GreCOR
GREEN CORRIDOR
Oslo-Randstad

The Interreg IVB
North Sea Region
Programme

Investing in the future by working together for a sustainable and competitive region

Final report on inventory and analysis for Green Corridor development

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Acknowledgements

This report is the final report of Work package 3 within the European project GreCOR as part of the North Sea Region program Interreg IVB. The GreCOR project consists of 7 different work packages in total. The purpose of our work package has been to create a common view of which needs there are within the transport corridor to make it greener, more efficient and safer both as input internally and as external output.

This report is a joint report of the material produced by all six of the involved partners represented in this work package. Many interesting studies have taken form beneath the umbrella of work package 3, both as new ideas and continuing work based on previous studies. We would hereby like to thank the GreCOR management for supplying the opportunity to make this work possible.

Please note that all material is available at www.grecor.eu/

Kind regards,

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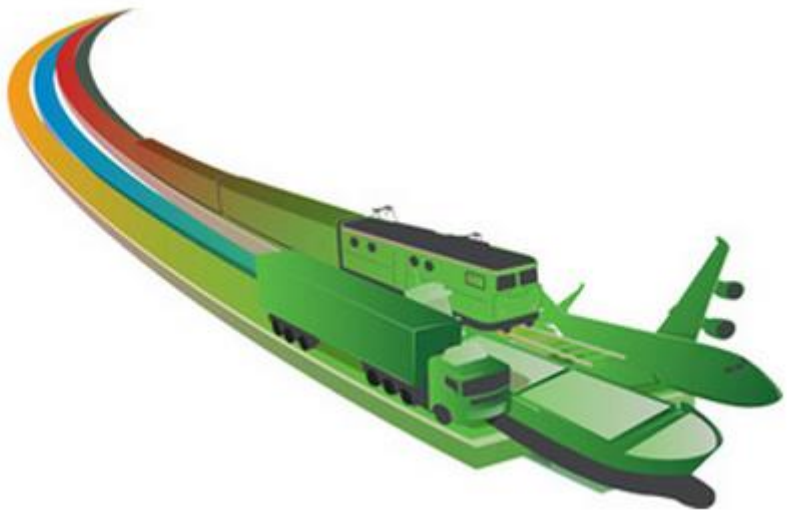
Content



GreCOR – Green Corridor in the North Sea Region

GreCOR – Green Corridor in the North Sea Region – is an Interreg IVB North Sea Region project that started 1 January 2012 and will end in June 2015. GreCOR promotes the development of a co-modal transport corridor in the North Sea Region. Important in this collaborative approach, is the that the focus is not only on the corridor itself, but also on secondary networks and the hubs, and the regional hinterland around the Green transport corridor between Oslo and the Randstad area (Amsterdam, Rotterdam, The Hague and Utrecht).

GreCOR has 13 partners and a total budget of 3.7 M€. The overall aim is to improve knowledge about the logistic needs and conditions and develop a strategy for the further promotion of environmentally friendly transports in the corridor. GreCOR focuses simultaneously on infrastructure and logistics for "greening" of transport and to make the region more competitive. The activities in GreCOR and the strategy will be a contribution to the EU objectives for transport as expressed in the White paper from 2011 "Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system"

The work in GreCOR was performed in seven work packages. More information at: www.grecor.eu

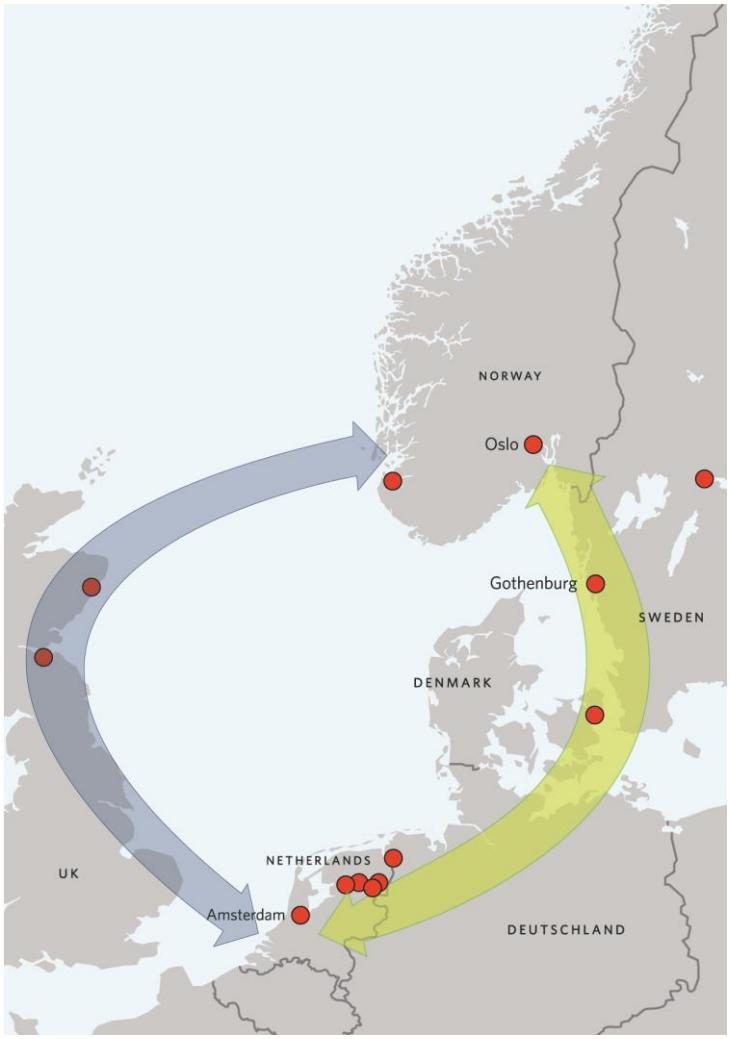


Figure 1. Map of the Corridor including locations of all project partners

Inventory and analysis for Green Corridor development within the GreCOR project

Work package 3 is one of the knowledge based work packages with aim to provide the grounds for the development of the first green corridor in the North Sea Region.

Developing sustainable transport corridors will increase competitiveness and contribute to a sustainable Europe. These transportation passages and projects are so called Green Corridors. The Green Corridor concept is a European Commission initiative aiming at strengthening the logistics industry's competitiveness and to create sustainable transport solutions, also aiming at developing a "greener" transport policy, which satisfies the climate challenge while increasing European competitiveness.

Background

The Corridor is a multimodal connection between major cities. The cargo flows in the corridor can comprise complex combination of different load carriers and modes of transports such as rail, road and sea transport. In some cases, the cargo is transported through the entire corridor, but most often it is transported in parts of the corridor to the destined market or the point for shipment. Several of the major North Sea ports are located along the GreCOR corridor. The corridor, with its hinterland connections, is important for cargo flows in the whole North Sea region and for a huge number of companies and many millions of citizens. The aim of GreCOR is to improve the transports of cargo flows in a sustainable direction to minimize the environmental impact as much as possible.

The material produced in WP3 will function as benchmark for other Green Corridor projects and public and private stakeholders in other parts of Europe. The purpose is to create a common view of which needs there are within the transport corridor to make it greener, more efficient and safer. Effects of the infrastructure measures will be developed including a mapping of which measures that are already planned so far. The sub-activities will focus on the green corridor but the recommendation and conclusions will be general and applicable in other corridors and the transport network as a whole. A close investigation and collection of statistics is a prerequisite for improved knowledge about the freight flows. This will form the basis for decision-making and policies which lead to implementation and development of the functions of the freight transports.

Structure

Work package 3 consist of four different activities which results in several sub-deliverables with an overall objective to make NSR attractive to business sector and improve knowledge about transport flows.

- Activity 3:1 – Identification of freight flows and standard development
- Activity 3:2 – Mapping of on-going and planned projects and initiatives in the corridor and its catchment area
- Activity 3:3 – Analysis of bottlenecks and gaps in the transport system of the green corridor and the secondary network
- Activity 3:4 – Develop a general method for how to measure the environmental consequences of the operations in the green corridor including the logistic hubs

Methodology

From the four activities, stated in the application, the work process took form. The structure (visualized in the picture below) is identifying two major areas within work package 3, freight flows and knowledge base including synergies and connections to both themes, as well as to other work packages within the project. Synergies have been identified throughout the process even if they are not highlighted in the structure below which have been discussed internally. All partners within work package 3 have contributed to proceeding with the work package structure.

Knowledge base is the direction of where increased knowledge of the corridor to achieve a holistic perspective of the prerequisites with a connection to national planning documents, this to create a common view of which needs there are within the transport corridor to make it greener.

Freight flows is the other main direction of which work is focused within this work package, not stand alone of course but knit together as a whole. Methods for collection of data and presentation of data have been discussed and evaluated.

