



CHALMERS

Effect of customer demand on transport climate impact

Are the customers demanding their carrier to use fossil free fuels and decrease airborne emissions?

Bachelor thesis for International Logistics Program

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CHALMERS UNIVERSITY OF TECHNOLOGY
Göteborg, Sweden, 2022

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PREFACE

This report is a bachelor thesis that was made by Jon Håkansson and Trifah Muradi who study International logistics at Chalmers Technical University. The bachelor thesis consists of 15 educational credits out of the total 180 credits for the whole program. The subject with lowering airborne emission is and will continue to be a hot topic for the shipping industry. The hope is that this report will help in identifying problems as well as what is needed to move towards a more sustainable shipping.

A special thanks to Kent Salo who acted as supervisor and provided very useful feedback and guidance along way. Even though the carrier and the transport buyers are presented anonymously they have contributed tremendously and deserves appreciation for participating.

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SAMMANDRAG

Sjöfarten är känd för att vara en konservativ bransch och sällan benägen att förändras. Trots den långsamma förändringen måste sjöfartsnäringen ställa sig i linje med- och möta regelverk som presenterats av den internationella sjöfartsorganisationen för att minska luftburna utsläpp som växthusgaser, svaveloxider, kväveoxider och partiklar. Ett perspektiv som ofta saknas för att efterfrågan ska kunna förändra transporterna till lägre klimatpåverkan är det av kunderna. Tidigare forskning har visat att den ekonomiska faktorn alltid väger tyngre än förändringsviljan för alternativ med mindre klimatpåverkan. Denna studie syftar till att undersöka efterfrågan från kunder av Ro-Ro-transporter att sätta press på sin transportör att erbjuda transporter med sänkta luftburna utsläpp och undersöka drivkrafterna för deltagarna att arbeta med att sänka luftburna utsläpp i framtiden. Den syftar också till att undersöka vilka åtgärder transportföretaget vidtar för att minska luftburna utsläpp.

Studien har visat att även om det fanns en efterfrågan på klimatneutrala transporter var kunderna inte beredda att betala mer för detta alternativ. Vidare visar studien att det inte finns någon efterfrågan på att påverka transportören för ett byte av bränsle för att minska luftburna utsläpp. Transportören planerar för framtida arbete med att sänka luftburna utsläpp för att möta framtida regler och implementerar för närvarande scrubbers som en metod för att minska luftburna utsläpp. Alla deltagare var överens om att drivkrafterna för att minska luftburna utsläpp kommer från regleringar och regelverk samt att detta behövs som stöd för förändring. Studien var begränsad till kunder till Ro-Ro transporter som har kontrakt med den samverkande transportören av rapporten och undersöker endast exporttrafiken från Sverige.

Nyckelord: Ro-ro, Växthusgaser, utsläpp, luftföroreningar, drivande krafter

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ABSTRACT

Shipping is known to be a conservative industry and not prone to change. Despite of the slow change the shipping industry must get in line and meet regulations presented by the International maritime organization regarding lowering airborne emissions such as greenhouse gases, sulphur oxides, nitrogen oxides and particulate matter. A perspective that is often lacking, for demand to change transport to lower climate impact, is the one of the customers. Earlier research has shown that the economic factor always outweighs the will to change for options with less climate impact. This study aims to investigate the demand from customers of Ro-Ro transport to put pressure on their carrier to offer transport with lowered airborne emissions. Furthermore, an aim is to investigate the driving forces for the participants to work with lowering airborne emissions in the future. It also aims to investigate what measures the carrier implement to lower airborne emission.

The study has shown that even if there was a demand for climate neutral transport the customers were not ready to pay enough for this option. Furthermore, the study shows that there is no demand to influence the carrier for a change in fuel to lower airborne emission. The carrier plan for future work in lowering airborne emission to meet future regulations and are currently implementing scrubbers as a method to decrease airborne emissions. All the participants agreed that the driving forces for lowering airborne emissions comes from regulation and this is needed as support for improvement. The study was limited to customers of Ro-Ro transport who have a contract with the collaborating carrier of the report and investigates only the export traffic from Sweden.

Keywords: Ro-Ro, greenhouse gas, emissions, air pollutant, driving forces

<i>List of figures</i>	v
1. Introduction	1
1.1 Aim of the study	2
1.2 Research questions	2
1.3 Delimitations	2
2. Theory	3
2.1 Introduction of Ro-Ro.....	3
2.2 Environmental aspects of Ro-Ro	3
2.3 Regulations and Environmental indexes.....	4
2.4 How shipowners can meet the requirements	8
2.5 Transport buyers and what they consider	9
3. Methods	11
4. Results	12
4.1 Environmental values of the transport buyers	12
4.2 Demand for a climate neutral transport service	13
4.3 Transparency of carrier’s environmental work.....	13
4.4 Collaborative Carrier (CC) - How they work with airborne emission	14
4.5 What support is needed	14
5. Discussion	16
5.1 Understanding customer demand.....	16
5.2 Future process	17
5.3 Method discussion	17
6. Conclusion	19
6.1 Recommendations for further research	19
<i>References</i>	20
<i>Appendix 1</i>	23

LIST OF FIGURES

Figure 1.....7

LIST OF TABLE

Table 1.....6
Table 2.....12

ACRONYMS AND TERMINOLOGY

CO ₂	Carbon dioxide
DCS	Data Collection System
ECA	Emission Control Area
EGR	Exhaust Gas Reduction
EEDI	Energy Efficiency Design Index
FAME	Fatty Acid Methyl Esters
GHG	Greenhouse gas
HFO	Heavy Fuel Oil
IMO	International maritime organization
LNG	Liquified Natural Gas
MGO	Marine Gas Oil
NECA	Nitrogen Emission Control Area
NO _x	Nitrogen oxides
PCTC	Pure car and truck carrier
PM	Particulate Matter
RORO	Roll-on/Roll-off
SCR	Selective Catalytic Reduction
SECA	Sulphur Emissions Control Area
SEEMP	Ship Energy Efficiency Management Plan
SO ₂	Sulphur dioxide
SO _x	Sulphur oxides
ULSFO	Ultra-Low Sulphur Fuel Oil
UN	United Nations
VLSFO	Very Low Sulphur Fuel Oil
VOC	Volatile Organic Compounds

