SEVENTH FRAMEWORK PROGRAMME

THEME [7]

Theme Title: Transport (including Aeronautics)

SuperGreen

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Benchmarking of Green Corridors

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0 Executive Summary

This document is the second and final Deliverable D2.4 of the SuperGreen project which aims at reporting on the final results of the task and describes in detail steps taken in the benchmarking exercise.

Task 2.4 has two main purposes - to describe the corridors in detail, mainly on the basis of the information from the corridor selection task (Task 2.1), and to evaluate either in a quantitative or qualitative manner the KPIs which were defined in Task 2.2. Due to the fact that Task 2.2 delivered only an initial methodology for benchmarking the green corridors and the Key Performance Indicators (the KPIs), an update and adjustment of both the KPIs and the methodology was carried out under Task 2.4.

In order to finalise the methodology and the KPIs for benchmarking the SuperGreen corridors, consultations were carried out with stakeholders and members of the Advisory Committee. In total four SuperGreen regional workshops were organised to involve stakeholders – in Nola/Naples, Italy on 19 October 2010, Antwerp, Belgium on 1 February 2011, Malmö, Sweden on 10 March 2011 and Sines, Portugal on 24 March 2011. In addition, the recommendations from the European Commission and the review team of the project (submitted on March 7, 2011) have been taken into account in the finalisation of the benchmarking task.

It is important to highlight that a distinction between transport operation related KPIs and infrastructure investment related KPIs was kept in mind when filtering the KPIs. For the purposes of the benchmarking exercise under this Task the KPIs related to transport operations were used. However, the KPIs can indirectly also be used for measuring infrastructural improvements, e.g. the effects of improvement of infrastructure or elimination of bottlenecks in terms of cost, emissions, speed and reliability. The final set of the KPIs used for benchmarking is presented in the table below:

Indicator	Unit
CO2 emissions	g/ton-km
SOx emissions	g/1000 ton-km
Relative transport cost	€/ton-km
Transport time, expressed in an average speed of the transport chain	km/h
Frequency, services per year	number
Reliability, on time deliveries	%

The final benchmarking methodology includes the following modifications to the previously reported methodology:

- The benchmarking exercise targeted the collection of data and set benchmarks for six corridors - Brenner, Cloverleaf, Nureyev, Strauss, Mare Nostrum and Silk Way.

- The aggregation of transport chain level KPIs to a single corridor level KPI set was not further pursued basically due to the low statistical value of the resulting figures.
- Due to the fact that the aggregation to an ultimate corridor KPI set was excluded from the exercise, the number of transport chains was reduced.
- Benchmarks for corridors were expressed as ranges of values based on the collected transport chain data, i.e. minimum and maximum values of all transport chain level KPIs were used as corridor level KPIs.
- The NP Should Cost calculator was not further pursued as it provides cost estimates, not real market prices. Instead, the data on real cost to shipper was found out during the interviews or based on the literature review.

For each benchmarked corridor, results were summarised and reported in the following areas:

- General description of the corridor and companies interviewed
- Description of the critical segment
- KPI evaluation results at a transport chain level and benchmarks for the corridor
- Description of identified bottlenecks
- Analysis of the results
- Connection to other work packages
- Other corridor related projects and studies

The table below presents a summary of the benchmarks for the six SuperGreen corridors by making a distinction between different modes of transport.

Corridor name	Mode of transport	CO2 (g/tkm)	SOx (g/tkm)	Cost (€/tkm)	Average speed (km/h)	Reliability %	Frequency x times/year
Brenner	*Intermodal*	10.62-42.11	0.020-0.140	0.03-0.09	9-41	95-99	26-624
	Road	46.51-71.86	0.050-0.080	0.05-0.06	19-40	25-99	52-2600
	Rail	9.49-17.61	0.040-0.090	0.05-0.80	44-98	60-95	208-572
	SSS	16.99	0.050-0.120	0.04-0.05	23	100	52-520
Cloverleaf	*Road*	68.81	0.091	0.06	40-60	80-90	4680
	Rail	13.14-18.46	0.014-0.021	0.05-0.09	45-65	90-98	156-364
Nureyev	*Intermodal*	13.43-33.36	0.030-0.150	0.10-0.18	13-42	80-90	156-360
	SSS	5.65-15.60	0.070-0.140	0.05-0.06	15-28	90-99	52-360
Strauss	*IWT*	9.86-22.80	0.013-0.031	0.02-0.44	-	-	-
Mare Nostrum	*SSS*	6.44-27.26	0.092-0.400	0.003-0.200	17	90-95	52-416
	DSS	15.22	0.22	-	-	-	-
Silk Way	*Rail*	41.00	-	0.05	26	-	-
	DSS	12.50	-	0.004	20-23	-	-

An important note has to be made that the results presented in the table above are indicative and using other tools and methods may lead to different results. Results presented here are achieved using EcoTransIT World web emission calculator, self-reported figures from interviewees and literature review.

The report contains a chapter on the consultation process with stakeholders and summaries of each SuperGreen regional workshop have been included. Every workshop had a unique value to the project as the final benchmarking methodology was developed and the filtering of the KPIs was carried out with the help of workshop participants. Moreover, the final benchmarking results were presented during the last regional workshop in Sines where they were accepted by the audience.

During this task it became evident that there is a lack of data and reliable and widely accepted tools to make a proper benchmarking exercise. Certainly this observation will be useful for at least Work Packages 5 and 6, dealing with future R&D and policy recommendations respectively (a better data collection system is clearly needed).

This report will serve as a direct input for the upcoming Task 2.5 which will define the areas for improvement, as well as for Tasks 3.3, 4.2 and 4.3 which will apply identified green technologies and ICT solutions to the corridors and measure their greening effect via re-benchmarking.

1 Introduction - Purpose of this document

Task 2.4 kicked-off on 15 September 2010 as planned and was concluded by 15 April 2011 (seven months). Task 2.4 had two main objectives. The first objective was to describe the current state of and future opportunities for the selected corridors based on the information provided by earlier tasks, mainly Task 2.1. The second objective was to benchmark the corridors using the methodology and the KPIs developed under Task 2.2 and taking into account feedback from stakeholders, members of the Advisory Committee and the modifications that are incorporated in Task 2.4 deliverables. Four regional workshops were envisaged in order to discuss the outcome of the benchmarking exercise with the stakeholders.

Task 2.4 dealt with the corridors which were selected in Task 2.1 by applying several criteria, e.g. transport volumes, average length of transport chains, existing transport infrastructure, types of transported goods, multimodality, effects on the environment, human settlement and land use planning, geographical preconditions, used transport and information technology, etc. During the selection process an effort was made to ensure a geographical balance between the corridors. The list of the nine selected corridors is presented in Table 1 (see deliverable D2.1 for more details). The 'metro' style SuperGreen network map can be found in Figure 1.

ACRONYM	BRIEF DESCRIPTION- BRANCHES	NICKNAME	EXPLANATION
BerPal	Malmö-Trelleborg-Rostock/Sassnitz- Berlin-Munich-Salzburg-Verona-Bologna-Naples-Messina-Palermo Branch A: Salzburg-Villach-Trieste (Tauern axis) Branch B: Bologna-Ancona/Bari/Brindisi-Igoumenitsa/Patras-Athens	**Brenner**	The Alpine pass that is the key of this corridor
MadPar	Madrid-Gijon-Saint Nazaire-Paris Branch A: Madrid-Lisboa	**Finis Terrae**	point of Europe (in Galicia)
CorMun	Cork-Dublin-Belfast-Stranraer Branch A: Munich-Friedewald-Nuneaton Branch B: West Coast Main line	**Cloverleaf**	Green Grass that is a Symbol of Ireland
HelGen	Helsinki-Turku-Stockholm-Oslo-Göteborg-Malmö-Copenhagen (Nordic triangle including the Oresund fixed link)- Fehmarnbelt - Milan - Genoa	**Edelweiss**	(also the shape of this Corridor)
RotMos	Motorway of Baltic sea Branch: St. Petersburg-Moscow-Minsk-Klapeida	**Nureyeev**	The top Russian Ballet Dancer of the
RhiDan	Rhine/Meuse-Main-Danube inland waterway axis Branch A: Betuwe line Branch B: Frankfurt-Paris	**Strauss**	Music Composer of the famous Blue Danube
AthDre	Igoumenitsa/Patras-Athens-Sofia-Budapest-Vienna- Prague-Nurnberg/Dresden-Hamburg	**Two Seas**	the Mediterranean Seas
SinOde	Odessa-Constanta-Bourgas-Istanbul-Piraeus-Gioia Tauro-Cagliari-La Spezia-Marseille-Barcelona-Valencia-Sines Branch A: Algeciras-Valencia-Barcelona-Marseille-Lyon Branch B: Piraeus-Trieste	**Mare Nostrum**	Latin for Mediterranean Sea
CNHam	Shanghai-Le Havre/Rotterdam-Hamburg/Göteborg-Gdansk-Baltic ports-Russia Branch:Xiangtang-Beijing-Mongolia-Russia-Belarus-Poland-Hamburg	**Silk Way**	The classical name for the road to China

Table 1 – Selected corridors

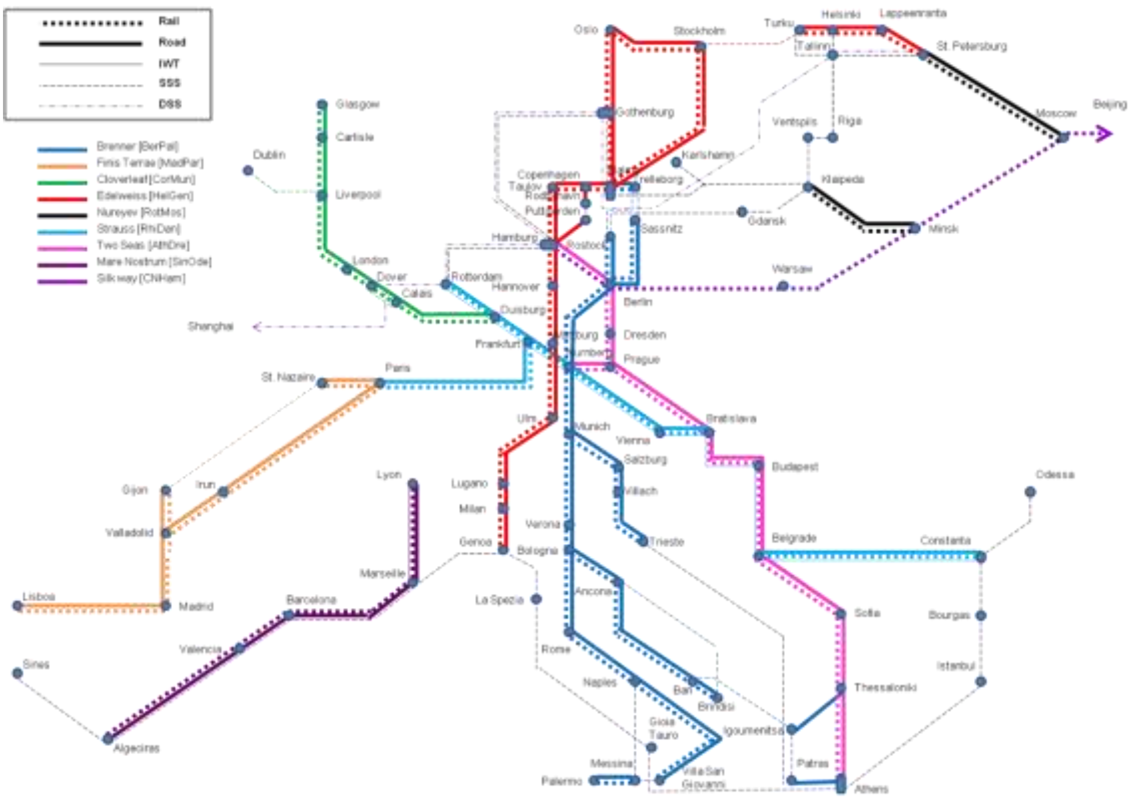

Figure 1 - SuperGreen network map

According to the Description of Works six partners are involved in Task 2.4: Procter and Gamble (PG) as the task leader, Norsk Marinteknisk Forskningsinstitutt (MAR), Sito Ltd. (SITO), Det norske Veritas (DNV), D'Appolonia (DAPP), and NewRail - Newcastle University (UNEW).

Task 2.4 has two deliverables; version 1 thereof has been submitted to the European Commission on 15 December 2010. This document is version 2 and concludes the work of the benchmarking task.

Deliverable 2.4-1 consisted of a detailed analysis of the feedback received from the stakeholders during the first regional workshop and presented possible changes to the KPI structure that had been proposed in Task 2.2. Also, a detailed description of the selected corridors was carried out. Simplified maps ('metro' maps) using different colours for different corridors and different type and weight of lines for different modes of transport was developed. The most important nodes in the SuperGreen corridors were selected and possible transport links between these nodes identified. This was done by using a matrix system and, based on elaborated matrices; corridor and network maps were created. These maps were used for the further benchmarking exercise and the description of the corridors was thus considered completed.

The current report, Deliverable 2.4-2, aims at reporting on the process and results of the benchmarking exercise and describes the modifications made to the benchmarking methodology and the KPI structure both of which have been evolving over the consultation process with stakeholders at the SuperGreen regional workshops.

The benchmarking methodology that was developed in Task 2.2 and further modified at the beginning of Task 2.4 has become highly complex and requires more time and effort than was foreseen in the project description. Therefore, the consortium has decided to reduce the number of corridors to be benchmarked from nine to six, which is still compatible to what is stipulated in the DoW. Also, as a further filtering of the KPIs has been recommended by a number of stakeholders and members of the Advisory Committee, the possibilities for filtering and/or categorisation of the KPIs were sought during the benchmarking study.

In order to test the general applicability of the developed benchmarking methodology and the selected KPIs, the Brenner corridor was tested as a pilot case. After the analysis of the results of the Brenner benchmarking exercise, the final methodology was applied to the other corridors.

The outcome of the benchmarking task will be the benchmarks for the six SuperGreen corridors. The stakeholders were regularly consulted on the benchmarking process and the summaries of the workshops organised are presented in this deliverable.

As to the content of this report, Chapter 3 sets out the evolution of the benchmarking methodology and describes the final methodology and the KPIs that were used for setting the benchmarks for the corridors. The final results of the benchmarking of the SuperGreen project are presented in Chapter 4. Chapter 5 gives an overview of the consultation process with the stakeholders and includes summaries of the SuperGreen regional workshops. The last chapter of the report describes further actions in the project related to this report.

The report is supported by four (4) appendices. Appendix I presents an overview of the internal KPI filtering results, Appendices II and III were used to support the reporting on benchmarking results of the Strauss and the Mare Nostrum corridors. A detailed input from interviewees for benchmarking corridors can be found in Appendix IV.

This document is a final report on Task 2.4 and concludes with the setting up of the benchmarks for the next benchmarking exercises in the project where several green technologies and ICT solutions will be tested.

2 Objectives

2.1 Objectives of the SuperGreen project

The Freight Transport Logistics Action Plan[1] published by the European Commission introduces a series of policy initiatives and a number of short to medium-term actions for improving the efficiency and sustainability of freight transport in Europe. One of these actions is to define “Green transport corridors for freight.” In this framework, the SuperGreen project, an acronym for the “Supporting EU’s Freight Transport Logistics Action Plan in Green Corridors Issues” project, was launched.

The general objective of the SuperGreen project is to support the development of sustainable transport networks by fulfilling requirements covering environmental, technical, economical, social and spatial planning aspects.

The SuperGreen project is a coordination action. It has sufficient “reach” in the wide area of freight logistics, and it will actively contribute by giving input to ongoing and new projects so that resources are used most beneficially. The SuperGreen project will:

- Give overall support and recommendations on Green Corridors to in the framework of EU’s Freight Transport Logistics Action Plan.
- Carry out a programme of networking activities between stakeholders (public and private) and ongoing EU and other research and development projects to facilitate information exchange, dissemination of research results, communication of best practices and technologies at a European, national, and regional scale, thus *adding value to ongoing programmes*.
- Provide a framework for overall benchmarking of Green Corridors based on selected KPIs, also including social and spatial planning aspects.
- Deliver a series of short and medium-term studies addressing topics that are of importance to the further development of Green Corridors.
- Make policy recommendations at a European level for further development of Green Corridors.
- Provide the Commission with recommendations concerning new calls for R&D proposals to support development of Green Corridors.

2.2 Objectives of Work Package 2 and Task 2.4

The objective of Work Package 2 (WP 2) is to determine major development needs and possibilities for the greening of transport chains in selected transport corridors. It also provides information on Key Performance Indicators (KPIs) suitable for assessing the economic efficiency, social acceptance and environmental sustainability of green corridors. The work is based on indicators developed for monitoring the sustainable development goals of the European Union. WP 2 will utilise the work done and on-going in the member states on supply chain accounting and reporting, as well as testing of sustainable development indicators for spatial and social planning. WP 2 will describe the current situation, sustainability, as well as future development aspects of transport corridors.

[1] Communication from the Commission: COM (2007) 607 final – “Freight Transport Logistics Action Plan”

The main method for collecting this information is through surveys, data from existing materials, and well-structured workshops having clear objectives. This work package provides basic information for subsequent work packages.

This work package is expected to produce the following information:

- General description of the EU's potential Green Corridors: preliminary definition, describing and grouping the most relevant corridors according to transport volumes, transport modes, infrastructure and average length of transport chains.
- Selection of most important corridors among those defined as part of the TEN-T, given prioritised criteria, for further information acquisition.
- Definition and grouping of benchmark indicators (key performance indicators).
- Clarification of general and specific corridor changes in operational and regulatory environment that may hinder or promote green logistics improvements in the selected corridors.
- Description of the state of selected corridors from the point of view of greening using defined indicators.
- Description of future aspects of the corridors.
- Grouping and assessing the corridors using the benchmark indicators.
- Description of major bottlenecks hindering the greening of transport chains in the selected corridors.
- Description of the most effective areas for improving sustainability of transport chains in the selected corridors.
- Definition of common development aspects for all transport corridors.

Task 2.4 has two main objectives - to describe the corridors in detail, mainly based on the information from the corridor selection task (Task 2.1) and to evaluate either in a quantitative or qualitative manner the KPIs which were defined in Task 2.2. The objectives will be presented as two separate deliverables. Outcomes of the research will be subject to consultation with stakeholders and corridor specific workshops will be organised for this purpose. The primary objective of the task is to get an overall understanding of the differences between and common factors of the selected corridors concerning different aspects of the greening of transport chains.

In order to carry out a successful benchmarking of the green corridors, input from Tasks 2.1 and 2.2 was needed. Figure 2 illustrates the input-output of the task.

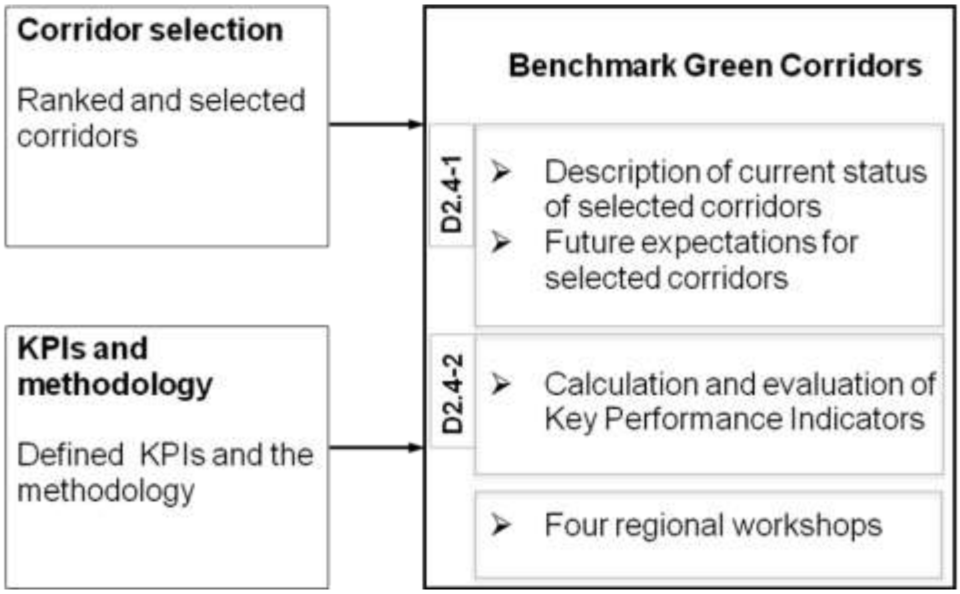

Figure 2 - Input-output of Task 2.4

By the beginning of the benchmarking task, the corridor selection had been successfully carried out and nine (9) corridors had been selected on the basis of multi-criteria ranking (please see Table 1) and consultations with stakeholders (corridor selection workshop in Helsinki, 28 June 2010). Based on the selected corridors and the information gathered, a detailed description of the current status of the selected corridors, as well as greening opportunities related to the corridors, was given in Deliverable 2.4 version 1.

Task 2.2 concluded that the developed KPIs and the methodology for benchmarking would be subject to amendment in later stages of the project as forthcoming activities in other parts of the project may feed back into them. Among such activities could be the regional workshops and, more generally, Task 2.4 of the project that deals with the benchmarking of the selected corridors. Feedback about the KPIs from the Advisory Committee members and stakeholders was thus expected over the duration of the task.

Due to limited resources for research in WP2, much of which was spent defining and adjusting the KPIs and related methodology, the project partners decided to target the data collection on six corridors. Benchmarks would be used further in the project to evaluate greening effects and applicability of identified green technologies (WP3) and ICT solutions (WP4).

To that effect, a reduced (vis-à-vis the 9 corridors selected in Task 2.1) number of corridors for testing the KPIs is needed to ensure better data acquisition and more effective resource utilisation. The corridors to be used for testing the KPIs must be selected by ensuring a modal and geographical balance as much as possible. The benchmarking exercise has to be carried out taking into account a revised methodology in Deliverable 2.4 version 1 and updating it based on the feedback and recommendations received from stakeholders via regional workshops (summaries and outcomes of the regional workshops will be presented in Chapter 5 of this report). Moreover, the final methodology will be in line with the ultimate goal of the Commission as this was clarified during the Year 1 review of the project, that is to use the concept of the green corridor for evaluating future TEN-T and Marco Polo projects.

3 Benchmarking methodology and KPIs

3.1 Introduction and background

The initial benchmarking methodology and the KPIs were developed in Task 2.2. As stated in the conclusions of the task deliverable the methodology for Task 2.4 is a follow-up of Task 2.2 and should consider the following actions:

1. Analysis of the corridors selected in Task 2.1 in terms of freight transport flows:
   - origin/destination
   - types of cargoes moved
   - modes used
   - routes taken
   - trade imbalances (empties), etc.

2. Selection of four to five typical cargoes being transported along the axis. Part load break bulk should be one of them due to the special logistics requirements imposed by this type of cargo. Dry bulk and liquid bulk commodities should most probably be also selected due to their high volume and different supply chain organization. Identification of a typical combination of modes/routes used for each selected cargo. Identification of other useful details such as types of vehicles used, technologies applied, etc.

3. Locating proper sources of data for estimating the defined KPIs.

4. Estimation of one set of KPIs for each selected case.

5. Identification of obstacles in the KPI estimation.

6. Suggestions for transforming the KPI values estimated at a route level into a single set of KPI values at a corridor level.

7. Suggestions for expressing the set of KPI values at a corridor level with a single numerical value, the ultimate corridor KPI.

8. Carrying out a comparative analysis of the nine SuperGreen corridors and drawing conclusions on benchmarking exercise for the further developing of the “green corridor” concept. This is essentially the objective of Task 2.5 but is included here for the sake of completeness.

Even though Deliverable 2.2 completed the task, it was clear that additional work was needed in order to complete the methodology and the final set of KPIs, including:

- Further elaboration of the KPIs in order to take into consideration the feedback from stakeholders and members of the project’s Advisory Committee.

- Further elaboration of the KPIs in order to take into consideration the input from other SuperGreen tasks.

- Full assessment of available tools for calculating costs and emissions.
- Developing a method for transforming the route-related KPIs into a set of corridor-specific KPIs.

After the submission of Deliverable 2.2 further steps were taken in order to have a set of operational KPIs and a methodology that could be used for the benchmarking exercise. A project's Advisory Committee meeting and the first regional SuperGreen workshop in October 2010 were dedicated to these issues. The outcome of the consultation process is reflected in Deliverable 2.4 version 1 that outlines a guideline to support the benchmarking exercise and describes a work that needs to be done in relation to the interviews to be carried out for collecting necessary information for the KPI estimation. The same deliverable gives recommendations in two sections – general approach and detailed actions.

General approach

Despite some gaps in Task 2.2 an effort has been made to make the KPIs operational and apply the methodology that had been developed for the corridor benchmarking.

In order to proceed with the benchmarking task and deliver Task 2.4 successfully on time, a detailed action plan was discussed at the Project Management Meeting (PMC) in Nola on 20 October 2010 where the following decisions were made:

- The remaining gaps in the benchmarking methodology and KPI calculations were to be covered by Task 2.4 partners during the benchmarking exercise itself based on whatever data they were able to find. It was recognised that this could create a comparability problem later on but this was something that had to be accepted.
- As regards data, partners were to use existing information, including studies and reports to the extent possible. A method for covering the data gaps was to be interviews with stakeholders. A questionnaire was prepared for this purpose by PG. Even then, for some indicators which can be different in each corridor, the partners were to improvise.
- The partners were to take full advantage of the contacts made during SuperGreen workshops and other events which the partners had attended. All relevant contact details were sent out to each partner.
- Macro level KPIs that had been calculated in the course of Task 2.1 were not to be examined again. A fine-tuning was necessary to cope with the changes in the description of the corridors.
- As for the tools used, the partners decided that the best alternative was to go with EcoTransIT and NP Should Cost calculator. The "Extended" mode of EcoTransIT was to be used, to the extent possible. In their data search and interviews the partners were to find out transport cost estimates. Knowing a priori that this could comprise sensitive information, expectations on this job were set realistically low.

Detailed actions

After the PMC meeting in Nola, the following guideline of six steps was developed and supported the work that needed to be done in relation to the interviews aiming at collecting the necessary information for the KPI estimation. It did not concern the work that needed to be done prior to the interviews (search for studies/reports dealing with the corridor under examination, solicitation of information from other “green corridor” projects, exploitation of contacts made during the SuperGreen workshops and other events that the members of the consortium had attended). Nor did it cover the work that needed to be done after the interviews (calculation of the KPIs at the corridor level and reporting).

The steps were as follows:

Step 1: Identification of a critical corridor segment

The first step in analysing a corridor was the identification of a “critical” segment of it, i.e. a segment that involves a major link of the corridor that cannot be bypassed. Examples are the Brenner passage of the Brenner corridor (link between Munich and Verona), the channel crossing of the Cloverleaf corridor (link between Calais and Dover) or the Pyrenees crossing of the Finis Terrae corridor (link between Valladolid and Irun). The critical segment was determined by the interviewer although the interviewee could help as well.

Step 2: Cargo flows along the critical segment

The step involved the identification of cargo flows (freight volumes and type of goods) along the critical segment. Partners had to look into existing studies or other sources of statistics for this type of information. It was very probable that special studies providing this type of information were expected to exist.

In parallel, an effort was to be made to locate this information from a central source (results of the TRANS TOOLS model). However, as the outcome of this effort was uncertain, partners were initially asked to rely on their own research.

Step 3: Selection of typical cargoes

Based on the flows identified under Step 2, partners were expected to select four to five typical cargoes being transported along the critical segment of the corridor. Part load break bulk was suggested to be one of them due to the special logistics requirements imposed by this type of cargo. Dry bulk and liquid bulk commodities were most probably also to be selected due to their high volume and different supply chain organization. As regards the selection, partners had to base their judgement on the relevant importance of each type of cargo and special requirements on the supply chain organisation and means of transport that each type of cargo imposes.

Unitised (containerised) cargoes were to be given emphasis due to the importance of co-modality for the SuperGreen project.

Step 4: Selection of typical transport chains

One to two typical transport chains were identified for each selected type of cargo. The origin/destination of the cargo could have been any pair of nodes belonging to the corridor. The routes/modes used should also have been among those defined for the corridor. This was where the analysis had to move from the critical segment to the corridor level. Partners had to pay attention to collectively cover all branches of the corridor and all modes involved. On the other hand, it was NOT necessary to cover all node pairs in the corridor matrix, as this would be intractable. Transport chains involving more than one mode were highly desirable. The knowledge and expert opinion of the interviewees was critical for the completion of this task.

Partners were to add to the list of typical transport chains the “best practice” cases identified in their literature survey, as well as those suggested by other “green corridor” projects (EWTC II, Scandria, TransBaltic, BatCo) which the partners had to contact for soliciting relevant information.