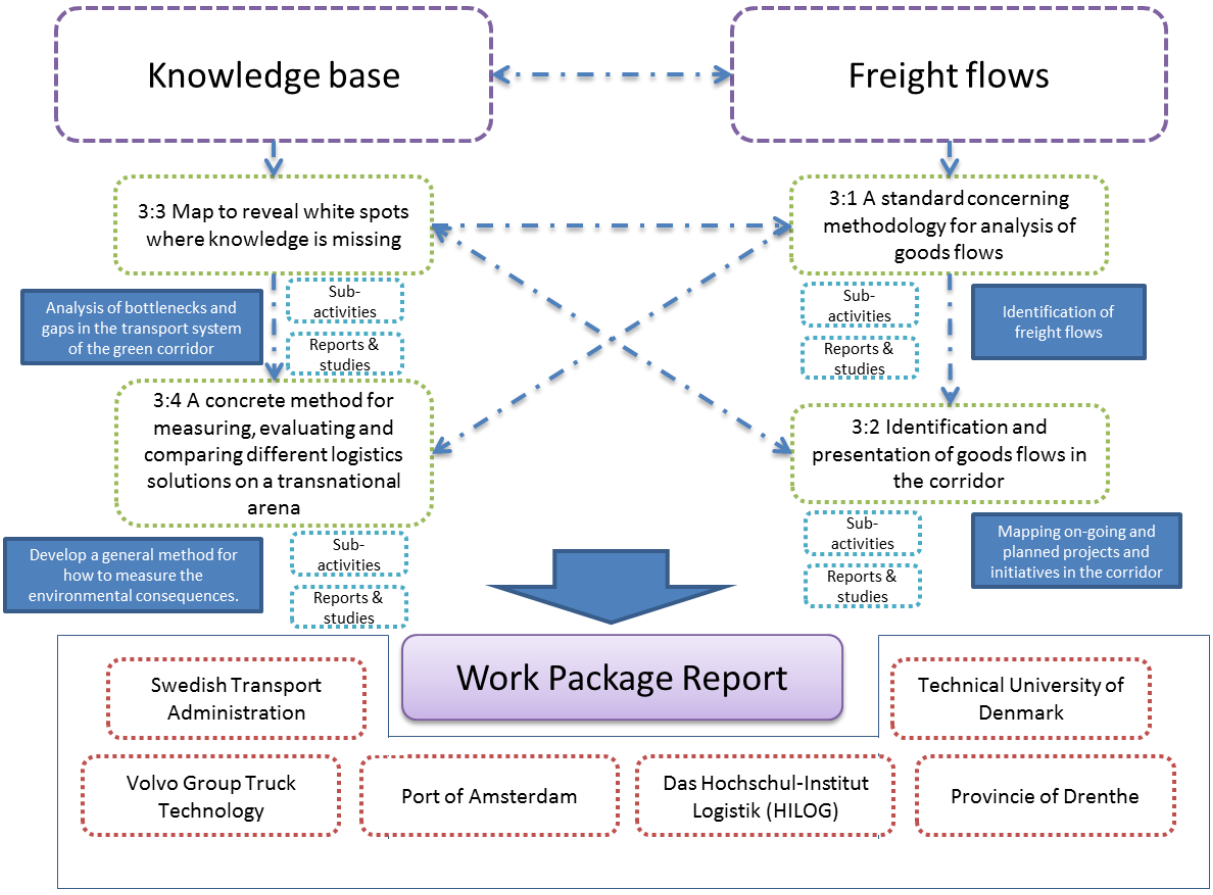
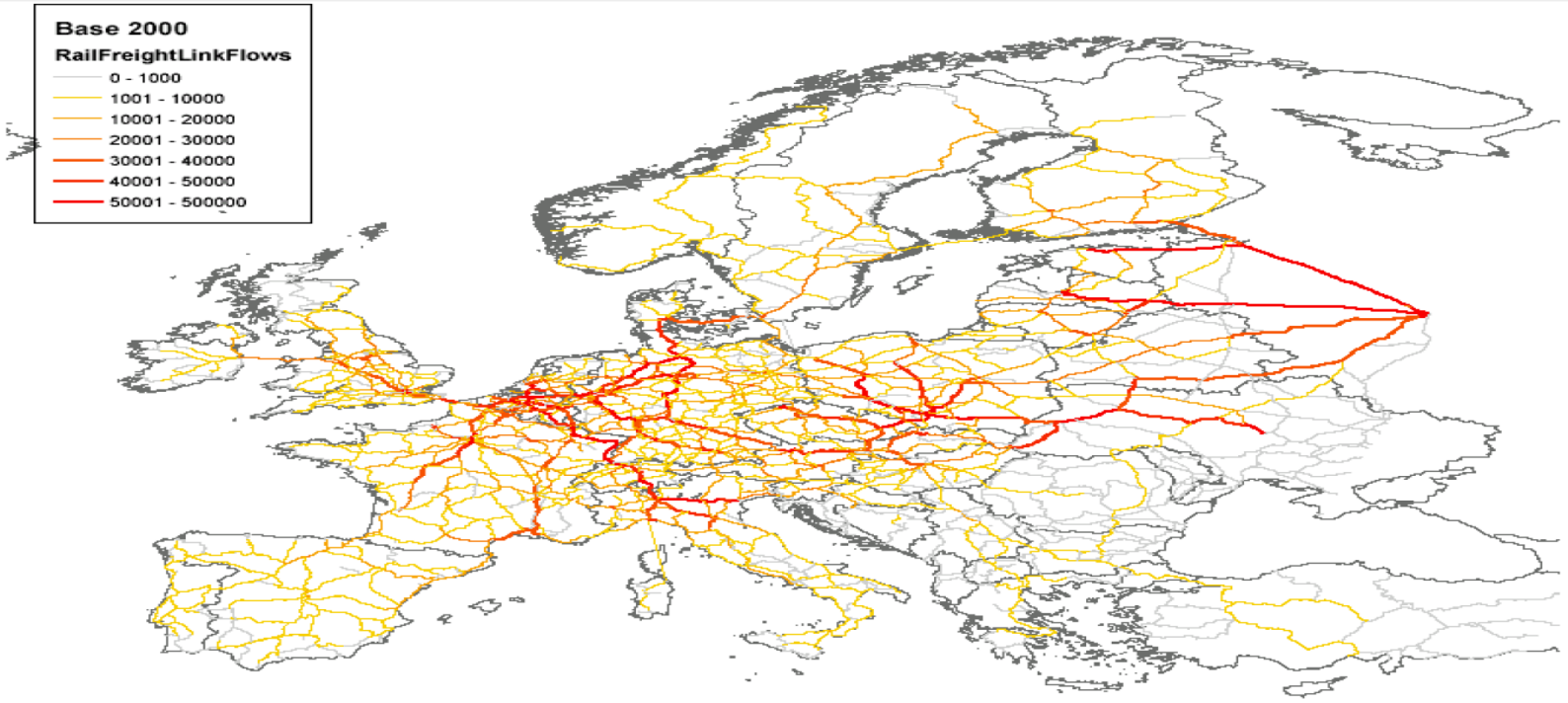


Figure 2. Work process of work package 3 - Inventory and analysis for Green Corridor development within the GreCOR project.

The output of Work Package 3 will create a common view of which needs there are within the transport corridor to make it greener, more efficient and safer. As example of sub output of work package 3 is the development and evaluation of corridor key performance indicators for corridor benchmarking. Securing that output from wp3 will support as input in other work packages, dissemination of the results and progress have been shared through the homepage, partner meeting, conferences etcetera.



Freight Flows

Freight planning is important to understand the challenges that come with increasing demand for freight transportation to improve mobility, productivity and greening. A prerequisite for planning is freight flow data and thus methods of how to create a united structure, especially across national borders.

The need for freight transport analysis along cross-border transport corridors is to allow for planning of the transport system. Analysis set on prerequisites for the specific corridor. The need mainly concerns transport surveying, but also action analysis is needed. Areas of interest are about the freight flows and understanding the nature of goods. The information about the freight flows that typically is being requested is the freight volumes in ton kilometres, the traffic modes used for different volumes, origin-destination (O-D) of the freight flow, and the commodity types. To allow for freight transport analysis, freight transport analysis models are typically used. In such models, freight transport flows appears in the transport network. In national and international transport models, the freight transport flow is typically described as flows between different zones where the size of the zones differs between different models.

Freight flows was selected as one of the main themes for Work package 3 (see methodology chapter above) including methods for data collection and visualization of freight data which have been discussed and evaluated.

The transport system is a complex system constantly changing and adapting to market factors and regulations. Companies most often hunt for cheap transports as they are performed in many levels of their company's supply chain. Time, security and management are other linked parameters one has to regard when developing a supply chain and thus transport routes, why a change in one factor could have direct consequences on the transport setup. Collecting real life freight flow data is thereby a long term commitment including many difficulties, not least as companies are reluctant to release company sensitive data of what is being transported, where and when.

Overlooking transport volumes must thus be done on an aggregated level. Within this Work Package 3 final report we will look into a few different ways of how to tackle the problem which has been investigated during the project.

Freight transport analysis in cross-border transport corridors

Freight transport models have been around in the transport research since the early 1960s and are of today the tools used when planning the transport system. The following section will give an overview of the state-of-the art models in order to give recommendations of how to proceed with available freight transport models and data for the purpose of the GreCOR project.

Background

In present time increasing pressure on the government to effectively deal with growing freight flows and holistic management of the infrastructure, the demand is increasing and so is the pressure on available freight transport models.

This is today even more relevant as nine core network corridors were recently established within the European Union to make sure that the corridors are developed effectively and efficiently by:

- Removing bottlenecks
- Build missing cross-border connections
- Promote modal integration and interoperability

National freight transport models are typically designed to be used for national purposes, i.e., national freight transport forecasts, transport surveying, and policy analyses. Moreover, national transport administrations typically want to conduct cost-benefit analyses from the model results in order to assess the benefits of suggested actions on the transport system. However, the models typically include transport to and from the country, why it can be used for studying transport to and from a country/region. There is also a need on a more aggregated level to enable transport analysis in cross-border networks e.g. core network corridors.

Freight transport models

Freight transport models are typically based on transport and foreign trade statistics, transport cost data, and network data. Since it is time-consuming to conduct surveys, for instance regarding commodity flows, as well as to update the national models with new data, the models often rely on old data. As an example, the Swedish model Samgods relies on data for the year 2006 and the European model TRANS-TOOLS relies on data for the year 2000.

The predominant model type for supporting the decision-making in public authorities is the sequential and aggregate (macro-level) four-step approach (see, e.g., de Jong et al., 2004), which include one or more of the following steps: trip generation, trip distribution, modal split, and traffic assignment. In addition, they often adopt the so-called ADA (Aggregate-Disaggregate-Aggregate) approach: they start with aggregate data, which is then disaggregated in order to enable to generate detailed estimations of logistics choices (e.g., of vehicle types and consignment sizes), and finally aggregated for further processing.

Forecasts are typically based on assumptions regarding the national and regional economic development for different industries and planned infrastructure investments.

National freight transport models in Europe are typically owned by the national transport administrations, but different types of organisations (the national transport administrations, consultancies, universities) can however administer the models (Vierth, 2011). In the case of TransTools it is owned by the EU and administered by JRC (Joint Research Center).