1. INTRODUCTION

The International Maritime organization (IMO) reported that greenhouse gas emissions (GHG) from all sectors in shipping, in 2018 alone were measured to approximately 1,057 million tonne (IMO, 2020). The total of greenhouse gases emitted from the global shipping sector alone measured up to approximately 3.1% of the world's total GHG emissions. IMO which is the responsible organization of maritime shipping of The United Nations (UN) are implementing the sustainable development goals presented by the UN. Among the 17 goals presented by the UN, IMO have implemented and adopted regulations and are working to achieve goal 13 which includes taking action to combat climate change and its impacts and goal 14 which focuses on conserving life below water (IMO, n.d.-c). Other than implementing the sustainable development goals IMO has worked with reducing oil spillage and cleaning up the oceans since there was several oil spill accidents occurring in the 1960s (Vidas et al., 2021). IMO introduced the International Convention for the Prevention of Pollution from ships (MARPOL) in 1973 which is the active organization working with preventing pollution, within IMO today. MARPOL has six annexes, each for a specific target area for the prevention of pollution. Annex V1 focuses on prevention of air pollution from ships which was adopted in 2005(IMO, n.d.-e).

The international shipping industry has always been considered a conservative industry. While changes are happening, and some innovations are welcomed it has always been a relatively slow change with the same policy's and working standard implemented for as long as possible (Lorange, 2020). In a study, "*Criteria and decision support for a sustainable choice of alternative marine fuels*", by Andersson et, al., (2020) the authors report that the most important factor regarding purchasing of bunker today is the economic factor. Furthermore, the authors explain that the shipping industry are fulfilling regulations and choosing the cheapest bunker thereafter. An aspect not mentioned in the report is the perspective of the customers and customers demand on transport with decreasing airborne emissions.

International cargo shipping can be divided into different segments depending on the type of vessel which is operating. The most common segments are container vessels, bulk cargo vessels, tankships and Ro-Ro vessels which are operating in a very niche industry, almost exclusively aimed towards vehicle providers (Raunek, 2021). Ro-Ro vessel, which will be further explained in the report, are niche in the way that they only transport cargo that can roll-on and roll-off the vessel without the use of extra equipment such as cranes lifting the cargo on board. Fridell (2019) writes in the book *Green ports, Emissions and fuel use in the shipping sector* that different ships are responsible for different emissions profiles depending on the segment the ships operate in and qualities of the ships such as size and equipment's needed. When evaluating CO₂ emissions for different ship types, RoRo vessel are responsible for emitting 52g/tonne-km which is much higher in comparison to container ships (15g/tonne-km) and tankerships (3g/tonne-km) (Fridell, 2019).

When the Kyoto protocol was established, IMO was assigned the responsibility to minimize greenhouse gas emissions for international sea trade (Transportstyrelsen, 2020). Shipowners today have regulations to fulfill from IMO, including the regulations from MARPOL and the Kyoto protocol. When the regulations are presented and known, an aspect of airborne emissions which is rarely included is the demand from the customer base to choose a shipowner or carrier who provides deep sea transport with minimum airborne emissions including GHG, Sulphur oxides, nitrogen oxides and particulate matters. This study aims to investigate the customer

demand for transport with lower airborne emissions today as well as the carriers driving forces to change to climate neutral transport. The study will focus on carriers of only Ro-Ro vessels.

1.1 Aim of the study

The aim of the study is to investigate the expectation and demand on environmental work and lowering airborne emissions from transport, which the carrier might be facing from their contracted customer base. The aim of this study is also to investigate if there are any incentives from the carrier to not only meet regulations but also work more actively in reducing airborne emission in transport and changing to fossil free fuels.

Furthermore, the secondary aim of the study is to investigate how the collaborating carrier involved in the paper are working actively by their own initiative with decreasing their airborne emissions.

1.2 Research questions

- What demand, if any, is the carrier facing from their customers in terms of decreasing airborne emission in transports?
- What measures does the carrier take to lowering airborne emission?
- What does the participants believe is a driving force for lowering airborne emissions in the future?

1.3 Delimitations

This study will only investigate the shipping aspects limited to Swedish shipping and specifically Ro-Ro vessels. There is a collaborating company involved in this paper which will be referred to as the collaborating carrier (CC). Since CC is participating as a supportive company for this study the customer perspective will be limited to the contracted customers of CC. The customer market is also limited to the export market and the import segment of shipping will not be taken in consideration. This study will focus on airborne emission and will not consider discharges to the ocean. The airborne emissions included in the study is Greenhouse gas, Sulphur oxides, Nitrogen oxides and Particulate matter.

2. THEORY

In this chapter of the report theory will be presented so the reader will have some basic knowledge and understanding of the subject. Earlier literature is also presented to further understand the report. When using shipowner in the report it refers to the owner of the ship (Cambridge, n.d). The shipowner can provide transport or rent out the ship to a carrier. When using the word carrier in a report it is referred to a person, thing, or company that transport other things (Cambridge, n.d, -a). The difference of the words in shipping relates to whether the transporter owns the whole fleet (shipowner) or owns some of the fleet and charters the rest (Carrier).

2.1 Introduction of Ro-Ro

According to Raunek (2020) Ro-Ro vessels are usually used for wheeled cargo and the term Ro-Ro is an acronym for Roll-on Roll-off. The term was introduced and defined in the IMO convention Safety of Life At Sea (SOLAS) the first time in 1995 (IMO, n.d.-h). Ro-Ro ships differ from all other types of vessels as it only carries wheeled cargo like cars, trucks, high and heavy cargo like mining equipment for example or the occasional heavy cargo which can be placed on a roll trailer and still roll-on deck of the vessel. Ro-Ro vessel can also include passenger vessels which transport both passengers and wheeled vehicles. Within the segment of Ro-Ro vessels there is also PCTC carriers which is an acronym for Pure-Car & Truck-Carrier that exclusively ships cars, trucks, and high and heavy vehicles (Raunek, 2020). Ro-ro vessels account for approximately 3% of the world fleet and the fuel consumption account for as much (Fridell, 2019).

2.2 Environmental aspects of Ro-Ro

Most of the vessels operating today are dependent on fossil fuel to operate ((IVL, 2021)). Combustion of fossil fuels lead to emissions of gases, harmful for both the climate and humans which are presented in the following part.

