UNIVERSITY OF GOTHENBURG

SCHOOL OF BUSINESS, ECONOMICS AND LAW

Inclusion of maritime transportation in the European Union Emission Trading System

A study investing the effects on the Swedish forest industry

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Abstract

Shipping has a leading role in our globalised world and accounts for 90 % of the global trade volume transported over the world. International Maritime Organization (IMO) forecasts that the demand for shipping will increase in the future, hence leading to a rise in emissions. By tackling the increased emissions from the maritime sector, the European Commission will in June 2021 present a suggestion regarding the review of the Emission Trading System Directive and an inclusion of the emissions from the maritime sector. The inclusion of maritime transport will lead to higher cost for transport buyers to use shipping as a mode of transport.

The purpose of this report has been to investigate how Swedish forest companies may be impacted by the inclusion of maritime transports in the EU ETS. The forest industry is the large transport buyer in Sweden and is the fifth largest exporter, thus an important industry for Sweden. Still, we know little of how forest companies may be impacted by the inclusion of maritime transports in the EU ETS. In order to answer the research question of the thesis, seven interviews with representatives from the Swedish forest industry where conducted, as well as an interview with a representative from a shipping line and one representative from the whole forest industry. Two scenarios where calculated to concretise the potential impact for the forest companies in increased costs.

The main conclusions and findings from this study is that the implications for a forest company are highly dependent on geographical location, infrastructure investments, product segment, markets and nearness to sea transportation, which in the following step affects how the company could be affected by the inclusion of maritime transport in EU ETS. The potential effects on the Swedish forest industry have been found to be potential losses in export due to the need to decline deals as a result of too low margins in a certain market. This relates to the decreased competitiveness the Swedish forest industry may face as competitors outside Europe, mainly in America, does not have the disadvantage of extra cost for transportation at sea. The possibilities for a modal shift for the companies is largely dependent on the investments in current infrastructure rather than the production itself but a modal shift to road haulage at certain markets due to competitive transportation cost to close markets in Europe where road haulage is a competitor. With the additional costs, the structural transformation of the industry may appear in a faster pace than seen at the moment.

Keywords: *EU ETS, Swedish forest industry, Competitiveness, Shipping, Maritime transportation.*

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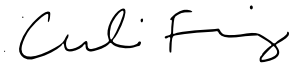

Caroline Ferning

Table of Contents

Table of figures

List of tables

Abbreviations

BAF:	Bunker Adjustment Factor
CO_2:	Carbon Dioxide
ECA:	Emission Control Area
EEA:	European Economic Area
EUA:	European Union Allowance
EU ETS:	European Union Emission Trading System
FEU:	Forty-foot Equivalent Unit
GT:	Gross Tonnage
GHG:	Greenhouse gases
IMO:	International Maritime Organization
MPP	Multi-purpose Vessel
MRV:	Monitoring Reporting and Verification
SECU:	Stora Enso Cargo Unit
SECA:	Sulphur Emission Control Area
SOL:	Swedish Orient Line
TEU:	Twenty-foot Equivalent Unit

Glossary

Bunker:	Term used for referring to fuel used for ships.
RoRo:	A ship designed for carrying vehicles and wheelbase cargo, which are driven onboard and ashore.
RoPax:	Combined RoRo and passenger ship, a ship equipped with large Roro decks and limited passenger facilities
European Short Sea Shipping:	Movement of cargo and passengers by sea between ports situated in geographical Europe or between those ports and ports situated in non- European countries having a coastline on the enclosed seas bordering Europe
Slow steaming:	The practice of purposely operating a ship at a lower speed than normal to achieve a reduction in total fuel consumed.
SECU:	Intermodal container used both for rail and in shipping by Stora Enso. Maximum load weight of 80 tonnes.
TEU:	Twenty-foot ISO-container. Maximum load weight of 21,6 tonnes
FEU:	Forty-foot ISO-container. Maximum load weight of 26,5 tonnes
Tonne-kilometre:	Measure of transported work where: tonne*kilometre
N miles:	Nautical miles, equals to 1,852 km.
Time charter:	The shipowner is placing its vessel at disposal for a certain period of time to the charterer which have the right to employ and dispose the vessel. The charterer controls the commercial functions of the vessel.
Emission Allowance Unit:	The right to emit one tonne greenhouse gases within the EU ETS.
Shipper:	A shipper is a person or a company who has an interest in the goods being transported, hence responsible for the purchase of the transport. Generally, the shipper bears the cost of freight, except otherwise stated in the transport contract before shipment.

1. Introduction

In this section a brief background to the problem will be presented, as well as a problem discussion which will end in the research question and the scope of this study.

1.1 Background

Shipping has a leading role in our globalised world and accounts for 90 % of the global trade volume transported over the world. International Maritime Organization (IMO) forecasts that the demand for shipping will increase, hence leading to a rise in emissions by 90-130% compared to 2008 emissions by 2050 (IMO 2020). At a global scale, the IMO has agreed to reduce the greenhouse gases (GHG) related to maritime transport by 50% until 2050, compared to 2008 (IMO 2019). With the demand for transportation increasing and the emissions with it, the European Commission has initiated an inclusion of the maritime sector in European Union Emission Trading System (EU ETS). The initiative is a part of the new Green Deal announced by the European Commission in the autumn 2019. The announcement was no surprise as the European Commission has previous initiated that actions need to be taken for reducing the emissions related to maritime transportations. The message from the European Commission was very clear, if IMO haven't found a solution to how to reduce the emissions connected to maritime transport by 2021, actions by EU would have to be taken to accelerate the pace of the reduction of the emissions and be implemented in 2023 at the latest by either IMO or the European Union (EC 2018). The whole idea of including the maritime sector is for the industry to take responsibility and pay for their emissions as other industries are forced to do. The inclusion brings the EU one step closer the goal of climate neutrality in 2050 (European Commission 2021i).

But it is not without any problems as shipping and maritime transport has a crucial role in EU's economy. 36% of the intra-EU trade is transported by shipping and it accounts for 75% of the external trade (European Commission 2020). From a Swedish perspective, 170 million tonnes of goods were handled in Swedish ports in 2019. Of that, 145 million tonnes, or 86% of the handled goods in Swedish ports consisted of foreign goods traffic (Trafikanalys 2020a). Shipping has a crucial part in the Swedish transport system when it comes to exportation of finished products and raw material. In 2020, Sweden's total export amounted to 2203 billion

SEK (SCB 2021). Sweden exports more than it imports, which means that we have a larger flow of products and service, leaving Sweden then entering, highlighting the importance of Swedish export trade. The four most important export goods for Sweden are: vehicles for roads (191), medical and pharmaceutical products (115), other non - electric machinery and appliances (88) and paper, cardboard and other forest products (80) (SCB 2021). Europe is one of Sweden's most important trade partners where 72% of the products goes. A lot of these products are reloaded at the continent for further transhipments (SCB 2021). This gives a clear picture of the importance of the maritime sector has for our export. In 2014, 70% of the outgoing goods were transported by sea, as railway and heavy trucks equally accounted for approximately 15% each (Trafikanalys 2016). The shipping industry accounts for a crucial part of the transport system that enables Swedish export.

Challenges which the maritime sector has faced and continues to face are tensions found from international trade wars, both supply and demand faced shocks that affected the global supply chain in ways producing companies, countries and logistic provider did not foresee. Even though the RoRo segment and international maritime trade, in general, has seen a decrease, the container segment has seen a small increase with 1% of number of containers transported/goods during 2020, largely due to economies of scale and an increased turnover time in port (UNCTAD 2020b). Sweden follows the same patterns where the volume of RoRo units decreased with 3% to 47,1 million tonnes and as containers increased with 1% to 13,9 million tonnes (Trafikanalys 2020a). Problems related to supply and demand affect the shippers' possibilities at the freight market, which affects the total cost for logistics.

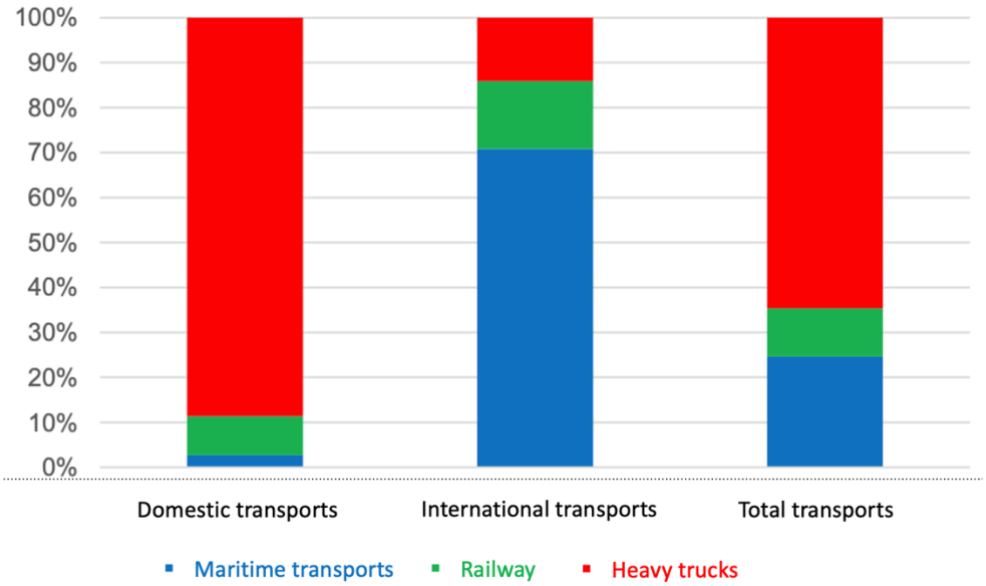

Figure 1: Share of shipping, railway and heavy trucks accounting for domestic and foreign transportations measured in share of freight volume (Trafikanalys 2016)

As mentioned above, pulp, paper and other forest products account for the fourth largest and most important export from Sweden. The forest industry is the largest transport buyer in Sweden (The Swedish Forest Industries Federation 2021b). Approximately 70% of the finished goods from the forest industry are exported by sea down to the continent and UK (The Swedish Forest Industries Federation 2021). The Swedish forest industry employs 115 000 and accounts for 9-12% of the Swedish Industry's export, employment, turnover and value adding. The forest industry is highly export focused as 90% of the pulp- and paper production and 70% of the sawed wood leaves for export (The Swedish Forest Industries Federation 2021i). With the high usage of shipping for export within the forest industry, any changes for the industry may have a ripple effect at the transport sector as well as the Swedish trade.

1. 2 Problem description and problem analysis

In June 2021, the European Commission presented a suggestion regarding the review of the Emission Trading System Directive, hence inclusion of the emissions from the maritime sector (EC 2019). With the European Commission wanting to include the maritime sector in the EU ETS, sea transport will increase regardless. The main question is how many or what kind of the voyages will be included in the scope, as how emissions might be allocated. Depending on the market, the structure and possible substitutes, higher ship running costs will lead to higher transport costs for the shipper. The scale of these cost on the one hand, and the cost incentives for shippers on the other hand, can determine how the possible outcome will look like. The possibility for actors to transfer the costs to the customer and to what extent are not clear and have not yet been analysed in a Swedish context. There have been a few studies at an international level where a global emission scheme has been analysed from a shipping perspective, but it is not clear how well these studies could apply to Sweden and the EU. In a pre-study made by Lighthouse (Mellin et al. 2020), different plausible alternatives for the inclusion were investigated and presented to analyse the extent of the possible consequences for the shipping sector within the European Economic Area (EEA). Further research looking at the potential consequences for the shipper is needed.

One other fear is that there is a potential modal shift towards road haulage and with that less energy efficient systems with more congestion. A second fear is that due to the increased cost

there will be a change in how and where shippers call port. A fourth concern is that higher cost for export and import may affect how other stakeholders would trigger a change in behaviour as warehouses and central hubs may move closer to the market and affect the logistical network (Halim, Smith & Englert 2019). Due to Sweden's location and geographical location, the usage of shipping within EEA is high. In 2019 short-sea shipping (SSS) accounted for 148.2 million tonnes of the total sea freight within Europe. As a higher price for emissions will then price for shipping will rise with an inclusion in EU ETS. The possibility for actors to transfer the costs to the customer and to what extent are not clear and have not been analysed in a Swedish context. It is not clear how well international studies could or would apply to Sweden due to specific circumstances.

In 2015 IMO introduced the sulphur cap of 0.1% in the Sulphur Emission Control Area (SECA). Before the introduction of the Sulphur cap, potential consequences other than higher cost for fuel had not been analysed to a larger extent. With higher requirements for lower sulphur content in the fuel, the cost expected to increase significantly and hence affect the shipping industry within the area. As a coincidence, the oil price dropped right before the introduction the projected increase defaulted, and the projected increases did not become as significant which did not affect the shipping industry profoundly. The increased cost has therefore been able to be carried both by the customers as well as the shipowners (Raza, Svanberg and Wiegmans 2020). Increased costs are transferred to the shipper and added to the freight rates. When there are inevitable circumstances, there is an acceptance between the shipper and carrier if held to the bare minimum (Jansson & Saarinen 2020). The outcome of the regulation with only slightly higher costs was only a good timing but could have had a large impact.

In a study by Bergqvist, Turesson and Weddmark (2015) an analysis of the potential impacts on the forest industry due to the adoption of the sulphur regulation where made. Due to uncertainty one of the strategies was to not sign any contracts with shipping lines beyond 2015. However, it differs depending on the logistical strategy, as for SCA since they are their own logistical company and hence act as carriers instead of shippers. According to the study the size of the transport flow is an important factor, since larger flows require a larger structural transformation and therefore, these strategic decisions need to be taken early. The study also concluded that depending on where the production facility was located it affected the possibility for modal shift to a large extent due to capacity problems at the railway. The study concluded that the forest companies had already started to move goods from sea to land, as another strategy

was to “wait and see”. But another aspect found was that the stricter regulations and increased costs increased the incentives for collaboration on logistics to increase the fill rate and upscale transport solutions, even though fierce competition between the companies.

Forest companies have an important role in the maritime sector as the forest industry is the largest transport buyer in Sweden with 25 billion annually (The Swedish Forest Industries Federation 2021). As 10-15% of the final price paid by the customers for the forest products consist of the transportation cost, it is a significant part of the company’s revenue, Tengberg and Wikdahl (2015) highlight how Stora Enso as a large actor within the forest industry and a large user of RoRo service moved their hub from Port of Gothenburg to Port of Zeebrügge to gain economics of scale. The move made the Port of Gothenburg to lose 1.5 million tonnes of goods being handled in port. In 2019 Stora Enso switched their choice of shipping line from SOL to DFDS which led to an increase of departures at the Gothenburg – Zeebrugge route (Port of Gothenburg 2019). Depending on the several factors, forest companies operating on the sea can have a huge impact on how the transportation system may look like in the future in Sweden.

The forest industry has been under a reconstruction phase where the product increases as the number of mills and production plants decreases (The Swedish Forest Industry Federation 2021e; 2021g). At the moment, the paper segment is also facing a lot of closures as for SCA and Stora Enso (SCA 2021; Stora Enso 2021). For segments with already low margins, the increased costs for transportation could potentially affect how or if transports are being done.

The industries using maritime transportations most often do not have any feasible alternatives for their transportation and whatever additional costs may initially have to be accepted[1]. Research also shows an aversion for shippers to change transport solution once established (Trafikanalys 2016). Therefore, the increased costs as an incentive may not affect how the company's logistical system would change due to no other feasible alternatives available. But large part of the extent of the changes are related to how much the cost will increase. The price for one allowance has never been higher than it is right now. The price for one Emission Union Allowance (EUA) has increased with 150% from €20 in May 2020 to €50 in May 2021 (Ember 2021). Even though the cost per EUA is reaching all-time high, the probability for the cost of the total EUAs needed for a shipping line to exceed the cost for investing in a new and more

[1] Linnea Nerman Freight Forwarder at Fortex, personal communication 26 January

efficient vessel solely thanks to the inclusion in EU ETS is considered low. This due to that there are only few operational alternatives for reducing the emissions if not investing in new technologies (Mellin et al. 2020). But as the cost for shipping lines increases there could be a risk for shipping lines on routes with low competition to be able to transfer the cost for the EUAs onto the transport buyers instead and enable a modal shift from sea to other modes of transport or hinder a modal shift from road to sea as well. Since cost and capacity are among the two most important factors when deciding how to transport the goods, all cost affecting the result may hinder the company and, with that, directly or indirectly affect the company's operational decisions.

With the conclusions from previous studies and the impact large actors within the forest industry have, pressure on the transportation system and investments may change. Therefore, it would be interesting to look at the decision processes within companies to try to find how and when the breaking point would be reached to trigger such system conversion. The breaking point may differ depending on the forest company's logistical structure or location as and thus not react dramatically to the increased price from shipping.

1.3 Purpose and research question

As previously described in the background and problem description, the forest industry has traditionally been built upon specific transport systems to transport their products from the production plants to the end customer. The forest industry has been and is highly dependent of the shipping sector to export their products with large and heavy volumes. Depending on segment and product, the willingness to pay for transport differs. With earlier studies looking at the impact of the SECA adoption and focusing on the increased cost for fuel or technological solutions, a further study looking at the effects from the inclusion of EU ETS from a shippers perspective might give further understanding of how an export intensive and high-volume industry may be affected. Therefore, the purpose of the thesis would is investigate how the Swedish forest industry would be affected by the inclusion of maritime transportation in the EU ETS. To be able to fulfil the aim of this study, interviews with represents from the forest industry are used to help answer the following research question:

***RQ**: How could the Swedish forest industry potentially be affected due to the inclusion of the maritime sector in the EU ETS?*

1.4 Scope

This thesis focuses on the forest industry and the potential impacts an inclusion of the maritime sector will have on their transport behaviour. This includes the three market segments within the forest industry: sawed wood, pulp and paper. The European Commission has announced that a review of the Emission Trading System Direction will be presented in June 2021. Before the review of the legislation, act can be accepted, there need to be negotiations with the Member States and the European Parliament. With that, how the scheme will exactly look like in the end is unknown. This study will therefore be based on the most plausible outcomes from Mellin et al (2020). Due to specific characteristics for each route, the geographical area will be limited to the Baltic Sea and the North Sea where the interviewed actors mainly operate and are relevant for EU ETS scope. There is a large part of uncertainty in how the outcome of the legislation will look. Due to the uncertainty, there is a need to do research about some of the plausible impacts the inclusion of maritime transport may have on different actors before the approval of the legislation entered into force.

2. Frame of reference

This section gives the reader a broader understanding of some of the important features for the context of which this thesis will be based on. It includes regulatory entities, the shipping industry, infrastructure, the forest industry as well as a description of possible comparisons between shipping and aviation.