The freight transport models evaluated is listed in the table below. For further analysis of the freight transport models, please see the full report available at the GreCOR webpage.

Table 1. Freight transport models evaluated

Method	Geographical scope	Traffic mode (freight)
Samgods	Sweden	Rail, road, sea, air
Sampers	Sweden	Road
Norwegian model	Norway	Rail, road, sea, air
LTM	Denmark	Road, rail, sea
BASGOED	The Netherlands	Road, rail, inland waterways
German model	Germany	Road, rail, sea, air
GORM	Oresund region (Swe: Skane, Dk: Sealand)	Road, rail, sea
TransTools	42 European countries	Road, rail, sea, inland waterways, air

Besides models that are currently used today for freight transport analysis by public authorities, there is also more long-term research focusing on other types of models with the potential to be used for freight transport analysis. Such model types are primarily agent-based freight transport analysis models, e.g., INTERLOG (Liedtke, 2009) and TAPAS (Holmgren et al., 2012). Agent-based models belong to the class of micro-level models, where individual entities are represented and the relations between them are studied over time. In agent-based models, one or more of the entities, often decision-makers, are modelled as agents. In particular, agent-based models enable to model the decision-making in freight transport, hence capturing causality.

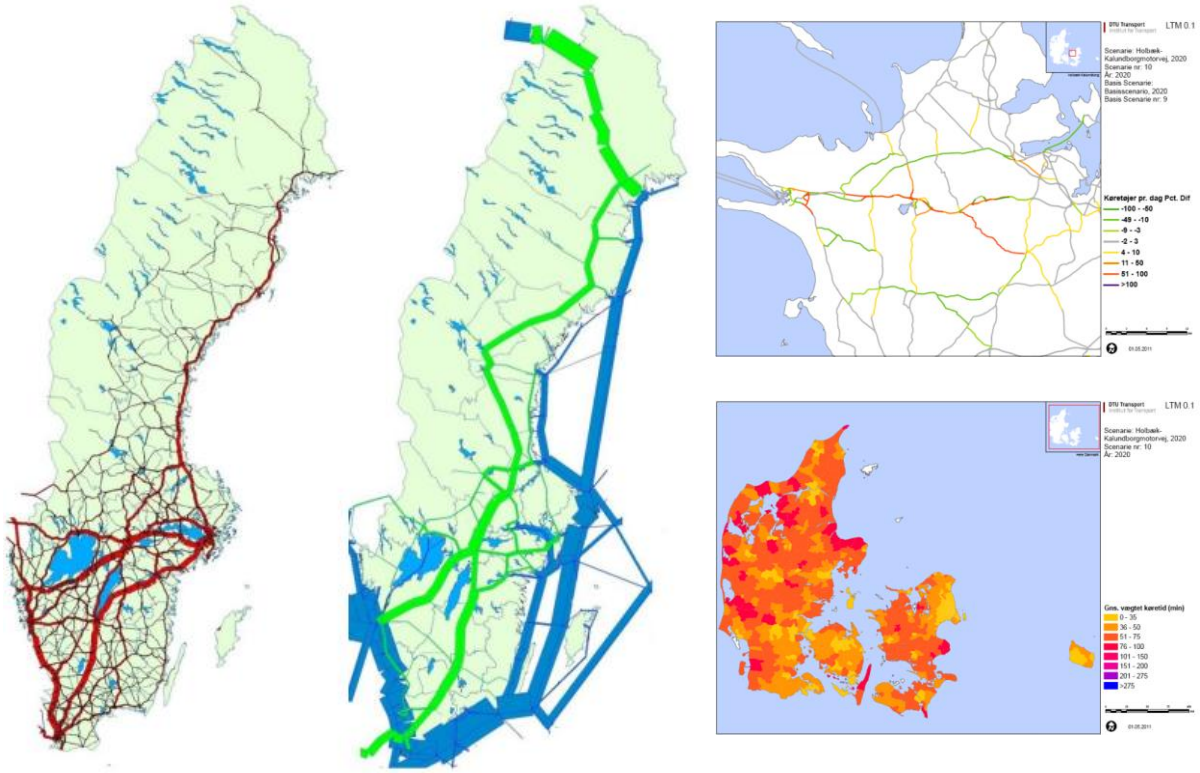


Figure 3. The picture illustrates example of output from the Samgods freight transport model, (left) and output from the Danish LTM freight transport model (Right).

Statistics

The countries along the GreCOR transport corridor collects national transport statistics. The way the statistics is collected as well as how it is developed often varies between the different countries, why it is difficult to compare. Even within a country, for instance Sweden, the transport statistics varies

between different traffic modes since they have different characteristics (Ramstedt et al., 2011). For instance, the commodity types that are used to describe the freight transport differ between the traffic modes. In Sweden, the commodity flow survey (CFS) includes detailed statistics of freight transport flows. A summary of the aggregated commodity flows are publicly available, however, detailed results from the survey are only available for universities for research purposes. Moreover, the statistics is only reliable for larger geographical areas – for smaller geographical areas the statistics is not reliable. In Norway a limited commodity type survey has been conducted.

European statistics is available from Eurostat. This statistics is in general more course-grained than the national statistics. The statistics include summaries of transport volumes, for instance freight tonnes per NUTS 2-region and modal split (tonnes and tonnes-kms) per country.

Recommendations

Today, there is no single freight transport model or statistics that can handle cross-border transport surveying and action analysis without quality issues. The level of detail of TransTools is rather low, especially in the Nordic countries, and there are also other quality issues with the results. There is however an ongoing EU project, led by the technical university of Denmark (DTU), where the model is being further developed in an international project group (TransTools 3). For instance, the demand matrices will be on a finer level (NUTS3) than the current NUTS2 level, which will generate more detailed results. To continue we recommend to:

- Continue the research and development of existing freight transport models as well as new freight transport models in order to meet the increasing need for cross-border freight analyses.
    - Due to the current development within the TransTools 3 project aiming at improving cross-border transport analysis, a general recommendation from the GreCOR project is not to develop a separate standard for data analysis and presentation but to follow the progress of DTU.

Main outcome

- National freight transport models are typically designed to be used for national purposes
- Greater need for international freight transport analysis along cross-border transport corridors
- A European transportation model, TransTools exists, it is however less detailed than traditional national freight transport models
- TransTool is under development in an ongoing EU project led by DTU
- TransTools is considered to be the best model for studying and analyzing cross-border freight transports.
- European statistics is available from Eurostat. This statistics is in general more course-grained than the national statistics

Cargo Bank

Grecor partner HILOG (Institute for Logistics) at the University of Applied Science Emden/Leer in Germany has developed and distributed a database (Cargobank) which contains the maritime freight flow data in the North Sea Region (NSR). The Cargobank makes it possible to retrieve and present cargo flows in a structured way. The methodology is based on data from Eurostat (discussed as part of TransTools in earlier chapters). An interactive online visualization of the data is available at http://www.hs-emden-leer.de/forschung-transfer/institute/hilog/grecor.html .

Description of the "Cargo bank"

The data collected in the Cargobank describe the maritime cargo flow to and from about 700 ports in the North Sea Region and about 1750 ports worldwide that are related to the NSR. These relations are defined by the available hub to region (NUTS-2 level) connection data from Eurostat. Also the geographical assignments from port to region to nation and continent are provided. That means also aggregated views on specific questions can be generated.

All freight flow data are available on a quarterly basis for 29 different types of goods that are assigned to one of the 8 carrier systems. At the moment data are included from 2005 to 2014 and will regularly be updated with the newest data available.

The Cargo bank also provides information about the infra and superstructure and the hinterland connections of selected German sea ports (integrated in an indicator tree system).

All data are stored on a SQL server and are online available (password protected). To make the data publicly available without SQL knowledge, an interactive web-based visualization tool was developed (for link see above). This graphical interface allows the user in different predefined views to make individual choices about the port or region, time period or type of good to focus on. Also export functionality for the selected data and figures are available.

Examples for analyses with the Cargo bank

The following examples give an overview of different types of analyses and presentations possible with the data in the Cargo bank.

- Ranking of the biggest NSR ports (filtered by individual objectives)
- Comparison of ingoing and outgoing cargo flow for ports/regions in the NSR
- Figures of cargo flow in GreCOR ports for different good categories or time periods
- Figures of cargo flow, separated in goods categories, in the most important ports for each NSR country.
- Development of volumes transported within time period
- Port-port comparison or region-region comparison
- Percentage of certain type of good compared to total turnover

There are lots of further options for possible analysis depending just on the question that has to be answered.

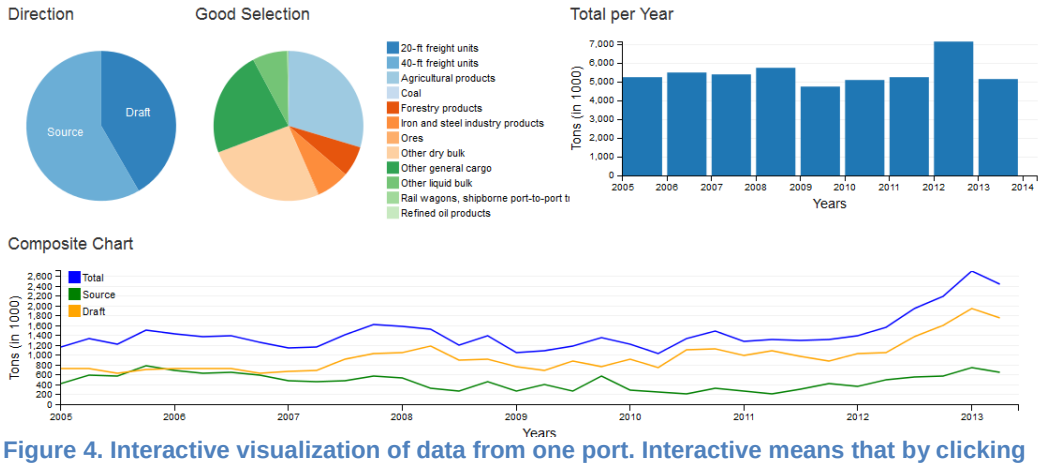


Figure 4. Interactive visualization of data from one port. Interactive means that by clicking in one of the graphs certain selections can be defined that are automatically applied also to the other graphs in that view.