2.2.1 Greenhouse gas

Greenhouse gasses origin from different sources (Kontovas, 2020). Included in the category greenhouse gas are carbon dioxide (CO₂), methane (CH₄) and Nitrous oxide (N₂O). CH₄ and N₂O are mainly emitted from landfills and rice paddies. CH₄ is also the main gas found in natural gas and can leak when transporting or refining natural gas (Naturvårdsverket, n.d). CO₂ occurs naturally in the atmosphere but has become the biggest contributor of greenhouse gasses due to human impact (Naturvårdsverket, n.d). CO₂ is released in the atmosphere upon combustion of fossil fuels used in vehicles, ships or industry. GHG are responsible for increasing the temperature on the planet and for climate change across the globe. The greenhouse effect is a natural phenomenon present on earth to make the planet habitable (Naturskyddsföreningen, n.d). The greenhouse effect absorbs some of the heat radiance from the sun to keep the planet at a habitable temperature. When GHG are released in the atmosphere it enhances the greenhouse effect making the atmosphere and the planet warmer and contributing to global warming.

2.2.2 Sulphur oxides

Sulphur oxides (SO_x) is a collective name that includes sulphur oxide, sulphur dioxide and sulphur trioxide. SO_x are created upon combustion of fuels containing sulphur, in the engines of a vessel. The sulphur from the fuel oxidizes and creates SO_x emissions and is therefore proportional to the sulphur in the fuel. The high emissions of SO_x from vessels are due to the marine fuels having a high sulphur content in comparison to other fuels. The international average of sulphur used in fuel for shipping was around 2,5% up until 2020, compared to the average of road diesel which is below 10 ppm. The sulphur average for shipping was therefore about 2500 times higher than road before regulations decreased the limit (Fridell, 2019).

SO_x are harmful to human health, particularly for the public living near ports and coastlines. SO_x can cause cardiovascular and lung disease as well as respiratory need. SO_x impact the environment when released in the atmosphere as it creates acid rain which falls on crops, forest, and aquatic species. SO_x in the atmosphere also contributes to the acidification of oceans and makes the water inhabitable for many species (IMO, n.d.-d)

2.2.3 Nitrogen oxide

Nitrogen oxides (NO_x) is a collective name for chemical compounds of oxygen and nitrogen that is formed from oxygen and nitrogen in the atmosphere mainly during high pressure and high temperature in combustion of fuels like oil, diesel, or gas (EPA, 1999).

NO_x also similarly to SO_x are harmful to human health especially in causing respiratory diseases (EPA, 1999). NO_x also acidifies through rain and creates both ground-level ozone (smog) and by reacting with volatile organic compounds (VOC) creating ozone. This ozone can travel large distances with few losses of NO_x and VOC.

2.2.4 Particulate matter

Particulate matter (PM) is a major air pollutant and health risk factor (Zhou et al., 2020). PM can be created both by natural sources from such as forest fire and volcanos, and from human activity such as combustion of coal or biomass. Other than carbon components PM also include inorganic elements and water-soluble ions. PM is also created secondary from sulfate, nitrate, and organic matter. Particulate matter has a negative effect on the human health both on lung function and irritation on eyes, nose, and throat. PM also affects the climate through aerosols that undergo chemical and physical processes and cloud condensation nuclei (CCN) are made. CCN makes the clouds change which can give a cooling effect and provide less precipitation.

The shipping industry is a significant source of particulate matter emission (Wan et al., 2021). The reason for this is that particulate matter often is connected to emissions of SO_x and NO_x since these can, through chemical reactions, form secondary particles. PM is closely related to the quality of fuel and by switching to a fuel with lower sulphur content, PM would also be reduced. The scrubber described in 2.4.3 can also somewhat reduce particle emissions.

2.3 Regulations and Environmental indexes

The formation and consequences of emissions in shipping have been presented above for the four most common emissions in shipping. In the following chapter the international regulations for international shipping which every shipowner must comply to will be presented.

2.3.1 IMO regulations

IMO is the body and specialized organ of the maritime industry within the United Nations that was created to ensure the security and safety of shipping and prevent pollution from ships (IMO, n.d.-f). IMO adopted the International Convention for the Prevention of pollution from ships (MARPOL) as a reaction to a series of accidents occurring in the 1970's at sea (IMO, n.d.-e). The convention has regulations included in six annexes which are aimed to prevent and minimize pollution, both accidental and from operations. The UN has several sustainability goals where the number 13 focuses on climate change. To contribute to this goal IMO has set out a vision and a strategy to reduce the GHG from international shipping.

IMO released their fourth greenhouse gas study in 2020 where they concluded that GHG emissions, expressed in CO₂ for international shipping across all sectors, have increased from 977 million tons from 2012 to 1,076 million tons in 2018. The increase is equal to 9,6% and includes all international shipping. IMO introduced the compulsory data collection system (DCS) for ships in 2016 (IMO, 2020). The DCS was adopted for ships to compile and report fuel consumption for vessel over 5000 gt. Furthermore in 2018 IMO introduced the Initial strategy on the reduction of GHG emissions which is a policy framework to set key ambitions in reducing GHG in international shipping. The initial strategy includes the goal of reducing GHG by at least half of the emissions from 2008 by 2050. Additionally, IMO have adopted short-term goals to decrease carbon intensity of all ships by 40% by 2030. The strategy is also an adoption that follows the Paris Agreement temperature goals set in 2015.

Regarding sulphur, up until 2020 the limit of sulphur used in fuel was 3.5%. Today IMO has regulations which does not allow sulphur used in marine fuel to go above 0,5% outside special emission control areas (SECA). For the SECA the limit is 0.10% (IMO, n.d.-b). PM is regulated together with SO_x in IMO's regulations, MARPOL Annex VI and has special regulations in SECA's where the sulphur content of the fuel must not exceed 0.1 % (IMO, n.d.-g).

NO_x emissions are regulated through regulation 13 in IMO's convention MARPOL and certain requirements are set based on ship construction date, engine's rated speed and this results in a total emission limit (IMO, n.d.-f). The strictest emission limit is Tier III control. Tier III control is further explained in the table 1, presented by IMO.

Table 1. The NO_x emissions limits set by IMO through MARPOL Annex VI. The limits are based on when the ship was constructed, and the engines rated speed.