The output of Step 4 was meant to be a set of 10-15 transport chains that were to be analysed in terms of the selected set of KPIs in Step 6. For each chain, a Transport Chain Card had to be compiled.

It was recognised that the approach described above might have been difficult to follow in case of sea-based corridors. In these cases partners were to select the transport chains to be examined based on:

- typical cargoes using each port in the corridor (use of port statistics)
- existing connections between ports in the corridor
- relative importance of connections in terms of volumes of cargo
- connections to land-based corridor segments
- types of vessels used
- ‘best practice’ cases identified in literature
- cases suggested by other ‘green corridor’ projects.

Step 5: Description of vehicles used

The EcoTransIT model was used for calculating emissions. An effort was made to obtain the necessary license to use the “expert” version of the model. In the end we could only use the “extended” version that comes for free.

The information needed for the “extended” version of EcoTransIT for each vehicle appearing in the transport chain cards of Step 4 was included (by mode) on page 4 of the questionnaire.

Step 6: Evaluation of selected KPIs

Key performance indicators (KPIs) were to be evaluated by companies/organizations that had access to information regarding transport flows between different nodes in the pre-selected corridors. In order to carry out the survey, Task 2.4 partners had to identify two to three companies or organizations, among which can be 3PLs, Transport Service Providers, freight villages, shippers, etc. that operate in the relevant corridors.

Alternatively, the evaluation could have been done by the SuperGreen partner companies themselves, based on the existing studies and research.

The evaluation was carried out for each transport chain selected in Step 4 and results were transferred into a table format that can be found on pages 6-8 of the questionnaire.

The KPIs were measured in a quantitative way or, if this was not possible, in a qualitative way.

Before a KPI was expressed in a qualitative way, it was recommended to try to measure it in a quantitative way. Only if the latter was not possible the qualitative scale was to be used. A qualitative KPI had to be skipped if a quantitative was available. Qualitative KPIs were on a scale 1 (low) to 5 (high). If used, no attempt to quantify them was needed.

By the time the reporting period of this deliverable started and after the first round of consultation with stakeholders and the Advisory Committee members (October 2010), the number of the KPIs had not been reduced. The aggregation methodology for converting transport chain level KPIs into a single segment level KPIs was proposed and planned to be tested on the pilot corridor Brenner.

The benchmarking exercise on the Brenner corridor was completed by following the methodology described above. The transport chain level KPIs were presented for the first time during the second regional workshop in Antwerp (see Section 5.3 for the summary). It could be said that the most valuable feedback from stakeholders was that the applied methodology and evaluated KPIs were not sufficiently focused and therefore the whole benchmarking exercise was too complex and specific to be carried out successfully. This feedback was taken on board by the consortium and an additional internal review of the KPIs was carried out and validated with stakeholders during the next regional workshop in Malmö.

The following two sections will describe the process of internal review of the KPIs and the final methodology that was used for the benchmarking task.

3.2 Internal review of KPIs

The full list of KPIs identified for the SuperGreen project, together with their aim and data needs is described in Chapter 7 of Deliverable D2.2 (pp. 117-133). However, after consulting with stakeholders during workshops in Nola/Naples and Antwerp and the Advisory Committee members, the consortium made a decision to filter the KPIs and to categorise them in three groups. The filtering was carried out by all partners that were involved in the project as each partner was asked to express their opinion on each KPI as to whether:

- the KPI must be included in the study;
- the KPI could preferably be included in the study;
- or the KPI can be excluded from the study.

A detailed but provisional (up to Dec. 2010) description of the stakeholder consultation process was described in the first version of this deliverable (D2.4v1). While indicating their preferences, the partners had to consider the final objectives of the SuperGreen study.

The categorisation of the KPIs by the partners who participated in the filtering process can be found in Appendix I. After consolidating the results, the KPIs were categorised as follows:

KPI	Input unit	Output unit	Assessment
Efficiency			
Absolute costs	ton, €	€/ton	3 Can manage without
Relative costs	ton, €, km	€/ton-km	1 Must have
Service quality			
Transport time	hours	hours	1 Must have
Reliability	Total number of shipments, On-time deliveries	%	1 Must have
ICT appl.	Availability, integration & functionality of cargo tracking & other services	graded scale	2 Prefer to have
Frequency	Services per week	number	1 Must have
Cargo security	Total number of shipments, Security incidents	%	2 Prefer to have
Cargo safety	Total number of shipments, Cargo safety incidents	%	2 Prefer to have
Environmental sustainability			
CO_2 emissions	ton, km	g/ton-km	1 Must have
NO_X emissions	kg, km	g/1,000 ton-km	1 Must have
SO_X emissions	kg, km	g/1,000 ton-km	2 Prefer to have
PM emissions	kg, km	g/1,000 ton-km	2 Prefer to have
Infrastructural sufficiency			
Congestion	ton, km, Average delay	hours/ton-km	2 Prefer to have
Bottlenecks	number & category	graded scale	2 Prefer to have
Social			
Corridor land use	Share of distance per area type	percent	2 Prefer to have
Traffic safety	Traffic safety incidents	percent	2 Prefer to have
Noise	Share of distance above level	percent	2 Prefer to have

Table 2 - Internal filtering of the KPIs

The filtering process was carried out by 11 out of 22 partners (50%), plus the project manager Harilaos Psaraftis. As a simple majority of the consortium was represented in the filtering process, the outcome can be considered to express the general opinion of the consortium.

As the purpose of the filtering process was to narrow down the number of KPIs and target the collection of data on specific fields, it was decided to evaluate only the KPIs ranked as 'must be included' in the benchmarking study. The final set of KPIs and the methodology were presented during the third regional workshop in Malmö for approval by the stakeholders (please see Section 5.4 for a summary).

3.3 Recommended set of KPIs and final methodology used

3.3.1 Recommended set of KPIs

The filtered set of KPIs was presented during the workshop in Malmö for the approval of the 'must have' KPIs by the participants of the workshop. The list of KPIs was fully accepted and validated with the exception of replacing NOx with SOx. After this step the

SuperGreen project chose to include a set of transport operations related KPIs in the further study. The final set of recommended KPIs is presented in Table 25, page 82, with the summary of the workshop in Malmö.

It is important to note that the workshop where the decision was made was organised in collaboration with the Swedish national initiatives in the field of green corridors and most of the participants were directly or indirectly involved in green corridor projects. This gave additional value to the validation process of the KPIs and ensured that the outcome was in line with other initiatives on green corridors.

3.3.2 Methodology used for the benchmarking

The final updates in the methodology were presented for the first time during the regional workshop in Antwerp and thereafter during the next two regional workshops in Malmö and Sines where the updated methodology was widely accepted by stakeholders.

Thus taking into account the work done under the previous tasks of the project and the feedback from stakeholders, the Advisory Committee members, the European Commission and the project reviewers, the consortium agreed on the following amendments to the benchmarking methodology described in Section 3.1:

- The benchmarking exercise targeted the data collection and set benchmarks for six corridors - Brenner, Cloverleaf, Nureyev, Strauss, Mare Nostrum and Silk Way. Out of those six corridors, Silk Way was examined purely based on relevant literature and previous studies, while the others were based mainly on interviews with transport service providers, freight villages, shippers, etc. combined with the review of relevant literature. The filled questionnaires are collected in Appendix IV of this report.
- The aggregation of transport chain level KPIs to a single set of corridor level KPIs was not further pursued due to the low statistical value of the resulting figures, since they would have been based on a very thin sample of transport chains using the corridor. However and only for indicative reasons, the aggregation was tested on the Brenner corridor and the results are presented in Section 4.1.
- Due to the fact that the aggregation to an ultimate corridor KPI set was excluded from the exercise, the number of transport chains was reduced. Instead of a large volume of transport chain data, it was decided to focus on the quality of data.
- In order to take into account recommendations from the technical review of the project, as well as from various stakeholders and the Advisory Committee, as these were expressed in various workshops and other meetings through the end of Task 2.4, it was decided that the project would mainly focus on operational KPIs, that being completely in line with the approach taken in the methodology thus far.

  However, in case there should be a need for a set of infrastructural KPIs at a later stage of the project when testing green technologies (WP3) and ICT solutions (WP4), the consortium could decide to include it. Also, the topic may be addressed further in WP5 and/or WP6.

- Benchmarks for corridors were expressed as ranges of values based on the collected transport chain data, i.e. minimum and maximum values of all transport chain level KPIs were used as corridor level KPIs. All qualitative indicators (in case the quantitative indicator was not available) were converted into quantitative indicators based on the rating scale. In case the difference between minimal and maximal values of a KPI is too wide, additional information collection may be necessary, including detailed transport chain level analysis. This deliverable sets only benchmarks for the corridors and does not investigate extream values of individual benchmarks. The analysis of extreams may be a subject for the upcoming tasks in the project, if needed.
- The NP Should Cost calculator was not further pursued as it provides cost estimates, not real market prices. Instead, the data on real cost to shipper was found out during the interviews or based on the literature review. The benchmarking exercise was designed to analyse relative cost to the end user of transport (shipper), including such cost elements as transport service provider profit margin.

4 Benchmarking results

4.1 Introduction

This Chapter presents the results of benchmarking the six corridors (Brenner, Cloverleaf, Nureyev, Strauss, Mare Nostrum and Silk Way), using the recommended final set of KPIs and the methodology described in Chapter 3.

The report on each corridor includes the following sub-sections:

- General description of the corridor and companies interviewed
- Description of the critical segment
- Results of the evaluation of the KPIs at a transport chain level and benchmarks for the corridor
- Description of identified bottlenecks
- Analysis of the results
- Connection to other work packages
- Other corridor-related projects and studies
- Description of the attempted aggregate results.

The Brenner corridor was selected as a pilot corridor for testing the applicability of the methodology due to the reason that this corridor had been studied the most before. As a part of the benchmarking exercise an attempt was made to express the set of KPI values at a corridor segment level (see Section 3.1, point 7). The methodology for testing the aggregation was as follows:

- Each transport chain was to be decomposed to a set of segments. KPIs were to be calculated for each segment and of each transport chain.
- Transport chain KPIs were then to be aggregated to corridor level by calculating weighted averages of the transport chain KPIs for each segment of the corridor.
- Different weights were recommended to be used for different KPIs:
    - Relative costs: ton-km
    - All emissions: ton-km
    - Delivery time: average speed for the entire chain
    - Reliability: number of shipments
    - Frequency: number of shipments
    - Cargo safety: number of shipments
    - Cargo security: number of shipments
    - ICT applications: ton-km

  - Bottlenecks: rating
  - Congestion: not included to the weighting

The results of the aggregation exercise and the summary with the aggregated KPIs are presented in Table 3. After the first analysis of the results, a conclusion was made that the aggregation should be left aside basically due to its limited statistical value. The problems identified include:

- The aggregation does not make a distinction between modes of transport and different types of transport chains are averaged. Also, as long as corridor KPI values are based on a limited sample of transport chains, they are not representative and their aggregation can be misleading. Moreover, the chosen transport chains have very different characteristics and volumes. As the aggregation is based on the selection of a set of sample transport chains, the result of the calculation is strongly affected by the KPIs from those transport chains that have high freight volumes. Therefore, the ultimate corridor KPI does not represent fairly the corridor KPI due to the fact that the aggregation is based on a small number of samples.
- The approach requires highly consistent data in order to carry out precise calculations. The transport chain level input data used in the SuperGreen benchmarking exercise cannot be considered consistent as they have been collected through a questionnaire, without a quality control mechanism.
- Due to the fact that both qualitative and quantitative KPIs were included in some of the evaluated transport chain KPIs (e.g. congestion, ICT, etc.) a conversion from qualitative into quantitative indicators was required. The scale which was used for evaluating qualitative indicators was 1-5. For example, in the case of some transport chains the value for congestion was indicated as a precise figure, whereas in other cases a qualitative evaluation was made by the interviewee. After the conversion from a qualitative into a quantitative indicator, the final results are strongly affected by the converted indicators.

After a thorough analysis of the benchmarking exercise of the pilot corridor Brenner, it was decided to carry out the exercise on the other corridors without the aggregation. Taking into account the objectives and future tasks of the project, it was recommended to use the ranges of KPI values at a transport chain level for benchmarking the corridors.

	Relative cost €/ton-km	CO2 g/ton-km	NOx g/ton-km	SOx g/ton-km	PM g/ton-km	Reliability % of OTD	Frequency x per week	ICT applications % of transport	Cargo Security % of incidents	Cargo Safety % of incidents	Congestion % of time	Bottlenecks Rating
Malmoe-Trelleborg												
Trelleborg-Sassnitz												
Trelleborg-Rostock	0.035	10.619	0.015	0.029	0.002	98.80	12.00	100	0.50	2.00	0	1
Sassnitz-Berlin												
Rostock-Berlin	0.035	10.619	0.015	0.029	0.002	98.80	12.00	100	0.50	2.00	0	1
Berlin-Nurnberg	0.047	36.004	0.091	0.047	0.004	96.79	19.84	96	0.08	0.10	2	0
Nurnberg-Munich	0.162	16.313	0.029	0.047	0.004	90.36	10.40	100	0.02	0.02	48	3
Munich-Salzburg	0.000	12.537	0.017	0.042	0.003	85.00	8.00	100	1.00	1.00	5	2
Salzburg-Villach	0.000	9.938	0.016	0.046	0.003	89.21	4.63	100	1.00	1.00	9	1
Villach-Trieste	0.000	10.487	0.017	0.049	0.004	90.42	5.13	100	1.00	1.00	9	1
Munich-Verona	0.162	16.356	0.029	0.049	0.004	90.91	8.25	100	0.01	0.02	46	3
Verona-Bologna	0.051	36.199	0.156	0.077	0.007	90.62	6.79	99	0.02	0.02	5	2
Bologna-Rome	0.050	32.139	0.174	0.086	0.008	88.17	3.36	100	0.00	0.00	7	3
Rome-Palermo	0.040	16.977	0.256	0.125	0.018	100.00	1.00	100	0.00	0.00	0	0
Rome-Naples	1.000	17.669	0.030	0.092	0.006	91.91	3.99	100	0.00	0.00	8	4
Naples-Villa San Giovanni	1.000	61.678	0.466	0.074	0.013	25.00	0.01	100	0.00	0.00	100	1
Villa San Giovanni-Messina	1.000	61.678	0.466	0.074	0.013	25.00	0.01	100	0.00	0.00	100	1
Messina-Palermo	1.000	61.678	0.466	0.074	0.013	25.00	0.01	100	0.00	0.00	100	1
Naples-Messina												
Bologna-Ancona	0.051	45.915	0.113	0.054	0.004	99.00	18.50	97	0.08	0.08	2	0
Ancona-Bari	0.050	46.512	0.111	0.054	0.004	99.00	20.00	100	0.00	0.00	2	0
Bari-Patras	0.050	47.833	0.120	0.060	0.004	99.00	10.00	100	0.00	0.00	0	0
Ancona-Igoumenitsa	0.092	27.120	0.195	0.057	0.006	99.00	2.00	0	1.00	1.00	6	2
Ancona-Brindisi												
Bari-Igoumenitsa	0.028	42.089	0.291	0.104	0.011	95.00	0.50	100	0.50	0.00	0	0
Bari-Brindisi	0.036	27.277	0.181	0.089	0.008	95.00	1.00	100	0.50	0.00	0	1
Brindisi-Patras	0.036	27.277	0.181	0.089	0.008	95.00	1.00	100	0.50	0.00	0	1
Igoumenitsa-Thessaloniki	0.053	36.341	0.254	0.086	0.009	96.87	1.20	62	0.73	0.47	2	1
Igoumenitsa-Patras												
Patras-Athens	0.046	42.574	0.135	0.067	0.005	97.02	5.54	100	0.25	0.00	0	0

Corridor characteristics

Corridor average speed:	**64.43**	km/h
Annual number of shipments:	**9061**	no
Annual freight volume estimation:	**4224**	tons (000's)
Annual transport work:	**2520.67**	tkm (million)

Assumed total freight volume in the corridor: over 50 milion tons

Table 3 - Aggregation of the Brenner corridor KPIs

The following sub-sections present the analysis of the six corridors. Benchmarks are presented and the connection with other project work packages is made for each corridor. This analysis will serve as an input for the future work in the project where the benchmarking with green technologies and ICT solutions will be made.

4.2 Brenner

General description of the corridor and companies interviewed

The traffic in the Brenner Corridor is relevant to goods transport from Sweden through Germany to Italy (Palermo) and Greece (Athens) through the Italian peninsula. It includes crossing of the Alps through the Brenner Pass, as well as the Ionian and Adriatic seas. It also includes the Tauern axis and freight transport across the Ionian/Adriatic seas.

The corridor is mainly rail and road-based but there are also parts handled by short sea shipping, such as Naples-Palermo and Patras-Igoumenitsa to Brindisi-Bari-Ancona, as well as Trelleborg-Rostock/Sassnitz.

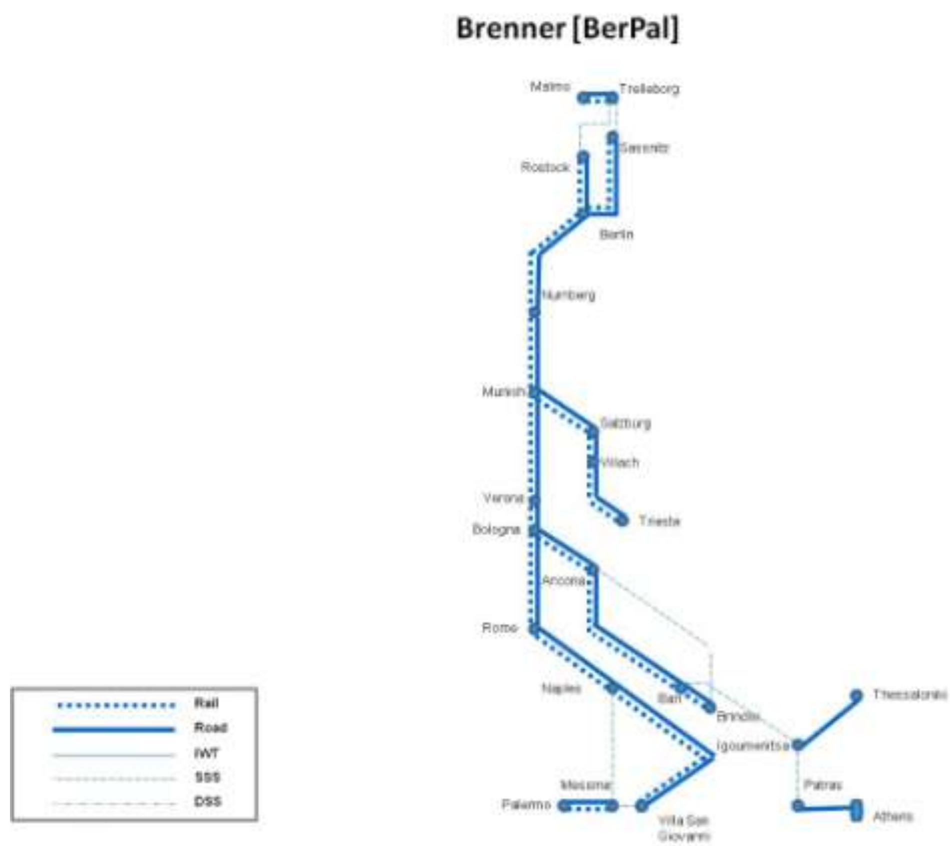

Figure 3 - Brenner map

Several projects are ongoing along the corridor in order to upgrade and modernize the current network. In particular, the Brenner Tunnel and two bridges (Ebensfeld-Erfurt, Messina) are under design or construction. Moreover, double track and high–speed railway lines are under construction; ERTMS (The European Railway Traffic Management System) will be introduced on the Munich–Verona rail line starting from 2015 and the port of Patras will be relocated in order to ensure sufficient in-land space and good connection to the intercity network. Also, infrastructural improvements are taking place on Patras-Athens road and rail sections.

The railway axis Malmö-Trelleborg-Rostock/Sassnitz-Berlin-Verona/Milan-Bologna-Naples-Messina-Palermo is an important high capacity north-south corridor across of the Alps along the Brenner Corridor. The axis, crossing three nations, i.e. Sweden, Germany, Austria and Italy, represents an important link between European areas and could contribute to a modal shift from road to rail in the mountainous region.

The Brenner Pass is the most important route for road freight transport crossing the Alps. In 2004, 42.7 million tonnes went through the Brenner Pass. One fourth of all road freight crossing the Alps passes through the Brenner tunnel, more than 30 million tonnes each year (2004, Cooperation on Alpine Railway Corridors 2006). Thus the modal split for road was more than 70%.

In 2005 the rail freight volumes from Berlin to Palermo were below 25 000 tons per day, with the exception of some segments characterized by more than 25 000 tons per day. In the same year also rail freight between Munich and Trieste was below 25 000 tons per day, with the exception of the section close to Trieste.

In 2005 road traffic from Munich to Trieste was below 50 000 vehicles per day, except for the section South-East of Munich and the section close to Salzburg where the traffic was higher than 100 000 vehicles per day. By 2030 the sections South-East of Munich, South-East of Salzburg and the section between Villach and Trieste will become more busy than today.

In order to get data and information on the transport chains, 47 companies (32 transport operators and 12 Freight Villages) and 5 experts have been contacted.

A summary of the type of data provided is presented in the table below.

		Type of Contact			
Data provided		**Expert**	**Freight village**	**Transport Service Provider**	**Total**
No	Confidential data			4	4
	Difficulty to provide data	2	3	6	11
	Not available to provide data		2	12	14
	Starting operational phase		5		5
	Not Useful - Corridor not covered		1	5	6
	Fee requested	1		1	2
Total		**3**	**11**	**17**	**42**
Yes	Only KPIs	2			2
	Transport chain+KPIs		1	7	8
Total		**2**	**1**	**7**	**10**
Total		**5**	**12**	**35**	**52**

Table 4 - Statistics on the feedback rate in the Brenner corridor

At the end of the analysis, 15 transport chains were considered to be useful for the study. The final list of transport chains analyzed is given in the following table.

TC n.	Origin – Destination	Mode	Type of contact
1	Verona – Naples	Train	Transport Operator
2	Verona – Nuremberg	Train	Freight village
3	Verona – Nuremberg	Train	Freight village
4	Verona – Berlin	Road	Transport Operator
5	Rome – Nuremberg	Road	Transport Operator
6a	Rome – Palermo	SSS	Transport Operator
6b	Roma – Palermo	Road	Transport Operator
7	Verona – Trelleborg	Train - SSS	Transport Operator
8	Bari - Athens	Road - SSS	Transport Operator
9	Bari – Thessaloniki	SSS - Road	Transport Operator
10	Trieste – Munich	Train	Transport Operator
11	Trieste – Salzburg	Train	Transport Operator
12	Trieste – Villach	Train	Transport Operator
13	Berlin – Thessaloniki	Road - SSS	Transport Operator
14	Bari – Athens	Road - SSS	Transport Operator
15	Bari – Berlin	Road	Transport Operator

Table 5 - Transport chains of the Brenner corridor[2]

Description of the critical segment

The Critical Segment of the Brenner Corridor is represented by the Brenner Pass (link between Munich and Verona) because this is the part that includes an important connection of the corridor that cannot be bypassed.

Table 6 presents the cargo flows characterizing the critical segment on the basis of types of products.

Products	%	Annual Volume Unit (tons)
Machinery, transport equipment, manufactured articles and miscellaneous articles	29.32	12,372,395
Foodstuffs and animal fodder	16.86	7,115,013
Agricultural products and live animals	13.47	5,685,437
Metal products	12.95	5,466,091

[2] Although the Transport Chain 6a is not part of the corridor, it could be useful as comparison

Products	%	Annual Volume Unit (tons)
Crude and manufactured minerals, building material	11.42	4,820,007
Fertilizers + Chemicals	8.39	3,538,702
Petroleum products	3.87	1,631,428
Ores and metal waste	3.45	1,454,374
Solid mineral fuels	0.28	116,556

Table 6 - Cargo flows along the critical segment in the Brenner corridor

KPI evaluation results at the transport chain level and benchmarks for the corridor

The results received from the interviews are summarized in Table 7. In total 16 different transport chains were identified and studied for the Brenner corridor.

Table 8 indicates the benchmarks for the Brenner corridor. The corridor is the most studied among all the corridors and comprises benchmarks for the intermodal, road, rail and short seas shipping transport.

TC no	Origin – Destination	Mode	Annual volume (t)	Key Performance Indicators (KPIs)													
				Cost EUR/tkm	Delivery time (h)	Emissions (g/tkm)				Reliability	Frequency (no per year)	ICT applications	Cargo Security	Cargo Safety	Congestion	Bottlenecks
						CO2 eq	NOx	SOx	PM10							
1	Verona – Naples	Train	61000	-	12	17.61	0.020	0.090	0.006	92%	260	100%	0%	0%	8%	4
2	Verona – Nuremberg	Train	500000	0.80	9	14.87	0.010	0.050	0.004	50%	260	100%	0%	0%	50%	3
3	Verona – Nuremberg	Train	2700000	0.05	9	14.87	0.010	0.050	0.004	100%	572	100%	0%	0%	50%	3
4	Verona – Berlin	Road	1100	0.07	25	71.86	0.510	0.080	0.013	50%	2600	0%	0%	0%	50%	1
5	Rome – Nuremberg	Road	32000	0.05	48	62.08	0.470	0.070	0.013	80%	104	100%	0%	0%	4%	2
6	Rome – Palermo	SSS	1500	0.04	24	16.99	0.250	0.120	0.018	100%	52	100%	0%	0%	0%	0
7	Roma – Palermo	Road	<100	1.00[3]	48	61.64	0.460	0.070	0.013	25%	52	100%	0%	0%	100%	1
8	Verona – Trelleborg	IT	13000	0.04	50	10.62	0.010	0.020	0.002	98,80%	624	100%	0,50%	2%	0%	1
9	Bari – Athens	IT	10000	0.04	72-96	27.28	0.180	0.080	0.008	95%	52	100%	<0,5	0%	0%	1
10	Bari – Thessaloniki	IT	3000	0.03	72-96	42.11	0.290	0.100	0.011	95%	26	100%	<0,5	0%	0%	0
11	Trieste – Munich	Train	81000	-	12	12.53	0.010	0.040	0.003	85%	416	100%	1%	1%	5%	2
12	Trieste – Salzburg	Train	652500	-	8	9.49	0.010	0.050	0.003	90%	208	100%	1%	1%	10%	1
13	Trieste –	Train	135600	-	4	16.36	0.020	0.090	0.006	95%	364	100%	1%	1%	5%	1

[3] Due to the high deviation, the data is not considered in final results. It can be assumed that a misstake has taken place on data collection

	Villach															
14	Berlin – Thessaloniki	IT	437	0,09	76	27.11	0.190	0.060	0.006	99%	104	0%	<1%	1%	5.88%	2
15	Bari - Berlin	Road	24000	0,05	72	46.51	0.110	0.050	0.004	99%	1040	100%	0%	0%	2%	0
16	Bari - Athens	IT	8500	0,05	24	25.41	0.250	0.140	0.024	99%	520	100%	0%	0%	0%	0

Table 7 - Brenner transport chain summary card [4]

List of acronyms:
Road – Road
Rail – Rail
Short Sea Shipping – SSS
Deep Sea Shipping – DSS
Inland Waterways Transport – IWT
Intermodal Transport – IT

[4] Fleets of the companies are composed of trucks Euro III, Euro IV, Euro V. Emissions are calculated using trucks Euro III

	Intermodal	Road	Rail	SSS
CO2 (g/tkm)	**10.62-42.11**	**46.51-71.86**	**9.49-17.61**	**16.99**
SOx (g/tkm)	**0.020-0.140**	**0.050-0.080**	**0.040-0.090**	**0.050-0.120**
Cost (€/tkm)	**0.028-0.092**	**0.05-0.06**	**0.05-0.80**	**0.04-0.05**
Average speed (km/h)	**9-41**	**19-40**	**44-98**	**23**
Reliability %	**95-99**	**25-99**	**60-95**	**100**
Frequency (no per year)	**26-624**	**52-2600**	**208-572**	**52-520**

Table 8 - Benchmarks for the Brenner corridor

Description of identified bottlenecks

Along the Brenner corridor various operational bottlenecks can be identified:

Transport of goods by road:

- Heavy road traffic inhibits smooth transport of goods. This often causes delays to the delivery of the consignment and consequently decreases efficiency and quality of the offered service. Furthermore the high traffic volumes on roads contribute to increased emissions of pollutants.