Main Outcome

- Interactive online visualization of data from about 700 ports in the North Sea Region and about 1750 ports worldwide that are related to the NSR.
- Identification of 29 different types of goods.
- Rankings, comparisons, port- port relations and freight development.
- The Cargo bank also provides information about the infra and superstructure and the hinterland connections of selected German sea ports

Study on Flow of Goods Eastern Middle Sweden Örebro

The study Freight Flows in East Middle Sweden was produced in a Swedish project performed by the GreCOR partner Region of Örebro and was within the GreCOR project translated to English where both results and methodology was discussed and evaluated.

The aim of the Freight Flows in East Middle Sweden project is to help to provide greater knowledge of freight transport in East Middle Sweden, and to further develop a method for the mapping and visualisation of freight flow with a view to making it possible to conduct analyses at regional level. "East Middle Sweden" (Swedish: Östra Mellansverige) refers to the counties of Stockholm, Västmanland, Örebro, Södermanland, Östergötland and Gotland.

Methodology used for mapping freight flows

Within the framework of the project, a tool was developed that allows players to communicate questions within the fields of regional planning and freight shipments more easily. Using maps, it is possible to show the transport flows for the entire region, or for the respective counties, in terms of where the production and consumption of various product groups takes place. The maps are based on model-calculated transport flows (from Samgods) and processed statistics on production and consumption. This information on the freight flows, and on the industrial and commercial structure of the region and the counties, will allow outline studies and analyses of current issues to be carried out.

Characteristics of shipments in East Middle Sweden and Örebro County as part of the study.

East Middle Sweden:

- Large road freight – the largest flows are on the E-roads (E4, E20, E18).
- Rail – the largest rail freight corridor in the area runs through Bergslagen.
- Ports - the Port of Oxelösund handles the largest freight volumes (in tonnes)
- Örebro and Hallsberg terminals – important hubs for road and rail freight.
- Arlanda airport – a nationally important node for air freight
- High proportion of transit shipments through the respective counties in all counties except Stockholm and Gotland.
- Stockholm is the only county with a larger proportion of intra-county shipments than the national average.

Örebro County:

- Road freight flows: E18 and E20 east and west directions, routes 49, 50 and 68 moving north and south.
- Rail freight flows: The Freight Corridor through Bergslagen and the Western Main Line west of Hallsberg.
- Large transit flows through the county.
- Hallsberg is Sweden's largest marshalling yard.
- No ports.

The summary of East Middle Sweden as a whole closely matches what we know about freight shipments. For the summary for Örebro County, the information on the size of the road and rail flow matches with that shown in the traffic measurements and statistics. The results with regard to information about the biggest product groups are generally reasonable. The information on transit, import, export and intra-county shipments also appears reasonable.

Figure 1 shows the total freight flows in East Middle Sweden divided by road, rail, sea and air. For the island Gotland, the road flow (grey lines) shows the measured flows of the numbers of lorries and buses (AADT), while the remaining flows in East Middle Sweden are model-calculated flows in tonnes.

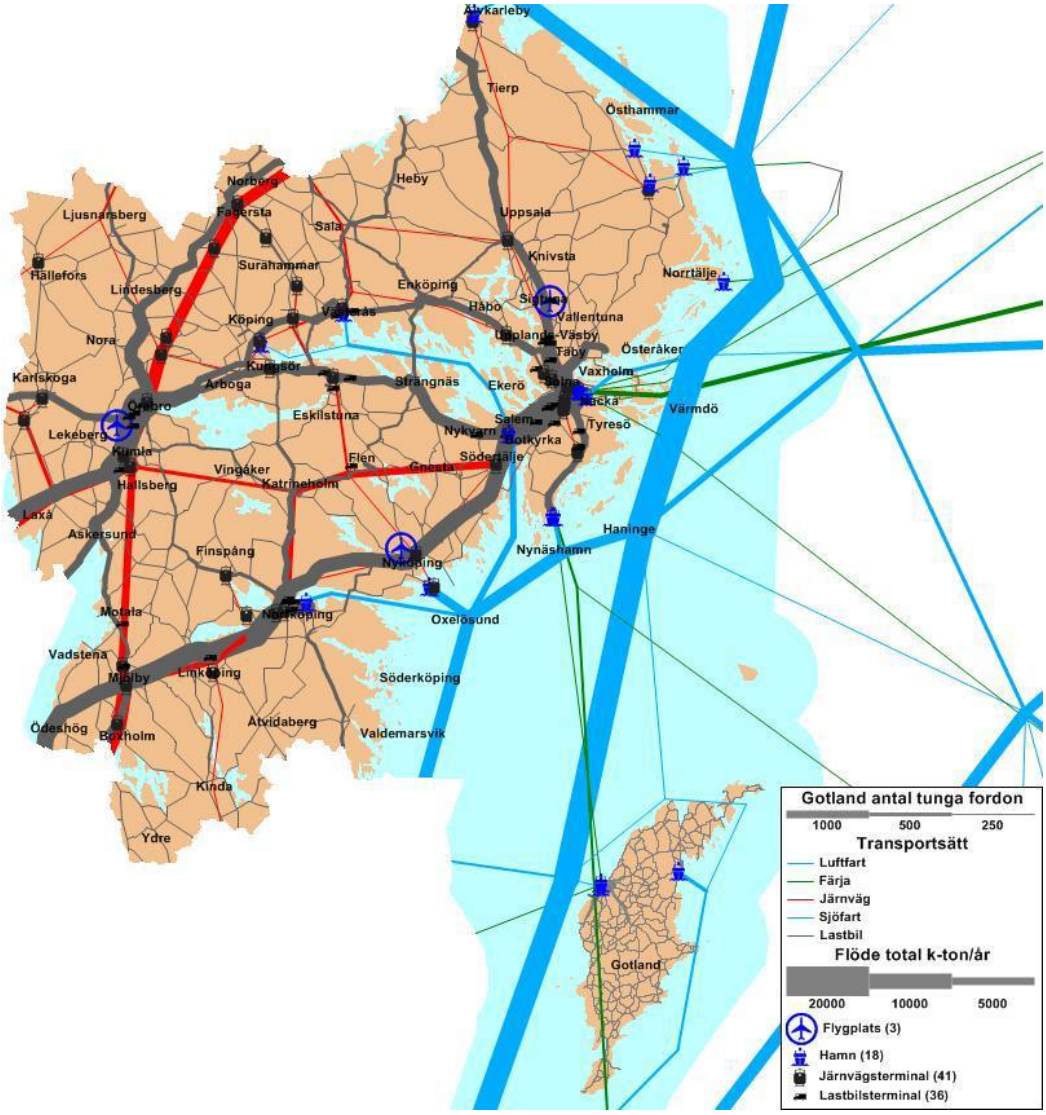
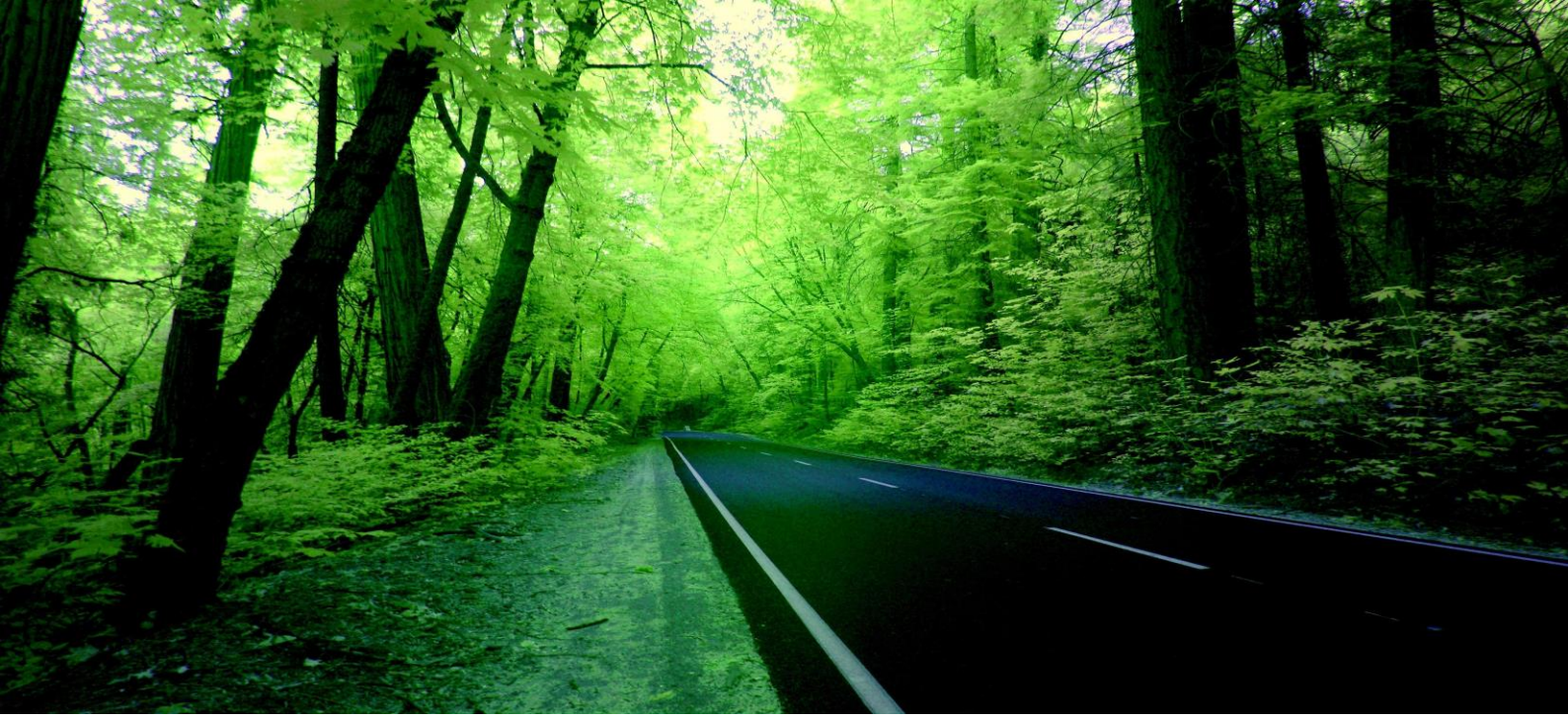


Figure 5. Total freight shipments for each type of shipment in East Middle Sweden. The thickness of the flows denotes the size of the shipments, measured in tonnes/year. The air freight flows have deliberately not been shown on the map as this would make the map difficult to read.