Tier	Ship construction date on or after	Total weighted cycle emission limit (g/kWh)		
		n = engine's rated speed (rpm)		
		n < 130	n = 130 - 1999	n ≥ 2000
I	1 January 2000	17.0	45·n ^(-0.2) e.g., 720 rpm – 12.1	9.8
II	1 January 2011	14.4	44·n ^(-0.23) e.g., 720 rpm – 9.7	7.7
III	1 January 2016	3.4	9·n ^(-0.2) e.g., 720 rpm – 2.4	2.0

SECA and NECA

IMO has created several sulphur emission control areas (SECA) and nitrogen emission control areas (NECA) across the globe in order to control shipping emissions (Zhao et al., 2021). Emissions of SO_x have been regulated by IMO to reduce these emissions by 80 percent and even 90 percent in certain SECA areas (Yoo, 2017). Operating in SECAs require a maximum of 0.1% sulphur content in the fuel used. In figure 1 the NECAs and SECAs that exists and areas that are considered in the future. Not included in the figure, but still relevant is that many countries such as Belgium, France, Germany, Norway, Singapore, Malaysia and also Hawaii and California in USA, ban open-loop scrubbers (Zhao et al., 2021).

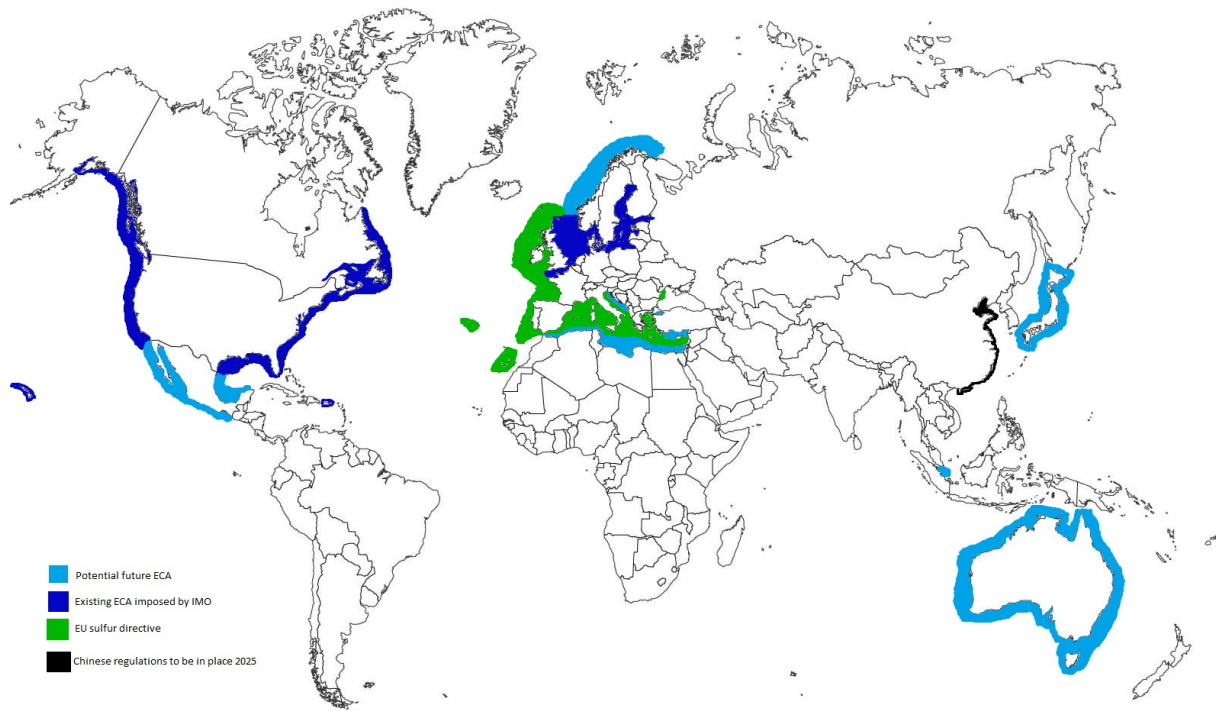


Figure 1, an illustration made to show the ECAs that exists and potential areas that will be regulated in the future.

2.3.2 Indexes

Rules for Energy Efficiency Design Index (EEDI) and the Ship Energy Efficiency Management Plan (SEEMP) are used as measures adopted by IMO to get numbers and concrete objectives.

2.3.3 EEDI

Energy Efficiency Design Index (EEDI) is explained as a technical measure on a certain minimum level ships need to reach in terms of energy efficiency on equipment and engines (IMO, n.d.-a). This is a measure that is mandatory on new ships and the level required depends on the ship type. The EEDI measure was implemented 2013 and the level of energy efficiency are strained every five years to stimulate development in technical areas.

2.3.4 SEEMP

SEEMP stands for The Ship Energy Efficiency Management Plan and has been created as a tool for ships to implement a plan with how to improve energy efficiency with a reasonable cost. The SEEMP also enables for the use of Energy Efficiency Operational indicator (EEOI) in order to measure fuel efficiency both in operation and the effect of a change in operation. The purpose with the SEEMP is to yearn for the ship owners and operators to always strive for new and better technology to keep the ship as energy efficient as possible (IMO, n.d.-a).

2.3.5 Clean shipping index

Clean shipping index is showing emissions that a ship emits to air and water and could be a tool for port or waterway charges, and a tool that transport buyers can use to determine a carrier ((IVL, 2021).

2.4 How shipowners can meet the requirements

The most obvious solution for shipowners to meet sulfur emission requirements is to operate with a fuel that have an acceptable level of sulfur content of 0,5 % and 0,1 in the SECA areas (Zhao, Y, 1Al., 2021). Fuel choice is overall the most determinant factor on whether the airborne emissions is living up to the regulations. If a fuel is used with high percent of sulphur, nitrogen and carbon actions may need to be taken in order to operate acceptably.

2.4.1 Marine fuels used today

With increasing global trade, the global maritime transport sector is a constant growing industry. With maritime transports reaching an all-time high comes a fossil fuels consumption just as high. Fuels that are most occurring today are based on oil, this includes Marine Gas Oil (MGO), Heavy Fuel Oil (HFO) and more sulfur reduced fuels, very low sulphur fuel oil (VLSFO) or ultra-low sulphur fuel oil (ULSFO) (Rickard Bergqvist & Monios, 2019).

When using fuels like MGO and HFO in marine engines, the combustion of the fuels creates GHGs and air pollutions including SO_x , NO_x , and PM as air pollutants and most commonly CO_2 as GHG emissions.

