SEVENTH FRAMEWORK PROGRAMME

THEME [7]

Theme Title: Transport (including Aeronautics)

SuperGreen

SUPPORTING EU'S FREIGHT TRANSPORT LOGISTICS ACTION PLAN ON GREEN CORRIDORS ISSUES

Grant agreement for: <Coordination and Support Actions (coordination)>

Grant agreement no.: TREN/FP7TR/233573/"SUPERGREEN"

Green Corridors Handbook
Volume I

Due date of deliverable: 15 Jan. 2013

Actual submission date: 20 Dec. 2012 (Revised: 25 Feb. 2013)

Organisation name of lead partner for this deliverable: Port Authority of Gijon

Document ID number: **07-20-PP-2012-05-01-3**

REVISIONS/DOCUMENT HISTORY:

Index	Date	Authors	Reviewers	Subject
01	Dec. 12, 2012	H. Moyano, PAG	G. Panagakos, NTUA S. Fozza, DAPP E. Holte, MAR	First draft
02	Dec. 18, 2012	H. Moyano, PAG G. Panagakos, NTUA S. Fozza, DAPP E. Holte, MAR P. Zacharioudakis, NTUA C. Georgopoulou, DNV	H. Psaraftis, NTUA	Second draft
03	Feb. 25, 2013	G. Panagakos, NTUA	H. Psaraftis, NTUA	Revision taking on board comments from the Commission

CLASSIFICATION AND APPROVAL

Classification: **R** Confidential (CO)

DEFINITION

Nature of the deliverable:
R = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

Dissemination level:
PU = Public
PP = Restricted to other programme participants (including the Commission Services).
RE = Restricted to a group specified by the consortium (including the Commission Services).
CO = Confidential, only for members of the consortium (including the Commission Services).

Confidential for the Duration of the Project:

As for 'Confidential', but only for the duration of the Project. After final Project Approval by the EC, status for reports classified 'Confidential for the Duration of the Project' are automatically down-graded to 'Public'.

Confidential:

The document is for use of the beneficiaries within the SuperGreen Consortium, and shall not be used or disclosed to third parties without the unanimous agreement within the project General Assembly and subsequent EC approval since document classification is part of the EC Grant Agreement.

Any executive summary specifically intended for publication may however be made known to the public by the author and/or the Coordinator.

Document summary information

Authors and contributors

Initials	**Author**	**Organisation**	**Role**
HM	Humberto Moyano	PAG	Author
GP	George Panagakos	NTUA	Author
SF	Sara Fozza	DAPP	Author
EH	Even Ambros Holte	MAR	Author
ZM	P. Zacharioudakis, T. Mpaliami	NTUA	Contributors
CG	Chara Georgopoulou	DNV	Author

Revision history

Rev.	**Who**	**Date**	**Comment**
1	All	Dec. 15, 2012	Various comments on the structure of the document
2	GP	Dec. 19, 2012	Response to comments of internal reviewers
3	GP	Feb. 25, 2013	Response to comments from the Commission

Quality Control

	Name	**Date**
Checked by WP leader	Valerio Recagno, DAPP	Dec. 19, 2012
Checked by internal reviewer	Atle Minsaas, MAR	Dec. 19, 2012
Checked by internal reviewer	Harilaos Psaraftis, NTUA	Dec. 19, 2012

APPROVAL:

The Coordinator of the project consortium via a return email has approved the final version of this SuperGreen Deliverable.

DISCLAIMER

Table of contents

List of Abbreviations

AVI	Automatic Vehicles Identification
CNG	Compressed Natural Gas
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent unit
DoW	Description of Work
ERTMS	European Rail Traffic Management System
ETA	Estimated Time of Arrival
ICT	Information and Communication Technology
IHS	Intelligent Highway System
ISA	Intelligent Speed Adaption
ITS	Intelligent Transport Systems
KPI	Key Performance Indicator
LNG	Liquefied Natural Gas
NOx	Nitrogen oxides (NO and NO_2)
PM	Particulate Matter
R&D	Research and Development
RFID	Radio Frequency Identification
RIS	River Information Services
SDS	Sustainable Development Strategy
SOx	Sulphur oxides (SO_2 and SO_3)
TEN-T	Trans-European Transport Network
VTMIS	Vessel Traffic Management Information System
WPx	Work Package x (of the SuperGreen project)

0 Introduction

The Dissemination Plan of the SuperGreen project provided for a book to be published by the end of the project as a compendium of its final results. Its purpose was set to provide an overview of the activities performed and the results achieved. The presentation of the quantitative and qualitative benefits associated with the development of green corridors, was, therefore, its main objective. In particular, the handbook was expected to describe:

- the green corridor selection and benchmarking;
- the application of innovative "green" technologies;
- the application of more efficient and smart ICTs;
- recommendations for future R&D programmes; and
- policy recommendations for the development of green corridors.

The present document addresses exactly this requirement. In fact, each one of the above bullet points corresponds to a separate section of the document. The only exceptions are:

(i) a very brief presentation of SuperGreen in terms of basic information, objectives, consortium composition and project structure, which is given in the next section; and

(ii) a description of the extended dissemination activities of the project, which are presented in the last section.

Two target audiences are mentioned in the project's Dissemination Plan:

(i) the general SuperGreen target audience consisting of shippers, transport operators, equipment suppliers, public authorities, the project's Advisory Committee, the partners' contact lists and the general public at large, which share a more general interest on the project; and

(ii) the logistics business community, which might be directly involved in green corridor development.

It was, thus, decided to present the Handbook in two volumes:

- **Volume I**, which provides a concise account of all project activities and results reached; and
- **Volume II**, which presents in more detail only those project results that have a practical value for the logistics business community.

Nevertheless, both volumes should be viewed as integral parts of the same document. An electronic version of both volumes will become available for downloading from the project's website upon approval by the European Commission.

1 The SuperGreen project

The European Commission's document *Freight Transport Logistics Action Plan* introduced in 2007 a series of policy initiatives and a number of short to medium-term actions to improve efficiency and sustainability of freight transport in Europe. One of these actions was to define "Green transport corridors for freight." In this framework, the SuperGreen project was launched in 2010.

Project identity

- **Project full title:** Supporting EU's Freight Transport Logistics Action Plan on Green Corridors Issues
- **Type of project:** Coordination and Support Action
- **Financed through:** 7th Framework Programme
- **Duration:** 36 months
- **Official start:** 15 Jan. 2010
- **Consortium:** 22 partners from 13 countries
- **Leader:** National Technical University of Athens
- **Total budget:** 3,453,747 EUR
- **EC contribution:** 2,634,698 EUR

Project objectives

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

The specific objectives of the project were:

