

Sustainable Port Development

Opportunities and Actor Relations at the Port of Trelleborg

Bernadett Kiss

Supervisors:

Tomas Käberger

Lars Hansson

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Tel: +46 – 46 222 02 00, Fax: +46 – 46 222 02 10, e-mail: iiiiee@iiiiee.lu.se.

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Abstract

Environmental performance of sea transport is of growing concern for the evolution of European transport policy as well as local air quality management of harbour cities. This study investigates the case of Trelleborg and highlights factors, which can hinder or facilitate the improvement of stakeholder cooperation for sustainable port development. The developed orientations suggest enhancement in the field of (1) environmental performance and (2) economic viability of port operations and also considers (3) social feasibility. The identification of opportunities for improvement and actor interaction considered being an essential step (a) to develop environmental performance strategies and (b) to implement on-shore and on-board technological alternatives.

Keywords: Trelleborg, port, ferry, stakeholder dialogue, environmental performance

Executive Summary

Problematization

According to annual air quality measurements Trelleborg has been one of the Swedish cities with the highest sulphur dioxide (SO₂) concentration values in ambient air since years. Sea traffic has been found to be the main source of these SO₂ cc. levels. Opposite to vehicles on road and rails, sea ships consume marine oil with high sulphur content. Recognizing the growth and the related environmental impacts of road transportation measures addressing air emissions have already been taken from international to local level. In the meanwhile, sea traffic got less attention and environmental regulations were evolving much slower. Because of the large volumes and thus less frequency, the European Union generally considers sea transportation as more environmentally sound way of goods shipping than road and air transportation. However, policymakers are also aware of the air pollution concerns related to the shipping industry. Regulatory measures have been recently introduced both at the European and global level. The new International Maritime Organization regulation in MARPOL (Marine Air Pollution Convention) Annex VI and the European Union Directive on sulphur content of marine fuel (Directive 2005/33/EC) will take effect from 2006. The advanced legislative framework is expected to have effects on local level in the near future. Identifying the relevance, actors around the port of Trelleborg are also to react to these new-coming regulations.

Trelleborg is the second largest harbour in Sweden in terms of tonnage of transported goods. In 2004, there were almost 11 million tons of goods transported and almost 2 million passengers travelling through the port. The city fulfils a function of a bridge between the Scandinavian Peninsula and Continental Europe and a logistics hub for intermodal transportation in the region. Harbour activities, including being an intermodal transportation node involve the presence of various actors. (1) Goods-owners or contracted suppliers, e.g. logistics companies transport their goods to Trelleborg. Goods arrive by trucks, trailers and trains at the harbour, where mostly (2) Trelleborgs Hamn AB (THAB), a limited company of the municipality amongst other duties is responsible for loading and unloading activities on the territory of the port. (3) Three ferry operators, Scandlines AB, Scandlines AG and TT-Line, with altogether eleven ferries ship the goods across the Baltic Sea to three German destinations. The port is located in the municipality of Trelleborg. (4) Trelleborg Municipality is the wholly-owner of THAB and amongst others responsible for air pollution issues and planning of future city development. (5) National authorities partly with the assistance of various governmental agencies manage the same fields, but on national level. The Swedish Environmental Protection Agency (Naturvårdsverket) coordinates and promotes environmental policy and protection. The Swedish National Rail Administration (Banverket), the Swedish National Road Administration (Vägverket) and the Swedish Maritime Administration (Sjöfartsverket) are involved in infrastructure planning and development as well as transport research.

Air quality concerns are present on international, national and local level. On local level harbour cities, in this case Trelleborg is challenged to face the problem of air emissions generated by sea traffic. Due to the municipality ownership, THAB integrates environmental and quality management into its daily activities and as stated in the environmental and quality policy expects the same from its customers involved in port and related activities. When it comes to environmental performance issues, the presence of various transportation modes and different actors requires (1) precise assessment of the exact sources of air emissions and (2) careful port development planning, where the opinions and demands of different actors are taken into consideration.

The concept of sustainable development has been introduced to facilitate strategic processes where ecological, economic and social objectives are handled together. The primary driving force may be the global ecological challenges, but the solutions must incorporate economic and social considerations to be feasible. Issues around air quality and pollution from the ferries posed a challenge to THAB, but solutions must preserve economic competitiveness of the harbour transport system and the activities should be socially acceptable to society.

Research question

The presence of several actors at the port of Trelleborg suggests a cooperative approach in strategic planning for improving economic, environmental and social performance of the port and the related businesses. The overall objective of the case study reported here is to identify relevant factors, which hinder and facilitate the cooperation for successful sustainable development among actors at the port of Trelleborg. Observations obtained during the case study have also contributed to evolve and further stimulate the cooperation among actors.

Research design and method

The process of the embedded case study was guided by methods from Scholz & Tietje (2002); these methods have already been applied successfully to several sustainable infrastructure development studies before. These approaches amongst others include readings, interviews, experiential case encounters, SWOT analysis and detailed calculations on air emissions and investment costs generated by port and related activities to get to know the case. Scenario construction, formative scenario analysis and exploration parcours was applied to obtain opinions and multi-attribute utility theory to evaluate different point-of-views. Besides few disadvantages of having a small research group, positive outcomes occurred during the research process as listed below.

(1) The experiential case encounter, i.e. the experience of travelling on the ferries with staff provided unique and valuable information during the phase of getting to know the case. This information could not have been obtained from literature review or other theoretical approaches.

(2) Scenario construction was applied to investigate actors' opinion on possible futures in ten years time perspective. Four local scenarios were created with the intention to investigate how open the different actors are for changes. The scenario called (1) *Present situation* represents the null alternative including no changes compared to today's state. (2) *Management on board* scenario consists of technical measures carried out on board the ferries, such as nitrogen oxides (NO_x) catalyst and wet scrubber for air emission reduction. The (3) *Utilization of land-based resources* scenario is based on investments on land, which facilitate the goods transportation. The fourth scenario, (4) *City integration* incorporates the widest range of measures both on board the ferries and on land, containing technical investments on board and some society-oriented investments on land, with e.g. cable-car and housing area next to the port. These local scenarios were also investigated in a context of global changes, including the raise of oil price and the change in volume growth. The evaluation indicated that each of the local scenarios appeared as the preferred one among at least one actor group. The project group members did not expect this variation among the actor groups.

(3) The geographical spread of actors contributed to the development of a new version of the evaluation methods, i.e. exploration parcours. The local scenarios were described in power point presentations on a laptop computer while answers were recorded on a second computer, or on paper. This made it possible to visit interviewees and to use the same questions for a random poll on the streets of the city.

Main findings and conclusions

Observations on actor relations

Personal interviews were conducted in the frame of exploration parcours, which resulted in the following observations on actor relations.

(1) THAB has good knowledge and mutual understanding of the interests of the municipality administration and of their customers, the ferry lines. However, THAB is less aware of the ideas of the customers of the ferry lines, i.e. logistics companies and end-customers. Extending the reach of their relation one more step may give earlier awareness of ideas and desires that will appear as demands via the ferry lines after a period in time.

(2) Most important in terms of long-term port development planning was the observation that national and regional authorities had very little knowledge about the conditions and options of THAB. The relationship between THAB and these authorities are mutually weak. The representatives from national authorities often claimed they had "no idea" of the interests of THAB and even refused to answer such questions. These actors have decision influence over important infrastructure investments as well as economic incentive structures. As national and regional authorities rule over strategic developments, improving the relationship with them appears to be vital for further progress of the harbour.

(3) A minor observation is that the mutual understanding between the ferry lines and the municipality may be improved. The ferry lines see the municipality more as a threat than they appear to be. At the same time the municipality believes that ferry lines want to handle their problems by themselves. The responses given to the research group indicated that the ferry lines were interested in using more of land-based resources that could be supplied by municipal actors.

Observations on environmental conditions

The observations on environmental conditions are based on air emission estimations at present and in the possible futures and actors' perceptions on air quality issues related to the scenarios.

(1) Calculations show that the relative share of air pollution in Trelleborg originating from the ferries has increased as land based emission sources continued to shrink. Figure 1 illustrates the share of SO₂ air emissions at present, which exceeds 96% and compared to 2000, it has risen with 2%. Taking into consideration an average value of three pollutants (NO_x, SO₂ and CO₂) sea traffic contributes with 82% to the total air emissions in Trelleborg. The absolute air emission values of these three pollutants show an increase of an average 17% compared to the values estimated in year 2000.

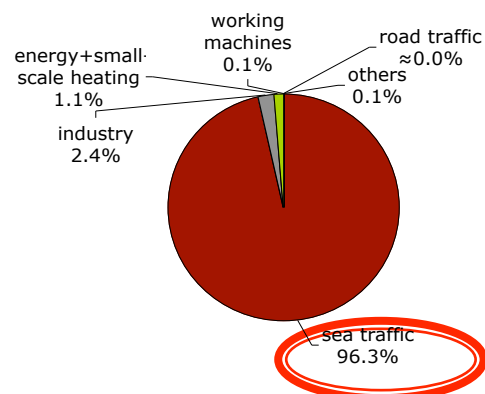


Figure 1 Contribution of sea traffic to the total SO₂ emissions, 2004

(2) Emission standards for ships set up by the IMO and the EU are not very stringent today; however new regulations on the sulphur content of marine fuel are entering into force from 2006. The ferry lines in Trelleborg use fuel with lower sulphur content than required today, thus perform significantly better than the present legal requirements. However, from 2006 one third of the ferries has to switch their marine fuel to ones with lower sulphur content to

comply with the European requirements. By 2010, all ferries have to lower the sulphur content of the marine fuel used presently at berth, unless new technologies are applied with the same results in SO₂ emission reduction. Figure 2 illustrates the required SO₂ emission levels at the port of Trelleborg.

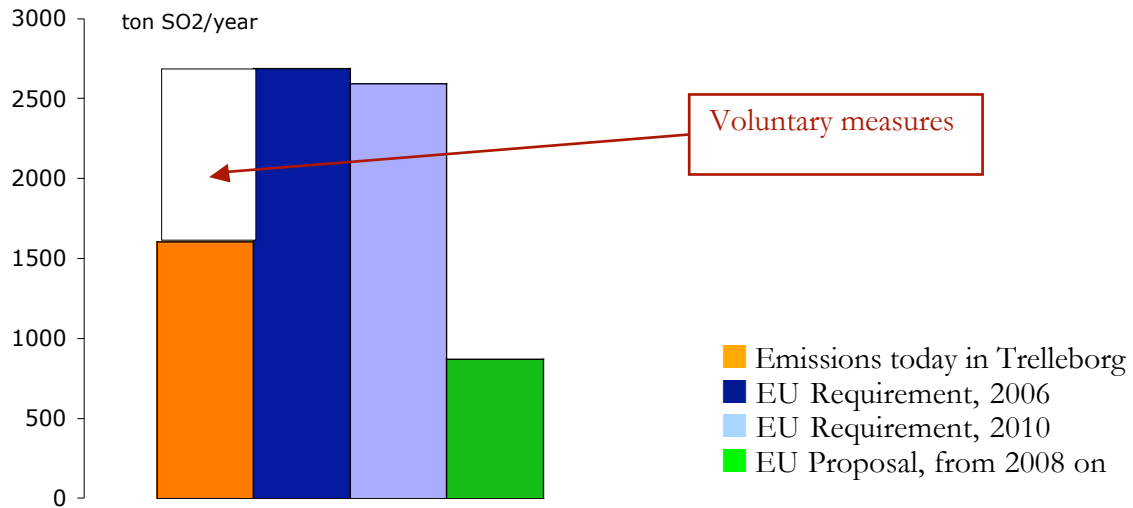


Figure 2 Future requirements of the European Union on the sulphur content of the marine fuel applied to ferries cruising in Trelleborg

(3) For sea transport compared to road transport there is a significant potential for further advancing its environmental performance. Improvements are possible if technologies such as catalysts and better fuels with lower sulphur content would be applied to the ferries. For instance, the installation of NO_x catalyst would result an emission reduction of 90%.

(4) The public, the municipality as well as the national authorities rank air pollution as the most important evaluation criteria for future harbour developments. During the analysis of future options it was found that the future plan preferred on the second place by all actors was the *Utilization of land-based resources* local scenario. A potential base for future cooperation can be seen in some favoured individual elements of this local scenario.

Observations on economic conditions

Observations made on economic conditions are based on cost estimations carried out by the research group, a literature review on economic instruments and actors' perceptions while evaluating local scenarios. The non-transparency of cost items due to the competition between the ferry lines in Trelleborg caused some difficulties in the calculations.

(1) Environmental incentives in the form of differentiated fairway dues appear to be desired by all actors. At present, the ferry operators seem to have a positive attitude towards both environmentally differentiated fairway dues and differentiated port dues. However, opinions on the level of these dues are ambiguous.

(2) Despite the cost-difference between different types of fuels, the ferry lines in Trelleborg have been able to operate side by side year after year. Ferries are running on two types of marine fuel at presence: heavy fuel oil (HFO) and marine diesel oil (MDO). In May 2005, the price of MDO was twice as much as the prices of HFO. Due to non-transparency on cost issues the research group could not identify the strength of economic incentives; however the fact that the ferries of Scandlines AB, Scandlines AG and TT-Line with different environmental performances are able to compete on the same ferry routes since years suggests an examination of the stringency and effect of the incentives of the fairway dues.

(3) Calculations show that even large infrastructure investments have moderate impact on transport costs. In spite of this, actors believe that infrastructure investments could significantly increase the transport cost, and thus these investments are not favoured for further development. Figure 3 illustrates the distribution of operational cost per ton of transported goods.

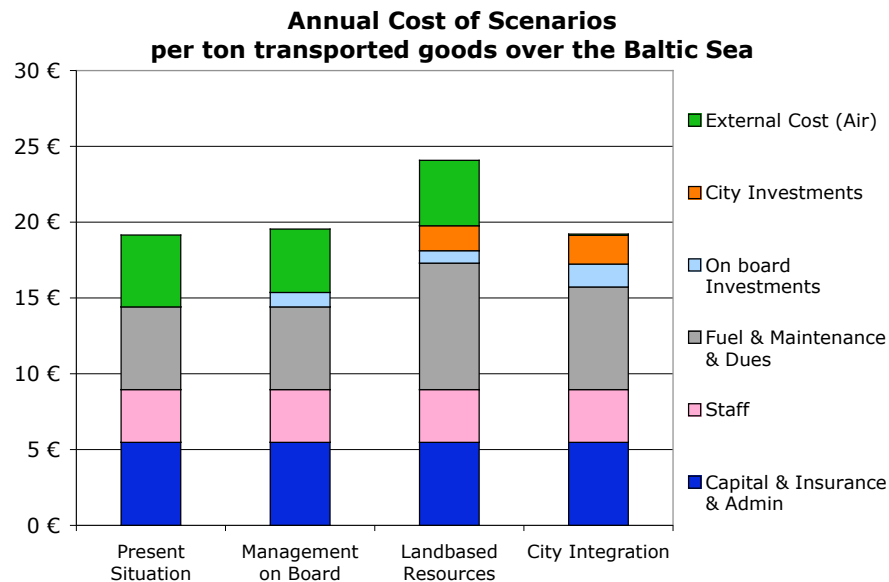


Figure 3 Annual costs of scenarios per ton transported goods across the Baltic Sea

(4) Generally, transport cost is still dominated by capital investments, personal and fuel costs. Technical investments on board, such as NO_x catalyst and wet scrubber or on land, such as shore-side electricity have only minor effect on the transport cost, taking out 1.5-3% of the total operational cost. According to the calculations, on board investments compared to infrastructure investments in the city are also much lower. However, the results of the interviews show that actors do not see these differences. Further improvement in the communication among actors could be achieved by (1) filling the gap of information insufficiency on infrastructure cost issues as well as on board technologies, (2) harmonize the structure how actors are looking upon the operational and transport costs and (3) clarify the way how these costs are related to each other.

As a general conclusion from the case study carried out for Trelleborgs Hamn AB, it can be drawn that multi-actor presence often demands transparent reporting on activities and future planning, smooth information flows and open communication channels among actor groups.

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1 Introduction

1.1 Shipping and trade

The continuous growth of transportation is a worldwide tendency. The average annual increase of freight transport in the past 30 years in the European Union has been around 4% (Eurostat, 2003). Each day, the transport industries and services of the EU have to get more than 150 million people to and from work, carry 50 million tons of goods, deal with 15 million courier, express and parcel shipments in the EU. The crucial role played by seaports is evident: in 2003, there were over 2.6 billion tons of goods handled in EU15 seaports. Short sea shipping accounted for 63% of the entire volume transported by sea (Xenellis, 2005).

The Baltic Sea is one of the busiest shipping areas in the world since the Hanseatic times. Long coastlines, large industries and busy harbour cities are the centres of trade since the Middle Ages. In 1998, around 330 million tons of goods were passing through this sea (Nordregio, 1998, p. 91). According to projections shipping in this region is expected to further grow with an average of 75% in the following ten years (Ågren, 2005a). Today, in nine countries, there are about 85 million people living in the Baltic drainage basin. Around 23% of the inhabitants are concentrated in the 10 km band around the coast. Sea traffic has always been a natural linkage between these countries. At any time one observes this sea, there are around 2000 sizeable ships cruising on the Baltic shipping routes (Ågren, 2005a).

Since 1994, sea transport performance in Sweden has increased by approximately 12%. In 2001, sea transport from Sweden to recipients within and outside the country had a share of 13% in terms of weight and 3% in terms of value (SIKA, 2005, p. 73). In 2003, 29% of the total freight transport (domestic loads) within the country was transported at sea, i.e. 150 million tons of goods (SIKA, 2005, p 71).

1.2 Environmental impacts of shipping

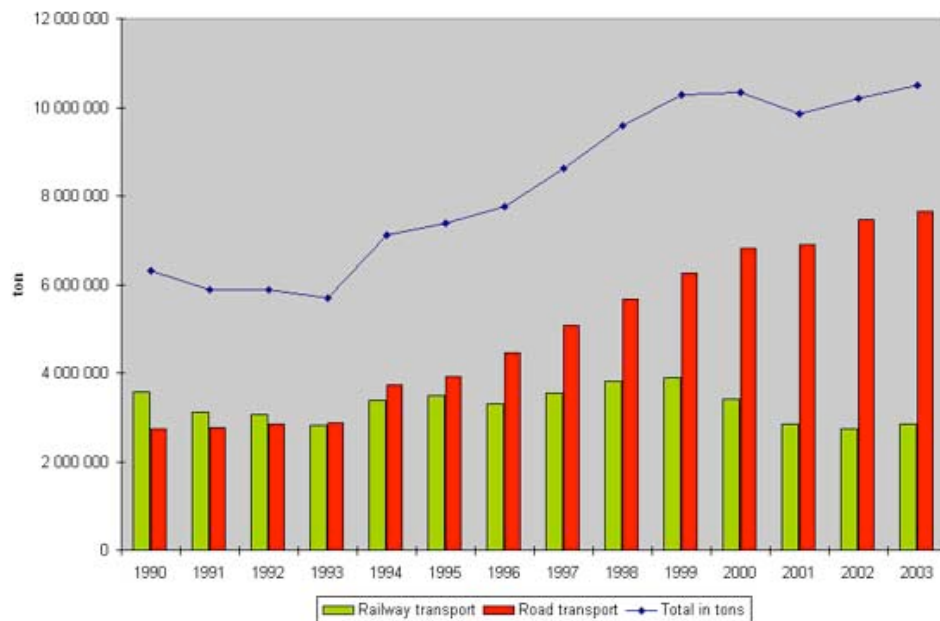
There is a growing concern regarding the environmental impact of sea transport. Amongst others the most relevant environmental aspects are air emissions, water and land pollution; additional aspects, such as the disturbance of marine environment or coastal fauna are partly outcomes of the above two. The generation of air emission is lead back to (1) the sulphur and polycyclic aromatic hydrocarbons content of marine fuels and (2) the incomplete combustion, thus the engine output. Water pollution could arise due to (3) mishandling of marine fuels, (4) spillage of hydraulic or lubricating oil, (5) waste streams lead into the sea with e.g. environmentally not favoured detergent used on board, (6) paints used for bottom-colour or protection from rust and (7) cooling-water (Ahlbom & Duus, 2003). Based on the humongous size of ships and the manifold material used while building, their end-of-life management could be problematic and could lead to land pollution and indirectly contribute to eutrophication. Recognizing the various environmental impacts of shipping, air emissions are chosen to be in the focus of this report.

While pollutant emissions, such as sulphur-oxides from land-based resources are gradually coming down, those from shipping show a continuous increase. At present, ships are one of the largest sources in the European Union, which generate sulphur dioxide emissions. Research recently carried out for the European Commission indicates that within 10-15 years, emissions from international shipping around Europe will have surpassed the total from all land-based sources in the 25 member states combined (Ågren, 2005b). It is not surprising that air quality issues are growing concerns not only on local level in harbour cities and in port management systems, but also on European policy level.

1.3 Case of Trelleborg

1.3.1 Sea transport

One characteristic of the Nordic countries, thus Sweden is that they all have long coastlines and are dependent on maritime transport. The ports are not only links between countries, but also important intermodal nodes connecting sea, rail and road traffic for freight transport. At present, the port in Trelleborg is the second largest port in Sweden in terms of the quantity of goods transported (THAB, 2005). Trelleborg is located in southern Sweden, on the shore of the Baltic Sea and has almost 40 000 inhabitants. Until the end of the 19th century the city was mainly living on fisheries, when in 1897 the first ferry line started touring between Sweden and Germany. The regular connection to the continent brought many industries into Trelleborg and the neighbourhood. The 20th century's industrial city has grown to be one of the most significant logistics hubs in the county today. Through the ferry lines THAB provides regular connections on the continent, to German destinations 85-120 km away from Sweden. Trelleborg also represents a crucial node for the Swedish industry towards the central European markets. The ferry operators offer passageway for passengers, cars, lorries and trains. Goods transported on trucks takes 75% of the total amount of goods transported through the harbour. Transportation volumes through Trelleborg have had a continuous growing rate since 1994 with an annual average of 3% (see Figure 1-1). In the past six years the amount of transported goods via the port was around more than 10 million tons per year, which represents approximately 15% of the Swedish foreign trade (Trivector, 2002).



Source: THAB, 2005

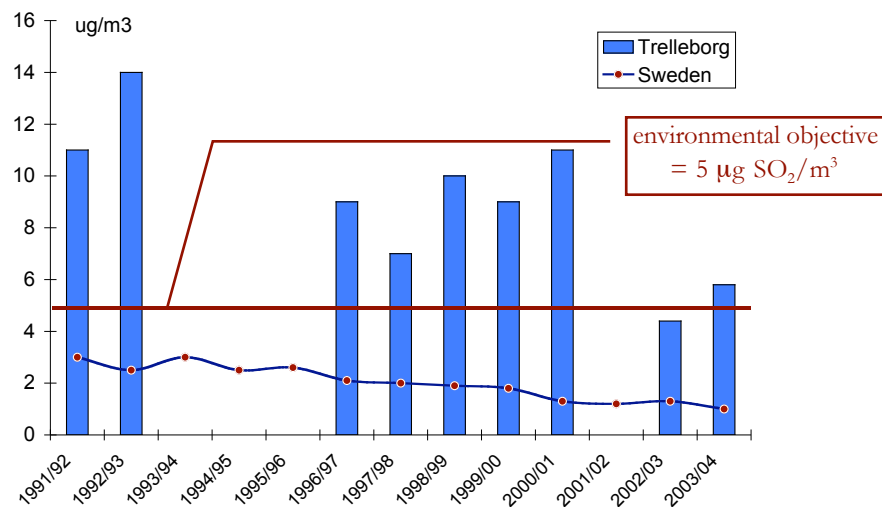
Figure 1-1 Statistics for goods tonnage in the period 1990-2003, THAB

2004 was a record year for the port with more than 10.8 million tons of goods passing through Trelleborg; never before have such high volumes of goods been handled there. One of the reasons of 100 000 tonnes increase - compared to 2003 - was the accession of new member states, in May 2004 (Borgemark, 2005). As before, the lorry traffic showed the highest increase (+ 3 %), with a total of 7.9 million tons. In the meanwhile, the conventional railway traffic decreased by 100 000 tons, amounting a total of 2.7 million tons. The decline is due to (1) infrastructural changes in whole Sweden, where large customers have shifted freight movements to other corridors, (2) changed operational patterns of customers and (3) the overall decline in market share of goods transports on rail. The number of passengers travelled via Trelleborg also decreased by almost 150 000 compared to 2003.

1.3.2 Air quality

Due to this heavy transport volumes through the port and the city, according to air quality measurements carried out in Swedish cities and surrounding areas, Trelleborg is placed among the ten most heavily polluted settlements in Sweden (IVL Swedish Research Institute, 2004). Previous regional and local environmental performance assessments carried out at THAB also pointed out a significant environmental load on the port, specifically in terms of air emissions. The contribution of shipping activities to air pollution in the city of Trelleborg in case of certain emissions, such as SO₂ and NO_x is above 95%, respective 86%.

In the frame of the URBAN Project, there are regular measurements of certain pollutants carried out by IVL during the winter half year in app. 42 settlements. According to these measurements amongst all the settlements, Trelleborg showed the highest values of SO₂ concentration in the ambient air in the past five years. The average SO₂ concentration in the air during these winters exceeded the environmental objective (miljömål), 5 µg/m³, set by the Swedish Environmental Code (Miljöbalk, 1998). Figure 1-2 illustrates the values of SO₂ concentration between 1992 and 2004. Improvements were experienced in the past 3 years, however the objective has still not been reached. The highest values of NO_x concentration in the air, amongst other areas, such as the West Coast and nearby Mälaren, were also measured in the county of Scania. In Trelleborg the NO_x concentration has been more or less stagnating over the past five years, although it is far above the country average. The same high values apply to particulate matter (PM₁₀)¹ concentration in the air. However, no trend can be set on the latter as the measurements originated from only the past three years.



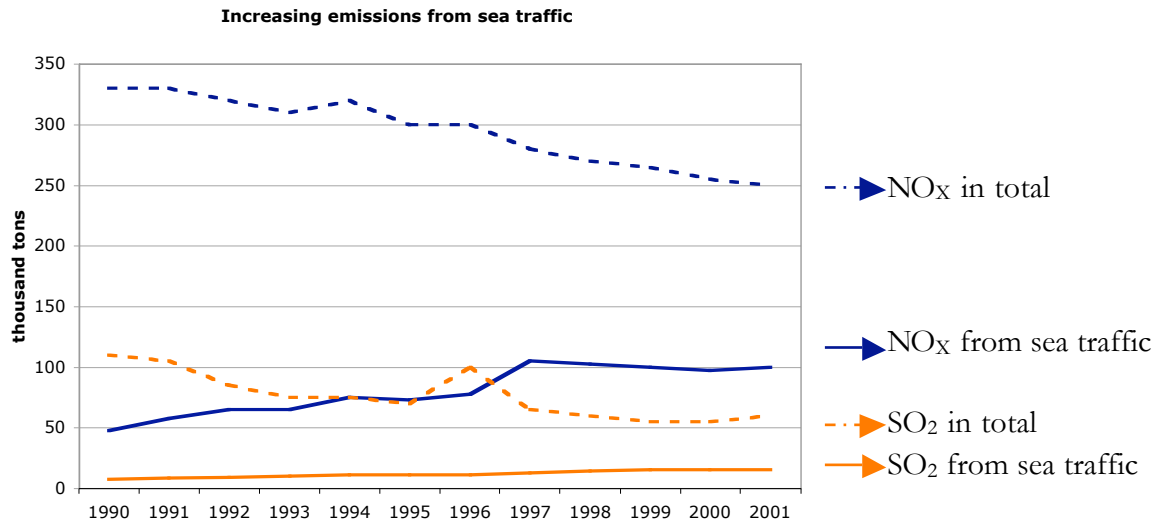
Source: IVL, 2004

Figure 1-2 SO₂ cc. during the winter in the past 12 years

1.3.3 Air emissions

According to estimations of the Swedish Environmental Protection Agency, SO₂ and NO_x emissions show an overall decreasing tendency in the past ten years in Sweden. SO₂ emissions generated by the sea traffic, conversely, display a slowly growing trend. NO_x emissions from sea traffic were increasing until 1998; since then a slight decline is occurring. Figure 1-3 illustrates the evolution of SO₂ and NO_x emissions produced by international sea traffic and in total in Sweden.

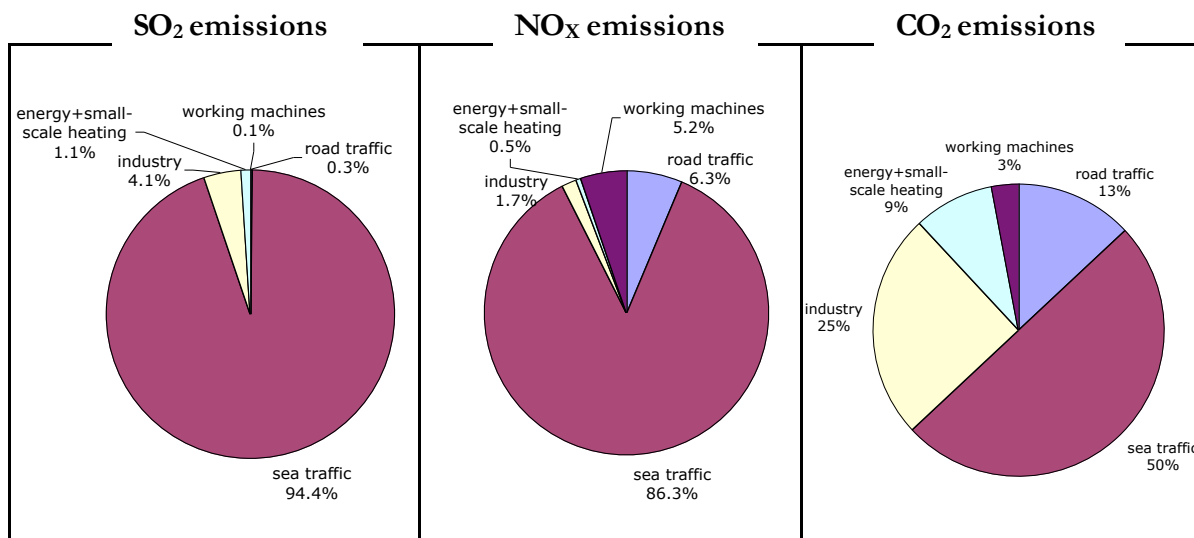
¹ Particulate matters consist of particles of solid matter and droplets of liquid that are small and light enough to remain suspended in the atmosphere. The diameter of PM₁₀ is smaller than 10 microns.