An alternative to diesel-based fuel is Liquid Natural Gas (LNG) which consist of high concentrations of methane, turned into liquid. LNG has become the popular option when looking for a fuel that emits lower GHG than diesel-based fuel such as MGO or HFO (Lindstad & Rialland, 2020). LNG emits about 25% less GHG than HFO and MGO in terms of tank-to-wake emissions. LNG is the favorable fuel to use when operating in the SECA or ECA due to its low sulphur content. When LNG is combusted, it has a reduction in NO_x and PM as well compared to diesel-based fuel. A known problem with LNG is the methane slip that occurs which is not yet regulated.

2.4.2 Fuel options in the future

In an article by Herdzik (2021) about the future of shipping some potential marine fuels that could be used in the decarbonization are brought up. The first category is biofuels which include various vegetable oils. A common one is fatty acid methyl esters (FAMES) that works as a biodiesel. Furthermore, alcohols can be used as fuel with methanol as the most common. The problem with methanol is that it is a toxic and more flammable fuel than traditional marine fuels. Another option mentioned in the article is ammonia which is a synthetic gas that can be procured from fossil fuels, biomass, or renewable sources. It is important that one of the latter two sources are the one that ammonia obtains from if it is a future option. Ammonia do not emit any SO_x , or PM when combusted (so long as the ammonia is sulfur- and carbon-free), but it is however toxic. Hydrogen is mentioned as potentially the best marine fuel in the future mostly because, water vapor is the only result of the combustion. Hydrogen can be made from water electrolysis. The main problem with hydrogen is the low density in both liquid and gaseous state and the lack of technology (Herdzik, 2021).

2.4.3 Scrubbers and catalysts

In order to comply with the SECA regulations a popular option for the shipowners is to install a scrubber that makes it possible to operate with fuels that otherwise have to high sulphur content (Zhao et al., 2021). The cheapest form of scrubber however is the open-loop scrubber which essentially just cleanse the exhaust of SO_x , and then letting it out in the sea water.

These scrubbers will have trouble when discharging exhaust water in some areas are banned meaning that ships with open-loop scrubbers are not prohibited.

For a shipowner to reduce NO_x emissions and be able to operate on NECAs there are two main technology options. Either a selective catalytic reduction (SCR) or an exhaust gas recirculation (EGR). SCR systems use a reducing agent, usually ammonia, to reduce NO_x emissions to an acceptable level (Kurzydym et al., 2022). The EGR work by recirculating the exhaust gas back into the engine and using it as inert gas and thereby reducing NO_x emissions.

2.5 Transport buyers and what they consider

There are three stages in the purchasing process of a transport. First requirements and what is needed for the service are specified. Secondly, based on the requirements a transport service provider is selected and finally the contract is formed and agreed upon (Rogerson, 2017). In all these stages environmental concerns can be discussed and will have different importance depending on the management.

When looking at organisations and what influences managerial decisions on companies' environmental management, there is three main forces (Jazairy & von Haartman, 2019). These forces come from companies need to be accepted and legitimized in the society. Organisations get pressured by regulatory forces which is coercive, market forces that are normative and competitive forces that are mimetic. These forces pressure companies in all parts of its business and in terms of environmental pressures from society including both regulatory and market pressures, that companies increasingly must deal with. Environmental awareness of both consumers and enterprises is something that have increased and become a big part of today's economy (Li et al., 2022). With increasing awareness and demand from customers, sustainability and environment rise higher on companies' agendas.

Since transportation is a big part of the CO₂ emissions (around 20 % of the global CO₂ emission) much can be done to reduce these emissions along with other airborne pollutants (Jazairy, 2020). To reduce emissions and environmental harm, not only the logistics provider is responsible, but also the logistics buyer who makes choices which in hand affect the business of the transportation company (Jazairy & von Haartman, 2019). Since it is the shipper that makes the choices of the transport service the transport provider is bound to those demands (Jazairy, 2020). Traditionally when a shipper wants a transport service the most important criteria's that they consider is cost competitiveness and timely deliveries. Environmental concerns are therefore frequently put aside. The study by Jazairy (2020) shows that the transport buyer has an interest of environmental sustainability in the beginning of the buying process, but these concerns decline and tend to not be included in the contract. The study also shows that the transport provider shows more interest in reducing emissions of their transport, than the buyer shows such interest. This means that even if the transport buyer at first provide interest in an environmental service their lack of effort in later stages demotivates the service provider and is thus inadequate for environmental concerns to be engaged in the relationship between the provider and the buyer.

2.5.1 Importance of customer awareness

In an article about customer awareness, the importance of being able to advertise the environmental initiatives within a company is key to a competitive advantage (Rahman et al.,

2020). In the article there has also been stated that customers are willing to pay more for eco-friendly products and services. Competitive advantage can therefore be gained and is the reason for firms across different industries to spend more resources towards products and services. The increase in performance in terms of the environmental impact would differentiate their product and services in comparison to the competitors. With this the company can get a financial benefit by going beyond regulations and through advertisement promote their work to environmental stakeholders which in this case is the customer. Overall, with a higher performance in both explicit and implicit environmental obligations a company can get a larger market share and be robust against competition, but also against price (Rahman et al., 2020).

2.5.2 Example of purchaser demand in retail

In a report conducted by Gomes de Oliveira et al., (2022) the authors investigated what the customers perceived as sustainable practices in the fashion industry, being the second largest polluter of the environment. The report investigated fast fashion and slow fashion brands in Brazil. The authors concluded that even though the consumers showed a positive view for change in sustainability in the fashion industry, none of the consumers were willing to pay more for a greener product. The consumers opted for an organizational change in sustainable practices in the companies, but they would not want the change to affect the cost of the product.

3. METHODS

This report is a qualitative study based on literature research and interviews with actors in the RORO industry. Since this study focuses on the relation between transport buyer and carriers, interviews have been done on a transport provider and their four customers. The interviews were conducted in a semi structured manner and allowed the questions of issue to be answered. The information from interviews were analysed together with the literature that have been collected.

3.1 Literature research

To get a solid base of information around the subject, identify problems and to get a support for this study literature research was conducted on both theoretical and fact-based sources. Academic journals, articles and other literature was accessed through Chalmers library, Science direct and Scopus. The process of finding literature usually started with the search function and some keywords. Common such keywords include transport buyer, Shipping emissions, marine fuels, future fuels, airborne emission, environmental concerns, transport service provider, environmental policy, emissions from Ro/Ro vessels.