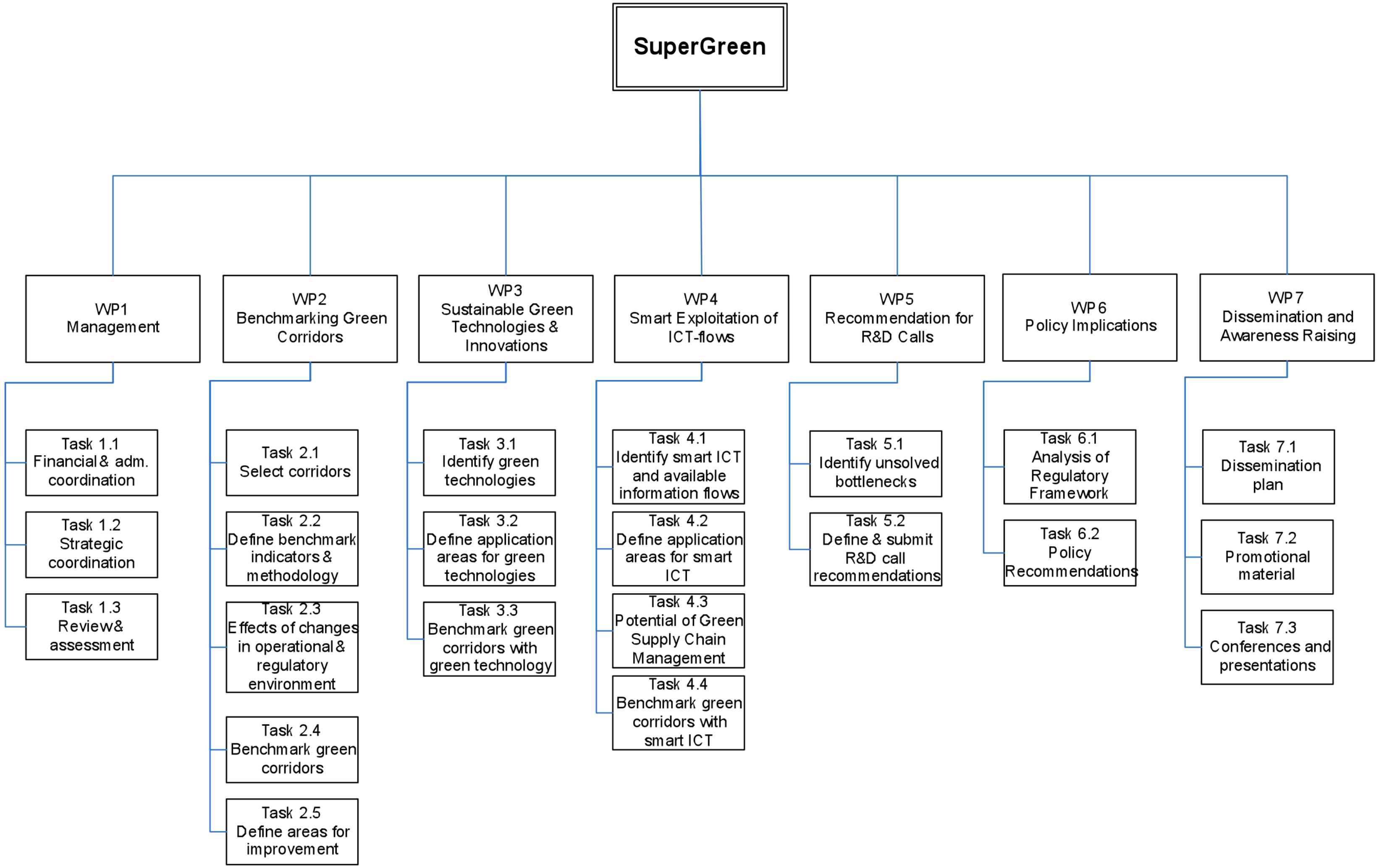
- Giving overall support and recommendations on green corridors to EU's Freight Transport Logistics Action Plan.
- Conducting a programme of networking activities between stakeholders (public and private) and ongoing EU and other research and development projects to facilitate information exchange, research results dissemination, communication of best practices and technologies at a European, national, and regional scale, thus adding value to ongoing programmes.
- Providing a schematic for overall benchmarking of green corridors based on selected KPIs, also including social and spatial planning aspects.
- Delivering a series of short and medium-term studies addressing topics that are of importance to the further development of green corridors.
- Delivering policy recommendations at a European level for the further development of green corridors.

- Providing the Commission with recommendations concerning new calls for R&D proposals to support development of green corridors.

Project partners

Partner Number *	Partner name	Partner short name	Country
1 (Coordinator)	National Technical University of Athens	NTUA	Greece
2	Norsk Marinteknisk Forskningsinstitutt AS, MARINTEK	MAR	Norway
3	Sito Ltd (Finnish Consulting Engineers Ltd)	SITO	Finland
4	D'Appolonia S.p.A.	DAPP	Italy
5	Autoridad Portuaria de Gijon Gijón Port Authority-	PAG	Spain
6	DNV Det norske Veritas	DNV	Norway
7	via donau Österreichische Wasserstraßen-Gesellschaft mbH	VIA	Austria
8	NewRail - Newcastle University	UNEW	UK
9	CONSULTRANS	CONS	Spain
10	PSA Sines	PSAS	Portugal
11	Finnish Transport Agency	FMA	Finland
12	Straightway Finland Ry	SWAY	Finland
13	SNCF Fret Italia	SFI	Italy
14	Procter & Gamble Eurocor	PG	Belgium
15	VR Group	VRG	Finland
16	Lloyd's Register-Fairplay Research	LRFR	Sweden
17	Hellenic Shortsea Shipowners Association	HSSA	Greece
18	Dortmund University of Technology	DUT	Germany
19	TES Consult Ltd	TES	Ukraine
20	Turkish State Railways	TCDD	Turkey
21	DB Schenker AG	SCH	Germany
22	Norwegian Public Road Administration	NPRA	Norway

Project structure



General notes on project scope and methodology

The following notes on project scope and methodology are in order right at the outset:

- The term 'sustainable transport' used in describing the general objective of the project is meant in its EU Sustainable Development Strategy (SDS) definition, according to which it encompasses three primary dimensions: economic, environmental and social. In this respect, the term is more general than some alternative uses, which only consider the environmental dimension of sustainability.
- Although the quality of transport and logistics services is seriously affected by passenger transport competing for route capacity, the project deals only with freight transport.
- The transport modes examined are limited to surface freight services. Aviation is outside the scope of the project, as is the use of pipelines for liquid cargoes.
- The term 'corridor' is used in a broad sense involving all related functions:
  - ✓ basic infrastructure and facilities;
  - ✓ transport technologies (including ICT applications);
  - ✓ logistics solutions (including business models); and
  - ✓ transport policies and regulatory procedures.
- Improved performance of a corridor is connected to improvements in any of the functions listed above or any possible combination among them.
- As in any other performance monitoring activity, benchmarking of a corridor, a technology or an ICT application requires ample reliable data. SuperGreen, being a Coordination and Support Action, mainly relies on existing information produced by studies or research projects. Extensive effort has been put in by project partners to locate the quantitative information needed. When this was not possible, we had to rely on stated preference data solicited through specially developed questionnaires. It is apparent that the uncertain character of this type of information weakens the validity and reliability of the resulting assessments. The reader should keep this in mind.

For more information on the SuperGreen project visit:

http://www.supergreenproject.eu/

Contact details:

Prof. Harilaos N. Psaraftis (SuperGreen Project Manager)

National Technical University of Athens
School of Naval Architecture and Marine Engineering
Laboratory for Maritime Transport
9 Iroon Polytechneiou st.,
GR 15773 Zografou
Athens, Greece

Tel.: +30 210 772 1403
Fax: +30 210 772 1408
E-mail: hnpsar@gmail.com

2 Benchmarking green corridors

The objective of WP2 was to determine the major development needs and possibilities for the greening of transport chains in selected transport corridors. Its specific objectives included the following:

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

The package contained five tasks:

- **Task 2.1 Selection of corridors**, to act as a basis for the definition of the benchmarking taxonomy to be developed;
- **Task 2.2 Definition of benchmark indicators and methodology**, reflecting the success factors of transport chains and corridors against the sustainable development goals of European Union;
- **Task 2.3 Effects of changes in operational and regulatory environment** that may hinder improvements of green logistics corridors;
- **Task 2.4 Benchmarking of green corridors** through the use of the selected KPIs in order to get an overall picture of the differences and common factors in relation to a number of greening aspects; and
- **Task 2.5 Definition of areas for improvement** after identifying major bottlenecks in the greening process as well as best practices for improving the sustainability of transport chains.

2.1 Selection of corridors

An initial list of 60 potential corridors was compiled on the basis of the TEN-T priority projects, the Pan European Transport Network and proposals made by the project's industrial partners. After two consolidation rounds, the number of candidate corridors was reduced to 30. A survey was carried out to gather information on these 30 corridors. Based on the information gathered and criteria like corridor length, population affected, freight volume, types of goods and multimodality, number and seriousness of bottlenecks, geographical preconditions, transport and information technology used, and assessment of the supply chain management, a pre-selection of 15 corridors was made. A geographic and modal balance was ensured among them. The aim at this stage was to select the ones with the highest "greening potential" rate.

Further information was collected on these 15 pre-selected corridors and a deeper analysis was performed taking into consideration land use aspects like the percentage of corridor surface comprising urban and environmentally sensitive areas. The analysis resulted to a recommendation of 9 corridors for final selection, which was presented to a stakeholder workshop especially arranged for this purpose. In line with comments received during the workshop, the selected corridors were modified by adding segments that exhibit advanced "greening" characteristics.

In addition to being geography- and mode-wise balanced, the resulting set of corridors comprised a mix of environmentally advanced ones on one hand, and those exhibiting a high "greening potential" on the other, thus constituting a suitable field for testing the benchmarking methodology and KPIs. Figure 1 presents the SuperGreen corridors in a metro format.

It should be made clear that the selection of these corridors was made only for the purposes of the SuperGreen project and by no means this implies any endorsement, direct or indirect, either by the SuperGreen consortium or by the European Commission, of these corridors vis-à-vis any other corridor, with respect to any criteria, environmental, economic, or other.