- Acoustic and chemical pollution feel like a major social problem at European and world-wide level, therefore new actions to reduce traffic on the roads will contribute to improve also the quality of the life (zone of the Brenner Pass).

- The holiday seasons in tourist areas causes discomfort and delays in boarding of trucks on ships; this is mainly due to the great traffic around the port area and to the boarding priority dedicated to tourists in these months (e.g., Port of Brindisi in Italy and Port of Patras in Greece).

- The intrusion of illegal citizens inside trucks is a problem along the Brenner Corridor. The clandestine immigrants have become so skilful in the intrusion that the drivers very rarely notice their presence before reaching destination.

Transport of goods by rail:

- The change of traction and signalling systems at the borders between European Railway networks still reduces effectiveness; at these spots, traction locomotives and drivers should be changed at the border, causing delays in the rail freight traffic. Multi-current and multi signalling locomotives (and sometimes the application of ETCS) are used to solve this issue; however, shift of personnel still has to take place often.

- Differences in permits and regulations represent another cause of delays. Access to railway terminals is often slowed down by long procedures to obtain the required documentation; heavy discomfort has been reported due to the lack of qualified staff.
- Liberalisation processes of train operation are very much delayed in Greece, adversely affecting the overall efficiency of railroad transport in the whole country.
- Italian infrastructures and competences of the staff are often degraded and inadequate.
- Concerning the regulation of railway traffic and circulation, during the interviews performed in the scope of task 2.4, limitations in the railway circulation in Italy have been highlighted (its line allows only trains of 1100 gross tons).

Along the Brenner corridor various <u>infrastructural</u> bottlenecks can be identified:

<u>Transport of goods by road:</u>

- Deficits in transport infrastructures relevant to goods transport, mainly in Italy and Greece: future bottlenecks generated by low capacity and road surface condition problems have been modelled up to 2030 (Petersen M.S., et.al. (2009)). The results of the analysis foresee three bottlenecks on the corridor, close to Florence, Rome and Naples.
- Frequent traffic jams due to insufficient road infrastructures capacity: this has been evidenced in particular along the Brenner Tunnel and in the segment between Forlì-Bologna.
- Localization of the port of Patras inside the urban centre of the city causes problems for increasing passenger and freight traffic to the boarding.
- During the winter in the area of the Baltic Sea the ice often create circulation problems and delays.
- Regarding geographic and climatic conditions, the Alps are an example of natural geographic barrier. The strong slopes negatively affect the average speeds. This disadvantage has been noticed along the railway line Erfurt - Nuremberg and along the Brenner Pass.

<u>Transport of goods by rail:</u>

- Regarding the rail network, an analysis has been done on future infrastructure improvements up to 2030; the results show an increase on rail freight transport of 78% with respect to the baseline scenario (2008) (Petersen M.S. et. al. (2009)). On the existing freight railways along the axis some bottlenecks are present in the baseline scenario: slot restriction in Milan conurbation, slot restriction from Verona to Wörgl and from Munich to Nuremberg. By 2030 the bottleneck from Verona to Wörgl will probably be solved but an electrification bottleneck between Nuremberg and Cheb could be present.

Analysis of the results

The KPI values reported in the previous table have been evaluated on the basis of the data/info collected on the Transport Chains.

The equivalent pollutant emissions have been calculated in g/tkm; this means that the results consider the quantity of goods and the length of each consignment.

In the table the minimum and maximum value per KPI and per mode of transport has been reported. On the basis of that the results show, for example, that high values of CO2 are typical for the road transport. The ranges for the SOx, instead, are more or less the same per each mode of transport.

The cost of transport is similar for the road, intermodal and SSS transport; the rail transport, instead, shows a very high value for the segment Verona – Nuremberg.

The average speeds for the rail transport show a high speed in the main axis of the corridor, and a reduced speed in the branch from Munich to Trieste. The average speed for the road transport is more or less comparable to the speed of the intermodal transport.

Considering the reliability of the service, the results show that rail, intermodal and SSS transports are more reliable than the road; in fact they are characterized by a little range from the minimum and maximum values. These ranges have been often evaluated on the basis of qualitative and not qualitative values and represent the perception of reliability of the operator.

Connection to the other work packages

The WP3 and WP4 aim at identifying, selecting and benchmarking Green Technologies and Information and Communication Technologies (ICT) to be applied into specific Green Corridors or specific segments of them to solve actual or future bottlenecks.

In fact, some of the bottlenecks identified in the analysis of the Brenner Corridor could be solved by applying technologies analysed in the other work packages (WP3 and WP4) or through important improvements in infrastructure, as for example in Italy in the area of the Brenner Pass and in the area close to Bologna where traffic jams occur frequently, and in Greece in the area close to Patras.

Also policies, laws and regulations relevant to transport systems can certainly facilitate and solve bottlenecks identified along the Brenner corridor.

Above mentioned operational bottlenecks related to traffic and pollution emissions could be solved also through specific regulations for the freight traffic. As an example, the region of the Brenner has already been recognized as a particularly environmentally sensitive area. Regarding environmental protection in fact, the Brenner has been defined as a sensitive area in accordance with Directive 2008/50 on air quality. Furthermore, Directive 2006/38 (Eurovignette) allows applying a mark-up for cross-financing that is also linked to the sensitive mountainous areas. Finally, reference shall be made to the Alpine Convention that aims at protecting the alpine range and has a series of protocols, amongst which a traffic protocol, that have recently been signed and ratified. Also the Commission is a party to this multilateral treaty.

The liberalisation processes regarding train operation in Greece will be able to bring remarkable advantages to the circulation of goods. In fact preferring the rail transport, a part of trucks that supply the distribution of goods in Greece today, could be removed from roads. The simplification of the procedures necessary to obtain the documentation to the railway terminal would facilitate disposal of the queue to the access providing remarkable advantages in the environment and in the quality of the service offered.

The bottlenecks present along the Brenner Corridor that can be solved using ICT technologies are relevant to road transport and railways.

Regarding the already mentioned Greek issue of the port of Patras, important contributions to possible solutions can be achieved by means of new ICT applications, which are expected to solve or to attenuate problems. As an example, the introduction of VMS (Variable Message Signs) can inform beforehand the drivers of the problem (traffic congestion, delays, bottlenecks on road, etc.), so that they can take new decisions for their routes.

Other corridor related projects and studies

Scandria project is a cooperation of 19 partners from Germany and Scandinavia willing to assume a future role in developing a green and innovative transport corridor between the Baltic and the Adriatic Sea as well as to promote a new European economic core area.

The Scandria Corridor is the shortest way between the Adriatic Sea and the Baltic Sea and stretches from the harbours in the Adriatic Sea to Scandinavia, with branches to Stockholm and Oslo.

An immediate problem of European freight traffic is the large use of trucks as means of transportation. As trucks causing large negative environment affects such as high emission levels, congestion on roads and deterioration of the infrastructure the European Union promotes use of other transport concepts. But the alternatives, railway and inland waterway transports, faces different kinds of barriers making them less competitive which obstructs their implementation.

The aim of the project is to suggest a sustainable and innovative concept for transporting goods applicable in the Scandria Corridor.

The project has identified a list of bottlenecks in the corridor due to the evolution of freight traffic in Europe. The bottlenecks can also be considered partly as bottlenecks for the SuperGreen project due to the fact that Scandria corridor is part of the Brenner corridor:

- A large bottleneck, or at least crowded area, is Western Germany where large goods flows are transported.

- How to get through the Alps is a matter that concerns all traffic. This fact has been a barrier to transports between places south of the Alps to places north of them for a long time.

- A large part of the goods with an origin in other continents than Europe and Africa with a destination in Central Europe comes by ship to ports in north-western Germany, Belgium and the Netherlands. The goods are transported further across the Europe mainly by road and rail therefore it affects also freight traffic in Brenner corridor.

Regarding the rail transport, a lot of problems or barriers in European railway networks have been identified:

- Many problems base on countries wanting to establish national optimum which creates negative effects when it comes to border-crossing. National solutions were in the beginning defensive actions to make sure other countries could not enter the national railway network.
- Some problems with railway are the earlier public monopoly on railways that still affects the supply of private actors in the railway industry.
- The traceability of goods does not function properly in many railway solutions and needs to be improved. The sensitivity to hard weather conditions, mainly snow and cold which affect Northern Europe in a larger extent than the rest of Europe.
- The railway networks in Southern and Eastern Europe are not extended and developed as much as in rest of Europe.
- One big problem for trans-national railway transports in Europe is that trains in many countries are bound to the driver and not intermodal adapted. This means that the train cannot leave the country where it belongs. Around 90 % of all trains are not intermodal adapted.
- A topic that interests a large audience is the implementation of high speed train lines for passenger transport. This obstructs the situation for freight trains because the tracks get crowded and calls for development of several branch lines to enable meeting of trains.
- Using railways are complex because some tracks are built with double lines and some with single lines, the capacity differs depending on tracks and routes, electrification and control systems varies throughout Europe and the prioritization of freight traffic is low.
- Most origins and final destinations are not directly connected to a railway network which calls for truck transports to and from train terminals.
- The fact that the railway electrification systems differs throughout Europe makes up for the biggest problem when designing the route for a transport concept. An option is to use diesel trains but since they are less environmentally friendly it is not an option for the concept in this thesis. The less systems trains need to operate in the better since locomotives needs to be equipped to handle all systems crossed. The best solution would be to just transport in one system but the dispersion of European electrification systems reject this option for transports all the way from the Adriatic Sea to Scandinavia.
- The need to limit the number of train control systems is however not as critical as the need to limit the number of electrification systems. A future solution to this problem is the implementation of ERTMS which will make cross-national railway transports easier. This is a needed solution but it will not take effect in several years since firstly by 2020 all the main railway lines should be implemented with ERTMS.

Trucks offer the most flexible choice in transportation but have other disadvantages compared to the alternatives:

- Intermodal transports have less environmental effects and can be formed in a more cost-effective way but the risk is higher because intermodal alternatives are more sensitive to distractions and changing conditions.

- A critical path in the Scandria Corridor is the Alps where nature prevents development of a comprehensive rail and road network. From the Adriatic Sea to the north there are, as in the current situation, three options how to get past the Alps: the first is to go to the west to Verona and then north to Innsbruck, the second is to go north to Salzburg through Villach and the third is to go northeast to Vienna. The first two options are crossing the Alps while the third goes to the east of the mountains.

Regarding the inland waterway and sea transport, the main bottlenecks are represented by:

- The geographical positions of the rivers in Europe does not offer any long distance north-south connections in the Scandria Corridor which makes inland waterway transports non applicable for a transport concept from the Adriatic Sea to Scandinavia.

Sea transporters are not applicable in the corridor except for the small part of the Baltic between Northern Germany and Sweden, if the route does not go through Denmark.

4.3 Cloverleaf

General description of the corridor and companies interviewed

The Cloverleaf corridor is passing through mainly the UK (from Glasgow – Carlisle – Liverpool – London – Dover with branch link to Dublin of Republic of Ireland at Liverpool) through Channel Tunnel to France via Calais and directly to Duisburg in Germany. The corridor segment in Europe mainland includes passing through Belgium and The Netherlands.

Four Transport Service Providers, among which three of them also represent Third Party Logistics (3PL), responded to be interviewed to allow some data of the corridor being obtained. Three interviewees are rail based freight operators and one interviewee is a road freight operator. The rail freight operators are delivering mainly food, drink and tobacco type of freight (60-100%); around 15% chemical products and 40% miscellaneous products including paper, glass and bottles. The road freight operator is mainly delivering retail goods and beverages within the London – Glasgow segment; and bio mass and waste paper for Duisburg – London segment.

Twelve NewRail freight and logistics companies were introduced about SuperGreen research project by emails and invited to the survey. Six contacts responded with a follow up call but only four companies completed the phone interviews. This creates a 33% response rate. One of the respondents answered two segments of the corridor that enable 5 segments in total to be examined (see Transport Chain Table 9).

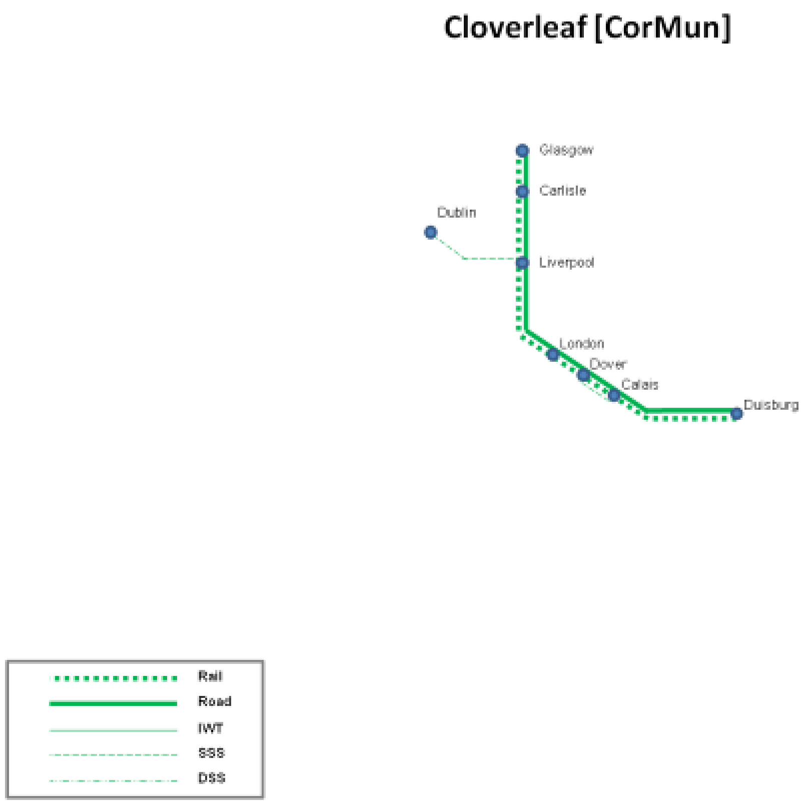

Figure 4- Cloverleaf map

Description of the critical segment

The Channel Tunnel should be one of the main critical segments especially for rail freight and deserve further discussion in this section. Around the year 2000, there are three different types of freight train used the Tunnel[5]:

- Intermodal trains (made up of wagons carrying containers and swap bodies);
- Conventional trains carrying palletised goods, automotive components and bulk loads in enclosed wagons or in adapted wagons (tankers, platforms etc.);
- Trains with specialized wagons for transporting new cars.

Goods trains are in competition with most of the other modes of freight transport in operation between continental Europe and the United Kingdom. Intermodal train services compete directly with road transport and maritime transport on container ships. Intense competition in the cross-Channel freight market between road haulage companies, especially companies based in continental Europe, puts constant pressure on freight rates, making it more difficult for the railway companies to compete. The goods transported by freight trains are mainly heavy, low value items for which speed of delivery is not generally a primary consideration.

[5] All source of information about Channel Tunnel is supplied by GB Railfreight – also known as EUROPORTE Channel (EPCH) – see references at the end of this document.

From the three types of freight trains described above, only the first one, intermodal trains that is still in operation up to date. The conventional trains carrying palletised goods have disappeared and the trains transporting new cars are dead. One of the reasons identified for this downturn is because operators wanted to defend their core business. In year 2000, there were five rail freight operators runs through the Channel tunnel but only one operator left by now. The only intermodal operator that is still in operation is Transfesa, a sharing ownership of family run business (49%) and RENFE (20%).

The downturn of the rail freight volume within the Eurotunnel can be seen in Figure 5 below. By 2007, Eurotunnel Group announced a new strategy to stimulate the rail freight operation through Channel tunnel with (i) a development of free access for all goods train operators, (ii) dealing effectively with border restrictions and (iii) a simplified and competitive pricing policy. However, following the recession that started off in 2008 that causes a new dawn up until now as Figure 5 demonstrated.

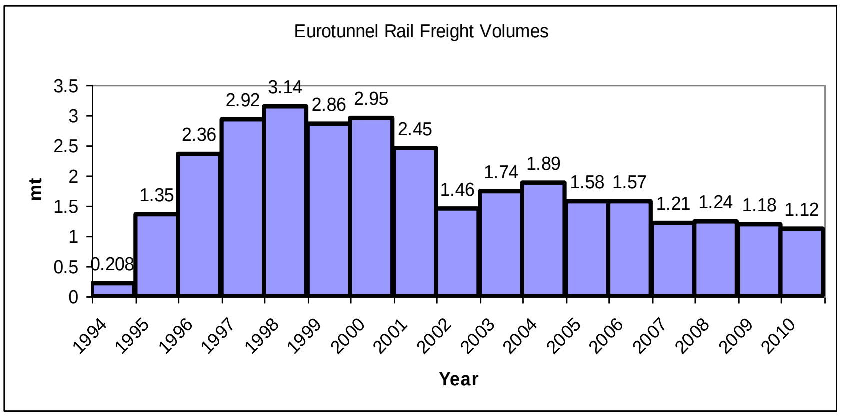

Figure 5 - Eurotunnel Rail Freight Volumes between 1994 and 2010 (Source: EPCH, 2010)

The tunnel has capacity for 10 million ton (mt) per annum (pa); the maximum capacity was reached in 1998 of 3.14mt. Eurotunnel Group aims to return to 3mt pa (according to the Eurotunnel Shareholders Report, 2008); then to 6mt – over time. In the year 2010, the volume through Tunnel was only at 1.05mt.

EPCH noted that there is an alarming decline in freight traffic across Europe (>30%). The annual tonnage transported through the Tunnel is less than 2% of the potential market between Continental Europe and the UK. There is an issue of complexity of setting up cross border rail transport in Europe despite the successive reorganisation of operating structures for cross-Channel freight in the UK. There is also a lack of competitiveness of rail versus road transport (due in particular to the fixed cost of border infrastructures) and moreover financial difficulties of rail freight in France.

The optimism comes from the EPCH that extended training of drivers; developed routes with EP France and ET acquire GBRf. Deutsche Bahn announced setting up of a European container network. Last but not least, SNCF freight is working to develop its own European network.

Having noted that Channel Tunnel is a critical segment of the Cloverleaf corridor, the results from the interview surprisingly shows no issue at all with the channel tunnel traffic. The interviewer believes that this is simply because UK is surrounded by the North Sea, and the link connection from Europe mainland to the UK as well as in the opposite direction can be substituted easily with short sea shipping.

The first three interviewees are representing rail freight operators. One interviewee who is a 3PL as well as Transport Service Provider (with 100% food, drink and tobacco delivery type product) reported that corridor between London and Calrlisle is the critical segment.

The second interviewee (with 80% delivery of food, drink and tobacco type of freight; and 15% chemical products) did not highlight any part of the corridor as truly critical as every route has alternative, be it the channel tunnel or midlands.

The third interviewee (with 60% delivery based on food, drink and tobacco; and 40% miscellaneous products including paper, glass and bottles) reported that segment between Midland (DC Daventry) and Glasgow is the critical link.

The fourth interviewee is representing road freight and reported two segments of the corridor. London – Glasgow corridor serves retail goods and beverages including soft drink freight; and London – Duisburg serve bio mass and waste paper freight.

KPI evaluation results at the transport chain level and benchmarks for the corridor

The results received from the interviews are summarized into Table 9. In total 6 different transport chains were identified and studied further for Cloverleaf corridor. It has to be mentioned that to obtain cost elements from the respondents was a very difficult task; therefore some of the numbers are roughly estimated.

In Table 10, benchmarks for Cloverleaf corridor are indicated. The corridor comprises benchmarks for the road and rail transport.

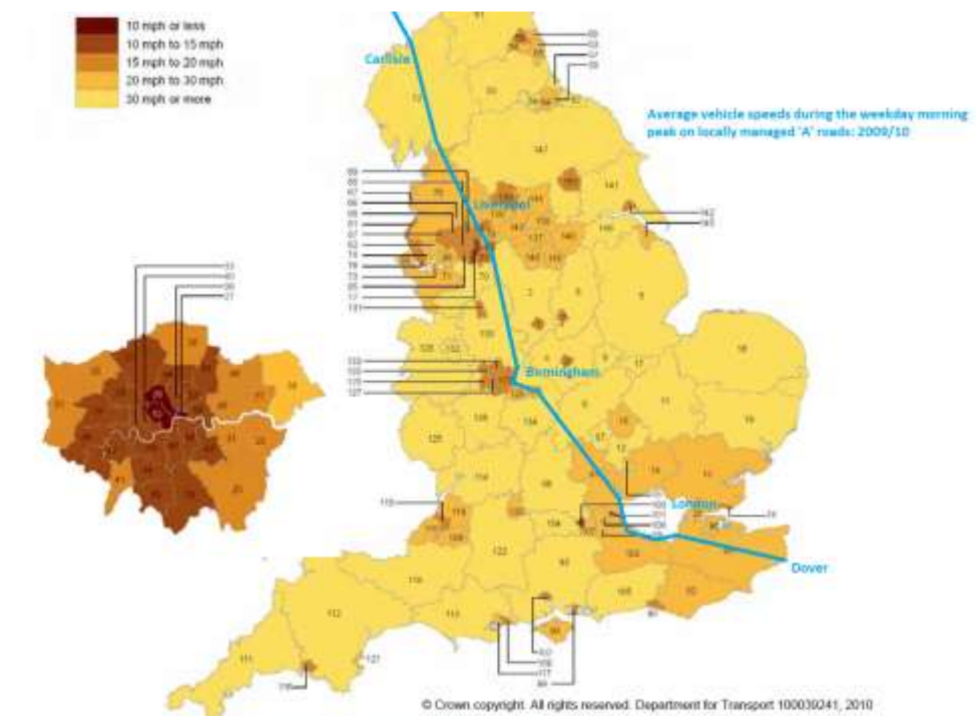

Figure 6 - Average vehicle speeds in England at morning peak (Source: DfT, 2010)

Figure 6 above demonstrated the speed variance for the road in England. From the interviewee response, the speed for road freight traffic is estimated between 40 to 60 km/hour. For rail speed range is estimated between 45 to 65 km/hour.

TC no	Origin – Destination	Mode	Annual volume (t)	Key Performance Indicators (KPIs)													
				Cost EUR/t km	Delivery time (h)	Emissions (g/tkm)				Reliability	Frequency (no per year)	ICT applications	Cargo Security	Cargo Safety	Congestion	Bottlenecks
						CO2 eq	NOx	SOx	PM10							
1	Rugby-Carlisle	Rail	194000	-	8	18.45	0.015	0.013	0.001	97%	312	0%	0%	0%	37%	3
2	Midlands-Glasgow	Rail	78000	0.05	10	18.45	0.015	0.013	0.001	98%	156	0%	0%	0%	5%	0
3	Duisburg-Midlands	Rail	68000	0.095	20	13.14	0.016	0.021	0.001	90%	156	0%	0%	0%	20%	1
4	Midlands-Glasgow	Rail	480000	-	8	18.46	0.015	0.013	0.001	98%	364	own	0%	0%	40%	2
5	Dusiburg-London	Road	112350	0.057	10	68.81	0.505	0.090	0.015	80%	4680	own	3%	1-2%	20-25%	3
6	London-Glasgow	Road	-	-	12	-	-	-	-	90%	-	own	1%	1%	20-25%	4

Table 9 - Cloverleaf transport chain summary card

List of acronyms:
Road – Road
Rail – Rail
Short Sea Shipping – SSS
Deep Sea Shipping – DSS
Inland Waterways Transport – IWT
Intermodal Transport – IT

	Intermodal	Road	Rail	SSS
CO2 (g/tkm)	**-**	**68.81**	**13.14-18.46**	**-**
SOx (g/tkm)	**-**	**0.091**	**0.014-0.021**	**-**
Cost (€/tkm)	**-**	**0.06**	**0.05-0.09**	**-**
Average speed (km/h)	**-**	**40-60**	**45-65**	**-**
Reliability %	**-**	**80-90**	**90-98**	**-**
Frequency (no per year)	**-**	**4680**	**156-364**	**-**

Table 10 - Benchmarks for the Cloverleaf corridor

Description of identified bottlenecks

The interview results revealed that bottleneck is quite well anticipated for most of the freight operations. However, it was observed that for a rail operation, the main bottlenecks are in places where there is only one track – thus it can be considered as an infrastructure problem. For the road operation, the problem is in and around cities and within town.

The first interviewee reported lowest level (rate number 1 – out of 1 to 5 scale as 1 is lowest and 5 is highest) of bottlenecks (might be due to anticipated congestion) but also reported there are 3 segments that have the 'anticipated' bottlenecks including: (1) Midlands, Stafford way; (2) Carlisle; (3) Near Glasgow. The issue is with shared track/routes with passenger trains and scheduled delays (infrastructural and operational issues).

The second interviewee reported that changing locomotives in every country including Germany and France adding extra one hour each (operational).

The third interviewee reported rate number 2 on bottlenecks (out of 1 to 5 scale). Two corridors: Warrington near Liverpool; and Motherwell near Glasgow are logged in with the capacity of infrastructure with only two tracks instead of four and considered as bottlenecks (infrastructural).

The fourth interviewee reported that between London – Glasgow, the main bottleneck is around M25 – road works around Milton Keynes area (rate number 4 out of 5); Birmingham toll road (rate 2/5); and M6 – junction 26 at Warrington (rate 4/5). For the segment between London – Duisburg, the main bottleneck reported is at Kennedy Tunnel at Antwerp (with reported 5/5 – means seriously congested); Channel Tunnel (2/5); and any major ring roads, especially the ones near Venlo in the Netherlands where one of the biggest centre for logistics in Europe is located.

Analysis of the results

The interviews and former research show that the main transportation mode along the corridor is road. Main challenge for modal shift is the cost of operations by rail and insufficient volumes.

The interviews indicate that channel tunnel does not represent a critical bottleneck within the corridor as shippers can and often do prefer to use alternative routes by SSS calling at the ports like Hull to bypass expensive channel tunnel and congested area surrounding London. Besides the channel tunnel is underutilised by freight in terms of capacity and slots.

The typical cargoes along the corridor are manufactured goods and foodstuffs along retailers' supply chains.

One of the interviewee comments regarding costs of rail freight that is 20% more expensive but also depends on many factors. 99% of the freight long distance operators have a desire to move by rail but it may not work for everyone. The issue with rail freight is weight load.

According to one of the interviewee: over the last 10 years the UK has witnessed the shift toward freight by rail by many major retailers, as for example ASDA (part of Wal-Mart giant supermarket chain) whose rail share is now at about 11% with an expected 20% increase by 2025.

Another interviewee agreed on green initiatives and prioritised just one that is modernisation of the truck fleet from Euro 2, 3, 4 to Euro5.

Connection to the other work packages

WP3 and WP4 of the SuperGreen project aim at identifying, selecting and benchmarking Green Technologies and ICT to be applied to specific corridors or specific segments of the corridor to solve bottleneck problems. The results from the interview show that some of the respondents are not using ICT to help their operations. The road freight operators reported full use of ICT of tracking/navigation system and this was reported helpful to help the trailer driver to anticipate bottlenecks. For rail operators, only one respondent reported use of ICT in its operation that is a terminal operation processing systems and a loading level software between Glasgow and Midlands. This initiative can be introduced to other rail freight operators that do not use the system.

Other corridor related projects and studies

Case study: Return of pallets from British Isles to continental Europe.

CHEP – the global leader in pallet and container pooling services has a number of initiatives in development of multimodal logistics:

In 2008, CHEP used train operated by Transfeca to transport Ford cars from factory in Valencia, Spain to the UK. On the return journey CHEP filled the containers with 150,000 pallets a year (1.5% of the total number of pallets returned in Europe annually).

In 2009, a weekly service with Stobart Rail, carrying fresh fruits in 30 containers from Valencia, Spain – Dagenham, UK with return journey transporting 12,000 CHEP pallets that would otherwise require around 30 trucks for transportation. The method produced savings of 6M km of road journeys with a corresponding reduction in CO2 emissions in over 5,500 tonnes.

In 2010, cooperation with Danone Eaux France, which uses up to 5 trains a week to deliver production to the UK and on return journey trains are filled with approximately 460,000 CHEP empty pallets annually. Such arrangement removes 1650 truck journeys, equivalent to saving of more than 1 000 tonnes of CO2 annually.

In the interview to CILT journal Focus Eamonn Casey, CHEP's logistics director for the UK and Ireland said that over 20% of CHEP's pallets are returned to continental Europe by rail, which minimises the impact of fluctuations of the fuel prices, as well as bringing a saving of over 3,500 tons of CO2 so far in 2010.