3.2 Collection of data through interviews

For this study the focus is on the transport buyer and if they put pressure on their transport provider in regards of environmental work and lowering airborne emissions. The case study was done in collaboration with a company that operates in the roro-industry and through this company we received information about their clients. Nine contracted customers were contacted through e-mail, and this gave us only one respond. The others answered when we decided to call, and this in total gave us four interviews and one answer on e-mail from the customers. The interviews were done in an online format much due to simplicity and to not have to deal with the distance gap where many of the interviewed are located far away. The interviews were recorded with permission from the interviewees so the focus could be on the conversation and respond instead of taking notes during the interviews. The recordings were then transcribed on to writing and analysed in compliance with the literature. The analysis was made with a couple of steps. After transcribing, relevant parts of the interview could be identified through reading and encoding. Parts were encoded if it was repeated, if it was similar to research that had been read, if it was declared by the interviewed that it was important, or if it was deemed relevant for another reason.

3.3 Sampling

The selection of candidates was made from CC. Since CC work with all their customers and have contracts of determined rates, volumes, and schedule it was assessed that the case study would be made in accordance with contracted customers and not spot customers. It was also believed that the value of demand from contracted customers were to be regarded higher than spot customers. The interviewed representatives from the customer side were all working with or was a part of sustainability project within in their company. In accordance with the participants, it was decided before the interviews that they would be anonymous when the result was presented. The transport buyers are therefore named A, B, C and D in the presentation of the result.

4. RESULTS

The results presented in this chapter are based on semi-structured interviews which were conducted in accordance with the study. The results are presented anonymously with the collaborating company named as CC and the customers named as transport buyer A (TBA), transport buyer B (TBB), transport buyer C (TBC), transport buyer D (TBD). All the participants were asked questions in an interview with the answers recorded except for TBD which answered in text via email. CC is referred to as the carrier in this study. The results are based on the questions found in Appendix 1 with different questions for the carrier and the transport buyers.

Table 2.

COMPANY	SHORT DESCRIPTION	MAIN CARGO TRANSPORT	MAIN TRADE WITH CC	TRANSPORTED VOLUME IN WM FROM EU
Transport buyer A	The company produces and sells construction equipment globally with the focus on production. Owns facilities	HIGH AND HEAVY	EU-NA & EU-OCEANIA	26128
Transport buyer B	The company produces and sells trucks globally. Owns production facilities	TRUCKS	EU-ASIA	550290
Transport buyer C	The company owns factory facilities with main production focusing on assembling. One of the worlds biggest producer of forrest machinery	HIGH AND HEAVY	EU-OCEANIA	9961
Transport buyer D	Produces and sells mining and construction machines. Owns production facilities	HIGH AND HEAVY	EU-OCEANIA & EU-NA/SA	54449

Table 2. Demonstrates a short description of transport buyers, main cargo transported by CC and an approximate amount of volume transported in Weight/Measurement from EU. As the table shows TBB have the highest amount transported by CC even though is operates in the trucks segment which is smaller and usually weighs less than High and heavy cargo.

4.1 Environmental values of the transport buyers

There are some slight differences in what the transport buyers' that got interviewed value in terms of environmental work. These values depend highly on the operation of the company. For the TBA that produces steamrollers, environmental concerns are not prioritized at all. The strategy they take is a reactive response to environmental requirements. Furthermore, TBA does not feel any demand from the market that would justify a greater environmental performance. The other transport buyers have a business with larger focus on environmental questions. For TBB, which produces busses and trucks, it is important with transparency and initiatives have been taken to focus on life cycle assessments of their products. In the life cycle assessment, they try to include not only CO₂, but also noise pollution, health issues and how the product interacts with society. TBC that is in the forest machine industry, point out that their priority in terms of environmental work is making sure their machines have a good standard, not emitting high levels of NO_x and CO₂. They also work with energy consumption and efficiency. Their focus is mainly about becoming carbon neutral in their production and factory mostly through

solar cells today. TBD consider GHG the most important environmental impact to reduce and consider environmental work highly. This work consists of reducing the company's footprint without going into detail too much.

The central environmental work that the company's interviewed does was about making sure their own products reach certain standards and reduce the negative impact they have on the environment. TBC explains that they are an assembling company, and that transportation becomes a big part of the emissions for the company's operation and therefore is a big subject. TBC are an assembling company, and the transport emissions is the main sources of environmental concern that the company work with. However, the main feedback and follow-ups are directed towards the rail and road, not towards the shipping segment. However, their engagement in lowering emissions from transports are directed towards the road and rail sector.

4.2 Demand for a climate neutral transport service

The willingness to pay more for a carbon neutral transport and the demand, as well as pressure for carbon neutral transport from the carrier differs among the customers. TBA would not be willing to pay more for carbon neutral transport and would not switch carrier if they were to find out the carrier was using polluting fuels unless there was a remarkable pressure from their own customers. TBB stated that they would be willing to pay more for climate neutral transport and are already implementing this on some of their transport chains. TBB doesn't have a direct demand on carbon neutral transports but rather they look at the operational factors when choosing a long-time carrier. The demand put on the carrier from TBB are set by the standards which TBB works with, and these must be fulfilled. These demands can include a maximum age limit of the vessel and of the engines. This due to environmental and operational factors. The demands also include that the "carriers meet regulations and are working with sustainable solutions and certifications" as they describe it without further explanation. TBB would not change carrier as a first procedure if they found out that their carrier is operating with dirty fuel but would rather evaluate the situation and give the carrier an opportunity to adjust. If the carrier do not fulfil the demands and change their procedure however, they would change carrier.

TBC do not have any direct environmental demand on the CC, but they gather reports and evaluate emission/machine transported. The representative of TBC stated that they would be willing to pay for climate neutral transport, but they don't know if this would be accepted by management. It is stated that usually environmental requirements fade in favor of the price aspect. They also state that the decision of fuel from their carrier is an important choice but due to the specific trade the carrier is offering and the lack of other carriers operating this trade, TBC will probably still use CC as a carrier. TBC would want to change carrier if they were to find out that they were using dirty fuel however they don't think that it would be a realistic option due to cost efficiency. TBD has answered that they approach their carrier's choice of fuel by requesting environmentally friendly alternatives, however it is not stated what this alternative is. Furthermore, TBD answers that they would not want to pay more for carbon neutral alternatives but rather discuss sharing the increased cost, among all involved parties. TBD answers that they would "take that under consideration" and "discuss opportunities" when asked if they would change carrier.