Towards Greener supply Chains within the corridor – Best practice and potential

This activity aims to create an understanding for the challenges required to implement “greener” supply chains. Previous activities have looked into which statistics to be used and how it should be presented. This report is more concrete and is aimed to create an understanding of the nature of goods and uses a case study with a marketing perspective to give suggestions to setup an intermodal supply chain. In order to succeed, access to accurate information and statistics is essential. The study was led by the Swedish transport administration.

Introducing green logistics in the supply chain

The transport system itself is very complex. It is built upon numerous parts in contact with each other in different ways. An effect in one sector can change the requirements for the whole supply chain. It is often hard to define the start and end of a chain. Often a company can play a part in several supply chains. The goals for the different supply chains are in the end to provide added value to the customer and thereby ensure the involved parties existence.

In order to direct the supply chains into a more sustainable direction it is vital that the original goals (customer satisfaction/value/profitability) remains. Environmental impact should be considered as a natural business factor like purchasing and sales to achieve best effect. Companies all over the world have adapted this way of working and environmental and sustainable aspects play a central role in their business culture.

Logistics and supply chain development can often support greener transports. For example can logistics trends for setting up fewer distribution centres (DCs) contribute to concentration of goods volumes. Concentration of volumes opens up new opportunities for volume demanding transport modes like railway and sea transports. These are transport commodities which can contribute to a greener transport system. Projects on international level like GreCOR support this development and promote creation of transport corridors with large concentrated freight flows. These corridors set the baseline for designing efficient intermodal concepts.

The road transports do and will however continue to play a dominating roll in the transport system. The transport mode distinguishes itself in particular within the area of delivery service. Rail- and seaway have difficulties to be competitive when it comes to logistics parameters like flexibility, service and lead-time. In order to even out the competition between the transports modes, intermodal solutions are a key factor.

Need of greener supply chains

The EU white paper in transports released 2011, aiming for a 60% reduction of greenhouse gas emissions until 2050. In order to reach the target several activities are required. One of the activities is to increase the usage of intermodal logistics setup. Recent statistics from Eurostat shows that the level of intermodal transport within EU has been almost unchanged since 2007. It could therefore be worth investigating what is required to setup a successful intermodal business. Cases studies have been used to facilitate this task.

In order to succeed with a sustainable or green transport solution it is important that the traditional supply chain goals like customer satisfaction, value and profitability still are in focus. Green logistic shall be a natural part in the business and not an additional task.

Long going logistics trend can support the greening of the transport system. Consolidation of distribution centres can for example often lead to concentration of goods volumes. Major volumes give new opportunities for transport mode like Railway and Sea. To be competitive against the road sector it is often required that the Railway and Seaway involve the road alternative in their transport setup, i.e. intermodal solution.

Best practise case studies and areas of improvement

The report delves into a case study focusing on transport parameters and successful green supply chain. The supply chain "shipping route Gothenburg-Ghent" is performed as an intermodal setup which on a yearly basis carries around 98 000 trailer equalities on the sea instead of occupying the road network. The setup has in a successful way managed to keep a strong focus on traditional logistics objectives and the sustainable outcome is added value. The intermodal ferry shipping route Gothenburg-Ghent can be considered to be a best practice case. The traffic has been up and running since the 1980. Main reasons for its success are that the traditional customer focus always has been in focus. Other contributing factor has been access to major volumes, balanced goods flow and a robust setup with high reliability.

Distribution of flowers is today one of the commodities within the corridor that is completely dominated by the mode road transport. This is mainly because there is a large focus on lead time and flexibility which makes it hard for other transport modes to be seen as an alternative. To make the transport chains greener and to keep the original commodity demands, an intermodal setup between the Netherlands and Sweden might be seen as an alternative in the future. This will however require a very robust railway network and a railway sector which for real puts the customer in focus.

Ideas and knowledge from the Gothenburg-Ghent case has been used to see if an intermodal alternative could be an option. The outcome is that an intermodal setup with road and rail way could be an option. It does however require that the railway sector can offer the same service as the road traffic.

Recommendation for introducing green logistics

Most supply chains are different and complex in their nature. A logistics setup for one chain can be hard to apply on another. As many parties and actors are involved in one way or another, it is important to have in mind that a change in one part of the chain can lead to unforeseen consequences in another part. It is therefore important to have a holistic perspective when introducing changes.

In order to develop the supply chains in a more environmental direction, it is vital that traditional business functions still are in focus. Central parameters within supply chain management like customer satisfaction and profitability shall still be in focus in order to setup a competitive green supply chain.

The road transport mode is very competitive when it comes to central logistics parameters like flexibility, cost and lead-time. In order to break the dominance from the road sector it is advised to be innovative, seek for new solutions and questioning old structures. Projects on EU level like GreCOR can support and facilitate this operation.

Table 2, ideas how to promote sustainable/greener logistics solutions.

PROPOSAL	DESCRIPTION
Holistic logistics perspective	Avoid sub optimization. Changes in one part of the supply chain can have negative effect on another.
Keep focus on traditional supply chain goals	Customer satisfaction, value and profitability still to be prioritized.
Consider green logistics to be a business factor among others	In order to created long-term sustainable setups.
Take advantage of technical transport development	Utilize the concentration of distribution centers and standardization of load carriers to initiate intermodal solutions
Logistic efficiency remains central	Continue to work and improve logistic objectives like delivery time and delivery security.
Challenge current view of the transport- and logistics setups	Demand the same type of quality and customer service independent of transport mode.
Promote transparency and cooperation	An intermodal setup often requires major volume of goods. Cooperation between companies is often a prerequisite for this.

Main outcome:

- Traditional supply chain goals (customer satisfaction, value and profitability) in focus when setting up greener logistic solutions
- General logistics trend can support the introduction of railway and seaway in the supply chains
- Major goods volumes and balanced goods flows are important factor behind successful intermodal solutions.
- Intermodal transports involving road and rail could under the right circumstances be an option for flower distribution within GreCOR.

Research of Northbound cargo between Amsterdam – Sweden

The "Holmen Case" performed by Port of Amsterdam aimed at identifying business opportunities for cargo flows between Amsterdam and Sweden in order to identify possibilities for a modal shift. As the previous sections have stated, it analyses specific goods flows in order to find possibilities to introduce greener transport concepts.

Background

Today there is an imbalance in the goods flows between Amsterdam and Sweden. Most of the ships are going empty in the north going direction to Sweden. This activity attempts to investigate if any improvements can be made.

Finding north going cargo should increase the competiveness from the sea transport mode. This could lead to increased market shares at the expense from the road sector which is the dominated transport mode between the countries.

Concept

Freight moving from East Sweden to Netherlands passes the GreCOR area with an attribute that most supply chains are performed by truck. Netherlands is one of Sweden's major trading partners where:

- 5,2% of Swedish exports goes to the Netherlands (2012)
- 6,6% of the Swedish imports has a Dutch origin (2012)

If some of these volumes were to be carried out by boat all the way to east Sweden, considerable road volumes in the hinterland would be removed. Another important aspect is that the market for seaway transport to east Sweden from Netherland was considered to be more immature and thereby more open for new business possibilities.

Imports to Sweden from Netherlands mainly consist of the category Machinery, nuclear reactors and boilers which is compiled of several sub-categories.

The region of east Sweden is an important region for imports by truck. 16 % of the import has origin NL and 18 % of the export has destination NL. The main category of freight transported by lorries is visualized in the picture below. Some distinctive flows are dominating the distance and large deviances comparing inbound and outbound flows occur.

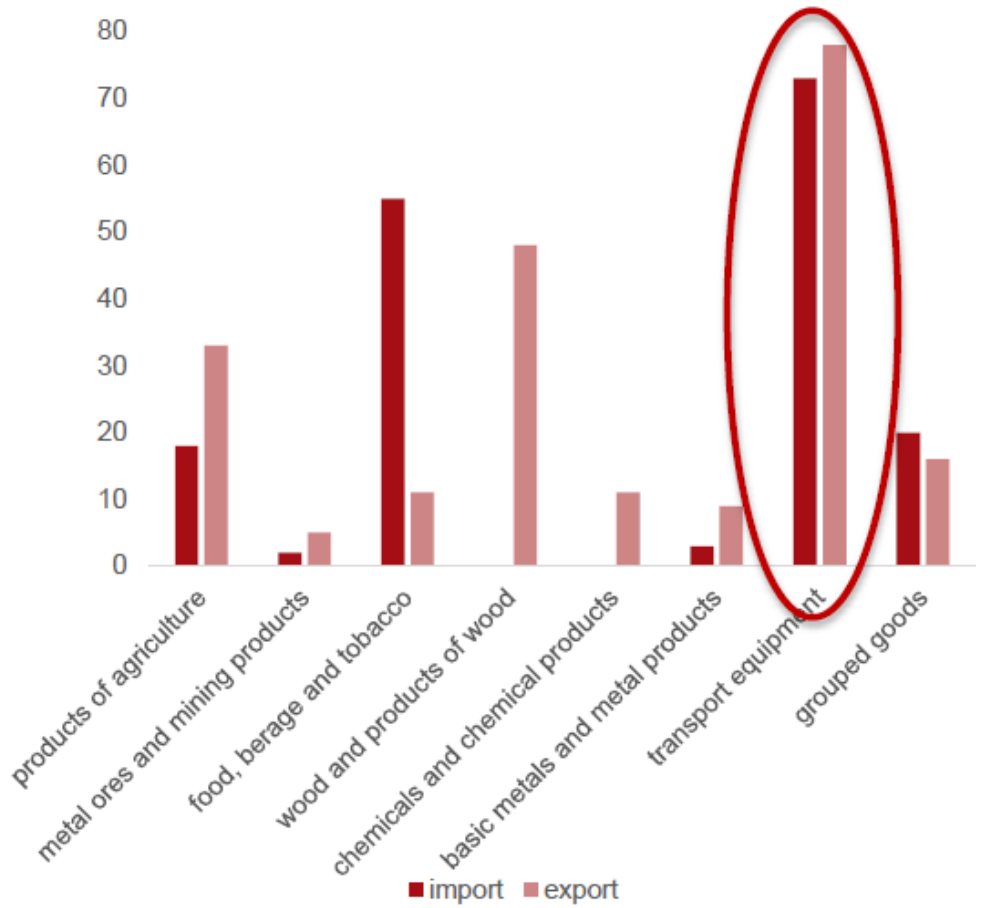


Figure 6. International goods NL - Sweden by registered lorries (*1.000 tonnes) 2012. Source Sveriges oficiella statistik