4.4 Nureyev

General description of the corridor and companies interviewed

Nureyev is mainly a short sea shipping corridor running in the Baltic Sea. Most of the Nureyev corridor is included in the TEN-T Motor Way of the Seas concept, more specific to the Motorways of the Baltic Sea corridor. It is a route connecting Russia to Europe. In addition the sea legs, it includes rail-road connection from Moscow to St. Petersburg and Klaipeda to Minsk, as well as land based routes to and from ports at each end. All countries around the Baltic Sea are involved in this 4,500 kilometres corridor. Kotka, Helsinki, St. Petersburg, Gothenburg, Hamburg and Rotterdam are the biggest ports along the route. The vast metropolitan area of Moscow is also included. Most of the ports of the region have excellent inland connections by rail and road. In Rotterdam, inland waterway connections are excellent via the Meuse and Rhine rivers.

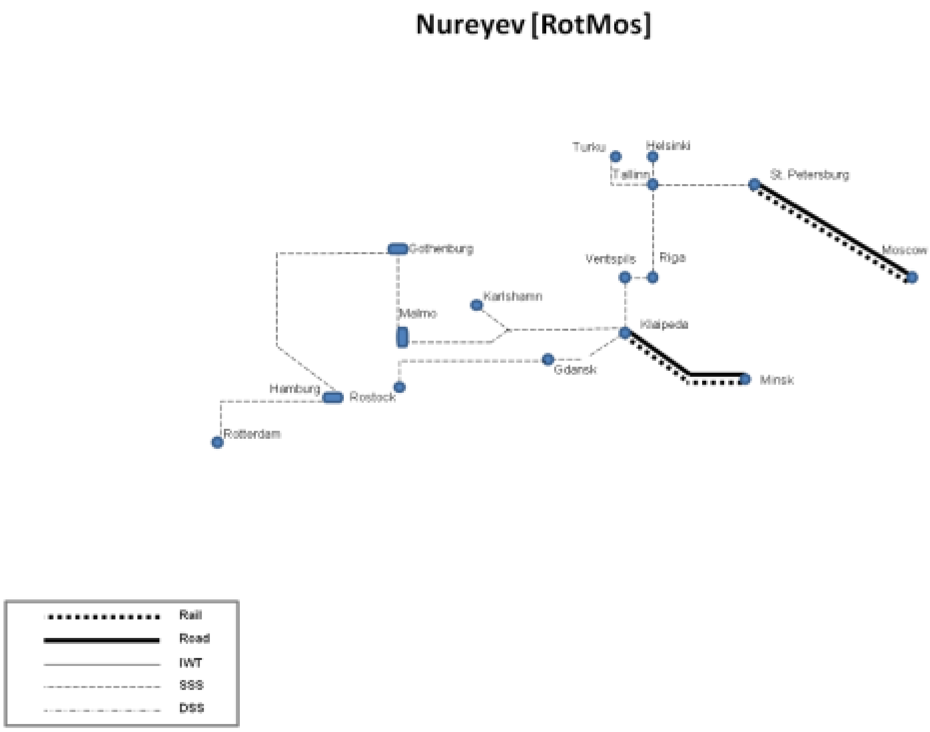

Figure 7 - Nureyev map

In order to obtain data for Nureyev corridor contact was first made with Straightway (one of the SuperGreen partners). Straightway is a marketing association with over 50 logistics member companies. The personnel have long and comprehensive knowledge and experience of the traffic along the Baltic Sea region and of the transit traffic to Russia.

Valuable information was obtained from Straightway via the interviews. In addition to interviews the questionnaire was released by e-mail to all members of Straightway. Despite of the fact that the email was sent to more than 50 companies, only 4 responses were received. The four companies responded are described next. NEOT Hamina terminal handles liquid chemicals and offers storage and transhipment services. Stingray Cargo Oy is the road transport operator based in Finland. Stella Corona Oy offers international shipping and logistics services. Nurminen Logistics Oyj offers also logistics services. Their services include for example railway transports, terminal services, forwarding and special and heavy transports. All of these companies have regular traffic in the Baltic Sea region.

Description of the critical segment

For Nureyev corridor the critical segment is Rotterdam-Moscow. The critical segment consists of sea legs from Rotterdam to the main ports feeding the rail and road transports to Moscow (and vice versa) and road and rail legs from these ports to Moscow.

As Nureyev is mainly a sea based corridor the identification of critical segment was done using the following criteria:

- typical cargoes using each corridor port (use of port statistics)
- existing connections between corridor ports

- relative importance of connections in terms of current cargo volumes and transport forecasts
- connections to land-based corridor segments
- types of vessels used
- ‘best practice’ cases identified in literature
- cases suggested by other ‘green corridor’ projects

Rotterdam is one of the world´s biggest ports, on some rankings and by some criteria even the biggest. It was therefore self-evident that Rotterdam would be part of the critical segment. It has the biggest volumes, frequent service to most of the other ports along the corridor, and excellent connections to land-based corridors.

Russia and especially the areas around St. Petersburg and Moscow form a huge market area. In order to cover the most critical flows along the Nureyev corridor and along the Baltic Sea, Moscow was selected as the destination node. This would ensure that EU-Russia connection and the most important flows are well covered. One of the main criteria of the selection was that these cargo flows to and from these areas are constantly growing.

The cargo flows along the critical segment consist of general cargo, groupage goods for example manufacture articles, clothes, food products, etc. In addition chemical products and oil are important cargo types.

KPI evaluation results at the transport chain level and benchmarks for the corridor

The results received from the interviews and the questionnaires are summarized into Table 11. In total 10 different transport chains were identified and studied further.

In Table 12, benchmarks for Nureyev corridor are presented. The corridor comprises intermodal chains and pure short sea shipping chains. Both these main types include 5 different transport chains.

TC no	Origin – Destination	Mode	Annual volume (t)	Key Performance Indicators (KPIs)													
				Cost EUR/t km	Delivery time (h)	Emissions (g/tkm)				Reliability	Frequency (no per year)	ICT applications	Cargo Security	Cargo Safety	Congestion	Bottlenecks
						CO2 eq	NOx	SOx	PM10							
1	Hamburg-Moscow	IT	600000	0.18	120	33.36	0.340	0.150	0.020	90%	360	100%	0.1%	1 %	10%	2
2	Hamburg-Moscow	IT	300000	0.16	168	16.02	0.130	0.030	0.010	90%	360	100%	0.1%	1%	10%	2
3	Hamburg-Moscow	IT	1000000	0.15	120	28.71	0.280	0.120	0.010	90%	360	100%	0%	1%	30%	2
4	Hamburg-St.Petersburg	SSS	125000	-	120	5.65	0.120	0.070	0.010	90%	156	100%	0.1%	1%	10%	2
5	Rotterdam-Helsinki	SSS	1000000	0.05	72	10.48	0.230	0.140	0.020	90%	360	100%	0.1%	1%	10 %	1
6	Hamburg-Helsinki	IT	2000000	0.10	28	13.43	0.240	0.130	0.020	90%	360	100%	0.1%	1%	10%	1
7	Gothenburg-Rotterdam	SSS	230000	-	48	10.46	0.230	0.140	0.020	90%	156	100%	0%	1%	1%	0
8	Rotterdam-Moscow	IT	1000000	0.13	96	25.82	0.280	0.120	0.010	80%	156	100%	0%	0%	40%	1
9	Hamburg-Helsinki	SSS	230000	0.06	60	10.15	0.230	0.140	0.020	90%	360	100%	0.1%	1%	10%	1
10	St.Petersburg-Helsinki	SSS	190000	-	24	15.60	0.260	0.140	0.020	99,9%	52	0%	0%	0%	0%	0

Table 11 - Nureyev transport chain summary card

List of acronyms:

Road – Road
Rail – Rail
Short Sea Shipping – SSS
Deep Sea Shipping – DSS
Inland Waterways Transport – IWT
Intermodal Transport – IT

	Intermodal	Road	Rail	SSS
CO2 (g/tkm)	13.43-33.36	-	-	5.65-15.60
SOx (g/tkm)	0.030-0.150	-	-	0.070-0.140
Cost (€/tkm)	0.10-0.18	-	-	0.05-0.06
Average speed (km/h)	13-42	-	-	15-28
Reliability %	80-90	-	-	90-99
Frequency (no per year)	156-360	-	-	52-360

Table 12 - Benchmarks for the Nureyev corridor

Description of identified bottlenecks

According to data gathered from the interviews there are two bottlenecks along Nureyev corridor. The first one, ice, is related to infrastructure or better yet geography and concerns almost all of the studied ten transport chains. During the winter almost half of the Baltic Sea is covered by ice. There are efficient, high performance, ice breakers in use, however sometimes if the situation is critical, delays may occur which are caused by the ice conditions. Based on the interviews the seriousness of this bottleneck was evaluated as 2 on the scale of 1-5. However this applies only for few months during the winter time. For rest of the year / most of the year, this bottleneck does not exist.

The other bottleneck along the corridor is the border crossing between Finland and Russia. There are mainly four border crossing places in use in these ten transport chains. Imatra, Nuijamaa and Vaalimaa border stations serve only road transports. The biggest one is Vaalimaa. Border station of Vainikkala serves only train traffic. The difficulties with the border crossing are caused by the complicated and time consuming customs procedures on the Russian side. The capacity of the Russian border stations is exceeded and this causes queues at the Finnish side.

Analysis of the results

Half of the transport chains were purely short sea shipping chains and the other half included also land based connections to hinterland. Annual volumes are big as most of the chains consisted of transportation of general cargo in containers from one port to another.

Reliability was seen rather good in all chains. ICT applications, tracking &tracing, are fully used in all chains, expect in one. Cargo security and safety was seen to be in a good level in all chains. The problems were more related to the congestion. Most of the congestion is caused by the border crossings between Finland and Russia. The Customs procedures in Russian side take often a long time. This causes queues which can be tens of kilometres on both sides of the border. The Finnish-Russian border and the ice coverage in the Baltic Sea during the winter are the two main bottlenecks identified along the Nureyev corridor.

In Nureyev only intermodal and short sea shipping transport chains were identified. Thus pure road or rail transport legs were not studied. Intermodal transport chains consisted of short sea shipping leg and road or rail transport leg.

The range of CO2 values calculated for intermodal transport chains is wide. This is based on the fact that some of the chains are sea-road and some sea-rail combinations. The sea-rail combination generates less CO2 per ton kilometre. The other factor is the length of the land transport, the more the chain has land based transportation the greater are the CO2 values. The lowest value is from short sea shipping from Helsinki to St. Petersburg and the greatest intermodal sea-road chain from Hamburg to Moscow. For the SOx values it should be noted that the lowest extreme 0,03g /tkm is from the intermodal sea-rail chain from Hamburg to Moscow.

Getting the information related to cost was the most difficult challenge. Out of the ten transport chains studied cost estimation was received only for seven. Furthermore for these seven, the received numbers are rough estimations, approximate averages per shipment, not exact figures. It should be noted that the calculated value for cost per ton kilometre is also estimation.

The delivery time (average speed is calculated based on distance and delivery time) is always matter of days in these studied transport chains. The figures are translated into hours from the original estimations which have been given in days. The given values should be evaluated bearing this fact in mind.

The problems in the Finnish Russian border have a major effect to the delivery time. In fact this is the reason for the much lower level reliability in intermodal transports chains than in pure short sea shipping chains.

Frequency in this sea based corridor and in transport chains running along it is highly dependent on the shipping lines, their services and the destination. So it depends on the demand of shipping services. For some destination there is daily liner traffic, but for some only one connection per week.

Connection to the other work packages

It can be clearly stated that Tracking & Tracing applications are widely in use in Nureyev. There are several applications in place and in use. However the applications in use are mainly company specific and thus serve company and its clients. In addition to Tracking & Tracing system, several other applications are available.

In order to utilize the applications in a more effective way and use them to improve the environmental performance of the transport chains, open and harmonized ICT systems and co-operation between companies are needed. However companies are not willing to share their company information with competitors and this challenges the development of more open systems. Probably the development of more open ICT systems is possible by defining the content so that it does not danger companies’ current position in the markets. But this requires mutual trust between the companies and neutral organization for kick off as well as for maintaining and developing the system. Maybe some “legal” enforcement to participate to some kind of environmentally certified common system comes to an issue in the future as well. This kind of common system should be more than just for tracking and tracing. It could cover also the reporting of environmental etc. data of transports using common format.

This study gives information and estimations of environmental performance of certain transport chains in Nureyev corridor. This information can be used when comparing that data with the data from other corridors for defining and targeting the development areas for ICT, SCM and policy development.

Other corridor related projects and studies

Numerous studies and publications confirm that the bottlenecks identified during the interviews are the ones that mostly cause problems along the Nureyev corridor.

Related to ICT systems in place, in the interviews, only Tracking & Tracing applications were considered. However according to other studies and publications there are several applications available and in use. These include among others: PortNet, tools from EMSA, SafeSeaNet, AIS (automatic identification), LRIT (Long-range Identification and Tracking), Port Community Systems, and Vessel Traffic Monitoring.

The problem however is to find a balance between individual systems and common communication platforms. In other words, there is a demand for the interoperability standards between all these individual technical systems which will be able to deliver a higher value service to the community of users of a specific logistics chain. Traffic information systems are effective way to increase the sustainability of transports. That is because they are maintained by public authority and are impartial from the private stakeholder’s point of view. However they produce only the pure traffic information and do not deal with the information concerning the commercial supply chains. The real challenge is to create more open systems to develop the environmental performance of supply chains. Still traffic information systems are good and easier way to increase sustainability and safety of transports.

4.5 Strauss

General description of the corridor and companies interviewed

The Strauss corridor includes the trade routes starting from Rotterdam, crossing the Rhine-Main-Danube region and ending to Black sea. The main nodes are: Rotterdam - Duisburg - Nuremberg - Vienna - Bratislava - Budapest - Belgrade – Constanta. In this corridor, inland waterways, railways and road networks are available for freight transport. The corridor includes a parallel rail and road branch Paris-Frankfurt. The main contribution on the data collection of transport chains in this corridor is made by Via Donau (Inland waterway infrastructure operator).

For the emission calculations of this corridor, two options were considered: one based on the literature review (Planco Study, see reference below) and one on the EcoTransIT World online tool. Both calculations and results are presented in the Appendix II of the report. After the consultation process with experts of the inland waterways transport, the benchmarks were set using a calculation based on the data presented in the Planco Study. It should be mentioned here that a number of IWT stakeholders have expressed reservations on the use of EcoTransIT World for inland navigation.

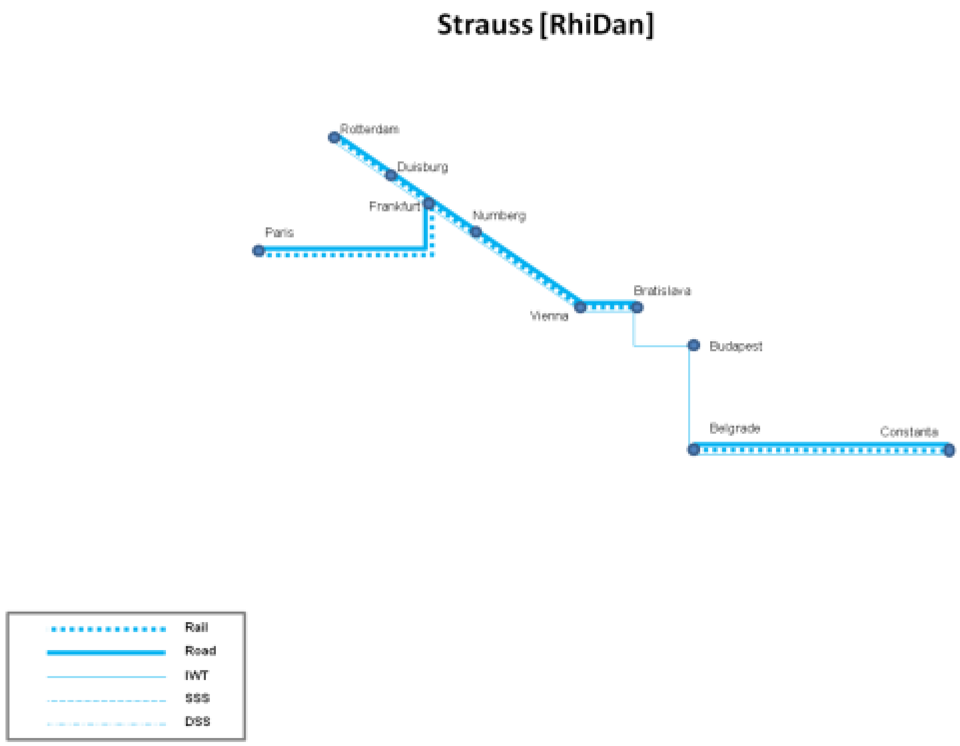

Figure 8 - Strauss map

Description of the critical segment

For inland waterways, the Rhine-Main-Danube canal is an important node, placed in the heart of the waterway axis.

KPI evaluation results at the transport chain level and benchmarks for the corridor

The results received from the interviews and literature reviews are summarized into

in – ation	Mode	Annual volume (t)	Key Performance Indicators (KPIs)											
			Cost EUR/tkm	Delivery time (h)	Emissions (g/tkm)				Reliability	Frequency (no per year)	ICT applications	Cargo Security	Cargo Safety	Conges n
					CO2 eq	NOx	SOx	PM10						
dam – ourg	IWT	-	0.02	-	9.86	0.138	0.013	0.002	-	-	-	-	-	-
dam - otzenb Main	IWT	-	0.02	-	19.30	0.276	0.026	0.004	-	-	-	-	-	-
dam - ourg	IWT	-	0.44	-	14.00	0.188	0.019	0.004	-	-	-	-	-	-
dam – sel	IWT	-	0.22	-	16.58	0.169	0.022	0.004	-	-	-	-	-	-
z – nberg	IWT	-	0.03	-	22.80	0.276	0.031	0.004	-	-	-	-	-	-
dam - eim - gart	IWT	-	0.22	-	12.39	0.159	0.017	0.003	-	-	-	-	-	-

Table 13. In total 6 different transport chains were identified and studied further. The detailed information about calculations of transport chain KPIs can be found in Appendix II, on page 91.

In Table 14, benchmarks for Strauss corridor are presented. The corridor comprises only benchmarks for inland waterways transport.

TC no	Origin – Destination	Mode	Annual volume (t)	Key Performance Indicators (KPIs)													
				Cost EUR/t km	Delivery time (h)	Emissions (g/tkm)				Reliability	Frequency (no per year)	ICT applications	Cargo Security	Cargo Safety	Congestion	Bottlenecks
						CO2 eq	NOx	SOx	PM10							
1	Rotterdam – Duisburg	IWT	-	0.02	-	9.86	0.138	0.013	0.002	-	-	-	-	-	-	-
2	Rotterdam - Großkotzenburg am Main	IWT	-	0.02	-	19.30	0.276	0.026	0.004	-	-	-	-	-	-	-
3	Rotterdam - Duisburg	IWT	-	0.44	-	14.00	0.188	0.019	0.004	-	-	-	-	-	-	-
4	Rotterdam – Basel	IWT	-	0.22	-	16.58	0.169	0.022	0.004	-	-	-	-	-	-	-
5	Linz – Nuremberg	IWT	-	0.03	-	22.80	0.276	0.031	0.004	-	-	-	-	-	-	-
6	Rotterdam - Mannheim - Stuttgart	IWT	-	0.22	-	12.39	0.159	0.017	0.003	-	-	-	-	-	-	-

Table 13 - Strauss transport chain summary card

List of acronyms:
Road – Road
Rail – Rail
Short Sea Shipping – SSS
Deep Sea Shipping – DSS
Inland Waterways Transport – IWT
Intermodal Transport – IT

	Intermodal	Road	Rail	IWT
CO2 (g/tkm)	-	-	-	**9.86-22.80**
SOx (g/tkm)	-	-	-	**0.013-0.031**
Cost (€/tkm)	-	-	-	**0.02-0.44**
Average speed (km/h)	-	-	-	-
Reliability %	-	-	-	-
Frequency (no per year)	-	-	-	-

Table 14 - Benchmarks for the Strauss corridor

Description of identified bottlenecks

The Priority Axis No18 projects, which aim at the improvement of the waterway axis connecting the North Sea to the Black Sea, could provide information on the current infrastructural bottlenecks in this region.

According to the D. A. N. U. B. E.[6] project, the Romanian water transport network includes 32 inland waterway ports with a total capacity of 52 million tonnes/year. At this region, the river ports have a total of 16,200 m of quays, of which some 20% are said to be over 60 years old and in need of reconstruction. In addition, another 65% are in poor physical condition due to lack of funds for maintenance and repairs.

As identified by Via Donau, despite the Rhine-Main-Danube canal inauguration in 1992, only a small part of Danube's transport capacity is used. In the 2007-HU-18090-S[7] it is mentioned that the Danube part between the town of Szob and Hungary's southern border does not meet UNECE VI B and C parameters for approximately half of the year. This project aims to study the elimination of fords and bottlenecks in this region, so as to meeting the requirements set for the Danube-Main-Rhine waterway (UNECE directives) and reduce the afore-mentioned limitation for 20 days as a maximum.

As identified in the 2007-AT-18020-P project[8], the Wien – Bratislava waterway connection is currently characterised by constant river bed erosion of +/- 2-3.5 cm per year. This has a negative

[6]Danube Access Network – Unlocking Bottlenecks in Europe.

http://tentea.ec.europa.eu/download/project_fiches/romania/fichenew_2007ro92301s_final_1.pdf

[7] Part of the Priority Project 18 on the improvement of the navigability on the Danube

[8] Part of the Priority Project 18 on the implementation integrated river engineering project Danube East of Vienna

effect on navigation, water resource management and the ecological viability of the Donau-Auen ecosystem.

The Rhine-Main-Danube canal itself is not considered as bottleneck as it has still significant free transport capacities. However, the stretch between Straubing and Vishofen limits the cargo carrying capacity of vessels due to the shallow water conditions and constitutes an important bottleneck in this area[9]. It has, however, only little impact on IWT taking place only in the Rhine or Danube regions.

Finally, the political changes and the war in the Yugoslavian region have had impacts on Danube navigation, both on infrastructure and operations.

For the rail freight transport, according to the summary of the Planco study, many nodes on the German railway network are overloaded, like the lines of Karlsruhe – Basel, and Emmerich – Duisburg. As stated in this study, there are planned network extensions that will relieve a number of overloaded sections, but even on the major routes, a high number of sections will remain with capacity utilisation rates between 80 and 110 %. If the capacity utilisation rate exceeds 80%, the delivery time extends significantly. For example, transit time at a utilization rate of 95% is by 20% longer than for a route with a low capacity utilisation level.

Analysis of the results

The transport chains reported herein are served by inland water navigation. Thus, the results for the emissions' KPIs are not varying significantly. On the other hand, there are differences in the specific costs per transport chain, which is due to the different cargo type transferred. For example, using the information on financial costs of the Planco Study, the transport of one tonne per km of bulk coal from Rotterdam to Duisburg seems to cost less than the transport of one tonne of unitised cargo at the same route.

Connection to the other work packages

Given the outcomes of the Planco Study (which are described below), it would be interesting to assess the impacts of green rail and road technologies on segments of this corridor and compare the results with green inland water navigation.

Other corridor related projects and studies

The Priority Axis No18 projects, which aim at the improvement of the waterway axis connecting the North Sea to the Black Sea, could provide information on the current infrastructural bottlenecks in this region.

[9] TEN-T Progress Report 2009: TEN-T Implementation of the Priority Projects

The Planco Study[10] on the Economical and Ecological Comparison of Transport Modes: Road, Railways, Inland Waterways was used, herein, as a source of data for cost calculations. Apart from costs, the final report of the Planco Study provides interesting information on the current utilization rates of transport networks, the impacts of taxation, the energy consumptions, etc., focusing in the area of Germany. Also, different modes of transport, including road, rail and inland waterways, are compared on the basis of external costs, accounting for transport safety, noise, emissions and area consumption. The results of this comparison give a clear advantage on inland shipping for bulk freight as well as for containers. The objective of the Planco Study was to properly account for IWT by performing a case-by-case analysis.

As follows, the results of the Planco Study per external cost factor are shortly presented:

- Concerning transport safety, the Planco Study findings position inland shipping as the safest transport mode compared to road and railways. As stated there, on the average, in the years 2000 to 2005 accidents with the involvement of freight vessels caused 0.04 death cases. For railway freight, the comparative figure is 0.28, and 2.48 for road freight.
- Concerning noise, the average external costs of inland shipping are rather low compared to the other modes of transport.
- Concerning CO2 emissions, the highest specific rates are caused by road trucks. Inland shipping causes lower CO2 emissions than railways. For example, the CO2 emission per TEU of inland shipping in the Rhine corridor is by 19% to 55% lower than for railways.
- Concerning other pollutants, inland shipping is more advantageous than road transport. At present, electricity-powered railways emit clearly lower pollutants (nitrogen oxide, sulphur dioxide, non-methane carbon hydrides, carbon monoxide and particles) than both road and ship transport. However, the introduction of more strict regulations in the near future will push towards reduced exhaust emissions from inland shipping.
- Concerning financial costs, the Planco Study addresses that the average transport cost of bulk cargo by inland shipping is 25% lower than that of rail transport. Also, the financial cost of inland ship transport of containers is 30% lower than that of railway transport. For both kinds of cargo, the financial cost of inland shipping and railway transport is lower than that of road.

4.6 Mare Nostrum

General description of the corridor and companies interviewed

The Mare Nostrum corridor includes Mediterranean and Black sea trade routes, focusing on trades between the following ports: Odessa - Constanta - Bourgas - Istanbul - Athens - Trieste - Gioia Tauro - La Spezia - Genoa - Marseille - Barcelona - Valencia - Algeciras - Sines.

[10] http://www.ebu-uenf.org/fileupload/GREENING%20TRANSPORT.pdf

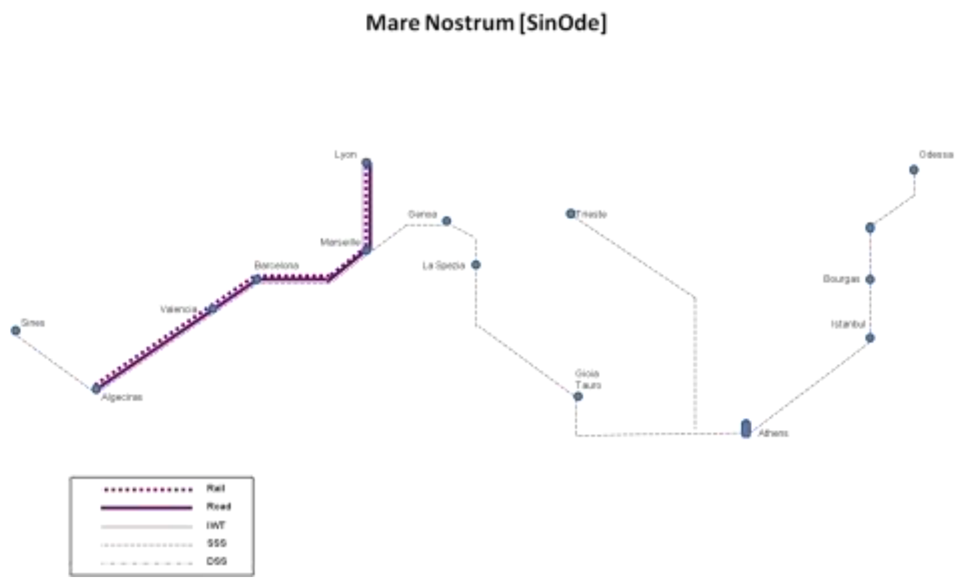

Figure 9 - Mare Nostrum map

The companies that participated in the survey were:

- Ship operators:
- U.N Ro-Ro İşletmeleri A.Ş.

  Mediterranean Shipping Company MSC S.A.

  Hellenic Sea Lines S.C.
- Port authorities:

  Piraeus Port Authority S.A.

Description of the critical segment

No specific critical segment was described by the interviewees. The argument is that this corridor can be served by all modes of transport.

KPI evaluation results at the transport chain level and benchmarks for the corridor

The results received from the interviews and literature reviews are summarized into Table 15. In total 11 different transport chains were identified and studied further. The detailed information about calculations of Mare Nostrum transport chain level KPIs can be found in Appendix III, on page 108.

In Table 16, benchmarks for Mare Nostrum corridor are presented. The corridor comprises mainly benchmarks for short sea shipping but also complementarily for some deep sea shipping KPIs.