4.3 Transparency of carrier's environmental work

When asking the transport buyers about their perception of CC's environmental work and whether they believed that CC was doing more or less than industry colleagues all the answers differed. TBA said that they had no perception of CC's environmental work and thus could not

give a conclusion on whether they were doing considerable environmental work. TBA did not state that they requested nor asked for further transparency on emissions from CC. TBB do not have full insight or concrete numbers of how CC's works with lowering airborne emissions. TBB does however cooperate with the Swedish environmental institute which gathers official reports from all shipping companies, thus giving TBB the possibility to compare airborne emissions in sea transport. From the information given to TBB, the perception is that CC has many good initiatives and are requesting more transparency in terms of environmental work from their carrier. TBC does not know much about CC's environmental work or emissions in transport, and they also state that they do not gather information on the topic. Since CC is not responsible for and thus not operating on the biggest market for TBC they have somewhat fallen out of the spotlight. TBC mentions that they wish that all carriers and institutions would measure their emissions in a similar way to make a comparison accurate and relevant. TBD gave very short statements and responded that they believe that CC is in the forefront of initiatives of reducing airborne emission together with others in the industry.

4.4 Collaborative Carrier (CC) - How they work with airborne emission

The CC state that measuring airborne emission directly is not effective and not how they work. SO_x are measured through how much fuel that is consumed and the sulphur content in that fuel which they both know with great accuracy. NO_x emissions are too difficult to measure directly and the whole industry instead look at the engine design. The CC therefore report on the fleet average NO_x intensity of the vessels that they own. They do not specify NO_x on the vessels they only charter. They calculate and report CO_{2e} instead of CO₂ which gives all the greenhouse gas emissions. They are not running on fuels like LNG, and it is therefore very little methane. They do not report on Well-to-wake since this is more complex, however they could calculate with a rule of thumb of adding ten percent to the emissions. About 20 of 85 vessels that they own have a scrubber installed and every one of them are of hybrid type.

In terms of going beyond regulations the CC distinguishes clearly between planning and what is performed. They consider planning far beyond regulations as standard good business sense, much due to regulations not being static and the industry does not really know how or how fast it will develop. Without this planning ahead for potential future regulations the business of the shipping company is not operated responsibly. In terms of fulfilment and achieving a better performance than is required by regulations, the CC feel that it could be justified if it is demanded by the company's stakeholders. If their customers have high requirements or "an appetite" for a carbon neutral service, then there could be a business justification. The problem is the substantial cost that is connected to the gap in performance between regulatory requirements and the exceeding potential performance. This high extra cost will in current situation be extremely hard to pass along to the customer without regulatory justification. The CCs customers have proved willing to pay extra for a carbon neutral service, but in comparison to what such a service would cost to provide it is insignificant. The CC also believes that the RORO industry with transport buyers with large volumes do not have margins to pay that extra cost. It is mentioned that the container industry may be more suited for providing such a service.

4.5 What support is needed

The actor from the CC considers the most important driver to be regulation and a global price on carbon as the most important policy piece. Their opinion is that the global price on carbon should work like a levy which is like a tax, and this makes it conceptually simple. With

something easy to explain to the customer it becomes much more likely that they can pick up the cost. This regulation would create a demand signal and investors and vendors would understand that such a product on the market would get buyers.

Furthermore, it is difficult right now to understand how shipping companies perform. The CC feel like a standard way of measuring performance is a key for a company to differentiate itself from the competition in terms of environmental work. Without a standard measurement it is hard for the customer to know which shipper perform better than the other.

5. DISCUSSION

All the participants that are involved in this study are working with their own environmental work inhouse and are aware of the change that their carrier and the whole transport industry is facing. What is consistent with all the participants are that their interest of lowering emissions is often overlooked by the cost competitiveness.

5.1 Understanding customer demand

Out of all the transport buyers there was only one who could answer with certainty that they would be willing to pay more for climate neutral transport. Furthermore, they were the only one who explained that they have frequent dialogues together with the carrier about changes for decreasing airborne emissions and would change carrier if they were to transport with dirty oil. The overall results shows that the demand from the contracted customers, for climate neutral transport, or even the demand for decreasing airborne emission is not significant enough to make the carrier opt for changing their fuel.

Even though it has been proven what harm the combustion of fuels used today are doing to the climate and to humans, the results also show that the majority were not ready to pay for climate neutral transport. One mentioned that even if the operating side of the company would wish for it, it would probably be hard to get it accepted above management. As CC mentioned the margins in deep sea trade are small and it would not be possible for the carrier to cover all the increased cost of climate neutral fuel. This can be compared to what was stated in chapter 2.5 about how transport buyers show environmental concerns in the procurement phase, but then not being included in the contract. In this case TBC presented just that and confirmed the theory from 2.5. The literature presented (Jazairy, 2020) and the result both shows that the cost aspect of the transport is seen by the transport buyers as the most important factor. However, the statement that environmental awareness has become a big part of today's economy (Shao, Liu, 2022) was not really reflected in the result.

Since the study was conducted in accordance with a Ro-Ro carrier all the transport buyers who participated were companies who produce trucks or construction equipment. These products have a long lifecycle, and the emission from transport becomes a small target focus. It is therefore reasonable that the transport buyers choose to focus on the products, inhouse emissions and the climate impact of the factories. However, the results show that the emission from transport is sometimes neglected when evaluating the climate impact of the cargo and one might think that the whole supply chain, from factory to end-customer is not being included in the final assessment. One might wonder if the customers are getting a realistic assessment of their product when not including transport in emission calculation.

As mentioned in the introduction from the study by Andersson et al., the cost is the highest, or a higher priority to the customer when arguing for climate neutral transport or transport of any kind. In accordance with the study by Andersson et al., and Gomes de Oliveira et al., from 2.5.2 the results give a similar conclusion that even though the customer is aware of the environmental impact or are given an option for climate neutral consumption, they are not ready to pay more for it.

5.2 Future process

With the demand being low from the customers the carrier is not receiving any pressure from their customers today. This shows that the driving force for offering climate neutral transport would be from regulations or as CC mentioned a global cost on carbon fuel.

