for interested customers as it reduces their financial risks.

One of the greatest barriers identified in this work is the residual value and secondary market for L-NGV. To overcome this, these strategies might ease the process; (1) scan the market for potential customers interested in L-NGV both in the primary and secondary market. This is to identify the "low-hanging fruits-customers" with a great interest in sustainable solutions; (2) taking the responsibility or supporting the sales in the secondary market. Based on the finding it might be necessary to provide service contracts or assistance for used vehicles as in newly produced vehicles; (3) invest and lobby to overcome the technical and regulation barriers to extend the secondary market as it is currently heavily constrained.

Because of the importance of the knowledge and trust from manufacturer to customer; knowledge is a key factor in L-NGV investments. Based from the findings, communication strategies might be necessary; (1) dealers should have a proper knowledge of the product to gain trust from the buyers. However, it might be as important to have knowledge of fuelling stations, subsidies, fuel price, and service contracts as having knowledge of the product; (2) there are many parts involved in the transition of alternative fuel. A regularly contact with government, customers and fuel supplier about their ambitions and expectations could be important to make the transition in LNG as smooth as possible.
(3) A deep understanding of customer's experience and perceived risks is needed among the manufacturers to be able to come up with solutions. Every transport company might have different experience and perceived risks, making it important to have a good communication with the customer to be able to provide a tailor-made strategy for each customer.

Future Research

A suggestion for further research is a comparison of the residual value of L-NGV and diesel-powered vehicles. A significant barrier for establishing an LNG system is the uncertainty of the residual value of an L-NGV and the current non-existent secondary market. However, the RV of diesel-powered vehicles is also uncertain because of the harmful emission, regulations and out phasing in an extensive number of cities. If an LNG system gets established within Belgium, and if the diesel market gets narrowed as the trend indicates, it might result in the technologies switch sides in the aspect of uncertainty in RV. A deeper research in this is to be recommended.

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Appendix

Interview Questions to Belgian Transport Companies

1. Introduction questions

How many vehicles are you operating?

Which segments are you driving?

What are the distances you are driving? Is it outside of the borders? Is it urban environment, rural, country, high ways?

(Main distance for one load trip?)

Are you refuelling your vehicles in Belgium or in other countries?

Who are your customers?

What kind of freight transport are you transporting? To which industries?

When was the last time you bought new vehicles to your fleet? What are the reasons you have renewed your fleet?

What are your visions?

(Future plans?)

- Enlarge your business?
- Do you have plans for finding new customers?
- How to attract good drivers in the future?

Who are your service partners?

Have you any experience of alternative fuel before?

2. Incitements/Driving factors for alternative fuels

Who was the one who took the initiative/approach to go for LNG? (If the company is using NGV)

The last time you renewed your trucks, did you consider going for LNG?

Are there any driving forces from your customers? Have you had any communication or discussions with them about going to alternative fuels?

What are the driving forces internally in your organisation to go for alternative fuel?

- Interested in climate
- Economical smart
- Driving Comfort
- Safety
- It is to have a sustainable relationship with customers?

Are there any driving forces from local or national governments for you to drive gas that you are aware of? Such as taxes, subsidies, premiums? Long-term or Short-term?

Do you feel like some support or subsidies from the government are important for you to go for alternative fuel?

Are there any taxes, policies or insurances incitements for you to switch from Diesel to alternative fuel?

(Are short-term policies too insecure? Do you want to get long-term incitements?)

Did you use a fuel-contract? What was the deal and who provided it?

A lot of European cities are struggling of reaching air quality standards and are banning diesel. Antwerp is also the first Belgian city that is implementing "Low Emission Zone", February 2017. Is this something that is affecting your business and is a driving force to go for LNG?

For your LNG-powered trucks, have you been forced to make any changes in your routines? In logistics etc.

Is being a part of different pilot-projects a good start and get going to go for LNG-powered trucks? Such a Blue LNG Corridor. And then to continue the alternative fuel journey from there?

3. Switching to alternative fuels

Does LNG open for increasing your business or new opportunities? Such as getting new customers, driving in urban areas.

Would you consider it is good PR (Public relation) by going for alternative fuel? Would your customers appreciate it?

(Have you been using LNG in the same role as your Diesel-car or has there been any changes in the business?)

(What do you take most into consideration when choosing a new truck?)

Do you feel like the hardest part biggest barrier with alternative fuels is to get going?

Do you feel safer having a fuel contract? With fuel security and fixed price?

Is the technical aspect a barrier? The range for alternative fuels, engine etc.

When taking into consideration of going to alternative fuels - do you look into other cases of alternative fuel in how they have been doing?

Are you worried about maintenance of alternative fuel-powered engine?

What are the biggest driving forces to for LNG?

4. The barriers

Would you consider the biggest barrier for you to get going (short-term), such as filling stations, fuel contracts, driving and fuelling education or the long-term such as repair & maintenance, fuel supply etc?

Is the (long)-term investment a significant barrier for you?

Classical expression - Chicken and egg- problem - fuel stations or trucks first, this is somewhat an early stage problem that is a struggle before an alternative fuel get established. Do you think there is a lack of fuelling stations? Is this a major problem for you?

If yes - there are investments for new fuelling stations, such as governmental, EU and different projects - would this solve the barrier? Would going for alternative fuels be much more attractive in future when the infrastructure is established?

There are several different actors participating when making the transition for alternative fuels - vehicle manufacturer, energy supplier, repair and maintenance, etc. do you feel safe that the communication is working, and everyone have the same ambition?

Do you know if your service partner can provide service for LNG? Is maintenance & repair a barrier you when speaking of LNG? Is there any problem with getting the parts for LNG?

Ending questions:

(What are the reasons why you haven't invested in alternative fuels?)

Are you satisfied and happy for trying LNG? Is this something you could be improve in the future?

What do experience are the biggest risks going for alternative fuel?

Do you think you will have an LNG-fleet in the coming future?