2.1 Regulatory entities

2.1.1 International level

International Maritime Organization (IMO) is a forum created in 1948 under the United Nations to be able to create a regulatory framework for the shipping industry that is effective and create equal opportunities for all Member States (IMO 2019a). At the moment IMO holds 174 Member States and three associate members (IMO 2019b). As for regulating the environmental impact from the maritime sector, the International Convention for the Prevention of Pollution from Ships (MARPOL) got signed in 1973 but did not enter into force until 1983 (IMO 2019c). From that on, six different annexes have entered into force with Annex VI: Prevention of Air Pollution from Ships was the latest from 2005. Over the years, a lot of amendments have been added to the convention to combat different pressing issues related to shipping, such as sulphur in fuel and oil tank accidents (IMO 2019c)

In 2018 IMO agreed upon an initial strategy for battling the GHG related to shipping (Paris Agreement of Shipping), since the actual Paris Agreement of 2015 does not include international shipping (IMO 2019d). The initial strategy from IMO includes three main ambitions where 1) the carbon intensity of the ship needs to decline through further implementations of energy efficiency design index (EEDI) for new ships, 2) to reduce the amount of CO_2 per transport work as an average of the overall international shipping by at least 40% until 2030 and striving for 70% in 2050 with the baseline of 2008 and 3) GHG emissions from international shipping to reach maximum as soon as possible and reduce the total annual GHG emissions by at least 50% in 2050 compared to 2008 while striving for a pathway of CO_2 emission reduction with the goal of contributing to the Paris Agreement temperature goals. (IMO 2019)

Emissions and environmental consequences related to maritime has with MARPOL increased in importance. In the beginning, IMO focus on physical damage as oil spill, with the importance of airborne emissions instead. In 2018 global transportation accounted for 21% of the total emissions in the world. Of these, international shipping accounts for 10,6%. (Ritchie 2020) In 2018 global transportation accounted for 21% of the total emissions in the world (Ritchie 2020). Two thirds of the emissions from transport come from road transport, 29,4% from road freight and 45,1% from passenger transportations (Ritchie 2020). International aviation accounts for 11,6%, and international shipping accounts for 10,6% of the 21% of global emissions (Ritchie 2020). At the same time, the GHG from shipping was 2.89% of the total global emissions in 2018 (IMO 2020). Compared to 2012, that is an increase of 9,6% and the demand for further usage of shipping is increasing. Global Maritime Forum (2020) states that the shipping industry would need $1-1.4 trillion until 2050, or $50-70 billion annually for the next 20 years to decarbonise and achieve IMOs goal of a 50% reduction of emissions until 2050.

2.1.2 European Union and the EU ETS

When it comes to emissions-related to transportation within the European Union, shipping accounts for 3,5% of the total emissions. As the share of the total amount of emissions it is not much, but with the demand and usage increasing and with a forecast of 90-130% increase until 2050, the emissions could become a substantial part of EUs emissions when the work towards climate neutrality in 2050 is to be reached. (European Parliament 2019)

The EU ETS is a market-based instrument used for reducing the GHG with a “cap and trade” system. According to economic theory, the optimal cost of emitting one tonne of CO_2 is the cost of cleaning or avoid one tonne of CO_2 emitted since the reduction of emissions will happen where it is most efficient (European Commission 2015). The two main ideas of a market-based system are that the reduction in emissions will happen where it is cheapest and most effective, only to prevent high "cleaning" costs for industries where the opportunities for reducing their emissions are lower (European Commission 2021). The 'cap' is reduced over time; hence the total amount of emissions is reduced in total (European Commission 2021). The allowances used for the system needs to be allocated by companies who want the right to emit emissions related to their business. The allowances are allocated by either auction or by free allocation. This means that companies can choose to pay for the right to emit one tonne of CO_2 or reduce the GHG if it is cheaper and more profitable to invest in low-emission techniques. In 2015 the

Market Stability Reserve (MSR) was introduced as a response to a huge surplus of allowances and a very low price per EUA (Rosendahl 2019). Until 2023, 24% of the EUA surplus will be removed from the auction. From 2023 and forward 12% of the surplus will be removed.

The GHG covered in EU ETS for the various sectors are carbon dioxide (CO_2), nitrous oxide (N2O) perfluorocarbons (PFCs). Today the aviation industry is the only one included from the transport sector, where the European Commission has the ambitions to include shipping in the near future. As shown in table 1 there have previously been three phases for EU ETS with the fourth phase starting in 2021 and ending in 2030.

Key features	Phase 1 (2005–2007)	Phase 2 (2008–2012)	Phase 3 (2013–2020)
Geography	EU27	EU27 + Norway, Iceland, Liechtenstein	EU27 + Norway, Iceland, Liechtenstein Croatia from 1.1.2013 (aviation from 1.1.2014)
Sectors	Power stations and other combustion plants ≥20MW Oil refineries Coke ovens Iron and steel plants Cement clinker Glass Lime Bricks Ceramics Pulp Paper and board	Same as phase 1 plus Aviation (from 2012)	Same as phase 1 plus Aluminium Petrochemicals Aviation from 1.1.2014 (aviation from 1.1.2014) Ammonia Nitric, adipic and glyoxylic acid production CO_2 capture, transport in pipelines and geological storage of CO_2 Aviation
GHGs	CO_2	CO_2, N_2O emissions via opt-in	CO_2, N_2O, PFC from aluminium production
Cap	2058 million tCO_2	1859 million tCO_2	2084 million tCO_2 in 2013, decreasing in a linear way by 38 million tCO_2 per year

Table 1: Description of the different previous phases in EU ETS (European Commission 2015)

The fourth phase includes a lot of different adjustments to tackle the previous surplus of allowances available. A new annual reduction of the total allowances to 2.2% is implemented, instead of the previous 1.74 in phase 3. In phase 3, 57% of the EUAs were auctioned and the number will stay the same for phase 4 as it looks for now (European Commission 2021g). If a

company is not complying with EU ETS and does not have bought the right amount of allowances, a penalty of €100 (adjusted for inflation over time) per each missing allowance needs to be paid (European Commission 2015).

The emissions included in the ETS has decreased with 35% between the start in 2005 and 2019 (European Commission 2021a). In 2020, the emissions within EU ETS fell by 13.3%, where 11.2% came from stationary plants and 64.1% from aviation were the large reduction of emissions from the aviation can be explained by the COVID-19 pandemic and travel regulations (European Commission 2021h). To reach the EU targets of emission reduction in 2030, the emissions from the ETS sector needs to be cut by 43% compared to 2005 levels (European Commission 2021f). The total amount of emissions decreased within the EU was 24% until 2019, which was more than the goal of 20% reduction EU had as a previous goal until 2020 (EEA 2020). With the announcement of the Green Deal, the European Commission included a revision of EU ETS again, which will be needed for reach the reduction of the emissions needed from EU to reach climate neutrality in 2050.

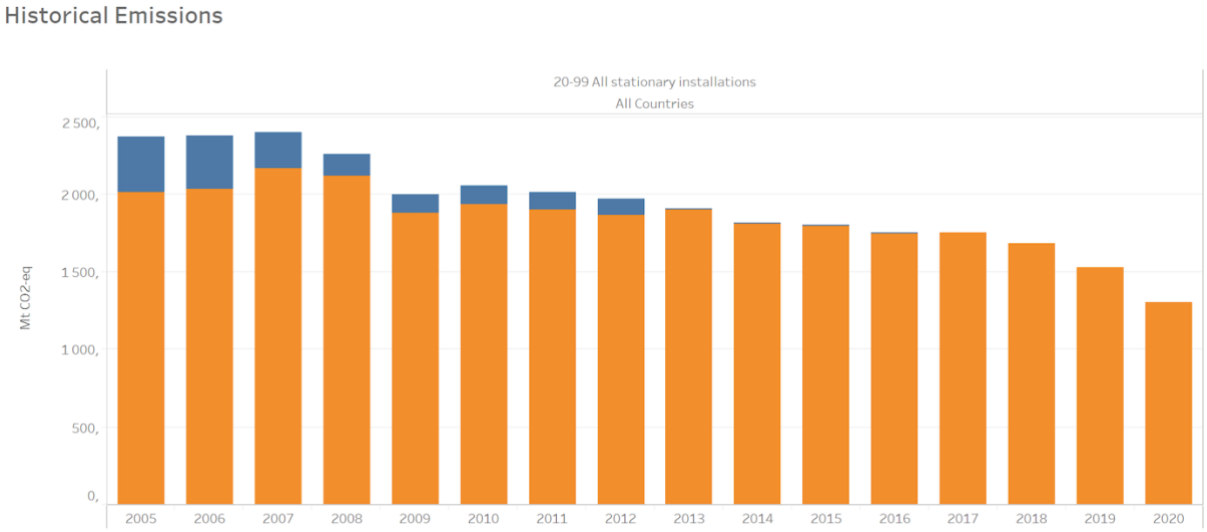

Figure 2: Historical emissions within EU ETS for all countries, all stationary installations (European Environmental Agency 2020b)

Monitoring, Reporting and Verification System

In 2015 EU adopted a new regulation as a first step of including maritime transports in the EU climate policy. The MRV system was adopted in 2015 (EU Regulation 2015/757) with first reporting period starting the 1st of January 2018. From 2018, each company operating at sea

needs to monitor, report, and verify their CO_2 emissions according to the MRV system. The regulation covers all ships arriving or sailing to an EEA port above 5000 GT. The scope is flag-neutral and applies to all flags with the demands for monitoring each voyage and reporting of fuel consumption and CO_2. Ship efficiency is declared with six different indicators related to the technical and operational efficiency, and an independent accredited verifier is needed to verify the data. The MRV covers approximately 90% of the CO_2 emissions and roughly 55% of the ships calling EEA ports (European Commission 2020). In 2019, 12281 ships reported using the MRV with a total amount of CO_2 reaching 146 million tonnes (EMSA/THETIS-MRV 2021). Additionally, in 2018 IMO Data Collection system entered into force with start on the 1st of January 2019. Therefore, the companies entering an EEA port need to both report according to the MRV system and the IMO system (European Commission 2021c). However, in the event of an international agreement on a global system for monitoring, reporting and verification system for GHG emissions, the European Commission would be required to, if appropriate, propose amendment for the MRV system applied in EEA to align with the international arrangement (European Commission 2019b).

2.2 Aviation – EU ETS and CORSIA

The aviation sector is the most appropriate comparison to the maritime sector since both are of an international character and are both excluded from international agreements such as the Paris Agreement due to the complex international supply chains and importance (Energy & Climate Intelligence Unit 2018). From the 1st of January 2012 the aviation has been included in the EU ETS (EC 2021c). From the beginning all flights arriving or departing from an EEA airport had to buy emission allowances regardless of the registration of the airline operator. With this, even non-European airline operators needed to be covered (Nava, Meleo, Cassetta & Morelli 2018). Until 2023 it continues to only include flights between airports located within EEA (EC 2021).

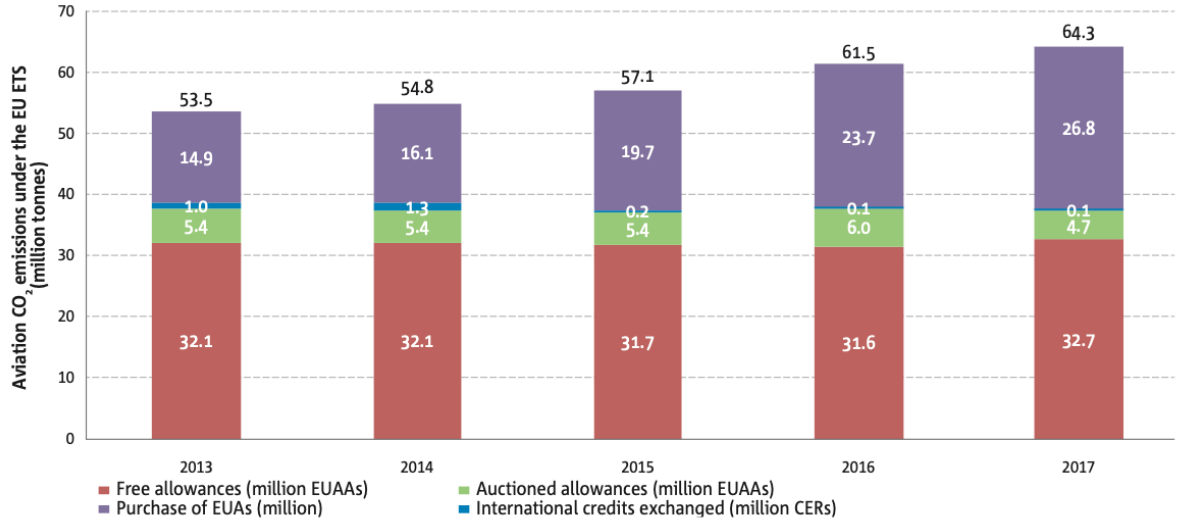

Figure 3: Aviation CO2 emissions under the EU ETS in 2013-2017 (1 EUA or EUAA equals 1 tonne of CO2) (EASA, EEA, EUROCONTROL 2019)

The layout and design for aviation looks a bit different from the other industrial sectors. The cap for emissions from aviation for the previous phase 3 (2013 to 2020) was decided by historical emissions and was set to 95% of these. The system is a semi-parallel system where the allocation and allowances are distributed by tonne-kilometre, called EU Aviation Allowance (EUAA). There have been a high number of free allocated allowances to the aviation industry. This due to the idea of carbon leakage and unfair competence for aviation lines operating within the EEA. The aviation sector in phase 3 got 82% of the EUAAs for free allocation, 15% was auctioned and 3% of the allowances were reserved for fast-growing aircraft operators and new entrances (EASA, EEA, EUROCONTROL 2019). The distribution was set for the airlines to receive 0,6422 allowances for every 1000 tonne-kilometre flown between 2012-2020 (EC 2021b). Between 2013 and 2017 the number of verified CO_2 emissions from aviation in the EU ETS increased by 4.7% per year (EASA, EEA, EUROCONTROL 2019).

In 2016 the International Civil Aviation Organization (ICAO) negotiated with their member states and agreed on a market-based solution called 'Carbon Offsetting and Regulation Scheme for International Aviation (CORSIA) (Nava et al. 2018). Within the scheme the emissions from aviation were to be allowed to increase until 2020, and the emissions from 2019 and 2020 constitutes the baseline for the baseline emissions. If an aircraft operator emits more than the baseline, they will have to buy offset credits to compensate for the amount they release over the baseline. The two first phases are voluntary, which includes a pilot phase between 2021-2023

and phase one between 2024 and 2026. From 2027 it will be mandatory to participate (ICAO 2021). In the pilot phase, all airline operators have to compensate for how the international aviation develops, and if the emissions increase with 3%, all the participants independent of size, needs to buy emission credits corresponding to the 3%. After 2023 and the start of the first phase, there will be a differentiation in how much an airline operator will need to buy emission credits partly depending on the individual emissions (Trafikanalys 2020).

The emissions from both aviation and shipping have initially been said to be solved by the two international organisations, ICAO and IMO. CORSIA could be compared to what IMO in the future might want to achieve with their 'Paris Agreement of Shipping' or IMO will have a hunch on how the future inclusion of the maritime sector might end up. The administration for the aviation sector and its allocation of free allowances is up to each member state. An aircraft operator based in the EU is assigned to the member state where the operator gets its licence, and for operators based outside the EU, they are assigned a member state where the bulk of the emissions have been made (Swedish Energy Agency 2019). When CORSIA was agreed, the aviation scheme within EU ETS came to only apply to intra-EU flights. With the similarities between the inclusion of aviation in EU ETS, CORSIA and IMO's ambitions to create a global scheme for CO_2, the shipping industry could face the same future with only intra-EEA travels that would be included in the future for shipping and then be supplemented with IMO's scheme for the rest of the voyages.

One issue mentioned with the inclusion of aviation in EU ETS relates to the competitiveness due to the additional cost airlines need to pay in comparison to airlines not operating in EEA. Nava et al. (2018) made a literature review of articles analysing profit margins, loss of market share, and reduction of growth rates related to aviation. The review shows that there might have been an effect on these areas due to the inclusion in EU ETS. The large amount of free allocated allowances and the low price in ETS, has led to cost reaching €189 million in 2017 for the aviation operators in the EU (EASA, EEA, EUROCONTROL 2019). The potential reduction from aviation relates to innovation and technological efficiency, which agrees well with the problematics shipping facing. Aviation holds relatively high barriers for entering, such as high initial costs related to inventory and shipping. Numbers from 2019 shows that emissions from aviation within the EU ETS scheme has not decreased, instead grown with 1.5% compared to 2018. It was also the only sector within EU ETS who did not decrease their emissions, as the rest of the included sectors decreased with a total of 8.9% (Transport & Environment 2020b).

One other lesson from including aviation into EU ETS was the difficulties of charging all travels entering or leaving EU. The decision received a lot of resistance at an international level as the legal aspects of the right to impose taxes outside European airspace But with ICAOs progressions regarding CORSIA, the decision to only include flights within EEA continued (Naturvårdsverket 2020).

2.3 Inclusion of maritime transport in EU ETS

2.3.1 Reducing atmospheric emissions from shipping

EU ETS is based on the concept of reducing emissions where the cost for emission abatement is lowest. According to Sims et al. (2014) the emissions from transportation in general could decrease by (1) avoiding journeys where possible, (2) modal shift towards lower-carbon systems, (3) lowering energy intensity by intensifying engine performance, increasing freight load factor and usage of new technologies and (4) reducing the carbon intensity in fuels. As supported and stated by Cullinane and Cullinane (2013), two main ways to reduce the emissions from shipping were pinpointed. These are increasing fuel efficiency and the regulating regime. The suggestion to include shipping in EU ETS is the policy way to steer the maritime sector to lower their emission without control in detail how it is being done. The largest decrease of emissions will come from fuel efficiency, a switch to other fuels or the identification and implementation of alternative propulsion methods. To be able to use less or better fuel or find other ways to propel ships, technical investments will be required (IMO 2019). Sims et al. (2014) states that decarbonising the transport sector will be more challenging than for other sectors, as the global demand of goods increases and the demand for faster transportation grows.

2.3.2 Carbon Leakage

One risk of implementing regional regulations for emission reduction is the uncertainty for carbon leakage. The term carbon leakage is used to describe the risk of businesses moving their production and activities outside of the EU, hence moving the CO_2 emissions to other countries with lower emission regulations and control (European Union 2015). To minimise the risk for that to happen, the EU has traditionally allocated free EUA to industries that hold a significant risk for doing so. In the first phases of the EU ETS the allocation of the EUAs to the different industries was based on grandfathering, historical emissions. Today the free allocation is decided upon benchmarks. Benchmarks are calculated from an average of the best 10% performances in the EU. The calculations of the benchmarks do not consider geographical

location, the size of the production plant or technologies used. The free allocation of EUAs relates to the industries with the most difficulties to reduce their emissions, hence has the highest risk of moving their emissions outside EEA (European Commission 2021r). The term carbon leakage could be used for shipping and as a move from the usage of shipping to either other transport modes with less regulations or less requirements for reducing emissions or entering the closest non-EEA port to escape the regulations. With the international character of shipping and the closeness of non-EEA ports (Great Brittan in the north and Turkey and Morocco in the Mediterranean), carbon leakage could be a real outcome. By calling a non-EEA port, the last or first leg of the voyage may shorten the distance that as a foundation for the ETS. Though, a study made by Transport & Environment (2021) shows that the risk of this might be small due to the requirements of a port of call within the MRV to be qualified as "*are the port where a ship stops to load or unload cargo or to embark or disembark passengers*" (Regulation 2015/755). The transhipment- and port cost would then act as an obstacle for shipping lines to not act like this. With a full scope (including all ships to the first EEA port) and to a cost of €50 per EUA, 15,6% of all the voyages would be tempted to change port to non-EEA port. (Transport & Environment 2021).