TC no	Origin – Destination	Mode	Annual volume (t)	Key Performance Indicators (KPIs)													
				Cost EUR/t km	Delivery time (h)	Emissions (g/tkm)				Reliability	Frequency (no per year)	ICT applications	Cargo Security	Cargo Safety	Congestion	Bottlenecks
						CO2 eq	NOx	SOx	PM10							
1	East of Suez /West of Gibraltar - Port Said/Beirut/ Malta/ Gioia Tauro - West of Gibraltar /East of Suez	DSS	10000000	-	-	15.22	0.400	0.220	0.035	If delay is caused during loading/unloading.	-	Ship tracking at origin/ destination	>1%	>1%	Loading/ Unloading delays.	No weather problems reported.
2	Port Said/Beirut/ Malta/ Gioia Tauro – all Mediterranean ports	SSS	< 1000000	0.003-0.004	55	27.26	0.700	0.400	0.058	If delay is caused during loading/unloading.	52	Ship tracking at origin/ destination	>1%	>1%	Loading/ Unloading delays.	No weather problems reported.
3	Istanbul – Trieste	SSS	140 412 units	1360 euro/trailer	60	7.18	0.168	0.101	0.014	Depends due to winter conditions	416	Cargo tracking	0%	1%	Port terminal area	Dardanelles Strait causes traffic
4	Mersin – Trieste	SSS	24 215 units	1360 euro/trailer	70	8.42	0.194	0.117	0.016	Depends due to winter conditions	104	Cargo tracking	0%	1%	Port terminal area	
5	Istanbul - France	SSS	7 621 units	1360 euro/trailer	70	12.43	0.285	0.174	0.024	Depends due to winter conditions	104	Cargo tracking	0%	1%		Dardanelles Strait causes traffic

6	Barcelona - La Spezia – Barcelona	SSS	< 1000000	30% cheaper than road transport	Same as for road	27.26	0.700	0.400	0.058	If delay is caused during loading/unloading.	182	Ship tracking at origin/ destination	>1%	>1%	Loading/ Unloading delays.	No weather problems reported.
7	Piraeus/Istanbul - Gioia Tauro (or Malta, or Taranto) - Barcelona/Valencia – Piraeus/Istanbul	SSS	< 1000000	0.003-0.004	55	27.26	0.700	0.400	0.058	-	52	Ship tracking at origin/ destination	>1%	>1%	Loading/ Unloading delays.	No weather problems reported.
8	Volos-ATHENS-Crete-Cyprus-Volos/Athens	SSS	200000	0,006	220-340	10.00	0.231	0.138	0.019	95%	52	ICT group A*	40%	5%	80%	Bottlenecks group A **
9	Kavala to Stylida-ATHENS-Patra-Nafplio-Crete-Cyprus	SSS	Cyprus 20000 tn Greece 200000	0,005	380	6.44	0.150	0.092	0.013	95%	104	ICT group A*	15%	1%	40%	Bottlenecks groupB***
10	ISTANBUL-Greek Islands (Rhodes, Karpathos, Cyclades)	SSS	300000	0,016	240	9.89	0.227	0.141	0.019	90%	104	ICT group A*	30%	1%	65%	Bottlenecks group A
11	Alexandria-Cyprus to ATHENS-Thes/niki	SSS	Alexandria: 20000 Cyprus: 8000	0,020	305	8.27	0.189	0.115	0.016	95%	52	ICT group A*	20%	2%	50%	Bottlenecks group C****

*ICT group A: (a) Cost Voyage Estimation, (b) Technical management (plans, repairs, defect factors), (c) Spare parts	***Bottlenecks group B: (a) Industry capacity production	****Bottlenecks group C: (a) Industry capacity production

management, (d) Crew data administration, (e) AIS **Bottlenecks group A: (a) Industry capacity production, (b) Demand, (c) Weather, (d) Congestion, (e) Ports facilities, (f) Periodical Production	(b) Demand (c) Weather (d) Congestion (e) Ports facilities	(b) Demand (c) Weather (d) Congestion (e) Ports facilities (f) Cargo nature (g) Periodical Production

Table 15 - Mare Nostrum transport chain summary card

List of acronyms:

Road – Road
Rail – Rail
Short Sea Shipping – SSS
Deep Sea Shipping – DSS
Inland Waterways Transport – IWT
Intermodal Transport – IT

	DSS	Road	Rail	SSS
CO2 (g/tkm)	**15.22**	**-**	**-**	**6.44-27.26**
SOx (g/tkm)	**0.220**	**-**	**-**	**0.092-0.400**
Cost (€/tkm)	**-**	**-**	**-**	**0.003-0.020**
Average speed (km/h)	**-**	**-**	**-**	**16.71**
Reliability %	**-**	**-**	**-**	**90-95%**
Frequency (no per year)	**-**	**-**	**-**	**52-416**

Table 16 - Benchmarks for the Mare Nostrum corridor

Description of identified bottlenecks

The interviewees identified the followings as infrastructural and operational bottlenecks of the Mare Nostrum corridor:

- Weather
- Congestion
- Ports facilities

Congestion at port site is caused by the infrastructural insufficiency of the road network around the port. To mitigate problems related to the increased traffic around ports, the interviewees suggested that road networks dedicated only to trucks and railway connections could become efficient solutions.

The interviewees also addressed the lack of port facilities as a cause of operation-related bottlenecks. The existence of sufficient port facilities, such as cargo loading/unloading and handling) is important for achieving efficient operations and bottlenecks' reduction.

The interviewees also commented that each transport chain itself may encounter problems related to the cargo nature and the industry production. For example, periodical production or demand fluctuations can increase or reduce the costs, affect the scheduling of other transport chains, etc.

Analysis of the results

The emissions' KPI seems to depend on the regime of each transport chain, i.e. the length, the load factor per trip and the vessel type. Long transport chains, like the one that sails across the Mediterranean Sea (from east of Suez to west of Gibraltar), are operated by large mother ships, which have different emissions' and load factor from the feeders. Thus, the difference in the emissions' KPI can be expected. Transport chains that serve local trading are also different: as identified by the interviewees, the load factor for these trips depends on the industry capacity production and the demand. Transport chains like the Istanbul-Trieste route serve the trade between EU and Turkey. A large capacity of different type of goods is transferred via this route. Similar to this chain, the Istanbul-France and

Mersin-Trieste routes also serve the EU-Turkey trade. As addressed by the interviewees, these trades are expected to augment in 2011, giving rise to around 35,000 units per year in each route and 70% load factor.

Connection to the other work packages

As identified by the interviewees, focus could be shed on how to resolve the bottlenecks by means of new technologies and/or infrastructure. It is interesting to identify which technologies could reduce emissions and increase efficiency while sailing. Also, cargo handling facilities and their benefits on increasing the efficiency of port operations could be identified.

Concerning ICT facilities, the interviewees identified the case of using satellite based applications for cargo tracking during trip. However, the current applications with which the cargo can be tracked on the trip's origin and destination were identified as sufficient.

Other corridor related projects and studies

The Euromed[11] transport project identifies and depicts the volumes of freight flows in the Mediterranean Sea per cargo type, i.e. unitised, solid bulk and general cargo. Current status and future trends are described and illustrated. As shown by the Euromed maps, the largest freight flow is the one that crosses the Mediterranean Sea with one/two intermediate transhipment points. Herein, this flow is represented by the first transport chain. Shorter flows, which herein are described as feeder loops (transport chain two, for example), connect the large intra-Mediterranean transhipment points to all Mediterranean ports.

The results of the COMPASS[12] (COMPetitiveness of EuropeAn Short-sea freight Shipping compared with road and rail transport) project are referred and compared to this study. The COMPASS project investigates the magnitude of the impact of selected policies for the improvement of SSS environmental performance in Europe on transport costs/volumes, emissions, etc. In the COMPASS final report it is reported that based on the cost data gathered it can be said that in general rail and SSS are cheaper than road. Herein, based on the interviewees answers, SSS can become 30% less expensive that the road alternative. The COMPASS results were used for the identification of the emissions' KPI on transport chains that are operated with Ro-Ro vessels.

4.7 Silk Way

Due to the challenges related to retrieving verifiable real-life and corridor specific data the analysis of the Silk Way corridor is based purely on a review of existing literature. Further, the analysis is based on the assumption that the railway and deep sea service will have equal hinterland transport at point of origin and at point of destination. This allows for a direct comparison of transport work between the two transport modes, namely container transport between Far East and Europe.

The background material for the analysis of the Silk Way corridor has been existing literature, as listed in the references.

[11] http://www.euromedtransport.org/index.php?id=137&L=0

[12] http://ec.europa.eu/environment/air/transport/pdf/sss_report.pdf

General description of the corridor

The Silk Way corridor consists of two main transport services linking the Far East with Europe. Today there are mainly two alternatives for shipping large transhipments of goods between the two regions, one being the deep sea service linking Shanghai to the Le-Havre-Hamburg region, while the other is the rail-link between Beijing and Duisburg/EU. Also note that the analysis focus on a single journey only, meaning that a transport company's ability to have several assets on the same service will not be accounted for. This means that for a deep sea carrier, only the performance of one ship will be analysed. The same applies for the railway service. The main goods transported in the corridor are consumer goods.

Below is a 'metro' style map of the corridor:

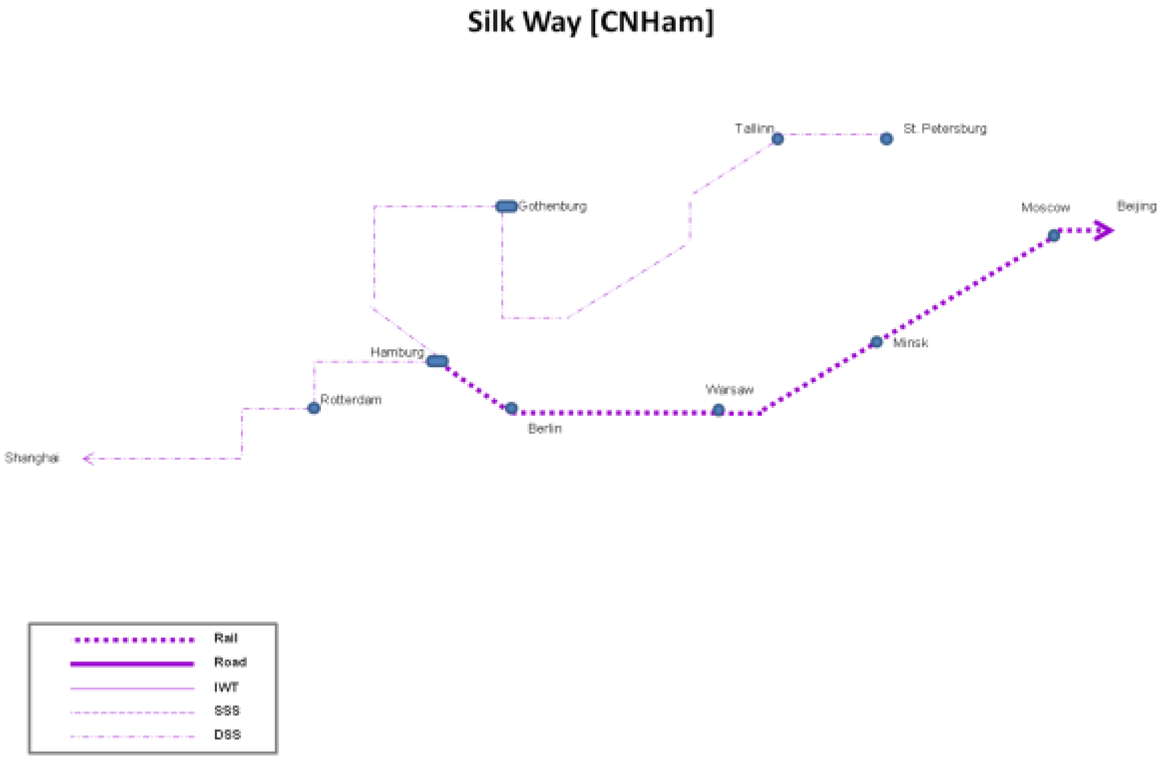

Figure 10 - Silk Way map

Deep sea – Shanghai to Le-Havre – Hamburg range

The Silk Way deep sea route has its origin in the port of Shanghai with the Le-Havre – Hamburg range as point of destination, via the Suez Canal (Figure 11).

Figure 11 - The Silk Way deep sea service, Shanghai to Rotterdam[13]

Different studies of the environmental performance of the deep sea trade between the Far East and Europe disclose that results do fluctuate. This is visualised in the table below, showing how the results of gCO2/tkm vary.

gCO2/tkm range value	gCO2/tkm (range average)	Vessel best practise in gCO2/tkm	Reference
12.5 – 36.3	Not given	12,5 (TEU > 8.000)	IMO Second GHG Study(2009)
15 – 79	19	15 (TEU > 8.500)	Lindstad & Moerkve, (2009)
10.8 – 31.6	12,1	10,8 (TEU > 4.400)	Psaraftis and Kontovas, (2009)
70.2 – 119.3* **(*gCO2/TEUkm)**	Not given	8,3 (TEU> 11.000)	Maersk Line, (2007)[14]

Table 17 - Overview of gCO2/tkm emission for container transport

For the studies presented in Table 17, the *range average* values of gCO2/tkm clearly shows there are considerable differences. The underlying reason for these differences can be traced back to variations in the baseline for the respective studies (i.e. applied data/statistics and assumptions). Thus, elements such as (1) estimated utilisation of cargo capacity and (2) level of detail of container fleet segmentation applied will have an impact on the provided results. Looking at segmentation of the world container fleet it is obvious that the more detailed the segmentation is, the more differentiated the reflection of the environmental performance will be. The latter is particularly relevant for explaining the variations in *gCO2/tkm range values* between the studies.

[13] Source: www.portworld.com

[14] Main source of information from Maersk Line is provided by Swedish Network for Transport and the Environment

The above is further visualised by the figures below, showing the results from the IMO 2nd GHG Study (2009), and the results from Lindstad and Morkve (2009).

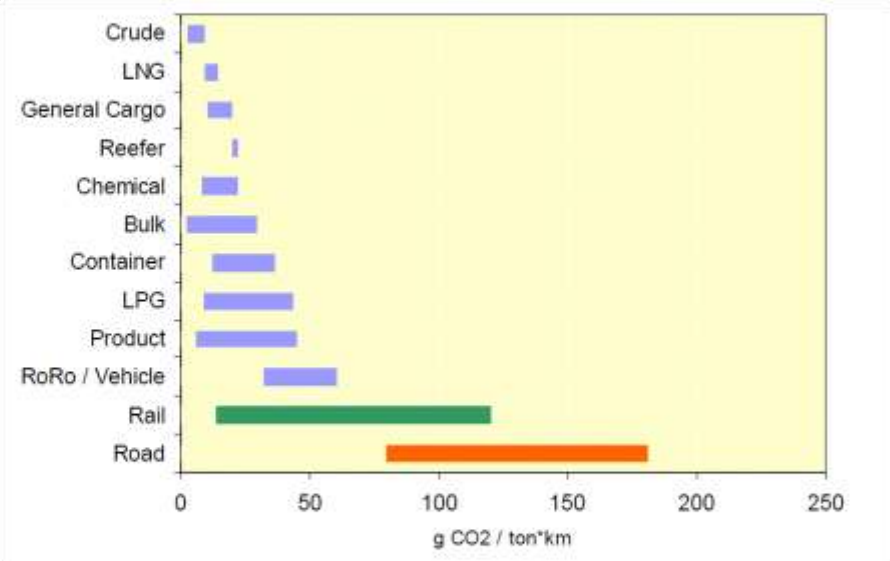

Figure 12: Typical ranges of CO2 efficiencies of ships compared with rail and road transport [15]

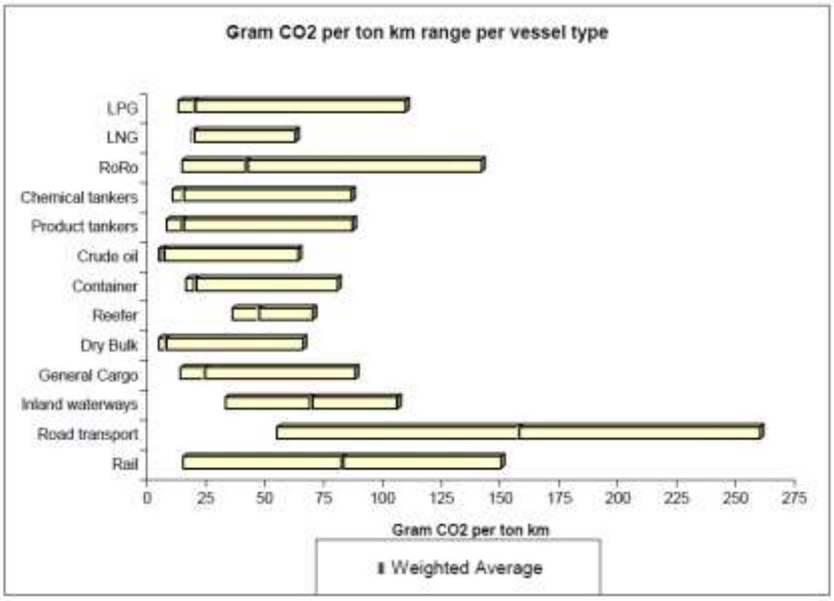

Figure 13: Cargo ship types [16]

For this analysis the results from the IMO Second GHG Study (2009), has been chosen and will be applied for completion of the summary KPI table below. Since the distance between the Far East and Europe is approximately 20.000 km, the total voyage is covered in the range of 35-41 days (assuming an average speed of 20-24 knots).

In order to calculate to the transport cost for shipping one TEU from the Far East to Europe, the end of fourth quarter 2009 freight rate from Review of Maritime Transport (2010), has been applied. Although freight rates may fluctuate substantially within and

[15] Source: IMO 2nd GHG Study, 2009

[16] Source: Lindstad & Moerkve, 2009

over the years, as well as between different container lines, the selection represents relatively updated figures and a market average of the three largest container lines covering the Asia-Europe trade.

Table 4.5. Freight rates (market averages) per TEU on the three major liner trade routes
(in dollars per TEU and percentage change)

	Trans-Pacific		Europe–Asia		Transatlantic	
	Asia–United States	United States–Asia	Europe–Asia	Asia–Europe	United States–Europe	Europe–United States
2008						
First quarter	1 757	845	1 064	2 030	1 261	1 637
Percentage Change	3	6	18	- 1	10	- 7
Second quarter	1 844	987	1 104	1 937	1 381	1 610
Percentage Change	5	17	4	- 5	10	- 2
Third quarter	1 934	1 170	1 141	1 837	1 644	1 600
Percentage Change	5	19	3	- 5	19	- 1
Fourth quarter	1 890	1 196	1 109	1 619	1 731	1 600
Percentage Change	- 2	2	- 3	- 12	5	0
2009						
First quarter	1 670	913	853	1 023	1 481	1 325
Percentage Change	- 12	- 24	- 23	- 37	- 14	- 17
Second quarter	1 383	802	742	897	1 431	1 168
Percentage Change)	- 21	- 12	- 13	- 12	- 3	- 12
Third quarter	1 232	817	787	1 061	1 424	1 133
Percentage Change	- 11	2	6	18	- 0	- 3
Fourth quarter	1 322	883	920	1 422	1 527	1 250
Percentage Change	7	8	17	34	7	10

Source: UNCTAD secretariat, based upon *Containerisation International Online* which is available at http://www.ci-online.co.uk.

Notes: The freight rates shown are "all in", that is to say, they include currency adjustment factors and bunker adjustment factors, plus terminal handling charges where gate/gate rates have been agreed, and inland haulage where container yard/container yard rates have been agreed. All rates are average rates of all commodities carried by major carriers. Rates to and from the United States refer to the average for all three coasts.

Table 18 - Freight rates by the end of fourth quarter, 2009 [17]

Based on the above the calculated cost per t/km follows in the table below.

Given cost in USD per container (TEU)	1 422 (€ 1002[18])
Distance covered in km	20 000
Average net tonnes transported per TEU	12
Cost per ton (1002,32/12 net tonnes per TEU)	84
Cost in €/tkm	**0,004**

Table 19 - Calculation of transport cost in €/tkm for Silk Way deep sea service

Railway – Beijing to Duisburg

According to the corridor description, the rail way link goes from Beijing to Hamburg but following the service provided by the TransEurAsia Express the analysis for the rail link will utilise Duisburg as point of destination. Although this means that the two transport services with similar points of origin now will have different point destination, the distance

[17] Source: Review of Maritime Transport, 2010

[18] Calculated by DnB Nor Markets currency exchange calculator, 04.04.2011

between Duisburg and Hamburg is not more than 376 km. Thus, it is assumed that the results of the analysis will not be significantly affected.

For cargo transport the rail link between Shanghai/ Beijing and Duisburg take approximately 18 days from terminal to terminal along the route as depicted below. Although such a train service is not capable of transporting the same amount of goods in one shipment compared to a large container vessel, the transport time is considerably shorter compared to deep sea transport (taking approximately 35-40 days depending on average speed at sea).

Figure 14 - Rail service linking Far East to Europe via Russia [19]

The service is based on a regularly scheduled transport with a fixed route and departure days. Due to differences in rail gauges between Russia and China, a block train is formed in Zabaykalsk at the Russian/Chinese border with containers coming from Shanghai/Beijing. From Zabaykalsk the train travels en-route to the EU border at Brest/Malaszewicze. From here, connections are available to Duisburg (including all gateway connections), Hamburg, Warsaw, Prague and other destinations in Europe. According to the EcoTransIT online calculation tool the total distance from Shanghai to Duisburg is approximately 11 000 km.

Similar to deep sea transport service there are a number of different publications regarding the energy efficiency of rail transport, and the tendency with fluctuating results is also evident for rail transport. As shown in the table below there are significant differences between the studies both in the gCO2/tkm ranges and the respective range average values.

gCO2/tkm range	gCO2/tkm (range average)	Reference	Geographical scope
10 – 119	41	IMO Second GHG study(2009)	USA, Europe, UK
-	18	Psaraftis and Kontovas, (2010)	Trans-Siberian railway
14 – 148	81	Lindstad & Moerkve, (2009)	USA, Europe
13 – 33[20]	20[21]	Geitz & Jia (2010)	Europe incl. Black Sea Region
-	17[22]	Maersk Line, (2007)[23]	Not given

Table 20 - Overview of CO2 emission for rail transport

[19] http://www.trans-eurasia-logistics.com/Products/China-Europe/index.php

[20] Calculated by the partner responsible for teh corridor (converting CO2 per train km to gCO2/tkm)
[21] Estimated by the partner responsible for the corridor
[22] Train- Diesel
[23] Main source of information from Maersk Line is provided by Swedish Network for Transport and the Environment

According to the results from the study performed by Geitz and Jia (2010), the emission of gCO2/tkm range is considerably lower than those provided by the Second GHG study (2009), and Lindstad and Moerkve (2009) (Table 20).

Further, there are also considerable differences in the presented gCO2/tkm *range average*. The reason for this is assumed to be much related to the energy mix applied in the different studies in addition to variations in geographical scope. Due to the difficulty of actually tracing how the electricity in the electricity mix has been produced (coal, nuclear power, natural gas, hydro, etc.), there are uncertainties to how comparable these numbers are to other transport modes. However, the results from the IMO Second GHG study (2009) are inserted in the summary KPI table.

Cost per t/km for one container is calculated as follows:

Quotation specifics	Cost elements
Freight main haul/train (40´ HC)	$ 8 230
Cross-docking Rail Terminal China (loaded)	$ 122
Insurance main haul/train China:	$ 25
Security costs Russian Federation:	$ 100
Re-expedition costs:	$ 35
Other Administration:	$ 210
Liability insurance	$ 35
Given Total cost per container (TEU) [24]	**$ 8 757 (€ 6159)**[25]
Distance covered in km	11 000
Average net tonnes transported per TEU	12
Total transported net tonnes	1200
Cost per ton in € (6 158,60/12 net tonnes per TEU)	513
Cost in €/tkm	**€ 0,05**

Table 21 - Calculation of transport cost in €/tkm for the Silk Way railway service[26]

KPI evaluation results

Below is the KPI summary table of the Silk Way corridor analysis. According to the Silk Way 'metro' map the corridor also consists of a SSS/feedering and road link but due to the reasons initially described these are left out of the analysis. Further, since the most important aspect of this analysis is to shed light on the energy efficiency and ability to perform transport work between the two regions, the focus has been on the rail link going

[24] Price quotation for the Transeurasia Express, Not included: provision of empty containers, risk surcharges, currency surcharges.

[25] Calculated by DnB Nor Markets Currency exchange calculator

[26] Source: Schenker, 2010, SuperGreen calculations, 2010

from China, via Russia into Europe, and the deep sea service linking China with Europe (Shanghai- Le-Havre-Hamburg range).

	Rail	Road	DSS	SSS
CO2 (g/tkm)	**41**[27]	**-**	**12,5**[28]	**-**
NOx (g/tkm)	**-**	**-**	**-**	**-**
Cost (€/tkm)	**0,050**	**-**	**0,004**	**-**
Average speed (km/h) [29]	**26**	**-**	**20 – 23**	**-**
Reliability (%)	**-**	**-**	**-**	**-**
Frequency (no per year)	**-**	**-**	**-**	**-**

Table 22 - Benchmarks for the Silk Way corridor

Description of identified bottlenecks

When analysing transport services there are always critical segments requiring attention. Such segments are known as transport bottlenecks, having a disruptive effect on the flow of goods through a transport chain.

For the Silk Way corridor such disruptive elements come in different shapes and a selection of these is included in the table below:

Transport mode	Description of critical segments/bottlenecks
Deep sea transport	Congestion at ports, particularly during peak seasons, may cause considerable delays for container carriers due to waiting time for available quay space and crane capacity. This may also have an effect on the European feeder traffic
	In the Aden Bay there is a security problem due to the increasing numbers of piracy incidents on vessels.
	The capacity of the Suez canal allows passage of ships up to 19 m (62 ft) draft or 210,000 deadweight tons and up to a maximum height of 68 m (223 ft) above water level and a maximum beam of 254 ft 3 in (77.5 m) (under certain conditions). Improvements are planned to increase draft to 22 m (72 ft) by 2010, allowing passage of fully laden supertankers. Since some supertankers are too large, a possible solution is to offload part of their cargo onto a canal-owned boat to reduce

[27] Block Train

[28] TEU > 8000

[29] Calculation is based on the distance/transit time

	their draft, transit, and reload at the other end of the canal. Alternative routes are around Cape Agulhas, South Africa, or Pacific Ocean, through the Panama Canal.
Railway transport	Transporting cargo by rail over large distances and across several borders can result in operational challenges related to differences in rail gauges between different nations (e.g. between Russia and Poland, and between China and Russia)
	Railway terminals also differ in terms of the ability to handle particularly long trains. This means that some terminals have to divide long freight trains into smaller segments before being able to initiate the (un)loading process. To what extent this particular service suffers from this bottleneck is subject for further investigation.
	Security of cargo travelling such large distances, also due to considerable time spent in distant regions.

Table 23 - Bottlenecks of the Silk Way corridor

Analysis of the results

From the analysis above the following concluding remarks are made regarding transport mode performance:

- Rail has significantly lower cargo carrying capacity compared to the average deep sea vessel deployed in such a trade (Far East – Europe).
- Rail has considerable lower transport time and is as such a competitive advantage compared to the deep sea service.
- Due to the deep sea scale effect of being able to transport a significant larger amount of TEUs in one shipment, deep sea transport achieves a better performance in terms of gCO2/tkm and much lower cost per tkm.

Connection to the other work packages

Related to container vessels there are a number of measures available for improving the environmental performance of operations. Some are best suited for new buildings; some are available for retrofitting, while others are more operationally focused. Looking particularly at waste heat recovery, it has a potential of reducing total energy consumption up to 10% (Wärtsila, 2008). According to Maersk, the installation of such a system on the vessel Emma Maersk reduces energy consumption by approximately 10%. This is achieved by capturing the excess heat from the exhaust, which in turn is utilised for propelling the vessel via the shaft engine, or for generating energy for on-board systems. This also has an effect on the emission of particular matters, CO2, NOx and SOx.