For more information on corridor selection refer to SuperGreen deliverable:

D2.1 – Selection of Corridors

found at: http://www.supergreenproject.eu/

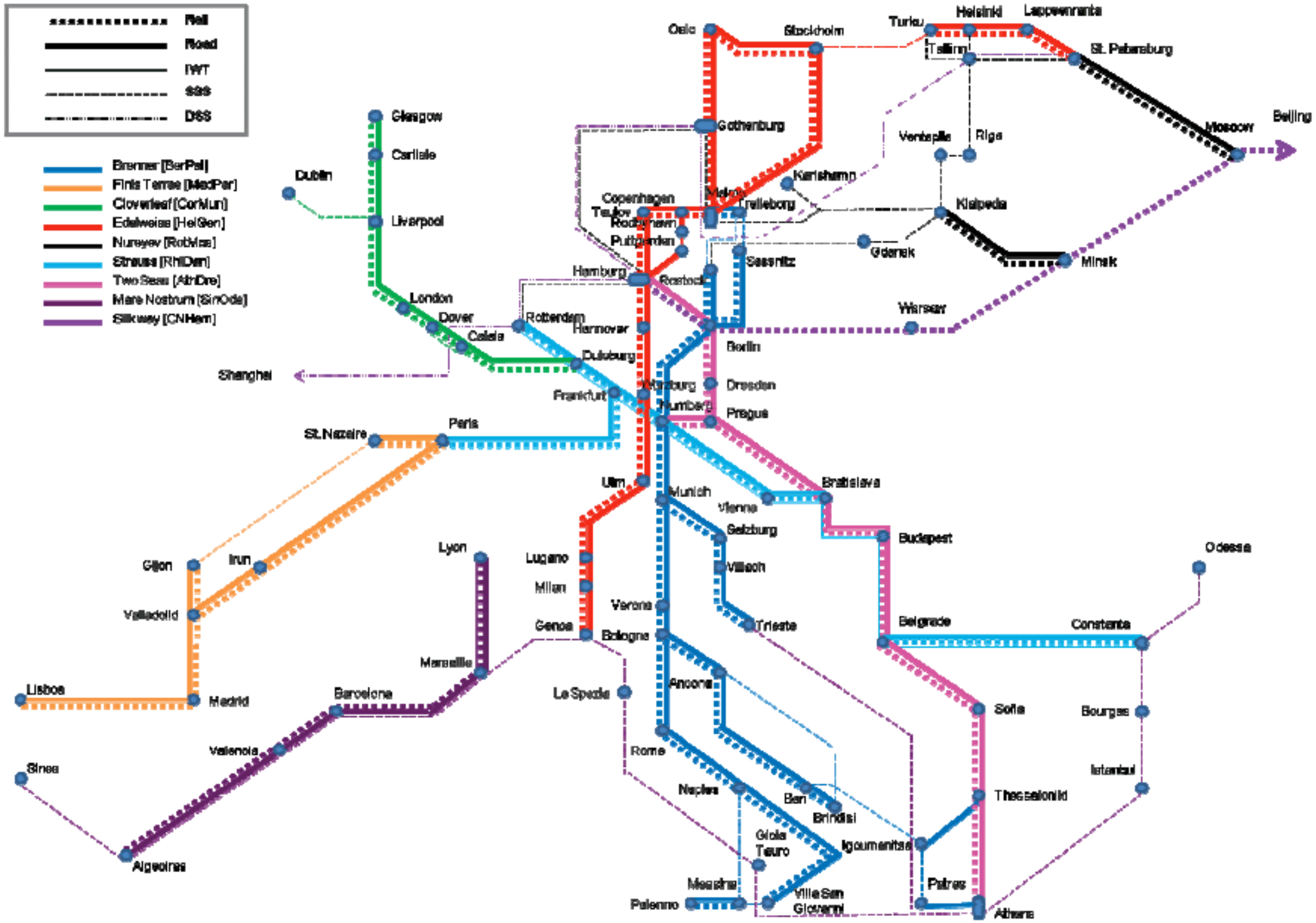


Figure 1. The SuperGreen corridors in metro format

2.2 Definition of benchmark indicators and methodology

The project developed a methodology that basically consisted of:

- decomposing the corridor under examination into transport chains;
- benchmarking these chains using a set of KPIs; and then
- aggregating the chain-level KPIs to corridor-level ones using proper weights for the averaging.

A second level of aggregation combining all corridor-level KPIs into a single corridor rating was also foreseen initially. The rationale for such a rating was to cope with interactions between different KPI groups, as is for example the case where measures introduced to improve performance in relation to one area might have adverse effects on another.

The initial set of KPIs resulted from a process that included the compilation of a gross list of performance indicators, their categorisation into different groups and their filtering during detailed discussions. These KPIs, grouped in five areas (efficiency, service quality, environmental sustainability, infrastructural sufficiency, and social issues), are presented in Table 1 along with their respective definition.

With the aim of soliciting feedback, the methodology and initial set of KPIs were presented in three events: two regional stakeholder workshops and a meeting of the project's Advisory Committee. The general consensus was that the methodology was in broad terms acceptable and that the KPIs proposed by the project cover all basic facets of the problem. However, there was also a general sense that the KPIs as proposed were too ambitious and there was a need to simplify them so that the set be useful. In that sense, reducing the set of KPIs to a more manageable one was considered as a desirable outcome.

Following an internal round of KPI screening, a revised set was presented to a third regional SuperGreen workshop, organised in Malmö, Sweden and hosted by the Swedish Transport Administration. The aim was to set a basis for collaboration with the numerous green corridor initiatives in the Baltic region and take advantage of an audience directly or indirectly exposed to the green corridor concept. The KPI set that resulted from this process is the following:

- **Out-of-pocket costs** (excluding VAT), measured in €/tonne-km;
- **Transport time**, measured in hours (or average speed, measured in km/h, depending on the application);
- **Reliability** of service (in terms of timely deliveries), measured in percentage of consignments delivered within a pre-defined acceptable time window;
- **Frequency** of service, measured in number of services per year;
- **CO_2 emissions**, measured in g/tonne-km; and
- **SOx emissions**, measured in g/tonne-km.

> It is noted that the cost and emission KPIs are specified in relative terms, i.e. expressed per tonne of cargo and km travelled. The reason is the comparison capabilities across corridors, routes, modes and origin-destination pairs that this specification enables. However, for certain applications, especially with regard to emissions, the absolute figures are also needed.

This set was reaffirmed at a fourth regional stakeholder workshop of the project in Sines, Portugal.

Table 1. Initial set of KPIs

KPIs	Units
Efficiency	
Absolute cost	**€/tonne**
Relative cost	**€/ton-km**
Service quality	
Transport time	**hours**
Reliability (time precision)	**% of shipments delivered on time (within acceptable window)**
Frequency of service	**Number of services per week**
ICT applications - cargo tracking, availability - cargo tracking, integration & functionality - other ICT services, availability - other ICT services, integration & functionality	**graded scale (1-5)** **graded scale (1-5)** **graded scale (1-5)** **graded scale (1-5)** **graded scale (1-5)**
Cargo security	**Number of incidents per total number of shipments**
Cargo safety	**Number of incidents per total number of shipments**
Environmental sustainability (*)	
CO_2-eq	**g/ton-km**
SO_2	**g/1000 ton-km**
NOx	**g/1000 ton-km**
PM_{10}	**g/1000 ton-km**
Infrastructural sufficiency	
Congestion	**average delay (hours) per ton-km**
Bottlenecks - geography - infrastructure capacity - infrastructure condition - administration	**graded scale (1-5) based on list of bottlenecks per category, accompanied by list of projects aiming at their removal/mitigation**
Social issues	
Corridor land use - urban areas - sensitive areas	 **% of buffer zone (**) covered by urban areas** **% of buffer zone (**) covered by environmentally sensitive areas**
Traffic safety	**sum of fatalities and serious injuries per year per million ton-km**
Noise	**% of corridor length above 50/55 dB**
(*) well-to-wheel approach (**) shaped by a radius of 20 km around the median line of the corridor	

For more information on the benchmark indicators and methodology refer to SuperGreen deliverables:

D2.2 - Definition of Benchmark Indicators and Methodology;
D2.4 - Version 1 (2010) - Benchmarking of Green Corridors; and
D2.4 - Version 2 (2011) - Benchmarking of Green Corridors

found at: http://www.supergreenproject.eu/

2.3 Effects of changes in the operational and regulatory environment

The objectives of Task 2.3 were to review the operational and regulatory environment, identify the most significant changes that take place thereto, and assess their effects on green corridor development through the proposed KPIs.

The method followed was a literature survey based on research works and other existing information. From an initial list of 242 documents, covering the last decade, 60 were selected to be reviewed. About 450 changes resulted from this review, which were bundled in 77 definite changes after being screened. These changes were grouped in seven themes (Business environment, Trends in logistics, Public policies, Operations, Infrastructure development, Technology development, and International regulations) and their effects on green corridor development were assessed through the use of the SuperGreen KPIs. Due to their bulkiness, the results are shown in Appendix I.