2.3.3 Design aspects

To be able to assert how the future impact on the shipping industry may look like various reports produced by researchers such as Mellin et al. (2020) and Transport & Environment (2021) looked at multiple factors which may impact the different scenarios for the final design of the inclusion of maritime transportation in EU ETS. Both Mellin et al. 2020 and Transport & Environment (2021) found the most probable way of measuring the emissions for the EU ETS is the MRV system. Further, they stated that future costs for the shipping industry depend heavily on the number of free allowances and the unit cost per allowance. Since the cost for the companies using maritime transports will probably be different depending on how much CO_2 the ships release per tonne-kilometre, the initiatives to lower the cost for EU ETS could be a way for shipping lines to compete with others by lowering the emissions per tonne-transported and hence lower the freight rates.

According to Mellin et al. (2020) the estimated financial outcome for the shipping industry varies between €0.2 billion and €12.5 billion. The amount depends on both the scope, the percentage of free allocations of EUAs and the price per EUA. In the study the example of €0.2 billion comes from the assumptions of €25 per EUA with only 5% of the allowances auctioned,

where €12.5 billion assumes a price of €70 per EUA and 100% of the allowances auctioned. Mellin et al. (2020) suggest that there will be free allocation for the shipping industry, as it was, and still is, for the aviation. However, this might not be the case since the European Commission with their Green Deal implies large emission cuts as well as other actors are not keen to the idea of free allocation of EUAs. With the fourth phase, the aviation sector has seen a number of reduced free allocated allowances (ICAP 2021).

The Greek and Swedish shipowner association views of an inclusion of maritime in ETS highlight a few of the main issues related to the design. The main topics of their concerns are to not only include intra-EU shipping, no free allowances allocated for the industry and to include the commercial operators as responsible actor in the system and establish a price stabilisation mechanism to reduce the administrative burden (Swedish Shipowners Association, Union of Greek Shipping & Transport and Environment 2021). The initiative indicates the shipowners desire for a larger involvement and an increased responsibility put at the shipper.

With the Commission wanting to include the maritime sector in the EU ETS, the cost per transported work will hit different for each segment within the maritime sector. Depending on the outcome, the impact on modal shift and export could range from a little or no impact to a vast impact. The parameters that could have a large impact on the shipping segment would be if no differentiation is made between the different types of vessels and shipping segment is made and the utilisation of the vessel is not considered (Mellin et. al 2020). By including maritime transports in the EU's "cap and trade" system, there will be an additional cost for the emissions and a cap on how much the total maritime sector would get to emit. It is difficult to predict the exact outcome of the European Commission's suggestion, but two things are clear with the goal, to let the shipping industry pay for their emissions as well as lower the CO_2 related to its usage.

2.4 Vessels, freight rate and modal shift

2.4.1 RoRo and RoPax

RoRo is one of the main segments used for SSS. RoRo-ships uses techniques to enable rolling units, such as vehicles, construction machinery, and goods loaded to rolling load carriers such as trucks, railway wagons, cassettes, and semi-trailers. The loading method is very useful for SSS, when there is a need for fast loading and unloading in port as well as an effective usage

of intermodal transportation (Lumsden, Stefansson & Woxenius 2019). Due to the nature of the rolling units loaded at RoRo ships, there is less utilisation of the vessel compared to comparable size of containerships. For this reason, the volume utilisation is lower and the emission per goods transported is higher than compared to containerships. RoRo can carry unaccompanied units, such as cassettes or semi-trailers. These systems often suit a large and complicated organisation that handles goods with high volume and weight (Christodoulou, Raza & Woxenius 2019). To incorporate an unaccompanied RoRo system a lot of organisational and operational changes needs to be done. Once a system is in place the incentives to change it are small (Christodoulou, Raza & Woxenius 2019). RoPax are ferries that combine both goods and passenger transports. The cargo rolls on as it does at RoRo ships and is distributed in the front and stern ramps. With the low turnover time in port, it is good for and commonly used for ferries at routes with higher speed requirements than passenger transportations. RoPax ships have the capability to unload and load cargo combined with passengers and passenger cars within 30 minutes (Lumsden, Stefansson & Woxenius 2019).

2.4.2 Containerships

Containerships were introduced in the middle of the 1900s as a natural reaction to the creation of the container. When standardised, the containers could be stacked above each other thus use the vessel more effective. Larger vessels can benefit from economies of scale, hence increase the goods loaded and fuel efficiency per tonne-km transported (Stopford 2009). Containerships built today are constructed bigger and with higher efficiency requirements. The largest vessel operating today (2021) is the HMM Algeciras with the maximum capacity of 23 964 TEU (Marine Insight 2021) with a reduction of 51% in CO_2 emissions compared to the previous generation of container vessels, thanks to a more efficient engine (International Institute of Maritime Surveying 2020).

Psaraftis and Kontovas (2009) compared the amount of emissions related to different vessels. The conclusion that can be drawn from the study is that the larger the capacity of the ship, the higher the total amount of emissions released but also the less CO_2 per tonne-km. The results show less competitiveness for smaller vessels that are normally operated in SSS in relation to the potential inclusion for maritime in EU ETS. Problems arise when larger ships are not fully loaded and with a high utilisation of space, as larger ships emit more but has a higher capacity to spread the emissions per tonne-kilometre. High utilisation of a ship creates lower emissions

per tonne-kilometre, as a low utilisation gives a high number of emissions per tonne-kilometre (Christodoulou, Raza & Woxenius 2019). Thus, a fully loaded feeder may emit less than a half-empty ULCV.

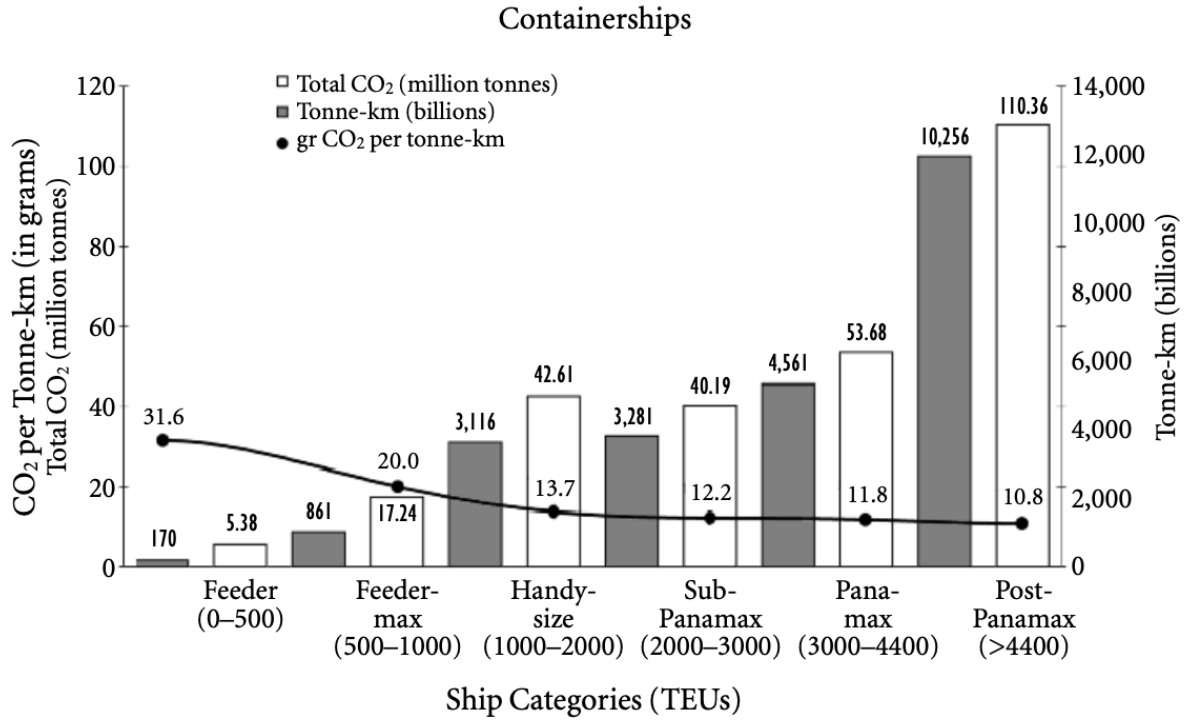

Figure 4: Amount of emissions related to different container ships (Psaraftis and Kontovas 2009)

A feeder with the capacity of ≤500 TEU can carry less than a Post-Panamax carrying 4400 or more; hence gets a higher CO_2 per tonne-kilometre transported (Psaraftis & Kontovas 2009). For RoRo the CO_2 emissions per transported work is higher as the ships' utilisation is limited due to the design.

2.4.3 Freight rates

Freight rates within the shipping industry are complex but mainly determined by supply, demand and the freight rate mechanism. According to Stopford (2009), there are five key variables for demand within the shipping industry. These are: commodity trades, average haul, political events, world economy and transport costs, where the cost of transportation holds an extra important aspect. On the supply side, there are five key variables affecting, which are: productivity, shipbuilding production, freight rates, scrapping and the world fleet. The size of the fleet available decides by the shipowners who reacts to the freight rate, which is decided by the scrapping, performance of the ships, and the number of new built ships waiting for arrival. When the freight rate is high, the supply is low, showing the shipping market to produce more

transportation. When the freight rates are low, it gives signals of a high supply of available transportation and the transport market reacts the opposite to steer the freight rate to create stability at the market (Stopford 2009).

95 % of the worlds shipping fleet runs on bunker oil (Cullinane & Cullinane 2013). As the oil price is traded on the world market and fluctuates, shipping lines have a bunker adjustment factor (BAF) to hedge towards higher oil prices. If the price for fuel increases, the cost will be transferred to the shippers. The freight rates are one of the factors which decide the choice of transportation. Capacity, speed, service and infrastructure available are also important factors.

2.4.4 Incentives for modal shift

Deep-sea shipping has little or no other competing transport modes at some routes, such as between two continents separated by sea (Rodrigue 2020), where RoRo and feeders compete against railway and road haulage (Raza, Svanberg and Wiegmans 2020). Large volumes and heavy goods from one continent overseas to another will still need to be transported by shipping. Due to the nature of SSS, other transport modes could potentially affect to what extent SSS is used.

A modal shift occurs when one mode of transport holds a comparative advantage in a similar market which the other mode of transport exists in (Rodrigues 2020). Depending on the product transported, the importance varies for different factors. The modal shift factors are cost, time, capacity, reliability, and flexibility (Rodrigue 2020). The higher the importance of a certain or few of the factors, the greater the incentives to shift from one mode of transport to another. The premisses for modal shift occur both at a macro level as well as a micro level. Regulations and other policies may affect the supply and demand of a certain mode of transport. At a micro-level individuals' preference as well as company policies may affect the modal shift. Notteboom (2011) found that the modal shift is different between the different routing alternatives available. Factors that affect the modal shift and the competitiveness are the varying degrees of SSS and truck. The change in demand of a certain mode of transportation is equal to the percentage change in demand in the price or freight rate, which means that if the price increases with a certain percentage, the demand for the service will experience a cutback with the same percentage. According to Notteboom (2011) this applies except for long-distance SSS which are in a senseless price sensitive. Notteboom and Kris Vanherle (2010) suggest the shorter distances, as the English Channel or Trelleborg-Travemünde, will stay competitive towards

“truck only” alternatives, as longer distances will see an increase competition with intermodal alternatives with as little sea leg as possible. Further Holmgren, Nikopoulou, Ramstedt and Woxenius (2014) concludes, intermodal competition may affect certain ports as increased costs for the sea leg may appear less attractive compared to rail and road haulage.

The distribution of market shares between the different transport modes in Sweden has been the same over the past years (Transportstyrelsen 2020). One explanation could be that each of the transport modes, road haulage, railway and shipping, has different pros and cons depending on the type of goods being transported. Railway and shipping have the capacity to carry large and heavy volumes of goods but is a slower choice of transport mode. Road haulage is seen as more flexible and quicker but holds lower volumes per truck as well as higher emission per tonne-kilometre. Due to their nature, shipping and railway are both dependent on a reloading and a second leg of transport, which puts further requirements on connecting transport for further transportation.

In 2018 railway stood for 24 billion tonne-kilometre and accounted for 40% of the outbound transportation of goods (Transportstyrelsen 2020). Railway becomes cost-effective in the case of longer transportations, which makes it a substitute for transportations by sea, especially inland transportation (Transportstyrelsen 2020). Even though railway theoretically is a substitute for shipping, the railway still has problems with cost, flexibility and availability. However, there are examples of projects and logistical companies investing in railway solutions where the limitations and access are limited. Feeders from Pitea in the north of Sweden are substituted by railway to Gothenburg for further transhipment to a ULCV with destination Asia. The trainset holds the capacity of 72 TEU and arrives once a week to the Port of Gothenburg. The lead time is cut by one week. The effect on the emissions is a decrease with 87% compared to the feeders according to the calculations made by IVL (APM Terminals 2021). The infrastructure at port holds an important aspect for how well the transhipment is handled. The container terminal in Gothenburg, operated by APM Terminals, created an initiative to increase the number of trains entering the terminal.

The reduction of emissions related to the transportation sector is not regulated on an EU level with common targets, which means the responsibility is on the Member States to achieve (EC 2021e). As Sweden has high set goals regarding reductions of the transport sectors' impact, Sweden is to reduce the impact from transportation with 70% compared to 2010 levels until

2030 (Sweden's Environmental Goals 2020). For the EU, 21% of the total emissions are related to road transport (EC 2021d); thus, a large reduction of the total emissions could be done by reducing the road transportation. According to Stelling, Woxenius, Lammgård, Petersson and Christodoulou (2019), a shift from road to sea may have a large impact on the emissions from heavy transports in Sweden. The report investigates goods transported via Skåne (Scania), where a shift from road to sea could reduce the CO_2 emissions from heavy transports with 4-11%. It would therefore be in both Sweden's and the EU's interest to facilitate a modal shift towards less emission intense transportation modes. But it is not as easy as to switch mode of transport. Styhre, Rogerson, Santén and Green (2019) identifies three main areas that hinder a modal shift from road haulage to sea from a transport buyer perspective. 1) it is not a prioritised issue to actively work with the modal shift, 2) it lacks knowledge regarding shipping solutions and 3) there is a lack of collaboration between actors. Previous research made by Trafikanalys (2016) and Lindgren and Vierth (2017) also shows aversion from transport buyers' perspective against changing their existing transport solution. The aversion against the change of mode of transport could become higher with the knowledge of certain regulations for sea transport.

2.5 Transport infrastructure

Infrastructure is the backbone that enables transport systems to exist and interconnect with different modes of transports. There is a distinction between companies' internal infrastructure, which consists of warehouses and terminals, for example, and external infrastructure, such as railways, roads, ports, and airports. The rail network in Sweden consists of approximately 15 600 km of rail and stretches from the north down to the south where Denmark's rail network takes over (Trafikverket 2019). When it comes to shipping there are different segments. The different segments can be divided into bulk, liner and specialised shipping (Stopford 2009). There is bulk cargo fleet, specialised cargo fleet and general cargo fleet. In the general cargo fleet we find container ships, RoRo and MPP. These are the most used when transporting forestry products (Christodoulou & Kappelin 2020), even though a small part is bulk cargo (Martiala 2017).

Port terminals holds There are many different alternatives for the forest industry today to export their products. Not all ports have the capacity to handle all the different vessels, but it depends on what kind of terminals are available. For example, Ultra Large Container Vessels (ULCV) most commonly used for deep-sea has the capacity of handling more than 14 501 TEU are too

big for certain ports and therefore the usage of feeders, smaller containerships that transport containers from smaller regional ports to larger hubs, the feeders "feed" the large containers, hence the name (Lumsden, Stefansson & Woxenius 2019).

For transportation with RoRo and RoPax the alternatives with substantial numbers handled per port are the alternatives found in appendix 1. With smaller ports, it is easy for users of maritime transport to become a large actor and hence larger negotiation power. But the choice of port depends on many factors (Torgersson & Ivarsson 2012). In a logistical chain, the ports are one of the infrastructures that enables transportation. Depending on what is being shipped, the infrastructure in port, the vicinity for the start destination and destinations available in that port, different options are available. The Port of Gothenburg is the largest container port in Sweden, followed by the Port of Helsingborg and the Port of Gävle. The largest port handling RoRo units are the Port of Trelleborg in the south of Sweden, followed by the Port of Gothenburg and the Port of Helsingborg. Freedom and flexibility could outshine the benefits of allocating to larger port with set infrastructure and specialised knowledge, due to flexibility in cheaper port fees, closer distances with train from production plant or less congestion in transit in the port area (Woxenius 2012). Depending on which system used by the company, direct call or feeder, or strategy, the number of available ports differs.

2.5.1 Direct call versus feeder system

Depending on the size and capacity in infrastructure, different ports and systems are appropriate to use. There are two main ways for containers to reach ports with the use of ships. These two systems are 'direct call' or 'feeder system'. For a feeder system, the feeders transport goods from or to smaller harbours for transhipment to larger vessels in the continent (Schøyen & Bråthen 2015). The system goes both ways which means both import and export are handled this way. Direct call refers to the ability of having the ship on a direct route towards the end destination, as it goes from port of origin to port of destination. Port of Gothenburg, as it is today, is the only port that has direct calls in Sweden and has previously been the only Swedish port capable of handling ULCV (Port of Gothenburg n.d.). There are many aspects to consider when choosing a direct call or feeder system. Found in Torgersson and Ivarsson (2012), aspects as the company's vision, strategy or policy could affect the choice of system. Other parameters are available departures, location, cost for transportation, transport time and environmental aspects.

According to calculations made by Jensen and Bergqvist (2006), the additional cost for using feeder versus direct call would be as seen in Table 3. The table shows the additional cost for choosing transportation with the feeder system instead of direct call. Looking at the Far East example, moving one container with a feeder system would cost €355, and with direct call system the cost as stated here would be €183. The numbers are assumptions made by the authors in 2005, which indicates that new assumptions should be made to create a more accurate picture of the potential cost savings. Also, by adding different types of ships with other specifications for available capacity, operational cost, capital cost, voyage cost and material handling costs in combination with more than one operator; the total cost and revenue would look profoundly different.