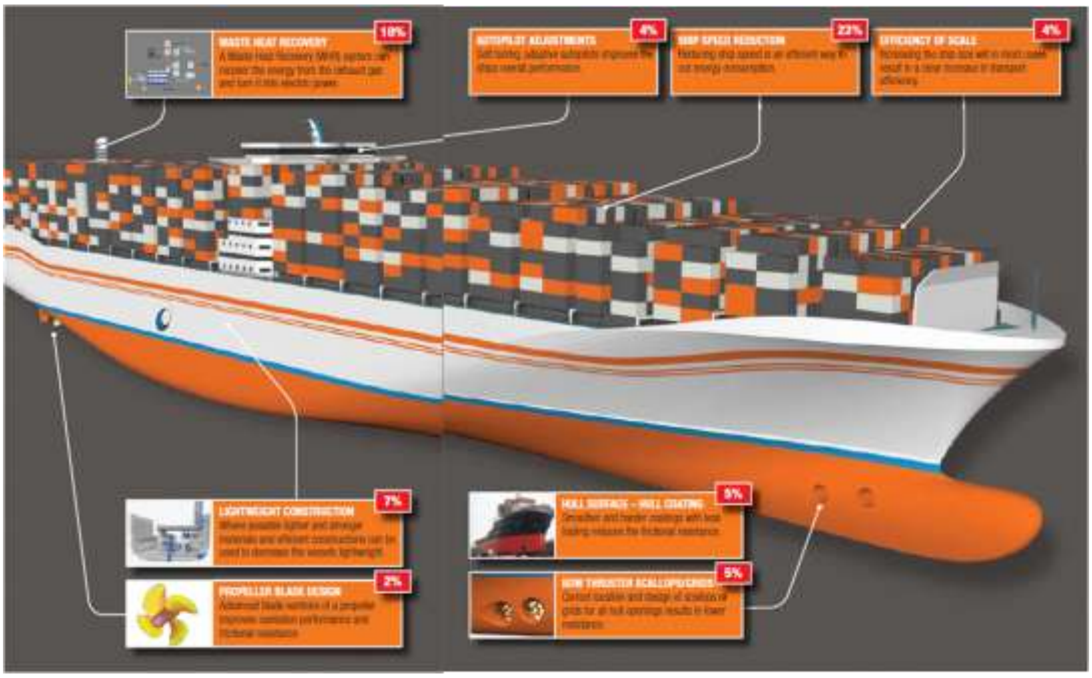

Figure 15 - Technological and operational measures for reducing environmental impact from container vessels[30]

In relation to cooling of reefer containers, Maersk has now started to use water as the main source of energy. Although this measure is not installed across the entire fleet, the majority of container newbuildings have this technology, giving a reduction of energy consumption of approximately 15-20% per container (Maersk, date unknown). Further, fast container handling in ports are also important, since this will allow for shorter turnaround times and thus allow for more slow steaming during transit. As depicted above, slow steaming have the potential of reducing energy consumption with as much as 23% (Wärtsila, 2008), which also contributes to reduced emission of Green House Gases (GHG) to air. These measures are directly linked to the technology mapping of SuperGreen WP3.

Regarding Information and Communication Technology (ICT) available for making the corridor more sustainable, AIS – Automatic Identification System, LRIT – Long Range Identification and Tracking, radar and SafeSeaNet could be utilised. With a wide-ranging implementation of such technologies relevant stakeholders are able to retrieve improved information of vessel position, vessel speed, ship identification, estimated time of arrival at the ports, estimated time of departure, and type of cargo transported. However, this requires a transponder onboard the ship (mandatory), and on-shore AIS infrastructure. The motivation for implementing these measures are the ability to improve the systems for port logistics and traffic monitoring, and increased efficiency and safety of operations. In addition, Port Community Systems and Single Window solutions can contribute through improved port resource management, electronic information exchange (EDI), and traffic statistics. These measures are directly linked to the technology mapping of SuperGreen WP4.

Specifically considering the rail service linking Europe with the Far East, below are a few examples of measures contributing towards a more sustainable transport service. As identified in WP3, brake energy recovery is a Railway Reversible DC Substation for recovering of dynamic braking energy and restitution to national grid. The company

[30] Source: Wärstila, 2008

Alström has carried out successful pilots, and although the time to market is considered to be medium-term, the system 'captures' close to 100% of the energy produced during breaking, energy that are regenerated. Although no specific data is available regarding actual contribution to fuel/ energy reduction, similar technology is successfully implemented in the automotive industry (i.e. hybrid cars).

Further, the Metrocargo technology is an innovative solution for handling containers in overhead electrified railways. More specifically, the containers are handled horizontally from an automated platform to train wagons. Although this technology is not readily available, Metrocargo will be tested on Maersk's new Platform in Vado Ligure (SV), Italy. With the Metrocargo's Platform ability to handle 0,67 train per hour, it has the potential of shortening rail shunting operations between trains and between road and rail. This is particularly valuable for the Silk Way rail service due to the difference in gauges between China, Russia, and Europe. These measures are directly linked to the technology mapping of SuperGreen WP3.

Finally, considering Liquefied Natural Gas (LNG) as one of the main sources of energy for all transport modes is a measure receiving more and more attention from the industry, various governments, NGO's, as well as among researchers. Although several challenges remain to be tackled, being related to various cost and operational aspects, the environmental upside of a wide-ranging implementing this technology is currently considered to be substantial. This measure is directly linked to the technology mapping of SuperGreen WP3.

Other corridor related projects and studies

On the long debated question if more stops in the Mediterranean sea would make the EU connection to China more sustainable the consortium has received two contrasting studies from Port of Hamburg[31] and University of Venice[32].

Hamburg maintains that as the ship needs to go to Hamburg anyway they are competitive CO2 footrprint wise on the land side. While in the study by the University of Venice declares that going to Rotterdam/Hamburg adds 2300 Nautical miles and makes an overall carbon footprint very high for the northern ports (e.g. Paris is better served out of Venice i.o. Hamburg).

The SuperGreen consortium believes that this is a typical example where a mono-modal analysis or a corridor analysis is not sufficient and an even higher holistic approach at continental level would be required to reach a no-nonsensical solution to this problem. Based on the above, the EU funded study CODE 24 on the Genova Rotterdam Corridor could be the right place where to address this issue.

4.8 Conclusions and final remarks

The benchmarking results presented in the sections above provide state of the art information on the corridors and serve as an input for measuring the greening effects in the upcoming tasks. The benchmarks evaluated in this document are based on the information

[31] Geitz, W.D. and Jia, N. (2010) *"Benchmark of Environmental Emission for Railway Hinterland Transport from the Port of Hamburg"*, Report for Hamburg Port Authority

[32] Prof. A. Cappelli, Arch. E. Fornasiero, Arch. Ing. A. Libardo (2011)*"Intercontinental freight transport impacts: modeling and measuring choice effects"*

collected on a limited number of sample transport chains and literature review. The Silk Way corridor could be considered as purely literature based research; no interviews were carried out for this corridor.

For each corridor a number of transport chains were identified. It varies from 6-16 and the quality level of the input data was also different. The biggest challenge for the partners in this task was to carry out the interviews. The willingness to collaborate from the industry side was relatively low and the rate of responses that the partners received to their requests was way below 40%. The lack of interest made the exercise extremely time consuming and required a lot of resources. The reasons why companies/organisations could not participate in the survey varied, e.g. confidentiality reasons, no data to provide, no corridor related data, not enough resources/time to collaborate, etc.

However, with the assistance of the interviewees who participated in the survey, the partners were able to identify the critical segments of the corridors, select the typical cargo that passes the segment and collect data on the transport chain. The collection of data on the transport chain involved the critical data for EcoTransIT calculations, e.g. consignment load factor, empty trip factor, etc. The non-environmental KPIs were either evaluated qualitatively or quantitatively and emissions were calculated with the online calculator EcoTransIT World. The results of the corridor benchmarking include a corridor KPI summary card that presents transport chain related KPI values.

The benchmarks for the corridors are set using minimum and maximum values of the KPIs, e.g. the value of the KPI differs for each transport chain, and the benchmarks are set using extreme values of those KPIs. The SuperGreen transport operations related benchmarks are summarised in Table 24. A distinction has been made between different modes of transport. Although the benchmarks are closely related to freight transport operations, infrastructural improvements and the greening effects can also be assessed in the future tasks of the project using the same KPIs.

An important note has to be made that the results presented in the table are indicative and using other tools and methods may lead to different results. Results presented here are achieved using EcoTransIT World web emission calculator, self-reported figures from interviewees and literature review. It should be also mentioned that some of the emission related results may be overestimated (e.g. for Strauss corridor).

The benchmarking study highlights corridor bottlenecks as both infrastructural and operational bottlenecks were mapped during the exercise. In case of the Mare Nostrum corridor, a pre-identified list of bottlenecks was prepared, including industry capacity production, demand, weather, congestion, ports facilities, cargo nature and periodical production related shortages. From all the listed bottlenecks the interviewees identified those relevant to their transport chain and put together a group of bottlenecks for their transport chain. As another example, the freezing of the Baltic Sea can be considered as a specific type of bottleneck in the Nureyev corridor and was mentioned by most of the interviewees. Although efficient, high performance ice-breakers are used, delays caused by the ice conditions may occur during some winters.

After setting the benchmarks for the corridors, an analysis for each corridor was prepared in order to interpret the findings. The aim of the analysis was to understand the bottlenecks and shortcomings of green technologies and ICT solutions that can cause inefficiencies and waste of resources during transportation in the corridor. Thus, the connection with other work packages in the project and recommendations for further analyses were made.

It is important to highlight that the connections with other corridor related projects and studies were sought. Projects such as Scandria, Euromed, COMPASS, as well as several studies, e.g. the Planco study, have been taken into account in the benchmarking process of the KPIs.

Corridor name	Mode of transport	CO2 (g/tkm)	SOx (g/tkm)	Cost (€/tkm)	Average speed (km/h)	Reliability %	Frequency x times/year
Brenner	*Intermodal*	**10.62-42.11**	**0.020-0.140**	**0.03-0.09**	**9-41**	**95-99**	**26-624**
	Road	**46.51-71.86**	**0.050-0.080**	**0.05-0.06**	**19-40**	**25-99**	**52-2600**
	Rail	**9.49-17.61**	**0.040-0.090**	**0.05-0.80**	**44-98**	**60-95**	**208-572**
	SSS	**16.99**	**0.050-0.120**	**0.04-0.05**	**23**	**100**	**52-520**
Cloverleaf	*Road*	**68.81**	**0.091**	**0.06**	**40-60**	**80-90**	**4680**
	Rail	**13.14-18.46**	**0.014-0.021**	**0.05-0.09**	**45-65**	**90-98**	**156-364**
Nureyev	*Intermodal*	**13.43-33.36**	**0.030-0.150**	**0.10-0.18**	**13-42**	**80-90**	**156-360**
	SSS	**5.65-15.60**	**0.070-0.140**	**0.05-0.06**	**15-28**	**90-99**	**52-360**
Strauss	*IWT*	**9.86-22.80**	**0.013-0.031**	**0.02-0.44**	**-**	**-**	**-**
Mare Nostrum	*SSS*	**6.44-27.26**	**0.092-0.400**	**0.003-0.200**	**17**	**90-95**	**52-416**
	DSS	**15.22**	**0.22**	**-**	**-**	**-**	**-**
Silk Way	*Rail*	**41.00**	**-**	**0.05**	**26**	**-**	**-**
	DSS	**12.50**	**-**	**0.004**	**20-23**	**-**	**-**

Table 24 – SuperGreen benchmarks for corridors

5 Consultation with stakeholders

5.1 Introduction

Task 2.4 on the benchmarking of the SuperGreen corridors is one of the most important exercises in the project in terms of enabling a later evaluation of technologies and ICT solutions in the upcoming tasks of the project. In order to ensure the quality of the outcome and the general acceptance of the results, regular consultations with the stakeholders were required. For this purpose, a series of regional workshops were planned in order to consult on the progress and next steps of the task. To attract the maximum number of participants, each workshop was designed with a focus on a specific topic closely related to the region and the venue. Workshop announcements can be found on the project website in the news section (http://www.supergreenproject.eu/news.html).

The timetable of the workshops provided for the first event to take place at the beginning of the task and the remaining three in the second half of the task. This enabled the partners to consult regularly on the progress. Moreover, due to the fact that Deliverable 2.2 did not provide a conclusive methodology and a final set of the KPIs, a further discussion with the stakeholders on the topic was urgently needed and regional workshops were seen as a perfect interface to fill this gap. The final methodology and the set of the KPIs to be used for the benchmarking evolved throughout the task and each workshop was used to consult the stakeholders on the progress.

The four planned regional workshops took place as follows:

- Nola/Naples, Italy on 19 October 2010
- Antwerp, Belgium on 1 February 2011
- Malmö, Sweden on 10 March 2011
- Sines, Portugal on 24 March 2011

Summaries of the SuperGreen regional workshops are presented in the following sections.

5.2 Regional workshop in Naples

The first regional SuperGreen project workshop took place at Interporto Campano in Nola on October 19, 2010. The workshop was the first in a series of regional workshops associated with the project benchmarking task and it attracted around 100 participants. The workshop entailed an overview of the project progress, including the selection of pilot corridors and the initial set of Key Performance Indicators (KPIs) that will be used for benchmarking the selected corridors and a consultation session with the stakeholders present. Despite its complexity, the concept of green corridors was welcomed and the potential of the SuperGreen project was recognized by stakeholders.

The audience of the workshop consisted of logistics service providers, shippers, carriers in all surface modes, intermodal terminals and transport companies, policy makers, researchers, environmental organizations and other stakeholders interested in green logistics.

As one of the most important events at the workshop, the consultation session with stakeholders was carried out in two groups – in Italian and English-speaking groups. The discussion was focused on the benchmarking methodology and selection of the Key Performance Indicators. The outcome of discussions in the consultation sessions can be summarized as follows:

- The overall concept was warmly welcomed and there was a feeling that pilot cases can probably help to better understand the scope of the project. In fact, this will be accomplished in subsequent phases of the project and presented in future events.
- The proposed methodology for benchmarking was in principle accepted as complete. However, it was recommended to leave the weighting task of the KPIs out of the benchmarking exercise. This was justified with the fact that different stakeholders have different approaches and criteria towards the proposed KPIs (for instance, some participants said that only two KPIs count, cost and service).
- One of the groups highlighted the need for identifying the specific end-users of the KPIs and the benchmarking methodology as it was not clear for whom the project aims to develop the benchmarking methodology.
- The general impression was that the presented KPIs are thoroughly studied but a further selection of the KPIs should be carried out in order to ensure full operability. Many participants said that an operational example of how the KPIs will be used should be developed as a matter of priority.
- Stakeholders expressed their opinion on the evaluation of the free access to the infrastructure and found that the project should not look at it at this stage. The general opinion was that it is a precondition which is already regulated at the EU level and must be applied by the Member States.

In addition to the input from the discussion, stakeholders made their contribution in writing by filling in questionnaires on the selection of the KPIs and the development of the methodology for benchmarking.

The event closed with a panel discussion where experts from the logistics industry gave their opinion on the project and the concept of green corridors. During the panel discussion several problems in Italian logistics emerged which were first considered to be regional but, as concluded at the end, are likely common to the whole of the European Union.

5.3 Regional workshop in Antwerp

The second regional SuperGreen project workshop was hosted by the Port of Antwerp on February 1, 2011. The event took place in Hotel Lindner in Antwerp and brought together around 70 participants. The audience of the workshop consisted of logistics service providers, carriers in all surface modes, public authorities, researchers and other stakeholders interested in green logistics.

The second regional workshop focused on two main topics – effects of changes in operational and regulatory environment and the progress in the benchmarking of green corridors. The aim of the workshop was to introduce the work carried out in both areas and to present preliminary results of the corridor benchmarking task. It is important to mention that the SuperGreen project makes the first ever attempt to benchmark freight transport corridors. The workshop involved general presentations in the morning and dedicated parallel workgroup sessions in the afternoon. In total two parallel sessions were held, one of which focused on effects of changes in operational and regulatory environment and the second on corridor benchmarking.

The method for evaluating the effects of changes in operational and regulatory environment was a survey based on research works and other existing information. The information has been collected in a few main areas: changes in business environment, trends in logistics, public policies, operations, infrastructure development, technology development and international regulations. The objective of the task was to determine the general and specific changes in the corridor´s operational and regulatory environment which may hinder improvements of green logistics corridors. Assessment of the effects has been made using the key performance indicators (KPIs) that will be used for benchmarking the corridors selected for the analysis.

The aim of the benchmarking task is to carry out a comparative analysis between corridors based on selected KPIs. According to the methodology, the evaluation of KPIs is carried out on the identified 10-15 typical transport chains in each corridor. After the evaluation of KPIs on transport chain level, an effort will be made to aggregate KPIs to the corridor level. Preliminary results on the evaluation of KPIs on transport chain level in the Brenner corridor were presented during the workshop.

Parallel sessions

Changes in operational and regulatory environment

A session opening presentation was given by the guest speaker Prof. Thierry Vanelslander of the University of Antwerp on "*Green corridors: Policy and regulatory issues*" with emphasis on inland waterway transport. More specifically, the positive effects of innovation and port capacity enhancement on the environment through shifting cargoes from road to inland navigation were presented. The main conclusions were:

- The internalisation of external costs, if applied on all modes, would lead to significant changes in modal split in favour of rail and inland navigation.
- There is a need for reliable and comparable statistics and indicators.
- Investments in innovation should be increased in order to be brought in line with those in other sectors of the economy.

The effects of the identified changes in the operational and regulatory environment on green corridor development were then discussed with the participating stakeholders. Emphasis was placed on public policy issues. The main conclusions were:

- All identified barriers to green corridor development have been adequately addressed by EU policies. Of particular importance are the administrative barriers addressed by the Freight Transport Logistics Action Plan. In general, the legal framework is pretty much in place. Special attention should be given to the enforcement of existing legislation.
- The corridor approach is an effective way to address the fragmented nature of European transport networks, especially in the rail sector. Valuable lessons can be drawn from Regulation No 913/2010, which introduced the freight-oriented corridors.

- The effectiveness of transport policy is enhanced by employing packages of complementary instruments. Very important is the role of technology (in particular commercially viable alternative fuels) for the long run, and of ICT applications for the immediate future. The significance of educating, informing and involving the greater public in transport policies is a precondition for their effectiveness.

- Over-regulating is an issue that needs not to be overlooked, since improvements in one aspect might create problems in another. A possibility worth assessing by the European Commission is the amendment of the new Marco Polo programme to include financial instruments aimed at preventing 'back-shift' from more environmentally-friendly modes to road transport.

- Green public procurement is a change that needs to be considered in the analysis.

Benchmarking of green corridors: preliminary results

The session was opened with the presentation by a guest speaker Prof. Felix Günther from ETH Zürich on the project called CODE 24 which intends to interconnect economic development, spatial, transport and ecological planning along the trans-European railway axis (TEN-T) no. 24 from Rotterdam to Genoa. The corridor partly covers the Edelweiss corridor in the SuperGreen network.

The aim of the parallel session was to introduce to the participants the methodology applied on pilot benchmarking and the questionnaire that was used for data collection on transport chains. A secondary propose was to identify potential stakeholders who operate in the SuperGreen network and would be willing to share operational data for the benchmarking purposes. Comments and recommendations received during the workgroup meeting can be summarized as follows:

- Many participants had an impression that the applied methodology and evaluated KPIs were not sufficiently focused and therefore the whole benchmarking exercise is too complex and specific to be carried out. Due to that fact, the general impression was that it would be difficult to establish contacts with the right interviewees.

- It was stated by some participants that access to sensitive operational information of major stakeholders (transport service providers, 3PL, etc.), such as cost and service related information, is extremely difficult, if not impossible.

- It was reminded that different stakeholders consider different KPIs important, i.e. some of the KPIs used in the SuperGreen project are irrelevant to some stakeholders.

- Additional clarifications were given by the consortium that one of the outcomes of the SuperGreen project could be an improved methodology for evaluating operational or infrastructural projects financed by the European Commission. This concerns especially the Marco Polo programme and TEN-T financing.

- The recommendation was made by participants to simplify the questionnaire to be used for the benchmarking exercise and to align it with the reviewed set of KPIs. It was also suggested that only questions relevant to the objectives of the task should be asked and the rest should be dropped.

Panel discussion

The event was closed with a panel discussion where Sergio Barbarino (Procter and Gamble Europe), Jan Blomme, (Antwerp Port Authority), Karin de Schepper (Inland Navigation Europe), Antonis Mikhail (ESPO), Pawel Stelmaszczyk (European Commission, DG-MOVE), Thierry Vaneslander (University of Antwerp) and the audience had a discussion on the project and the concept of green corridors.

The next steps in the project include the finalization of the benchmarking task and the review of the set of KPIs and the methodology, if needed. The deliverable on the changes in operational and regulatory environment will be concluded (taking into account the comments made during the workshop) and submitted to the European Commission.

5.4 Regional workshop in Malmö

The third regional SuperGreen Workshop took place in Malmö on March 10, 2011 and provided a forum for dissemination and discussion on topics such as Swedish projects Green Corridors, East West Transport Corridor (EWTCII), Scandria, TransBaltic and Øresund EcoMobility, progress on the Key Performance Indicators (KPIs) and related methodology, and interim results on corridor benchmarking. The workshop brought together around 80 participants with the presence of logistics service providers, carriers in all surface modes, public authorities, researchers and other stakeholders interested in green logistics.

The event was organized with a focus on connecting various green corridors projects both at a regional and European Union level and to leverage the experience acquired from those projects. The workshop involved general presentations in the morning and a dedicated workgroup session with a panel discussion in the afternoon.

The day was opened by describing the vision of green corridors and reporting on the progress made with such Swedish initiatives as EWTCII, Scandria and TransBaltic. Currently, these initiatives form grounds for the establishment of pilot green corridors in Sweden and the Baltic Sea region and the first demo is expected to take place in the second half of 2011. The long term vision foresees that all freight transport corridors in Europe will be green and form a single integrated freight transport network that is driven by market needs.

Next on the agenda was the presentation of the SuperGreen project with a focus on introducing the methodology and the KPIs for the benchmarking task. The SuperGreen consortium presented the preliminary results of the evaluation of the KPIs and a new approach in the methodology that takes into account previous recommendations from stakeholders. The main changes in the methodology concern abandoning the aggregation of the KPIs to the corridor (segment) level and focusing on the performance of individual transport chains. The final filtering of the KPIs, carried out by the consortium, was presented and put up for discussion at the afternoon workshop session.

In order to demonstrate best practices in sustainable freight logistics a presentation of practical examples of green logistics in the fast moving consumer goods sector was given by Procter & Gamble. The second example from the industry was given by the railway engineering company Kockums Industrier who introduced the innovative solution Megaswing.

Workshop session with panel discussion

The workshop session took place jointly with the panel discussion allowing interventions from the audience. The panel consisted of project managers of the Swedish initiatives, representatives of the industry and was led by the SuperGreen project coordinator. The objective of the discussion was to finalise the set of the KPIs and the methodology for benchmarking. The validation of the final filtering of the KPIs with stakeholders could be considered as one of the most important outcomes of this workshop. The list of the KPIs filtered by the consortium after the workshop in Antwerp and the change of methodology (to focus on individual transport chains and to analyse operations in corridors) was accepted (with minor changes) by the audience and members of the panel.

After a lively discussion, the set of the KPIs that received the highest endorsement as most relevant and important for corridor benchmarking were the following:

Indicator	Unit
CO_2 emissions	g/ton-km
SOx emissions	g/1000 ton-km
Relative transport cost	€/ton-km
Transport time, expressed in an average speed of the transport chain	km/h
Frequency, services per year	number
Reliability, on time deliveries	%

Table 25 - The final set of recommended KPIs

The closing speech was given by the representative of the European Commission (DG-MOVE) who gave an enlightening presentation of the expected evolution of the Green Corridors in the context of the new White Paper on Transport Policy and the revised TEN-T Guidelines.

5.5 Regional workshop in Sines

The fourth regional SuperGreen Workshop took place in Sines on March 24, 2011 and provided a forum for dissemination of information on project progress to and discussion with stakeholders in Portugal and the Iberian Peninsula. The workshop was hosted by the Port of Sines, Portugal's leading port in terms of volume of cargo handled, and PSA Sines which belongs to the PSA International Group, one of the leading global port operators with terminals in 28 ports in 16 countries across Asia, Europe and the Americas.

The main objective of the Sines workshop was the consultation of benchmarking results and the appraisal of green technologies. One of the sessions focused on ICT systems applied in the maritime sector and their contribution to achieving sustainable logistics and greening of transport corridors. The participants of the workshop included logistics service providers, carriers, and transport companies, policy makers, researchers, environmental organizations, all in all around 50 participants.

The event started with a presentation by the representative of the European Commission who gave an overview of the evolving Green Corridors in the context of the new White Paper on Transport Policy and the revised TEN-T Guidelines. After the Commission's presentation the project coordinator continued by introducing the SuperGreen project. In order to give a detailed overview of the progress of the project, two separate presentations were made. The first aimed at presenting the benchmarking results to stakeholders and introduced the final set of KPIs and methodology used. The second focused on introducing different identified green technologies.

It was highlighted by the SuperGreen consortium that six corridors will be used for testing the final benchmarking methodology and the recommended set of KPIs (chosen during the previous workshop in Malmö). Thus, benchmarks will be set for the Brenner, Cloverleaf, Nureyev, Strauss, Mare Nostrum and Silk Way corridors. Based on different transport chain KPIs, the project is setting ranges of KPI values for the above-mentioned corridors. These values will act as benchmarks and will be implemented to measure the greening effect of green technologies and ICT solutions in a later phase of the study.

A presentation on the identification and selection of green technologies explained the approach that has been applied in this task. The identified technologies have been broken down into nine categories, including engines and propulsion systems, fuels and sources of energy and navigation technologies, and covering all modes of transport. In total forty most important green technologies have been selected for testing purposes in the SuperGreen project. These technologies meet a number of criteria, e.g. availability, easiness to adopt, maturity, etc.

After lunch, a port tour and a presentation by the Port Authority of Sines took place, with an introduction of the Single Port Window System (JUP) that makes paperless administration possible. The system allows ships to enter and leave the port using web-based communication with relevant administrations. The system connects the industry with the administration, e.g. the port authority, the maritime authority, the customs, the border and health authority with terminal operators, service providers, shipping agencies and enables real-time communication and tracking of shipments. JUP was recognized as an ICT system that turns the maritime transportation greener and most importantly increases the throughput and the capacity of the port.

In the afternoon panel session, issues regarding ICT and its potential impact on the greening of corridors and in particular on ports and short sea shipping were discussed.

5.6 Conclusions

It can be concluded that the regional workshops organised under Task 2.4 were successful and there was considerable interest in the concept of the green corridors among the stakeholders. Throughout the series of regional workshops a lively discussion was held on the following topics: what is a truly green corridor, which technologies make a freight transport corridor green and how to measure the greening effect. The venues for the workshops were selected with the aim of maintaining a geographical balance, and at the same time holding the events at important freight hubs or corridors. With the only exception of Antwerp, all workshops were organised in places that are covered by the SuperGreen network.

The first regional workshop was organised in Nola/Naples at Interporto Campano. Although the workshop gave an overview of the initial set of the KPIs used for the benchmarking, general opinions on the project and the concept of green corridors were also received from experts of the logistics industry. Participants highlighted several problems in national logistics which were first considered to be regional but, as concluded at the end, are likely to be common to the whole of the European Union. The venue where the event was organised, a freight village Interporto Campano, was an excellent example of infrastructure establishment contributing to the green corridors – bundling of freight flows enables transport of scale and facilitates environmentally friendly transport for shippers.

The second regional workshop in Antwerp, hosted by the Port of Antwerp, focused on two main topics – introduction of the identified effects of changes in operational and regulatory environment and reporting on the progress of the benchmarking task. During the panel discussion, a debate on the regulatory environment continued among the representatives of different public authorities, interest groups and academics. This workshop was organised in conjunction with Task 2.3 to consult on the findings of Deliverable 2.3.

It can be said that probably the best workshop in the series was the third one in Malmö where the basis for collaboration between the SuperGreen project and the other green corridor initiatives in the Baltic region was laid down. The ultimate goal of the event was to present the work done in the SuperGreen project, share experience and converge green corridor projects both at the EU and regional level. The participants concluded that there are similar elements in all projects, although the approach can be slightly different. The final approval of the selection of the KPIs could also be considered as an added value of the workshop – six KPIs under the category 'must have' were selected and decided to be used for the analysis. It is interesting to note that with the exception of the SOx/NOx KPIs, whose importance was reversed, all other KPIs that were considered important by the consortium were also characterised as important by the workshop's audience. An important note was made by some of the stakeholders that the noise KPI should be included in the set of environmental KPIs rather than in the social. This is of course a valid point. The SuperGreen consortium assigned noise to the set of social KPIs because it was considered as an important social issue. Ultimately, it was determined that where this KPI is assigned to is less important so long as it is staken into account. Due to the fact that the noise was not ranked as a „must have" KPI for the SuperGreen project, no amendments to the assignment of this KPI took place.

The fourth regional workshop in Sines was dedicated to introducing the final results of the benchmarking and discussing the ICT systems applied in the maritime sector and their contribution to achieving sustainable logistics and the greening of transport corridors. Throughout the years, the Port of Sines has been a strategic port in Portugal for receiving and storing bulk freight. In recent years the port has been extended and, among other developments, a container terminal has been completed. The container terminal together with the adjacent railway station contributes to the growth of green logistics in the region.