Modified source: SEPA, 2003, p. 22 and p. 79

Figure 1-3 SO₂ and NO_x emissions generated in total and by sea traffic in Sweden

In 1999, Skånes Luftvårdsförbund² carried out estimations on the port's contribution to air emissions in Trelleborg Municipality, including the ferries' half way trip to Germany (Trivector, 2002). According to the results of these air emission calculations, the port contributed to the total SO₂ emissions generated on the territory of the municipality and on half way between Sweden and Germany with almost 95%. From a national perspective, in 1999, SO₂ emissions generated by port and related activities in Trelleborg took up around 8.5% of the international maritime and more than 2% of the total SO₂ emissions in Sweden (SEPA, 2003). The contribution of NO_x emissions originate from port activities to the total was more than 86%. This percentage represents app. 6.5% of the international maritime and 2.6% of the total NO_x emissions in Sweden (SEPA; 2003). 50% of the total carbon dioxide (CO₂) emissions in Trelleborg Municipality originate from shipping. Figure 1-4 shows the contribution of sea traffic to the total emissions in Trelleborg Municipality regarding SO₂, NO_x and CO₂ in 1999.



Source: Trivector, 2002

Figure 1-4 Sea traffic's contribution to SO₂, NO_x and CO₂ emissions in 1999

² Skånes Luftvårdsförbund is a co-organization, which is dealing with air quality issues in the county of Scania.

The continuous growth of transportation and the large contribution of the port and related activities to the total air emissions generated in the municipality of Trelleborg leads to increasing demand on one hand for well organised infrastructure for all types of transportation and on the other hand for more attention and caution to the environmental load related to the growing frequency of transportation. By integrating air quality issues into its management system THAB decided to take proactive steps for diminishing the environmental load on the port and on the city of Trelleborg.

1.4 Objectives of Trelleborg case study

The ambition of the Trelleborg case study includes (1) the provision of a credible way to update the estimates of environmental load (i.e. air emissions) on Trelleborg from port and related activities; and (2) the identification of opportunities for improvement and actor interaction intended to develop strategies for implementation of technological alternatives. This thesis does not cover the overall ambition of the case study, but represents a significant part of it, namely the second goal: assessment of actor relations around THAB.

The objective of the embedded case study reported here is to (1) identify factors, (2) to provide an insight and (3) to develop orientations on options how the environmental performance of the port can be improved. This report focuses on the assessment of the relation and interaction among actors involved in port and related activities. In order to initiate and facilitate the dialogue among actors air emissions generated by port and related activities in relation with the air quality of Trelleborg were taken as a thought-provoking tool. In the light of this ambition, the **research questions in focus** are the following:

1. *What are the factors, which hinder and facilitate the successful future cooperation for sustainable development among the actors around the port of Trelleborg?*
2. *How can further cooperation be built on the common point of views on the actors' possible futures?*

In order to address these research questions having been conducted the project the following **sub research questions** needed to be answered:

1. How is the present relation among actors around the port of Trelleborg?
2. Where is agreement and disagreement between the actors?

The assessment of the above questions required a tailor-made approach from the research group to investigate the case. The method to be chosen had to also have a general aim, namely to provide the readers with an insight of economically, socially and environmentally relevant factors in port management, which could serve as a basis of further research.

1.5 Embedded case study methods

Embedded case study methods were applied for the case of Trelleborg. These methods were developed at the Department of Environmental Sciences at the Swiss Federal Institute of Technology (ETH Zurich) for groups of 30-50 students. The ambitions were to integrate qualitative and quantitative approaches, using methods of natural science as well as social science in combination the sometimes-implicit knowledge among case experts (Scholz & Tietje, 2002).

“Case studies are good for problems where truth is relative, reality is realistic and the structural relationship is contingent.” (Scholz & Tietje, 2002, p. 4) Embedded case study methods were found to be the most adequate approach to investigate the case mainly because of four reasons. Firstly, they are often used in sustainable development studies, where researchers are facing contemporary problem in a real life context. In this case the quality of the

environmental system and its relationship to business and social systems needed to be addressed. Secondly, these methods are developed for systems where different interest groups are involved or affected by the case. In this way, individual analysis can be conducted per actors or larger units (actor groups) and per different topics, i.e. interview questions. Thirdly, the approach was not known for the actors involved, which led to high participation level driven by intense curiosity from the case members' side. The research group believed that new applications could often result in new relations and changed behaviour. Fourthly, case studies are a lot complex, thus in general no one and only solution exists. Embedded case study methods do not merely imply looking for the best solution, but often opinions, interests and orientations by providing structured information for actors with different interests.

Due to the environmental concerns of THAB, there were a few environmental impact assessments conducted and several future 'visions' were developed; however there have not been any projects implemented with the objective to reveal the actual behaviour, interest and opinion of actor groups closely related to or being involved in port activities. This case study was put into practice in order to satisfy the needs and fill up this gap arose regarding the awareness of the actors of each other's attitude.

Following the principle of these case study methods, i.e. *learning by doing*, the conduction of the Trelleborg case study will be described here below step by step, how this approach was put into action.

1.5.1 How to understand the case?

The first phase of the project was to get to know the case; for this reason the following routines were used: (1) establishment of a project group and (2) conduction of project meetings, (3) experimental case encounter, i.e. on board visits on ferries and (4) informative and descriptive interviews. It also included general (5) literature review of the shipping industry, and the surrounding policy framework, the actual environmental impact assessments of THAB, daily news and article reviews. The first project goal, (6) the update and estimation of air emissions generated by port and related activities provided a good insight into the problem. The project group was formulated in the beginning of the project and consisted of the consigner, THAB, two competing ferry operators, Scandlines AB and TT-Line and the research group from IIIEE: two students and their supervisor. The project group functioned as a reference group, providing a platform for a continuous discussion and feedback to the research team on the achieved part results during the whole case study.

1.5.2 What are the possible futures of the case?

The second phase of the project was dominated by the creation of scenarios, which by understanding options and procrastinating the reaction of other actors under varying conditions aimed to present possible orientations, i.e. future actions of THAB and actor groups. For modelling the system and pointing out the relations between significant factors, such as new technologies, fuel consumption, ferry speed and so on, four local scenarios were constructed. These local scenarios were then put into a context of global changes. The difference between local and global scenarios is while in the local scenarios actors can have an influence on certain factors; in the global scenarios, they generally cannot affect changes, such as oil price or volume of transportation. After the identification of the actors around the port, actor groups were formulated, based on their common interests. In order to figure out the opinions, interests and views on possible futures of the different actor groups, formative scenario analysis was applied.

1.5.3 How to get an insight into actors' view?

In the third phase, the presentation of the scenarios, questionnaires and interviews were conducted. This method is called exploration parcours and enables the researcher to focus on what is important for individuals within the system of study and draw conclusions from combined results reflecting the opinion of certain actor groups. Individuals in each actor group were confronted with the scenarios and criteria according to which the scenarios were to be evaluated. The interviewees were also provided with a detailed questionnaire regarding the criteria, local and global scenarios. The technical set-up of the four scenarios was partly a slide show on screen of a portable computer with straightforward description and colourful sceneries and partly printed descriptions of the scenarios. The questionnaires were available both electronically on another portable computer and in printed version to facilitate the filling in process by being able to look at the images while filling in the forms.

1.5.4 How to understand the results of interviews?

The fourth phase contained the evaluation of interviews and was inspired by Multi-Attribute Utility Theory (MAUT). This method serves as a clarification for the preferences, comprehension and evaluation of different actor groups. The knowledge obtained from this evaluation can be laid as a basis of searching for future solutions of the case, which are favoured and supported by all actors. There were three types of MAUT method used in this report: MAUT α , β and χ . After having estimated values on air emissions and transport costs of local scenarios in the frame of MAUT α , the researchers could set preferences on the criteria and scenarios. MAUT β facilitated to put the actors' criteria-choice into comparison with experts' opinion and estimated values. MAUT χ is the phase, when interviewees themselves could determine how well certain criteria are fulfilled in different scenarios. Chapter 4.4 will provide a deeper insight into this evaluation method.

Strengthening the principle of the learning by doing approach, in the process of a case study regular feedback and approval from the case members are necessary. The monthly presentations of results on the project meetings provided possibility for continuous interactions and also each time a new comprehension of the case.

1.6 Scope and limitations of the case study

1.6.1 Scope

The scope of this report is limited to the case study conducted at the port of Trelleborg. It examines how Trelleborgs Hamn AB and some related actors could improve their future cooperation in the light of sustainable development. In order to smooth the progress of this cooperation, case-specific facilitators and hindrances were to be identified. These factors could serve as a basis for further discussions on improvements among actors involved in port activities, including improvement of their environmental performance. By environmental performance, air emissions were taken into focus. It is recognised, however, that ports and ferry operators directly or indirectly contribute to other environmental impacts, such as noise, water and land pollution. These environmental aspects are out of scope of this report.

The case study is about the port of Trelleborg and was initiated in November 2004 by THAB. The IIIEE research group implemented the assignment in the form of a four-month project and further two thesis works. This case was studied, firstly because THAB engaged itself to initiate and manage environmental dialogue among actors involved in port operations. Secondly, because this case seemed to imply an opportunity to gain a comprehensive view of the environmental challenges ports, ferry operators and local and national authorities are facing today in Sweden. These companies and organisations are mentioned in the report as

actors, which are related to THAB and can have a direct economic, environmental or social influence on the port activities.

Due to the narrow reach of the case, it is beyond the scope of this study either to determine the concept of sustainable development or to map and analyze all the opportunities of future improvements and all possible actor relations. However, the scope is to point out certain facilitators and hindrances, based on which the actors can make a step ahead on the way of sustainable development. The concept of sustainable development is interpreted in this report as the catalyst of strategic processes where ecological, economic and social objectives are handled together. For companies and organisations, sustainability is defined as a moving goal towards which they are to strive; it is never seen as an end product of any actions. Based on that, sustainable development can be defined as the progress of actions taken in the project. The primary driving force may be the global ecological challenges, but the solutions must incorporate economic and social considerations to be feasible. This case study reflects a similar process. Issues around air quality and pollution from the ferries posed a challenge to the harbour, but solutions must preserve economic competitiveness of the harbour transport system and the activities should be socially acceptable. Align with sustainability pathway the economic viability of the port was investigated in the frame of the other thesis work related to the Trelleborg case study (Buxhoeveden, 2005). Questions addressed in Buxhoeveden (2005), such as how could certain factors, such as speed, fuel consumption and various technological investments support the environmental performance and the economic viability of the port are out of the scope of this study.

1.6.2 Limitations

The boundary of this study is the port of Trelleborg, which also covers port related activities on regulatory as well as business field. The author was facing the following restraints before the conduction of the case study: (1) current non-final status of the national, regional and local development plans, (2) geographical and organizational dispersion of actors, (3) questionable effectiveness of policy instruments, (4) period of implementation coinciding with the summer holiday season and (5) some parts of the methodology.

(1) A large limitation of the research is that regional, city and port plans are still in the process of development. Description of these plans is therefore limited to what actors have developed so far and information that could be gathered from interviews.

(2) Another large limitation of the data gathering part of this report is the ownership and organisational structure of the ferry operators, which made it difficult to get hold of relevant data and involve all actors of relevance.

(3) It is recognized that from an economic viability point of view economic instruments are important tools when looking at overall economic and environmental performance of ports and ferry operators. For better understanding of the study's background, these instruments, differentiated fairway and port dues are comprised in the report. However, due to the need for practical limits in the scope of this study, the effects of these economic incentives are not extensively addressed and not analyzed.

(4) The period of the research took place during summer, the holiday season, which drew limit to the number of available interviewees both for open interviews for data gathering and air emission and cost calculations and for the exploration parcours.

(5) Another sizeable limitation was the human resource constraint. In the type of embedded case study methods applied for the case, both the research group and the project group represents higher variety of students, respective company representative. Given the time

frame of this research study and the limited human resources, still many of methods have been applied.

Conclusions and recommendations are mostly unique for the port of Trelleborg and actors around. There are, however, some of the implied methods and certain findings that can be applicable for other ports and other ferry operators in Sweden.

1.7 Target groups of the case study

The intended audience of the case study, from a practical point of view, is the consigner of the project, Trelleborgs Hamn AB and the case members, i.e. the ferry operators: Scandlines AB and TT-Line. The results of the case study can be used for improving further co-operation with actors involved or drawn into further stakeholder dialogue, such as Scandlines AG, the Danish-German Scandlines ferry operator. Some findings can be relevant for other ports and ferry operators in Sweden to obtain an insight into sustainability issues concerning sea transportation and port management.

In general, through the applied methods, opinions and evaluations of the actors can be obtained. These new perspectives of the co-operative partners can lead to new actors' behaviour, new constellation of the actor groups and new concept of the future development. One portion of this new constellation can show the way to inclusion of other actors, such as Trelleborg Municipality and logistics companies.

The case study could be interesting for other study teams, supervisors and universities, which are interested in this working method or already working with them in order to learn from the faults of this case and also to improve its findings. Utility of the case study for the researchers could contain new projects based on the case study, new research constellations for the same case study and new relationships between the case members and the researchers.

1.8 Readers' guide

The report is structured into six main chapters. *Chapter 1* introduces the reader into the case of Trelleborg from the perspective of the current trends in sea transport, air quality measurements in Sweden and air emissions generated by sea-going ferries docking at the port. The main concern is the environmental load on the port, more specifically the air emissions generated by ferries while at berth, during manoeuvring and at open sea. *Chapter 2* briefly summarizes the policy framework on air emissions generated by shipping on global, European, national and local level. *Chapter 3* introduces to the actors around the port of Trelleborg, whom considered being relevant for the sustainable development of the port. At a later phase they were interviewed to express their opinion about economic, environmental and social factors of sustainable development. In *Chapter 4*, the milestones of the interviewing process are laid down. The second part of this chapter provides the outcome of the interviews, namely the point-of-views of those actors groups, which have been described in Chapter 3. The results include (1) the importance of economical, environmental and social factors in harbour development, (2) the possible futures of the port and the city of Trelleborg as well as the (3) environmental performance of these future scenarios and (4) actors' perceptions about each other. In *Chapter 5*, the agreements and disagreements among different actor groups are discussed and the present relation among these actors are described. *Chapter 6* highlights the main facilitators and hindrances of a further cooperation and provides suggestions for the involved actors how to act.

2 Policy framework on air emissions from shipping

This chapter provides a brief description of those incentives, which are influencing the activity and strategy development of Trelleborg Hamn AB: present regulations, economic instruments and voluntary agreements.

Environmental performance of sea transport is of growing concern for the evolution of European transport policy as well as local air quality management of several harbour cities. Emissions, such as NO_x and SO₂ from sea traffic are continuously growing while these emissions from other means of transportation are decreasing due to an extensive policy framework. Regulations on sea traffic have not been stringent enough to lead to air emission reductions of the maritime sector. The International Maritime Organization recently managed to put into effect Annex VI of Marine Air Pollution Convention on NO_x and SO₂ emission generated by sea-going ships, with a special clause including requirements for the Baltic Sea. The EU followed the international trend and adopted a directive on the sulphur content of the marine fuels consumed by sea-going ships. To stimulate improved environmental performance of maritime shipping, in 1998 Sweden introduced differentiated fairway dues on a mandatory and differentiated port dues on a voluntary basis. In 1998, more general air quality measures were introduced in the country in the National Environmental Code (Miljöbalk, 1998). Regional goals are set up in the form of environmental objectives, which are continuously revised and individually adopted by each county. In 2005, the differentiated fairway dues were also revised, setting higher requirements on the ferry operators.

This review on measures regarding air emissions generated from shipping gives an insight into the (1) content of the measure, (2) its stringency in terms of participation and deadlines and the (3) present compliance of THAB and the ferry operators.

2.1 Policies on global level

2.1.1 MARPOL 73/78 Annex VI

Globally, the IMO regulates shipping activities. In 1997, after years of negotiation, an agreement was reached on Annex VI to the Marine Air Pollution Convention, MARPOL 73/78 for the prevention of air pollution from ships. Annex VI regulates the amount of emissions: ozone depleting substances, nitrogen oxides, sulphur oxides, and volatile organic compounds generated by ships of 400 gross tonnes (GT) and above (IMO, 2005). The regulation also contains specification on emission sources, such as incinerators, reception facilities and fuel quality. Annex VI establishes a (1) global sulphur cap of 4.5% for marine heavy fuel oil (HFO)³, as well as designating two so-called (2) sulphur emission control areas (SECAs) – the Baltic Sea and the North Sea – where the sulphur content of fuel used by ships must be below 1.5%. It also prescribes (3) emission standards for NO_x for diesel engines with a power output of more than 130 kW.

The permissible NO_x emission levels are given as weighted average values for specific emissions over the engine load range. NO_x emission levels are closely correlated with the engine speed. The permissible emission is a function of the engines rpm and varies from 17.0 g/kWh when the rated engine speed is less than 130 rpm, to 9.8 g/kWh when the engine speed is equal to or above 2000 rpm. Permissible emission levels are calculated; and how actual levels are to be controlled for an engine is specified in “Technical Code in Control of Emission of NO_x from Marine Diesel Engine”. This code is mandatory; however according

³ HFO, also called residual fuel is any petroleum-based fuel, which contains the undistilled residue from atmospheric or vacuum distillation of crude oil.

to engine manufacturers these standards are so weak that all engines since the late 1990s have been in compliance (Commission Communication COM(2002)595 final).

The emission requirement for SO₂ includes a mandatory bunker delivery note and a representative sample from each bunkering. The sulphur content of any marine fuel oil shall not exceed 4.5%. For vessels operating in SECAs, such as the Baltic Sea, the sulphur content in the oil used on board ships shall not exceed 1.5% or 6.0 g SO_x/kWh.

The follow-up of the regulation includes issuing certificates on NO_x and SO₂ emission levels. Ships of 400 GT and above and rigs engaged in voyages in international waters are required to document compliance with Annex VI by having an International Air Pollution Prevention (IAPP) Certificate approved by the flag state, i.e. the nation in which a ship is registered and which also holds legal jurisdiction over operation of the ship. Engines complying with the NO_x Code will be issued an Engine International Air Pollution Prevention (EIAPP) Certificate. Before issuing IAPP Certificate, an *Initial Survey* takes place, which will be followed by *Periodical Surveys*, at least every five year. More over, at least one *Intermediate Survey* is conducted within this five-year period. The regulation also gives specific guidelines how to conduct surveys, and how to react upon any non-compliance. In 2005, a proposal from several EU member states (Finland, Germany, Italy, UK, Netherlands, Norway and Sweden) was handed in to initiate a revision process on the NO_x Code. Additional objectives are to (1) review emission reduction technologies and the need for (2) reduction of not only NO_x but an extended set of pollutants (NO_x, SO₂, PM, VOC) and to (3) check alternative fuels and (4) engine systems/power plants other than diesel engines (Euromot, 2005).

Annex VI entered into force 19th May 2005 and will be bound for all signatory parties, twelve months after the date of ratification, i.e. 19th May 2006. It was ratified by twenty-two individual States, which have membership in IMO. So far eight EU member states have ratified Annex VI: Cyprus, Denmark, Finland, Germany, Greece, Spain, Sweden, UK.

At present, all ferries comply with the requirements of the MARPOL Convention. However, by 2006, the marine fuel with more than 2% sulphur content used on board four ferries has to be changed for other fuel with maximum 1.5% sulphur content. In case other circumstances do not change and the other seven ferries consumed the same fuel as before, this modification could result approximately 20% decrease in SO₂ emissions in Trelleborg.

2.1.2 Other global actions

Besides Annex VI, other international actions have been taken to reduce and prevent air emissions. The Kyoto Protocol⁴ calls for parties to pursue the limitation or reduction of greenhouse gas emissions from ships' bunker fuels. This action on greenhouse gases (GHGs) is also working through IMO, which took the responsibility of controlling emissions from international shipping. In 2000, a number of proposals for reducing GHG emissions from ships were identified, including (1) voluntary agreements, (2) environmental indexing, (3) emission standards for new and existing vessels and (4) emissions trading. In 2003, IMO adopted a resolution⁵ related to the reduction of GHG emissions from ships. In 2005, the marine Environment Protection Committee (MEPC) approved Interim Guidelines for Voluntary Ship CO₂ Emission Indexing for Use in Trials. In the meanwhile, MEPC also recognized that the list of addressed GHG should be extended to all six emissions covered by the Kyoto Protocol⁶.

⁴ Action on Greenhouse Gases Article 2.2 was adopted in 1997, and was ratified by all EU Member States on 31 May 2002.

⁵ A.963(23) IMO Policies and practices related to the reduction of greenhouse gas emissions from ships, November 2003.

⁶ Carbon dioxide (CO₂); methane (CH₄); nitrous-oxide (N₂O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); and sulphur-hexafluoride (SF₆)

2.2 Policies on European level

2.2.1 Directive 2005/33/EC on the sulphur content of marine fuels

In 2002, the European Commission published a strategy to reduce air pollution from sea-going ships, including a series of objectives and recommendations for bringing about such reductions over the next ten years. As a part of the strategy, the EC handed in a proposal for reducing the sulphur content in marine fuel oils. In April 2005, after the second reading of the European Parliament, a compromised agreement was reached and modified Directive 1999/32 as regards the sulphur content of marine fuels.

The main provisions of the directive are the following:

- (1) 1.5% sulphur limit for fuels used by all ships in the Baltic Sea from 11th August 2006, and the North Sea, including the English Channel from 11th August 2007;
- (2) 1.5% sulphur limit for fuels used by passenger ferries on regular services between EU ports from 11th August 2006; and
- (3) 0.1% sulphur limit on fuels used by inland vessels and by sea-going ships at berth in EU ports from 1st January 2010.

The first provision is a confirmation of already agreed commitments under the IMO's MARPOL Annex VI. The two other points suggest more stringent steps towards air pollution prevention from European shipping. On the other hand, flexibility is shown, when the directive allows member states to approve trials on ship emission abatement technologies (Council Directive 2005/33/EC). The follow-up of the regulation includes annual reviews and reporting to the Commission on the fuel used on the territory of each member states.

The Parliament amended the proposal amongst others demanding the extension of 1.5% sulphur limit to cover all EU sea areas, and establishing a second phase lowering of sulphur limit to 0.5%. Although, these amendments failed, the directive contains commitments that in the form of a Commission report foreseen for 2008, (1) second-phase limit of 0.5%, (2) tighter requirements on the availability of low-sulphur fuel, (3) the use of abatement technologies and (4) an incentive for ships in port to plug in to clean shore-side electricity will be reviewed. While with the amendments proposed by the Parliament, sulphur emissions could have been reduced by around 80% in European waterways, the compromise will result around 10% sulphur emissions reduction. It also means that by 2020, SO₂ emissions from shipping in European seas would exceed all EU25 land-based SO₂ emissions (Robinson, 2005).

The Directive 2005/33/EC entered into force on 11th August 2005 and will have to be transposed into national law one year later, by 11th August 2006.

At present, all ferries comply with the EU directive. However, by August 2006, due to this directive and the MARPOL Convention four ferries, which use HFO with more than 2% sulphur content, shall switch to marine fuel with lower than 1.5% sulphur content.

2.2.2 Other European actions

In the frame of the 6th Environment Action Programme the EU addresses key environmental objectives, such as to achieve levels of air quality that do not give rise to unacceptable impacts on, and risks to, human health and the environment and to stabilise atmospheric concentrations of greenhouse gases at a level that will not cause unnatural variations of the earth's climate (Commission Communication COM(2002)595 final).

There are three separate EU directives, which consider measures to reduce air pollutant emissions originate from the maritime sector. Directive 2001/81/EC on national emission ceilings for certain atmospheric pollutants, which commits member states to report on the extent to which emissions from international maritime traffic contribute to acidification, eutrophication and the formation of ground-level ozone within the EU. Directive 1999/32/EC relating to the sulphur content of certain liquid fuels, which already sets sulphur limits for marine distillate oil used in EU territorial waters and was amended by Directive 2005/33/EC (see Chapter 2.2.1). Directive 1994/63/EC on the control of volatile organic compound (VOC) emissions resulting from the storage of petrol and its distribution from terminals to service stations, which requires member states to address volatile organic compounds emitted during the loading and unloading of ships. With regard to halon, EC Regulation 2037/00 on “Substances that Deplete the Ozone Layer” bans the marketing and use of ozone depleting substances in the EU, including their use as fire protection systems on board ships with limited number of exemptions.

In 2001, the Clean Air for Europe programme (CAFE) was launched with a view to adopt a thematic strategy on air pollution covering all relevant emission sources, giving priority emphasis to ground level ozone and particulate matter⁷. In addition, EC has recently issued a report on ship emission assignments, abatement and market-based instruments that evaluates ship emissions (SO₂, NO_x, PM, CO₂, VOCs) compared to land emissions for EU member states (Commission Communication COM(2002)595 final). The findings of the report provide information how emissions from internal maritime traffic could be included in the review of the National Emission Ceilings Directive (2001/81/EC) in the framework of the CAFÉ programme (Euromot, 2005).

Nevertheless, considering atmospheric emissions from ships in the broader policy context, transportation, there is an urgent need expressed that harmful emissions from all modes of transport, including shipping shall be regulated. It is recognized that ships compare well with other modes of transport; for example, they create less congestion and noise, and require less land for infrastructure. For these reasons a modal shift in transport is promoted in the frame of EU *White Paper on European Transport Policy for 2010*, which include moving the carriage of more goods from road to sea transport (Commission Communication COM(2002)595 final). But it is nonetheless important to examine the environmental impact of shipping and propose measures where necessary to bring shipping into line with other land-based sectors and transport modes.

At present, there are several concrete projects aiming at the creation of a high-class transport infrastructure for goods/freight and passengers and for all transport modes in Northern Europe. The Nordic Triangle is one of these projects, which is trying to achieve a “more efficient and environmentally sound multimodal transport system”. Sweden has received TEN-T support from the European Union for port projects in Trelleborg, Stockholm and Gothenburg. Another initiative is the TransLogis project, which in the frame of the EU Interreg Programme, focuses on (1) strengthening of the international transport corridors inside the TransLogis area, including Berlin-Rostock and Sassniz/Mukran-Trelleborg and Ystad; and Trelleborg and Ystad-Szczecin-Gorzow-Wroclaw-Katowice routes; and (2) assisting ports in establishing intermodal service, as they are already important bundling points with very good access to intermodal infrastructure such as transshipment terminals and the main railway network (TransLogis, 2005).

⁷ The reason why the CAFE program gives priority emphasis to these pollutants is that the European Environment Agency (EEA) found a high level of urban air quality excess for both pollutants.

2.3 National legislation

2.3.1 Swedish Environmental Code

Besides transposing and implementing the European directives and regulations on air quality and transportation issues into the national law, Sweden brings about its own national requirements. In 1999, the National Environmental Code entered into force and brought together fifteen existing central environmental laws. The overall aim of this Code is to promote sustainable development based on the understanding that nature is to be protected and those who are to exploit it must carry the responsibility.

In line with the Environmental Code, 15 national environmental quality objectives were adopted. Almost all of these objectives are to be attained by 2020. These objectives do not only create a framework for environmental programmes and initiatives, but also serve as guidance for such efforts on all levels in the society. Regions and municipalities are key players in integrating these environmental objectives into their own activities, such as infrastructure planning, development of the transport system, improvements and maintenance of the green areas and energy and water supply, etc. By doing so, significant results can be achieved. The form of the integration and activities varies, but the introduction of environmental management systems and cooperation with local Agenda 21 activities are general occurrences. Some regions and municipalities have developed their own environmental objectives and strategies based on the national standards. The interim targets facilitate the implementation of these local objectives. Altogether, there are 71 interim targets, which describe the situation in a given year, usually 2010. Each environmental objective consists of a few of these targets. Several objectives focus on air quality issues; some of these targets are presented below. The process of fulfilment of these environmental objectives is observed and summarized in the region of Scania, respective in the city of Trelleborg.

(1) The objective of *Reduced Climate Impact* is based on the goal of Kyoto Protocol, i.e. the mitigation of six greenhouse gases defined by the IPCC. The interim target being set is that as an average for the period 2008–12, Swedish emissions of greenhouse gases will be at least 4% lower than in 1990. According to the County Administration, Scania faces difficulties regarding meeting this objective. Emissions from the transport sector have been continuously increasing in the region. Today, CO₂ emissions from the transport sector represent 50% of the total CO₂ emissions (Scania County Administration, 2005). In 2001, CO₂ emissions generated by the ferry lines operating in Trelleborg took up 7% of the total CO₂ emitted in the county (SEPA, 2003). As the volume of transport has a growing tendency, if no changes are to be implemented, the County Administration do not see how this region will achieve the targeted requirements by 2020.

(2) In the frame of the *Clean Air* objective it is stated that the air must be clean enough not to represent a risk to human health or to animals, plants or cultural assets (Environmental Objectives, 2005). In order to reach this state, targets have been set to the level of sulphur dioxide, nitrogen dioxide, ground-level ozone and volatile organic compounds.

The first goal is that the level of sulphur dioxide of 5 µg/m³ as an annual mean shall be achieved in all municipalities by 2005. The timeframe for nitrogen dioxide is slightly broader, as the level of 20 µg/m³ as an annual mean and 100 µg/m³ as an hourly mean shall be achieved by 2010 in most places. Although, a large part of SO₂ and NO_x emissions are transported to Scania from the continent; another large part these emissions are generated in the county and transported to other parts of Sweden. Besides air transport, other sizeable source of SO₂ emissions is sea traffic. That is the reason why the highest SO₂ concentrations in air are in the coastal areas of Southern Sweden, Trelleborg and Helsingborg.