As mentioned in the theory of the report the customer needs awareness of how the transport provider is working with the environment if this is going to be an order winner. With the current situation in shipping there is not a standard measurement, and it is hard to mediate to the transport buyer if a company is doing something better than the competitors. This will be necessary if there are transport buyers that would want a performance of the transport provider that goes beyond regulations. There are definitely different ways of measuring what is used today and some of them are presented in the index part of this report. These indexes can be an option that is used, but as the CC was emphasizing, the most important thing is that the measuring can be done in the same way no matter where in the world. A standard appliance of reporting and measuring environmental performance will also reduce the risk of transport buyers being misled by the carrier.

The TBA mentioned that they would only change if a better environmental performance was demanded by their own customers they would put through that demand on the carrier. Similarly, TBD states that they would want to discuss with all the stakeholders in order to possibly share the increased cost that a carbon neutral service would require. This means that in the future there probably needs to be a shared interest from stakeholders in shipping in order to meet requirements and possibly doing more than the regulations.

5.3 Method discussion

In the literature research the aim was to use scientific articles and reports to understand previous research and develop an understanding in the subject. Most of the sources are scientific articles where the relevance is based on date of publication and closeness to the subject. The most challenging part of the literature research was to find sources that process a customer perspective when it comes to environmental issues. This was also a motivation for this study to be made, since the subject was rather unexplored. Information and regulation regarding chemical and natural gas was gathered from environmental and maritime institutions and was assessed to be correct and truthful.

The interviews that were conducted is the core of the data collection. It would have been useful to get some additional interviews with transport buyers and the reliability of the report could increase with more participants representing the transport buyer perspective. The main problem was the lack of time and engagement from all the contacted transport buyers. As mentioned in the method chapter, there was three out of nine transport buyers that agreed to be interviewed while one was willing to answer questions in short by text. First contact was made through email, second contact was made about a week later through phone. When calling the transport buyers, the responses increased with about 300% and some interviews could be planned. The total response rate was summarized to 44% of all asked transport buyers. What could have been done to increase the response rate is contact the customers a third time to make sure they haven't missed or forgotten about the earlier contact. One company declined to participate due to secrecy reasons which was unfortunate but respected.

One representative answered that they might not have been the right person for the interviews as they may not be the most knowledgeable in environmental work. However, the results from this interview could still be used and was a good representation of the company's value on environmental work overall. It could have been a good idea to involve more people from each company to be sure that all the aspects in their environmental work would be covered. Now interviews were done with only one representative and Benefits of the collaboration was that the interest for the transport buyers to participate seemed to increase when it was told that it was a collaboration with their carrier.

The conclusion was made that interviews was the appropriate method to gather the data needed to find a reliable result. This was concluded much due to the way case studies benefits from the qualitative nature of interviews which allows for the researcher to get profound and detailed information. Since the focus was to examine the demand from one carrier and their contracted customers the number of participants would be small and methods such as surveys would instead be preferable in a case that required larger volumes of data with more participants. A disadvantage with case study is that the information is narrowed, and it is sometimes harder to make sure that the result can be representative of the generalization that the aim is to make. The one customer who answered through text gave much shorter answers than the ones in interviews and it was chosen to be careful with this data, since they may have misinterpreted questions and body language cannot be registered.

6. CONCLUSION

Environmental concerns have an increased importance in today's economy, but the result from this report shows that customers of the ro-ro industry is slower in starting to value these concerns as an important factor in transportation. The results are unanimous and demonstrate that CC does not get any significant demands from their customers to decrease airborne emissions for their transports. Instead, the motivation for the carrier to work with lowering airborne emission originates from regulatory requirements. The motivation comes from both regulations that exist, but also from potential regulations that might be implemented in the future. The importance of planning ahead is emphasized by the carrier as the main way that they take initiative to lowering airborne emission. The CC concludes that fulfilling all regulations but also working actively with and preparing for change to fulfil any future regulation is smart business.

Furthermore, both CC and the asked transport buyers regard regulation as the primary driving force in lowering airborne emission or overall climate impact. In accordance with the study the conclusion can be made that regulation or laws will for now remain as the driving force for lowering airborne emission. As some earlier research shows in 2.5 there might be normative forces in the market for purchasing of less climate impact services or product. However, this is not something that has been known within shipping yet.

6.1 Recommendations for further research

This study was conducted in accordance with a CC operating exclusively within the Ro-Ro vessel market. For further research a study could be conducted in accordance with another market of shipping, for example container, bulk or passenger vessels. Container industry was also believed by the CC to be more suitable for a transport service with higher standard. The study was also limited to the area of exportation cargo out of Sweden. It would be interesting to make a comparison to the neighbouring countries such as Norway and Denmark. Further there is the perspective of demand for the ports which works with the anchoring of vessels. Whether the ports receive any demand from the shipowner, carriers or customer and which driving forces the ports find. This is a subject and perspective first thought about but had to be delimited for this study.

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APPENDIX 1

Questions for customers

1. What is the meaning of environmental work for you?
2. Which environmental impact do you find the most important to reduce?
3. Would you say that environmental work is important for your company?
4. Is environmental work something that you work actively with within your company?
5. How does your company implement environmental work?
6. Would you say that the fuel used by your transporter/carrier is an important decision?
7. How do you approach you carriers' choice of fuel?
8. How do you approach you carriers' choice of working with decreasing airborne emissions?
9. Would you pay more if you knew that your cargo is being transported with climate neutral transport?
10. If you were to find out that your carrier where using, for example, heavy crude oil/heavy fuel oil would you consider changing carrier? Why/Why not? (only customer question)
 - What would make you change carrier? Is there a limit?
11. Do you feel that your carrier is better than others in terms of working with lowering airborne emissions?
12. Do you think this carrier does more than their industry colleagues in lowering airborne emissions and changing to fossil free fuel?
13. Do you have any demands on your carrier today?

Questions for carrier

1. What does environmental work mean to you? How would you define it?
2. Which environmental impact do you find the most important to reduce?
3. Do you think that it is necessary to do more than the regulations ask of you to lower airborne emissions and fossil fuel consumption? Has this evolved throughout the years?
4. Do you measure you GHG emission and airborne pollutions in any way? If so how/why?
5. Does your company feel any demand in environmental index or classifications from your customers?
6. If it would be demanded of your customers that you transport with fossil free fuels, or they would not hire you as a carrier, would it be a demand that you would fulfill?
7. What support would be needed to meet that certain demand?
8. Do you think that your company does more or less than your industry colleagues in lowering airborne and changing to fossil free fuels?
9. Do you have a vision for offering fossil free transport in the future?
 - If yes/no, why? Please explain
10. How does the company handle different demands from different customers?

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