The regional workshops organised in the framework of the SuperGreen project provided an enormous value to the project and served as an interface between the project and the stakeholders. The feedback received and the discussions held during these events gave an important input to the project in terms of bringing it in line with the expectations on the concept of green corridors as well as helping to complete the benchmarking exercise. It can be stated that after the consultation process with the stakeholders throughout the regional workshops, the methodology and the KPIs used for the benchmarking study and the presented benchmarks for the six corridors are valid and generally accepted. The results can be used as an input for the other tasks of the SuperGreen project.

6 Conclusions

The aim of Task 2.4 was to carry out the benchmarking of the SuperGreen corridors and give an overall picture of the differences between and common factors of the selected corridors as regards different aspects of the greening of transport chains.

Based on consultations with the stakeholders, members of the Advisory Committee and technical reviewers of the project, this report describes the development of the final methodology for the benchmarking of the SuperGreen corridors and the categorisation of the KPIs in terms of their importance for the SuperGreen project. The consortium has decided to carry out the benchmarking with the six KPIs which have been selected internally by the partners as the most important KPIs (category ‘must have’) and approved by the stakeholders during the regional workshops. The benchmarking was carried out for the six corridors applying six ‘must have’ KPIs that are related to transport operations.

This report presents the results of the calculation and evaluation of the KPIs achieved by using selected tools and interviews carried out by project partners, respectively. However, the analysis of the Silk Way corridor is based purely on literature. The benchmarking methodology was first tested on the Brenner corridor as a pilot case and after the successful results most of the methodology was used for carrying out the benchmarking of the other corridors. The Brenner pilot case highlighted difficulties with the aggregation of transport chain level KPIs to corridor/segment level KPIs, due to incoherent data and the need to convert the indicators. Moreover, the aggregation attempt pointed out that considering the small number of sample transport chains, the aggregated KPIs should not be used to make general conclusions on the situation in the corridors as a whole. However, using transport chain level KPIs, minimum and maximum values of KPIs from all transport chains can be used as benchmarks for different modes of transport. This approach was used in the SuperGreen project. In the benchmarking exercise 6-16 different transport chains were identified for each corridor. The accuracy of the benchmarks can be improved by using the same methodology but increasing the number of transport chains per corridor. It should also be stated that this report was not able to deliver all benchmarks for each one of the six corridors, e.g. due to the lack of data on the Strauss corridor three out of six KPIs could be calculated. In general, it could be stated that the collection of data was the most difficult part of the task and therefore, the quality of the data varies considerably. The data issue, which is very important will be investigated further in the upcoming work packages of the SuperGreen project, both in WP5 that deals with future R&D recommendations (e.g. technologies or methods to gather data) and Task 6.2 that will come up with appropriate policy recommendations.

Task 2.4 was meant to establish regular consultations with the stakeholders to include their opinion throughout the benchmarking exercise. Four regional workshops were held for this purpose. Every workshop had a unique value to the project as the final benchmarking methodology was developed and the filtering of the KPIs was carried out with the help of workshop participants. Moreover, the final benchmarking results were presented during the last regional workshop in Sines where they were accepted by the audience. Therefore, the work performed under Task 2.4 can be considered conclusive and the results will be used in the other tasks of the SuperGreen project.

This report will serve as a direct input for the upcoming Task 2.5 which will define the areas for improvement, as well as for Task 3.3, 4.2 and 4.3 which will apply identified green technologies and ICT solutions to the corridors and measure their greening effect via re-benchmarking.

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Appendix I. Internal KPI filtering results

KPI	Input unit	Output unit	Assessment	IHSF	NTUA HP	NTUA GP	MAR	SITO	DAPP	DNV	UNEW	CONS	PSAS	PG	VRG	TOTAL		
Efficiency																		
Absolute costs	ton, €	€/ton	3 Can manage without	3 Can	3 Can m	3 Can m	3 Can	3 Can	2 Prefe	- Choo	3 Can	3 Can n	3 Can n	3 Can m	2 Prefer to ha	0	2	9
Relative costs	ton, €, km	€/ton-km	1 Must have	1 Must	1 Must h	1 Must h	1 Mus	2 Pref	1 Must	2 Prefe	2 Pref	1 Must	1 Must	1 Must h	3 Can manag	8	3	1
Service quality																		
Transport time	hours	hours	1 Must have	1 Must	1 Must h	2 Prefer	3 Can	3 Can	1 Must	1 Must	1 Must	1 Must	1 Must	2 Prefer	1 Must have	8	2	2
Reliability	Total number of shipments, On-time deliveries	%	1 Must have	2 Prefe	2 Prefer	1 Must h	1 Mus	1 Must	2 Prefe	1 Must	1 Must	2 Prefer	2 Prefer	1 Must h	1 Must have	7	5	0
ICT appl.	Availability, integration & functionality of cargo tracking & other services	graded scale	2 Prefer to have	2 Prefe	2 Prefer	1 Must h	2 Pref	2 Pref	2 Prefe	1 Must	2 Pref	2 Prefer	3 Can n	3 Can m	2 Prefer to ha	2	8	2
Frequency	Services per week	number	1 Must have	3 Can	1 Must h	3 Can m	3 Can	3 Can	1 Must	1 Must	1 Must	1 Must	1 Must	2 Prefer	3 Can manag	6	1	5
Cargo security	Total number of shipments, Security incidents	%	2 Prefer to have	3 Can	2 Prefer	3 Can m	1 Mus	2 Pref	2 Prefe	1 Must	1 Must	2 Prefer	2 Prefer	3 Can m	3 Can manag	3	5	4
Cargo safety	Total number of shipments, Cargo safety incidents	%	2 Prefer to have	2 Prefe	2 Prefer	3 Can m	3 Can	2 Pref	2 Prefe	1 Must	1 Must	3 Can n	2 Prefer	3 Can m	3 Can manag	2	5	5
Environmental sustainability																		
CO_2 emissions	ton, km	g/ton-km	1 Must have	1 Must	1 Must h	1 Must h	1 Mus	1 Must	1 Must	1 Must	1 Must	1 Must	1 Must	1 Must h	1 Must have	12	0	0
NO_x emissions	kg, km	g/1,000 ton-km	1 Must have	2 Prefe	2 Prefer	2 Prefer	1 Mus	1 Must	2 Prefe	1 Must	1 Must	1 Must	1 Must	2 Prefer	1 Must have	7	5	0
SO_x emissions	kg, km	g/1,000 ton-km	1 Must have	2 Prefe	2 Prefer	2 Prefer	1 Mus	1 Must	2 Prefe	1 Must	2 Pref	1 Must	1 Must	2 Prefer	1 Must have	6	6	0
PM emissions	kg, km	g/1,000 ton-km	1 Must have	2 Prefe	2 Prefer	2 Prefer	1 Mus	1 Must	2 Prefe	1 Must	2 Pref	1 Must	1 Must	2 Prefer	1 Must have	6	6	0
Infrastructural sufficiency																		
Congestion	ton, km, Average delay	hours/ton-km	2 Prefer to have	2 Prefe	2 Prefer	1 Must h	3 Can	3 Can	2 Prefe	1 Must	1 Must	1 Must	2 Prefer	3 Can m	2 Prefer to ha	4	5	3
Bottlenecks	number & category	graded scale	2 Prefer to have	2 Prefe	2 Prefer	2 Prefer	1 Mus	1 Must	2 Prefe	1 Must	1 Must	2 Prefer	2 Prefer	3 Can m	2 Prefer to ha	4	7	1
Social																		
Corridor land use	Share of distance per area type	percent	1 Must have	3 Can	2 Prefer	2 Prefer	1 Mus	1 Must	3 Can	1 Must	2 Pref	1 Must	1 Must	3 Can m	3 Can manag	5	3	4
Traffic safety	Traffic safety incidents	percent	2 Prefer to have	3 Can	3 Can m	1 Must h	2 Pref	2 Pref	2 Prefe	1 Must	2 Pref	3 Can n	2 Prefer	3 Can m	2 Prefer to ha	2	6	4
Noise	Share of distance above level	percent	2 Prefer to have	2 Prefe	2 Prefer	1 Must h	1 Mus	3 Can	2 Prefe	1 Must	2 Pref	2 Prefer	2 Prefer	3 Can m	1 Must have	4	6	2

Appendix II. Memo attached to the transport chains' card of the Strauss corridor

MEMO

SUBJECT Memo attached to the transport chains' card of the Strauss corridor.		FOR YOUR ATTENTION	COMMENTS ARE	FOR YOUR
REFERENCE NO.	**DISTRIBUTION**			
	DNV	X	X	
DATE: 17/4/2011	NTUA (project coordinator)			
NUMBER OF PAGES: 14	PG (task 2.4 leader)			
PERSON RESPONSIBLE/AUTHOR: Chara Georgopoulou, DNV	VIA (data contributor)			
DOCUMENT ID NO. 02-24-IM-2011-06-00-2				

Table 1. Data on Strauss transport chains and ecotransit results.

										ecotransit results				
Route	Cargo	Cargo type	Description	Vehicle	Distance km	Consignment tons	Max Capacity tons	Load factor %	Return trip load %	CO2 eq tons	NOx kg	SOx kg	PM10 kg	Overall distance
Rotterdam - Duisburg	Coal	bulk	Important inland waterway link between Rotterdam and Duisburg allowing for very large IWW vessels as well as seagoing vessels	Pushed convoy (6 lighters)	227	13400	16 800	80	0	0.0086	0.11	0.056	0.0037	227
Rotterdam - Großkotzenburg am Main	Coal	bulk	Important inland waterway link between Rotterdam and the Main area being characterised by a stretch with deep water, allowing also for seagoing vessels, as well as a stretch being representative for inland waterway	Coupled unit (= MCV + lighter)	586	4560	5700	80	0	0.021	0.27	0.14	0.009	586

			transport											
Rotterdam - Duisburg		Container	Important inland waterway link between Rotterdam and Duisburg allowing for very large IWW vessels as well as seagoing vessels	JOWI class vessel	229	3960	4312	90	91	0.015	0.2	0.098	0.0065	434
Rotterdam - Basel		Container	Important inland waterway link between Rotterdam and Switzerland covering almost the entire Rhine with long distance container transport	Coupled unit (= MCV + lighter)	838	2343	?	90	96	0.056	0.72	0.36	0.024	1641

Rotterdam - Mannheim - Stuttgart		Container	Important inland waterway link between Rotterdam and industrial centre of Germany with high tech enterprises covering a part of the Rhine with long distance container transport	Neckar vessel	737.98	…	…	90	76 - 100	0.038	0.58	0.24	0.016	1533
Linz - Nuremberg	Iron and steel	break bulk	Important inland waterway link between Bavaria and Austria incuding a large amount of locks and the bottleneck Straubing - Vislhofen	Large motor cargo vessel, L = 110 m	384	1380	2450	56	100	0.033	0.43	0.22	0.014	753
Százhalombatta - Korneuburg	mineral oil products (gasoline, diesel)	bulk	Important inland waterway link between Hungary and Austria including the bottleneck Vienna -	Pushed convoy with 2 lighters	553.19	2000	3400	59	0	0.03	0.38	0.19	0.013	553

			Bratislava											
Rotterdam - Enns	feedstuff	bulk	Important long distance inland waterway link between Rotterdam and Austria including a all characteristics of IWT as well as the bottleneck Straubing - Vilshofen	Coupled unit (1 MCV + 1 lighter)	1332.93	2000	3700	54	100	0.12	1.55	0.78	0.051	2666
Izmail - Linz	iron ore	bulk	Economically highly important long distance inland waterway link between Ukraine and Austria including all characteristics of IWT on the Danube.	Pushed convoy with 4 lighters	1941.57	4200	6800	62	0	0.099	1.28	0.64	0.042	1942
Rotterdam - Linz	iron ore	bulk	Important long distance inland waterway link between	Coupled unit (MCV + lighter)	1317.5	2000	3700	54	0	0.077	1	0.5	0.033	1318

			Rotterdam and Austria including all characteristics of IWT .											

Table 2. Results for the transport chains based on Ecotransit calculations.

Route	CO2 eq	NOx	SOx	PM10
	gr/tkm	gr/tkm	gr/tkm	gr/tkm
Rotterdam - Duisburg	37.88546256	0.484581498	0.246696035	0.016299559
Rotterdam - Großkotzenburg am Main	35.83617747	0.460750853	0.23890785	0.015358362
Rotterdam - Duisburg	34.56221198	0.460829493	0.225806452	0.014976959
Rotterdam - Basel	34.12553321	0.438756856	0.219378428	0.014625229
Rotterdam - Mannheim - Stuttgart	24.78799739	0.378343118	0.156555773	0.010437052
Linz - Nuremberg	43.8247012	0.571049137	0.292164675	0.018592297
Százhalombatta - Korneuburg	54.24954792	0.68716094	0.34358047	0.023508137
Rotterdam - Enns	45.01125281	0.581395349	0.292573143	0.019129782
Izmail - Linz	50.97837281	0.659114315	0.329557158	0.021627188
Rotterdam - Linz	58.42185129	0.758725341	0.379362671	0.025037936
MIN	24.78799739	0.378343118	0.156555773	0.010437052
MAX	58.42185129	0.758725341	0.379362671	0.025037936

Table 3. Results for the transport chains using the emissions reported in the Planco study.

Planco study				
Route	CO2 eq	NOx	SOx	PM10
	kg/100TEUkm	g/100TEUkm	g/100TEUkm	g/100TEUkm
Rotterdam - Duisburg	10.85	152.29	14.77	2.51
Rotterdam - Basel	18.24	186.67	24.84	4.36
Rotterdam - Mannheim - Stuttgart	13.63	175.23	18.57	2.89
	kg/100tkm	g/100tkm	gr/tkm	gr/tkm
Rotterdam - Duisburg	1.4	18.82	1.91	0.39
Rotterdam - Großkotzenburg am Main	1.93	27.56	2.63	0.38
Linz - Nuremberg	2.28	27.56	3.11	0.37
Százhalombatta - Korneuburg				
Rotterdam - Enns				
Izmail - Linz				

Rotterdam - Linz

Table 4. Post –processing on the Planco study results for the emissions of the Strauss corridor transport chains.

Planco study - Post processing				
Route	CO2 eq	NOx	SOx	PM10
	g/tkm	g/tkm	g/tkm	g/tkm
Rotterdam - Duisburg	9.863636364	0.138445455	0.013427273	0.002281818
Rotterdam - Basel	16.58181818	0.1697	0.022581818	0.003963636
Rotterdam - Mannheim - Stuttgart	12.39090909	0.1593	0.016881818	0.002627273
Rotterdam - Duisburg	14	0.1882	0.0191	0.0039
Rotterdam - Großkotzenburg am Main	19.3	0.2756	0.0263	0.0038
Linz - Nuremberg	22.8	0.2756	0.0311	0.0037
Százhalombatta - Korneuburg				
Rotterdam - Enns				
Izmail - Linz				
Rotterdam - Linz				
MIN	9.863636364	0.138445455	0.013427273	0.002281818
MAX	22.8	0.2756	0.0311	0.003963636

Estimation of cost/tkm:

Origin – Destination	type	Cost (euro/tn)	Distance	Cost (euro/tn.km)	comment
Rotterdam – Duisburg	bulk	4.5	217	0.02073733	
Rotterdam - Großkotzenburg am Main	bulk	9	532	0.01691729	
Rotterdam - Duisburg	container	95	217	0.43778802	
Rotterdam – Basel	container	180	821	0.21924482	
Linz – Nuremberg	bulk	10.5	376	0.02792553	
Százhalombatta, Hungary - Korneuburg, Austria	bulk	7.5	553	0.01356239	assumed equal to average
Rotterdam - Enns, Austria	bulk	7.5	1332.93	0.0056267	assumed equal to average
Izmail, Ukraine - Linz, Austria	bulk	7.5	2026.5	0.00370096	assumed equal to average
Rotterdam - Linz, Austria	bulk	7.5	1317.5	0.0056926	assumed equal to average

References

1. Planco Study. Economical and Ecological Comparison of Transport Modes: Road, Railways, Inland Waterways
2. Ecotransit background report: http://www.ecotransit.org/.

Annex

Energy and emission figures (PLANCO Study 2007). Source: Via donau contribution.

BULK

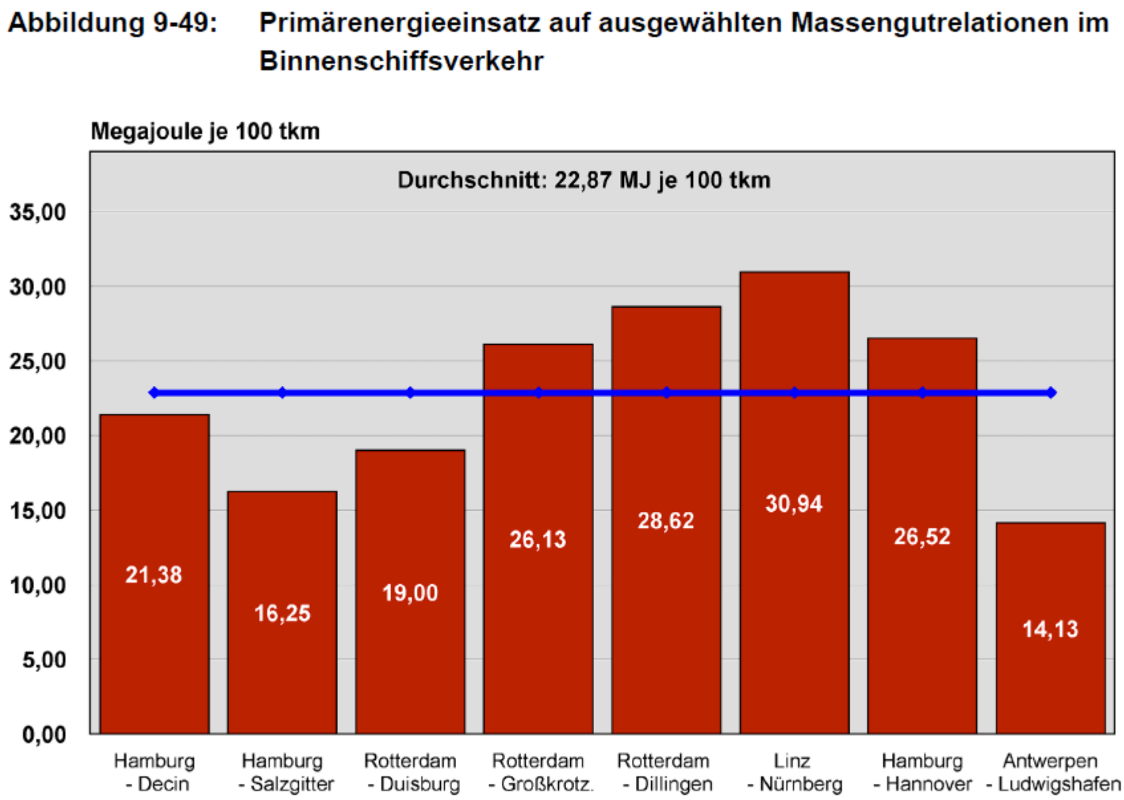


Figure: Primary energy demand for transportation of bulk cargo on selected routes in Megajoule per 100 tkm (Planco, 2007).

Abbildung 9-50: CO_2-Emissionen auf ausgewählten Massengutrelationen im Binnenschiffsverkehr

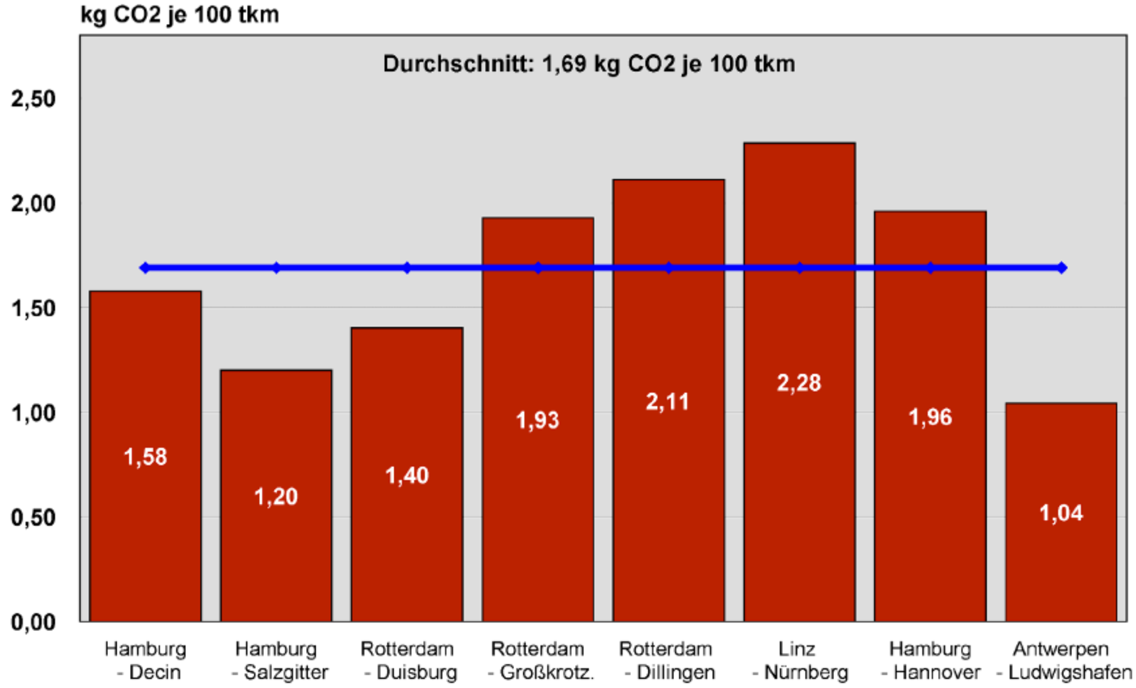
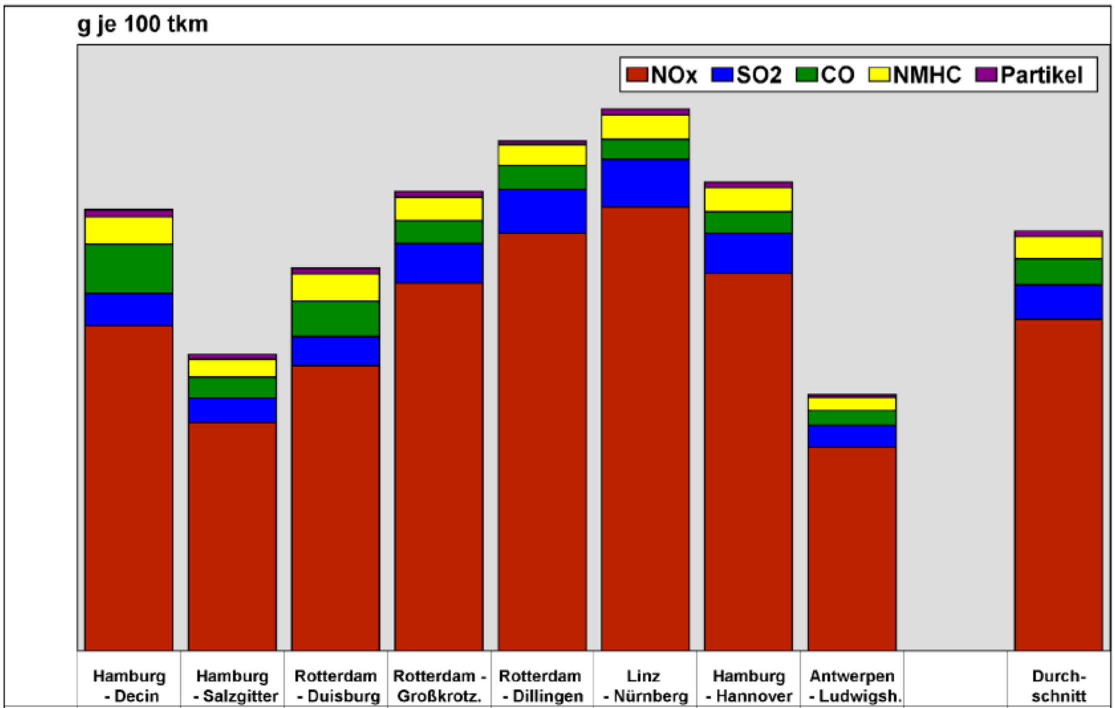


Figure: CO2 emissions resulting from transportation of bulk cargo on selected routes in kg per 100 tkm (Planco, 2007).

Abbildung 9-51: Schadstoffemissionen (NOx, SO_2, CO, NMHC, Partikel) auf ausgewählten Massengutrelationen im Binnenschiffsverkehr



	Hamburg - Decin	Hamburg - Salzgitter	Rotterdam - Duisburg	Rotterdam - Großkrotz.	Rotterdam - Dillingen	Linz - Nürnberg	Hamburg - Hannover	Antwerpen - Ludwigsh.		Durch-schnitt
Partikel	0,48	0,32	0,39	0,38	0,28	0,37	0,36	0,19		0,35
NMHC	1,78	1,21	1,79	1,55	1,37	1,60	1,59	0,86		1,47
CO	3,24	1,36	2,33	1,49	1,57	1,34	1,40	1,01		1,72
SO2	2,15	1,63	1,91	2,63	2,88	3,11	2,67	1,42		2,30
NOx	21,45	15,05	18,82	24,26	27,56	29,31	24,89	13,44		21,85

Figure: Particulate matter, NMHC, CO, SO2 and NOX emissions resulting from transportation of bulk cargo on selected routes in g per 100 tkm (Planco, 2007).

CONTAINER

Abbildung 9-52: Primärenergieeinsatz auf ausgewählten KV-Relationen im Binnenschiffsverkehr (ohne Vor-/Nachlauf Lkw)

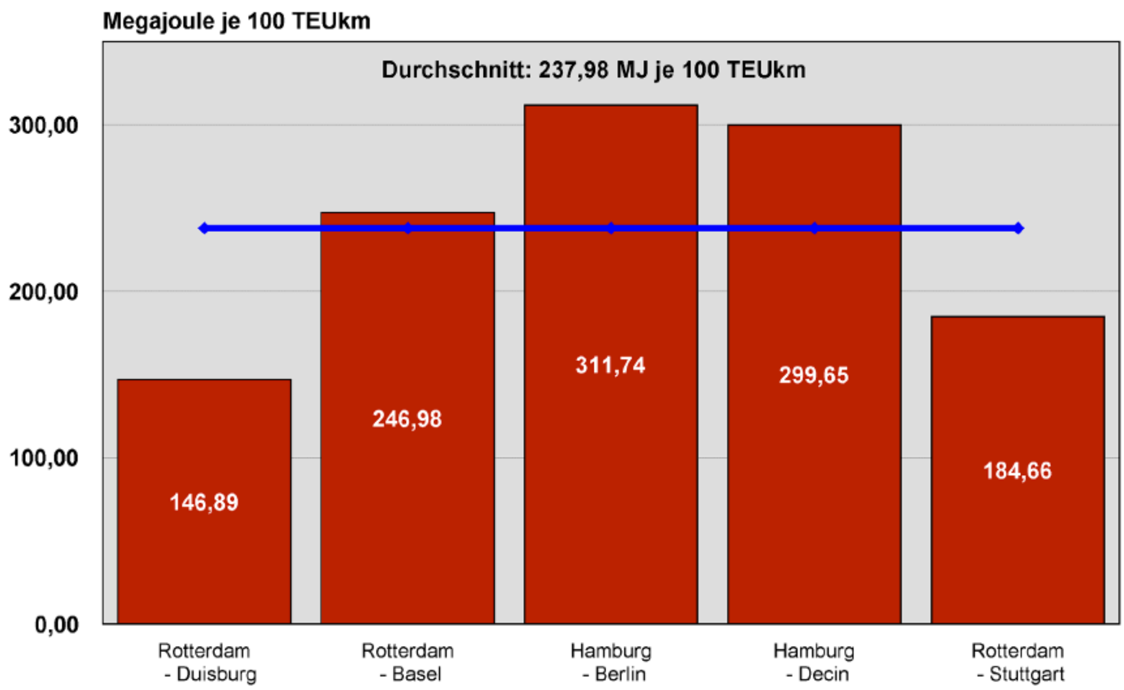


Figure: Primary energy demand for transportation of containers on selected routes in Megajoule per 100 TEU km (Planco, 2007).