According to measurements carried out by IVL (2004), the SO₂ concentration in the air in Trelleborg exceeds the level of 5 µg/m³ in the past ten years. However, improvements can be seen from the year 2002 (see Figure 1-2) and the county also expects additional improvements in SO₂ emission reduction. In terms of NO_x emissions, the largest sources are cars, maritime traffic and working machines. Scania belongs to the counties with the highest NO_x emissions and in the past five years, no decrease has been experienced. According to the County Administration, due to the increasing transport volumes, nitrogen dioxide limits will be more difficult to meet than the sulphur dioxide.

(3) Objectives of *Natural Acidification Only* and (4) *Zero Eutrophication* address the acidifying effects of deposition and land use and the nutrient levels in soil and water. Limits are set on the level that can be tolerated by soil and water (Miljöbalk, 1998). Amongst other interim targets, goals are set to limit the total NO_x and SO₂ generated on the territory of Sweden. By 2010, emissions of sulphur dioxide to air in Sweden are expected to be reduced to 60 000 tons and emissions of nitrogen oxides to 148 000 tons. According to SEPA (2003), in 2001 there were already 60 300 tons of SO₂ generated in Sweden, out of which 2.1% originated from the activities around THAB. On the basis of their prognosis the amount of SO₂ emissions will go down to 50 000 by 2010. However, NO_x emissions are not expected to decrease so fast. In 2001, there were 251 000 tons generated in the country and by 2010 app. 160 000 tons are estimated. 2.6% of the amount generated in 2001 was from the port of Trelleborg (SEPA, 2003). In order to reach the NO_x limit regionally, radical decrease of NO_x emissions is needed from the transport sector.

The Environmental Code is further specified in the form of ordinances and regulations issued by public authorities. For instance, there are presently three ordinances on environmental quality standards. Air quality issues are covered by the ordinance (2001:527) on environmental quality standards for ambient air, containing standards for nitrogen dioxide, oxides of nitrogen, sulphur dioxide, carbon monoxide, lead, benzene, particulate matter (PM₁₀) and ozone in ambient air. Its content is based on EC directives: 1996/62/EC, and its daughter directives 1999/30/EC, 2000/69/EC and 2002/03/EC. Although, as seen above, some limit values have been made more stringent in the Swedish legislation.

2.3.2 Economic instruments

Experience suggests that well-designed market-based approaches can reduce the costs and increase the likelihood of achieving environmental targets (Ellerman, Joskow & Harrison, 2003). Some countries and ports introduced economic instruments in recent years to encourage ships to reduce their atmospheric emissions. These include differential taxes on marine fuels, differentiated port and fairway dues, and differentiated tonnage taxes. However, often times, seagoing ships are untouched by taxation, and pay only the costs of the services provided in ports. In Sweden and the port of Mariehamn in the Finnish autonomous region of Åland, the system of environmentally differentiated fairway dues was introduced in 1998. Some Swedish ports offer complementary reductions in the form port dues. There are other market-based measures in the EU and elsewhere, which reward low-emission ships. The Green Award scheme offers varying incentives in around 35 ports around the world depending on performance against a number of environmental and safety awareness criteria. For instance, the Port of Rotterdam issues around a six percent discount of port dues to ships and ship-owners that meet these criteria (NERA, 2004, p.13). In 2001, the Port of Hamburg introduced the Green Shipping bonus, offering a rebate of port dues depending on the ship's environmental performance, including emissions. Norwegian flagged vessels', depending on their environmental and safety rating against several criteria, pay differentiated tonnage tax.

2.3.2.1 Differentiated fairway dues

The Swedish Maritime Administration (SMA), the Swedish Ship-owners' Association and the Swedish Ports' and Stevedores' Association made a tripartite agreement in April 1996 to employ measures in order to decrease ship generated air pollution, particularly NO_x and SO₂. As one goal of the agreement the parties aimed at decreasing air emissions by 75% by the beginning of the 21st century. In order to reach this goal, economic incentives are applied in the form of environmental differentiated fairway and port dues. The environmental differentiated fairway dues entered into force from 1 January 1998 according to the ordinance SFS 1997:1121. In 2004, the Swedish Government assigned the Swedish Maritime Administration the task of developing the fairway dues system based on the proposals presented in the Ds 2003:41 Report (SMA, 2004). The proposal was presented and from the 1st January 2005 the new fairway due scheme is applied.

Fairway dues are a national levy collected from all ships using the waters where the dues apply. Dues are to be paid to the Swedish Government via the Swedish Maritime Administration. They are payable by ships of all flags visiting Swedish ports, on the basis of the size of the ship, computed on their gross tonnage (GT) and the volume of cargo transported by the ship. The portion being based on the GT is environmentally differentiated according to the ships' emissions of nitrogen oxides and sulphur oxides. It means a distinction between individual ships in a way that ships, which have taken environmentally protective measures will be charged reduced dues, while according to the polluter pays principle, ships with higher emission levels will pay higher dues. Environmentally protective measures include installation of certain NO_x reduction technologies and/or use of low sulphur content marine fuel. In Appendix 2, some of those factors are described, which are considered when setting up the differentiated fairway dues: type of ship (passenger, cargo, cruising ship), type and sulphur content of the fuel, emissions of NO_x/kWh.

The differentiated fairway dues approach target shipping routes rather than destinations and take the advantage of the fact that most ports already imposed charges on vessels that use their facilities and waters. However, they do not affect port authorities directly, only maritime authorities and ship-owners. Fairway dues are intended to cover the costs of services provided by the Swedish Maritime Administration to all ships (e.g., icebreaking, fairway maintenance, etc.) discussed in Chapter 3.4. As the fairway dues scheme is administered at state level, it avoids the difficulties associated with port competition. Charges are set transparently and not subjects to negotiation with vessels.

The follow up of the fairway dues goes through the Swedish Maritime Administration, which is responsible for ensuring that shipping entities are complying with environmental requirements on NO_x and SO₂ emissions. The periodic monitoring is supplemented with additional enforcement inspections to check fuel type⁸ and other compliance issues. SMA is also a certification body. To benefit from reduced port dues for SO₂ emissions, ship-owners must sign an affidavit, promising to use a certain type of bunker oil during all operations. Fuel characteristics are confirmed through a series of random, unscheduled checks (Jeppsson, 2005). Other requirements vessels must comply with include records to make available for inspection any time. For example, vessels operating selective catalytic reduction (SCR)⁹ to reduce NO_x emissions must keep records of their purchases of the active input urea to remain certified. NO_x emissions are tested and certified every three years.

⁸ Testing of fuel sulphur content, samples are taken during most visits to port; inspections for NO_x are less frequent.

⁹ SCR is a process where a gaseous or liquid reductant (most commonly ammonia or urea) is added to the flue gas stream and is absorbed onto a catalyst. The reductant reacts with NO_x in the flue gas to form H₂O and N₂ (Johansson, et al, 2001, p.93).

Three of the eleven regular ferries docking in the port of Trelleborg have reduced fees related to sulphur content of the fuel. However, as no NO_x reduction measures are installed, none of the eleven ferries has reduced fairway fees and obtained NO_x certificate because of the decreased NO_x emissions.

2.3.2.2 Differentiated port dues

Port dues are regarded as an autonomous affair for ports and are structured in a different way from one country to another and even from port to port. The structure and content of the port dues is traditionally part of an individual port's policy and based on its own circumstances (European Sea Port Organization, 2003). Gross tonnage is very often used as a basic parameter, but the other parameters can be diverse. In Sweden, the two-part tariff pricing practice is commonly applied, especially in ferry ports. This practice consists of a *fixed fee* depending on the characteristics of the vessels and the number of calls, plus a *variable fee* based on the volume of traffic (passengers, vehicles and cargo) transported onboard the vessels. Port dues are charged to the users of the port for the provision of all facilities and services on the seaside, with the exception of pilotage and towage, and for some facilities and services on the landside. The transparency of the structure and content of port dues varies from port to port. For example, the Port of Gothenburg and the Port of Helsingborg publish them on an annual basis, while in case of THAB, due to the competitive circumstances dues are set at the discretion of the port and its customers.

The differentiated port due system in Sweden is often considered as the natural effect of the differentiated fairway dues. At the same time, as it is described above, there are no formal national jurisdiction over these dues. In 2002, out of the 52 there were about 25 Swedish ports, which introduced the differentiated scheme to encourage reductions in NO_x and SO₂ emissions (Swahn, 2002, p. 6). Large harbours with frequent cargo and passenger traffic, like Gothenburg, Helsingborg and Stockholm already have differentiated port dues since 1998, when the differentiated fairway dues were introduced. The ports have the opportunity to design their own system of differentiated charges. The new charges replaced existing port dues in a way that they designed to be revenue-neutral, but still take into account average vessel emissions. By 2001, about 30 ships introduced measures to reduce emissions of NO_x. Thereof 25 commercial ships have received NO_x-certificate. In 2002, 1043 ships were registered for continuous operation with low sulphur bunker oil¹⁰ (Swahn, 2002, p. 6). Based on measures between 1998 and 2002, it is estimated that the programme reduced emissions of SO₂ by around 30% and NO_x emissions by around 10% (Swahn 2002, p. 7). Single ports achieved better results, for example, between 1995 and 2003, emissions of NO_x from regular-traffic ferries and container ships in Stockholm harbour decreased by 43% (Stockholms hamnar, 2005).

The target group of the environmentally differentiated port dues consists primarily of ferries and secondarily of other ships in frequent, weekly traffic throughout the year. According to Lemieszewski (as cited in NERA, 2004, p. 66), due to the fact that Scandinavian vessels spend more time in Swedish waters and they have greater sensitivity to Swedish public opinion; they are more likely to take advantage of the lower rates offered by the differentiated scheme. One of the driving forces to adopt cleaner technologies appears to be public relations and corporate image for customers (Swahn, 2002). Often times the direct financial benefit for ships is not sufficient to cover the overall costs of achieving lower emission rates; as a consequence, e.g. German vessels are less likely to take advantage of these lower dues.

¹⁰ The limit for low sulphur is 0.5% by weight for passenger ships and railway ferries; and 1% for other ships.

The effectiveness of the environmentally differentiated port dues is still under discussion (Figure 2-1). The importance of these port dues is recognized. However, stakeholders do not think that intervention towards more transparency or environmental benefit should be done.

Discussion over environmentally differentiated port dues

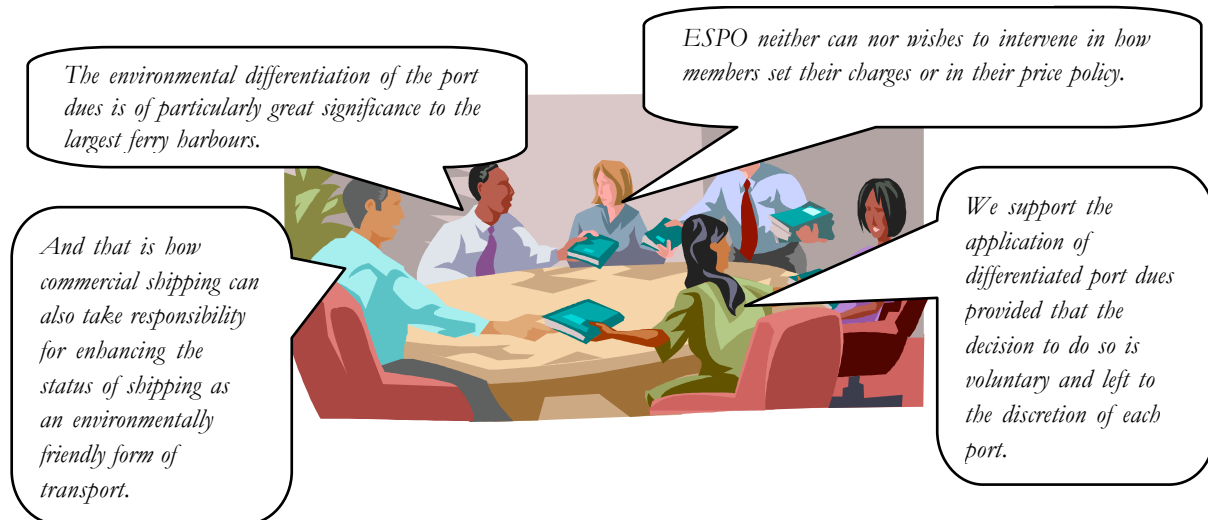


Figure 2-1 Point of views on environmentally differentiated port dues

A system of environmentally differentiated port dues in Trelleborg is not applied. In case of application, it could take advantage of the fact that THAB already imposes charges on vessels that use their facilities and waters. Environmentally differentiated charges in this context involve basing port dues in part on emissions of various pollutants. To encourage ports to adopt these instruments voluntarily additional incentives are suggested to create, for example, the establishment of emissions targets and progress monitored toward these targets, with the possibility that if the targets were not achieved more mandatory requirements could be put in place (NERA, 2004, p. 102).

2.4 Voluntary agreements

Voluntary measures are when organisations and companies are aiming for emission reductions beyond regulatory requirements. All over the world, such as in Sweden, there have been a couple of initiatives taken in the shipping industry for voluntary air emission mitigation.

In Los Angeles, voluntary speed reduction program has been introduced, restricting commercial cargo ships to cruise on 12 knot¹¹ within 20 nautical mile¹² radius of the port. The estimated air quality benefits were app. 3.4 tons NO_x reductions per day. In the European Union, six EU shipping companies have registered for the European Commission's Eco-Management and Audit Scheme (EMAS), which requires continuous improvements in the companies' environmental performance, including atmospheric air emission reductions (Commission Communication COM(2002)595 final). In the Baltic Sea region, the *New Hansa of sustainable ports and cities* project was initiated in 2002 aiming at reducing ship borne emissions, especially from still traffic in all ports and cities in the Baltic Sea Region. The background of the project was an Agenda 21 process, initiated by the city of Lübeck, during which it became known that 80% of all air emissions in Travemünde, the port of Lübeck originate from shipping. The results also showed that 60% of these air emissions come from

¹¹ 1 knot = 1 nautical mile per hour, i.e. approximately 1.85 kilometers per hour.

¹² 1 nautical mile = 1852 meter

still traffic, i.e. from auxiliary engines and boilers pre-heating heavy fuel for the sea passage (New Hansa, 2005). The project is co-financed by the European Initiative Baltic Sea Region INTERREG-III-B and endeavouring to achieve its goals by good practices, bonus system and a technical system to provide ships amongst others with electricity in the port. In Sweden, at the port of Gothenburg shore-side electricity is installed. Stena Line committed for the Gothenburg-Kiel ferry line to connect to shore-side electricity, i.e. cold ironing in the port. In 1990, the shipping companies at the ports of Stockholm arrived at a voluntary agreement to use bunker oil with lower sulphur-content. Today, all large-sized ships cruising to Finland using bunker fuel with 0.5% sulphur content. In 1995, catalytic converters were installed on some ships to reduce NO_x emissions. After 1998, the ports of Stockholm supported these installations by means of differentiated port dues. The Stockholm-based Wallenius Lines was running low-sulphur fuel project, whereby the goal was to reduce the fleet's average sulphur content in bunker to 1.5% by 2004.

Naturally, it is open to ship-owners, charterers and port authorities to take voluntary measures going beyond regulatory requirements to deliver air emissions reductions. In the decision-making process whether to take up voluntary measures for emission reductions various actions could be encouraging: (1) economic and (2) environmental benefits, (3) positive publicity and (4) green awards, such as the European Commission's Clean Marine Award Scheme, which demonstrates best practice in low emission shipping beyond regulatory measures.

2.4.1 Voluntary measures in Trelleborg

In the past five years there have been some changes affected the operation and environmental performance of the ferry lines in Trelleborg. When the National Swedish Railways owned the Swedish part of Scandlines, the ferries were using low sulphur content diesel oil (0.1%), as it was available in the form of a special pricing system designed for the railway company. After 2000, Stena Line took over Scandlines AB with three Swedish ferries and the sulphur content of the oil has been risen to 0.48-0.49%, which was still far lower than the that time applicable regulatory measures: 4.5% sulphur content of heavy fuel oil (MARPOL 73/78, Annex VI). Since then, the new European directive (2005/33/EC) came into force in 2005, setting the sulphur-content level of marine fuels on 1.5% on the Baltic Sea. The three Swedish Scandlines ferries are still far below this level of sulphur content. There was another incentive to decide over the sulphur content to be set below 0.5%. Until the new fairway dues were introduced in January 2005, ferries using marine fuel above 0.5% sulphur-content paid higher charge per GT. With the new scheme, more differentiation were implied, and only ferries using less than 0.2% heavy fuel oil are not charged for sulphur due (SMA, 2004). The German-owned ferries bunker higher sulphur content (app. 2%) fuel in Germany. The differences in fuel use could be partly due to the ownership structure of the ferry lines (see more details in Chapter 3.2.1) and partly due to the fact that Swedish ferry operators are more sensitive to Swedish public opinion.

As later described in Chapter 3.2.1, Stena Line, the mother company of Scandlines AB, applied for the first ISO 14 001 certification in 2001. During 2004 all the German routes were certified. ISO 14 001 certifications imply commitments for continuous improvement in the environmental performance of the companies, including air emission reductions generated by the ferries.

TT-Line has a relatively new fleet with to date four so-called Green Ships. The company started to use this label in 1995, when two ferries Nils Dacke and Robin Hood were constructed with state-of-art technology, the new propulsion system of pod drives. These pods resulted less manoeuvring time, thus less air emission in the coastal waterways. In 2001, additional two ferries, Peter Pan and Nils Holgersson were delivered with the same system.

The use of these propeller systems leads to less time spent in the port, thus less fuel consumption and less SO₂ emissions. For its consistent environmental commitment and its fleet policy TT-Line received awards like the *Environmental Company of the Year 2000*, voted by Sweden's transport industry, *Ship Pax 2001* and *Innovation Prize 2003* from the Swedish Transport Industry Association.

A few attempts have been taken by ferry operators at the port of Trelleborg to go beyond regulatory requirements. These attempts were taken mainly due to economic incentives, presumably public opinion and various awards. For municipality owned companies, like THAB, obtaining funding for maintenance and development of facilities to further facilitate goods and passenger transportation is a large incentive to take voluntary measures for air emissions reduction. The autumn of 2005, the Committee of Transport and Communication (Trafikuskottet) plans to come up with around a dozen of environmental criteria for ports. Ten Scania ports are going to get financed on the implementation of their commitment made in compliance with these criteria (Karin Svensson-Smith, 2005). In the form of this project, THAB initiated a narrow-scaled stakeholder dialogue, which on one hand can encourage ferry operators to take further steps in air emission reduction, on the other hand can result positive publicity towards government, and potential investors and customers.

3 Actors around the port of Trelleborg

In this chapter, detailed description is given on some relevant actors around the port of Trelleborg. The subchapters provide with a picture on the actors' main activities, their role in the logistics chain and regulative and monetary obligations and relations towards each other. Trelleborgs Hamn AB is the consigner of the project; orientation and relations to other actors are investigated in relation to the consigner. Actors include the (1) case members, i.e. active participants of the project: THAB and the ferry operators, TT-Line and Scandlines AB, and (2) other actors, which were not case members, i.e. directly involved in the project but still representing high-level interests in port activities.

As part of the embedded case study method, the actors depicted here are already set into actor groups according to approximately common economic, environmental and social interests. The following groups have been created by the researchers: (1) THAB, (2) Customers, including the ferry operators and logistics companies, the (3) Trelleborg Municipality, representing local authorities, (4) National Authorities¹³ and the (5) Citizens of Trelleborg. This grouping approach aims to facilitate the further steps of interview evaluation (see in Chapter 4 and Chapter 5) and thus being familiar with the actor groups it helps the reader to simpler grasp the results of this report, which is based on the expressions of the actor groups' opinion about economic, environmental and social issues and about each other.

3.1 Trelleborgs Hamn AB

The company, Trelleborgs Hamn AB was established in 1999 with the merger of a stevedoring company that engaged in loading and unloading, (a) Trelleborg Terminal AB and the previous port authority, (b) Trelleborgs Hamn. THAB is a Swedish limited liability company wholly owned by the Trelleborg Municipality, as with few exceptions most of the ports in Sweden are municipality owned. THAB operates three business areas: Port Management, Goods Handling and Real Estate Management. Port and real estate management include full responsibility for the (1) running of the port, i.e. the construction and maintenance of the port facilities, (2) the provision of facilities and services to vessels using the port, such as ferries, and (3) the determination of the fees that each user of the port has to pay for those facilities and services. In the frame of goods handling the company offers cargo handling, terminal and truck services, and storage facilities to its customers. The real estate management covers the formerly municipality-owned 16 real estates, 3 land areas of 631 000 m² and buildings in the form of terminals, warehouses, office-buildings, workshops, ferry berths and cranes, of which THAB recently became the owner.

In the past, ports were seen as providing public services and were paid through taxation. Certain deregulation of port operations took place in the early 1980's in Sweden when the state-regulated tariff system was abolished and ports could freely set their tariffs. Nowadays ports are considered commercial entities required recovering their full costs from customers. THAB had a yearly turnover of about 150 million SEK (15.8 million €)¹⁴ in 2004. Ship owners, liner operators, ship's agents, importers and exporters pay for the services rendered by THAB. The two most significant elements of the income source are (1) the payment for stevedoring work and (2) the port dues. In general, port dues are set at the discretion of individual ports and are applied to ships that rely on port services. Due to the competitive nature of business run in Trelleborg, no data is available on each ferry operator's contribution to the port dues, thus to the total turnover of the port.

¹³ The actor group National Authorities includes actors from SEPA, SMA, SSNC and a Member of the Parliament.

¹⁴ In the calculations: 1 €=9.50 SEK, 1 US\$=7.90 SEK, 1 £=14 SEK (Sveriges Riksbank, 21 October 2005).

Some 25 Swedish ports, including Gothenburg and Stockholm introduced environmentally differentiated port dues, which include an additional charge for the vessels according to their environmental performance. At present, there are no environmentally differentiated port dues applied in Trelleborg. THAB has chosen other means to gradually integrate environmental issues into the port's daily, short-term and strategic, long-term activities. Such approaches are the quality (ISO 9001:2000) and environmental (ISO 14 001) certificates, high environmental standards on harbour vehicles and actors' dialogue with customers and suppliers.

As described in Chapter 1.3.1, the volume of transport via Trelleborg is continuously growing. In 2004, almost 2 million passengers and 10.8 million tonnes of goods were passing through the port. Counting on the growth in trade with the new EU member states and the predicted increase of freight traffic in the Southern Baltic Sea area, the port of Trelleborg is to be enlarged. THAB has put "Vision 2005" into effect and prepares to be well equipped to meet the logistic demands of the future. By the end of 2007, new investments of 450 million SEK (47.4 million €) will be realized in a form of an extended logistics centre (13 500 m²), new ferry berths for road and railroad traffic and a new intermodal terminal (100 000 TEU¹⁵) to manage the increasing amount of intermodal traffic. In a few years, a total of ten RoRo berths for handling of railway as well as road vehicles will be disposed. Further plan of THAB is to open a new ferry route. Today the Polish shipping companies, Polline and Polferries, have routes via Ystad to Swinoujscie. According to THAB's plans a new route is to be opened for goods between Trelleborg and Swinoujscie in the near future (Borgemark, 2005). These possible enlargements would significantly boost the capacities of the port, enabling a possible traffic growth of 50 % (THAB, 2005).

3.2 Customers

3.2.1 Ferry operators

Ferry operators are the customers of THAB, and are offering trips between Trelleborg and three ports in Germany: Rostock, Sassnitz and Travemünde. The ferries started touring between Germany and Sweden at the end of the 19th century with weekend tours; today there are ferries travelling from Trelleborg every second hour. In 2004, thirteen ferries made 12 226 trips in total between the two countries (Olsen, 2005). TT-Line, Scandlines AB and Scandlines AG are the three companies offering these frequent connections to the continent. United European Car Carriers (UECC) has recently established a liner service to Trelleborg via Hangö, Gdynia, Bremenhaven and Southampton. The service runs on a weekly basis and is mainly used to carry cars (THAB, 2005). Other types of goods regularly shipped through the port including chemicals, refinery products, grains and fertiliser. These two latter services are out of the scope of this report.

The ferry operators are travelling with eleven ferries from April 2005. Two of them were built in 2001 and another two were recently renewed. Further details on ferries can be found in Appendix 3. The continuous growth of freight transport is one of the strongest incentives for the ferry operators to invest into tonnage capacities, to renew the existing fleet or to purchase new ferries. Lorries represent far the single largest segment of the RoRo traffic; however the conveyance of the railway wagons also represent an important aspect of the service.

¹⁵ TEU = twenty foot equivalent unit. This is a standard size of container and a common measure of capacity in the container logistics business.

3.2.1.1 TT-Line

TT-Line GmbH & Co. KG is a privately owned German company with the headquarters in Hamburg. In 2004, the company transported 871 217 passengers and 296 870 freight units over the Baltic Sea. The same year the company's turnover was 1 200 million SEK (126.5 million €) (TT-Line, 2005). There are six RoPax¹⁶ ferries serving the routes between Trelleborg – Travemünde and Trelleborg – Rostock. Two ferries, Nils Dacke and Robin Hood were built in 1995 and were the first so-called Green Ships equipped with a new propulsion system, a pod drive. It results in better manoeuvrability of the vessels, which leads to more efficient engine use and economical fuel consumption. In 2001, two new jumbo-liners were delivered: Peter Pan and Nils Holgersson; both equipped with diesel electric engines and consuming low sulphur content marine diesel oil¹⁷ (0.2%). Tom Sawyer and Huckleberry Finn are older ferries, but were rebuilt and refurbished in 2001, respective 2002. These ferries are not equipped with pod drivers and they are running on higher sulphur content HFO (2.2%).

3.2.1.2 Scandlines AB and Scandlines AG

Scandlines serve the connections Trelleborg – Sassnitz, Trelleborg – Travemünde and Trelleborg – Rostock, using five RoPax ferries, four of them are also carrying trains. Scandlines AB and Scandlines Deutschland GmbH jointly operate the latter two routes, while only Scandlines AB is present on the Trelleborg-Travemünde route.

Three out of five ferries are operated by Scandlines AB: Götaland, Skåne and Trelleborg. Scandlines AB was owned by the National Swedish Railways (SJ) and sold to Stena Line in August 2000. Stena Line is a wholly owned subsidiary of Stena AB, which is owned by the Olsson family. With 18 ferry routes, 39 ferries, more than 17 million passengers and app. 1.6 million freight units a year, Stena Line had 3 545 million SEK (373.5 million €) turnover in 2004 (Stena Line, 2005).

Scandlines Deutschland GmbH operates the other two Scandlines ferries: Mecklenburg-Vorpommern (MVP) and Sassnitz. Scandlines Deutschland GmbH is the German-owned part of Scandlines AG, which is a relatively recent addition to the ferry scene on the Baltic Sea. It was formed in 1998 by the merger of Denmark's Scandlines A/S and Deutsche Faehrgesellschaft Ostsee of Germany. The ownership divided 50-50% between the Danish government's Ministry of Transportation and Deutsche Bahn AG. On 14 routes, with 26 vessels, 20 million passengers and 1.1 million freight units a year, the turnover of the company was 500 million € (4 745 million SEK) in 2004 (Scandlines, 2005).

In general, Scandlines ferries represent an older generation of ferries than TT-Line's. The newest ferries, MVP and Skåne were built in 1996, respective 1998, others in the 1970's and 1980's and went through refurbishment in the 1990's, often because of lack of tonnage capacity. For instance, MVP was reconstructed at the beginning of 2003, to increase lorry capacity by 25%. The Swedish Scandlines ferries are using low sulphur-content HFO (0.48-0.5%), the German counterpart purchase high sulphur-content oil (app. 2-2.2%). Three ferries are equipped with computerized fuel saving system, which continuously watch and automatically minimize the bunker use by controlling the propeller pitch and revolutions (Edensten, 2005). In 2001, the process of certifying Stena Line's operations in accordance with ISO 14001 was started. The freight route Gothenburg-Travemünde was first to be certified at year-end 2002/2003, followed by all of the German routes during 2004.

¹⁶ All ferries are RoPax ferries, specially designed to carry not only cars and passengers such as RoRo ferries, but also accompanied and unaccompanied freight, trucks, trailers and containers. Tourist and freight vehicle capacity is interchangeable.

¹⁷ Thin diesel, less refined than gas oil.

3.2.1.3 Economies of the ferry operators

The ferry operators' main income source is the customers, who are carried via the Baltic Sea: passengers, cars, caravans, busses, heavy trucks (with or without trailers) and containers. Onboard sales today account for 23% of Stena Line's and 16% of TT-Line's total revenue. (There are no data available for Scandlines AB and Scandlines AG specifically.) A clear reduction has taken place in the last few years. According to the ferry operators "customers appreciate the opportunity to shop onboard at prices that are up to 40% cheaper than prices on land" (Stena Line, 2005). Ticket revenue and onboard sales to travellers together account for 60% of sales at Stena Line and 41% at TT-Line. The freight business accounts for 39% of sales at Stena Line and 59% at TT-Line. Other elements of income source include e.g. port activities. Freight tariffs are calculated after the type of freight unit, length and weight. Surcharges are paid after over width, overweight, additional cargo handling and bunker fuel. The knock on effect of the oil price rise across almost every industry has been significant, with the transport industry in particular suffering more than most. "Our fuel costs have more than doubled and we have no way of bearing the whole burden of this cost," says Michael McGrath, Freight Director at Stena Line (2005). To handle these higher costs ferry operators increased the fuel surcharge, which is paid by customers in addition to the ferry ticket. The price model is flexible, which means that the price follows the trend of the oil price. Raw oil prices have climbed to record levels in 2005 to around US\$ 70 (551 SEK or 58 €) a barrel. In October 2005, the average fuel surcharge was around 28 SEK, i.e. 3 €/commencing lane meter for freight transport and 52 SEK, i.e. 5.5 €/trip for passengers. Fuel costs account for 18-27% of the ferry operators' total cost.

The ferry operators are paying charges both to the port for port services in form of port dues and to the Swedish Maritime Administration in form of differentiated fairway dues. Figure 3-1 illustrates the structure of the annual cost division for an average ferry operating on the above-described routes. It also shows how these dues are related to other annual ferry operational costs. Due to the competitive situation between the ferry operators in Trelleborg, the question of costs is a sensitive issue. Therefore there was no exact figure available on real costs, however the referred figure is based on the information and approval of both ferry operators.