Destination	**Flow of containers in 2005**		**Cost per year**		**Additional cost for Feeder**	**Additional cost per TEU**
	TEU/year	**TEU/week**	**Feeder**	**Direct**		
Far East	150000	2885	€5 332 526	€27 522 782	€ 25 802 481	€ 172
USA/Canada	60000	1154	€26 246 983	€16 690 853	€ 9 556 130	€ 159
Total	210000	4038	€79 572 246	€44 213 635	€ 35 358 611	€ 168

Table 2: Additional cost for feeder system compared to direct call (Jensen and Bergqvist 2006).

2.6 Swedish forest industry

Sweden is the fifth largest exporter of sawed wood, paper and pulp, as most of what is produced in Sweden is exported. The industry of pulp, paper and sawed timber is Sweden's third-largest export-category with an export value of 135,2 billion SEK in 2020 where the paper and cardboard product segment accounts for the largest part of exported value. Approximately 70% of the finished goods from the forest industry are exported by sea down to the continent and UK. Sweden accounts for approximately 6,4% of the pulp export and 8,1% for paper export. In 2019, the global production reached 413 million tonnes of paper and 184 million tonnes of pulp. (The Swedish Forest Industries Federation 2021o)

2020	**Sawed wood products**	**Paper and cardboard**	**Pulp**	
			Total	*Of which market*
Production	18,5 million m^3	9,3 million tonnes	12 million tonnes	4,8 million tonnes
Export, volume	14,1 million m^3	8,6 million tonnes		4,2 million tonnes
Export, value	31,5 billion SEK	80,4 billion SEK		23,3 billion SEK

Table 3: Production of different forest segments (The Swedish Forest Industries Federation 2021h)

The forest industry is a multifaceted industry with many different possible uses, as the whole tree is used for different areas. See figure 5 for an illustration of the overarching picture of how the raw material from the forest is used. Even though some parts of the industry have seen an increase in export, the export value is not as high due to that the export price in Swedish kronor fell by about 5%, which was largely due to the strengthening of the krona's exchange rate. (The Swedish Forest Industries Federation 2021h)

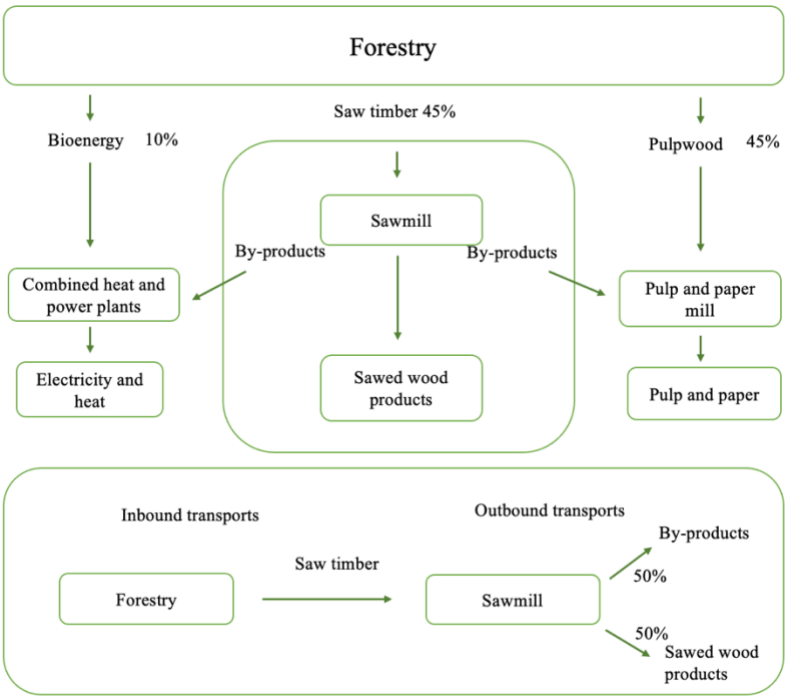

Figure 5: Usage of the forest (PWC 2017)

The Swedish forest industry is categorised by few but large actors, such as Stora Enso, SCA, BillerudKorsnäs, Holmen and Södra. These actors own their own forest to a large extent and have their production plants located in the vicinity of the forest and the raw material.

Company	**Turnover (mSEK)**	**Geographical location**	**Production capacity in Sweden (tonnes)**
SCA	19 591	North of Sweden	Pulp: 1 000 000 Paper: 850 000 Sawed wood: 2 189 000 m^3

Södra	20 351	South of Sweden	Pulp: 1 900 000
Martinsons	1 900	North of Sweden	(no information)
Holmen	16 959	Middle of Sweden	(no information)
Metsä Board	6 692	North of Sweden	Board: 650 000 Pulp: 730 000
Swedpaper	590	Middle of Sweden	Paper: 75 000
BillerudKorsnäs	25 400	Middle of Sweden (One production plant in the North of Sweden)	Board and paper: 3 165 000

Table 4: Turnover and production of the forest companies in the study

Over the last couple of years, many large actors have decided to close down a few of their production plants. Just recently Stora Enso announced the closure of two paper plants, Kvarnsvedens mill in Borlänge and Veitsiluoto mill in Kemi (Stora Enso 2021). With the two closures, Stora Enso decreased its production of paper capacity by 35%, to 2.6 million tonnes. SCA closed the paper machine used in Ortviken to reinvest at the location and redirect its production towards chemically pre-treated thermomechanical pulp production (SCA 2021b). The common area related to the two large companies' decisions are the need for a new strategy when the demand for paper decreases. The decreased demand for graphic paper compensates with a higher demand for cardboard and sack kraft paper (The Swedish Forest Industries Federation 2021h), which correlates to the strategical closures and reinvestments in new production machines.

The forest companies producing facilities are already a part of the EU ETS system, which requires production plants to buy allowances for the prognosed emissions related to the production. Compared with emissions from 2019 and 2020, the paper- and pulp industry decreased their emissions with 11% and accounts for 4% of the Swedish emissions within EU ETS (Naturvårdsverket 2021).

2.6.1 Product segments

As mentioned before, there are three main segments within the forest industry. These are sawed wood, paper and pulp. The price for roundwood depends on what region (North, Middle or South) in Sweden and if the wood cutting is done by the landowner or a forest company. Figure

6 shows the average prices in Sweden between 2010 and 2020. As shown in the figure, pulpwood gives much lower reimbursement than sawlogs.

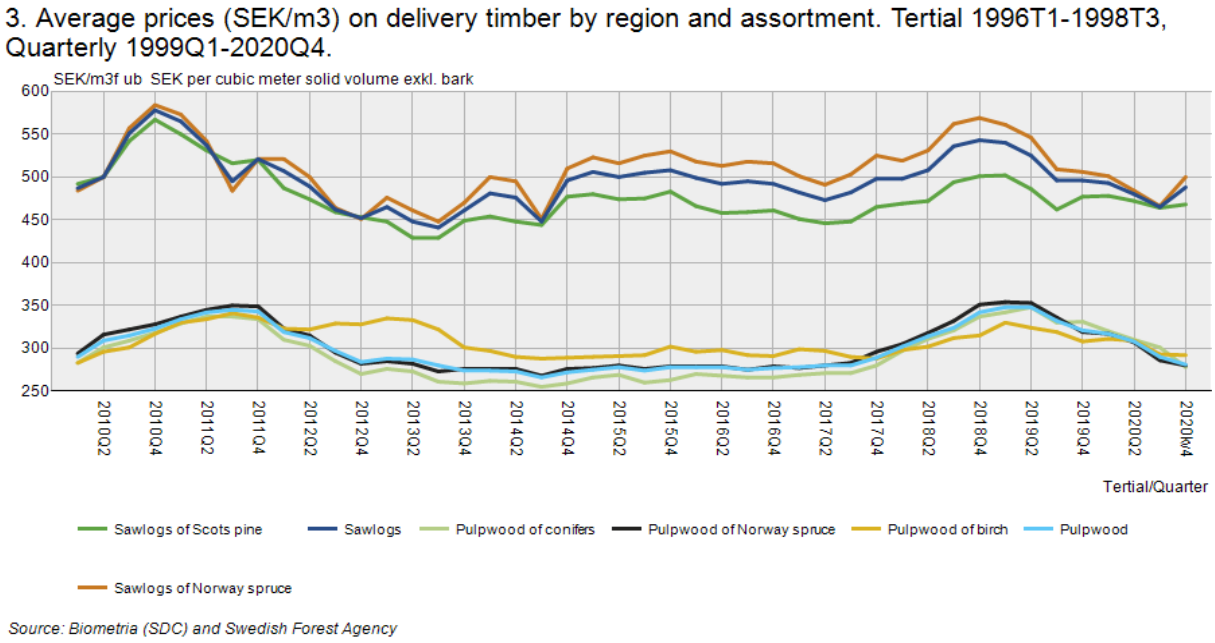

Figure 6: Average prices (SEK/m^3) on delivery timber by region and assortment (The Swedish Forest Agency 2021)

Sawed Wood Products

Sweden is the third-largest exporter of sawed wood products. In 2019 the forest industry produced 18.3 million m³ and exported two thirds of the amount. From the 1970s, the number of sawmills has decreased while at the same time, the amount of sawed wood products has increased. This shows that companies rather reinvest in a few existing sawmills to be able to capture economies of scale. The 10 largest companies within the segment account for 60% of the total production. (The Swedish Forest Industries Federation 2021e)

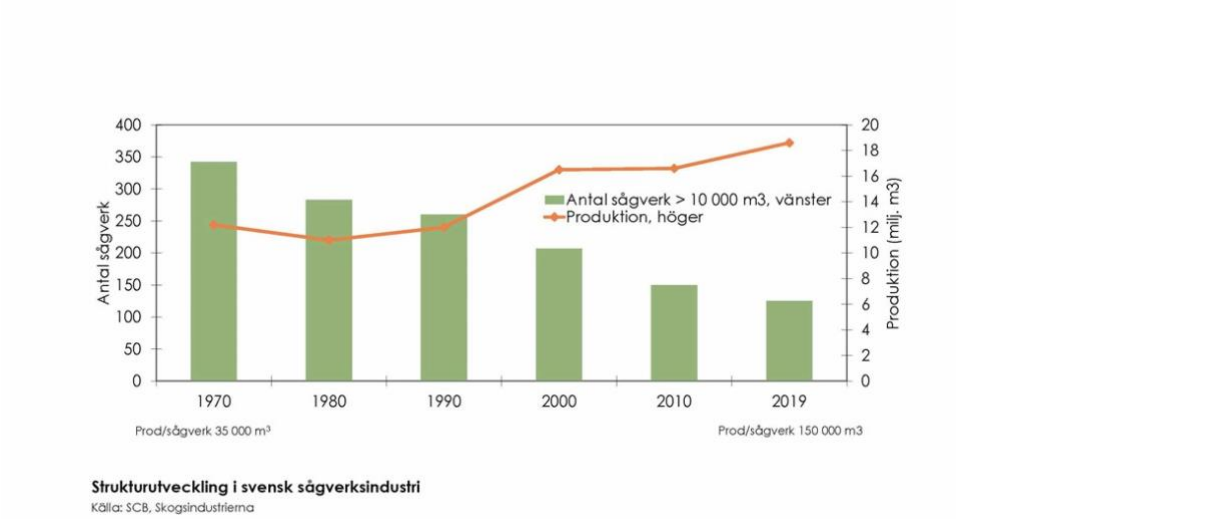

Figure 7: The structural development in the Swedish sawmill industry. Number of sawmills > at the left scale and production in million m^3 at the right scale (The Swedish Forest Industries Federation 2021e)

During 2020 there has been a decreased production of sawed wood as a consequence to the pandemic and uncertainties in the demand in the world market. With a pick-up of the USA and Great Britain demand, the price for sawed wood has increased, and the export value for sawed products is high (The Swedish Forest Industries Federation 2021h).

Sawed and planed	**(1000 m^3)**	**Change compared to last year**
Sweden	5259	-5%
Great Britain	2631	5%
Germany	908	22%
Norway	1053	7%
Denmark	979	21%
Netherlands	1058	16%
The rest of Europe	1702	
Total Export Europe	8332	12%
Egypt	1360	-1%
Algeria	374	-5%
The rest of Africa	539	
Total export Africa	2273	-5%
Total Export Middle East	557	10%
China	853	9%
Japan	803	6%
The rest of East Asia	371	
Total Export Asia	2027	8%
USA	845	76%
Other	70	
Total Export	14104	11%

Table 5: Deliveries of wood products in 2020 (The Swedish Forest Industries Federation 2021h)

Looking at the transportation costs for sawed products, PwC (2017) analysed three different sawmills and their total cost of transportation. According to the study, the average cost in percentage was 20,5% when SCB estimated the cost for transport was 6%. The difference between the two numbers depend on that SCB did not include the customers cost of

transportation and the trading houses, which shows a large amount of products being exported via other trade channels.

Pulp Production

In 2020 the pulp production reached 12 million tonnes. 60% of the amount is used in Sweden for the own production of paper and cardboard. The other 40% pulp produced are sold as 'market pulp'. Of these 40% market pulp, 90% goes for export, mainly to Europe (64%) and Asia (28%). In 2020 the export of market pulp reached to 4.3 million tonnes which means 0,5 million tonnes of market pulp is sold within Sweden. China is the single largest market for Swedish pulp and accounted for 1,2 million tonnes. (The Swedish Forest Industries Federation 2021h)

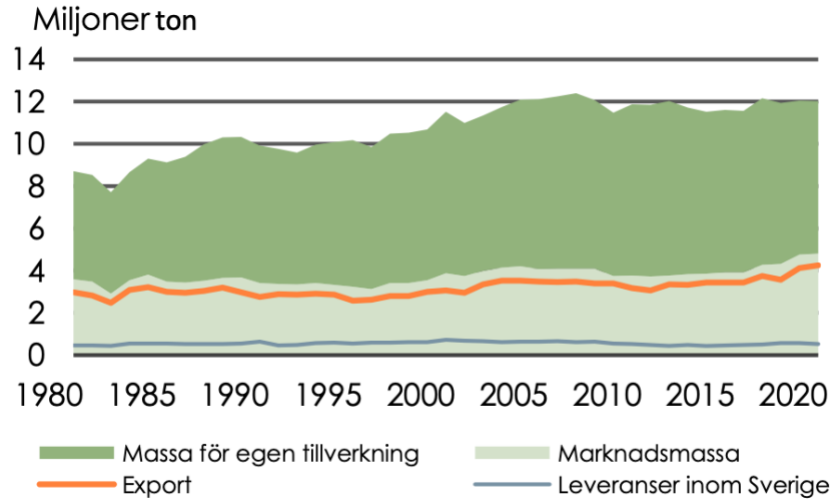

Figure 8: The Division of pulp. Pulp for own production, Market pulp, export and deliveries within Sweden in Million tonnes (The Swedish Forest Industries Federation 2021h)

The demand for pulp is driven by the demand for paper and cardboard. There are two different pulps, chemical- and mechanical pulp. The chemical pulp is used for producing cardboard, and the mechanical pulp is used for paper, hence when the demand for paper decreases, the demand for mechanical pulp does as well. The demand for chemical pulp increased with 2% as mechanical pulp decreased by 7%. (The Swedish Forest Industries Association 2021h)

Paper Production

The production of paper reached 9.3 million tonnes in 2020 of which 90% of that was exported. The largest part of that was exported to Europe (72%) and Asia (16%). Paper production is

divided into two main categories, graphical paper such as printing paper and newsprint, and packaging material which includes paperboard for packaging, wrapping paper and corrugated material. (The Swedish Forest Industries Federation 2021g)

1000 tonnes	**Production**	**Change compared to last year**	
		1000 tonnes	*%*
Newspaper	707	-182	-20,5
Wood-free printing paper	670	-77	-10,3
Wood-containing printing paper	1409	-209	-12,9
Graphic paper	2786	-468	-14,2
Tissue	356	0	-0,2
Packaging paper	924	-6	-0,6
Corrugated cardboard material	2179	68	3,2
Cardboard packaging	3034	130	4,4
Packaging material	6137	192	3,2
Other paper	54	-7	-11
Total Paper and bard board	9333	-283	-2,9

Table 6: Production of paper and cardboard in 2020 (The Swedish Forest Industries Association 2021h)

The largest part consists of paperboard for packaging and is an increasing share of the total production in Sweden. Since the 1960s, there has been a structural transformation where the number of paper production plants has decreased where the total amount of production has increased (The Swedish Forest Industries Federation 2021g). The paper market has seen a lot of challenges and changes, especially for graphic paper, wherein 2013 a lot of paper mills shut down their production due to decreased demand. Graphical paper accounts for 30% of the total paper deliveries. The demand for graphical paper has decreased since 2007, and in 2020 the demand declined with almost 15%. As mentioned before, the trend continues where large paper mills close and the demand for graphical paper decreases. Instead, the demand for packaging materials increased with 5% in 2020 and accounts for 66% of the total deliveries of the paper production. The increased demand is partly due to an increased e-commerce and disposable items.

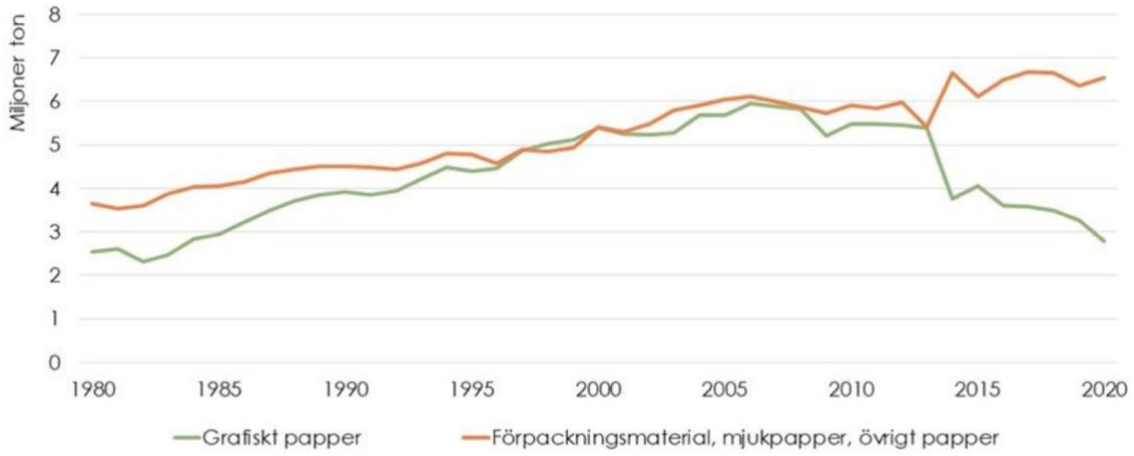

Figure 9: Paper production 1980-2020. Graphical paper and packaging material, tissue, other paper (The Swedish Forest Industries Federation 2021)

2.6.2 Transportation in the Swedish Forest industry

As previously mentioned, the forest industry is the largest buyer of transport services with 25 billion SEK annually (The Swedish Forest Industries Federation 2021b). The cost for transportation accounts for 10 to 20 % of the value of the goods depending on the product segment and market (The Swedish Forest Industries Federation 2021h) and approximately 80% of the products within the forest industry are being exported (The Swedish Forest Industries Federation 2021). The industry is heavily dependent on transports, as it requires transportation from the collection of roundwood in the forest to the mills, and the finished goods from the mills to the customers and markets around the world.