Abbildung 9-53: CO_2-Emissionen auf ausgewählten KV-Relationen im Binnenschiffsverkehr (ohne Vor-/Nachlauf Lkw)

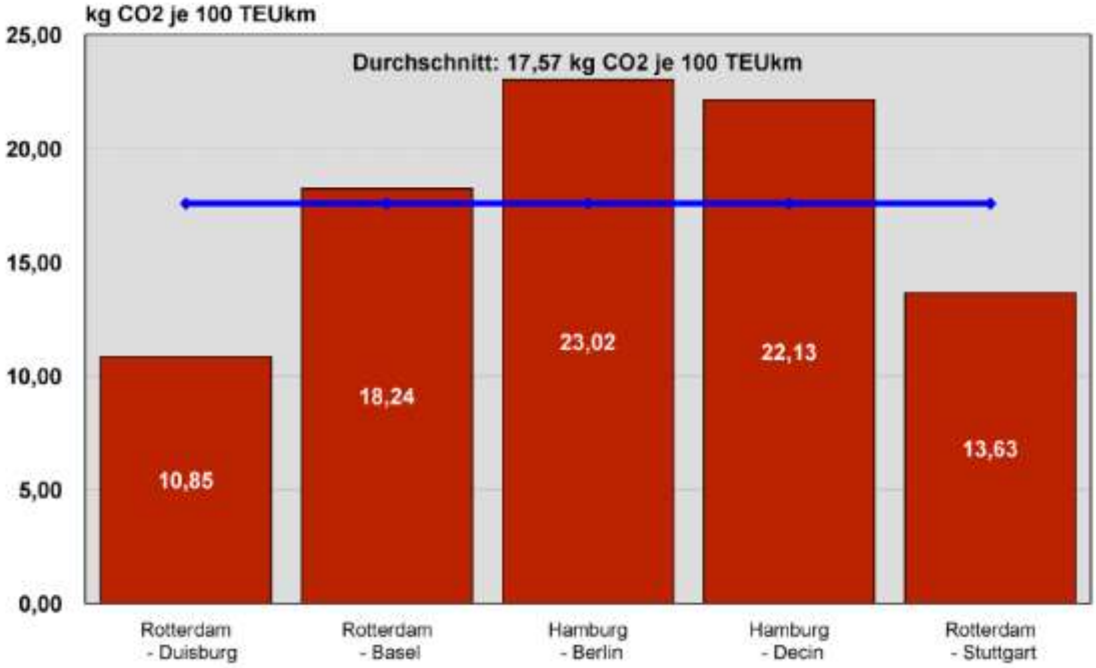
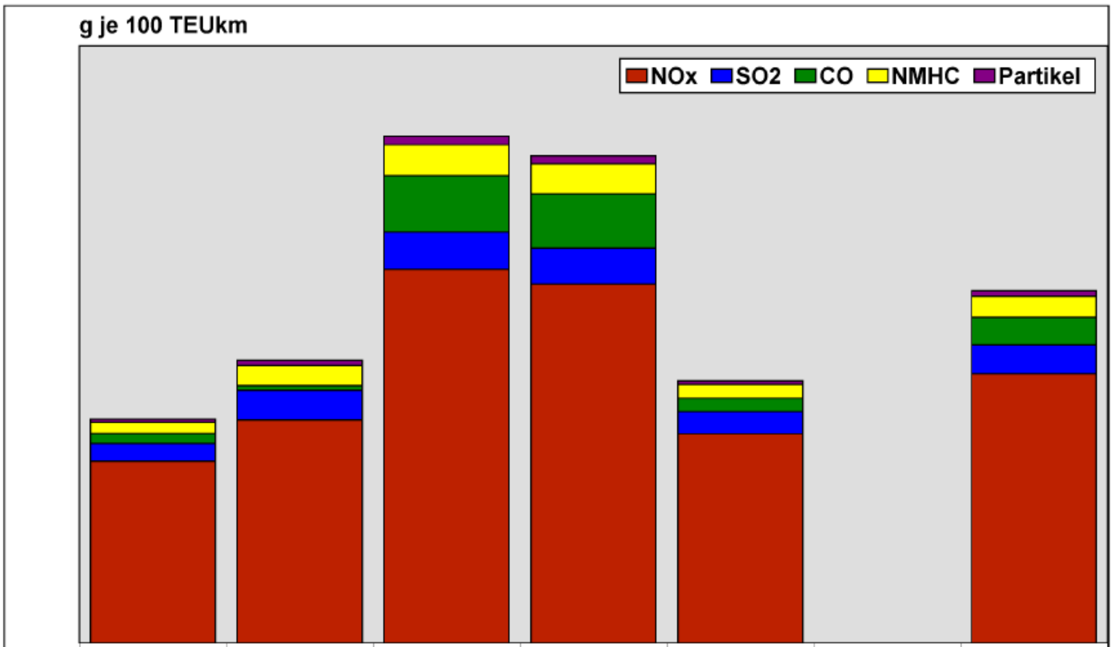


Figure: CO2 emissions resulting from transportation of containers on selected routes in kg per 100 TEU km (Planco, 2007).

Abbildung 9-54: Schadstoffemissionen (NOx, SO_2, CO, NMHC, Partikel) auf ausgewählten KV-Relationen im Binnenschiffsverkehr (ohne Vor-/Nachlauf Lkw)



	Rotterdam - Duisburg	Rotterdam - Basel	Hamburg - Berlin	Hamburg - Decin	Rotterdam - Stuttgart		Durchschnitt
Partikel	2,51	4,36	6,96	6,69	2,89		4,68
NMHC	9,44	16,68	26,01	25,00	11,50		17,73
CO	8,35	4,05	47,23	45,40	11,27		23,26
SO2	14,77	24,84	31,36	30,14	18,57		23,94
NOx	152,29	186,67	312,84	300,71	175,23		225,55

Figure: Particulate matter, NMHC, CO, SO2 and NOX emissions resulting from transportation of containers on selected routes in g per 100 tkm (Planco, 2007).

Table: Emission factors of motor cargo vessels in g/kWh (Tragfähigkeitsklasse = deadweight tdw, Durchschnitt = average, Planco, 2007).

Tabelle 8-20: Emissionsfaktoren der aktuellen Gütermotorschiffflotte nach Tragfähigkeitsklassen in g/kWh (Gesamtflotte 2006)

Tragfähigkeitsklasse	CO	HC	NO_x	PT
<400	2,07	1,01	9,82	0,28
401 - 650	1,78	0,88	9,70	0,24
651 - 900	1,83	0,90	9,49	0,25
901 - 1.000	1,66	0,82	8,79	0,23
1.001 - 1.500	1,51	0,75	9,51	0,20
1.501 - 2.000	1,08	0,59	9,13	0,15
2.001 - 2.500	0,67	0,47	8,95	0,12
2.501 - 3.000	0,38	0,42	9,00	0,12
> 3.000	0,59	0,49	8,97	0,13
Durchschnitt	**1,61**	**0,81**	**9,49**	**0,22**

Table: Emission factors of motor tank vessels in g/kWh (Tragfähigkeitsklasse = deadweight tdw, Durchschnitt = average, Planco, 2007).

Tabelle 8-21: Emissionsfaktoren der aktuellen Tankmotorschiffflotte nach Tragfähigkeitsklassen in g/kWh (Gesamtflotte 2006)

Tragfähigkeitsklasse	CO	HC	NO_x	PT
<400	1,81	0,89	10,20	0,25
401 - 650	1,75	0,86	10,15	0,24
651 - 900	1,59	0,76	9,44	0,23
901 - 1.000	1,48	0,73	8,97	0,20
1.001 - 1.500	1,39	0,71	10,46	0,19
1.501 - 2.000	1,00	0,55	9,31	0,13
2.001 - 2.500	0,71	0,47	8,85	0,12
2.501 - 3.000	0,78	0,52	9,14	0,14
> 3.000	0,71	0,53	9,04	0,14
Durchschnitt	**1,29**	**0,69**	**9,75**	**0,18**

Table: Emission factors of pushers in g/kWh (Tragfähigkeitsklasse = deadweight tdw, Durchschnitt = average, Planco, 2007).

Tabelle 8-22: Emissionsfaktoren der aktuellen Schubbootflotte nach Leistungsklassen in g/kWh (Gesamtflotte 2006)

Tragfähigkeitsklasse	CO	HC	NO_X	PT
<100	1,98	0,97	12,19	0,27
100 - 300	1,74	0,86	10,52	0,24
301 - 1.000	1,62	0,81	8,93	0,22
1.001 - 1.500	1,16	0,66	9,21	0,18
1.501 - 2.500	0,61	0,46	9,35	0,11
>2.500	1,12	0,80	9,34	0,19
Durchschnitt	**1,63**	**0,82**	**9,73**	**0,23**

Table: Comparison of emission factors for inland waterway transport derived from different studies (Planco, 2007)

Tabelle 8-23: Vergleich der globalen Emissionsfaktoren mit den Ergebnissen anderer Studien

Quelle	CO	HC	NO_X	PT
Planco 2007	1,56	0,79	9,56	0,22
GL 1998	2,60	0,60	9,00	0,20
VBD 2001	1,16	0,68	9,60	0,20
ifeu 2005 (185 g/kWh Dieselkraftstoff)	k.A.	0,87	11,10	0,31
ifeu 2005 (200g/kWh Dieselkraftstoff)	k.A.	0,94	12,00	0,34

Figure 20: Financial Transport Cost of Transport Modes for Selected Bulk Freight Routes

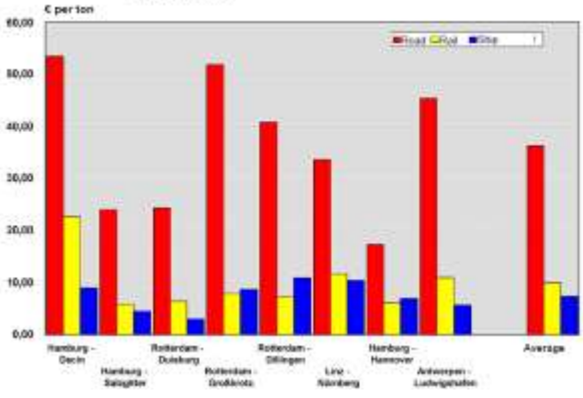


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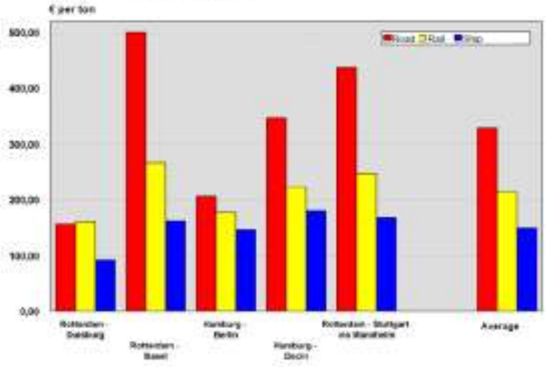
Figure 21: Financial Transport Cost for Selected Container Routes, by Modes of Transport



Source: Planco Study

Appendix III. Memo attached to the transport chains' card of the Mare Nostrum corridor

MEMO

SUBJECT Memo attached to the transport chains' card of the Mare Nostrum corridor. Updated version with feedback from interviewees for the Istanbul – Trieste transport chain.		FOR YOUR ATTENTION	COMMENTS ARE INVITED	FOR YOUR INFORMATION
REFERENCE NO.	**DISTRIBUTION** DNV NTUA (project coordinator) PG (task 2.4 leader)			X
DATE: 1/4/2011				
NUMBER OF PAGES: 8				
PERSON RESPONSIBLE/AUTHOR: Chara Georgopoulou, DNV				
DOCUMENT ID NO. 02-24-IM-2011-06-00-2				

Estimation of cost/tkm for container trade:

- For the feeder transport chains: Port Said/Beirut/Malta/ Gioia Tauro – all Mediterranean ports, Barcelona/Valencia – Piraeus/Istanbul
- Source: COMPASS final report

Table 53: Cost structure container

Container Ship (€/day)				
Size (TEUs)	1000-2000	5000-6000	8000-9000	10000-12000
	2000	5500	8500	11000
Guide DWT	15,000 - 25,000	50,000 - 60,000	90,000 - 100,000	120,000 - 140,000
Manning	€1,588	€2,176	€2,313	€2,466
Insurance	€443	€931	€1,168	€1,336
Repairs & Maintenance	€977	€2,603	€2,786	€3,092
Stores & Lube Oil	€580	€1,557	€1,847	€2,122
Administration	€550	€931	€962	€1,008
Capital Repayments	€4,378	€11,276	€16,848	€20,430
Interest	€3,599	€9,269	€13,850	€16,794
Gross Margin	€2,059	€4,886	€6,762	€8,032
Port	€2,500	€5,200	€6,800	€8,300
Fuel (Ton/day)	45.0	77.0	91.0	116.0
Fuel (€/day)	€14,341	€24,540	€29,002	€36,969
Speed (knots)	14.0	18.0	18.0	18.0
Full Cargo Weight (Ton)	18,000	66,000	102,000	132,000
Total (€/day)	€31,015	€63,370	€82,337	€100,547

Typical distance & delivery time:

Gioia Tauro	–	Barcelona:	1301.52	km
Gioia Tauro	–	Marseille:	1244.26	km
Gioia Tauro	–	Trieste:	1296.72	km
Gioia Tauro	–	Piraeus:	1007.45	km
Gioia Tauro	–	Istanbul:	1585.30	km
Gioia Tauro	–	Limassol:	1768.69	km
Gioia Tauro	–	Larnaka:	1768.69	km
Average distance			1424.66	km
Average speed			14	knots
Average speed			14X1.852= 25.928	km/hr
Average delivery time			1424.66/25.928=55	hr
Average delivery time			2.29	days

Other routes

Istanbul	–	Trieste:	2228.03	km
La Spezia	–	Barcelona:	721	km
Gioia Tauro	–	Piraeus:	1007.45	km
Gioia Tauro	–	Istanbul:	1585.30	km
average			1296.375	km

Cost in Euro/tkm:

2 of 7

Feeders of 2000 TEUs: average capacity 20.000tn

31015 euro /day X 2.29 days/trip X trip/(1424.66)km = 49.85 euro/km

49.85 euro/km / (0.7 X 2000TEU X 14 tn /TEU) = 0.0025 euro/tkm

49.85 euro/km / (0.7 X 20000 tn) = 0.0035 euro/tkm

<u>Estimation of annual volumes of container trades:</u>

Unitised trade traffic flows / year (associated with container feeder services) [Source: Euromed]

Figure 3.5 Unitised trade in West MEDA Region: Base Year

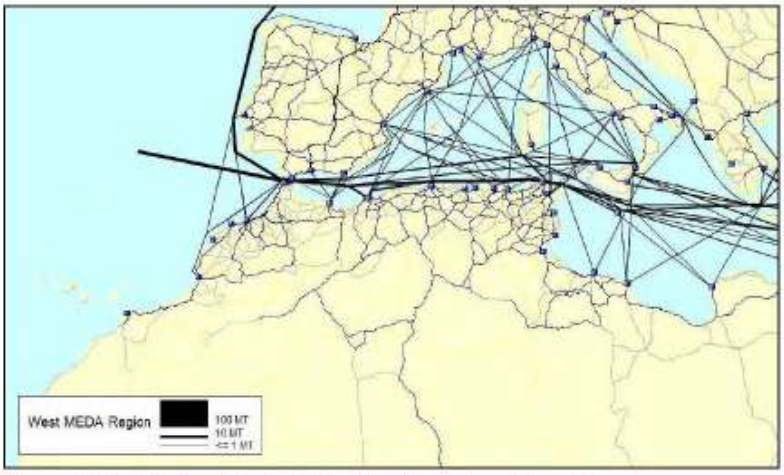
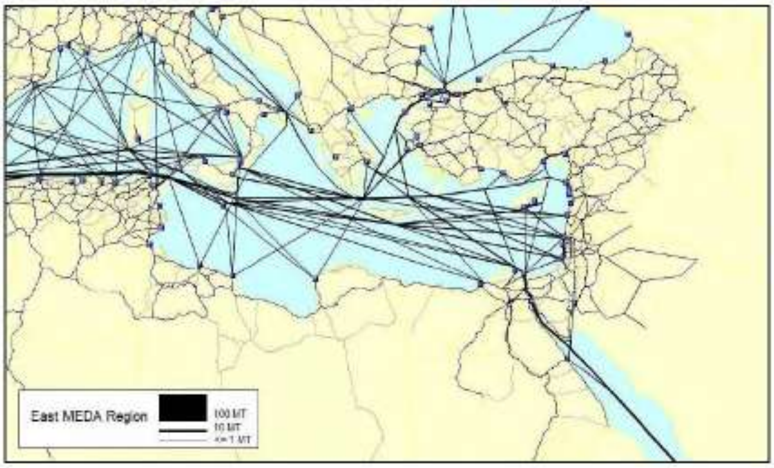


Figure 3.6 Unitised trade in East MEDA Region: Base Year



<u>Frequency of container feeders [Source: European Short Sea Network]</u>

Container feeder

Istanbul	Genoa	weekly	Adriazov Break Bulk Serv.	CSA
Istanbul	Genoa	weekly	Compagnie Meridionale de Navigation	Express
Istanbul	La Spezia	weekly	Turkish Cargo Lines	La Mercantile
Istanbul	Trieste	weekly	Rickmers Linie	Martinoli
Istanbul	Gioia Tauro	weekly	Contship	Maritime Transport & Agencies AB
Istanbul	Genoa	1 x 9 days	Compañia Trasatlantica Española S.A., Madrid	Naviera del Odiel de Contenedores, S.A. (Contenosa)

Genoa	Piraeus	weekly	Compagnie Meridionale de Navigation	Express Srl
Genoa	Piraeus	1 x 9 days	Compañia Trasatlantica Española S.A., Madrid	Naviera del Odiel de Contenedores, S.A. (Contenosa)
Genoa	Piraeus	1 x 15 days	Nordana Line	Weco Agencia Marítima
Gioia Tauro	Piraeus	weekly	Maersk Line	Maersk Benelux B.V.
Gioia Tauro	Piraeus	weekly	Contship	Maritime Transport & Agencies AB
La Spezia	Piraeus	weekly	Turkish Cargo Lines	La Mercantile
Trieste	Piraeus	weekly	Rickmers Linie	Maritime Agency
Genoa	Barcelona	weekly	Safmarine Belgium nv	Safmarine
Genoa	Valencia	1 x 10 days	Laso Corp. Ltd	Solas
Genoa	Valencia	1 x 15 days	Compañia Trasatlantica Española S.A., Madrid	Transatlantica
Genoa	Barcelona	weekly	NATVAR PARIKH INDUSTRIES, LTD	Romeu y Cía, S.A.
Genoa	Valencia	weekly	Lloyd Triestino di Navegazione	Global Container Agency, S.A.
Genoa	Barcelona	weekly	Lloyd Triestino di Navegazione	Global Container Agency, S.A.
Genoa	Barcelona	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Genoa	Valencia	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Genoa	Valencia	1 x 15 days	Nordana Line	Weco Agencia Marítima
Genoa	Barcelona	1 x 15 days	Nordana Line	Weco Agencia Marítima
Genoa	Valencia	1 x 9 days	Contship	Contship Container Lines, S.A.
Genoa	Barcelona	1 x 9 days	Contship	Contship Container Lines, S.A.
Genoa	Barcelona	weekly	CMA CGM	Navispain, S.L.
Genoa	Barcelona	weekly	NAVICON / Multitrade Spain SL	Bergé Marítima, S.A.
Genoa	Barcelona	weekly	X-Press Container Lines	Burger Feeder Services B.V.
Genoa	Barcelona	daily	Compañia Trasatlantica Española S.A., Madrid	???
Genoa	Barcelona	daily	Navimport International	???
Genoa	Valencia	daily	Navimport International	???
Gioia Tauro	Barcelona	2 x month	POL-LEVANT Shipping Lines Ltd	Europea de Consignaciones, S.A.
Gioia Tauro	Valencia	1 x 9 days	Contship	Contship Container Lines, S.A.
Gioia Tauro	Barcelona	1 x 9 days	Contship	Contship Container Lines, S.A.
Gioia Tauro	Valencia	weekly	Maersk Line	Maersk Line
La Spezia	Valencia	weekly	MSC	MSC Belgium NV
La Spezia	Valencia	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
La Spezia	Barcelona	weekly	Contship	Contship Container Lines, S.A.
La Spezia	Barcelona	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
La Spezia	Barcelona	weekly	Comanav	Transbull Valencia, S.L.
La Spezia	Barcelona	weekly	Compañia Trasatlantica Española S.A., Madrid	Naviera del Odiel de Contenedores, S.A. (Contenosa)
Genoa	Odessa	weekly	Compagnie Meridionale de Navigation	Express
Gioia Tauro	Odessa	weekly	X-Press Container Lines	Burger Feeder Services B.V.
Genoa	Constantza	weekly	Compagnie Meridionale de Navigation	Express
Genoa	Constantza	1 x 10 days	Laso Corp. Ltd	Solas
Gioia Tauro	Constantza	weekly	X-Press Container Lines	Burger Feeder Services B.V.
Piraeus	Constantza	weekly	ZIM Israel Nav	Van Ommeren Sweden AB
Piraeus	Constantza	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Thessaloniki	Constantza	weekly	ZIM Israel Nav	Van Ommeren Sweden AB
Piraeus	Odessa	weekly	ZIM Israel Nav	Van Ommeren Sweden AB

Piraeus	Odessa	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Piraeus	Marseille	weekly	Borchard Lines Ltd	MEDSHIP
Piraeus	Marseille	2 x month	ZIM Israel Nav	MARSEILLE CONSIGNATION
Piraeus	Valencia	weekly	Maersk Line	Maersk Benelux B.V.
Piraeus	Barcelona	weekly	Blue Cont. Line	Lineas Regulares, S.L.
Piraeus	Barcelona	weekly	GRIMALDI GROUP GENOVA	Agencia Marítima Condeminas, S.A.
Piraeus	Barcelona	weekly	Emes Line Shipping & Transport	Green Ibérica, S.A.
Piraeus	Valencia	1 x 9 days	Compañia Trasatlantica Española S.A., Madrid	Naviera del Odiel de Contenedores, S.A. (Contenosa)
Piraeus	Barcelona	1 x 9 days	Compañia Trasatlantica Española S.A., Madrid	Naviera del Odiel de Contenedores, S.A. (Contenosa)
Piraeus	Barcelona	weekly	KENZ MARITIME	Compañía Barcelonesa de Consignaciones, S.A.
Piraeus	Valencia	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Piraeus	Barcelona	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Piraeus	Valencia	1 x 15 days	Nordana Line	Weco Agencia Marítima
Piraeus	Barcelona	1 x 15 days	Nordana Line	Weco Agencia Marítima
Piraeus	Barcelona	weekly	Sermar Line Srl	Romeu y Cía, S.A.
Piraeus	Barcelona	weekly	Sudcargos	Marítima Sudcargos España, S.A.
Piraeus	Barcelona	weekly	Neptune Shipping	Neptune Barcelona, S.A.
Piraeus	Valencia	1 x 3 weeks	SolNiver Lines	SOL Lines
Piraeus	Valencia	weekly	Grimaldi Euromed-Servce	Grimaldi Belgium
Constantza	Odessa	weekly	ZIM Israel Nav	Van Ommeren Sweden AB
Constantza	Odessa	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Constantza	Odessa	weekly	C.M.N. International	Ernst Glässel GmbH
Constantza	Odessa	weekly	Kraftmar Co. Ltd	Marítima Dávila Barcelona, S.A.
Constantza	Odessa	weekly	CARGO STEM	Global Container Agency, S.A.
Constantza	Odessa	bi-weekly	CEC Lines	???
Constantza	Odessa	weekly	Compagnie Meridionale de Navigation	Overseas Maritime Transport N.V.
Constantza	Odessa	weekly	K Line	K Line (Nederland) BV
Constantza	Odessa	weekly	X-Press Container Lines	Burger Feeder Services B.V.
Constantza	Barcelona	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Constantza	Barcelona	weekly	Kraftmar Co. Ltd	Marítima Dávila Barcelona, S.A.
Constantza	Barcelona	weekly	CARGO STEM	Global Container Agency, S.A.
Constantza	Barcelona	weekly	CMA CGM	Navispain, S.L.
Odessa	Barcelona	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Odessa	Barcelona	weekly	Kraftmar Co. Ltd	Marítima Dávila Barcelona, S.A.
Odessa	Barcelona	weekly	CARGO STEM	Global Container Agency, S.A.
Odessa	Marseille	weekly	ZIM Israel Nav	MARSEILLE CONSIGNATION
Marseille	Algeciras	weekly	Maersk Line	Maersk España, S.A.
Marseille	Barcelona	weekly	CMA CGM	Navispain, S.L.
Marseille	Valencia	weekly	CMA CGM	Navispain, S.L.
Piraeus	Istanbul	weekly	MSC	F.H. Bertling Schiffahrtskontor KG
Piraeus	Istanbul	weekly	Borchard Lines Ltd	Best & Osterrieth NV
Piraeus	Istanbul	1 x 9 days	Armada Lines	Unamar N.V.
Piraeus	Istanbul	weekly	ZIM Israel Nav	Van Ommeren Sweden AB
Piraeus	Istanbul	weekly	Evergreen	Scandinavian Shipping Agencies Sweden

Piraeus	Istanbul	weekly	Contship	Maritime Transport & Agencies AB
Piraeus	Istanbul	weekly	Blue Cont. Line	Lineas Regulares, S.L.
Piraeus	Istanbul	weekly	Emes Line Shipping & Transport	Green Ibérica, S.A.
Piraeus	Istanbul	1 x 9 days	Compañia Trasatlantica Española S.A., Madrid	Naviera del Odiel de Contenedores, S.A. (Contenosa)
Piraeus	Istanbul	weekly	Mediterranean Shipping Company (MSC)	Mediterranean Shipping Co., España
Piraeus	Istanbul	weekly	KENZ MARITIME	Compañía Barcelonesa de Consignaciones, S.A.
Piraeus	Istanbul	weekly	Sermar Line Srl	Romeu y Cía, S.A.
Piraeus	Istanbul	weekly	Sudcargos	Marítima Sudcargos España, S.A.
Piraeus	Istanbul	1 x 3 weeks	SolNiver Lines	SOL Lines
Piraeus	Istanbul	weekly	United Ocean Lines	TOS

Estimation of emissions for container carriers in SSS:

Emission factors for container carriers – Category: like Panamax, [Source: Ecotransit]

	CO2 eq SUM g/t-km	Nox SUM g/tkm	SOx SUM g/tkm	PM10 SUM g/t-km
Container carrier: like Suezmax	15.22	0.4	0.22	0.0351

Emission factors for container carriers - feeders, [Source: Ecotransit]

	CO2 eq SUM g/t-km	Nox SUM g/tkm	SOx SUM g/tkm	PM10 SUM g/t-km
Feeder Container carrier	27.26	0.7	0.4	0.0579

Istanbul – Trieste – Istanbul:

MoMs of meeting with MSC:

Annual volume: 1 trip/day X 365 days/year X 250 trucks/trip

Loading: Assuming a load of 250/255 trucks/trip / max trucks/trip, return empty

Concerning cargo security and safety, the interviewee said that almost 100% of the goods are transferred with safety and without accidents or security problems.

The Istanbul – Trieste chain was described in detail by the feedback of UN-Roro in the SuperGreen survey. The results from these data are very close to the literature based estimations. As follows, a detailed description of the calculation of KPIs is given.

Ecotransit calculations:

Istanbul – Trieste		4456 km	
	tn	gr/tn	gr/tn/km
co2 equiv	0.032	32000	7.181329
nox	0.75	750	0.168312

sox	0.45	450	0.100987
pm	0.063	63	0.014138

Mersin – Trieste		5107 km	
	tn	gr/tn	gr/tn/km
co2 equiv	0.043	43000	8.419816
nox	0.99	990	0.193852
sox	0.6	600	0.117486
pm	0.084	84	0.016448

Istanbul - France		5471 km	
	tn	gr/tn	gr/tn/km
co2 equiv	0.068	68000	12.42917
nox	1.56	1560	0.28514
sox	0.95	950	0.173643
pm	0.13	130	0.023762

Estimation of overall KPIs (averaging on results)

TC	Emissions (g/tkm)				Cost in euro/tkm*
	CO2	NOX	SOX	PM10	
1	15.22	0.4	0.22	0.035	
2	27.26	0.7	0.4	0.058	0.003
3	7.181329	0.168312	0.100987	0.014138	0.018957
4	8.419816	0.193852	0.117486	0.016448	0.01654
5	12.42917	0.28514	0.173643	0.023762	0.01544
6	27.26	0.7	0.4	0.058	
7	27.26	0.7	0.4	0.058	0.003
8	10	0.231	0.1379	0.0193	0,0055
9	6.44	0.15	0.092	0.0128	0.0052
10	9.89	0.227	0.141	0.019	0.0156
11	8.27	0.189	0.115	0.016	0.0196
Average	14.51185	0.358573	0.208911	0.030041	0.012167

* We use the assumption of 16.1tn/ trailer

Appendix IV. Filled Questionnaires for corridor benchmarking