The main conclusions regarding the EU transport policy are:

- 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.
- 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. Table 2 summarises the most effective among the 77 policies/ changes when they are sorted on the basis of different criteria. The significance of educating, informing and involving the greater public in transport policies is a precondition for their effectiveness.
- The points made above are adequately addressed by the new White Paper, which:
  - takes on board most of the initiatives of the *Freight Transport Logistics Action Plan* that have not been completed yet (e.g. e-Freight, ITS, single transport document, standard liability clause, 'end-to-end' security, new legislation on weight and dimension, best practice guidelines for urban freight flows, etc.);
  - foresees a vigilant enforcement of the competition rules across all transport modes;
  - exploits the advantages of the corridor approach through the introduction of the core network concept; and
  - recognises the need for new transport patterns, in fact naming the use of alternative fuels and advanced ICT applications as prominent features of two of the three strands that future developments must rely on; the third one concerns the performance of multimodal logistic chains, which is the main objective of green corridors by definition.
- Over-regulating is an issue that should not be overlooked, since improvements in one aspect might create problems in another.

Table 2. Most effective changes when sorted on the basis of different criteria

Primary criterion	Four most effective changes in descending order
CO_2-eq	Support R&D
	Use alternative fuels
	Promote intermodal freight villages
	Develop ICT applications
Transport cost	Containerisation
	Support R&D
	Promote intermodal freight villages
	Develop ICT applications
Transport time	Containerisation
	Construct dedicated freight rail lines
	Create freight-oriented corridors
	Promote intermodal freight villages
Reliability	Construct dedicated freight rail lines
	Create freight-oriented corridors
	Containerisation
	Promote intermodal freight villages
Frequency	Construct dedicated freight rail lines
	Containerisation
	Liberilise transport operations
	Establish a polar code

The main conclusions regarding the green corridors are:

- Valuable lessons can be drawn from Regulation No 913/2010 that introduced the freight-oriented corridors.
- In relation to the criteria for labelling a particular corridor as ‘green’, it is suggested that the European Commission assesses the possibility of including as prerequisites:
  - the fair and non-discriminatory access requirement of the *Freight Transport Logistics Action Plan*, and
  - the internalisation of external costs, which for the time being remains voluntary.
- Intermodal terminals and freight villages have a crucial role in the development of green corridors.
- The KPIs on emissions, congestion and accidents should include absolute in addition to relative units.

For more information on the operational and regulatory environment refer to SuperGreen deliverable:

D2.3 – Effects of changes in the operational and regulatory environment

found at: http://www.supergreenproject.eu/

2.4 Benchmarking of green corridors

The Brenner corridor, extending from Malmö (SE) to Palermo (IT) with branches from Salzburg (AT) to Trieste (IT) through the Tauern axis, and from Bologna (IT) to Athens/Thessaloniki (GR) through the Italian and Greek Adriatic/Ionian ports, was selected to be examined first as a pilot case for testing the methodology. The following steps were taken:

*The most characteristic segment of a corridor is considered as its **critical** segment. Examples are the Brenner Pass 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 Brenner Pass (Munich – Verona) was selected as the corridor's critical segment;
- the cargo flows along this critical segment were located in literature;
- a small number (15) of typical transport chains concerning typical cargoes were identified;
- detailed information concerning these transport chains (type of vehicles used, load factors, etc.) was collected from studies and interviews with transport service providers; and
- the selected KPIs were evaluated for each one of these transport chains (emissions were estimated through the EcoTransIT World web based tool).

Two levels of aggregation were foreseen in the initial methodology. The first one concerned the estimation of one set of KPI values for each and every segment of the corridor by aggregating all flows that involve the relevant segment. Weighted averages would be used for this aggregation. The respective transport work (tonne-km), cargo volumes (tonnes) or other flow characteristics (e.g. number of consignments) were to be used as weights depending on the definition of each KPI. However, the reliability of such an estimate was questioned due to the fact that:

- the sample was very thin (for some segments there was only one observation) and the resulting figure would have limited statistical value if any;
- not all of the chains reflected the entire door-to-door transport as needed to ensure comparability; some of them covered only terminal-to-terminal operations; and
- most data was collected through interviews and reflected personal assessments without strict validation.

It was, thus, decided to express corridor benchmarks as ranges of values that resulted from the transport chain data, i.e. minimum and maximum values of all transport chain level KPIs. Table 3 below summarises the KPI values of the Brenner corridor presented by transport mode.

The most important conclusion of this exercise is the width of the range within which some KPI values fluctuate. Even after taking into consideration the drawbacks mentioned above, one would expect more concise estimates.

Table 3. KPI values for the Brenner corridor

KPIs	Intermodal	Road	Rail	SSS
Cost (€/tkm)	0.03-0.09	0.05-0.07	0.05-0.80	0.04
Av. speed (km/h)	9-41	19-40	44-98	23
Reliability (%)	95-99	50-99	50-100	100
Frequency (no/year)	26-624	104-2600	208-572	52
CO_2 (g/tkm)	10.62-42.11	46.51-71.86	9.49-17.61	16.99
SOx (g/tkm)	0.02-0.14	0.05-0.08	0.04-0.09	0.12

The second level of aggregation initially foreseen concerned an overall corridor (or corridor segment) rating, that would combine all KPIs into a single numerical value through the use of relative weights assigned to each KPI. However, this approach was later considered as an unnecessary complication on the grounds that:

- the weights needed for such calculation very much depend on the user (different users will propose different weights),
- it is a political issue best left for policy makers to decide and hence one that we should avoid,
- weights, if assigned, might lead to wrong interpretations,
- weights change over time (e.g. social issues might become more significant in the future), and
- weights would not reflect country specific characteristics of transport operations.

The issue was discussed extensively in a SuperGreen workshop organised in Naples, Italy and a decision was reached to exclude such attempt from the methodology. The decision was later confirmed by the project's Advisory Committee.

The methodology, as resulted from the pilot exercise, was then applied for benchmarking five other corridors (Cloverleaf, Nureyev, Strauss, Mare Nostrum and Silk Way). Lack of data combined with time and resource restrictions did not permit the examination of the remaining three corridors (Finis Terrae, Two Seas and Edelweiss). The results are summarised in Table 4.

It is important to note that the results of Table 4 are achieved using the EcoTransIT World web emission calculator and self-reported figures from interviewees and literature review. As such, they are only indicative. Using other tools and methods might have led to different results. The accuracy problem identified in the Brenner corridor is confirmed.

Table 4. Benchmarking results (all corridors)

Corridor	Mode	Cost (€/tkm)	Av. speed (km/h)	Reliability (%)	Frequency (no/year)	CO_2 (g/tkm)	SOx (g/tkm)
Brenner	Intermodal	0.03-0.09	9-41	95-99	26-624	10.62-42.11	0.02-0.14
	Road	0.05-0.07	19-40	50-99	104-2.600	46.51-71.86	0.05-0.08
	Rail	0.05-0.80	44-98	50-100	208-572	9.49-17.61	0.04-0.09
	SSS	0.04	23	100	52	16.99	0.12
Cloverleaf	Road	0.06	40-60	80-90	4.680	68.81	0.09
	Rail	0.05-0.09	45-65	90-98	156-364	13.14-18.46	0.01-0.02
Nureyev	Intermodal	0.10-0.18	13-42	80-90	156-360	13.43-33.36	0.03-0.15
	SSS	0.05-0.06	15-28	90-99	52-360	5.65-15.60	0.07-0.14
Strauss	IWT	0.02-0.44	-	-	-	9.86-22.80	0.01-0.03
Mare Nostrum	SSS	0.003-0.20	17	90-95	52-416	6.44-27.26	0.09-0.40
	DSS	-	-	-	-	15.22	0.22
Silk Way	Rail	0.05	26	-	-	41.00	-
	DSS	0.004	20-23	-	-	12.50	-

The comparison of rail transport attributes across corridors shows very high variance of cost and reliability for the Brenner corridor, which requires further investigation. The very low speed and high emissions of the trans-Siberian service is also noticeable, albeit expected due to the diesel traction and the gauge incompatibility problem along this route. The wide fluctuation of intermodal transport attributes is also impressive and can be explained by the different nature of schemes examined in each case.

A number of conclusions can be derived from the benchmarking work described above:

- Corridor benchmarking is possible but we need to standardise the measurement and allocation of emissions if we want to develop operational KPIs used for benchmarking purposes.
- Even then, the definition of acceptable limits for KPI values requires due consideration of corridor specific conditions. This type of risk is eliminated when comparing KPI values over time for the same corridor.
- Data collection proves to be a serious problem. Relevant obligations imposed by the corridor management might be a solution. The formation of corridor specific stakeholder groups can be helpful in this regard. Automated ICT applications, able to provide cargo flow data without causing physical disruptions of the vehicle flows or other administrative bottlenecks, can also be useful.
- Aggregating chain-level KPIs to a single set of corridor- or segment-level ones is possible provided that an adequate sample of transport chains is examined under the same conditions. Otherwise, the use of value ranges is suggested.
- Aggregating corridor-level KPIs to an overall corridor rating should be omitted because there are problems associated with the weights needed for such calculation and, more importantly, it is a political issue best left for policy makers to decide.