For domestic transportations, road haulage and railway dominate (The Swedish Forest Industries Federation 2021m). The most common way of handling the transportation for these companies are with multimodal transport systems. This in order to fulfil their needs and keep the structure flexible with a high level of technological openness. The systems are often a combination of rail and truck within Sweden, and RoRo or feeders to reach the continent. For SSS, feeders and RoRo is the most common used ships. The RoRo segment accounts for 22% of the maritime segments in Sweden, with the Swedish forest industry as one of the largest actors using the segment (Christodoulou & Kappelin 2020). Companies often either operate the vessels within their own transport system or they outsource the operations. The vessels are most commonly built for the purpose of transporting goods with the special requirements the forest industry need (Christodoulou & Kappelin 2020).

Depending on the forest product and company, there are different ways to transport the forest products. The main ways are depending on the company's strategy. It could be either in SECU, cassettes, containers, break-bulk or bulk. For containers, the two most common are 20 TEU and 40 TEU and can both be used by trucks, trains, loaded on container ships or roll-on RoRo. SECU is a special designed container created by Stora Enso and has the capacity of 80 tonnes, specialised built for intermodal transportation (Samverkansområdet Transporter 2004). Cassettes are unaccompanied and used to load goods where they are spun to the cassette and can carry the capacity up to 80 tonnes. There has been an increase of the usage of unaccompanied semi-trailers and cassettes over the last years (Stelling et al. 2019).

Figure 10: Division between different transport modes for export. Amount measured in million tonnes (The Swedish Forest Industries Federation 2018).

The transportation chain for each route is complicated and complex, mostly driven by large shippers. According to Christodoulou, Raza & Woxenius (2019) is most often the shippers engagement that creates and sustain high loading frequencies at routes of their interest. Stora Enso chose to outsource the vessel operations to SOL, which created a new single-purpose company working with Stora Enso. In turn, Stora Enso sold the empty spaces to third parties via SOL but still was the owner of the charter contract. This set-up was only applied to one route. This way of setting up the transportation system for forest companies are decreasing and are transforming the way forest companies think about shipping.

The largest potential for transfer between transport modes within the forest industry is found for pulp, recycled paper and wastepaper (Trafikverket 2015). There is little usage of RoPax within the forest industry where the main ships used are RoRo and containerships (feeders) for the connection to the continent. Well at the continent there are transhipments from other transport modes to containers for further transport to other continents. According to Christodoulou, Raza and Woxenius (2019), large shippers and ship operators could realise the advantages in cooperation regarding the transport chain. With an increased intermodal integration, collaborations between cargo owners, freight forwarders, and ship operators become more important. It could reduce emissions and costs, shorter lead time, and, hence, a more efficient system.

3. Methodology

The following chapter will describe the methodology of the study by presenting the research strategy related to qualitative data, the collection of data as well as the study participants and the scenarios used as a discussion material for the interviews.

The overall aim of this master thesis is to increase an understanding how different actors within the forest industry in Sweden could be affected from an inclusion in EU ETS and what effects this may have on the Swedish transport system. As an understudied field of research, a deeper understanding of how companies located in Sweden and the transport system itself may be affected, the perceived reality of the concerned parties needs to be investigated. Due to this reason, the most suitable research design would be to conduct qualitative in-depth interviews with representatives from the forest industries since this qualitative approach would allow to get a deeper understanding and interpretation of how different processes and phenomenon's are affected in the context they occur in "the real world" (see e.g. Bryman & Bell 2011: Justesen and Mik-Meyer 2011) and thus allowing to construct hypotheses that can be used to explain these patterns. In this chapter, the study's methodology and research design will be explained and motivated.

3.1 Literature review

In a first step and in order to plan for the study a literature review was made to create an understanding for the problem and the research field chosen for the thesis. The literature used in this thesis is academical sources such as books, articles but also non-academic texts such as information from websites. The literature used has been chosen to create legitimacy for the research and research question, put the research in a context, and create a structured approach and legitimacy to the interview guide.

The collection phase included searches on 'Google Scholar' and Gothenburg University Library 'Supersök'. Key words related to the research have been used to create a systematic literature search. Words used for the literature search have been: *EU ETS; shipping; aviation EU ETS; forest industry Sweden; forest industry and shipping; feeders; container; transport system; carbon leakage; voyage costs; RoRo; Short Sea Shipping; transportation cost shipping, modal*

shift. These words have then been combined and with synonyms to get a grasp of the variety of literature available. The literature has mainly been delimited to the Baltic- and North Sea due to certain characteristics for RoRo as well as feeders within the shipping segment. Another delimitation relates to possible comparable industries where previous research limited to aviation has been done.

3.2 Sample and interviews

The chosen forest companies were selected based on their location in Sweden, what they produced in that area, and export a lot of their finished products. The study participants interviewed were representatives from these companies of the Swedish Forest Industries' Federation, representatives from forest companies within the pulp and paper sector, and one shipping line mainly focused on transportation for the forest industry. Within this study, 12 study participants were asked to participate in the study and nine chose to do so. Of these nine individuals seven where from the forest industry, one from the shipping line industry and one representing the forest industry as a whole. The companies that have been a part of this study are: *Wallenius-SOL, SCA, Södra, Holmen, Metsä Board, Swedpaper, BillerudKorsnäs* and *Martinsons*. Wallenius-SOL was chosen as a strong shipping line collaborator with the forest industry at the northeast side of Sweden and have had a long partnership with the forest company Stora Enso. By adding the view of a shipping line with strong connections to the forest industry, other points of contact were hoped to be found. The criteria for being considered for the study were a large share of export, some usage of shipping and production in Sweden. Table 6 gives a summary of the study participants.

Company	**Main production**	**Name of the respondent**	**Role at the company**	**Date**	**Duration**
Wallenius-SOL	Shipping line	Ragnar Johansson	Managing Director	29/3	60 min
Swedish Forest Industries Federation	Represent of the Swedish paper-pulp and woodworking industries	Karolina Boholm	Head of Transport Policy	26/3	65 min
SCA	Wood, pulp, kraft paper	Peter Eriksson	Sustainability & Logistics Manager	9/4	63 min
Södra	Pulp	Anders Ripström	Purchasing Manager for Logistics and Transport	26/4	63 min

					70 min
Metsä Board	Board and pulp	Peter Strömberg	Head of Logistics	20/4	
Swedpaper	Sack and kraft paper	Jim Karlsson	Warehouse & Logistics Manager	19/4	36 min
Martinsons	Sawed wood	Niklas Wiggh	Product Manager Sawed Wood for Bygdsiljum & Kroksjön Sawmills	21/4	37 min
Holmen Paper	Paper	Thomas Samson	Logistics Development & Purchasing Manager	22/3	60 min
BillerudKorsnäs	Board and paper	Daniel Larsson	Senior Logistics Ocean Manager	27/4	35 min

Table 7: Description of all interviews in the study

The in-depth interviews have been semi-structured with an overarching interview guide, constructed based on earlier research as current theoretical developments (see chapter two frame of reference) written towards each interview group. Questions included in the interview guide are found in appendix 2. According to Bryman and Bell (2011), semi-structured interviews are more open than structured interviews, giving the interviewer the possibility to follow interesting questions that occurred during the interview. Semi-structured interviews are also mainly categorized by themes that the researcher can refer to during the interview but are left open to decide when each theme and question should be asked. This gives the researcher (as well as the study participants) the freedom to choose the order of themes depending on how the interview proceeds. Taken together, the usage of semi-structured interviews made the proceedings more dynamic which is more suitable for research that is underdeveloped. The interviews have all been done via digital meeting setups due to the pandemic. As one can expect, there were several problems by conducting interviews digitally, primarily the ability to build a natural and social contact with the study participants as well as my ability as a researcher to read the body language and other "silent signals". However, to encore that the interviews had been conducted satisfactory, I asked the participants at the end of the interview whether or not I had missed something during our discussions. Furthermore, I have let the study participants review my analyses of their interviews to ensure that I haven't misinterpreted their statements or made any errors. Lastly, I want to highlight that there are many benefits in conducting interviews digitally. For example, it was easier for us to coordinate the interviews and let the study participants conduct the interview during a time and setting that suited them.

As there have been a multitude of different actors within this study, different interview guides have been used for each industry. This to be able to capture each of the characterized issues related to the shipping industry. The interview guide can be found in appendix 2. As mentioned, the themes for the semi-structured in-depth interviews are based on the literature review and information gathered from the meeting with Karolina Boholm at The Swedish Forest Industries Federation as well as an expert, Anna Mellin from IVL which is one of the researchers in the pre-study Mellin et al. (2020). The themes for the interviews were: *Background – how the current logistical system emphasising the maritime transport, Shipping as the mode of transport, Green transportations* and *EU ETS and the two scenarios*. The two scenarios where only presented for the forest companies, except SCA. This decision to present the scenarios for the forest companies except SCA was to concretize the potential impact of the additional costs related to an inclusion in EU ETS. SCA holds their own logistical company where a part of the business strategy is to sell transport to third party customers. To make it more illustrative and accurate, I the chose to give SCA calculations of their actual emissions from the ships they use. The decision for the two scenarios will be further explained in the next section, where the result of the calculations will be presented in chapter 4.

3.2.1 Scenarios for interviews

The two scenarios have mainly been based on the research made by Mellin et al. (2020). As earlier described, the most plausible setup the inclusion would follow the reporting according to MRV system. The regulation includes all ships over 5000 GT which are loading or unloading passengers or cargo in a port found in the EEA to monitor and report their CO_2 emissions as well as other relevant information (European Commission 2021f). The most plausible is that the shipping lines will be the regulatory entity responsible for reporting accurately (Mellin et. al. 2020). Since the European Commission has not yet presented any suggestions for how the legislation will look, I wanted the scenarios to be as easy to grasp as possible. This means that in the two different scenarios presented, I have calculated with everything else equal and simplifications have been made. It connotes that for the scenarios each company has their own actual transporting costs to relate the surcharges to. I have only looked at the numbers reported CO_2 for transport work per n mile in the MRV system, compared the distance from nine different ports in Sweden to four ports at the continent and I have only looked at different RoRo ships as it is the most common used by the forest industry (Christodoulou & Kappelin 2020).

I have overlooked other aspects that affect the cost for shipping, such as fairway fees, port charges, taxation, pilotage and the cost for bunker when developed the scenarios. It is not that they are out of importance, but it would have created too complex scenarios based on assumptions which are specific for route and ship used. The premisses for the outcomes are as previously mentioned, highly dependable on the type of ship used (container, RoRo), emission levels and the utilization of the ship. The ports used for the scenarios in Sweden are Husum, Gävle, Gothenburg, Karlshamn, Stockholm, Norrkoping, Skelleftea, Trelleborg, Oxelösund. The ports used at the continent are Kiel, Zeebrügge, Rotterdam and Sheerness. During the research before the interviews with the companies, these ports came to be found as frequent usage by the forest companies. The ports chosen also represents a diversity in geographical location in Sweden.

3.3 Data analysis

The data analysis followed Braun and Clarke (2006) five step analysis. In the first step, after the qualitative interview data had been transcribed, the analysis started with initial read-through of the data material. In the second step, an additional reading focused on recurring themes to find initial patterns followed by the third step, an initial categorization of themes, and a further processing of the themes. In the fourth step, the empirical data was re-described using theoretical concepts. The fifth step included reflection based on the results, in related to the literature.

The choice of research method reflects the systematic approach which the researcher finds information about the subject studied. Deductive study starts at looking at the theory to be able to set up hypotheses which the research will reject or not. Inductive theory starts with observation and from that, the theory is chosen (Bryman & Bell 2011). An alternative to both deductive and inductive theory is what Dubois and Gadde (2002) calls ‘systematic combining’, an abductive approach to research. The idea of systematic combining is that the process of research is shifting between the theoretical framework, the empirical work and case analysis is done concurrently (Dubois and Gadde 2002). An abductive approach starts with a problem or a "surprise" that needs to be explained. The abductive approach sees to solve the problems inductive and deductive approaches each has within research. It is not limited by the deductive logical conclusions and hypothesis and the inductive limitations of relying too much on the

empirical information to create theory (Bryman & Bell 2011). An abductive approach goes back and forth between the researcher's perceived knowledge and the data accompanied. For the study, I used a primarily abductive yet flexible coding process that drew on existing theory and literature. However, as explained these themes were changed, eliminated, and supplemented with new themes during the process until every piece of text was coded in a suitable way. In this way, themes were treated as a way to reformulate the existing model or theory from which they were drawn. The final stage of the analysis, retroduction, focuses on causal mechanisms and conditions. The goal of retroduction is to identify the necessary contextual conditions for a particular mechanism to take effect and to potentially explain empirical trends observed. To say, identify potential factors and develop hypotheses of how an inclusion of shipping in EU ETS and its effects on the Swedish forest companies.

3.4 Study limitations

As in all research, methodological limitations must be acknowledged. This current research data has the same limitations as qualitative data in general – importantly width generalizability. The study only includes Swedish companies and their production in Sweden. Due to limitations in both time and capacity, a majority of the forest companies have not had the opportunity to be heard. Further studies with other forest companies could highlight other issues related to transportation and shipping. Since many of the companies have production in other countries as well, the study cannot be generalized to these due to the certain transport systems and locations of production facilities in each country. But since the study includes a few of the largest actors within the Swedish sector, this could give a certain indication for the potential direction. How and what kind of transportation is used differs from production plant to another, which makes impact of a certain regulation to hit differently for each company and each segment within the forest company's production. I have strived to interview persons in charge of the company's transport structure, persons with the ability to take decisions related to how transportation is being done, and knowledge of the overall strategy.

As briefly discussed earlier, different factors may have affected the quality of the interviews. Mainly that the interviews had to be conducted digitally, that the study participants are, at an individual level, not fully anonymous, my lack of experience in conducting interviews and such as being a master student, reflects with the interviewed study participants – however, none of these factors are unique for this study but common in qualitative research.

3.4.1 Trustworthiness and authenticity

According to Bryman and Bell (2011), reliability and validity are two key criteria when it comes to quantitative research. Validity is related to how well the researcher actually measures what she intends to measure. Reliability includes how well the research can be replicated. Since it can be hard to fit qualitative research with quantitative criteria's, Lincoln and Guba (1985) presents two main criteria for qualitative research: *trustworthiness* and *authenticity*. Trustworthiness includes four sub-criteria which are*: credibility*, *transferability*, *dependability* and *confirmability*. Credibility emphasises the importance of respondent validation, were the researcher sends back the result of the research to the persons included to ensure that the researcher has perceived the information correctly. Transferability refers to how well the research can be transferred to other contexts than the described one. Therefore, the researcher needs to describe the context where the research is made to ensure the criteria. According to Lincoln and Guba (1985), the third sub-criteria within trustworthiness is dependability and refers to a description of how the research has been conducted. To fulfil this criterion, the researcher needs to fully disclose how the research has been conducted. According to Lincoln and Guba (1985), the last sub-criteria are confirmability, which refers to the researchers acting in good faith and not knowingly letting their personal values affect the research. Since researchers are social beings that act under social context, it is hard to completely act outside their personal values.

The second main criteria of Lincoln and Guba (1985) includes authenticity which implies a larger discussion regarding the research in general, such as if the research gives an equitable picture of the subject or area. To ensure the research is being done within the ethics, the findings have been sent to each of the respondents to ensure that I have perceived them correctly. The investigated context has been described earlier in this chapter to ensure a clear image of the study's focus. Both to ensure future research on the topic and subject as well as for the reader to understand important contextual parameters. I have tried to be as objective as possible with the ambition to interpret the respondents related to the known knowledge existing.

4. Findings and analysis

This section will present both the result from the interviews and the calculations, as well as the analysis integrated. The findings and analysis will be divided into three main sections with a number of sub-chapters which was found during the interviews. In the first part the attitude towards greener transportation will be discussed as a first issue related to the potential consequences for the forest companies. In the second part, the two scenarios will be presented and discussed from a cost perspective. The third part raises issues found during the interviews as potential impacts the inclusion may have on the forest companies.

4.1 Greener and fossil free transports

The question comes down to whether the shipping lines and the forest companies are prepared to pay the extra cost it takes to lower the emissions from their transports, both within Sweden as well as international. To the question of the forest companies' customers interest in fossil free or greener transportations, the demand was low. If the customers to the companies involved would be interested to pay for "greener" or fossil free transportation, the potential effects might be greater as the cost would then be able to split at multiple actors as the customers, shippers and carriers. But there is a lack of interest from the customers, making the transformation towards more environmentally friendly fuels slower.

The lack of engagement is slowing down the transformation towards greener transportation is the custom of including the cost of transport to the customer. By doing so, the margin of the deal gets better the lower the cost for transportation is. Combined with the low demand from the customers to choose greener transportation, the tendency to stick to a logistical system once it is set up and works, the few available alternatives, few things are happening. Many of the interviewed companies sell their products with freight included in the sell custom with certain Incoterms where the products are sold to a certain port.

"We usually always sell DAP (Delivered At Place) so that we are responsible for the shipping only to the customer's factory. We have taken this as a strategic issue and done so, which means that the customer can ignore the market mechanism. If there is a shortage of drivers, they can say that it is not their problem and that we must fix it."

Ripström[2]

With this, the customers do not see the actual cost of transportation or does not care how the product is being delivered, as long as it is there at agreed time and place. The willingness to pay for higher transportation weather it comes from a "climate tax" or higher price for freight due to new and high-tech ships that release less, or zero emissions seem to be very low. With the number of investments needed for the industry to change fleets from operating on bunker to less carbon intense or "zero emission" ships, the cost would need to be spread on not only the shipper, but also their customers which in the end gets usage of the transport for their goods. Focus from the forest companies has been on their own production instead of transportation

"Several of the companies within the forest industry has improved their own production and made it fossil free, but until now they have not cared about transportation at all. But they will need to catch up too, we will only have to wait and see."

Johansson[3]

But to be able to give the customers the alternative or opportunity for greener transportation, feasible alternatives need to be in place. As it is right now, there are little alternatives to replace the bunker used. If liquefied natural gas (LNG) is not to be considered as an alternative, there are even fewer alternatives available today. The amount of biogas is limited, and the demand is high and increasing from many industries. With an increased demand for biofuel in the future, the Swedish forest industries may help their own needs for alternative fuel. According to Eriksson at SCA, the company has entered into a collaboration with Finnish ST1 where SCA commits to deliver material to ST1 biorefinery. The same applies for Södra where they have a biorefinery at the production site in Mönsterås where they produce ethanol. The main issue is the produced ethanol is "too good" to use as fuel for ships.