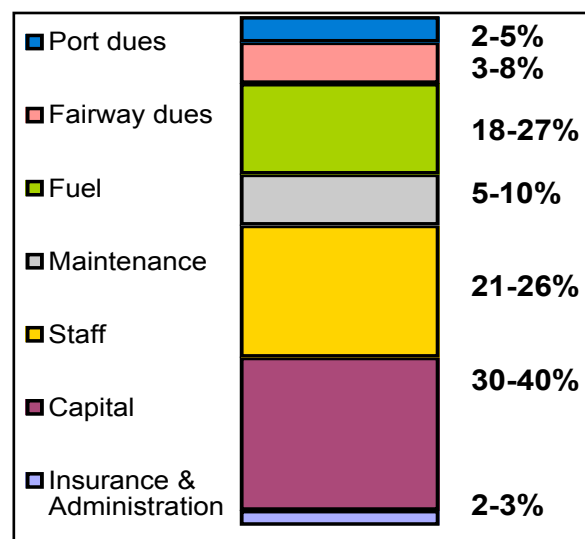


Figure 3-1 Annual operational cost of an average ferry travelling via Trelleborg

3.2.2 Logistics companies

Logistics companies and manufacturers are businesses involved in international trade transporting goods through the port in various ways. Logistics companies are also the customers both of the ferry lines and of Trelleborgs Hamn AB. The port has a key linking and storing role in the customers' logistics chains by having contact and managing several logistics companies' goods transport. The port acts as an intermodal node, by being a transfer terminal for trucks, trains, RoPax ferries and containers operated and transported by logistics companies.

In 2004, 7.9 million tons of goods were transported by 485 000 trucks via Trelleborg. Goods arrive by trucks with or without trailers to the port, check in and drive directly on board. Other goods also come by trucks on trailer and in containers, but left in the port, so that with port services they are to be placed on board. 2.7 million tons were travelling on 94 100 wagons, which is 1 700 wagon decrease compared to 2003 (THAB, 2005). Goods arriving by train are either driven directly on board on wagons or are handled individually as containers. Containers are transported either on road by trucks or on rails by trains; in both cases they are left for further port services to be placed on board as unaccompanied freight. The amount of goods and vehicles are summarized in Table 3-1.

Table 3-1 Volumes of goods transported via the port of Trelleborg, 2004

	Trucks	Trailers	Intermodal	Railway	Other	Total
No. of units	485 000	95 000		94 100		N/a
Tons	7 900 000		52 000	2 700 000	171 000	10 823 000

Scania is a significant cluster of logistics operators and integrators. All major logistics service providers, with numerous transporters are present in the region. Major forwarders and integrators such as Schenker, DHL, DFDS Transport, FedEx, TNT and UPS have daily inbound and outbound services through the port. Regarding the largest forwarders; Schenker such as Scandlines AG is partly owned by Deutsche Bahn AG. DHL belongs to Deutsche Post AG. DFDS Transport is a subsidiary of DFDS, the oldest shipping company in Denmark.

The route choice of these logistics companies partly depends on the relatively (1) short distance to the continent and the available ferry services. The ferry lines operate according to a (2) strict time schedule, meaning that the ferries are aiming to meet the arrival time, irrespective the delays at departure. It highly supports and facilitates just-in-time transportation to the logistics companies. On these routes ferry operators offer the required break time and chances to sleep to truck-drivers in the form of (3) night-trips. The short distance, the strict timetable and the night ferries seem to have an important competitive and operating impact on the transport companies' choice of logistics routes.

3.3 Trelleborg Municipality

Municipalities (kommun) are the local decision-making bodies in the Swedish three levels governmental administrative system. There are 290 municipalities in Sweden and each has an elected assembly, the municipal council (kommunfullmäktige), which takes decisions on municipal matters. According to the law, municipalities are responsible for matters concerning (a) social welfare, (b) city planning, (c) health and environment, (d) waste treatment, (e) water and sewage systems, etc. Other areas, such as (f) energy and (g) culture can also be covered on a voluntary basis. The municipal council is the central administrative body and is assisted in its work by a number of committees (nämnd), e.g. technical committee, environmental committee. The municipal council appoints the municipal executive board (kommunstyrelse), which leads and coordinates municipality work. As a rule an administrative organization (kommunal förvaltning) is attached to each committee; e.g. the technical office (tekniska förvaltningen) is attached to the technical committee (tekniska nämnden). The activities are financed through municipal taxes, government grants and charges, and are primarily regulated by the Swedish Local Government Act (Trelleborg, 2005a).

One part of the municipal activities, instead of the form of a committee, is managed in the form of limited companies, whereby the municipality is the owner in certain percentage. In Trelleborg, (1) Trelleborgshem AB, (2) Östersjöterminalen AB and (3) Trelleborgs Hamn AB are examples for this form of management (Trelleborg, 2005a). Trelleborg Municipality is the wholly owner of Trelleborgs Hamn AB.

The municipal executive board, via long-term planning and structured organization, is responsible for the development and the economic state of the whole municipality. The offices are responsible for different areas, such as the technical office manages public areas, food, energy, water, sewage in the whole municipality. The activities of the environmental office are based on the 15 national environmental quality objectives stated in the Swedish Environmental Code, with special attention to control, consultancy and recommendations concerning food and water handling, air pollutions, noise and environmentally damaging activities.

The city planning committee and office are responsible for the planning of future building and present maintenance of buildings, roads, settlements and surroundings. The committee applies the Planning and Building Act ('Plan- och bygglagen') when exercising authorities. The most comprehensive planning can be seen in the overview plan of the municipality, which is continuously reviewed and completed. The overview plan with its three main functions: (1) vision of the municipal development, (2) orientation for municipal decisions, and (3) reflection of national interests; is not only an important political document but also serves as a basis of the future development of the whole municipality. It shows how the land and water on the territory of the municipality will be used and how the built environment will be developed and maintained (Trelleborg, 2005a).

Recognizing the (1) importance of large city regions in Sweden and the (2) increasing volume of transportation, a city development plan was carried out for Trelleborg Municipality this year. Trelleborg's favourable geographical location makes it possible to further enhance the role of the city in the Öresund Region, which consists of Copenhagen in Denmark and the whole Southwest Scania. Meanwhile, the alternative plans of infrastructural development for the western part show the attempts to establish an economically sustainable and a socially attractive city. The plan among others includes the replacement and extension of the E6 road Trelleborg-Vellinge to motorway standard, in order to facilitate (1) the driving circumstances into and out of the city, (2) the access to the port and also (3) to take away the environmental burden, such as noise and air emissions from the coastal zone of Trelleborg. The further build of E6 would fulfil both industrial and commuter expectations by facilitating the transportation between Sweden and Denmark. The plan also contains the re-establishment of the commuter railway between Malmö and Trelleborg. The port, which is said to be the lifeblood of Trelleborg, is also expanding. From the citizens' point of view better access to this core of the city would be favourable. As a response to this request new housing and office quarter, Stavstenudden is planned nearby the western coastal area, close to sea and nature. The centre of Trelleborg gets several new houses with view over the port considered as a new commercial and cultural attraction value. A new school as well as new houses with view over the sea is being built in the eastern part of Trelleborg (Trelleborg, 2005b).

City development plans are amongst others reflections of the interests of national actors, how they see the future orientations of municipalities. Therefore, it is very desirable for all affected actors not only (1) to gain an understanding of these plans but also (2) to cooperate and advice when it comes to the implementation phase.

3.4 National Authorities

At national level, the cooperation of several authorities, agencies and public administrations in the infrastructure development and the transport sector are required for future port development. Taking this perspective as a basis, activities of some relevant actors are described hereby.

After the decisions taken by the Swedish Parliament (Riksdag), the Government presents the proposals for new laws and also implements various European directives and national regulations. The Government is assisted in its work by the Government Offices, comprising a number of ministries, and some 300 central government agencies and public administrations.

The Swedish Environmental Protection Agency, SEPA (Naturvårdsverket) is such a central government agency, which coordinates and promotes environmental policy and protection at national and international level. The SEPA drafts proposals for objectives, action strategies and policy instruments, disseminates information and evaluates the environmental situation and work being undertaken (Government Offices of Sweden, 2005).

Other relevant Swedish state agencies involved in infrastructure planning and development as well as transport research amongst others are the Swedish National Rail Administration, the Swedish National Road Administration and the Swedish Maritime Administration. The Swedish National Rail Administration, SNRailA (Banverket) is the authority responsible for rail traffic in Sweden. It follows and conducts development in the railway sector, and also responsible for the operation and management of state track installations. It coordinates the local, regional and inter-regional railway services and provides support for research and development in the rail sector. The Swedish National Road Administration, SNRoadA (Vägverket), is assigned the responsibility for the entire road transport system. SNRoadA is also responsible for drawing up and applying road transport regulations and for the planning, construction, operation and maintenance of the state roads. It is recognized that upgrading of the rail and road links to ports is essential for further effective solutions of multimodal transport.

The Swedish Maritime Administration, (Sjöfartsverket) is a public enterprise, governed by the Ministry of Industry, Employment and Communications. SMA is responsible for the safety of navigation on Swedish waters, by supervising Swedish merchant and fishing vessels and leisure boats and providing infrastructural services. Services include pilot assistance, ice breaking, hydro-graphics, maritime search and rescue, safety inspections and maintenance of fairway facilities. These are costly services, which are not found in land-based transportation and not used by all taxpayers. This is one of the main reasons why SMA activities are financed by dues, levied on merchant shipping for fairway use. From this aspect Maritime Administration differs from SNRoad and SNRail Administration, which do not have monetary liability over expenses. As Figure 3-1 shows, some 3-8% of the ferry operators' operational costs are fairway dues paid to SMA. This cost structure is not applied in the neighbouring countries; therefore docking in Swedish ports could cost double compared to other ports.

3.5 Citizens of Trelleborg

There are 39 477 people living in the municipality of Trelleborg. This number is increasing with 200-300 annually. The city itself has approximately 24 000 inhabitants (Trelleborg, 2005b). Couple of decades ago, Trelleborg used to be a heavy industry city; almost all families were in one way or another dependent on the dominating rubber factory. Today the city looks different. Instead of one actor's dominance, there are several companies represented in the economical life of the city. The living style has also changed; there are thousands of people commuting between Trelleborg and the surrounding cities in the region.

In average, the earning capacity in the municipality is 53%. Altogether more than 14.5 thousand people are working in the private (57%) and the public (43%) sector. The ratio of women employees in the public sector almost reaches 60%, while most of the man employees are working in the private sector (70%) (Trelleborg, 2005c). Although, THAB has only 97 employees, the number of businesses related to the port activities and transportation are high. According to the author's knowledge, there have been no studies carried out on quantifying the ports' significance as a localisation factor for other newly located companies. However, in a research made on Stockholm's ports and economy life was shown that in big cities, like Stockholm, where knowledge-intensive activities replace traditional goods handling, companies put the availability of the port almost on the last place, while in smaller settlements, like Kapellskär, the location of the port do play a significant role (Stockholms hamnar, 2005). Based on this background information, the port is assumed to have an important role when establishing businesses in the region, thus providing new working places.

3.6 Other actors

The numerous companies and organisations described above shows that there are a lot of actors involved when it comes to port development and environmental performance issues. Naturally, there are additional players, which have an influence on the economics and the behaviour of the port and other actors. However, the limitations of the report did not allow to include all of them.

Ship and engine suppliers have a long-term influence on the ferry operators firstly in the form of capital cost; secondly the set-up of the ferry determines its performance more or less in the following 20-30 years. The ferry operators, depending on the mother company, are relying on a few Swedish respective German fuel suppliers in the region. Contracted fuel suppliers have a continuous effect on the ferry operators' operational costs. Travel agencies and buss companies with their offers and communication can influence the number of passengers and the volume of travels crossing the Baltic Sea. Customers of the port, such as ferry operators and logistics companies have been described, however industrial customers and bulk transports were left out. Despite being the representative of port and maritime interests in different forums and facilitator of cooperation among ports, the Swedish Port and Stevedores Association has also fallen outside the scope of this report. The Swedish Ship-owners Association represents the Swedish ferry operators all over the world, by establishing decent competitive environment. Their role in the negotiations over the European Port Directive¹⁸ and its consequences on Trelleborg seem to be of relevance in the future.

The activities of non-governmental organisations have to be also mentioned in this chapter. Although they are not directly related to the port and it's surrounding, their work have indirect effect on the attitude of the relevant actors. The Swedish NGO, Secretariat on Acid Rain is a joint venture between five Swedish environmental organizations. The chief purpose of the Secretariat is to promote awareness of the problems associated with air pollution generated from, among others maritime activities. As a result of public pressure, Acid Rain also take the initiative to bring about the required reduction of the emissions of air pollutants. One organization of the joint venture organization is the Swedish Society for Nature Conservation (SSNC), which is the biggest nature conservation and environmental organization in Sweden. One way of its intervention in port development issues is that SSNC demands the decrease heavy vehicle traffic through measures to encourage the use of railways and seaways for the conveyance of goods. It also includes work to create a market for more environmentally friendly fuels and engines, so that these fuels and engines will actually be used.

¹⁸ The proposal for a Directive (Commission Proposal COM(2001)47 final) was handed in by the European Commission and the Council aiming to ensure access to the port services market. The European Parliament rejected the proposal.

4 Insight into the actors' interest

In this chapter, the opinion of the actors involved in port and related activities in Trelleborg is described. While Chapter 3 gives a general picture of some relevant actors around the port, hereby a deeper insight into these actors' point-of-views on five main issues are provided: (1) the importance of economical, environmental and social factors in harbour development, (2) the possible futures of the port and the city of Trelleborg as well as the (3) environmental performance of these scenarios, (4) the key players of implementing these possible futures and (5) actors' perceptions about each other. The actors got their judgements expressed by answering questionnaires in the frame of personal interviews, i.e. exploration parcours.

4.1 Actor groups

The interest groups were selected and grouped based on a normative deductive approach, where the research group decided over the key actors according to their administrative role in the legal system and their business interest. From this top-down perspective, five different groups were identified, each but one consisting of further sub-groups. Detailed description is provided on the key actors in Chapter 3, hereby the author focuses on the technical manner these interest groups were created.

(1) *Trelleborgs Hamn AB*, the initiator of the project was set in an individual actor group so that other actor groups' reactions and opinions could be simpler put into comparison with THAB's point-of-views. The second actors group, (2) *Customers* are grouping the direct and indirect customers of THAB together. This group consists of two subgroups, (a) *Ferry operators* and (b) *Logistics companies*, representing sole business interests driven by high volume of carried goods and low transport cost through the Baltic Sea. *Trelleborg Municipality*, hereinafter called (3) *Municipality* is representing the different departments of the local authority. Regarding the varying duties of municipality departments, depending on which field of responsibilities s/he is fulfilling, the research group expected slightly different opinions from the interviewed individuals. The (4) *National Authorities* actor group represents individuals from different governmental administrations and agencies, e.g. Transport and Communication Committee, SMA, SEPA, SSNC. The reason behind of setting up this fairly widely spread group was to gain an understanding on how authorities on national level, being responsible for strategic developments, infrastructure investments and economic incentive structures look upon local initiatives and possible future developments. The fifth group consists of randomly selected (5) *Citizens of Trelleborg*. With this group the researchers' intention was to cover the public, who is actually experiencing both economically and socially the life quality in Trelleborg: the available infrastructure, city development and air quality.

Technically, 4-6 individuals, employees of companies and organization are representing the five actor groups. Appendix 4 contains a detailed list of interviewees. Interviewees were to be confronted with the scenarios described in the following chapters.

4.2 Introduction to the scenarios

Based on formative scenario analysis approach, local and global scenarios were constructed to identify preferences, alternatives, possible futures and directions chosen by certain actor groups; and thereby to investigate factors, which can prevent, divert or facilitate future dialogues.

The scenarios were constructed based on nine impact variables selected by the researchers together with the project group. It is recognized that the impact variables are one of the most decisive factors on the case, therefore discussion and detailed description of the current state and dynamics of the case, i.e. the impact variables and the relationship between them is the subject of the thesis written parallel with this one (Buxhoeveden, 2005). The number of impact variables is limited partly because they seemed to offer satisfactory resources for further analysis, partly because on these chosen variables the actors could directly have an influence. Table 4-1 and this chapter with the brief and concise description of the scenarios merely include the results of the scenario construction process¹⁹.

Table 4-1 Impact variables in the local scenarios

	IMPACT VARIABLES	LOCAL SCENARIOS			
		I. Present situation	II. Management on board	III. Land-based resources	IV. City integration
1.	Fuel type	X	✓=dual fuel	✓=MDO	✓=DME ²⁰
2.	Wet scrubber	X	✓	X	X
3.	NO _x catalyst	X	✓	✓	✓
4.	Shore-side electricity	X	X	✓	✓
5.	Design for port-operations	X	X	✓=pier arrangements	X
6.	Speed of ferries	X	X	✓=higher	✓=lower
7.	Railway double-track	X	X	✓	✓
8.	Dry Port	X	X	✓	✓
9.	Access to sea	X	X	✓=slight	✓=extensive

X = e.g. impact variable *Access to sea* does not exist in *Management on board* scenario

✓ = e.g. impact variable *Speed of ferries* is a constructor of *Land-based resources scenario*; it also has a value, meaning that ferries are travelling on lower speed than today

4.2.1 Local scenarios

The local scenarios are simplified version of possible futures, put in ten years time perspective, 2015. They are merely focusing on the nine selected variables, therefore in some cases typical consequences of local and global scenarios were not taken into consideration; such as if the volume of transportation increased three folds new ferries were to be bought. However, the ignorance of direct consequences in general did not affect the results and the tool of scenario construction achieved the intended outcome. The scenarios were also constructed in such a way that there were no one and only best solution, which meant to make the interviewees more active and reactive expressing their opinion while filling in the questionnaire. The establishment of the scenarios and thoughts behind is the subject of Buxhoeveden (2005); the implications and the brief descriptions of the local scenarios follow hereby.

¹⁹ The entire scenario construction and the description and relation among the impact variables is the subject of Buxhoeveden (2005).

²⁰ DME (dimethyl ether) is an oxygenated hydrocarbon. It is generally produced from natural gas but almost any carbon-based feedstock can be used, including crude oil, coal, crop residues, oil sands, wood, or straw.

I. Present situation

Present situation represents the null alternative, meaning that no “radical changes”, such as large investments or ferry operational modifications are made. There are three ferry lines and eleven ferries competing with each other, using at least three different types of marine fuel with sulphur-content from 0.2% to 2%. No technological investments are made either on board or on shore to reduce air pollution, such as SO₂ and NO_x. Regarding the speed of ferries there are day- and night-trips – the latter are slower. This scenario is based on today’s situation; there are no large investments either on land in the port or in the infrastructure of the city. E6 road from western and the railway track from eastern are seen to cut off the city from the sea. The check-in is on the territory of the port by the sea.

II. Management on board

This scenario is based on the ferry operators’ initiative and willingness to handle the occurring problems by themselves solely with the support of installing cleaner technologies on board. It is one way of reacting to the legislation, which offers individual technological solutions to, for instance, SO₂ reduction; supposing that ferries can use higher sulphur-content fuel then. This scenario represents significant changes on board, as at present, no technological investments are made either on board (wet scrubber, NO_x catalyst) or on shore to reduce air emission, such as SO₂ and NO_x. Regarding the speed of ferries there are day- and night-trips – the latter are slower, like in the present scenario and the check-in takes place on the territory of the port.

III. Land-based resources

In the Utilization of land-based resources scenario the focus is on the infrastructural development on land, facilitating the transportation both at sea, on road and on rail. For that reason the ferries are cruising in a high-speed, consuming marine diesel oil with lower sulphur-content than today’s ferries and the pier system of the port are reconstructed in order to decrease maneuvering time of the ferries. Infrastructural investments on land are carried out, similarly to the City integration scenario: dry port is established at the edge of the city for check-in and queuing and there is a railway double-track between Trelleborg and Malmö for passenger and goods transportation. The port area is gradually opening up for the public, by establishing a bar with a viewpoint on the inner berth, new houses right next to the port and a walking and cycling path out to the western pier.

IV. City integration

This scenario represents radical changes in the city infrastructure and on board, through the integration and the common planning of city and port infrastructural development. The ferry operators use DME (dimethyl ether) as marine fuel, technologies for reducing air pollution is installed on board as well as on the shore and the ferries are traveling on lower speed than they do today. Infrastructural investments on land are carried out: dry port is established at the edge of the city for check-in and queuing and there is a railway double-track between Trelleborg and Malmö for passenger and goods transportation. From the centre of Trelleborg passengers can reach the ferry terminal by cable car by the first stop and by the second stop a restaurant on the outer berth can also be reached. Housing area and office buildings are built on the western coast of the city.

The intention of the scenario construction is to observe how actors react, how moderate or radical their attitude is towards developments on different fields, how they handle the upcoming responsibilities and how intensive is the willingness to participate in multi-stakeholder situations. The attributes related to the Present scenario are “afraid of changes”,

”satisfied with the present situation” and ”moderate”. City integration was constructed to provoke actor groups and investigate how radical and cost conscious at the same time they are in their decisions; moreover whether they look upon continuous cooperation and actors’ dialogue as driving forces of sustainable development. Management on board basically let the ferry lines handle environmental problems on their own, which suggest a less integrative, but much more of a ‘complete use of new technologies’ approach. Utilization of land-based resources scenario is almost as complex as the integration of the city, except it is described as “moderate development” compared to the City integration with presumably higher costs. In the Land-based resources scenario there is also more emphasis on infrastructure utilized by the transport business and less on spectacular investments available for public use.

4.2.2 Global scenarios

The local scenarios were put into a context of global changes, focusing on two main variables: (1) oil price and (2) volume of transported goods over the Baltic Sea (see Table 4-2). The construction of the local scenarios and the global scenarios was followed by discussions on their genesis, the differences between them, their quality and matching. The main characteristics of these global variables are that local actors have no influence on them.

Table 4-2 Global variables and their values

GLOBAL VARIABLES	VALUES OF GLOBAL VARIABLES		
Oil price	present*	higher (3*present)	
Transport volumes	lower (0.5*present)	present**	higher (3*present)

*Present oil price is the bunker oil price on 25th July 2005 on the Rotterdam stock exchange: (a) IFO180 US\$ 263/MT and (b) MDO US\$ 511/MT (Bunkerworld, 2005).

**Present sea transport volume is the volume passing through the port of Trelleborg in 2004: 10.8 million tons.

Having matched the values of the global scenarios, the research group found four of them to be relevant for further description and presentation to the actors. The choice was based on experience and discussions occurred on the project group meetings. On these meetings, certain actors had doubts on economically viable futures in the light of rising oil price, while others expressed their interests in the consequences of changes in transport volumes via the port. The four global scenarios are listed below:

- A) Lower volume of transported goods and present oil price
- B) Higher volume of transported goods and present oil price
- C) Higher volume of transported goods and higher oil price
- D) Present volume of transported goods and higher oil price

The main reason for the set up of global changes was to observe (1) the actors’ preferences of local scenarios and (2) their opinions on other actors’ first choices.

4.3 Evaluation criteria for scenario assessment

The questionnaire started with a list of six criteria. Based upon this list the interviewees could evaluate the scenarios themselves. The criteria were preference-related dimensions of a system, aspects that were considered relevant for the evaluation. They were based on objective measures, economic and environmental criteria and subjective/preference measures, social criteria, such as people’s perception on quality, aesthetics, etc. Six criteria were given, but as a sub question interviewees could add additional ones according to their preferences. In order to have all the relevant criteria, which further used in the case evaluation, the following question was to be answered: “Which aspects or criteria do you consider to be important for the sustainable development of the port in Trelleborg?” Table 4-3 shows all those criteria that the project group set up.

Table 4-3 Criteria list for scenario evaluation

TYPE OF CRITERIA	CRITERIA	VALUE OF THE CRITERIA
ECONOMIC:	Transport costs	€ /ton goods transported across the Baltic Sea
ENVIRONMENTAL:	Air quality in Trelleborg	Winter half year: SO ₂ µg/m ³
		Winter half year: NO _x µg/m ³
		Kg CO ₂ /ton transported across the Baltic Sea
SOCIAL:	Attractiveness of Trelleborg	Number of visitors/year
	Attractiveness of the port in the city	Number of visitors in the port vicinity/year

Transport cost was taken as economic criterion to evaluate the scenarios. By transport cost is meant the total cost of bringing one ton of good through the Baltic Sea. Ferry operators prefer to look at costs volume-wise, as their measure of calculation are containers on board. However, unit of tons were chosen because of comparative reasons to other mode of transportation. *Air quality in Trelleborg* was set up as an environmental criterion, with focus on SO₂ and NO_x concentration in the air. In case of CO₂, it was put into context of the tons of goods transported across the Baltic Sea. Therefore, while interviewing air quality was always meant these three pollutants. In the estimations on air emissions, the amount of these pollutants emitted was calculated describing the differences between the four scenarios. *Attractiveness of Trelleborg and the port vicinity* were taken as social criteria. They cover the number of visitors in the city and in the neighbourhood of the port, including visitors who pass through Trelleborg because of the ferry connections, overnights in Trelleborg or other attractions of the city. These criteria are solely asked during the interviews, no measurements or estimations were carried out to be able to put them into comparison. The results represent merely the actors' view.

4.3.1 Calculated evaluation criteria

Values for the above described evaluation criteria were estimated by the author so that the scenarios can be compared with each other and with the actors' opinion. The estimations are based on (1) information on cost of various technical solutions and infrastructure investments and (2) the update of air emissions from port and related activities. These data gathering was carried out in the first phase of the project work where the case was to get acquainted with.

4.3.1.1 Economic criterion: transport cost

The transport cost estimation includes all investment costs described in the scenarios. It is expressed then in € per one ton of goods transported across the Baltic Sea. The main cost factors are the impact variables, listed up in Table 4-4; more detailed information is provided in Appendix 5. Buxhoeveden (2005) provides with a detailed scenario description on the investments carried out in three fields: on board, on shore and in the city, and the relation between them. The responsibilities for the implementation of the investments are for the most part in the hand of the actor groups being interviewed during the thesis work: THAB, Customers, Municipality, National Authorities and the Citizens of Trelleborg.

Table 4-4 Main factors of investment cost in the scenarios

Investment type	Installation description	Cost [€]	Source
On board			
Wet scrubber	On 11 ferries, 75% reduction efficiency	14 371 890	Entec, 2005a
NO _x catalyst	On 11 ferries, 90% reduction efficiency	8 669 265	Entec, 2005b
Shore-side electricity ¹	11 ferries	1 841 840	Entec, 2005c
On shore			
Shore-side electricity	5 connections, 8 berths	6 080 000	Entec, 2005c
	7 connections, 10 berths	7 425 990	Entec, 2005c
In the city			
Road E6	18 km	105 400 000	SNRoadA, 2005
Railway double-track	62 km, train station	158 1000 000	SNRailA, 2005
Dry port	120 000 m ²	31 6000 000	SNRoadA, 2005
Cable car	2 end-stations, 1 stop	14 700 000	CCC ²¹ , 2005
Restaurant	150 guests	500 000	SHR ²² , 2005
Terrace bar	60 guests	200 000	SHR, 2005
Berth arrangements	2 berths	18 400 000	THAB, 2005

¹ On board the ferries installations are needed for shore-side electricity connections.

Based on the information on investment costs and the approximate operational costs of the ferries, annual transport cost of one-ton good carried across the Baltic Sea was calculated for each scenario. The operational cost of an average ferry travelling between Sweden and Germany was roughly estimated with the assistance provided by the ferry lines. However, exact figures are not available due to the confidential nature of cost issues. External costs originate from air emissions were also calculated based on the air emission update and values from Swedish Institute for Communication Analysis (SIKA) on sea transportation (see Appendix 5). Figure 4-1 illustrates the cost of transferring one-ton goods through the Baltic Sea. According to the allotment, the highest factor seems to be the fuel and maintenance segment, followed by the capital cost. The external costs originate from air emissions represents 20-25% of the total costs.

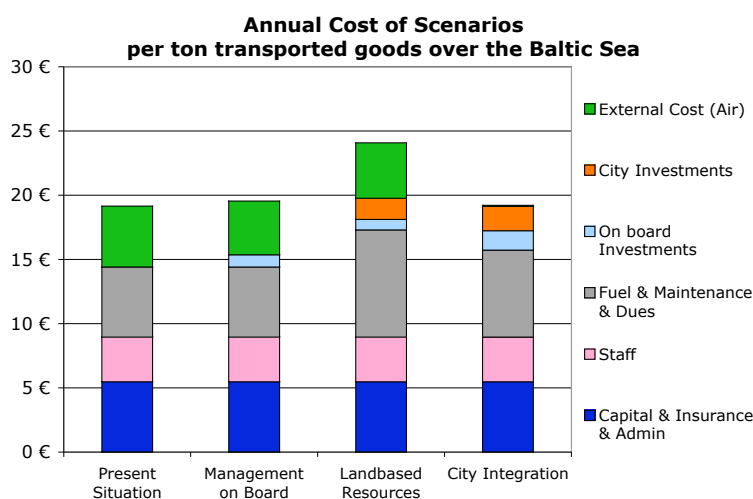


Figure 4-1 Transport cost of the scenarios

²¹ Cairngorm Chailift Company Limited established a skilift system in Cairngorm Ski Area, Aviemore in 1997. Information from Highlands & Islands Enterprise (2005) was used to estimate the cable car in Trelleborg.

²² Swedish Hotel and Restaurant Association

4.3.1.2 Environmental criteria: air emissions

The environmental criteria “air quality” is displayed in the form of calculated values of emitted tons so that the scenarios environmental air quality performance could be put into comparison with each other and with the actors’ opinion. In the questionnaire the measures were given in SO₂ and NO_x concentration in the air (µg/m³), while in the evaluation SO₂ and NO_x emissions were calculated in tons. Previously, present air emissions generated by port and related activities were calculated in the form of a first assignment of researchers (Appendix 1). Based on these calculations and the environmental effectiveness of technologies applied in certain scenarios, estimations were made on the air emissions in each scenario. As the main message was the level of air quality improvement, the difference in the evaluation measures did not influenced the final outcome.