For more information on corridor benchmarking refer to SuperGreen deliverables:

D2.4 - Version 1 (2010) - Benchmarking of Green Corridors; and
D2.4 - Version 2 (2011) - Benchmarking of Green Corridors

found at: http://www.supergreenproject.eu/

2.5 Definition of areas for improvement

Major bottlenecks in greening each one of the nine SuperGreen corridors were defined in Task 2.5. Based on this and in combination with other work of WP2, common development areas across all corridors were defined. They were grouped in the following four categories: Operations; Policies, regulations and legislation; Infrastructure; and ICT & technology.

The major development areas concern:

- new ICT systems;
- improvement of railway operations;
- harmonisation of national regulations;
- improvement of customs procedures;
- hinterland connections; and
- adequate capacity in all transport networks and transfer points.

Improvements towards sustainability are needed in each one of the corridors for different purposes. Several good practices to improve sustainability were identified in all corridors and for all transport modes. The basic problems were lack of harmonisation and co-operation. These are vital elements that need to be addressed in order to exploit good practices more effectively.

Based on the identified common development areas and best practices, the most favourable areas for improving sustainability were identified:

- improvement of green supply chain design and management;
- harmonisation of policies and regulations;
- development and harmonisation of transport infrastructure and technology;
- harmonisation and development of ICT solutions and transport documents;
- improvement of information transparency;
- increased cooperation in supply chains and transport systems; and
- *ensuring supply* of good quality labour.

Figure 2 summarises the findings of the survey carried out in Task 2.5.

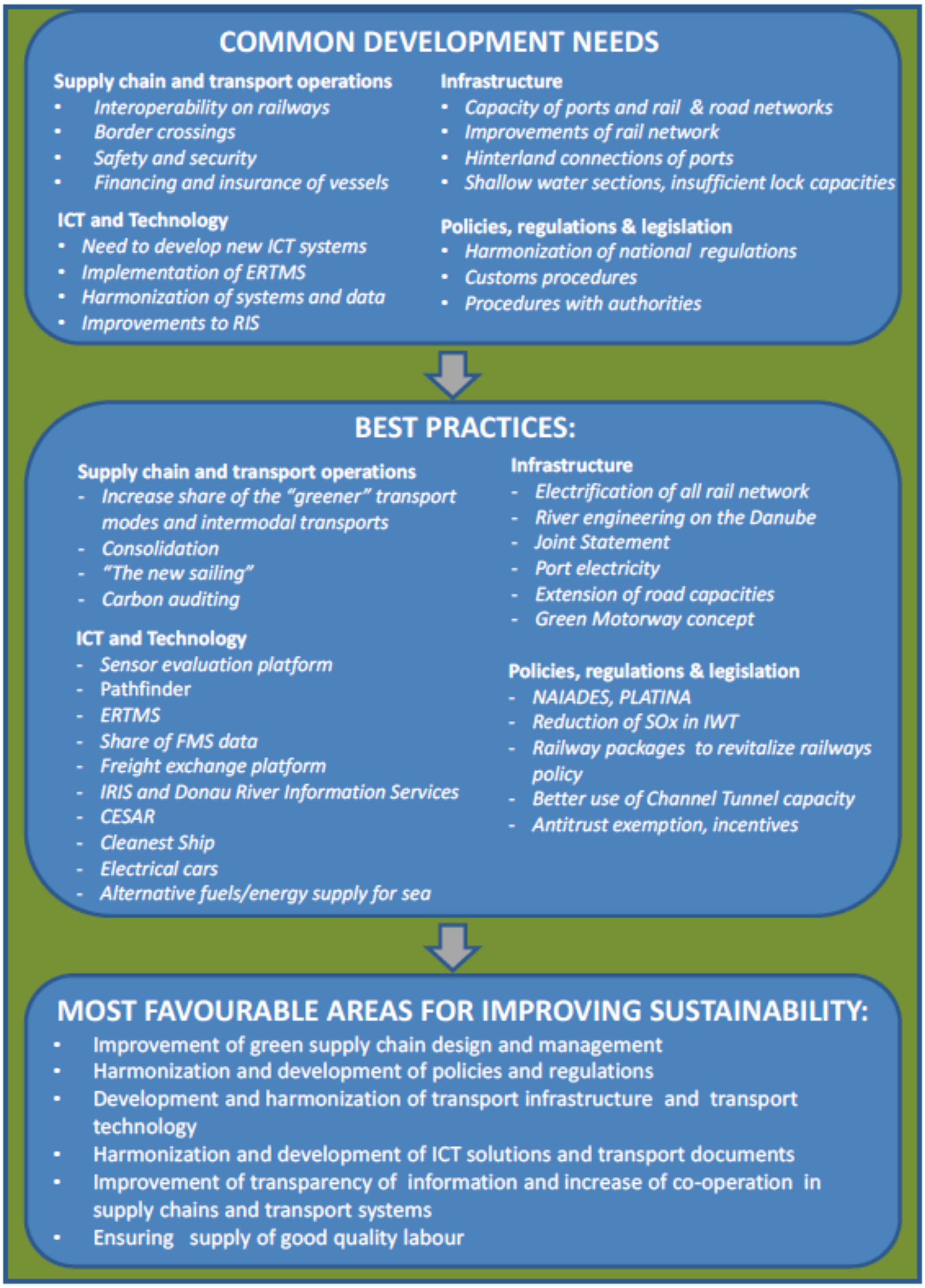


Figure 2. Most favourable areas for improving sustainability

For more information on the identification of common development areas refer to SuperGreen deliverable:

D2.5 – Definition of Areas for Improvement

found at: http://www.supergreenproject.eu/

3 Sustainable green technologies & innovations

Work package 3 aimed at identifying, selecting and benchmarking 'green' technologies, to be applied into specific green corridors while solving bottlenecks and improving sustainability. Its specific objectives included the following:

- definition of technology categories: nine groups of technologies have been identified;
- definition of the template to collect information on technologies: the common template for the collection of potentially interesting innovative technologies has been prepared taking into account the different technology categories;
- collection of information on technologies: the collection of the information/data on the different technologies has been done with reference to the transport modes;
- analysis of technologies: starting from the list of technologies previously collected, a first analysis has been conducted on their characteristics in order to identify the more promising ones according to the SuperGreen scope and objectives;
- definition of the Technology vs. Application Matrix to provide the main indications on possible application of each technology on one or more sections (nodes/links) of the green corridors identified in WP2;
- identification of the baseline for the benchmark;
- creation of the benchmark.

The package contained three tasks:

- **Task 3.1. Identify green technologies** dedicated to the identification of green technologies suitable to a set of applications.
- **Task 3.2. Define application areas for green technologies** dedicated to the analysis of the technologies vs. application and to the development of the web tool repository.
- **Task 3.3. Benchmark green corridors with green technologies** dedicated to the preparation of the baseline and to estimate the impact of green technologies with respect to the baseline.

3.1 Identify green technologies

In order to facilitate the process of identifying innovative technologies to be analysed in the scope of SuperGreen, it has been decided to consider the following categories:

- **Engines and propulsion systems**: innovative technologies concerning engines and propulsion systems in general, which can be applied to any kind of transport modes on green corridors;
- **Fuels and energy sources**: technologies related to energy production, including for instance solar panels, wind turbines and other renewable energy sources; furthermore innovative fuels will also be considered;

- **Cargo handling and transfer technologies**: technologies related to loading or unloading or cargo, transfer of loading units between different transport modes, internal handling of transport units;

- **Cargo preparation technologies**: this category is relevant to all technologies used in preparing cargo before it is transported, such as preservatives for perishable goods, packaging, sealing, etc;

- **Heating and cooling technologies**: this category includes innovative heating or cooling technologies embedded into transport vehicles, implemented into warehouses or used during handling and transfer operations;

- **Innovative loading units and their treatment (cleaning, etc)**: this category includes new loading units able to reduce the time required for loading/unloading and transfer operations, as well as the energy consumption and pollution emissions in case they involve heating/cooling devices. It also considers ancillary technologies needed for pre- or post-transport treatment of the loading unit;

- **Vehicles**: new vehicle concepts with the purpose of improving transport time and reducing pollution emissions shall be reported in this category;

- **Navigation technologies**: this category is referred to technologies facilitating vehicles navigation during transport, including tracking/tracing, and automatic vehicles identification (AVI);

- **Best practices of technologies integration**: this category is dedicated to the identification of best practices derived from real cases, related to the integration of innovative technologies on transport systems, with particular reference to their impact on energy and carbon footprint reduction, and their potential for exportability to different environments.

The green technologies collected have been described by means of well defined indicators; this allowed the analysis of their relevant characteristics and the definition of the baseline needed for identifying the most promising technologies for further analysis in the scope of the project.

After three rounds of data collection performed during the project lifetime, 202 technologies have been identified covering all nine categories and all modes of transport (road, rail, maritime and inland waterways).