"We have at Mönsterås. Could probably have that at each mill. But the product is too good for us to use, better we sell the fine ethanol to high end customers and then we buy inferior ethanol".

Ripström[4]

[2] Anders Ripström Purchasing Manager for Logistics and Transport at Södra, digital interview 26 of April
[3] Ragnar Johansson Managing Director at Wallenius-SOL, digital interview 29 of March
[4] Anders Ripström Purchasing Manager for Logistics and Transport at Södra, digital interview 26 of April

Even though the fuel is considered to high valued to be used in ships, the contribution of biofuel is considered necessary. With the contradictions related to infrastructure and LNG, which in many cases is seen as a transitional fuel, the infrastructure that enables gas to be stored is limited. Storage for LNG could later be used for liquefied biogas (LBG). LNG is still a fossil fuel and if the suggestion of the inclusion of maritime transports include methane as well, the decrease in cost would not be significant compared to fuel used today.

"No one want to bet on the wrong horse. But someone has to step forward and take a position, take the first leap. We have our time-chartered ship where we see that we can make a change, it is "only" for us to decide to do it. We are very careful when it comes to believing that LNG are the future fuel, we believe there are other options to hope for."

Ripström[5]

The shipping line Wallenius-SOL has another view on the issue of alternative fuel for greening the shipping sector. They have chosen their path for the future by ordering two new RoRo vessels run by LNG. The ships are 242 meters long and has the loading capacity of 27 000 tonnes at 5700 lane meters. According to Johansson[6], the investment in LNG vessel resulted from both the strong environmental engagement from the board in Wallenius and the uncertainties relating to future regulations within the maritime sector. According to Johansson[7] the new vessels will lead to 57% less fuel consumption and 63% decrease in CO_2 per transported work compared to Wallenius-SOL's older vessels used in operation. The reason for the lower fuel consumption and emissions per transported work is the larger capacity of loaded goods and a more efficient ship design and engines. The problem with larger ships is that they need to have a full utilisation to be able to capture the benefits of low CO_2 per tonne-kilometre. As Psarafatis and Kontovas (2009) show, the total CO_2 increases with the size of the ship, as the gram CO_2 per tonne-kilometres decreases. But as the reverse relationship shows, there will be more important for shipping lines or companies operating ships in their own operation, to be able to increase the utilisation to be able to benefit from the energy efficiency.

"But the point is, if we had ordered two conventional ships here now instead, and then we know that the EU ETS and other things will come, it will cost us money. So that we built ships that we are as far ahead as we can be and that we believe will be compliant with the new

[5] Anders Ripström Purchasing Manager for Logistics and Transport at Södra, digital interview 26 of April
[6] Ragnar Johansson Managing Director at Wallenius-SOL, digital interview 29 of March
[7] Ragnar Johansson Managing Director at Wallenius-SOL, digital interview 29 of March

rules as far as possible. and it is not certain that they will be, not certain in 10 years. But at least the old technology will NOT be compliant, and that thing is at least clear."

Johansson[8]

The indications of stricter legislation and demands on emissions helps sending signals to the shipping industry. By setting a price on CO_2 emissions from shipping, regulatory entities rewards fuel efficiency. This is according to Cullinane and Cullinane (2013) two of the ways to reduce emissions from shipping. Including maritime transport in EU ETS includes both, as the regulatory entities in IMO and the EU, as well as the fuel efficiency to create incentives for shippers to lower the emissions and pay less for the emissions. As mentioned earlier, Sims et al. (2014) emphasises modal shift towards lower-carbon systems, lowering energy intensity by intensifing engine performance, increasing freight load factor, usage of new technologies, reducing the carbon intensity in fuels and avoiding journeys where possible to decrease the emissions from transportation in general.

At the question if the cost an inclusion of maritime transport would be enough to change the shipping industry and shift the vessels used towards greener alternatives, Johansson believes that. According to Johansson it is the operational cost that is the driver for which ship to use. As operational costs can be lowered using slow steaming, avoidance of voyages and changed routings among other measures, which are low hanging actions to take to reduce the emissions.

4.2 EU ETS and the two scenarios

To address the issue methodologically, two different scenarios were presented to the study participants. The scenarios do not include other aspects such as increased cost for bunker, increased fairway or other aspects that affects the transportation cost. As the design and outcome of how the inclusion will look like in the end, the interesting part are to consider the potential cost at different emission levels. The two scenarios (see table 8 and 9) were presented as additional costs that could be added to the existing cost for shipping. Scenario 1 could represent a scenario where shipping lines hold a high utilisation on the ships and a relatively high cost per EUA (compared to 2020). Scenario 2 could then be seen as the higher scenario where the shipping lines cannot maximise the utilisation and get a higher CO_2 per tonne/n mile. Or the usage of a ship, example a RoRo ship which traditionally has higher CO_2 per tonne/n

[8] Ragnar Johansson Managing Director at Wallenius-SOL, digital interview 29 of March

mile due to the design of the ship. The ambition of giving the forest companies two different cost scenarios was to find a breaking point for at which levels the increased cost for shipping would affect the company. There was a large consensus related to that if the additional cost would increase with the highest scenario, it will have an impact. How it will affect the companies differs due to the production, geographical location and logistics strategy.

4.2.2 Calculations for scenarios

The two scenarios are based on the assumptions related to two different amount of emissions for a ship transporting goods (per tonne) per kilometre, as well as a lower and higher price for one EUA. The two numbers for the lower and higher scenarios are gathered from an average of RoRo ships used by SCA, Holmen, Wallenius-SOL and DFDS which can be found in appendix 4, table 16. The low average is found from dividing the numbers under 60g CO_2 per tonne and n mile with the number of units. Everything above 60g CO_2 per tonne and n mile is included for the higher emission scenario (see appendix 4 table 16). The numbers are the actual numbers for their emissions with the current utilization onboard. The numbers are therefore not final but rather used as guidelines for the current emissions from ships used within the forest industry. The cost per EUA for the two scenarios are based on the current cost of €40 (end of Mars 2021) and the non-compliance penalty for EU ETS which are €100. If the price for a EUA would be greater than €100, it would be more economical for companies to take the penalty instead.

In table 13 and 14 in appendix 4, calculations can be found related to the amount of emissions released from transporting one FEU with the maximum weight of 26,5 tonnes from the different ports in Sweden to the chosen ports on the continent. The assumption of a full load FEU are assumptions made due to the large volumes the forest industries handle and that a container is more often full when it comes to weight rather than volume. The two scenarios do not include any free allocation of allowances as the decision for how to calculate benchmarks is too uncertain and no suggestion is yet presented by the European Commission.

Scenario 1

In scenario 1 the assumption is 50g CO_2 per tonne per n mile (see appendix 4, table 14). The table shows an average voyage for a 26,5 tonnes container being transported with a ship who emits 50g per tonne-n mile between the different ports. For example, between Husum and Sheerness 2,104 tonnes CO_2 will be released and can be derived from the container. Compared

to the amount of emissions released from Trelleborg to Kiel the emissions from the voyage is 0,202 tonnes of CO_2. When computing the cost for one EUA of €40, the additional cost for transporting the container from Husum to Sheerness is €84,16, compared to €8,08 as additional cost for one FEU between Trelleborg and Kiel.

Average 50g CO2/n mile, total per FEU 26,5 ton in €				
Ports (n mile)	**Zeebrugge**	**Kiel**	**Rotterdam**	**Sheerness**
Gothenburg	35,12	15,72	32,16	40,88
Gävle	71,76	35,08	68,76	77,52
Stockholm	65,96	29,40	63,12	71,84
Skellefteå	86,44	49,76	83,44	92,20
Karlshamn	50,72	14,04	47,72	56,48
Trelleborg	44,44	8,08	41,84	50,60
Norrköping	58,76	22,08	55,80	64,52
Husum	78,36	41,68	75,40	84,16
Öxelösönd	61,20	24,52	58,24	66,96
1 EUA = €40				

Table 8: Scenario 1

Scenario 2

In scenario 2 the assumptions for the emissions per tonne per n mile are higher, which gives 123g CO_2 per n mile (see appendix 4, table 15). The table shows an average voyage for a 26,5 tonnes container being transported with a ship which emits 123g CO_2 per tonne-n mile between the different ports. To continue with the same example as for scenario 1, there will be 5,176 tonnes CO_2 released from transporting the FEU between Husum and Sheerness. Compared to the amount of emissions released from Trelleborg to Kiel the emissions from the voyage is 0,498 tonnes of CO_2. When computing the cost for one EUA of a higher scenario, €100, the additional cost for transporting the container from Husum to Sheerness is €517,60 compared to €49,80 as additional cost for one FEU between Trelleborg and Kiel.

Average 123g CO2/n mile, total per FEU 26,5 ton in €				
Ports (n mile)	**Zeebrugge**	**Kiel**	**Rotterdam**	**Sheerness**
Gothenburg	216,10	96,80	197,80	251,60
Gävle	441,30	215,70	423,10	476,80
Stockholm	405,80	181,00	388,20	441,90
Skellefteå	531,60	306,10	513,30	567,10
Karlshamn	311,90	86,30	293,60	347,20
Trelleborg	275,40	49,80	257,50	311,20
Norrköping	361,40	135,90	343,20	397,00

Husum	482,10	256,50	463,80	517,60
Öxelösönd	376,40	150,90	358,20	412,00
1 EUA = €100				

Table 9: Scenario 2

The difference within Sweden is substantial depending on the destination as well as the starting point for the sea leg as companies with production locations further south is located closer to the main market.

SCA

SCA who operates their own shipping line and logistical company got two scenarios based on the €40 and €100 but calculated in relation to the average actual released CO_2 from their three RoRo ships and two chartered container ships operating in 2019. With no free allocated allowances and without any differentiation of the different segments and everything else equal, the two scenarios generated additional cost in the range of €680 000 per container ship up to €2 500 000 per RoRo ship per year.

SCA	**Average total CO2 in m tonnes per year and ship**	**EUA €40**	**EUA €100**
RoRo	25 000	€ 1 000 000	€ 2 500 000
Container	17 000	€ 680 000	€ 1 700 000

Table 10: Calculations SCA scenario.

With the two scenarios presented, a discussion arose related to the potential implications the additional costs from the inclusion in EU ETS, for the forest companies, may lead to.

Implications of the increased costs

The price for shipping has since the containerisation been very low and competitive towards other modes of transport due to the high capacity of each voyage. Traditionally, the cost of transporting goods has only been seen as an unfortunate necessity which has been possible due to the low cost of transportation. But now as the container market is in a disruptive phase with demand and supply in disorder, the discussion of how goods are transported is up for discussion. When the study participants discuss the increased cost for transportation related to the EU ETS, the total cost for the logistical activities is calculated and compared with.

The reactions to Scenario 1 were low. The general comment was that it would not affect any decisions or have an impact, more than the cost has to be taken from the marginals of the company. There are many other components affecting the cost for freight, companies have a certain amount of buffer for smaller changes in increased bunker or higher demand which in turn increased the freight rates.

Scenario 2, however, generated several negative reactions from the study participants. Wiggh[9] mentioned an increase of €10 per m^3 of sawed wood as additional freight cost. Samson[10] and Holmen Paper see a potential increase of 20-25% of the transport cost if scenario 2 where to be incorporated. Eriksson and SCA further sees an increase with the equivalent of 20-25% per tonne transported. For an industry with already 10-20% cost for transportation depending on market and segment, the increase from Scenario 2 could lead to actual changes within the forest industry.

"1-2 € adjustment on procurement per tonne, it is a bit within the margin of error, it changes through bunker price and diesel price, you have to reckon with that. We need to use a little by sea, we need a little something else. But over 3 € and more, then it becomes a serious discussion, it is long-term? If it is over 5 €, it goes as a small signal in the house to the sellers that the market, here something is happening, and the price will go up. Here (with scenario 2) we are talking 12 €."

Ripström[11]

From the shipping lines perspective, handling the additional cost from the EU ETS, Johansson compare it with the agreements in the contracts regarding BAF and how fluctuations in fuel price are handled.

"It will be like with the BAF, which also depends on the degree of filling, it will probably be quite similar to it, I think. You can probably base the EU ETS fee on a certain degree of filling, if it is 80 or 90%, difficult to say. Then it will be what it is. This is what we do with the BAF, otherwise there will be too many parameters to include. It is not possible to calculate on

[9] Niklas Wiggh Product Manager Sawed Wood for Bygdsiljum and Kroksjön Sawmills, digital interview 21 of April

[10] Thomas Samson Logistics Development and Purchasing Manager at Holmen Paper, digital interview 22 of March

[11] Anders Ripström Purchasing Manager for Logistics and Transport at Södra, digital interview 26 of April

each individual product owner and voyage, but you have to calculate a degree of filling and then we have to take the risk of it, whether it is up or down".

Johansson[12]

Further, Larsson at BillerudKorsnäs sees the issue related to the increased costs to be solved in a dialogue between the customers and the sales department, where the cost (in Scenario 2) as Larsson sees it, would need to be added to the customer in the end. Depending on which product segment and market, there are different margins for transportation.

The study participants are from the companies' logistical department and refer to the sales department to decide upon the solutions, as there are particular margins and prerequisites for each geographical market, which makes it more difficult to come to an overall conclusion for how the reactions may look. Regarding the SECA regulation and adding the cost to the customers, Wiggh said:

"We noticed a difference, we did. We tried to divide the cost against the different customers. And that we thought there was some acceptance for that. When it affects everyone equally, there is an acceptance of it".

Wiggh[13]

All study participants agreed on the statement where the additional cost for EU ETS will be put on them as shipper. This follows the view Johansson at Wallenius-SOL has to say:

"For this with the EU ETS, we have to deal with it, get to take the first blow and then we have to charge them in some way. It comes to them and they cannot do much about it. That's actually the case".

Johansson[14]

One of the problems identified is the lack of understanding from the public how the shipping industry is working. Especially when it comes to the question of additional costs added to the

[12] Ragnar Johansson Managing Director at Wallenius-SOL, digital interview 29 of March 2021
[13] Niklas Wiggh Product Manager Sawed Wood for Bygdsiljum and Kroksjön Sawmills, digital interview 21 of April 2021
[14] Ragnar Johansson Managing Director at Wallenius-SOL, digital interview 29 of March 2021

shipping lines or operators, as the costs will be transferred to the shipper and transport buyer in the end. Boholm[15] highlights the problem in Sweden with the example of fairway fees as an example. The invoices for the fairway fees are sent to the shipping lines, but is then added onto and included in the final price the transport buyers pay. The additional cost then become a supplementary cost for industries producing and already included in the EU ETS system, as paper and pulp production facilities.

"All costs that are added to the transport industry must be charged, and it is charged to the transport buyers. It does not matter if it is a fairway fee. It does not matter what aspects are behind it. And it is then costs that we cannot put on the products."

Strömberg[16]

The more refined product the higher price a company can charge. With a higher price, there are larger marginals for additional costs necessary such as transportation. Therefore, there has been a strategy from the forest companies to locate the production plants close to the raw material, as the price for the raw material (see figure 6 for price examples) versus the transport would be too expensive to transport further distances. Strömberg emphasises as if the cost for transportation would increase with numbers as seen in Scenario 2, they might redirect their export of pulp to stay within the corporate group in Finland, as it then would be much shorter distances for transportation, even though they will lose in revenue from the export price.

4.3 Impacts for the forest companies

Besides the most obvious, the direct impact of increased cost of freight for the forest companies, an inclusion of maritime transport may lead to other consequences in the long run. There were further aspects identified which will be described in the following sections.

4.3.1 Own operations versus customer

There is an attitude shift from how the shipping is done within the forest industry. Earlier the majority of the forest industries had their own ships that they had full control and "ownership" of, which meant they also had large posts on the balance sheets. Now several companies either reduce the number of ships in their control or leaving the old idea totally.

[15] Karolina Boholm Head of Transport Policy at Swedish Forest Industry Federation 26 of March 2021
[16] Peter Strömberg Head of Logistics at Metsä Board Husum, digital interview 20 of April 2021

There is a pattern of how the forest industry is changing their view of how shipping is being done. From owning or long-time time charter contracts towards being a customer in the transport system. Holmen Paper has at the moment two ships on time charter. After 2022 when the contract is over, they will only have one in their own operation.

"The need for own capacity has decreased and we have troubles filling the boats with our own material. (….) We are scaling down to minimise the exposure towards fixed costs and to have variable costs and use the system when we want and need it".

Samson[17]

Until 2019, SOL operated Stora Ensos route between Gothenburg and Zeebrugge when Stora Enso terminated the contract and sold everything to DFDS (Port of Gothenburg 2019). Until then, Stora Enso had been one of the major forest companies with long-term chartered ships which were specially made for their products. Before, it was seen as a strength for Stora Enso to be in charge of the logistical system, which gave them a low cost per unit. Metsä Board has a history of own ships from the middle of the 80s. The last couple of years Metsä Board had a long-time chartered ship which was used for transporting the products down to the continent. But that contract and ship was taken out of business in 2020.

"We are too small to have our own shipping operation. Then we would need to fill the boat in both directions, and then we will be a little far away from our core business". "We let them who are experts on shipping to do that instead. (…) Nevertheless, owning or having control over a ship means more security and flexibility for deliveries as the ship is in our control".

Strömberg[18]

There are both pros and cons to being a customer in a system or acting as an own operator. With all that is going on in the shipping industry, it is hard to know what to follow and the right option for shipping in the future. As a customer in the system, the flexibility increases, and the transportation can be adapted after the demand and possibilities to change shipping lines if a certain fuel or vessel get additional costs or regulations. With the increased uncertainties within

[17] Thomas Samson Logistics Development and Purchasing Manager at Holmen Paper, digital interview 22 of March 2021

[18] Peter Strömberg Head of Logistics at Metsä Board Husum, digital interview 20 of April 2021

the industry, the operators of the ships are the ones who become vulnerable and need to take action to hedge against the different potential risks.

Wallenius-SOL did not have any requirements from the customers when the company decided they would invest in new low emitting ships. The decision was based on a risk adversment and the to hedge against new laws and regulations that might impose within the next 10 years within the EU. According to Johansson, the extra cost for the ships to run on LNG was $5 million. For the payback of the investment, the voyage cost needs to continue to stay cheaper than running on MGO. Otherwise, the payback time for the investment would be longer as well as changes in price for the voyages may be added.

Since SCA owns their own ships and the depreciations are done, the usage of shipping is very cheap at the moment. The ships may be kept until 2030, which also gives SCA no cost incentives to change their way of operating as the current system is very affordable.

"Our main focus and core business is the sawed wood business, not the transport business. We don't put that much time and effort on the transport".