The environmental impacts of the following impact variables are taken into account: (1) fuel type, (2) NO_x catalyst, (3) wet scrubber, (4) shore-side electricity and (5) ferry speed. The environmental impacts of those investments, which are not directly connected to the emissions generated by the ferries, such as (6) dry port, (7) railway double-track and (8) cable car are not included in the air emission estimations for the scenarios. The (9) rebuild pier system in the port is also excluded due to insufficient information on reduction measures.

SO₂ emissions are basically dependent on the sulphur content of the marine fuels ferries consume. In the Present scenario ferries are using the same marine fuels as today, sea detailed information on the sulphur content and the type of fuels ferries use in Appendix 3. In the Management on board scenario ferries switch to higher sulphur content fuel: (a) heavy fuel oil with 2.7% sulphur content and (b) marine diesel oil with 1.5% sulphur content. To clean the fuel wet scrubbers are applied on board. The reduction efficiency of the wet scrubber is 75%. At berth all ferries use 0.1% sulphur content fuel. Figure 4-2 shows the SO₂ emissions of the different scenarios. These measures altogether results 18% decrease in SO₂ emissions compared to the Present situation.

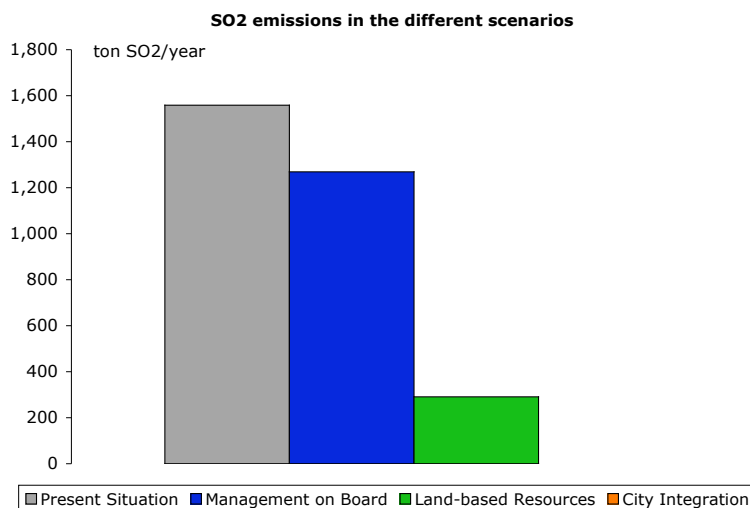


Figure 4-2 SO₂ emissions in the four scenarios

In the Land-based resources scenario ferries consume marine diesel oil with 0.1% sulphur content at sea and no fuel at berth due to the installation of shore-side electricity. The amount of SO₂ emissions has fallen to 291 tons, which is 81% of the SO₂ emissions in the Present scenario. The DME used in the City integration scenario does not contain sulphur, thus SO₂ emissions generated in this scene are close to zero.

NO_x emissions mainly depend on the completeness of the engine combustion, thus the engine output (kWh), the speed and how much time the ferry spends in certain state of operation: at berth, manoeuvring, at sea. NO_x emissions can be cleaned after being generated in the engine with urea or ammonia (Johansson, et al., 2001). One of today’s often-applied technologies is selective catalytic reduction (SCR), which can work with around 90% reduction efficiency.

This NO_x catalyst was applied in three scenarios: Management on board, Land-based resources and City integration. Minor differences among these three scenarios appear due to the variances of the ferry speed and the application of shore-side electricity. In City integration scenario ferries are cruising 10% less than today's average speed, while in the Land-based resources scenario the ferry speed is 10% higher. In case of shore-side electricity, the ferry engines are switched off at berth (see Figure 4-3).

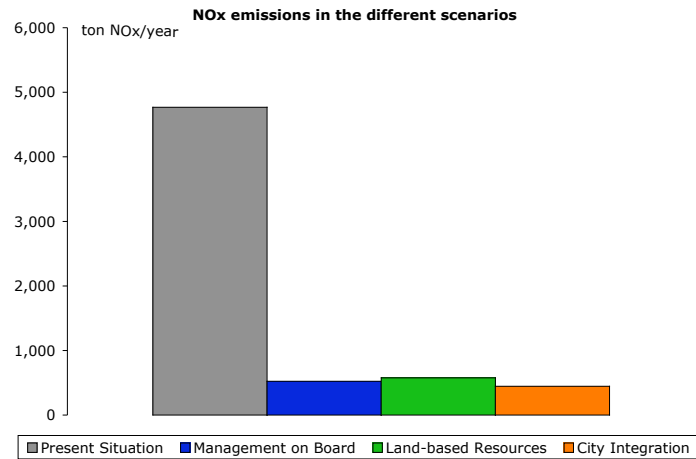


Figure 4-3 NO_x emissions in the four scenarios

CO₂ emissions are directly linked to the type and the amount of fuel consumed. In the four scenarios there are no specific measures applied for CO₂ reduction. By 2015, the volume of transported goods over the Baltic Sea was estimated 12 million²³. Figure 4-4 illustrates the CO₂ emissions per ton of goods in the different scenarios.

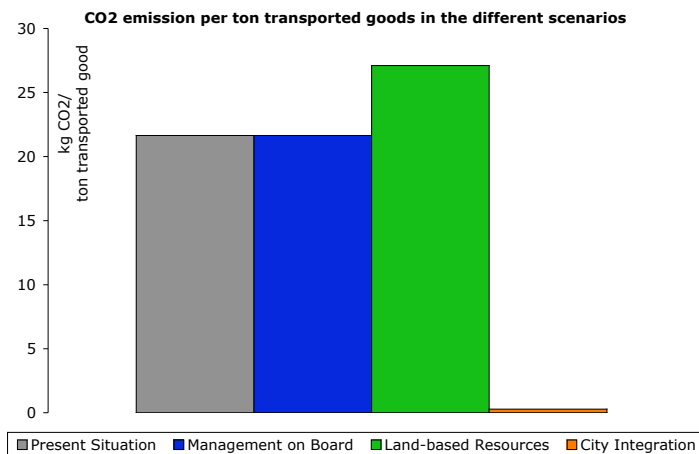


Figure 4-4 CO₂ emissions in the four scenarios

In Land-based resources scenario ferries are travelling faster than today, while in City integration slower. The speed factor, thus the fuel consumption seems to have one of the strongest influences on the emitted CO₂. The other impact factor is the type of fuel. In City integration, DME is used, a renewable alternative, which based on the gasification of black liquor from timber raw material and results practically zero CO₂ emissions.

The social criteria: (1) attractiveness of Trelleborg and (2) the port cover the number of visitors in the city and in the harbour neighbourhood. The present number of passengers passing through THAB on board is close to 2 million. However, due to the limitations of this report, no estimations were made on the reason of visits and how the different scenarios affect the these reasons and numbers.

After the preparatory phases: (1) set up of actor groups, (2) creation of scenarios and (3) establishment of evaluation criteria for the scenarios, in order to obtain the actors' point-of-views they were confronted with most of the results from this phase. Answers are to be described in the following chapter.

²³ SIKA estimated 15% growth of transportation in the Baltic Sea region (SIKA, 2005).

4.4 Actors' opinion

Exploration Parcours approach was used to understand the specific perspective and relation of the key players to the case, by confronting them with the scenarios. *Multi-Attribute Utility Theory (MAUT)* method was applied for measuring interests and evaluations of the participants. Depending on the means of the questions, in some cases the Citizens of Trelleborg were left outside of the scope.

Technically, the confrontation happened in the form of personal interviews, starting with the presentation of each scenario, supported by colourful images on screen and one page description per scenario in printouts. During the presentation in order to avoid misunderstandings, the interviewees had the opportunity for asking questions for further clarifications and for intervening if they had more knowledge about certain factors in the case. After the presentation, the actors were provided with a questionnaire according to their request either an electronic or printed version. In this way, they reflected upon the different scenarios identifying, searching and understanding the message by using their directed and intuitive evaluation systems. During the answering phase they were welcome to ask and discuss again. This method was applied, because during the confrontation in person the interviewees and interviewers could establish a semi-formal conversation over the scenarios, which enabled the interviewers to obtain an insight into aspects that were not raised in the questionnaire due to time-constraints or lack of background knowledge.

MAUT approach was applied to a limited extent in the evaluation phase of this report to result data about comprehension and opinion of the actors, more over weighting of the described criteria and possible futures in question. Based on MAUT the collected information is further evaluated and the different actor groups' preferences, comprehensions and evaluations of the case are highlighted.

In the frame of *MAUT α* (alpha), the researchers set preferences on the scenarios, considering the results of the air emission (SO_2 , NO_x and CO_2) and cost (of tons transported goods) calculations. The research group, based on today's calculated values of air emission, made the estimations for the different scenarios.

MAUT β (beta) method was applied to compare the actor groups' preferences of the evaluation criteria with estimated values of air quality in the form of calculated air emissions and costs. The application of *MAUT β* clearly shows which criteria are of relevance for the actor groups. Based on these preferences, the researchers could rank the scenarios with the background knowledge of the calculated values.

MAUT χ (gamma) method was used to obtain the actor groups' subjective input by expressing their view upon how well the above-listed criteria are fulfilled in different scenarios. This portion provides an overview over how the actors cognized and prioritized the scenarios themselves and how they looked upon other actors preferences and opinion. Having compared the actors' own ranking with other actors' opinion on their ranking, a fairly good understanding of the case and the relation between the actors could be obtained: how they see themselves and how others do. Differences can depend on misunderstandings, lack of objective information and communication between the actors in question or other reasons.

Based on MAUT methods there are hundreds on observations can be stated about the case, however due to the limitations of this report and the qualitative manner of the interviews, certain issues have fallen outside the focus of this report.

4.4.1 Evaluation criteria

In the questionnaire, the interviewees were introduced to the six criteria and asked to identify missing ones, which are of relevance for their company or organization. They also had to weight how important these criteria were for their company or organization. The scale consisted of twenty units from “not at all” to “very important”. 55% of the interviewees did not make difference between the different air pollutants; therefore the three criteria related to SO₂, NO_x and CO₂ emissions were aggregated to one criterion named air quality. Five actor groups were interviewed. The participation was 100% in this question.

4.4.1.1 Outcome of the criteria-related questions

All the actor groups agreed upon that the listed criteria were of relevance for their companies and organisations. Individuals from each actor group added single criterion, such as economic viability, integration of transportation, environmental load generated by all modes of transportation and customers’ demand.

Four actor groups: THAB, Municipality, Citizens of Trelleborg and National Authorities consider air quality as “very important” evaluation criterion (see Figure 4-5). THAB has two preferences; besides air quality, it puts emphasis on the attractiveness of the port as well. Customers classify air quality as of average importance for their companies. The same actor groups, which considered air quality as a “very important” evaluation criterion, put transport costs on a lower importance level, Municipality and Citizens of Trelleborg almost make it equal to “not at all”. All actor groups, except THAB regard the attractiveness of the port lying on a low level of importance. For Customers and National Authorities the attractiveness of Trelleborg is “not important at all”.

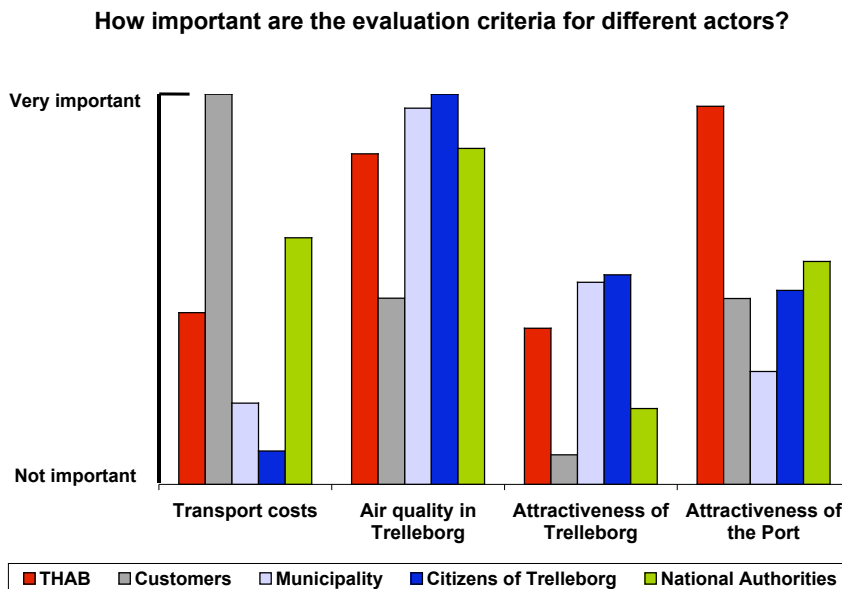


Figure 4-5 Importance of the evaluation criteria for different actor groups

4.4.2 Scenarios fulfilling the evaluation criteria

After having obtained knowledge about the validity and significance of the criteria, the interviewees were asked about to what extent the criteria are fulfilled by the four local scenarios. The questions were to be answered on a twenty-unit scale, from “not at all” to “completely”. Specific criteria fulfilment was also asked when the Present situation was set under the four global circumstances. The results are grouped according to the scenarios in question. Four actor groups were interviewed on this question. The participation was 100%.

4.4.2.1 Outcome of the criteria fulfillment-related questions

4.4.2.1.1 Present scenario

The present scenario fulfils the transport costs and air quality criteria on an average level according to three out of four actor groups (see Figure 4-6). National Authorities are concerned that if no changes will be implemented in Trelleborg in the future the transport costs will be increasing. Customers set the fulfilment of air quality criteria the same level like the fulfilment of transport costs. The number of visitors in Trelleborg and in the harbour neighbourhood will not be increasing.

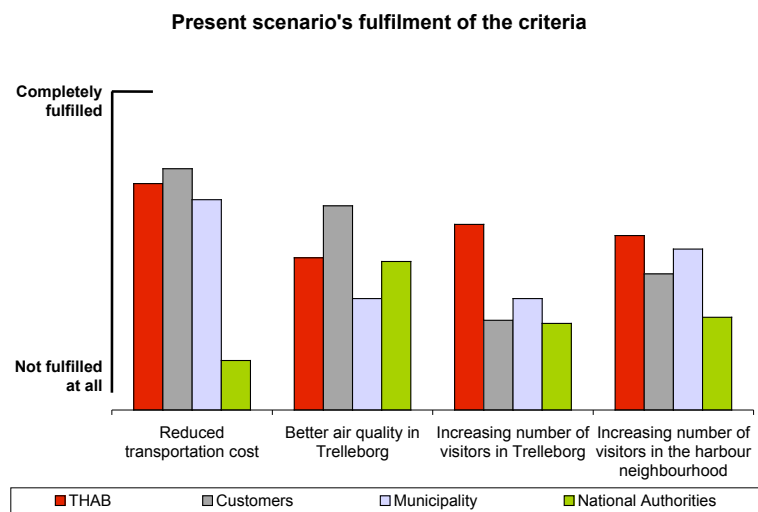


Figure 4-6 Present scenario fulfilling the different criteria

The present scenario was set into a global context to discover changes in circumstances, which could lead to more complete fulfilment of the criteria. Due to limitations of the method, this process has been done solely in relation to the present scenario. All actors agree that the present scenario is performing better in terms of air quality when the volume of transported goods falls to half of the present volume. National Authorities expect improved air quality also when the oil price grows by three folds. In terms of the fulfilment of transport costs and the number of visitors, the most favourable global scenario was the one when the oil price remains stable and the volume of transported goods grows by three folds.

4.4.2.1.2 Management on board

The Management on board scenario according to all actor groups' perception provide an above medium level fulfilment of the air quality criterion (see Figure 4-7). Transport costs will presumably be increasing, only THAB regards this criterion as to be fulfilled above average. Opinions on the number of visitors in Trelleborg and in the harbour neighbourhood are diverse: THAB and Customers are positive and indicate a slight increase, while Municipality and National Authorities expect the same amount or even less visitors than at present.

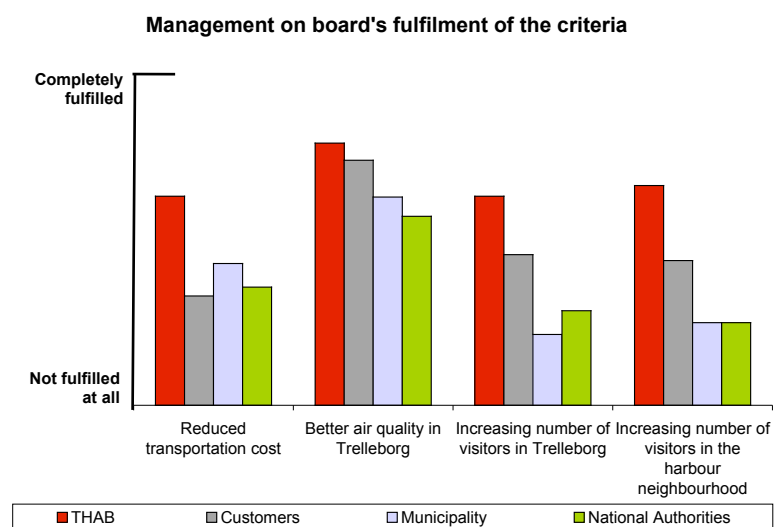


Figure 4-7 Management on board scenario fulfilling the different criteria

4.4.2.1.3 Utilization of land-based resources

This scenario fulfils the air quality requirements as well as the expectations on number of visitors in Trelleborg and in the harbour neighbourhood (see Figure 4-8). Regarding all criteria THAB and Customers seems to be more optimistic than Municipality and National Authorities. In case of the increase in number of visitors the Municipality shows pessimism and does not count on any positive effect of this scenario. Transport cost is expected to increase according to three actor groups, while THAB is concerned that the changes described in the frame of this scenario will not cause a rise in transport costs.

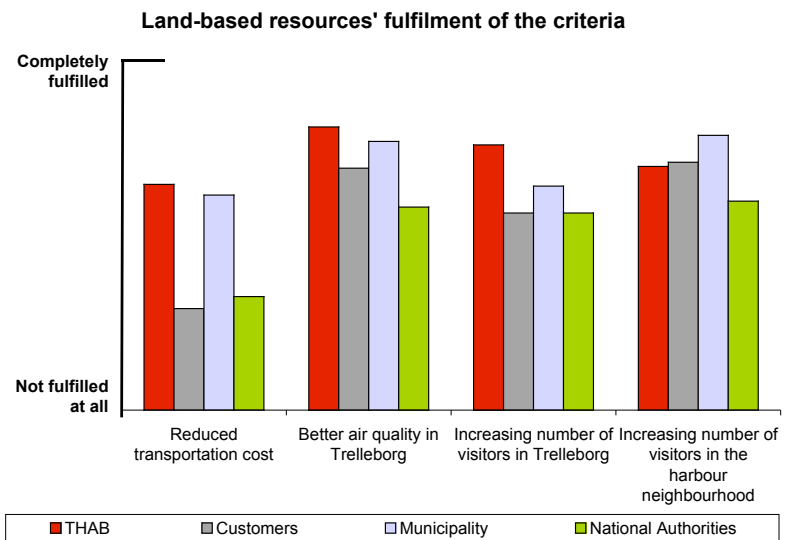


Figure 4-8 Utilization of land-based resources scenario fulfilling the different criteria

4.4.2.1.4 City integration

The City integration scenario fulfils three out of four criteria far above average level (see Figure 4-9). It satisfies actor groups regarding air quality and the number of visitors in Trelleborg and in the harbour neighbourhood. Transport costs according to three actors: THAB, Customers and National Authorities will not be decreasing; Municipality, on the other hand, expect a slight decrease. In general, the actors' opinions are very similar.

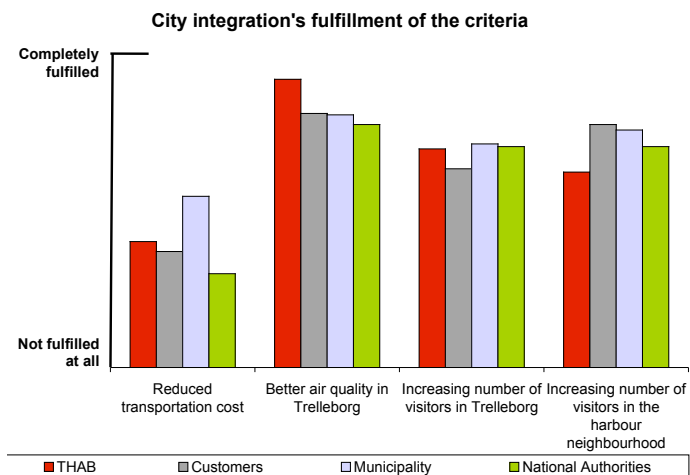


Figure 4-9 City integration scenario fulfilling the different criteria

4.4.3 Preferences of scenarios

After the interviewees having been introduced to each scenario, they were requested to express their preferences. Firstly, the actors' opinion was asked about the quality of the scenarios, in the form of listing up two strengths and two weaknesses per scenario. Secondly, the interviewees had to express their preference of the local scenarios by ranking them from 1 (best available) to 4 (worst available). Thirdly, the interviewees had to give their opinion and estimation on how other actors ranked the scenarios. The author used these answers to gain a first insight into actors' perceptions about each other. The same questions were repeated under the changing global circumstances: actors' (a) own and (b) view on other actors' scenario ranking. The participation in listing up the strengths and weaknesses of the scenarios was around 55%, and 100% in the scenario ranking. All the five actor groups were presented.

4.4.3.1 Outcome of the scenario-related questions

4.4.3.1.1 Strengths and weaknesses

Strengths and weaknesses are considered that several actors mentioned independently, and thus got the majority votes per scenario. According to all actors the strength of the *Present situation* is its economic viability without costly investments. On the other side, all actors mentioned that the environmental load on the port would either remain the same or even increase, according to the Municipality. THAB and Customers also consider road and rail infrastructure to and from the port and logistics in the port as weak points of this scenario. The strengths of *City integration* are clearly the railway double-track and the dry port. This scenario is also claimed to be very attractive. Its weak points are the low frequency of ferries and the costs of on board, but especially city investments, more over safety, health and water quality issues in the western coastal area of Trelleborg were mentioned. Three actor groups (THAB, Customers and Municipality) claim that the *Management on board* scenario has some achievements on the environmental field and air quality, but at the same time it is also said not to be enough environmentally sound. All actors mention the lack of integration and understanding of each other's point of views. Regarding cost issues the results are contradictory even inside the actor groups. Concerning the *Utilization of land-based resources* scenario, three actor groups (THAB, Municipality, Citizens) mention integration as one of its strength; THAB and Customers also indicate infrastructure as another strength, including railway double-track, dry port and extended pier system in the port. The operation of faster ferries is a contradictory issue between THAB, Municipality and Customers. According to three actors (THAB, Customers and Municipality) the air quality improvement is also a strength point of this scenario, while the Municipality and National Authorities indicate that the improvements being implemented are not enough for reducing environmental and health problems in the region. The same contradictory opinions were given on the economic feasibility of the scenario: one group of Customers and the Municipality say that it is the advantage, while others from the Customers group and THAB says that it is the disadvantage of the scenario. Table 4-5 provides with the summary of the strengths and weaknesses of the scenarios.

Table 4-5 Strengths and weaknesses of the local scenarios

LOCAL SCENARIOS	STRENGTHS	WEAKNESSES
Present situation	1. Cost neutral	1. Air quality 2. Infrastructure
Management on board	1. Cleaner technologies 2. Low cost	1. Technology costs 2. Noise
Land-based Resources	1. Infrastructure 2. Air quality	1. Costliness 2. Slight environmental improvement
City integration	1. Infrastructure 2. Attractive environment	1. Costliness 2. Frequency of ferries

4.4.3.1.2 Scenario ranking

After the ranking of the local scenarios at least three of the five actor groups clearly indicated their choices. THAB's first choice is Land-based resources scenario based on moderate changes. Customers choose the Present situation and National Authorities favours the City integration scenario. Both Municipality and the Citizens of Trelleborg placed two scenarios on the same level: City integration and Land-based resources scenarios have been evaluated similarly well. Customers put these two scenarios as their last choices. In general, the least preferred scenario is the Present situation among four actor groups (see Figure 4-10).

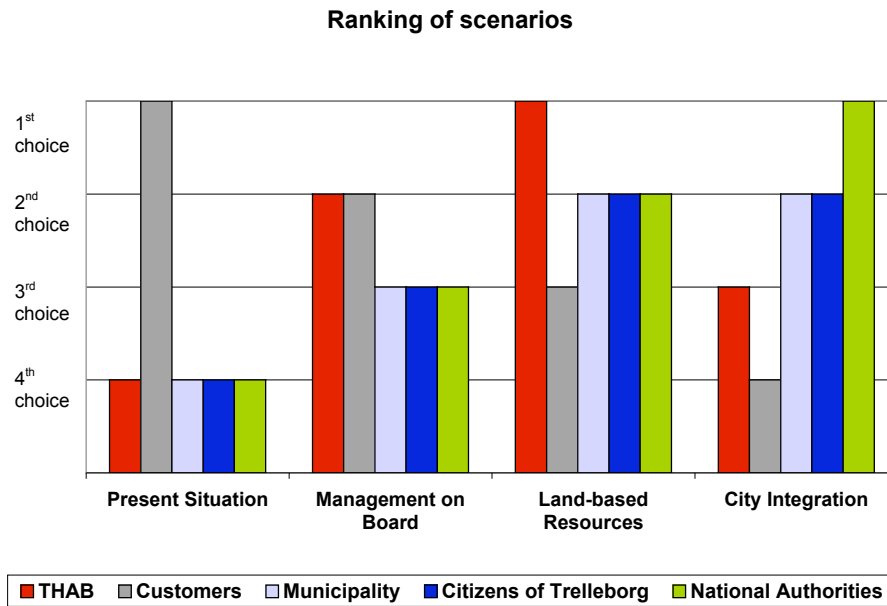


Figure 4-10 Ranking of the scenarios by different actor groups

The local scenarios were placed in four different global contexts, described in Chapter 4.2.2. The outcome of these questions focuses on the observations of relevance for THAB. Results other than that are briefly summarized here and illustrated in Appendix 6. Municipality and National Authorities regardless changes in the volume transported over the Baltic Sea or oil price give the same preference order to the scenarios: Municipality’s first choice is Land-based resources and National Authorities’ is City integration. Customers only react to the volume increase; otherwise they give the same ranking to the scenarios like without the global context (see Figure 4-10). THAB and Customers under the changing circumstances do not want City integration. THAB is the only actor, which reacts to all single changes. Figure 4-11 illustrates how different actor groups counter to the increasing volume flow over the Baltic Sea.

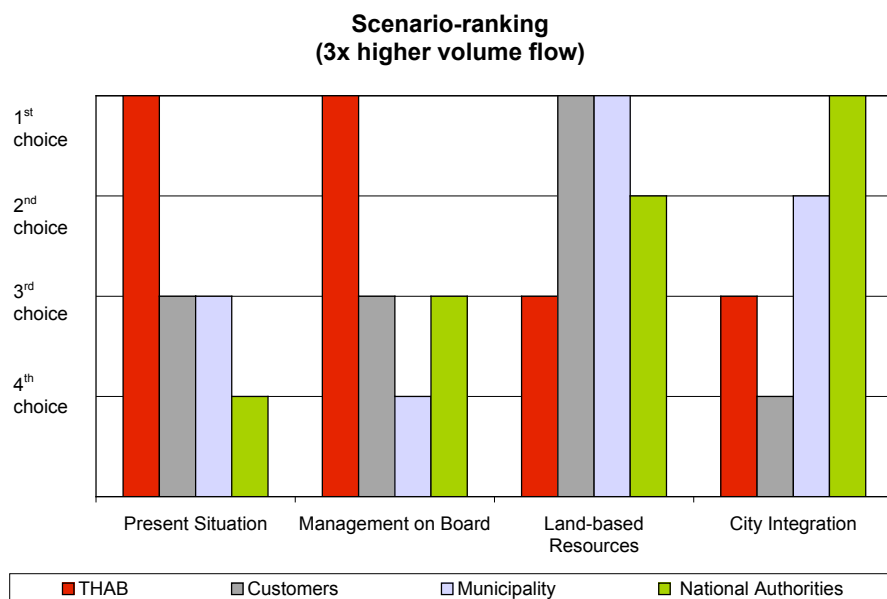


Figure 4-11 Scenario ranking, the volume of transported goods is three folds higher

4.4.3.2 Outcome of the actors-related questions

In the frame of this question all actors were required to express their opinion about other actors' possible scenario ranking. Hereby, results obtained in relation to THAB are presented; additional results in connection with the other actors can be seen in Appendix 6. Having pointed out the first placed scenarios of Customers and the Municipality, THAB seems to have a relatively good perception of these actor groups' future plans. THAB, however, does not seem to have a clear idea about the plans of National Authorities. According to THAB National Authorities are satisfied with the Present situation or if they are about to go for changes, only moderate ones in the form of land-based resources. By voting for the City integration scenario as a first choice, National Authorities act to be more radical than THAB assumes. Figure 4-12 shows the actors' ranking of different scenarios, while the red dots indicate THAB's perception on how the other actors ranked the scenarios.