It has to be mentioned that a single technology can be applicable to more than one transport mode, raising the total number of technologies analysed in the project to more than 260. In Table 5 the distribution of technologies per mode of transport is reported.

Following the collection of all data on the different types of technologies, an analysis and selection of the most relevant technologies for the project were carried out.

The analysis started from the list of technologies previously collected. This analysis has been conducted in order to identify technologies that are promising accordingly to the SuperGreen scope and objectives. The analysis divided the technologies into 6 different categories:

Table 5. List of technologies collected within the project

Transport mode	Engines and Propulsion Systems	Fuels and Souces of energy	Cargo handling and Transfer	Cargo Preparation	Heating and Cooling	Innovative units and Treatment	Vehicles	Navigation technologies	Best practices	TOTAL
Inland Waterways	11	10	3	0	0	0	4	2	0	**30**
Maritime	11	21	29	0	1	2	3	14	2	**83**
Railway	8	17	4	0	0	13	12	3	11	**68**
Road	7	18	0	0	2	1	17	3	1	**49**
Multimodal	0	3	16	6	5	3	0	0	0	**33**
TOTAL	**37**	**69**	**52**	**6**	**8**	**19**	**36**	**22**	**14**	**263**

A – Very important. These technologies are believed to have a large impact on the greening potential of cargo transportation in a transport corridor. The technologies are mature and are considered to influence the greening potential in near future.

B – Important. These technologies are believed to have an impact on the greening potential of cargo transportation in a transport corridor. The technologies are mostly mature and are considered to influence future greening.

C – Low importance. These technologies are believed to have less impact on the greening potential of cargo transportation in a corridor or are less mature than those found in category A or B but are still considered valuable to the project.

D – Merged. These technologies are regarded special cases of the technologies that are placed in categories A, B or C, and are considered as valuable information to the project.

X – Need information. More information is necessary to evaluate these technologies.

Z – Not relevant. These technologies are regarded as not relevant to the SuperGreen project and are not included in the final selection.

At the end of the analysis, about 30% of the identified technologies have been selected as the most promising ones in terms of greening potential (category A+B). Their distribution in relation to type and mode appears in Figure 3.

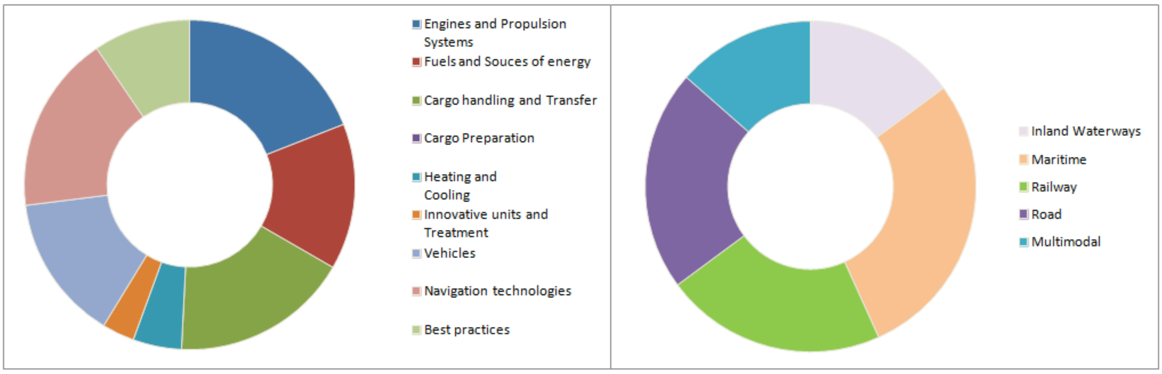


Figure 3. Distribution of promising technologies by type and transport mode

Appendix II presents the final list of technologies believed to have the largest potential for the SuperGreen project (Categories A, B or C).

For more information on the identification and selection of green technologies refer to SuperGreen deliverable:

D3.1 – Identify Green Technologies

found at: http://www.supergreenproject.eu/

3.2 Define application areas for green technologies

The objective of the Technology vs. Application Matrix is to identify the application areas of green technologies and assess their usability for improving the performance of the transports and logistics operations in studied corridors. The scope of the work of this activity is to indicate the importance of the technology for each application or nodes/segments of each corridor.

The population of the matrix is based on: (i) the material and information provided by SuperGreen partners (operators and cargo owners); (ii) on information collected during the project workshops; and (iii) on the data collected from interviews with experts and stakeholders familiar with each corridor. The matrix constitutes a knowledge tank accessible to the users and the stakeholders by means of the SuperGreen Knowledge Base.

The SuperGreen Knowledge Base is hosted at:

http://88.32.124.84/SuperGreen.

The compilation of the matrices has been performed in three different steps:

- Assignment of the matrices on geographical basis: each matrix is referred to one corridor; matrices have been assigned to partners involved in the task on the basis of their specific corridor knowledge.
- Assignment of technologies on the basis of transport mode: in order to verify the data collected, all matrices have been reviewed by partners involved in the task on the basis of their expertise on the mode of transport.
- Verification of data collected: the final review of the data collected with the matrices has been performed with the support of the questionnaires available to internal and external partners of the project through the SuperGreen Knowledge Base.

For more information on the Technology vs. Application Matrix refer to SuperGreen deliverable:

D3.2 – Define application areas for green technologies

found at: http://www.supergreenproject.eu/

3.3 Benchmark green corridors with green technologies

Task 3.3 was dedicated to the comparative evaluation of the effects that green technologies could have on current corridor performance. The effects were analysed with respect to the KPIs of Task 2.4, which are related to transport cost, CO2 and SOx emissions, average transport speed, frequency and reliability of service. The task was decomposed into two phases:

- the baseline preparation, i.e. the analysis of current corridor performance through conventional technologies, and
- the benchmark creation, i.e. the evaluation of green technology impacts with respect to the baseline.

The benchmark was created via a stepwise methodology. First, the KPIs were decomposed into factors, linking them with the performance specifications of the green technologies. Then, the green technology performance has been analysed independently of the application area with regards to the KPI factors.

Figure 4 summarises the influence of the technologies on the KPI factors. The horizontal axis shows the KPI factors and the vertical axis presents the percentage of green technologies that have positive, negative or neutral influence on the factors. An average positive influence of 35% on all KPI factors was estimated for all 59 technologies.

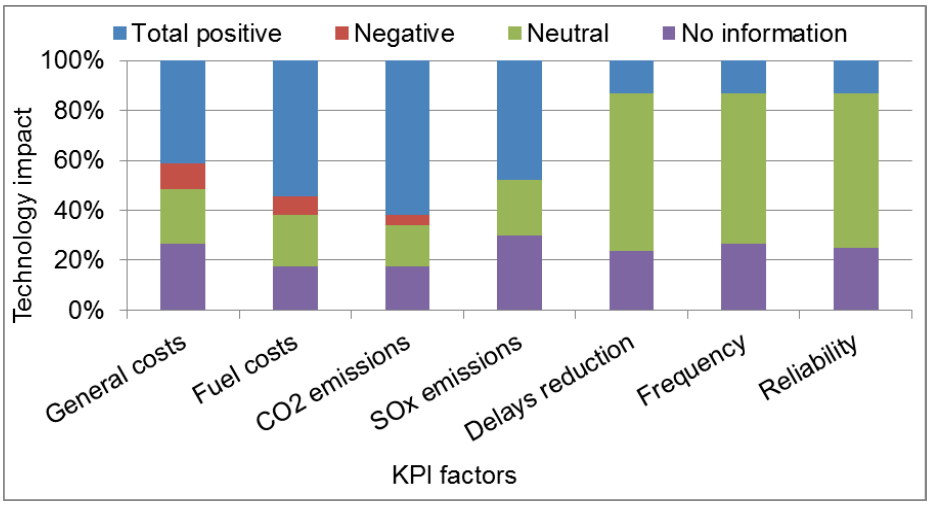


Figure 4. Estimated impacts of the green technologies on the KPI factors

The baseline performance changes were shown on selected case studies, for which sufficient data was available. Each case was a combination of a green technology and a set of corridor segments and nodes. A summary of them is given in Table 6, which presents the results of the detailed SuperGreen benchmark created with reference to the following KPIs:

- Cost: estimated fuel cost savings;
- Emissions: emissions reduction potential;
- Average speed: potential increase in speed of service;

- Frequency of service: potential increase of trips;
- Reliability of service: potential improvement of reliability (cargo safety and security, on-time delivery).