Wiggh[19]

In the study by Christodoulou, Raza and Woxenius (2019) they analyse the case of Stora Enso and the integration of an own transport system. The study was conducted before Stora Enso decided to sell their vessels operations to DFDS and instead become a customer in the DFDS system (Port of Gothenburg 2019). The contract with DFDS guaranteed 700 000 tonnes on a yearly basis from Stora Enso and is how the contracts and customer relationships are set up by Wallenius-SOL[20].There is a shift happening from owning and long-term charter contracts towards finding solutions that are commercial. Explanations found are the need for less risk exposure to fixed costs. Metsä Board in Husum just changed their system, Holmen Paper is about to change and decrease the number of chartered ships and SCA with their own logistical company may redistribute what kind of vessels to use after the old ones need to be scrapped. Södra are the only company who holds their system to continue in the same way as it is now.

[19] Niklas Wiggh Product Manager Sawed Wood for Bygdsiljum and Kroksjön Sawmills, digital interview 21 of April

[20] Ragnar Johansson Managing Director at Wallenius-SOL, digital interview 29 of March 2021

Samson[21] at Holmen Paper says the amount of paper being transported by sea might be the same, it is only the contractual and structure of the transport at sea that will be different.

4.3.2 Modal shift

The geographical location affects the competitiveness between different transport modes. The production of the products and pulp is where it is due to the closeness of the forest or the raw material. This is a strategic decision which has led to a longer distance to the market and customers. With lesser refined products, the lower willingness to pay for transportation, the more challenging it seems to be to change mode of transport. Not due to the produced volume per se, but the difficulties to reach the same level of economics of scale as it is with shipping. The modal shift scale is further dependent on what additional taxes or costs will be imposed on rail and road haulage.

All the study participants use road, rail and sea to different extents. Ripström[22] describes it as Södra has to have all the backbones to spread and minimise the risk, and because their companies demand a certain mode of transport of service level that is not reached with shipping. According to Ripström[23], rail is not the most cost effective, but if customers demand it there is little for Södra to do and has to work with it.

The ability to switch mode of transport from sea to railway needs a lot of investments from different actors. The APM terminal in Gothenburg has an outspoken goal of increasing the number of goods arrivals at port by train, which required an investment of a logistical company as well as the capacity available in port to handle. Even though ports are having the infrastructure, the total logistical cost and nearness to port is more important than the infrastructure in port. One recurring theme from the respondents relates to the distance between production and port. When decided to use shipping, the closeness to the port is important. Many of the mills have own ports, or are located close to a port to be able to drive shuttle service between the mill and port. The choice of port relates to a lot of operational decisions depending on destination, port charges, capacity and infrastructure in port. When BillerudKorsnäs works with shipping containers, it is the closest port available for each paper mill. By doing so, the

[21] Thomas Samson Logistics Development and Purchasing Manager at Holmen Paper, digital interview 22 of March 2021
[22] Anders Ripström Purchasing Manager for Logistics and Transport at Södra, digital interview 26 of April 2021
[23] Anders Ripström Purchasing Manager for Logistics and Transport at Södra, digital interview 26 of April 2021

cost for pre-transportation decreases and the mills keep being separated from each other. At the question if BillerudKorsnäs container flows could be redirected to one port instead, the question was no.

"I would not be able to point at one port and say, "lets go there". They cannot handle the volumes. And the ones we already use are under high pressure and all of the warehouses are full." One other perc of being in a smaller port is that it is easy to become a large actor even with smaller amounts of volume. As a larger actor the service and possibilities for price negotiations are better".

Larsson[24]

There are many aspects to consider when choosing a direct call or feeder system. Torgersson and Ivarsson (2012) raises aspects such as the company's vision, strategy or policy could affect the choice of system. Other parameters are available departures, location, cost for transportation, transport time and environmental aspects. Hence, according to Larsson, the solution where Gothenburg would be a more attractive port due to extensive port infrastructure, more departures, the possibility for direct call and less need for transhipment is not enough if the location of the production plant is far from Gothenburg with a port located closer. The transhipment cost illustrated in Jensen and Bergqvist (2006) and economies of scale has less importance than the flexibility, less congestion as well as the bargaining power found in smaller ports. One other example is the transhipment from rail to ship in port, where the cost for rail from the production plant to port is the same as with trucks, but the extra cost of transhipment excludes train usage even though the train might be smarter from a CO_2 perspective. With higher costs related to the sea leg, the cost incentives to use truck for the whole trip may be greater.

"It is the total cost that makes it hard to find profitability when driving with several different modes of transport together. The cost of transhipment nibbles more of the profitability than you see directly. When we do the calculations for railway, it is what it stands and falls on. We get the same price for railway as truck from Gävle to Gothenburg, but you can only load 50 cubic meters at railway wagon and 70 cubic meters at the truck. And for railway the transhipment cost adds up to the calculation (….) It is better for the environment, but it is not competitive so that the customer wants to pay extra for it."

[24] Daniel Larsson Senior Logistics Ocean Manager at BillerudKorsnäs, digital interview 27 of April 2021

Wiggh[25]

Martinsons already has a high share of sawed woods transported by road and Wiggh describes it as a possible outcome to upscale the share of road haulage if the price increases in accordance with the numbers from Scenario 2.

With a tariff like that (EU ETS) and if it would only hit against the maritime transports, then it would force goods to road haulage, simply. … We export one million cubic meter per year. A lot of it is already transported by truck today, but with these numbers (scenario 2 foremost) a larger part would be transferred to truck (….) We compare modes of transport against each other, we look at shipping versus truck all the time".

Wiggh[26]

The possibility for substitution according to Eriksson are low. Truck could take a part of the transportations, with a cost of the environment as a result. Railway would not be able to provide the service and capacity needed to be competitive compared to road haulage. It also depends on which market to access. Northern Germany, Netherlands, Belgium, and France are located close to the sea, the market and for further transhipments, making it more competitive to access by sea. Looking at Italy, southern Germany and Austria, railway is more competitive compared to shipping from Eriksson's perspective. Larsson and BillerudKorsnäs on the other side have seen it to be more competitive to transport the goods in containerships to the markets in Italy and Greece compared to intermodal by rail and truck. The competitiveness between the mode of transport changes as Martinsons used bulk to Spain, but after 2008 and the financial crisis the number of bulk ships decreased and a shift towards containers were made. Today Martinsons has increased the number of transports to Spain by road haulage as the container segment is no longer competitive and a better alternative for them. Samson and Holmen Paper only uses railway to Italy. The different solutions show there will be as differentiated impacts if the price for shipping increases, which at specific routes are hard to predict in advanced of how much goods will be transported in another way.

[25] Niklas Wiggh Product Manager Sawed Wood for Bygdsiljum and Kroksjön Sawmills, digital interview 21 of April 2021
[26] Niklas Wiggh Product Manager Sawed Wood for Bygdsiljum and Kroksjön Sawmills, digital interview 21 of April 2021

There are a lot of opportunities for the Swedish forest industries to do a modal shift into either intermodal or by sea from road haulage. Especially Swedpaper which holds 20,4% of their transport with road haulage. As a small company with little possibility to compete with the large actors regarding price and therefore compete with service and accessibility. As Swedpaper analysed their customer's behaviour and demands, relatively fast deliveries were one of the most important factors. Compared to the other respondents in the forest industry, where there is little need for speed as long as the deliveries are right on time, speed is important for SwedPapers customers. With intermodal a shipment can reach Italy in 6-7 days. SwedPapers usage of shipping is very limited and is only used as a complement to rail and road haulage. According to Karlsson[27] their main issue relating to use more rail is the capacity and the markets which SwedPaper work with.

The scenarios for SCA after 2030 when their ships are to be taken out of business, Eriksson sees the possibility that RoRo will decrease, and usage of containers will increase. RoRo is better on the short routes as to Kiel with fast loading and unloading in port. The usage of fuel increases but with the short distances, it does not differ that much, which indicates other factors as more important than the fuel consumption per se.

"From our perspective, RoRo will decrease if we look beyond 2030, and the share of container will increase. RoRo is really good for the short movements, as down to Kiel and Malmö with fast handling in port. Even if RoRo has a higher usage of energy, it is not that crucial on the short distances".

Eriksson[28]

The geographical location affects the cost for road haulage. In northern Sweden, the population reaches just over one million. As there are a few people living in the north, the consumer deliveries are limited. With that, the number of available trucks and drivers is limited.

[27] Jim Karlsson Warehouse and Logistics Manager at SwedPaper, digital interview 19 of April 2021
[28] Peter Eriksson Sustainability and Logistics Manager at SCA, digital interview 9 of April 2021

"In the southern parts of Sweden, it is more advantageous since their carriers can call and ask for goods to transport. Up here it is the reversed where we call the carriers and ask for them to transport our goods".

Wiggh[29]

The view is shared by Ripström at Södra, where he points out cheap transportations by truck as one of the main advantages related to other forest companies located in the north.

"We are lucky with such good industry in the south. This gives us the opportunity to choose a good price, as trucking companies profit comes from the north going transportation and they need to have cargo on the way back again".

Ripström[30]

For many of the study participants, truck was seen as a feasible alternative due to the cost and service aspect. Railway holds a lack of capacity and always needs transhipments, as shipping do. For SwedPaper with a relatively small production compared to the others, truck and intermodal are the two main ways of transportation. According to Karlsson[31], SwedPaper are competing with speed and service, the waiting time for port of call in Gävle as well as the shipping time at sea, are the biggest challenge and reason for not using shipping as the main mode of transport.

Larsson[32] highlights the problems that has arose at the container market with a European market which is unbalanced with a lack of empty containers to use. This raises the freight rates for transportation with containers overseas.

"If this continues and the price continues to stay as high it is now, I need to look for other alternatives for transportation to China, either by rail or bulk".

Larsson[33]

[29] Niklas Wiggh Product Manager Sawed Wood for Bygdsiljum and Kroksjön Sawmills, digital interview 21 of April 2021
[30] Anders Ripström Purchasing Manager for Logistics and Transport at Södra, digital interview 26 of April 2021
[31] Jim Karlsson Warehouse and Logistics Manager at SwedPaper, digital interview 19 of April 2021
[32] Daniel Larsson Senior Logistics Ocean Manager at BillerudKorsnäs, digital interview 27 of April 2021
[33] Daniel Larsson Senior Logistics Ocean Manager at BillerudKorsnäs, digital interview 27 of April 2021

The uncertainty of not knowing how the future might look regarding cost for shipping increases the need for other solutions as well, to diversify the transportation and have different backbones. With a system initiated at the first place, the step to increase the volumes are easier as it, according to Trafikanalys (2016) is a high threshold to change a system once it is in place. Long-lasting and highly costly changes is a natural push towards change.

There is a substantial risk for carbon leakage that the EU ETS system may contribute to. Earlier solution from the European Commission have been to give industries free allowances based on the best performing actors in the industry. The risk for relocation of first port of call rises as the cost per EUA increases, which works in a counterproductive way, as the shipping industry is said to need regulations and higher costs to invest in fossil free or lower fossil emitting ships. With a higher number of free allowances allocated to the shipping industry, the lower the cost will become. As Mellin et al. (2020) showed, with 95% free allocated allowances and a price of €25, the cost for the total shipping industry reporting according to MRV will only reach €200 million which is in line with the amount the aviation industry paid in 2017 (EASA, EEA, EUROCONTROL 2019). The low cost stipulates with the additional cost in Scenario 1, which did not create any reactions or said to make any changes. Just as Larsson mentions, the higher the price over time, the more incentives to look for other alternatives.

Other alternatives within the forest industry related to carbon leakage could be have the first port of call in Great Britain, as the country is a large market for the forest companies (see table 5). As found in Transport & Environment (2021), the cost incentives for choosing another port of call outside EEA under a full scope of the MRV, to bypass the cost for EU ETS, it would foremost be larger vessels operating overseas that would profit from it. The potential displacement to a non-EEA port reached 15,6% of the voyages are at risk, where the forest industry could participate in. In accordance with the study, there were few of the study participants who though changed routes and changed first port of call in Great Britain would be a feasible way to address the increased cost for SSS within the Baltic- and Northern Sea. Nevertheless, Samson[34] and Holmen Paper and Eriksson at SCA saw a potential opportunity if the shipping lines saw a possibility to save costs by calling a port in Great Britain instead of Rotterdam, and then use feeders between the UK and the continent.

[34] Thomas Samson Logistics Development and Purchasing Manager at Holmen Paper, digital interview 22 of March

Investments impact

Investments made in existing infrastructure which hold companies in a certain system even if it would be possible to change creates "look in" effects. The decision of which port used by companies depends, according to the majority of the respondents on the frequency of departures, port calls available, infrastructure to, from and within the port. The decisions are also based on own infrastructure available at the production plants. Many of the paper- and pulp facilities have their own ports or docks just outside the production. This enables the companies to load directly from production to ships which then transports it further down to the continent. By having that possibility, all other logistical choices related to shipping, becomes not logical as other choices of ports would need pre-transportation, reloading, storage in port and reloading to a new ship in port.

Each of the paper mills has traditionally had their own logistical set up at each paper mill. It is only recently the idea of a central logistical unit at the head office, handling the contracts. BillerudKorsnäs has their own train company, which has a contract with Green Cargo to handle a part of their volumes. For BillerudKorsnäs to have a private train company to operate with, there is a lot of investments made within this as BillerudKorsnäs became the main owner in 2016. Approximately 80% of their products are being transported by train and every third freight train leaving Sweden by the Oresund Bridge are controlled by the company[35]. This includes both for export and products to ports for further transhipment in containers. BillerudKorsnäs only works with commercial contracts and does not have any chartered ships. As previously mentioned, SCA's ships are paid and very cheap as there are no capital costs included in the calculations, which facilitates SCA with very cheap transportation by sea compared to other companies within the forest industry.

"Because we have our own ships, and as long as we have them, it is important to try to fill them".

Eriksson[36]

[35] Daniel Larsson Senior Logistics Ocean Manager at BillerudKorsnäs, Digital interview 27 April 2021
[36] Peter Eriksson Sustainability and Logistics Manager at SCA, digital interview 9 of April 2021

SCA's will therefore use their RoRo-ship to transport pulp, even though the willingness to pay for the transportation of pulp is lower and the operational cost for RoRo is higher. This is due to the fact that SCA's paper production in Ortviken was closed due to decline in demand for paper. With the reinvestment in other forest products, the need for RoRo transportation will decrease, which correlate to Eriksson's forecast for SCA's usage of RoRo beyond their current ships until 2030. There have been a long trend of decreasing mills and increased production, which is a trend that could be increasing as margins may decrease even further due to increased cost for transportation if no other feasible alternative is available. SCA's investments in creating a logistical company also creates barriers for the company to change how they use shipping.

The companies not seeing a potential modal shift are the companies with either high investments in own infrastructure or low volumes, rather than high production and a great need of export. As Metsä Board in Husum, which has not any own ships or time-chartered ships remaining in their service, with a production of almost 700 000 tonnes of board and 730 000 tonnes chemical pulp, sees very little chances for them to change mode of transport.

"Very unwise not to send it via your own port anyway, even if it would only earn a 1 SEK on it".

Strömberg[37]

With a modal shift from sea to rail, Metsä Board Husum would need to invest a lot of money to rearrange the internal logistics to fit the railway and slot times to them. With a large investment in the port, it would not be motivated.

4.3.3 Competitiveness

One aspect, as all of the study participants mention, is the aspect of service. After cost for the transportation, service is the most important aspect. As all the modes of transport has certain pros and cons, the need to diversify the transports are important. With road haulage being the fastest mode of transport and compared with companies that has production plants with a small amount of production, the cost of transhipments from truck to storage and reshipment in port are costs that affect how the products are being moved. The short-term consequences will,

[37] Peter Strömberg Head of Logistics at Metsä Board Husum, digital interview 20 of April 2021

according to Eriksson, be competitive advantages for the competitors in North- and South America, as the products are sold and negotiated at the world market, additional cost for a certain area will only lead to smaller margins for Swedish companies and better room for negotiations for others outside.

" .. and it will be passed on to the consumer in the end. In the end, we have to make money to be able to survive. We cannot bear all the costs by our self. We calculate logistics costs from A to B. And that is part of the calculation that you make if you are to take in an order. Must have a certain coverage rate to be able to take the deal. If the cost goes up for the logistics, you have to make the trade-off if you are to say no to the deal or accept a lower gross margin."

Samson[38]

As it is today for the forest industry, their main competitors would be outside of Europe as the main forest companies today are located in the north of Europe and gets the same playing field.

4.3.4 Investments and reinvestments

With small margins at certain markets or within certain product segments, an increase of 1-3% might be the difference of reinvesting in a production plant or not. As there are many fluctuations and a lot of different parameters that affect how a business is run, where the production is located, the cost of transportation itself might not hold the power to close or relocate certain productions. Though, if there would be a guaranteed cost for the next years and an industry stands and weights to either invest or not, the verdict might not be in favour of the certain production plant.

According to Eriksson, the long-term consequences could help fasten the closing of businesses with low margins, such as for production plants producing paper for newspapers and magazines. The existing machines producing kraft paper as well as pulp will continue producing and even increase. The usage of the existing plants will increase in production volume and centralised.

SwedPaper exists in Gävle due to the pulp production of BillerudKorsnäs. If SwedPaper invested in further production, they would need to expand beyond Gävle and find deliveries for

[38] Thomas Samson Logistics Development and Purchasing Manager at Holmen Paper, digital interview 22 of March 2021

pulp somewhere else. The closeness to the raw material and the need to minimise the transportations of pulp are more important than to be able to centralise the production and distribution of the products.

Husum Board's way of handling their transportations with the main focus on shipping is their large port investments. The paper mill has a railway entering the area and leaves timber to be processed into pulp, but there are no possibilities or ideas to use the railway for outbound transportation. The reason is the inbound logistics that would be invested further in and the timing of the incoming trainsets, which might not fit the production and deliveries to customers.

For a question regarding the different market and market segments to sell their products, Strömberg[39] says that the information that the investments were made to be shipped to the USA market was the most important part. If Metsä Board had told the investment of several billion in a new production line to sell to Europe, the reactions at the stock market would not have been as positive as they were. The possibilities for continuing to sell to USA at a lower price are due to the direct call from Husum to the American East coast. As it is now, the Dutch shipping lines has enough of calls and goods to transport overseas. But if the cost would increase and the demand to ship overseas would get lower from other actors using the same shipping line and route, Metsä Board would not be able to bear the cost by themselves. The ability to facilitate ships with direct calls from their own port just outside their paper mill, lowers the costs for transportation as the need for transhipments and additional transports is not needed. As a comparison with Jensen and Bergqvist (2006) the need for an extra transhipment cost with a feeder system down to the continent and then to the American east coast could almost be double. If the lack of possible shipping lines with direct call would disappear, Metsä Board in Husum would probable do as they do with shipments to Australia, put them on RoRo to Zeebrugge, Antwerp or Lubeck, load in containers and from there overseas in large ULCV. Everything that goes to Sweden and Finland is transported by road.