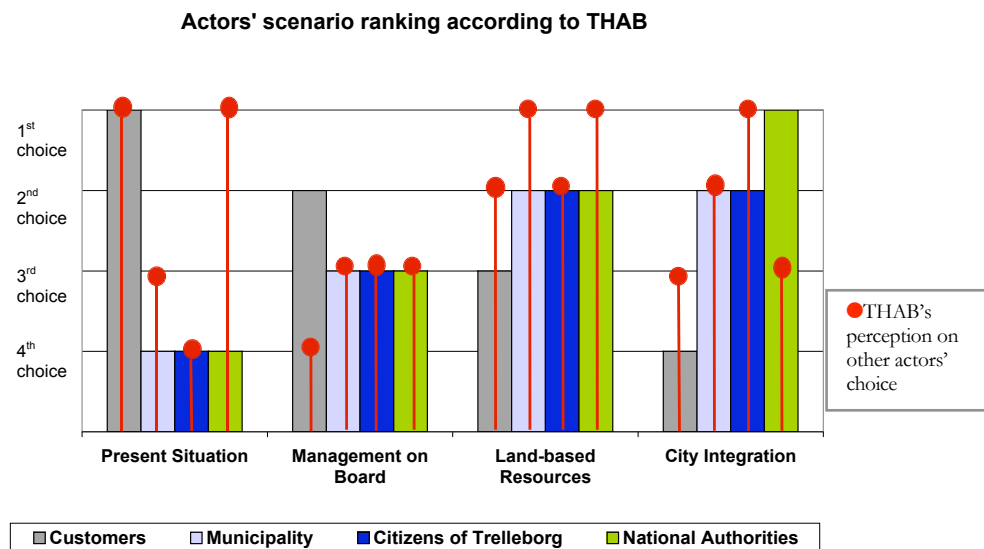


Figure 4-12 THAB's perception about other actors' scenario ranking

It is shown in Figure 4-13 how much other actor groups understand the way of THAB's thinking. Having voted for the Land-based resources scenario, almost all actor groups show high awareness of THAB's planning. Assuming the Present situation as THAB's first choice, Customers seem to consider THAB more moderate. National Authorities placed the Present situation and the Land-based resources on the same mostly preferred level. It shows a slight uncertainty about how open THAB is even for small changes.

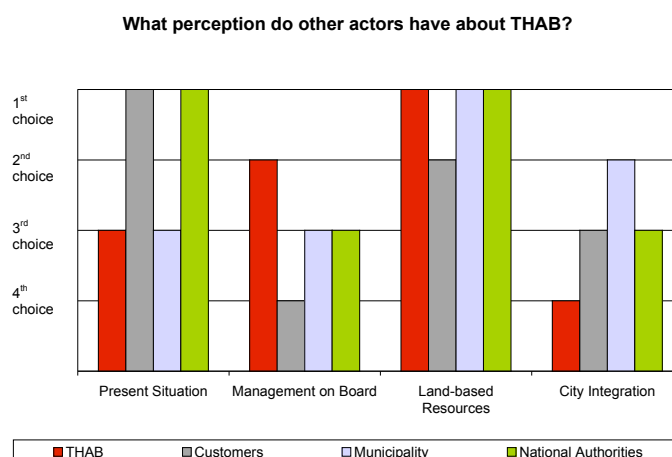


Figure 4-13 Actors' perception about THAB's scenario ranking

The results about other actors' perceptions show that Customers have a good idea, but not precise knowledge about all other actors. Customers perceive that Municipality is going towards some kind of integration, but according to them a radical one (like City integration) and not merely a moderate one (like Land-based resources). Municipality and National Authorities tend to think that Customers would go for Management on board, new technical solutions on the ferries with reasonable investments. The results also indicate that Municipality is completely aware of National Authorities' way of thinking, as well as seems to keep a closer eye on THAB, but does not know Customers' plans. The relationship with National Authorities is not the same vice versa, as they do not have an understanding about either Municipality's or Customers' plans. National Authorities have a slight understanding about THAB's planning, though, but they also perceive that THAB is halfway satisfied with today's situation. THAB has a picture about authorities "not wanting changes" in the system, or if yes only moderate ones. Looking at the National Authorities first choice: City integration scenario; it seems to be quite a large change compared to the Present situation. Graphs on actors' perceptions about each other are shown in Appendix 6. Additionally, the results of the scenario ranking under changing circumstances, such as oil price and the volume of transported goods shows that Customers do not recognize THAB's reaction.

4.4.4 Identification of key players

In this phase, the interviewees had to select two key players whom they personally think could contribute to (1) lower transport costs, (2) improved environmental performance of certain stakeholders, i.e. to better air quality in Trelleborg and (3) higher numbers of visitors in Trelleborg and in the harbour neighbourhood. The role of key players in intervening the case also had to be supported by arguments. In general, the participation in this question with the exception of the Municipality was high, although very often only one or the same key player was named in the first two places, who could contribute to the above questions.

4.4.4.1 Outcome of key players-related questions

According to all actor groups National Authorities have the most significant role when it comes to the level of transport cost. Customers also marked that THAB as a key player in this question. All actor groups believe that by setting stringent requirements National Authorities are one of the most important actors to contribute to better air quality in Trelleborg. The other major actors are ferry operators, by implementing these stringent requirements in practice. In general, Municipality is pointed out as the one, who can act for the increasing number of visitors in Trelleborg. The opinion about additional actors, who could be involved in the municipal work were diversified, travel agencies, the port and actors of commercial life in the city were named as examples. In case of the increasing number of visitors in the harbour neighbourhood, Municipality and THAB are indicated to have the responsibilities and capacities to contribute. Table 4-6 provides an overview over the key actors in regards with the four evaluation criteria.

Table 4-6 Key players with regards to contribution to criteria-improvement

CRITERIA	KEY PLAYER I.	KEY PLAYER II.
Transport costs	National authorities	THAB
Air quality	National authorities	Ferry operators
Visitors in Trelleborg	Municipality	diverse
Visitors in the port vicinity	THAB	Municipality

4.5 Observations

4.5.1 Significance of the criteria

All criteria have to be clearly defined and measurable for all actor groups. Individuals from each actor group added single criterion, such as economic viability, integration of transportation, environmental load generated by all modes of transportation and customers' demand. The researchers considered these additional criteria; when setting criteria, however it is important to have an easily measurable value on it. That is one of the reasons why most of the suggested criteria were not integrated into the basic criteria list. Other criterion, such as environmental load, fell out of the scope of this research as it was also seemed to be too wide aspect, including noise, vibration, water pollution, etc. to put a single value on it.

Suggestions were also made on better values of the evaluation criteria: air quality measurements and the attractiveness of Trelleborg. For air quality values the number of hours or days per year when e.g. the SO₂ concentration exceeded the national environmental air quality standard was recommended to use. The attractiveness of the city was proposed to cover not only the number of visitors to the city, but also the number of industries, which were geographically and economically attracted by and settled in Trelleborg Municipality.

4.5.2 Preference of the scenarios

When actors evaluating the strengths and weaknesses of the scenarios, there were some contradictory issues brought up. For instance, when one group considered some factors positive, another group set negative value on it. The central location of the port caused contradictory statements even inside the actor groups. According to THAB and one part of the Customers, the central location of the port was favourable from a transportation point of view, while others from the Customers groups pointed out that this situation is not feasible from a logistics and also from a social perspective.

Besides that the City integration scenario was claimed to be the most attractive, environmentally sound and with its land-based logistical solutions for a customer friendly future of both freight and passenger transport, some individuals from THAB and the Municipality argue that it is economically unreal. In the meanwhile, other actors also from the Municipality estimate lower transport costs than at present. Nevertheless, THAB and the Citizens express their worries about health issues and the quality of seawater on the western part of the port area, where residents and office buildings are to be built.

Management on board scenario seems to be the most contradictory scenario of all; whatever factors an actor group mentioned as strength, another brought it up as weakness of the scenario. THAB, Customers and Municipality estimated that as this scenario does not have large investments, it brings lower transport costs, at the same time, other individuals from the same actor groups expect high transport costs based on technological investments.

Contradictory issues in the Land-based scenario are: (1) faster ferries and (2) infrastructural investments. While for THAB and Municipality higher speed seemed to be a good approach to facilitate transportation, Customers regard it as further operational cost factor in an already competitive environment. Customers and the Municipality consider this scenario economically feasible. On the contrary, others from the Customers group and THAB say that all these infrastructural investments are the weaknesses of this scenario.

Scenarios with and without global context have been observed; some major points are noted here. Irrespective the global context Municipality insists on moderate integration, Land-based resources scenario, which is a less progressed version of the city development plan of Trelleborg Municipality. The Municipality recognises the deficiencies of the Present situation,

therefore any changes are better than the today's situation; however on board solutions fall low on their preference list. The same consistency can be discovered in case of National Authorities. They definitely want changes, more over radical ones by implementing City integration under all changing circumstances.

A general comment came up during the interviews from three actor groups; they mentioned the lack of railway capacity in and to Trelleborg. At present goods, which is transported by rail as far north as the region of Stockholm is transported by truck to Malmö before continuing the journey by rail. Actors suggested putting more emphasis on railway developments in the scenarios.

4.5.3 Key players

A main observation here is that actors tend to pass the burden on each other's shoulder when it comes to the identification of main 'doers' and 'responsibility carriers'. It is very rarely experienced that actors are pointing at themselves as key players in certain questions. THAB without exceptions and contradictions inside the actor group considers ferry operators the 'big polluters'. The only approach to solve this question is the intervention of National Authorities in the form of stricter demands on the environmental performance of sea traffic. Customers have the same view on air quality; they see the potential for improvement as a result of the better environmental performance of the ferry operators, more over they emphasize that the initiative is in the hand of National Authorities, as ferry operators have already taken voluntary measures. National Authorities face the challenge and name themselves as one of the actors who could stand up for better air quality, however they ask for international assistance, such as EU and IMO, pointing out that in any case shipping is an international issue.

Observations in terms of number of visitors are that the public is the only group, which believes that the ferry operators could also intervene and cooperate with other actors to contribute to an increased number of visitors not just to the port vicinity but also to Trelleborg.

4.6 Uncertainty and validity of the results

Although the interviews included all the actor groups, which are related to THAB and could influence the outcome and the future of the project, the project group decided the set up of the actor groups. Despite the research group's intention to cover the key players, there might be additional actors whom representing the same interests, but were not addressed or actors put together in the same actor group, but having slightly different interests. The number of interviewed people does not represent quantitative statistical significance inside the actor group. There were 3-6 people interviewed in each actor group; it means that sometimes only one person per company, which represents high uncertainty factor regarding the relevance of answers from that company. All together there were 26 interviewees whose answers were taken into the further evaluation. Given the time frame of this research study and the limited human resources, still many of methods have been applied though not to the quantitative degree that statistical significance of results can be shown. In a multi-actor environment it is always difficult to obtain high certainty and statistical significance, though the slightest outcome is considered to be of use for the project designer. The results of this report should be seen in the light of these limitations.

5 Discussion on actors' opinions

Based on the knowledge obtained from the actors, in this chapter the author aims to respond to the two sub research questions, namely:

1. *How is the present relation among actors around the port of Trelleborg?*
2. *Where is agreement and disagreement between the actors?*

Having been answered to these questions, in Chapter 6 factors are to be summarized, which can hold back or smooth the progress of cooperation among actors. The factors of successful cooperation are investigated based on the agreement and disagreement expressed by the different actor groups during the interviews. The two milestones of the analysis are (1) the result of the interviews and the (2) results of the air emission and cost calculations.

In general, all actor groups are concerned about the environmental load on Trelleborg, as air quality is indicated to be “very important” on the scales of the questionnaires. All actor groups approach this question in their own ways and are looking for solution and best practices to improve air quality. That is one of the reasons why all three scenarios, with the exemption of the Present situation are seen to be a step towards better environmental life quality. Attractive values, such as logistics and housing solutions, raise the popularity of scenarios in the eye of certain actor groups; however no absolute agreement is found on one single possible future. Actor groups show consistency concerning the criteria importance and the scenario performance. By and large, City integration fulfils the criteria on the highest level, except transport cost, which not only seems to be a sensitive, in the meaning of confidential, but also an issue of contradiction between the different groups. The Present situation was examined under changing circumstances, and the only context where it is found to perform better in economic and social terms is when the volume of transported goods increases three-folds. Air quality improvements are closely correlated with the transportation volumes; so when a drop appears in volume flows, an improvement is assumed in air quality. Increasing oil price seemingly does not have the same effect, although in National Authorities' point-of-view, based on presumably less fuel consumed, it also leads to better air quality. The aggregated results show that regardless global changes the Land-based scenario is far the most favoured one, which fulfils the criteria to the highest extent.

The analysis is based on three evaluation criteria, which represent environmental, economic and social perspectives. From these three aspects, the actors' attitude is observed: (1) similarities and differences, (2) agreement and disagreement and (3) causes for these point-of-views and connections are investigated. In the results, the three different air emission criteria were already aggregated to one criterion: air quality. During the evaluation two additional criteria showed similarities: number of visitors in Trelleborg and in the harbour neighbourhood. These two criteria have been grouped together and represent the social aspect.

5.1 Environmental conditions

5.1.1 Air quality

Companies located in Scania, local authorities carrying out continuous environmental measurements in the municipality, governmental administrations and citizens of Trelleborg are all aware of the air quality problems of the city. The criterion “better air quality” falls onto the “very important” part of each actor's scale. Citizens show the most concern, as they are the ones directly affected by air pollution. The level of importance then drops gradually according to the actors' involvement, interest and legal or public pressure (see Figure 4-5).

Municipality and National Authorities represent the interests of the citizens. THAB is owned by and have reporting responsibilities towards the Municipality and is confronted both (a) air pollution complaints from the inhabitants' and the authorities' side and (b) business demands for keeping up an economically viable harbour. Thus, THAB sets air quality issues on a lower level than for instance the citizens. The Customers show the least interest; they indicated a medium level of importance for air quality, even though the importance level of the criteria was not in relation with each other where interviewees had to compare and rank the criteria. On the other hand, the Customers' position indicates their flexibility when it comes to choosing transportation routes and logistics hubs. Customers are not bound to Trelleborg, for them Trelleborg is a chain-link, which in case of malfunction can be switched to another one. The criteria analysis shows that air quality improvement being a common goal of all the actors, could be a decent starting point for further stakeholder dialogue and future action.

5.1.2 Key actors

National authorities and ferry operators considered to be the key actors when it comes to air quality improvement: the first by regulating the latter by obeying the regulations. All the actors seem to have full trust in the national authorities and the power of environmental regulations. However, 78% of the Swedish shipping, including the ferry routes between Trelleborg and the three German ports falls under European shipping legislation, which means that mostly European directives implemented in all member states could regulate the environmental performance of these shipping routes. The European directives would cover all the ships travelling on these routes. The role of European and international actors, such as IMO were recognized only by the National Authorities.

5.1.3 Legislative framework

Today, the ferry lines altogether perform significantly better than the legal requirements. Although looking at each single ferry, one could conclude that voluntary measures are only taken by some of the ferries, while others are performing poorly. Even though ferry lines are under double pressure, neither the international nor the European requirements are stringent enough to cause radical reductions of atmospheric air pollution originate from shipping. Regulations regarding SO₂ emissions after years of negotiation have been recently approved. (see Chapter 2.1.1 and 2.2.1) Annex VI with a special clause on the Baltic Sea and the EU Directive on the sulphur content of marine fuels allow not higher than 1.5% sulphur content in the fuel used in vessels cruising in the Baltic Sea. In case of NO_x emission, the requirements of NO_x Code of MARPOL are so weak that basically at present the all the vessels travelling on the Baltic Sea apply with them.

The new EU Directive on the sulphur content of marine fuels enters into force from 2006. From 2006 one third of the ferries has to switch their marine fuel to ones with lower sulphur content in order to comply with these requirements. However, another third of the ferries might swap to fuels with higher sulphur content, as at present they consume fuel with much lower sulphur content than demanded. Figure 5-1 shows the present (first column) and required (second and third column) SO₂ emission levels at the port of Trelleborg in the future. By 2010, all ferries have to lower the sulphur content of the marine fuel used presently at berth, unless new technologies are applied with the same results in SO₂ emission reduction. At the port of Trelleborg, significant SO₂ emission reduction can only be expected if modifications of the EU Directive will be approved after 2008 and the required level of the sulphur content in heavy fuel oils will be set on 0.5% (fourth column).

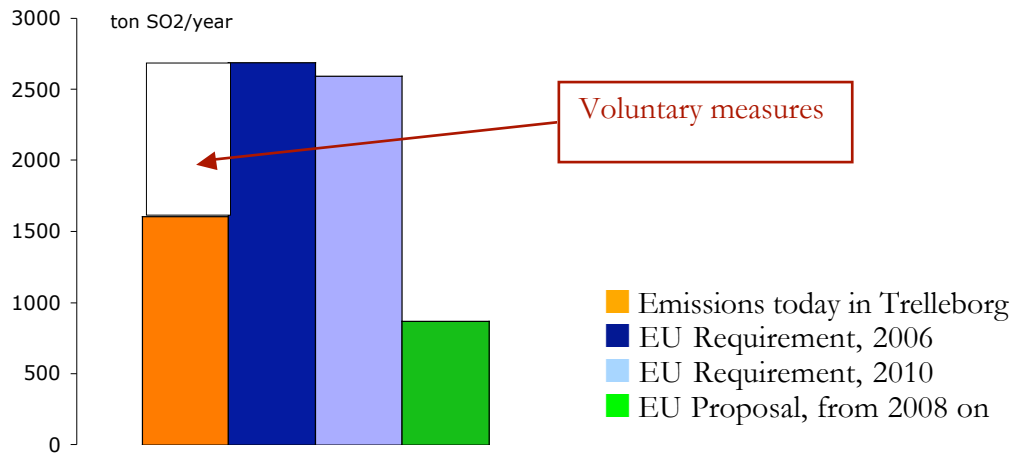


Figure 5-1 Future requirements of the EU applied to ferries cruising in Trelleborg

Besides international legislation national measures, such as fairway dues on the Baltic Sea seem to provide the only incentive for improved environmental performance. The new fairway dues system proposed from 1st January 2005 includes measures for both the sulphur content of the fuel and gram NO_x emitted per kWh. (For more details on the fees set-up see Appendix 2.) Until 2005, the three Swedish Scandlines ferries were holding SO₂ certificate. After the change of the system these ferries are charged 0.30 SEK (0.03 €) per ton fuel. The four TT-Line ferries running on marine diesel oil are complying with the legislation. The German Scandlines ferries are to pay 0.60 SEK (0.06 €) per ton fuel. The use of fuel also depends on where the ferry companies purchase it, thus the management and the ownership of the ferry lines. Stena Line buys the oil from TopOil for Scandlines AB being a subsidiary of Stena Line. The German Scandlines as well as the TT-Line ferries are bunkering in Germany. The marine fuel bunkered in Sweden contains 0.48-0.49% S, while the fuel bunkered in Germany has 2-2.2% S.

Additionally, national laws could also provide a partial solution to air pollution problems setting requirements firstly within the geographical boundary of Swedish land and territorial waterways and secondly on the ships operating under Swedish flag. (1) Regulations referring to territorial waterways would cover all ferries in question. However, most likely that due to German ownership only operational measures, such as speed limits in 12 nautical miles from the shore, and not on board restrictions could be carried out. (2) Regulations based on flag country would apply to three ferries at present, which are owned by Scandlines AB (see more about ownership in Chapter 3.2.1.2). (3) Regulations including on land measures could include the territory of the port, for instance in the form of mandatory port dues. The application of voluntary port dues in Trelleborg would arise competition between neighbouring harbours, such as Malmö and Ystad.

5.1.4 Technical and operational measures

Even small changes on board compared to the Present situation recognized to bring improvement in air quality in Trelleborg. Besides complying with the present and coming legislation, additional measures can be taken on a voluntary basis. Operational measures regarding fuel type and consumption are already taken to some extent; it could also be further extended to speed limit and on board cleaner technology installations. TT-Line changed two third of its fleet in the past five years. While ordering the ferries from the shipyard, environmental design, in the form of pods and diesel engines were considered as an important criterion for the ferry company. It is one of the examples how ferry companies could include the environmental requirements in an early stage of the ships' operating life.

Significant improvements are possible if technologies such as catalysts and better fuels together with other operational measures, such as optimization of fuel consumption would be applied to the ferries.

(1) The amount of SO₂, NO_x and CO₂ emitted was calculated for the different scenarios and the results of SO₂ emissions showed that the efficiency of wet scrubbers installed on board allowing ferry lines to use marine oil with 2.7% sulphur content, however it results only 18% emission reduction compared to the Present situation.

(2) In case of NO_x emission mitigation, the utilization of selective catalytic reduction does not only shows good reduction efficiency values (90%), but also has been successfully tried out by several ferry operators, among others by Scandlines AB in Helsingborg.

(3) As NO_x emissions are dependent on engine output, thus operational measures to reduce these emissions have to address the engine performance. The engines of ferries at berth and during manoeuvring are running on app. 20-50% load, meaning inefficient combustion thus more NO_x emissions than at sea, when the engine is on app. 80-90% load. The elimination of engine use at berth (e.g. by using shore-side electricity) and cutting off the manoeuvring time would lead to further NO_x emission reduction.

(4) CO₂ emission estimations, such as SO₂ emission estimations are based on fuel consumption. Therefore, among many operational measures to be taken, reducing fuel consumption is not only the most obvious one, but also applicable to all vessel categories. In general, ships are already reasonably fuel-efficient in the interests of economy, for instance three Scandlines ferries are operated with the assistance of a fuel saving system, where by setting the speed limit fuel consumption can be optimized. Due to the exponential relation between speed and fuel consumption ferries are not travelling with more than 80% of their maximum speed. Exceeding 80% means a radical increase of not only fuel use, but also of atmospheric air pollution.

(5) Another mean of improving efficiency is the use of anti-fouling paints, which prevent biological organisms, such as slime, weed and shell adhering to ships' hulls. These organisms can lead to increased water resistance, thus requiring additional power and fuel to maintain the same vessel speed (Commission Proposal COM(2002)595 final).

The application of (1) shore-side electricity, (2) decreased manoeuvring time, (3) decent pier system arrangement and (4) limited cruising speed, for instance on territorial waters, implemented together with (5) on board technologies lead to more effective SO₂, NO_x and CO₂ emissions reductions, than the sole installation of cleaner technologies on board.

5.1.5 Agreement and disagreement

All actors seem to agree that the air quality in Trelleborg can be significantly improved. Slight differences, however, can be discovered among opinions on which pollutant is to pay attention to on the first place. Annual measurement shows that Trelleborg is among those ten cities, where the SO₂ concentration in the air is the highest in Sweden. According to the same measurements, there is a high level of NO_x concentration in the air of the city. More over PM₁₀ concentration level, which is shown to be above the national average, is also becoming a growing concern, especially of Trelleborg Municipality. In general, air quality issues seems to be widely known, which provides with an explanation why all actors believe in that any changes could lead to better air quality. Naturally, the level of changes the actors would be positive about depends on how certain actor group considered the importance of the other two criteria for sustainable port development.

The scenario ranking brought more disagreement than agreement among actors. Ranking is strongly in correlation with the given importance to certain criteria and how these criteria are fulfilled. Even though, all actor groups claimed air quality to be a very important criterion, the opinions under which circumstances it is fulfilled on the highest level are diverse. Nevertheless, some actors indicated additional “very important” criteria, besides air quality and it is not unusual that those criteria are to be fulfilled on the first place instead of air quality.

In case of THAB, besides air quality, the attractiveness of the port, i.e. increasing number of visitors is placed in focus. THAB expects to achieve both criteria by moderate changes in and around the port area, with the implementation of the Land-based resources scenario. This choice certainly reflects the ongoing development plans of THAB, with the pier system and the partial access to the port by establishing some blocks of houses nearby the port with view on the sea. Therefore, the choice of these actors could be clearly interpreted.

National Authorities favour radical changes, large infrastructure investment; keeping in mind the development of national transportation, local commercial life and living surroundings, provided by the City integration scenario. Municipality, Citizens of Trelleborg and National Authorities did not highlight two very important criteria in parallel. These actors had merely air quality of highest importance. Both Municipality and the Citizens of Trelleborg consider two scenarios performing similarly environmentally sound: City integration and Land-based resources. In some cases the scenarios were very close descriptions of certain actors’ future plans. The scenario choice of the Municipality is very much correlated with its future city development planning and the choice of National Authorities reflects the infrastructure investments, such as the Trelleborg-Vellinge part of the E6 motorway, which are aimed to facilitate transportation on national, regional and international level.

In general, the less preferred scenario is the Present situation; on the contrary it is the Customers first choice. Customers are transport companies in a broad context; they are to certain extent flexible in terms of destinations and transportation routes. Differing from the Municipality and THAB, these companies, including logistics companies and ferry operators can adapt to changes, as their future plans are neither based on stable resources nor are bound to Trelleborg. Although, there were no common choices indicated by the actor groups, Land-based resources scenario was generally preferred on the second place. It suggests that changes implemented step-by-step are a decent starting point for further stakeholders’ dialogue.

5.2 Economic conditions

5.2.1 Transport cost

The importance of the criterion “transport cost”, unlike “air quality” varies from one actor group to another. Customers, being business driven and profit-oriented companies in case of development issues, carry out decisions by placing transport cost on the top of their priority list. The logistics companies and the ferry lines then paying for various services provided by THAB and the fairway dues to SMA, a governmental agency. These two actors, being the second chain-links in the financial flow conceive transport cost the same way. The Municipality, as the owner of THAB, being further away from the cost source, acts according to its third party position in this flow. The citizens of Trelleborg look on this criterion similarly and put a very low level of importance on transport cost. The view of the actors on transport cost clearly reflects their place in the monetary flow.

However, their perceptions on how much they influence or they are influenced by the cost criterion does not necessarily cover the real causes and effects. The Municipality and the citizens of Trelleborg might not recognize that an increase of transport cost in Trelleborg, for

instance due to lack of infrastructure or higher fees could result less competitive circumstances. Searching for more economically viable places the transport and logistics companies could find other harbour cities and logistics hubs and move away from Trelleborg. It could have a larger impact on both the economic and the social life of the city, for instance in terms of employment intensity, tourist attraction and also income of the city.

The researchers expected transport cost to be very important for Customers, and they performed accordingly. However, THAB’s reaction was in a way surprising as they did not consider transport cost “very important”. On the other hand, THAB did consider the number of visitors very important, which criterion did not only cover the actual visitors of the harbour neighbourhood, but also passing through traffic, including customers. This comprehension of the criteria can explain the differences between the criteria cost and port attractiveness. Some representatives of National Authorities and the Citizens even indicated transport cost as a non-relevant evaluation criterion for the case. It gives an indication that certain individual focus so much on environmental issues that the economic viability is sometimes excluded from the concept of sustainable development.

5.2.2 Operational cost of ferries vs. transport cost

Operational cost of the ferries varies between 72 and 83% of the total transport cost in the different scenarios. Figure 5-2 illustrates the estimated transport cost of the Present situation and City integration scenario, including annual operational cost of an average ferry travelling via Trelleborg. The main fixed factors in the operational cost structure are the (1) capital and (2) administration costs; the moving factors are (3) fuel, depending on raw oil prices on the world market, (4) maintenance depending on the type of fuel purchased, (5) fairway dues set by National Authorities and (6) port dues, agreement between ferry companies and THAB. (7) Staff and salaries can also vary according to the circumstances and company strategies.

The capital cost, which is based on the investment in the ferry and allocated for the following 20-25 years, takes around 27% of the total transport cost. Besides this capital cost, the fuel and the personal costs represent the highest cost value factors. Personal cost contributes app. 18-19%, and the fuel cost between 19-20% to the grand total transport cost.

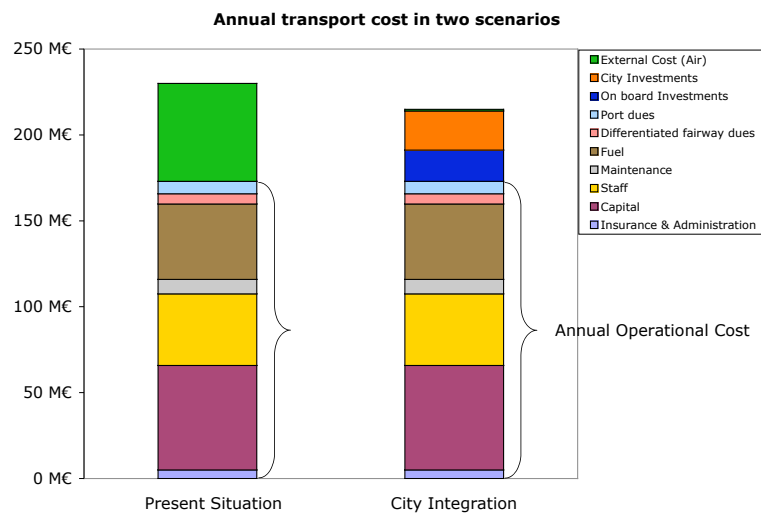


Figure 5-2 Transport costs and annual operational costs of ferries

In comparison with the capital and fuel costs even large infrastructure investments seem to have only moderate impact on transport costs. This relation might not be realized entirely for instance by the ferry operators as they have a different way for the annual cost calculation of ferry operation. In the maritime business, operational cost includes fuel, maintenance and dues; while other relevant factors such as cost of capital and personal are excluded. This structure of costs can provide an explanation why THAB, Customers and Municipality estimated that the Management on board scenario would have lower transport costs. The scenario suggests cheap heavy fuel oil and on board technologies, which believed to be efficient enough to result low fairway dues.

The difference in prices of fuels with different environmental performances is significant. Scandlines ferries are running on heavy fuel oil, while TT-Line's diesel-electric ships consume marine diesel oil. Marine diesel oil costs twice as much as heavy fuel oil. Still, ships using different fuels are competing side by side. One of the reasons why is that the maintenance cost is closely correlated with the fuel cost. TT-Line's diesel electric ships are claimed to cost less to maintain than the traditional ones running on heavy fuel oil (Hansson, 2005). Scandlines purchases heavy fuel oil, which means lower expenses on fuel, but higher maintenance cost.

5.2.3 Key actors

The general opinion is that National Authorities have the most significant role in influencing transport costs. The reasons given in the questionnaire were (1) taxation on fuel and (2) salary, (3) requirements on (4) safety and (5) environmental issues and (6) maritime dues. Estimations of annual operational cost of an average ferry travelling between Sweden and Germany support this perception (see Figure 5-2).

Decreased transport cost, independent on the mean of transportation, could lead to an increase in frequency, thus an increase of transport-related, specifically sea traffic-related environmental impacts. Opposite the industry and economy sector, the individuals interviewed from national authorities, dealing with environmental issues therefore reluctant to support decreased transport costs; as it might cause additional external cost, which most of the cases hardly can be covered.

5.2.4 Differentiated port dues

Environmental incentives in the form of differentiated fairway dues are also in place to balance out differences between the ferry companies. Differentiated port dues could also appear to be desirable to express the environmental performance in economic terms and promote fair competition. The differentiated port dues system works on voluntary basis and in the port of Trelleborg it has not been introduced. In the following section, the author highlights some concerns and perspectives about why the introduction and use of environmentally differentiated port dues is contradictory.