Table 6. Detailed benchmark results

Technology name		Corridor	Mode of Transport	SuperGreen KPI	Impact compared to baseline [%]
Hybrid trucks	VE03	Brenner	Road	Cost [euro/tn.km]	6% to 7%
				CO_2 emissions [gr/tn.km]	25%
Aerodynamic drag improvements	VE29	Brenner	Road	Cost [euro/tn.km]	3% to 4%
				CO_2 emissions [gr/tn.km]	10% to 26%
				SOx emissions [gr/tn.km]	13% to 25%
Low rolling resistance tires	VE33	Brenner	Road	Cost [euro/tn.km]	0% to 1%
				CO_2 emissions [gr/tn.km]	2% to 4%
Waste heat recovery systems	FU26	Mare Nostrum	Maritime	Cost [euro/tn.km]	1% to 5%
				CO_2 emissions [gr/tn.km]	2% to 5%
				SOx emissions [gr/tn.km]	1% to 5%
Exhaust abatement systems	EN21	Mare Nostrum	Maritime	Cost [euro/tn.km]	-4% to -1%
				SOx emissions [gr/ tn.km]	90% to 96%
Integrated short sea transport	BP08	Mare Nostrum	Maritime	Average speed [km/hr]	5% to 8%
Contra rotating propeller	EN61	Nureyev	Maritime	CO_2 emissions [gr/tn.km]	5% to 15%
				SOx emissions [gr/tn.km]	4% to 16%
Mechanical azimuth thrusters	EN06	Nureyev	Maritime	CO_2 emissions [gr/tn.km]	0% to 20%
				SOx emissions [gr/tn.km]	0% to 21%
Wind propulsion - Sails	FU25	Nureyev	Maritime	CO_2 emissions [gr/tn.km]	0% to 15%
				SOx emissions [gr/tn.km]	0% to 14%
LNG	FU08	Nureyev	Maritime	CO_2 emissions [gr/tn.km]	10% to 20%
				SOx emissions [gr/tn.km]	98% to 100%
Cargo cassette translifter	HT11	Nureyev	Maritime	Average speed [km/hr]	0% to 38%
				Frequency of service [times/year]	0% to 6%
				Reliability [%]	0% to 6%
Exhaust abatement systems	EN21	Strauss	IWW	Cost KPI [euro/tn.km]	0% to 1%
				CO_2 emissions [gr/tn.km]	-5% to 8%
Route	NA16	Strauss	IWW	Cost KPI [euro/tn.km]	1% to 1%

Technology name		Corridor	Mode of Transport	SuperGreen KPI	Impact compared to baseline [%]
optimisation systems				CO_2 emissions [gr/tn.km]	10% to 10%
				SOx emissions [gr/tn.km]	10% to 10%
LNG	FU08	Strauss	IWW	CO_2 emissions [gr/tn.km]	10% to 19%
				SOx emissions [gr/tn.km]	95% to 100%
Aerodynamic drag improvements	VE29	Cloverleaf	Road	Cost KPI [euro/tn.km]	2% to 8%
				CO_2 emissions [gr/tn.km]	10% to 26%
				SOx emissions [gr/tn.km]	10% to 26%
Hybrid trucks	VE03	Cloverleaf	Road	Cost KPI [euro/tn.km]	13% to 23%
				CO_2 emissions [gr/tn.km]	-49% to 25%
				SOx emissions [gr/tn.km]	10% to 26%
EREX	BP13	Cloverleaf	Railways	Cost KPI [euro/tn.km]	1%
Braking energy recovery & **On-board energy storage systems**	LU13 & LU14	Silkway	Railways	CO_2 [gr/tn.km]	30% to 40%
LNG & CNG (for road)	FU08 & FU03	Multi-corridor	Road	CO_2 emission reduction potential	11 to 23%
			Maritime		20 to 25%
			IWW		similar to maritime
			Hubs		positive
			Road	NOx reduction	Positive (similar to maritime)
			Maritime		90%
			IWW		similar to maritime
			Hubs		positive
			All modes	SOx	Tank-to-Wheel: ~0%
Route optimisation	NA16		Maritime	Fuel savings	3.5-8% depending on the measure (§5.2.1)
				Average speed	Positive influence
				Reliability	
			IWW	NOx, PM, CO2 emissions reduction potential	10%
Waste heat recovery	FU26		Maritime	Fuel savings	Differs depending on size and complexity. Indicatively, 7%
				Emissions reduction	Relative to fuel savings

Compared to the baseline for road transportation, an improvement of up to 8% in operating cost and 26% in CO_2 emissions can be achieved; however this can change if the capital cost is included in the assessment and the return of investment is evaluated on a full corridor basis. For the maritime mode of transport, the use of energy efficiency measures can bring up to 20% reduction of CO_2 emissions. An improvement of about 38% on the average speed can be possibly achieved with better cargo handling systems. SOx emissions of the total chain could be reduced by more than 73% through SOx cleaning systems. LNG and CNG are the cleanest fossil fuels for shipping and road transportation. The energy settlement systems in railways can provide energy savings between 15% and 30%. Finally, optimal design of waste heat recovery systems can provide economic benefits in large cargo flows with deep sea shipping.

The study also reached the following conclusions:

- The creation of a benchmark of green corridors with green technologies is possible. A clear quantitative definition of all KPIs is required, like for reliability and quality of service. Inclusion of social aspects, such as noise reduction, land use and safety, would be important.
- Statistical information on corridor flows is of great importance for future research. This would support a more representative baseline description, such as a large survey on long distance transport operations with multimodal coverage per corridor.
- Further work is necessary for the estimation of the performance changes of the technologies.
- Future research on the benchmarking of green corridors should consider the adoption capacity of green technologies on an aggregated level (fleet basis). The inclusion of capital cost is of great importance in order to evaluate the return of investment from each technology on a corridor level.
- Future analyses should create large cargo volume case studies for intermodal transport.
- Future studies should include indices related to regulatory barriers or benefits on national and/or community level, as well as the infrastructure capacity to support the adoption of the technologies.

For more information on the benchmark activities refer to SuperGreen deliverables:

D2.4 – Benchmarking of Green Corridors

D3.3 – Benchmark Green Corridors with Green Technologies

found at: http://www.supergreenproject.eu/

4 Smart exploitation of ICT flows

The objective of WP4 was to define and exploit the role of ICT flows towards the goal of greener transport. This was complementary to the objective of and the work in WP3. Both packages ultimately seek to identify 'win-win' solutions and best practices based on implementation of methodologies that achieve a cost-effective utilisation of transport resources on the one hand, and a green supply chain management on the other.

Issues that were looked at include:

- management of real-time and static information;
- improved network design;
- efficient 'just-in-time' inventory management in nodes and links;
- fleet and vehicle management and scheduling;
- tracking and tracing;
- weather routing and speed optimisation;
- freight flow management in terminals;
- influence of external costs; and
- influence of other social costs, including those due to spatial planning.

The package contained four tasks:

- ***Task 4.1 Identify smart ICT and information flows*** providing an inventory of ICT and other information systems that have the potential to make the supply chains greener.
- ***Task 4.2 Define application areas for smart ICT*** flows towards the goal of optimising environmental attributes of a supply chain.
- ***Task 4.3 Potential for green supply chain management*** including a list of measures, practices and other means ICT-wise that will lead to an improved environmental performance.
- ***Task 4.4 Benchmark green corridors with smart ICT*** and conduct sensitivity analyses on the corridors identified in WP2.

4.1 Identify smart ICT and information flows

This task aimed at making an inventory of ICT and other information systems that exhibit corridor greening potential and at providing a mapping for such systems in relation to various environmental attributes of the components of a logistics chain. In order to achieve this objective, the following 5-step methodology was developed:

Step 1: Compilation of the basic template to collect information on ICT. For each ICT under consideration, information needs to be collected on functions, components, data and attributes.

Step 2: Collection of information on the ICT technologies. Information/data on the different technologies has been broken down by transport mode.

Step 3: Analysis of ICT technologies, applications and relevant research projects. Based on a set of identified technologies, a preliminary analysis of their features has been conducted in order to determine those more suited for the scope and objectives of SuperGreen. This includes an analysis of how data from all these systems, tools and info flows can map to environmental and non-environmental attributes of the supply chain that one would like to improve.

Step 4: An inventory of successful ICT applications and projects (EU, national projects, and other) was established. Issues addressed include the type of information needed to improve identified attributes, ways enabling a better use of this information from a supply chain management perspective, and bottlenecks or other deficiencies that prevent or hinder the use of this information. A preliminary discussion of systems outside Europe and of other industries like air transport is included in this step.

Step 5: Draw conclusions and provide information on future work.

It is also mentioned here that for a well defined ICT system, one should provide answers to the following questions:

- What is the evolution of information (static/dynamic)?
- What is the nature of information (known / deterministic / forecast / probabilistic / unknown)?
- What is the dissemination of information (local transportation mode / complete transportation chain)?
- Where is the processing of information taking place (local node / along the transportation chain)?