The latest trends within the forest companies are that paper mills close and refocus on carton paper or other material, which has a higher demand. Paper is more sensitive to crush injuries and have a higher willingness to pay for transportation as they need to be handled more gently than other segments and preferable in RoRo. With RoRo having traditionally higher emissions

[39] Peter Strömberg Head of Logistics at Metsä Board Husum, digital interview 20 of April 2021

per tonne/n mile, the transportation requirements in an already pressed business could be speeding on reshaping the industry in Sweden. Samson[40] rises that as the future problem for Holmen Paper, where there will either be that they find new areas of usage, other markets for their existing products, or switches from current production to others. With other product segments increasing, a certain segment within the forest industry could decrease, and more than now could be transferred to containers.

[40] Thomas Samson Logistics Development and Purchasing Manager at Holmen Paper, digital interview 22 of March 2021

5. Discussion

The discussion chapter will highlight the main implications and the limitations of this study. The section also aims to clarify the results and the research problem as generalisation as one factor.

This study has aimed to investigate how companies within the forest industry will be impacted. The forest industry is widely segmented and holds a variety of different companies. The different companies in this study are active in different product segments, different markets hold different strategies and operates at different geographical locations. The inclusion of maritime transportation in EU ETS is foremost to reduce emissions from the maritime sector. But by including the emissions from maritime transports, there might be consequences and additional unpredictable outcomes for the sectors who heavily depend on shipping. Things that unite the companies in this study are the raw material, a large share of export, competing in the world market and dependence on reliable transportation for their movement of goods. Even with their different geographical locations and markets, there are some touching points in how inclusion of maritime transport in EU ETS could affect the industry.

The main reasons for the current modes of transportation and system used in this study are the prioritisation of price, service, accessibility and capacity. This follows what Rodrigues (2020) highlights as important factors for a modal shift. Depending on the production capacity, geographical location, business strategy, market segment and product category, different aspects are considered more or less important to the study participants interviewed. The geographical location affects the availability of different modes of transport. The largest ports and the majority of the customers are found in the continent, which makes the transportation of products shorter if production is done in the south. The closeness to the market and infrastructure affects the cost for transport, hence, the choice of mode of transport. With a higher production capacity, the limitations follow the capacity for different modes of transport. Shipping is a good mode of transport for high volumes in a cost-efficient way as well as railway when full trainsets are used. The relation between the business strategy, market segment, and product category is that these require different modes of transport due to the service defined (speed), different levels of quality of the products (for example, paper are sensitive to crush injuries) and different margins at each market. From the interviews, several factors were

identified that give examples of how the forest industry could be impacted when shipping is included in EU ETS.

5.1 Towards a fossil free shipping industry

The biggest challenge, in general, is the transition towards fossil-free or low fossil transport. The majority of the interviewed forest companies has worked with their own production to reduce the CO_2 emissions, which shows in numbers between 2018 and 2020, where the paper- and pulp sector decreased their emissions by 21,6% (Naturvårdsverket 2021). The larger companies in the study hold ambitious targets as fossil free transportations from 2030 (Södra), a fossil free value chain (SCA), hence transport is next in line to be dealt with.

IMO has, as mentioned before, the 'Paris Agreement of Shipping' where the numerous goals of emission reduction are to be found. With IMO gathering 174 member states, the best and fair way for global trade and equal competition over the world would be to impose a trading emission system at a global scale for all emissions related to shipping. IMO's plan to further implement EEDI for new ships and reduce the CO_2 per transported work (IMO 2019). The inclusion of maritime transports in EU ETS is the EU using regional regulation to pressure IMO to increase their means within the climate regulations, since the European Commission wants to go further. The investments needed to decarbonise the shipping industry are estimated to $50-70 billion annually over the next 20 years to reach a reduction of 50% of the emissions until 2050, which signals the enormous investments needed to be done for European actors operating within EEA ports. Compared to aviation, maritime transports will see an increase in emissions due to increased demand. With the uncertainties related to which future technologies are the best to invest in, the industry is in a vacuum where no one wants to be the one betting on the wrong technology. This delays the investments needed, as the cost for a new ship are large and holds a risk to the shipping lines for a long period of time ahead. With regional solutions, shipping lines may choose to redirect their cleanest ships, including European routes and ports and use less clean vessels at other regions, not having the same pricing mechanisms for CO_2.

The inclusion of maritime transport in EU ETS will increase the cost, which could exacerbate product segments and mills to close down in advance, as the interviews show the cost need to be taken from somewhere. For industries with large volumes and low value goods existing at

the world market, the impact seen here could be huge with impacts in where the trade is being made and which products. The impact may not be as significant for goods with products with lower volumes, and higher value as it is the cost per tonne transported that will increase. Companies or industries operating with low volumes and high valued goods hold the potential to spread the cost on more units per tonne transported. As further implications, the more refined the products are the higher chances for products to be able to increase the willingness to pay. With increased cost for transportation this could lead to further structural transformations within how the forest industry look like in Sweden, as pulp for export could be less attractive as the marginals decrease.

With products competing in the world market with actors without increased shipping costs, the alternative is either to decline the offer at a certain market or to streamline production even more. As previously described, how transports are being done starts to change within the forest industry. There are sometimes charters or ships that will be taken out of business in the near future. There is also a shift within the forest industry in which products to produce, which could restrict which mills to reinvest in or close. SCA has already closed their paper mill in Ortviken, and Holmen Paper stresses the need for transforming their production to more competitive and attractive materials for the market. However, the trends could be enforced at a faster pace. Some parts of the forest industry are highly sensitive to price changes related to transportation due to the low price of the unprocessed material. With additional surcharges of 20 to 25% per tonne shipped material with own vessels, it could seriously affect production plants where the marginals are already low, especially in the north where other modes of transport down to the continent are limited in capacity and flexibility. With a decreasing demand for graphical paper due to the decreased demand for printed newspapers and magazines, the industries/companies with higher willingness to pay for their products' transportation are also decreasing.

As Cullinane and Cullinane (2013) mentions, the easiest way of lowering the emissions is to take operational decisions such as more efficient transports and usage of other fuel. The way forward for the Swedish forest companies should be to collaborate even more when it comes to consolidate. Either by reducing the number of own time charter contracts or to engage in commercial contracts with shipping lines. This correlates to what Christodoulou, Raza and Woxenius (2019) finds where reductions in emissions, cost and reduced lead time combined with higher system efficiency as well as increased revenues. The alternative is not to stop transports and exports overseas but to make them more efficient and cleaner. With a lot of

different actors that can bear the cost of cleaner fuel, the risk and cost would not affect a certain shipper.

One way to handle the increased costs related to shipping could be to or use other Incoterms that has traditionally been used by the forest industry. Another solution could be to sell via trading houses and sell to port, where the trading house takes over the responsibility and cost for the rest of the transportation. Trading houses are most commonly used at markets that are more complex or risky, but if the uncertainty increases relating to the shipping industry within EEA, the risk for the forest companies would decrease and focus could be directed to the core business of producing products of wood. Using trading houses instead, the companies would theoretically not have to focus on the cost of shipping and the increased costs for further environmental engagement. But the risk for that is lower margins and dependency on external sales channels for revenue. Looking at the report from PwC (2017) there already is a large amount of products being exported this way.

One other impact the inclusion of EU ETS might have on the forest industry is speeding on the transformation of own operated vessels towards being a customer in a transport system instead. As the study has shown, the trend towards not owning or operating their own vessels is happening at a slow pace due to long-time charterer contracts that are hard to cancel in advance. The cost for EU ETS will most certainly add on to the operational actor who are responsible for the reporting to MRV, which will make it extra clear with additional costs for not full shipments or empty ones for all the time as the ship is being used. By being a customer in a system with conventional contracts, the additional cost will at least be for the actual transported goods. And the risk for increasing cost per EUA will be put at the shipping line.

In line with earlier studies, this thesis indicates a shift from own transport operations within shipping towards commercial contracts, as Wallenius-SOL. But their investments in new LNG ships are very large, which means not all ports outside production plants are available or can be reached by them. The larger the ship, the less emissions per tonne-kilometre and more tonnes to spread the operational and voyage cost for running a ship. With the need for new investments in fossil-free, smaller ships that can run on battery or with alternative fuels. This points towards a smaller but high technical usage. But what is seen is a larger focus on commercial contracts, which would benefit the EU ETS system as it measures emissions per tonne-kilometre. With that, larger ships are encouraged if the knowledge that the fill rate is high. Pre-transportation

and cost of transhipment are costs that affect the marginals, the need to minimise and reduce the distance to port would be needed.

All the forest companies hold significant transportation by road. With the reactions and insights from the study participants, increase usage of shipping and a modal shift from road to sea seem to not happen in a larger extent. With trucks and road haulage accounting for the largest share of the emissions per transport in Sweden and Europe, and the ambitions from the European Commission to lower the emissions from road transports, the non-modal shift could become a larger problem than the modal backshift from sea to road by the forest companies. The modal shift may not be as enormous and change the Swedish transport system per se, but what it might affect is the attractiveness of moving road haulage to sea transport, which is more effective in handling larger and heavier shipments. One argument for non-differentiated design of the EU ETS could be that transport modes which is not efficient enough have to bear the cost and would then stimulate vessels which emit less.

In one way, it is the need for the shipping industry to pay for the emissions they contribute with, but a second aspects include the need for key industries such as the forest industry to stay competitive and contribute with fair substitutes for packaging, building material etc. If the shipping lines are to be considered a long-time changing industry, the cost for the transportation will in the short term be transferred to the companies. As the usage of RoRo within the forest industry in the north differs from other types of RoRo services in the south, and the accessibility to the railway is better in the south, the inclusion will affect companies differently depending on location in Sweden. The usage of RoRo for shorter transports are important for trucks from the north to shorten the distance between Sweden and the east Baltics. Therefore, an inclusion of maritime will not only affect the competition in the world market but will exacerbate the differences within Sweden due to the level of access of other mode of transports as companies located further south will have better access to transport services who is not covered under environmental surcharges such as railway.

6. Conclusions

The last chapter concludes the findings of this study by answering the research question "How could the Swedish forest industry potentially be affected due to the inclusion of the maritime sector in the EU ETS?". As a finalizing part policy implications and further research will be presented.

There are a lot of parameters affecting how shipping and ships are used within the forest companies in the study. One of the main conclusions from this study is that the implications for a forest company are highly dependent on geographical location, infrastructure investments, product segment, markets and nearness to sea transportation, which in the following step affects how the company could be affected by the inclusion of maritime transport in EU ETS. The potential effects on the Swedish forest industry have been found to be potential losses in export due to the need to decline deals as a result of too low margins in a certain market. This relates to the decreased competitiveness the Swedish forest industry may face as competitors outside Europe, mainly in America, does not have the disadvantage extra cost for transportation at sea. The possibilities for a modal shift for the companies is largely dependent on the investments in current infrastructure rather than the production itself but a modal shift to road haulage at certain markets due to competitive transportation cost to close markets in Europe where road haulage is a competitor. With the additional costs, the structural transformation of the industry may appear in a faster pace than seen at the moment.

6.1 Policy recommendations

From the study certain aspects have been identified for policy advisors to further work with to as to ease the impacts on the forest industry in Sweden. The shipping industry sees an increasing demand for the future and will increase regardless of more effective and higher utilisation. Shipping is good for high volume and heavy products, which most commonly correlates to basic industry, which are essential and is a step towards replacing single-use plastics with renewable products instead. Thus, it should be in Sweden's interest to work for a unified system with a global cap on CO_2 emissions to minimise the distortion of the market for forest products and hinder the Swedish forest industry to further expansion instead. To be able to give the industry a fairer transition, politicians should work for:

- Global price on CO_2 emissions from shipping to hinder distorted competition in a global market
- Innovation fund to concentrate the initiatives related to technical progress and help share the cost for the technological investments needed
- Differentiate according to type of vessels to obstruct Sweden's usage of RoRo and vessels for SSS.

6.2 Generalisability

In this study, representatives from the larger forest companies in Sweden has been interviewed. Due to its nature, qualitative research makes it hard for generalisation, the study opens up for a deeper understanding of the unforeseen implications an inclusion of the maritime transportation in EU ETS might lead to. As this study is based on qualitative data, the conclusions of this study must be taken with caution. Firstly, the sample consists of a non-random sample of individuals that are representatives of forest companies. Secondly, many factors may have influenced the participant's narratives during our discussion, including that the data was gathered via digital meeting, that the participants may have been unwilling to declare some information, my lacking ability to interpret or that they simply were wrong in their assessments to name only a few examples that can have affected the validity of the study negatively. Still, this is nothing specific for my study but typical for qualitative research in general. To further our understanding of what factors may influence the inclusion of maritime transports in EU ETS, I would advise upcoming research to use other research methods both with qualitative, quantitative and mixed research methods. This current study result may function in a way as guiding individuals interested in this endeavour and where they can draw inspiration.

6.3 Further research

This thesis aims to analyse the potential impacts an inclusion of maritime transports in EU ETS may have on the Swedish forest industry. During this paper, several interesting aspects have been identified which may be interesting to look deeper into.

- Monitor the actual outcome from the inclusion of maritime transportation and analyse the impact of emissions and the distribution between emissions, as an increase in methane versus CO_2. Especially as trucks moving towards zero emission solutions as well.

- How oligopoly at certain routes may affect the technical change and ships used within the SSS.

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Appendix 1 – Port statistics in Sweden

Port	TEU (2019)
Port of Gothenburg	772 300
Port of Helsingborg	269 500
Port of Gävle	176 800
Port of Norrköping	103 600
Ports of Stockholm	61 600
Port of Sundsvall	38 000
Port of Umeå	23 700
Port of Malmö	18 200
Port of Södertälje	15 600
Port of Piteå 15 500	
Port of Skärnäs	15 000
Port of Oxelösund	10 100
Port of Wallhamn	7 700
Port of Karlshamn	1 500

Table 11: Ports with container service in Sweden (Port of Gothenburg 2021j)

Port	Number of RoRo units (2019)	Turnover in total (tSEK) 2019
Port of Gothenburg	551 100	763 000
Port of Gotland	46 611	2 716 453
Port of Gävle	-	148 167
Port of Halland (Halmstad & Varberg)	35 422	274 899
Port of Helsingborg	435 367	419 262
Port of Husum	9 655	-
Port of Karlshamn	80 536	333 575
Port of Karlskrona	132 844	-
Port of Landskrona	-	31 816
Port of Malmö	243 494	85 007
Port of Norrköping	-	278 843
Port of Oskarshamn (Smålandshamnar AB)	23 519	87 933
Port of Oxelösund	27 754	395 650
Port of Piteå	281	44 285
Port of Stockholm	502 504	889 000
Port of Sundsvall	-	31 545
Port of Trelleborg	795 778	258 599
Port of Umeå	18 949	14 910
Port of Ystad	286 607	113 065

Table 12: Ports with Trucks with or without trailers; trailers and semi-trailers without towage for road haulage; trailers belonging to the port or ship and other mobile non-self-propelled devices (RoRo) (Transportföretagen 2020; Port of Gothenburg 2021k; Alla Bolag 2019)

Appendix 2 - Interview guide for forest companies

Background – how the current logistical system emphasising the maritime transport

This section in the interview focused on creating an understanding for the interviews company's flows and included questions related to how the flow from each production plants was handled, how much that was transported and exported with each transport mode, how different product segments where suited for modal shift.

Shipping as the mode of transport

Included questions related to how the companies used shipping as a mode of transport, if they had own operation or acted as customers to shipping lines. Infrastructure and ports used as well as type of ship used (RoRo, container etc.)

Other mode of transports

This section in the interview included questions related to the forest companies' possibilities to use other mode of transports for export, related to the different product segments.

Green transportations

Addressed issues related to willingness to pay for greener or fossil free transportations and how the forest companies view on their emissions related to transportation.

EU ETS and the two scenarios

This theme the two scenarios calculated and presented in section four were presented and disused as well as the potential consequences they may have to the forest companies. Issues as increased cost for logistical services may impact the investments and reinvestments, modal shift, competitiveness and changes in operation where questions raised.

Appendix 3 – Interview guide Shipping Line Wallenius-SOL

Background – how the current logistical system emphasising the maritime transport

This section included questions relating to the shipping lines role in the Swedish transport network, decision of port of call, customer and lessons from earlier collaborations with forest companies.

Competition from other mode of transports

Wallenius-SOLs view of the possible modal shift towards other mode of transports.

Green transportations

Addressed issues related to the shipping line role to make shipping greener and less polluting, as well as the customers' demands for greener transportations. The choice of LNG where discussed and what is needed to accomplish transformation in the shipping industry.

EU ETS

The theme brought up questions related to the EU ETS and if it is enough for shipping lines to change their behaviour and business models to achieve emission reductions. Questions related to the impact the sulphur regulation and how that affected the shipping operations. Potential ways for shipping lines to add the cost onto the shipper were discussed as well.

Appendix 4 – Bases for the calculations for the scenarios

Ports (n mile)	Zeebrugge	Kiel	Rotterdam	Sheerness
Gothenburg	663	297	607	772
Gävle	1354	662	1298	1463
Stockholm	1245	555	1191	1356
Skellefteå	1631	939	1575	1740
Karlshamn	957	265	901	1066
Trelleborg	845	153	790	955
Norrköping	1109	417	1053	1218
Husum	1479	787	1423	1588
Oxelösönd	1155	463	1099	1264

Table 13: N miles between the different ports own table (Port.com 2021)

Ports (n mile)	Zeebrugge	Kiel	Rotterdam	Sheerness
Gothenburg	0,878	0,393	0,804	1,002
Gävle	1,794	0,877	1,719	1,938
Stockholm	1,649	0,735	1,578	1,796
Skellefteå	2,161	1,244	2,086	2,305
Karlshamn	1,268	0,351	1,193	1,412
Trelleborg	1,111	0,202	1,046	1,265
Norrköping	1,469	0,552	1,395	1,613
Husum	1,959	1,042	1,885	2,104
Oxelösönd	1,530	0,613	1,456	1,674

Table 14: Low emission scenario. Average 50g CO2/n mile, total in tonnes

Ports (n mile)	Zeebrugge	Kiel	Rotterdam	Sheerness
Gothenburg	2,161	0,968	1,978	2,516
Gävle	4,413	2,157	4,231	4,768
Stockholm	4,058	1,81	3,882	4,419
Skellefteå	5,316	3,061	5,133	5,671
Karlshamn	3,119	0,863	2,936	3,472
Trelleborg	2,754	0,498	2,575	3,112
Norrköping	3,614	1,359	3,432	3,97
Husum	4,821	2,565	4,638	5,176
Oxelösönd	3,764	1,509	3,582	4,12

Table 15: High emission scenario. Average 123g CO2/n mile, total in tonnes

SCA, Wallenius SOL, Holmen and DFDS	CO2 per n mile (gram)
Exporter	93,93
Shipper	92,91
SCA Ortsviken	44,86
SCA Obbola	46,93
SCA Östrand	47,73
Fiona Seaways	135,50
Thuleland	50,27
Jutelandia	155,13
Tavastland	51,30
Tundraland	44,73
Hermine	70,34
Flandria Ropax	188,32
Ysaline	58,01

Table 16: Table over the ships used for the scenario calculations (EMSA 2020)