- (1) Ports are generally used to the old way that port dues are designed to reflect a contribution towards commercial services provided by the port, and they are not instruments of environmental policy, which burden they have to bare, by aiming to reduce emissions from ships over which they do not have control.
- (2) Port dues are generally based on GT, while GT is not the only determinant criterion rewarding low-emission shipping; fuel consumption or engine output could be significant factors in emission reduction questions.
- (3) The environmental effectiveness of the differentiated port dues can also be questioned, when recognizing competition between ports. Ports are in competition with each other for establishing attractive circumstances it is a common business practice to offer discounts to vessels. Due to the increasingly competitive market, these discounts are often confidential business secrets (Kågeson, 1999a). This lack of cost transparency means that vessels do not always pay the stated charges.
- (4) Another potential obstacle to the environmental effectiveness of differentiated port dues is the subsidies that many ports receive from local and state governments.

Uncertainty about the extent of adoption of differentiated charges and uncertainty about the effect of the charges on vessel behaviour (e.g. route and port changes), combined with the option for ports not to differentiate dues at all makes voluntary dues differentiation among the instruments least likely to yield environmental benefit (Kågeson, 1999a). On the other hand, the differentiated port dues schemes could create incentives for the use of shore-side electricity, via an explicit specification of the discount given to ships making use of these facilities, as it does in Gothenburg or Stockholm (NERA, 2004). As described above it is not an obvious step for ports to introduce port dues. However, based on close co-operation with customers and suppliers, and with a high awareness and knowledge about their environmental performance, THAB could strategically plan for long-term finances, whether it is economically feasible to introduce differentiated port dues in Trelleborg and become an environmental friendly hub in the transport chain, from sender to receiver.

5.2.5 Agreement and disagreement

Customers' driving force is transport cost; the most cost efficient scenario is estimated to be the Present situation. The main reasons for this perception derived from the answers given by the actor groups are: (1) Customers are risk averse and familiar with the costs associated with today's businesses, (2) often times transport cost for Customers does not include external costs, while other actors count with them, (3) infrastructure investments and (4) new on board technologies are seen to be costly. National Authorities seem to look at this question from a different angle. Their view is that with an integrative approach, both the transport cost and the environmental load on the port would decrease. The rough calculations made by the research group on the transport cost of goods across the Baltic Sea show similar results (see Figure 4-1).

Regarding cost factors, the presence of night trips are considered to be important by all actor groups, not only because they are maximally fulfilling customer demands with sufficient resting and sleeping possibilities, but also because they are saving fuel via cruising on slower speed during the nights. As cost calculations show, the fuel factor represents high share, app. 20% of the total transport cost.

The increasing oil price creates disagreement among actors, apart from that THAB and Customers would not like to invest in anything than the given resources at present. The summer of 2005 showed that oil price could increase drastically. It suggests to all actors a deeper understanding of each other's perspectives. According to the results, despite THAB has a good knowledge about its direct customers, it does not have a clear perception on the logistics companies' strategies and future plans. Establishing a project group based on continuous communication towards other actors could facilitate to obtain lacking awareness.

The Municipality and Customers do not have an exact understanding on the preferences of each other. Even though preferring Present situation Customers are more interested in on-shore changes than the Municipality imagines. On the other hand, the Customers' view on the Municipality is that it has more radical future picture. Investing in land-based resources, with moderate changes is the second choice of all actor groups. This scenario immediately becomes even more popular among all actors groups when the volume of transported goods increases.

On-shore solutions will involve financing from national authorities. It is important that the authorities engaged get to know the local conditions of Trelleborg and how THAB is working as well as to become familiar with some of the people working at THAB, the Municipality and of the Customers. As all actors do not recognize the causes and effects of infrastructure and on board investments, this information gap could be filled up by (1) stakeholders' dialogue on costs and benefits of the development plans, (2) various workshops and probably more (3) scenario trials on new technologies.

5.3 Social conditions

The criterion “attractiveness of the harbour neighbourhood” represents “medium importance” for four actors with the exemption of THAB. THAB considers it as the most important one. The attractiveness of Trelleborg is placed nearly on the same importance level. None of the actors put high emphasis and believes that solely aesthetic values could lead to an overall port development. The argumentation for setting these social criteria on an average level might differ among actors. National Authorities do not show particular interest in the local situation in terms of living places, recreation areas and access to the sea; according to their opinion the Municipality is responsible for the creation of these circumstances. Customers regard Trelleborg as a transit place, not a destination, which does not have to be attractive for passing through. However, social values increase in correlation with environmental and economical conditions.

The results show that both environmental and economic changes, pictured in the City integration scenario, are needed to increase social values. The City integration scenario is considered by all actors to fulfil this criterion. It provides new perspectives for housing in the harbour neighbourhood and good connection between the city and the port. All actors agree that the Municipality and THAB to the same extent are responsible for the improvement of this social value of Trelleborg and the harbour neighbourhood. It is in contradiction with the Municipality’s opinion, which does not consider specifically the attractiveness of the port as an important social aspect for sustainable port development. On this criterion there is a disagreement between THAB and the Municipality. It could be due to differing interests or task delegation among actors. In order to draw all actors’ interest, THAB could improve its external communication both towards National Authorities and the Municipality.

5.4 Reflections on actors’ relations

The conduction of the embedded case study method not only provided with a deep understanding of preferences and various futures of the actors around the port of Trelleborg, but also made it possible to observe how the relation functions among the interviewed players. Figure 5-3 illustrates the quality of the awareness about each other among the studied actor groups. The relation and awareness evaluation was carried out based on the actors’ perceptions on each other’s scenario ranking.

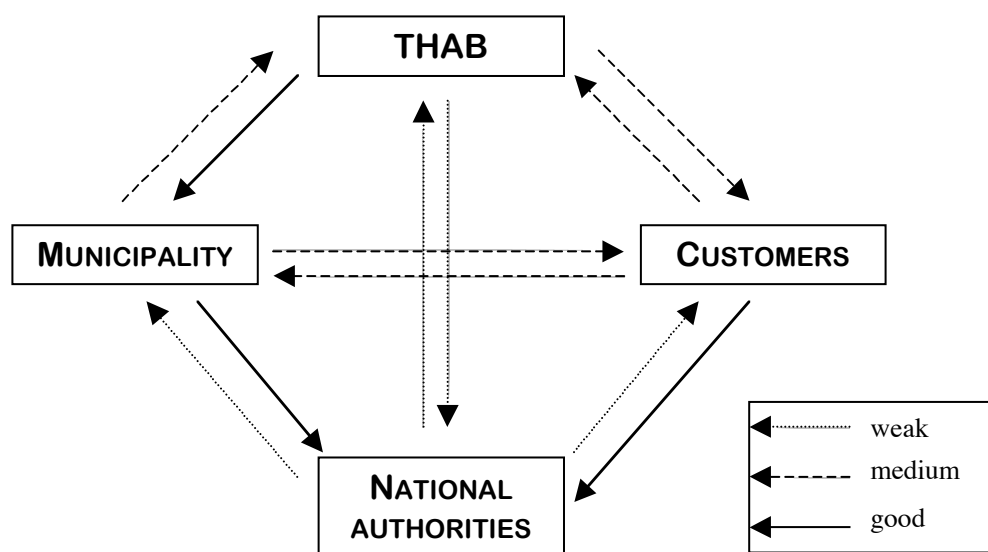


Figure 5-3 Awareness and relations among the studied actor groups

THAB has good knowledge and mutual understanding of the interests of the municipality administration and of its customers, the ferry lines. This means that THAB knows what their customers want and prefer as well as THAB is aware the future planning of the municipality. The relation between THAB and municipality is mutually satisfactory, while not all the customers are entirely informed about THAB's strategy. In general, it seems like THAB has a good contact with the customers and municipality. However, THAB is less aware of the ideas of the customers of the ferry lines, e.g. logistics companies. Extending the reach of their relation one more step may give earlier awareness of ideas and desires that will appear as demands via the ferry lines after a period in time. This knowledge will provide a good basis for long term strategic planning of THAB.

The relationships between THAB and national authorities are weak. The representatives from national authorities seemed not to know the local circumstances and often claimed they had "no idea" of the interests of THAB and even refused to answer such questions. As national authorities are vital to the strategic developments as they rule over important infrastructure investments as well as economic incentive structures this may be an important observation, which needs some further input from both parties to work on.

A minor observation is that the mutual understanding between the ferry lines and the municipality may be improved. The ferry lines see the municipality more as a threat than they appear to be. At the same time the municipality believe that ferry lines want to handle their problems by themselves while the responses given to us indicated that the ferry lines were interested in using more of land-based resources that could be supplied by municipal actors.

Relation between the citizens of Trelleborg and the Municipality was not in the focus of investigation. In general, however, the answers reflect a deep awareness from municipal side. The municipality has the same view like the citizens of Trelleborg. It shows not only a good knowledge but also a decent representation of public interests.

All these actors are planning separately, with a very cautious and careful way of giving information away. The links are sometimes too vague among them and the information given away does not always reach the broader target. Information often stays in inner circles. It might be of use to further handle these issues and set up project group on information sharing and future planning.

6 Conclusion

This chapter summarises the responses to the research problem. Firstly, it describes some relevant hindrances and facilitators of a successful collaboration at the port of Trelleborg. Secondly, it elaborates on how further cooperation can be developed with the assistance of the common point-of-views on actors' possible futures. Thirdly, by suggesting some further research fields, the author underscores to what extent the problem has been solved.

6.1 Main findings

Transportation volume is growing worldwide. The European Union tries to restrict and direct the means of transportation in the frame of the White Paper, which suggests rail and sea transport as environmentally sound transport modes, compared to road and air. It is true to a certain extent. Though, according to estimations, the environmental load resulted by sea traffic for example in case of certain pollutants exceeds the environmental impacts originate from other means of transportation. If European politics suggests this modal shift, evidence must be obtained on that the environmental impact of other means of transportation is definitely lower than of road and air. Besides, transportation go over borders and have an extensive impact of nature and human all over the world. Large logistics hubs, where all modes of transport meet, as well as harbour cities are especially exposed to sizeable environmental load. Air emission estimations at the port of Trelleborg shows that in case of certain pollutants, such as SO₂, NO_x and CO₂, the ferry traffic contributes the most to the environmental load the city exposed to. Sustainable port development, including environmental performance, economic viability and social competence of a port depends on various factors, which could be influenced by actors with various interests in port activities.

Some first steps have been already taken at the port in Trelleborg in the frame of sustainable port development. The ferry operators on voluntary basis have already taken some concrete measures. The choice of fuel heavily determines the environmental performance of the ferries; Scandlines AB due to the commitment to ISO 14 001 use lower sulphur content fuel than it is required according to the legislation. TT-Line introduced the diesel-electric ferries that based on complete combustion emit less NO_x than the traditional ones. THAB recently initiated a dialogue with the ferry operators; about which Trelleborg Municipality has been also informed. Still, according to the recently estimated air emissions in Trelleborg, the contribution of the sea traffic has not decreased.

There are several ferries operating with different environmental performance in Trelleborg. Other ports have implemented other measures to decrease air emissions in the port, e.g. shore-side electricity or differentiated port dues. Other countries have set speed limits in territorial waterways. This indicates that there is some potential for further discussion on measures to implement among actors in Trelleborg to limit the growing impacts of sea transport that might further grow after the implementation of the White Paper. This report is the continuum of the stakeholder communication started up by THAB, providing an analysis of the actors' interest as well as a description on the key factors that might hinder or facilitate the further cooperation among actors.

Hindrances and facilitators of stakeholder cooperation at the port of Trelleborg are plentiful and of different nature. Key agreements among actors, from an environmental perspective, were found to be (1) the importance of air quality, (2) non-stringent legislation related to sea transport and air quality, and (3) the lack of integrative approaches in sustainable development in Trelleborg. From an economic point of view (4) the existence of environmentally differentiated dues appears to be desirable for all actors. In general, regarding actor relations (5) local actors seem to have fairly good knowledge about each other.

The key hindrances that might limit and counteract a smoother cooperation among stakeholders were found to be (1) false perceptions on each other's behaviour concerning important criteria for sustainable port development, (2) different future pictures on the approach of environmental improvement and economic development, (3) information deficit on cost of infrastructure as well as on board technologies and (4) various ways of looking upon operational and transport costs. In general, actors have relatively good knowledge about their direct partners in business and regulation, but not about (5) their indirect partners, i.e. their "secondary partners" in the relation chain. (6) The local actors do not have (good) relation with actors operating on national and international level.

The core message of sustainable development is the equal consideration of economic, environmental and social aspects. In order to facilitate this three dimensional development extensive information sharing and comprehensive communication is required among the actors. The factors addressed here are (1) the importance of air quality, (2) actors' perceptions of each other, (3) relationship with "secondary partners" and (4) information gap on cost issues. To focus on other factors, such as (5) the effect of integrative approaches, (6) on-shore and (7) on-board investments as well as (8) environmentally differentiated fairway and port dues, further analysis on costs and benefits are to be carried out. The following section will provide an answer to the second research question and suggest further actions for sustainable development at the port of Trelleborg.

6.2 Recommendations

Remedial actions to further proceed do exist at the port in Trelleborg; nevertheless the first movements have been already taken. In this section, approaches how to overcome the hindering factors of future cooperation are investigated. The factors found and listed in Chapter 6.1 that might facilitate future cooperation serve as a base for suggestions and potential actions. The following hindrances are addressed here to counteract: (1) actors' false perceptions of each other, (2) different possible future pictures, (3) relationship with "secondary partners", including (4) connections on national and international level, (5) information gap as well as (6) distinct conceptions on cost issues.

Actors' perceptions of each other often do not conform the facts or truth. Additionally, relation between actors and their "secondary partners", for instance THAB and logistics companies from the business side and national authorities from the public side are not well established. These obstacles could be overcome by more intensive and reciprocal communication among stakeholders. Mutual information sharing and understanding of business behaviour are two crucial baselines to improve business relations. The initiative of an extended stakeholder dialogue based on the consent factors is recommended. The starting point of the collaboration originates from the results that show local actors fairly good knowledge about each other. The ground stones of the dialogue could be the agreement on (1) the importance of air quality, (2) low stringency level of legislation related to sea transport and air quality, (3) the existence of environmentally differentiated dues and (4) the need for integrative approaches in sustainable development in Trelleborg. Stakeholder dialogues are rather country specific. In other European countries, lobbying might be the usual way to approach and implement stricter regulations; in Sweden stakeholder dialogue is a fairly common way to start with setting requirements for all involved actors.

Further ground stones can be detected by a SWOT analysis of the Present situation from a sustainability point of view; with focus on the answers gathered from the transport companies. The analysis would highlight additional factors considered as strength of today's situation that are favoured and weaknesses, which are to be counteracted. Another SWOT analysis of THAB compared to the ports of Ystad and Malmö can be a tool used to increase

the knowledge on what is an advantage and disadvantage in the perspective of Trelleborg and which fields THAB should focus on to strengthen its position in the region.

At present, a project group is already in place, including THAB and two ferry operators, Scandlines AB and TT-Line. The complexity and the international nature of the case suggest the involvement of other actors related to the port, i.e. extend the existing project group to an overall stakeholder dialogue; hereinafter could be called as *SO₂ Group*. Due to diverse ownership of the ferry companies both Swedish and German parties are to be invited to attend the group meetings, for instance the German part of the Danish-German Scandlines AG. In the light of promoting more private and business sector interaction to reveal the opportunities in further cooperation, Trelleborg Municipality, as the whole-owner of THAB could also be a regular attendant representing environmental, economic and social objectives of the municipality and the region. The city development plan includes increased railway capacity in the port as well as between Malmö and Trelleborg, new highway between Vellinge-Trelleborg and a dry port. The infrastructure investments will involve the Swedish National Road Administration, the Swedish National Rail Administration and other national authorities. In order to have a decent relationship with them, all local actors need to increase their knowledge about actors on the national level and at the same time create an impressive insight of the local conditions for the national authorities. It will be important when national actors are to be influenced. Information can be shared at study visits or in the frame of participation in *SO₂ Group* meetings. Nevertheless, it could also be done as a separate project where THAB takes leading role, as an intermediate between business and public actors.

Furthermore, the regional *SO₂ Group* could broaden its geographical boundaries and initiate international cooperation, if necessary on another level, by involving other ports in this dialogue. Participating in other sustainable port development, green shipping and air quality projects tailor made for harbour cities, such as the New Hansa program in Lübeck, would also facilitate obtaining knowledge and understanding of the relevant actors and identify additional catalysts.

Naturally, it is not only THAB, who can act for sustainable port development. The concern can be supported on a regional level as well, even though the options for the region to actively influence the development are limited to long term planning stability. Amongst others it covers infrastructure investments, local and regional land use planning and the provision of sufficient infrastructure. The region could also help to initiate sustainable port development projects by taking a leading role in identifying transport volumes and potential improvements related to the identified volumes. The region could also start up the leading consultation processes between private and public stakeholders: municipality, shipper, transport operators and terminal operators. They can act as a facilitator and intermediate between competing business partners in order to identified bottlenecks on the links that have to be overcome and smooth the progress of sustainable port development. Also the region could allot financial incentives for the risky initial phase of installation of new technologies both for on-shore and on-board operations to the transport operators. In the short run, the region could establish international project groups, which could work upon solutions for e.g. sustainable ports in the region. These groups could consist of representatives from the different involved authorities as well as of market actors.

As international shipping is in focus, one must have a broader view than inside the Swedish borders, and see the problem in an interregional aspect. Networks could not only be developed on a national, but also on an international basis under involvement of different regions of the neighbouring countries. For such cross border planning no general administrative restrictions exist. There are a few incentives to start cross border co-operations, such as TransLogis, Nordic Triangle and other projects, some in the framework of the European Union Interreg programme. These projects can help to establish contacts across

borders, which can be used for future planning and cross co-operation of the field of transport planning and air quality issues. The established contacts, the discussion of transport and air quality related problems and solutions as well as the increased knowledge about demand and potentials could facilitate a joint planning in the future and contribute to a better integration of the area across borders.

The first outcomes of the above described ways of cooperation could be a (1) common criteria list for sustainable port development, (2) harmonized future plans, (3) workshop on-shore infrastructure and on-board technologies and (4) standardized method of looking upon cost structures. The cooperating ports could also promote further (5) voluntary measures, for example in the form of environmental award schemes.

6.3 Further research

The report in the frame of sustainable port development mainly focuses on the relations among actors around the port in Trelleborg. However, several other aspects of sustainable port development exist which have not been extensively examined here.

A recommended field for an integrated economic, environmental and technical research could be the applicability and the economic viability of on board technologies, such as selective catalytic reduction, wet scrubbers and fuel use as well as on shore installations, including shore-side electricity. The list of additional investments and regulatory measures, such as voluntary port dues and fairway dues that might have larger effect on port development can be extended after a brainstorming session with the project group. Actors' opinions, pros and cons on these impact variables are needed for further evaluation.

Based on the different perceptions on transport costs and its fulfilment of the scenarios, detailed and convincing information is required on any type of costs. Cost-benefit analysis would be desirable on the economic viability of the port. Infrastructure investments, cleaner technologies on board, environmentally differentiated dues, their environmental impacts and effects on the economy of the port are to be included and investigated in the light of the monetary flows and their consequences regarding actors' behaviour.

Due to the topic on stakeholder dialogue and the qualitative nature of the applied case study methods there is lack of statistical significance in this research work. On one hand it warns both the researcher and the reader to handle the results with caution, on the other hand it serves basis for further research on the same topic. The research could apply additional segments of embedded case study methods, extend the number case member groups and gain statistical significance by increasing the number of interviewees from each actor group. The following research could lay more emphasis on the opinion of the citizens of Trelleborg, which actor group was not investigated in depth hereby. In case of scenario construction the research could use comments were given on the scenarios created for this work: more radicalism, broader range of potentials and more distinction.

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Questionnaire interviews are attached in Appendix 4.

Abbreviations

€	Euro
CAFÉ	Clean Air For Europe
CO	Carbon monoxide
CO ₂	Carbon dioxide
DME	Dimethyl ether
EIA	Environmental Impact Assessment
EU	European Union
g/kWh	gram/kilowatt-hour
GIS	Geographical Information Systems
GT	gross tonnage
HFO	heavy fuel oil
IMO	International Maritime Organization
IVL	Swedish Environmental Research Institute Ltd.
Kwh	kilowatt-hour
MARPOL	Marine Air Pollution Convention
MAUT	Multi Attribute Utility Theory
MDO	marine diesel oil
MGO	marine gas oil
NO _x	nitrogen oxides
PM	particulate matter
RoRo traffic	roll-on roll-off traffic
SCR	Selective catalytic reduction
SECA	Sulphur Emission Control Area
SEK	Swedish Crown
SEPA	Swedish Environmental Protection Agency
SIKA	Swedish Institute for Transport and Communications Analysis
SMA	Swedish Maritime Administration
SNRailA	Swedish National Rail Administration
SNRoadA	Swedish National Road Administration
SO ₂	sulphur dioxide
THAB	Trelleborgs Hamn AB
US\$	United States Dollar
VOC	volatile organic compound

Appendix 1: Environmental load on the port of Trelleborg

This appendix provides an update of the air emissions generated by Trelleborgs Hamn AB and related activities. This portion of the report also gives an insight into how various businesses contribute to the environmental performance of the port.

1. Introduction

1.1 Background

In 2001 Trivector Traffic AB (Trivector) carried out an investigation on the environmental performance of the port and related activities in Trelleborg. This report was limited to the calculations of air emissions from three main sources of port related activities: (1) ferry traffic, (2) road, rail and passenger traffic and (3) the vehicle pool of THAB. In 2003 Trivector was engaged to conduct an environmental impact assessment (EIA) including the present harbour activities and the expected environmental and legal consequences of the planned changes until 2010. In November 2004, THAB assigned the International Institute of Industrial Environmental Economics (IIIEE) to complete an update of these air emission estimations for the year 2004.

1.2 Objective

The air emission update is carried out in the frame of a more extensive case study, which investigates the relations among various actors involved in the port and related activities. The first objective of this portion of the study is to scrutinize the present environmental load (i.e. air emissions) on Trelleborg originate from harbour activities in the form of quantifying the amounts emitted of SO₂, NO_x, CO₂, CO, VOC, and PM₁₀. The second goal of the estimations is to detect how the air quality in Trelleborg city and Trelleborg Municipality is related to these emissions generated from port and related activities.

1.3 Scope

By environmental load on the port of Trelleborg is meant air emissions generated by port and related operations. The scope is limited to air pollutants, which are considered to be significant environmental aspects in the harbour area and at open sea: SO₂, NO_x, CO₂, CO, VOC, and PM₁₀. Other environmental impacts such as noise, odour, and water pollution was excluded from the environmental assessment, because of the generic limitations of the case study.

Port and related activities include the operations, which are related to the main activity of the port: transportation of goods and passengers, thereby loading and unloading operations. These activities are divided into three main groups of activities. (1) Three ferry lines are responsible for the *sea transportation*: Scandlines AB, Scandlines AG and TT-Line. (2) *Road and rail transportation* includes trucks, with or without trailers, trains, passenger cars and passengers. It also covers the transportation of containers and the so-called combined or intermodal traffic, which can involve all means of the transportation present in Trelleborg: rail, road, and sea. (2) *Loading and unloading* operations are carried out by the vehicle pool of the port, including several different types of working machines and passenger cars owned or leased by THAB.

The estimated air emissions of these activities are also put into context of the total air emission measured in Trelleborg Municipality and at the Baltic Sea. However, this report is not to review or judge air emissions estimated or measured from other sources than the above described.

1.3.1 Geographical boundaries

Air emission estimations are made considering the following restrictions. Concerning road transportation the (1) fenced area on the territory of THAB, (2) a 500-meter long service road is outside the fenced area and (3) a 3 km driving distance in the city of Trelleborg is taken into account. Mainly the vehicles to check in and drive on board use the service road. The driving distance in the city is an approximate value, which is counted from the border of the city until the service road to the fenced area of the port. In case of sea transportation, the following measures are taken into account: (1) air emissions of ferries generated at berth, (2) during manoeuvring, which is until the touching buoy (1.5 km from the berth at open sea) and (3) half way to Germany, with the last following the approach of Skånes Luftvårdsförbund.

1.3.2 Temporal boundaries

The air emission estimations cover one-year period of time. Most of the data used in this report was measured in 2004, thus the air emission update is valid for year 2004. When no data was available for 2004, for instance in the case of air emissions originate from other sources than sea traffic in Trelleborg, the author applied former years measurements with the assistance of EnviMan Opsi system used by the Geographical Information System Centre in Lund (Gustafsson, 2005).

1.4 Limitations

The results of this report are based on estimated values of air emissions. There are two main drawbacks of this fact. Firstly, the use of generic fuel consumption and emission factors, either provided by the ferry operators, engine manufacturers or other institutions, which have conducted several air emission studies and published emission factors, which is for instance applicable for whole Sweden. Naturally, individual emission factors for each ferry would consequence more precise results. Secondly, compared to calculations, even more accurate results can be achieved by measuring air emissions on board. A minor observation is that at present, there are no officially provided factors to calculate CO₂ emissions during idling. Therefore, the road and rail emissions are based on fuel consumption instead of idling time in the harbour; which increases the data uncertainty.

The input data is occasionally uncertain. These data for the calculation derives from the ferry operators. Despite the continuous relationship with the ferry lines, the data availability was weak due to several reasons including (1) shared Swedish-German ownership of the ferries, (2) holiday season and (3) no exact measurements and information e.g. on the engine output of each ferry in each operational phase. The data quality is also questionable in several cases due to change of the fleet and names of the ferries since the last EIA was conducted.

1.5 Methods

The precise estimation of each air emissions requires accurate background data and credible methodology with reliable and relevant formulas for calculations. The data collection has been continuously conducted between the end of May and mid September. The form of data collection was: previous reports, archival records, documents, scientific data from laboratories, internet sites and databases, on-line reports, electronic questionnaires, personal and phone interviews, focused, structured and open-ended interviews, e-mail inquiries, project group meetings. In order to apply the appropriate methodology for air emission calculations from the three main sources a detailed description will follow below.

1.5.1 Ferry lines

There are several methods for taking measurements of air pollution generated by ships. The quality of the results always depends on the availability of background data. In case of two pollutants: SO₂ and CO₂, air emission calculations are based on the methodology recommended by report of Entec (2005) prepared for the European Commission. The method is based on the annual fuel consumption of each ship and time spent in certain operational phases. The drawback of this method is that not all the ships are provided with fuel meter, so it is difficult to get hold of the fuel consumption of each ship in each phase.

SO₂ emission calculations:

$$\sum M = \sum \frac{(T_{\text{phase}} * S_{\text{cont}}) * 2}{100}$$

M: total SO₂ emission (ton/year)

T_{phase}: fuel consumption (ton/operational phase/year)

S_{cont}: sulphur content of the marine fuel (%)

CO₂ emission calculations:

$$\sum M = \sum (T_{\text{phase}} * E_{\text{fact}})$$

M: total CO₂ emission (ton/year)

T_{phase}: fuel consumption (ton/operational phase/year)

E_{fact}: 3.179 ton CO₂/ton fuel

NO_x-emissions are mainly dependent on the engine performance. In case of NO_x-emission estimation another method was used, whereby the size and the capacity of the engines were taken into account; namely the size of the engine work, i.e. the actual engine output during different operational phases, such as at berth, during manoeuvring and at sea. In addition, engine output was used for estimating CO, VOC as well as PM₁₀ emissions. The weak point of this method is again the data availability, as obtaining the appropriate input data requires accurate measurement on board or reliable engine work estimations in each phase.

NO_x, CO, VOC and PM₁₀ emission calculations:

$$\sum M = \sum P_{\text{phase}} * T_{\text{phase}} * E_{\text{fact}}$$

M: total air emission (ton/year)

P_{phase}: engine load (kW/operational phase/year)

T_{phase}: operating hours (h/operational phase/year)

E_{fact}: emission factor (g/kWh)

Emission factors applied for the four emissions that are dependent on engine work are summarized in Table 1-1.

Table 1-1 Emission factors in the three ferry operational phases

	NO _x [g/kWh]			CO [g/kWh]	VOC [g/kWh]	PM ₁₀ [g/kWh]	
	HFO _{2%}	HFO _{0.5%}	MDO _{0.2%}	N/a	N/a	HFO	MDO
Fuel type (S%)							
Sea	14.0	13.2	11.8	1.1	0.2	0.5	0.2
Manoeuvring	11.2	10.6	11.8	2.2	0.4	1.0	0.4
Berth	14.5	13.8	11.8	0.9	0.2	0.5	0.2

Source: Cooper, 2004 and Entec, 2005

1.5.2 Road and rail transportation

At the calculation of air emission originates from road and rail transportation emission generated during both driving and idling phases are taken into account. Emission factors applied are based on the recommendation of SNRoadA (2001). The geographical boundary of the air emission measurements generated by road transportation vehicles is the territory of the port, until the boarder of the densely populated area of Trelleborg. Trucks are standing in queue in average 15 minutes and drive with 30 km/h in the territory of the port and with 45 km/h in the densely populated area of Trelleborg (Trivector, 2003). The average stretch driven to and from the harbour through the city is estimated for 3.5 km. The goods arriving by train to the harbour are further transported by diesel engine, therefore the calculations are based on the number of trains arriving at or departing from the harbour. The geographical boundary covers the same area as described above. The stretch differs depending on the destination; whether it is the intermodal terminal or not.

Train to the terminal: 3 km.

Train from the terminal to the ferry: 1.2 km.

Train from or to the ferry: 2.5 km.