Further analysis showed that the port landscape of east Sweden involved a lot of competitive ports with possibility to handle more capacity. The ports of Norrköping and Hallstavik attracted extra consideration. The reasons for this were that the ports are used by a major forest industry i.e. Holmen and that the industry already today use vessels to distribute their products. An opportunity for a potential business case has been identified. The continuing step for this desk-study would be to get in contact with chambers of commerce in east Sweden and the Netherlands, in order to locate potential businesses. Different types of events could be arranged to facilitate meetings with partners interesting in using a competitive sustainable transport setup in order to create a change in the supply chains from road to sea.

Main outcome:

- Imbalance in the goods flow from the Netherlands to Sweden
- There is a good insight in flows but not (yet) in costs and time
- Seaway transport between Netherlands and east Sweden would imply a significant saving of road transports between Gothenburg and East Sweden.
- Capacity among ports of east Sweden to handle increased freight volumes
- Paper distribution by vessels from the Holmen company could be the base to start a new business form

Research E233 Green Corridor

To gain insight into the amount of freight and the charge, GreCOR partner Gemeente Emmen performed a traffic study on the corridor between the Netherland/German and the German/Danish border. In order to gain a clear sample of freight movement, the methodology was based on identifying the license plates of the trucks at determined border crossings. The trucking companies were thereby identified where subsequent interviews was conducted to answer the question why.

Background

Gemeente Emmen has worked on mapping of freight flows to and from the region. This includes the identification of trucks passing the border by identifying license plates in order to identify owners and conduct interviews. The reason is to get an understanding for the present freight flows passing the border and also for further analyses when estimating the potential of modal shifts. To gain insight into the amount of freight and the charge, a traffic study on the corridor between the Netherlands and the Danish German border was done by Grontmij BV[1].

Origin Destination matrix (OD matrix)

Obviously, carriers and truck drivers prefer the following routes between Netherlands and Scandinavia, (see also picture below):

1. A1/E30 border crossing at Enschede / Oldenzaal and the A37/E233 passing at Emmen / Zwartemeer to
2. E45 border crossing at Flensburg and the Rödby ferry at the Fehmarn passing.

To register the amount and route choice of freight determined between the Dutch border crossing E233/A37 and the E30/A1 on one hand and the German / Danish border E45 and Rodby ferry on the other hand the license plates of passing freight carriers were registered during 27.October till 5.November 2014. By comparing this registration the following tables of Origin and Destination Matrix between these four locations results.

[1] Onderzoek E233 Green Corridor door Grontmij 13 november 2014

Figure 7. Border crossings investigated in the study.

The tables below show the OD matrices over the entire measurement period. The first table shows the absolute number of trucks passing the border crossings while the second table shows the percentage numbers. The last table shows the number of trucks per origin (Dutch or Danish border) again.

Table 3. Absolute numbers of trucks passing the boarders illustrated in the picture above, followed by a percentage comparison.

	A1-Nederland-in	A37-Nederland-in	E45-Denemarken-in	E47-Denemarken-in	Eindtotaal
A1-Nederland-uit			419	253	672
A37-Nederland-uit			446	258	704
E45-Denemarken-uit	753	710			1463
E47-Denemarken-uit	308	348			656
Eindtotaal	**1061**	**1058**	**865**	**511**	**3495**

Verdeling per herkomst

	A1-Nederland-in	A37-Nederland-in	E45-Denemarken-in	E47-Denemarken-in	Eindtotaal
A1-Nederland-uit			62%	38%	100%
A37-Nederland-uit			63%	37%	100%
E45-Denemarken-uit	51%	49%			100%
E47-Denemarken-uit	47%	53%			100%

Table 4. Shows the percentage of the number of trucks per origin at the Dutch or Danish border.

Verdeling over herkomstland					
	A1-Nederland-in	A37-Nederland-in	E45-Denemarken-in	E47-Denemarken-in	Eindtotaal
A1-Nederland-uit			30%	18%	49%
A37-Nederland-uit			32%	19%	51%
Totaal Nederland uit			63%	37%	100%
E45-Denemarken-uit	36%	34%			69%
E47-Denemarken-uit	15%	16%			31%
Totaal Denemarken uit	**50%**	**50%**			**100%**

Results of the interviews

The above HB matrix shows insight into the amount of truck traffic on the mentioned routes. However, it provides no information on how often carriers use this route and what goods they transport. To gain more insight telephone interviews were taken with carriers who regularly use A37 and A1. Grontmij interviewed 51 carriers. 24 companies actually contributed to the interview.

The following response only includes the results of the companies that cooperated.

- About 50% of companies use the E233 as well as the E30 crossing. The other 50% said only to make use of the E233.
- Most often the E233 is preferred (70% of the interviewed companies make use of this border crossing).
- The choice of border crossing is the result of a variety of choices. 58% of the answers refer to the quickest or shortest route.
- About 58% of the respondents do have “trucks at the border almost every day “ Almost all carriers indicated they used the border crossings during the last two weeks.
- Most trips (58%) have their destination in the North of Germany, usually region Bremen-Hamburg. About 25% passes to Sweden and another quarter to Denmark. Only one was destined to Norway.
- Many transports contain fresh refrigerated goods. For this reason a lot of conveyors stop as little as possible. Their first stop is usually near Bremen.
- Most companies use tractor/trailers (90%) for long-distance transport. The vehicles all are filled to their maximum capacity, approximately 25 tons. Following types of goods are mainly transported:
    - Horticultural 16%
    - Food 16%
    - Bulk 16%
    - Fodder 16%
    - Cattle 16%
    - Materials and diverse 12%
- Transporters from the Westland who have nearby only fresh products on board, usually return to the Netherlands with bulk goods. Some of them indicated that they carried back from Scandinavia deep frozen fish to the Netherlands.

- Almost all carriers mention the saving of time on the E233. This is also the reason for them to (re)use the E233. In particular the calm traffic on this route is an advantage for the driver's.
- Trucks on the E233 often are delayed by agricultural traffic. Some people rather would see that the conversion of this route, planned to be realized during 2016 - 2022, already was finished today. Many companies worry about the fact that the E233 no longer will be free of Maut

Figure 8. Plans are to develop E233 due to traffic overload.

Main outcome:

- The number of trucks leaving Netherlands via E233 and A1 is evenly divided (50%)
- 70 % of the trucks travel by E45, Flensburg. Only 30 % take the ferry by Rodby.
- Many transports contain fresh refrigerated goods. For this reason a lot of conveyors stop as little as possible. Their first stop is usually near Bremen

Knowledge

When developing sustainable transport corridors (Green Corridors) in order to increase competitiveness and contribute to a sustainable Europe there is a need to understand the subject both theoretically and practically. The Green Corridor concept is a European Commission initiative aiming at strengthening the logistics industry's competitiveness and to create sustainable transport solutions, also aiming at developing a "greener" transport policy, which satisfies the climate challenge while increasing European competitiveness.

The Green Corridor itself is a multimodal connection between major cities. The cargo flows in the corridor can comprise complex combination of different load carriers and modes of transports such as rail, road and sea transport. In some cases, the cargo is transported through the entire corridor, but most often it is transported in parts of the corridor to the destined market or the point for shipment.

The corridor, with its hinterland connections, is important for cargo flows in the whole North Sea region and for a huge number of companies and many millions of citizens. The aim of the GreCOR project is to improve the transports of cargo in a sustainable direction to minimize the environmental impact as much as possible.

Depending on the route from A to B, the prerequisites and supply chains vary from corridor to corridor. One of the unique factors of the GreCOR area is the overlapping of TEN-T corridors (see figure 8). As part of the North Sea region, GreCOR unite the Scandinavian market to large European ports. GreCOR is either the start/end node or overlapping the Scan-Med corridor, North Sea –Baltic corridor, North Sea – Medditeranean, Orient/East - Med and Rhine – Alpine corridor.

Knowledge base is, within this report, the direction and focus area to increase knowledge of the corridor to achieve a holistic perspective of the prerequisites in the corridor. Connection to national planning documents has been made to secure a common view of which needs there are within the transport corridor to make it greener.

Green Corridor in the North Sea region - Inventory report

In order to increase synergies with other Work Packages and to create an understanding of the prerequisites in the GreCOR area a report was initiated by the Swedish Transport Administration to invent and analyze the Green Corridor development to provide knowledge of existing and future conditions to establish which needs there are within the transport corridor to make it greener, more efficient and safer.

Background & Corridor Scope

The aim of the Green Corridors Concept is to create freight corridors of excellence, where large and concentrated freight traffic flows between major hubs and by relatively long distances of transport can be handled in the most efficient, environmentally friendly and business driven manner.

A transport corridor can thereby not only be viewed as a link from A to B but as a combination of transportation networks that link together the same major origins and destinations, see figure below.