The calculations in idling phase were based on the following formula:

*Number of vehicles*idling time (s)*emission factor (g/s)*

The calculations in driving phase in case of trucks, busses and cars were based on the following formula:

*Number of vehicles*driven stretch in Trelleborg (km)*emission factor (g/km)*

The calculations in driving phase in case of trains were based on the following formula:

*Number of trains*driven stretch in Trelleborg (km)*fuel consumption (l/km)*emission factor (g/l)*

1.5.3 Vehicle pool of THAB

The calculations of air emissions generated by working machines are based on the availability of data on fuel consumption, rate of use, engine-performance and the estimated rate of load. The air emissions that are dependent on engine work, such as NO_x, CO, HC and PM₁₀, are calculated according to the following formula also taking into consideration the operational time of the machines:

$$M = E_{fact} * P_{max} * P_{load} * T$$

M: total air emission (kg, ton/year)

E_{fact}: emission factor (g/kWh)

P_{max}: maximum output of the engine (kW)

P_{load}: rate of load (utilized/maximum output of the engine)

T: rate of use (h/year)

The emission factors the calculations are relying on were taken from Directive 2004/26/EC, whereby the fulfilment of EU Stage I is assumed for all the working machinery. The emissions calculated in g/h are based on an estimated capacity of 70%. As this value was given by one of the manufacturers, it has to be treated by caution, due to the fact that the rate of load heavily depends on the frequency of the utilization, the loading and the proportion of idling. THAB provided data on operational time of each working machine. Air emission calculations for passenger cars and smaller trucks owned by the harbour are based on the age of the car, total fuel consumption and the driven kilometres per car during a year.

2. Air emission estimations

2.1 Ferry lines

Sea transportation itself is seen as a relatively environmentally sound way of transportation, mainly because of two reasons: firstly the size of the loading capacity and secondly the minimization of the transportation route; namely ships do not rely on any preliminary built infrastructure, in contrast to road or railway transportation. On the other hand, air pollution generated by ships is in linear relation to their size; thus shipping activities are responsible for a large amount of air emissions. The air emission estimations were taken in three operational phases: (1) at berth, (2) during manoeuvring and (3) at open sea.

There are two methods used to calculate air emissions depending on the relevance of the method and the relation between the method and the type of emission. (1) In case of SO₂ and CO₂ calculations, the fuel consumption method was applied: SO₂ emission depends on the sulphur content and CO₂ on the carbon content of the fuel. (2) While NO_x, CO, HC and PM₁₀ emissions mainly depend on the completeness of the combustion in the engines, where the size, type and output of the engines were considered.

In 2004, there were thirteen ferries cruising between Trelleborg and the three German destinations: Rostock, Sassnitz and Travemünde (see more details on the ferries in Appendix 3). The air emission estimations show that regarding SO₂-emissions, the catamaran emits the less, as it uses city-diesel with low sulphur content; and Mecklenburg-Vorpommern, Sassnitz, Huckleberry Finn and Tom Sawyer belong to the high SO₂-emission level ships. The younger ferries, such as Peter Pan, Nils Holgersson, Nils Dacke and Robin Hood, which have diesel electric engine, due to the low sulphur content fuel they use, emit less SO₂. In case of NO_x-emissions differences were found between ordinary and diesel electric ferries. As the latter ones spend less time with manoeuvring, thus decrease the time spend with low engine load, whereby the combustion is not complete and the NO_x-emission factor is higher. With regards to CO₂ emissions, the contribution of the vessels is dependent on their fuel consumption, which is highly dependent on the time schedule. An important point here is that regardless the departing time of the ferries with a decent speed management they can keep the arrival time, which is the most relevant aspect for the customers. On the other hand, delays and higher speed lead to higher fuel consumption, thus higher air emission values. A general observation on air emission levels, which are dependent on engine work, is that diesel electric ships perform better.

Table 2-1 Air emissions originate from the operation of 13 ferries, 2004

	SO ₂ [ton/year]	NO _x [ton/year]	CO ₂ [ton/year]	CO [ton/year]	VOC [ton/year]	PM ₁₀ [ton/year]
Ferry lines	3 210	11 562	570 051	1 887	194	374

2.1.1 Emission in Port vs. Emission at Sea

There are different ways to look at air emission estimation results. Skånes Luftvårdsförbund suggests taking into account emission generated at berth, during manoeuvring and half way of the official ship-route. While the approach of the ferry lines is to consider emissions originate at berth and during manoeuvring: a) until the touching buoy, 1.5 km away from the harbour or b) until the official territory of Sweden, 12 nautical miles from the shore. Emission estimations were made according to two methods: a) at berth, during manoeuvring and half way to Germany and b) at berth and during manoeuvring.

Table 2-2 Air emissions originate from the operation of 13 ferries, 2004

Emissions from ferry lines [ton/year]	SO ₂	NO _x	CO ₂	CO	VOC	PM ₁₀
a) at berth & manoeuvring & half way	1 605	5 399	285 025	950	90	179
b) at berth & manoeuvring	230	852	53 261	562	19	41

According to the estimations, in the port (at berth and during manoeuvring), the NO_x emission amounts to 852 tons per year. At open sea (half way to Germany), this amount is more than six times larger, namely 5 399 tons. In percentages, SO₂ and NO_x emission in port counts for app. 15% of the amount emitted during halfway crossing of the Baltic Sea. In case of PM₁₀, the ratio is higher: 41 tons is emitted in the port, while 179 tons is emitted at sea during the halfway crossing, it makes almost 22%. CO emitted in the port takes up more than 59%. These CO and VOC emissions values are very high, however a possible explanation can be that the engines of the ferries have a lower burning capacity when they are at berth, than when they are manoeuvring or cruising at sea.

2.2 Road and rail transportation

While mapping the air emission sources related to harbour activities, road transportation should be considered as one of the most significant sources. It is mainly because of the continuous growth of the commercial and tourism sector. The number of trucks, busses and cars is near to 3000 per day. In contrast to the ships, the lifetime of road vehicles are shorter, thus the pool is under frequent change and fast development. Regulations have been also more stringent for vehicles on road, thus for instance low sulphur content fuel, energy efficient engines and catalysts are basic requirements. However, the main concern is that these vehicles are spending hours and long minutes in the harbour area, quite often with their motors on; thereby being responsible for a large part of air pollution caused by indirect activities being carried out in the port area and neighbourhood. As the train wagons are driven on and off the ferries with diesel locomotives both from the marshalling yard and from the intermodal terminal, train transportation is also included in this section among port activities.

Applying the formulas used for air emission calculations (see Appendix 1, Chapter 1.5.4) from road and rail transportation, Table 2-3 presents the results of the air emission calculations.

Table 2-3 Air emissions originate from road and rail transportation at the port of Trelleborg, 2004

	SO ₂ [ton/year]	NO _x [ton/year]	CO ₂ [ton/year]	CO [ton/year]	HC [ton/year]	PM ₁₀ [ton/year]
Road and rail traffic	0.12	32.97	2 097	36.69	13.62	0.86

2.3 Vehicle pool of THAB

The air emissions generated by THAB can be traced back to two sources: working machines and passenger cars. The main duties of the working machines are to load and unload goods onto or from the ferries, trucks and trains. In THAB the following working machines are operating: 1 electric forklifts, 12 semi trucks, 4 forklifts, 2 reach-stackers, 1 small excavator (small digging machine) and 2 wheel mounted loader (Borowiec, 2005). All the working machines are running on city diesel. THAB owns 14 cars, including smaller trucks (with truck bed), which are mostly driven by the production and service department.

According to the calculations, working machines are responsible for a significant part of the air emissions generated by activities related to the port of Trelleborg. In case of NO_x emission for instance 99.5% of the total derives from working machines. It is clear from the emission factors that the age of the machines plays a large role when it comes to emission values of SO₂, NO_x, CO and HC; newer models emit less. For instance, the new models of semi trucks have half as much NO_x emission as the older ones, and CO and HC emissions represents only a few percent of the older types' emission values. Renewal of the motor pool took place recently, which shows remarkable decrease in NO_x, CO and HC emissions. Emissions derive from passenger cars share a very little part of the total SO₂, NO_x, CO and HC emissions of motor pool.

Table 2-4 Air emissions originate from the vehicle pool of THAB, 2004

	SO ₂ [ton/year]	NO _x [ton/year]	CO ₂ [ton/year]	CO [ton/year]	HC [ton/year]	PM [ton/year]
Working machines	0.01	29.20	1 215	13.44	4.04	0.94
Passenger cars	0.001	0.19	53.30	1.77	0.35	0.01
Total	0.011	29.39	53.3	15.21	4.39	0.95

2.4 Total air emissions from port and related activities in Trelleborg

In this section the total air emission from the three main operational areas, (1) ferry lines, (2) road and rail transportation and (3) the operation of THAB is summarised. Table 2-5 provides an overview of the total air emissions of SO₂, NO_x, CO₂, CO, VOC and PM₁₀ in year 2004. As the figures show, the ferry traffic is responsible for the largest proportion of air emissions generated by the port and related activities.

Table 2-5 Total air emissions originate from port and related activities in Trelleborg, 2004

Total emissions [ton/year]	SO ₂	NO _x	CO ₂	CO	VOC	PM ₁₀
Ferry lines a)*	1 605	5 399	285 025	950	90	179
Ferry lines b)**	230	852	53 261	562	19	41
Road and rail traffic	0.12	32.97	2 097	36.69	13.62	0.86
Vehicle pool of THAB	0.011	29.39	53.3	15.21	4.39	0.95
Total a)	1 605	5 843	287 175	1 141	115	189
Total b)	230	948	55 411	620	39	44

* Emissions at berth and during manoeuvring are considered

** Emissions at berth, during manoeuvring and halfway to Germany are considered

2.5 Contribution of sea traffic to the total emissions in Trelleborg

This section will provide an overview of the air emission in Trelleborg and compare the results with and without considering the method of Skånes Luftvårdsförbund to count with the emission generated during the halfway crossing to Germany. The air emission modelling took part with the assistance of Susanna Gustafsson from the GIS-Centrum in Lund.

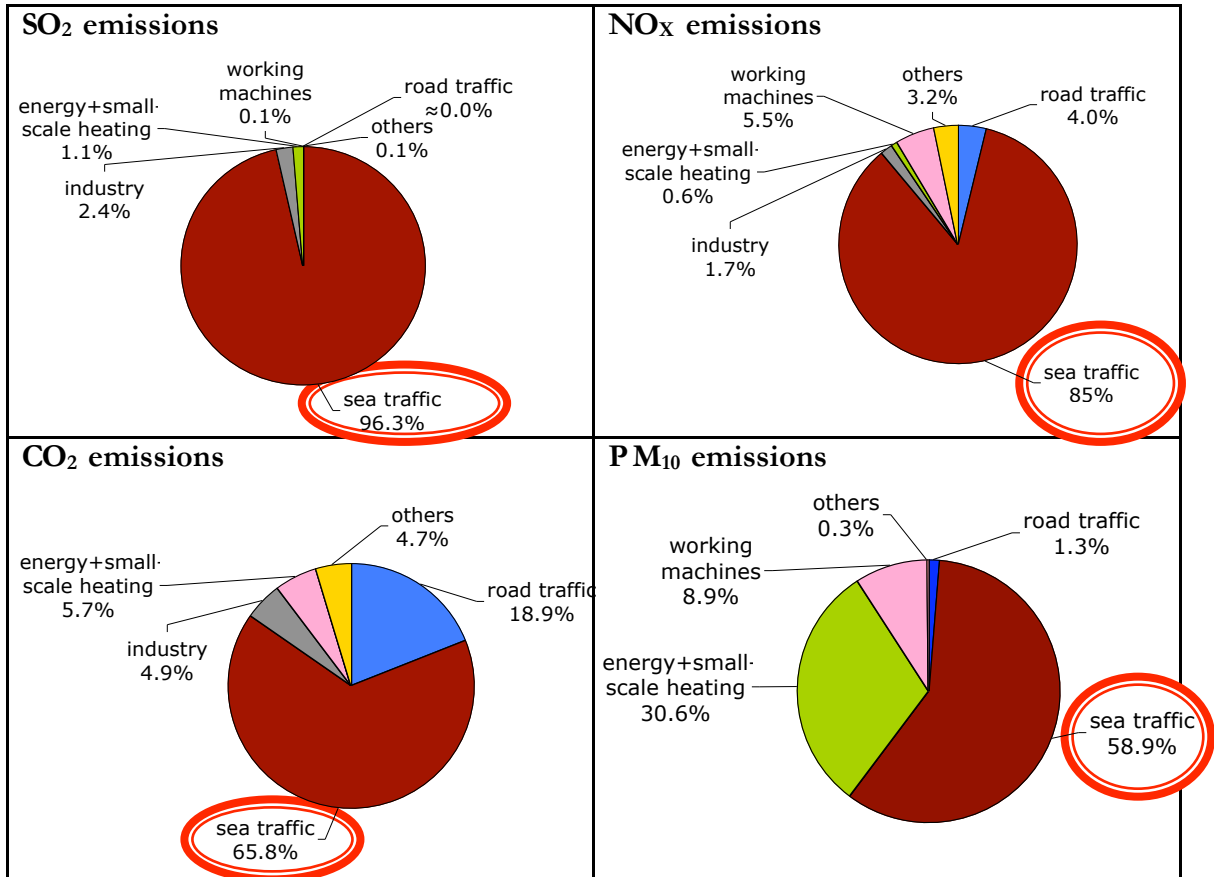


Figure 2-1 Contribution of the port and related operations to the total SO₂, NO_x, CO₂, and PM₁₀ emission in Trelleborg, when the geographical boundary is the municipality of Trelleborg on land and halfway between Germany and Sweden at sea

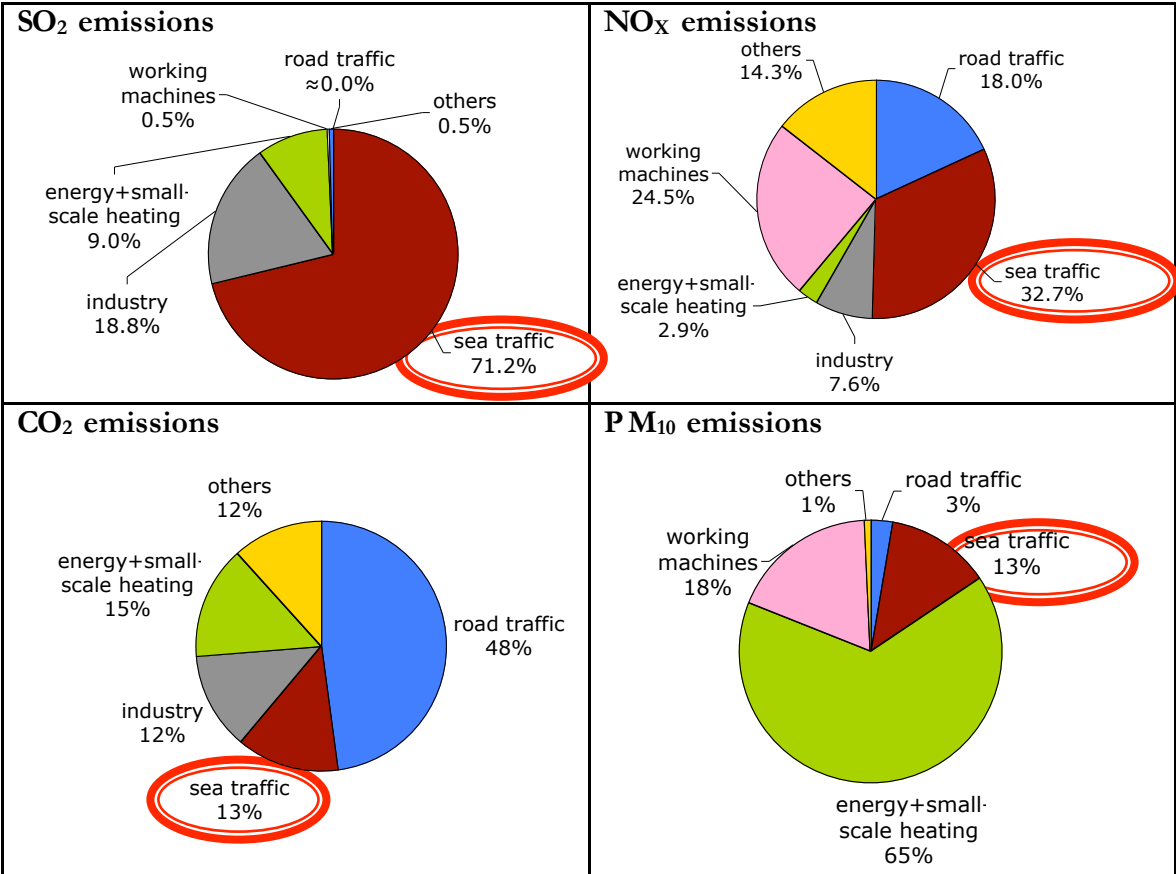


Figure 2-2 Contribution of the port and related operations to the total SO₂, NO_x, CO₂, and PM₁₀ emission in Trelleborg, when the geographical boundary is the municipality of Trelleborg on land and 1.5 km away from the shore at sea

Appendix 2: Differentiated fairway dues in Sweden

Table 1 Fairway dues based on the sulphur content of the fuel, 2004

Sulphur content, weight %	Passenger vessels [SEK]	Other vessels [SEK]
0.00 – 0.20	0.00	0.00
0.21 – 0.50	0.30	0.20
0.51 – 1.00	0.60	0.20
1.01 –	0.60	0.60

Source: SMA, 2004

Table 2 Fairway dues based on the engine output of the ship, 2004

Emission level, gram NOx/kWh	Passenger vessels, SEK	Cruise vessels, SEK	Oil tankers, SEK	Other vessels, SEK
0 – 0.50	0.60	0.38	1.00	0.90
0.51 – 1.00	0.70	0.44	1.10	1.00
1.01 – 2.00	0.90	0.50	1.30	1.15
2.01 – 3.00	1.08	0.60	1.48	1.33
3.01 – 4.00	1.17	0.65	1.57	1.42
4.01 – 5.00	1.26	0.70	1.66	1.51
5.01 – 6.00	1.35	0.75	1.75	1.60
6.01 – 7.00	1.44	0.80	1.84	1.69
7.01 – 8.00	1.53	0.85	1.93	1.78
8.01 – 9.00	1.62	0.90	2.02	1.87
9.01- 10.00	1.71	0.95	2.11	1.96
10.01 -	1.80	1.00	2.20	2.05

Source: SMA, 2004

Appendix 3: Ferries operating on the regular routes in Trelleborg

Name ¹	Owner	Route	Year	GT	Trip/year	Fuel type	Sulphur content [%]	Fuel consumed [ton/year]	Engine Capacity [kW/main engines]
Götaland	Scandlines AB	Trelleborg-Travemünde	1973	18060	1324	IFO 380	0.48-0.5%	10229	10300
Ask ²	Scandlines A/S	Trelleborg-Travemünde	1982	13294		IFO 380	0.48-0.5%	7753	23140
Skåne	Scandlines AB	Trelleborg-Rostock	1998	42705	2036	IFO 380	0.48-0.5%	16269	28960
Mecklenburg-Vorpommern	Scandlines AG	Trelleborg-Rostock	1996	37987		IFO 380	2.0-2.2%	15651	25200
Trelleborg	Scandlines AB	Trelleborg-Sassnitz	1983	10882	3468	IFO 380	0.48-0.5%	17976	17600
Sassnitz	Scandlines AG	Trelleborg-Sassnitz	1989	21154		IFO 380	2.0-2.2%	21064	18200
Huckleberry Finn	TT-Line	Trelleborg-Travemünde	1988	26391	2616	IFO 380	2.0-2.2%	12150	14800
Nils Dacke	TT-Line	Trelleborg-Travemünde	2001	26790		MDO	0.18-0.2%	11548	29880
Peter Pan	TT-Line	Trelleborg-Travemünde	2001	36468		MDO	0.18-0.2%	14389	29880
Tom Sawyer	TT-Line	Trelleborg-Travemünde	1989	26478		IFO 380	2.0-2.2%	12883	14800
Robin Hood	TT-Line	Trelleborg-Rostock	1995	26796	2782	MDO	0.18-0.2%	11801	18000
Nils Holgersson	TT-Line	Trelleborg-Rostock	1995	36468		MDO	0.18-0.2%	16642	18000
Delphin ³	TT-Line	Trelleborg-Rostock	1996	5333		MGO	0.1%	10175	24000

¹ Data summarized in the above table collected from the ferry operators in the form of reports, e-mails and personal communication.

² Ask was in operation until April 2005.

³ Delphin was in operation until December 2004.

Appendix 4: Interviewees

Actor Group	Company/Organization	Name	Date of interview ¹
Trelleborgs Hamn AB	Trelleborgs Hamn AB	Borowiec, Tomas	2005, July 27.
	Trelleborgs Hamn AB	Bosevska, Anita	2005, July 27.
	Trelleborgs Hamn AB	Eklund, Elisabeth	2005, July 27.
	Trelleborgs Hamn AB	Ljungbeck, Mats	2005, July 27.
	Trelleborgs Hamn AB	Ohlin, Håkan	2005, July 27.
Customers	Scandlines AB	Lindblom, Kjell	2005, August 10.
	Scandlines AB	Olsen, John	2005, August 10.
	Scandlines AB	Svensson, Dan	2005, August 10.
	TT-Line	Larsson, Johan	2005, August 8.
	TT-Line	Lundgren, Carl-Ove	2005, August 12.
	DHL	Blomqvist, Bengt	2005, August 10.
	Schenker	Larsson, Hans-Göran	2005, August 29.
Municipality	Trelleborgs kommun	Ferm, Stefan	2005, August 12.
	Trelleborgs kommun	Johansson, Per-Arne	2005, August 12.
	Trelleborgs kommun	Persson, Rutger	2005, August 8.
	Trelleborgs kommun	Pettersson, Johan	2005, August 12.
National Authorities	Naturskyddsföreningen	Ortmanns, Susanne	2005, September 8.
	Naturvårdsverket	N/a	2005, September 7.
	Trafikutskottet	Svensson-Smith, Karin	2005, August 29.
	Sjöfartsverket	N/a	2005, September 9.
Citizens of Trelleborg		N/a	2005, August 18.
		N/a	2005, August 18.
		N/a	2005, August 18.
		N/a	2005, August 18.
		N/a	2005, August 18.
		N/a	2005, August 18.

¹ Interviews were conducted by Alexander von Buxhoeveden and Bernadett Kiss.

Appendix 5: Annual operational costs in the scenarios

Table 1 Annual operational cost in the scenarios

Investment and operation	Investment cost [€]	Annuity factors	Annual cost ¹ [€]
On board			
Fuel switch to DME			14 062 943
to MDO at berth			6 114 323
to MDO			5 565 661
Wet scrubber	14 371 890	12 years, 4%	1 530 606
- operation			305 716
NO _x catalyst	8 669 265	12 years, 4%	923 277
- operation			2 577 431
Shore-side electricity ¹	1 841 840	30 years, 4%	226 198
On shore			
Shore-side electricity (5 connections)	6 080 000	30 years, 4%	372 256
(7 connections)	7 425 990	30 years, 4%	460 409
In the city			
Road E6	105 400 000	40 years, 4%	5 300 000
Railway double-track	158 1000 000	40 years, 4%	8 000 000
Dry port	31 6000 000	12 years, 4%	3 400 000
- operation			1 100 000
Cable car	14 700 000	10 years, 4%	1 800 000
- operation			2 100 000
Restaurant	500 000	5 years, 4%	100 000
- operation			1 100 000
Terrace bar	200 000	3 years, 4%	100 000
- operation			20 000
Berth arrangements	18 400 000	12 years, 4%	2 000 000

¹ Annual cost=Investment cost*Annuity rate

Annuity rate=[discount rate*(1+discount rate)^{life span}]/[(1+discount rate)^{life span}-1]

Table 2 Annual costs in the scenarios

ANNUALIZED COSTS	Present situation	Management on board	Land-based resources	City integration
Capital & Insurance & Admin Staff	66 M€	66 M€	66 M€	66 M€
Fuel & Maintenance & Dues	42 M€	42 M€	42 M€	42 M€
On board Investments	66 M€	66 M€	100 M€	81 M€
City Investments	0 M€	11 M€	10 M€	18 M€
External Cost (Air)	0 M€	0 M€	20 M€	23 M€
	57 M€	50 M€	52 M€	1.0 M€
TOTAL	230 M€	235 M€	289 M€	231 M€

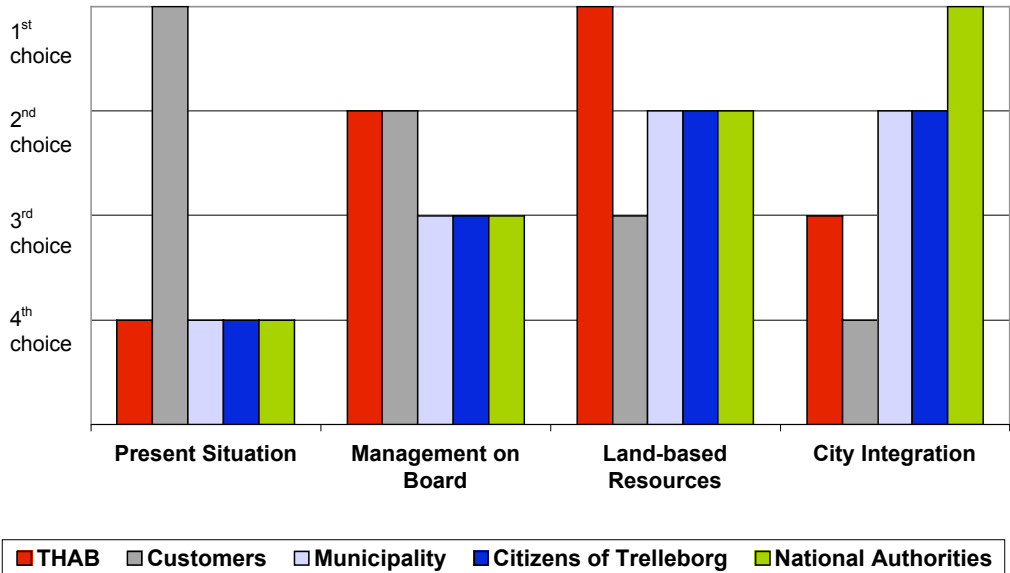
Table 3 Air emission values of the Swedish Institute for Communication and Analysis

SO _x : 8500 €/ton	NO _x : 1000 €/ton	CO ₂ : 150 €/ton
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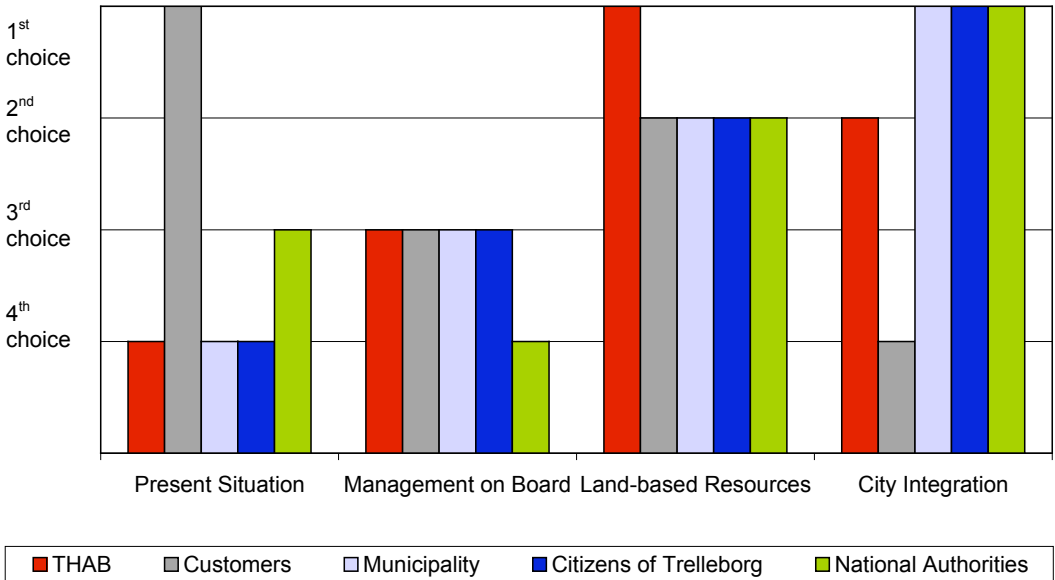
Source: Kägeson, 1999b

Appendix 6: Actors' opinion about each other

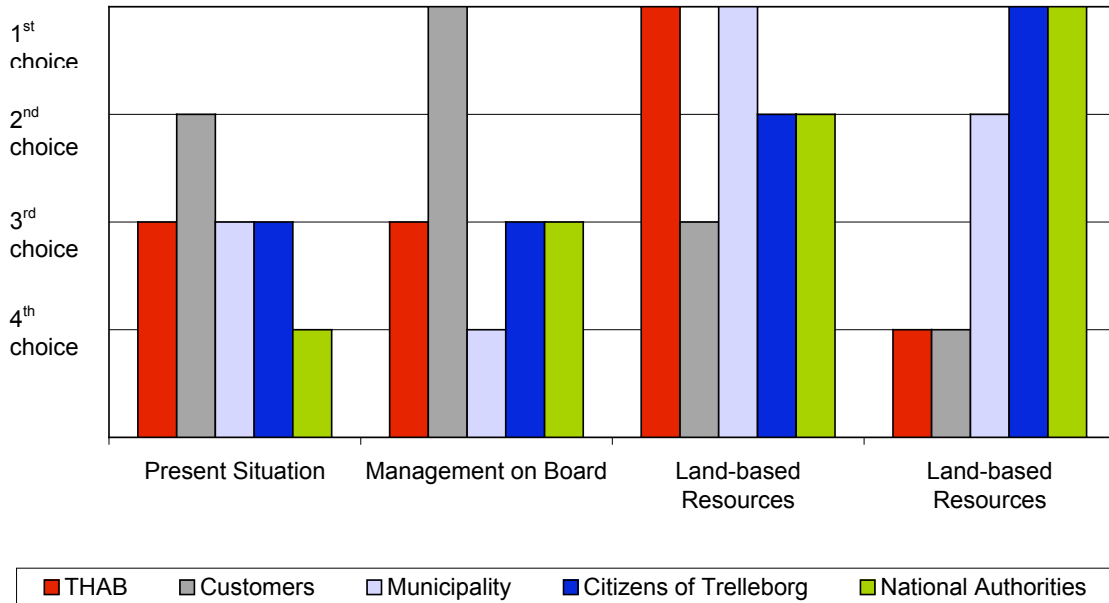
Ranking of scenarios



Customers about other actors' scenario ranking



Municipality about other actors' scenario ranking



National Authorities about other actors' scenario ranking