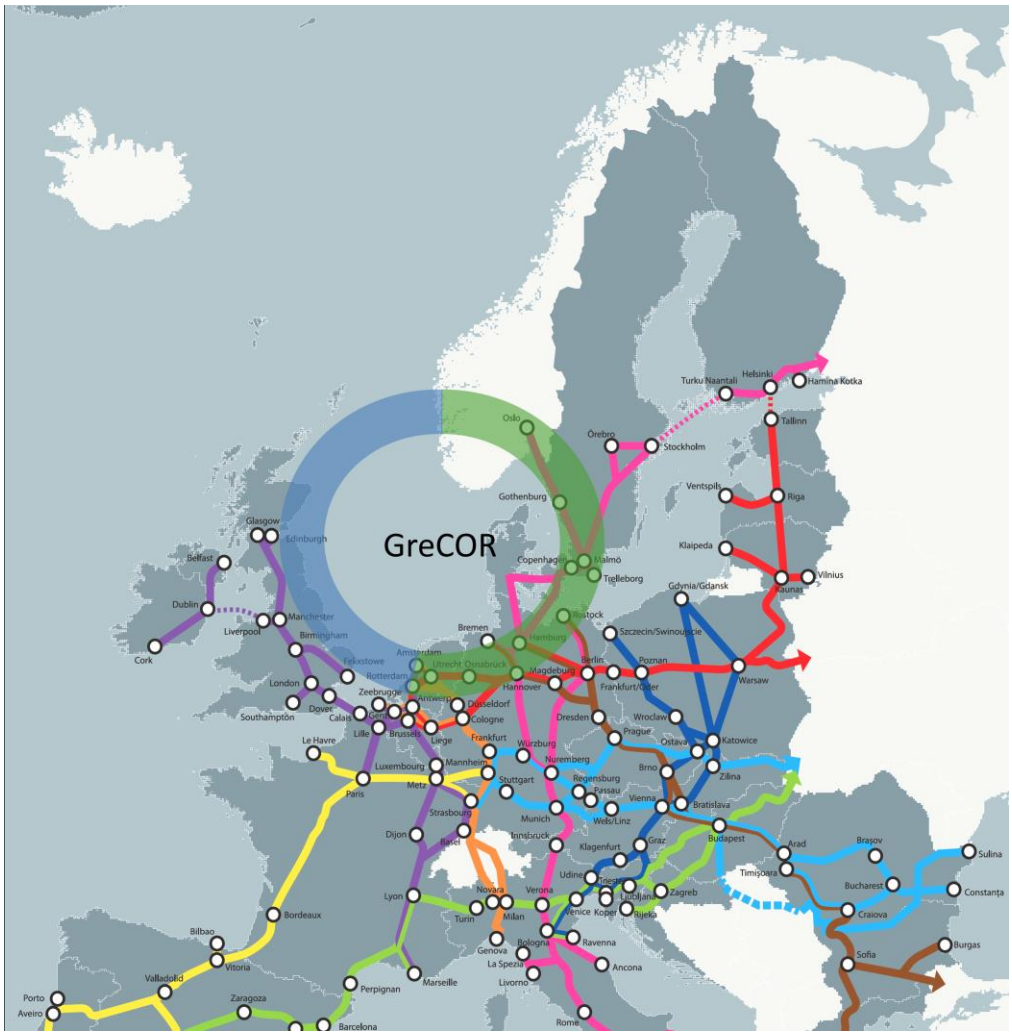


Figure 9. GreCOR in context to TEN-T core corridors.

All transport modes have different competitive and comparative advantages where they both need to compete and cooperate to achieve suitable and sustainable transport setups.

To visualize the prevailing conditions in the corridor a division has been made by transport mode. For planned measures se full report.

Railway Transport

The transport mode with most barriers regarding international traffic is the railway as a consequence of a globalized market and different standards hindering movement, EU now strives for a harmonization of rules and regulations to facilitate efficient cross-border transportation. One example of EU:s effort is a single European train control and communication system called ERTMS.

Only a few customers have real life experience of railway transports as the market shares for the transport mode are slim in comparison to other modes. Even though the market is now deregulated allowing any company to operate, there are still only a few companies to choose between. This can be compared to road haulers where there are several hundred companies to choose between.

Road Transport

Truck transport is a transport mode with high flexibility for small loads and is thereby a transport mode included in almost every supply chain offering door-door solutions.

Sea Transports

The North Sea is a busy place as far as shipping goes, with over a 1000 ships occupying these waters at any given time. Most of the traffic is concentrated to the area between the larger ports of Antwerp, Rotterdam and Hamburg,.

A clear trend of the shipping activities is the transition towards larger vessels when transporting goods over the sea. Economy of scale is certainly applicable as the new larger ships have less energy consumption per tonnage and are therefore more cost effective than their smaller counterparts.

Main outcome:

- The transport mode with most barriers regarding international traffic is the railway
- A single European train control and communication system called ERTMS will be implemented within EU to facilitate cross-border transports for railway.
- Few companies offer railway transport solutions, compared to several hundred road hauler companies.
- Truck transport is a transport mode with high flexibility and is thereby a transport mode included in almost every supply chain offering door-door solutions.
- The majority of the ports have several planned measures for improving the hinterland infrastructure connections.

Action plan for the development of the green corridor GreCOR.

Apart from investments in infrastructure in the corridor, a large number of measures can be undertaken to develop the green corridor. To be able to identify suitable measures it is of importance to keep in mind those characteristics of green corridors that was proposed by the EU commission. The Swedish Transport Administration initiated the work to form an action plan for the development of the green corridor and to suggest interesting projects/initiatives to develop the corridor further.

Since the definition of green corridors was proposed by the European Commission, a number of efforts have been made to develop the concept of green corridors further. One such attempt has been made in the Macroregional Transport Action Plan[2] that was developed as part of the Trans Baltic project. In the plan it is proposed that the concept of green corridors and their development should take into account the:

- Need to be attractive to transport buyers and provide better operational conditions than "normal" freight transports
- Necessitates the development of "soft issues", like rules and regulations, in addition to overcoming "hard obstacles", e.g. infrastructure.
- Requires a government structure to coordinate all parts of the corridor and push for the development of the corridor

Measures to solve existing problems in the corridor

In order to create an action plan, numerous measures, that have the potential to contribute to the development of the corridor in alignment with the characteristics presented above, were identified. As the overall performance of the corridor is depended both on the efficiency in which operations are carried out in individual links or nodes and how well they work together, the aim and scope of the identified measures varies. The identified measures have been divided into four main categories based on what part of the corridor that they target. The four categories are visualised in the figure below.

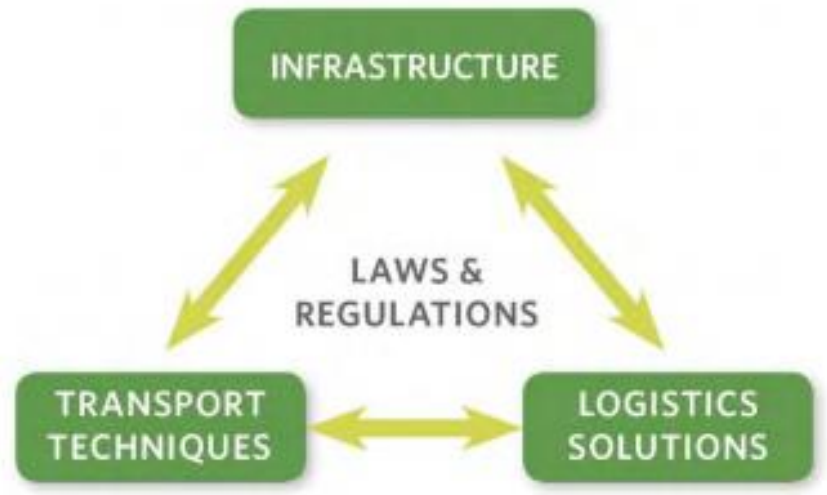


Figure 10 Categories of measures

[2] http://www.ipprvs.org/wp-content/uploads/2012/09/TransBaltic-MTAP-2012-edition-5.09.pdf

- The corridor networks (**Infrastructure**) – Measures within this category are to promote collaboration between transport modes and/or the optimal use of respective transport modes (including the hubs).
- **Transport techniques** – Measures within this category are focused on the features and properties of equipment used in transport operation, e.g. trucks, port handling and cranes.
- Transport/**Logistics solutions** (business models) – The measures that belong to this category focuses on the integration/collaboration of different partners and stakeholders in the corridor to optimize "green" business performance.
- **Policy and regulations** – Measures that fit into this category are focused on how regulatory bodies/policy makers can contribute to the development of a green transport corridor.

A total of 23 measures were presented within the categorisation above. All measures are evaluated by four aspects: WHY – explains why the measure is of interest for the corridor development, IMPACT – expected effects of the implementation of the measure, WHO – important stakeholders that need to get involved, CRITICAL FACTORS – obstacles that needs to be handled successfully & CATALYST – things that can facilitate the implementation. The expected effects of the implementation of the measures as well as important stakeholders, critical factors and catalysts were presented.

To get a better overview of the expected effects of the proposed measures, the measures were compiled in the following table.

Table 5. Collection of measures.

	Corridors					Transport tequniques				Transport/logistic solutions						Policy and regulation							
	Reduce the effect of disturbances in train traffic	Differentiation of freight rates to level demand	Green corridor trains	Increase through-put of terminals	Benchmarking of corridor nodes	New techniques to facilitate transfer of freight between transport modes	More efficient short-distance transports	Land-based power supply to vessels in ports	New techniques to make freight movements more energy efficient	Cooperation among transport buyers	Cooperation among transport operators	Freight brokers that work with all transport modes	Corridor logistics advisors	Educate transport-buyers to book transports earlier	Comparison of freight alternatives	Reduced required distance between trains	Rules and regulations to reduce emissions	Certification/Rewarding mechanisms	Flexibility of processes that regulates rail transports	Harmonization of rules and regulations	Measure the transport development	Adjust costs to promote environmental friendly transports	Alternative vehicle configurations for road transports
Market offer	X	X	X	X	X	X	X		X	X	X	X	X		X	X	X	X	X	X	X	X	
Efficiency	X	X		X	X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Reliability	X										X									X	X		
Energy & emissions			X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

In the table it is highlighted in which of the four areas below their implementation can be expected to have an effect: MARKET OFFER – The transport market in the corridor, e.g. effects on transport prices and/or the attractiveness of a particular transport mode when compared with other. EFFICIENCY – The utilization of the transportation network, for example effects on the capacity of the system. RELIABILITY – Minimize disturbances in the transportation network. ENERGY & EMISSIONS – Reduce the impact that freight movements in the corridor have on the environment

To successfully create a corridor management structure a number of considerations need to be taken into account[3]. Power, resources and accountability need to go hand in hand in the corridor. This means that those who have the power to decide what actions should be undertaken in the corridor should also have the resources to carry them out and the responsibility for the outcomes. Additionally, coordination is vital in corridors. Stakeholders and actions need to be well coordinated to achieve positive development. Apart from coordinating interested stakeholders and actions, it is also important to make sure that all essential parties in the corridor get involved. A significant part of successful corridor management is strong leadership, i.e. clear visions, action plans and coordination. It is also important to achieve lasting procedural changes in the corridor to become successful. A tool to make sure that visions are shared, action plans fulfilled and coordination achieved in a corridor is the use of formalized agreements. Additionally, communication at all levels, involving all actors in the corridors is a key factor for success. To achieve development in a transport corridor, it is advised that a bottom-up approach is applied. Thus, one shall look at the resources that are available in the corridor and based on that form goals to reach.

Main outcome:

- The concept of green corridors and their development should take into account the Need to be attractive to transport, Necessitates to develop soft issues & hard issues, government structure to coordinate all parts
- 23 measures presented within the four categorizations: Infrastructure, Transport techniques, Logistics solutions & Policy and regulations.
- A significant part of successful corridor management is strong leadership, i.e. clear visions, action plans and coordination.

3 See the material of Maria Öberg presented at one of the Bothnian Green meetings at http://www.bothniangreen.se/wp-content/uploads/2012/10/120912-13-WP6-partnermeeting-pori.pdf

Interview survey to identify needs and ideas for improved transport efficiency and decreased environmental footprint

During the project period, a number of interviews were performed. Volvo interviewed a number of transport companies in Norway, Sweden and Denmark to better understand their business reality. It is vital to understand the methods which are required in order to facilitate the usage of sustainable transport solutions.

The main focus is on efficiency, or more often on factors that can cause inefficiency. A general assumption is that more effective operation will also benefit the environment, as the number of transports and the total fuel consumption will be reduced, but this does not always have to be the case. More effective transports will also be more attractive as the cost for them can be reduced. This could lead to an increased number of transports, that in worst case may spoil the effect of the energy saving.

The companies were in general positive towards discussing environmental issues, even though they made clear that they are operating in a competitive business environment with a high focus on costs. They had opinions and ideas and many had tried green solutions, like vehicles using alternative fuels, in their operation. Some persons also displayed a clear personal engagement in environmental issues.

As the concept of a green corridor is not very precise, most of the discussions and the ideas that came up are not linked to the corridor concept, but are more general about efficiency and reduced environmental impact.

Work Approach

Five logistics providers along the Oslo-Randstad corridor were chosen for the interviews. They represented different countries along the corridor and was specialized in different types of Cargo.

The interviews were held on site at the different organisations. This allowed for personal meetings and a chance to get the different facilities and operations presented. Each interview lasted typically for about two hours.

Figure 11. Illustration by Claes Pihl, Volvo

To structure the discussions, a model that breaks down transport efficiency into different sub-types was used. The sub-types were performed by: driver-, vehicle-, ITS and route-, utilization-, package-, mode-, regulatory and incentive- efficiency.

Summary of interviews

- General impression from the business is that environmental concern is an important matter for them. Tough competition and heavy cost focus is however a factor that prevent actors to try new solutions
- Fuel represent 30 % of the total transport cost. It is therefore of great interest for the companies to work with this subject. Most of the companies have work with Eco driving, but not in a structured way. A general issue is to measure the effectiveness.
- Some companies were willing to try out vehicles with alternative fuel, even if they couldn't motivate it from a strict business perspective. The infrastructure i.e. access to fuel station was considered to be the main issue.
- Intelligent transport system (ITS) has become an important part of the daily operation for transport companies. In general does the road haulier has access to good internal communication and information. The communication ways and system against the subcontractor leaved however room for improvement.
- The utilization of the vehicles might be improved by better planning and coordination between actors. The companies are negative to all kind of restrictions against empty or partly empty transports. They refer to the fact that it is already today is in their interest to keep the empty transport to a minimum.

Main outcome:

- Companies in general interesting in discussing environment issues
- Eco driving important since fuel cost represents 30% of the total transport cost.
- Hard to motivate environmental investment from a strict business perspective
- Lack of infrastructure for alternative fuels
- Lack of ITS system between logistics actors
- Companies are negative to restrictions against empty transports

Green Corridor Benchmarking

Development of a general method for how to measure the environmental consequences of the operations in the green corridor including the logistic hubs

Background

Comparing the performance in a corridor to evaluate the development is one of the ambitions within the GreCOR project. The work is a continuation of the finalized work within the project Supergreen where one of the areas investigated relevant parameters (KPIs) like energy consumption and emissions, operational aspects and SCM issues, external costs (including social and spatial planning aspects), infrastructure costs and internal costs: identification of areas and candidates for improvement (i.e. bottlenecks).

Previous projects have made an effort to establish Key Performance indicators (KPIs) but in practice the established KPIs diverge depending on the project objective. One of the conclusions from the Supergreen project was that: KPIs should be selected by the corridor management on the basis of the objectives being pursued. The measures developed for Supergreen are:

- Out-of-pocket costs, measured in €/tonne-km;
- Transport time, measured in hours (or average speed, measured in km/h, depending on the application);
- Reliability of service (in terms of timely deliveries), measured in percentage of consignments delivered within a pre-defined acceptable time window;
- Frequency of service, measured in number of services per year;
- CO2 emissions, measured in g/tonne-km; and
- SOx emissions, measured in g/tonne-km.

No specific operational KPIs were established within the GreCOR project as the overall objective is to: *"promote the development of a co-modal transport corridor in the North Sea Region.*

Important in this collaborative approach, is the focus on secondary networks and the hubs, and the regional hinterland around the Green transport corridor Oslo-Randstad from a co-modal perspective."

Methodology

The method developed within the GreCOR project is a variation of the methodology proposed by the SuperGreen project for green corridor applications and is divided into four steps. It is important to identify the specific conditions of the evaluated corridor.

- **Step 1:** Disintegrate the corridor into transport chains.
- **Step 2:** Select a representative set of typical transport chains (through the transport market study).
- **Step 3:** Estimate KPI values for each and every chain selected in Step2.
- **Step 4:** Aggregate these values into corridor level KPIs by using weights and methods specified in the transport market study.

Applying the Methodology

The GreCOR application abovee, which happens to be the first implementation attempt of the method after taking its final form described above, deviates from SuperGreen with regard to the main source of information. While SuperGreen suggests a 'study-based' approach using the Transport Market Studies of the TEN-T Core Network Corridors and/or the corresponding Rail Freight Corridors for constructing the corridor sample, timing constraints forced GreCOR to rely on a 'model-based' approach using the Danish National Traffic Model (LTM) as the principal source of information for both sample construction and KPI estimation.

After limiting the scope of the analysis to the Oslo-Randstad segment of the corridor, imposed by the use of LTM, the transport networks of GreCOR were viewed in conjunction with the TEN-T ScanMed and North Sea – Baltic core network corridors and its catchment area was defined.

The chain-matrix results of LTM for Year 2010, consisting of 2.9 million entries, was reduced to a database of 37,446 international chains originating and ending within the GreCOR catchment area. A total of 156 chains formed the corridor sample. The annual tonnes and tonne*km (tkm) of these chains, which are used as weights in KPI aggregation, were adjusted to reflect also chain types not included in the sample.

A corridor index involving a normalization procedure through setting the corridor-level values of each KPI to 100.0 was developed, allowing temporal and modal comparisons for a specific commodity or group of commodities. The corridor indexes by commodity group and chain type were produced.

Table 6. Methodology used on the GreCOR area showing modal indexes.

Mode	KPI Indexes				
	COST	SPEED	FREQ.	CO_2-eq	SOx
Road	344,6	217,5	23,3	113,9	80,4
Rail	79,0	154,4	14,0	69,5	50,1
Shipping	42,6	50,8	133,7	65,9	92,8
Ro-Ro shipping	158,1	233,9	14,4	540,2	284,9
Grand total	100,0	100,0	100,0	100,0	100,0

The structure of the index permits comparisons between 1-leg and 3-leg arrangements or between containerships and conventional ships. The basic conclusion is that the methodology described in this report can effectively assess the performance of a freight transport corridor. It can be further improved by:

The basic conclusion is that the methodology described in this report can effectively assess the performance of a freight transport corridor. It can be further improved by:

- Excluding from the sample atypical chains identified during the analysis;
- Revising the sample with the aim of merging commodity groups that use the same type of vehicles and have similar characteristics in terms of the KPIs examined;
- Revising the sample with the aim of excluding chains that do not affect the corridor indexes (when expressed as one decimal point numbers);
- Dropping the frequency indicator from the analysis, which is meaningful only for scheduled services; and
- Calculating corridor indexes excluding shipping (Ro-Ro ships should not be excluded as they serve road transportation).

However, a major improvement would result from estimating chain-level KPIs through raw data obtained from specialised studies covering specific routes or directly from the stakeholders (shippers, freight forwarders and transport service providers) who use the relevant chains. It is believed that combining the 'model-based' approach for the sample construction with the 'study-approach' for the estimation of chain-level indicators takes advantage of the strengths of each method and avoids their weaknesses.

Main outcome:

- KPIs should be selected by the corridor management on the basis of the objectives being pursued.
- Lack of standardisation both in terms of process and KPI estimation
- Data collection proves to be a serious problem
- Thin samples render any statistical analysis meaningless
- The method permits monitoring of the performance of a single corridor over time. It is not suitable for comparisons between corridors.

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