The answers to the above questions depend on the nature of the transportation system under study, the scope of the ICT and the available information. For example, an ICT system may produce an estimated time of arrival (ETA) for a specific vehicle based on departure time. This is truly a static ICT. By combining possible speed alterations with a simple ETA calculator, the ICT obtains dynamic features. With possible speed and routing changes due to weather conditions the ICT could become more sophisticated implementing computational algorithms and optimisers.

A dynamic ICT system must be based on real time information. For example, it should be able to gather dynamic data (i.e. current position, previous position, current speed, previous speed, etc.) while following the vehicle route. Dynamic systems generally can be classified into stochastic and deterministic variants. Many ICTs are based on an integration of specific optimisation models and, dynamic operation simulation models that emulate the actual operational conditions.

It is a common premise that incorporation and development of ICT systems in the transport chain is synonymous to greener transport. The increased importance of ICT systems for the implementation of new holistic green logistics and transport concepts has been recognised by stakeholders and researchers in the transport sector within the EU and globally. The main common benefit of ICT systems is that they improve transport performance. An improved transport system is very likely to be also improved in terms of environmental performance.

In general, ICT applications for greener transport should:

- be compatible with existing ICT systems in the transport chain;
- be integrated (= enable the smooth information flow along the transport chain);
- incorporate algorithms that increase efficiency and reduce costs; and
- switch nature from static to dynamic in order to improve efficiency and environmental performance.

Key features towards greener transport systems for the different transport modes are:

- Road transport: Dynamic road supervision systems coupled with on board units to supervise vehicle movements. In road transport, ICTs can increase capacity utilisation, optimise routeing through shortest and quickest paths, and help avoid traffic jams and queues in terminals.
- Rail transport: Introduction of cross-border interoperable systems. Rail is in most cases "greener" than road. Therefore rail ICT applications can contribute to greener transport to the extent they enhance the attractiveness of railway connections. Such systems can be tools providing information on available rail services or ICTs that enhance the quality on interfaces between different actors and countries. Rail could benefit from energy savings thanks to traffic flow management.
- Inland waterway transport: Introduction of cross-border interoperable systems. River Information Services (RIS) can lead to improved utilisation of the inland vessels' capacity through the online availability of accurate fairway information. This allows improved fleet management (optimised deployment of personnel and fleet based on up-to-date information) as well as more detailed trip planning and draught management. RIS can thereby increase the efficiency of inland navigation; the fuel consumption per tkm can be significantly reduced. RIS provide planning information that can be used to plan voyages and calculate more reliable time schedules. Based on the current and expected positioning data of the vessels in the network, lock/bridge/terminal operators can calculate and communicate the Required Times of Arrival to the skippers. While approaching the lock/terminal the skipper can decide to adjust the cruising speed and possibly achieve more homogeneous travel speeds. This also results in lower fuel consumption figures, and consequently in lower operational costs.
- Maritime transport: Integrated port systems. ICT systems are already present in port and vessel operations and what is probably missing is the integration of ICTs that can help maritime and port operations to reduce costs and emissions at sea or in port. Overall a more sophisticated, informative and decision supporting ICT

portfolio would help maritime and port operations to be more environmental friendly.

Apart from the above mode specific ICT improvements, the interoperability between intermodal IT systems covering the entire transport chain should be improved. An overview of the processes related to the actors involved in a transport corridor should form the foundation for the requirement specification of such IT systems. A common framework and the identification of roles will, in addition to improved communication infrastructures, give more opportunities for automated information exchange between IT systems. This will again lead to less human interaction, less errors due to human mistakes, higher efficiency and reduced faster operations along the corridor.

For more information on smart ICTs refer to SuperGreen deliverable:

D4.1 - Identify smart ICT and information flows (ver.1, ver.2, and ver.3)

found at: http://www.supergreenproject.eu/

4.2 Define application areas for smart ICTs

The task described possible motivations and obstacles for greener transportation and proposed solutions linked to ICT systems. Each solution has been analysed in relation to the rationale, the motivation and the expected improvement in financial, environmental and quality based attributes. ICT technologies were classified into the following “ICT clusters”:

- expert charging systems;
- centralised transportation management systems;
- decentralised transportation management systems;
- broadcasting, monitoring & communication systems;
- safety systems;
- e-Administration systems; and
- emissions footprint calculator systems.

The general methodology followed involves the following three steps:

Step 1: For each of the 9 corridors selected in Task 2.1, identify a set of specific ICT contexts suitable for greening. Input has been also received from Task 2.4 (Benchmarking green corridors) and Task 2.5 (Definition of areas for improvement).

In order to collect the relevant information, a dedicated questionnaire was constructed, soliciting the following:

- Application No.

- Partner responsible
- Corridor name
- Segment or transport chain
    - Transport modes
    - Major mode involved
    - Other direct beneficiary users
- Specific ICT technology
- Data/information
- Installation requirements (technology, software, data)
- Bottleneck/motivation
- Related KPIs or attributes

Step 2: Based on the results of Step 1, define appropriate "ICT clusters" for the proposed ICT applications. These clusters are broad ICT categories that have some common characteristics or functionalities with one another. The ICT clusters that were identified are the following:

(A) Expert charging systems: these are ICT systems whose main function is to apply charges to traffic. These can range from simple toll collection systems to more elaborate charging systems for congestion avoidance or even emissions reduction.

(B) Centralised transportation management systems: These are ICT systems devoted to managing traffic and whose decision-making scheme is centralised, such as for instance, a VTMIS or a railway traffic control system.

(C) Decentralised transportation management systems: Same as (B) but in which the decision-making scheme is decentralised. This can be for instance an intelligent highway system (IHS) in which each car has its own ICT that is interconnected with the ICT systems of other cars, but no central control exists.

(D) Broadcasting, monitoring & communication systems: These are ICTs whose main functions are the provision of information to transport operators but no major decision-making is involved.

(E) Safety systems: These are ICT systems whose main function is safety.

(F) e-Administration systems: These are ICTs that have a major commercial functionality, such as cargo booking, ticketing, billing and other transactions.

(G) Emissions footprint calculator systems: These are ICT systems whose main function is to calculate emissions.

Of course systems can belong to more than one cluster. However, their classification was determined by the most prevalent feature.

Table 7 presents the ensuing taxonomy. The first column of the table shows the various ICT systems identified in Step 1, while the corresponding ICT cluster appears in the second one.

Table 7 Main clusters for smart ICT systems

ICTs	ICT cluster
Unified Electronic toll system (CHD) Congestion Charging Toll amount depending on the pollutant category of the truck (German highway truck toll system) Skymeter EREX Waterway charges and harbour dues (CHD)	Expert charging systems
ERTMS TIS Train information System ICT Freeway Traffic Management System: The COMPASS ICT RAILTrack ICT Traffic flow optimization, Caesar (or systems of individual operators like kombiverkehr, ökombi, etc) VTS/VTMIS Electronic Traffic Management, River Information Service (RIS) Fairway Information Service (FIS) Information for Law- enforcement (ILE) Traffic control systems (TMC pro/TMC Plus, GPS/GSM) OPTIMAR International networking of national traffic control centres ICT: How to assign icebreakers to other vessels Traffic signalling optimization RAILTrack ICT IBNet ICT	Centralised transportation management systems
Platooning Intelligent Speed Adaption (ISA) Speed limits on the highway depending on CO2 emission values (VBA Umwelt Tirol) RAILTrack ICT	Decentralised transportation management systems
Conducted communication systems Broadcasting systems (TMC, TMCpro, TPEG, DVB, DAB) Mobile radio systems (GSM,SMS,GPRS,UMTS) Car-to-X-Communication	Broadcasting, monitoring & communication systems

ENC/ECDIS Broadband communication (WiFi/WiMAX, digital VHF, etc), GNSS (GPS, Glonass, Galileo) Automatic Identification System (AIS) LRIT – Long Range Identification and Tracking, radar SafeSeaNet AGHEERA RFID SCHENKER SMARTBOX Route Guidance systems Personal navigation assistant (Navigationssysteme) Head-up display (HUD) Navigation system for trucks: Map & guide professional GPS Insight ICT VeriWise Dry Van ICT VeriWise for Rail ICT ExactAIS Viewer/ marine traffic ICT Port vision / port vision advantage/ PV onboard Global ICT The Portnet2 ICT	
Road-weather-information systems (SWIS, AWEKAS, GFS Europa, Coupled general Circulation Models Eumesat Polar Systems (EPS)) Speed limiter Night Vision System Distance control systems Collision warning systems Braking assistant systems Lane Departure Warning (LDW) Lane keeping assistant Adaptive speed limit RescueNet Road Safety ICT Port vision / port vision advantage/ PV on-board Global ICT	Safety systems
Single Window solutions JUP Fretis ShortSeaXML DAKOSY - the Port Community System Emodal - Port Community System	E-Administrative Systems

Valenciaportpcsnet - Port Community System Seagha/ APCS - Port Community System U-Port / Port-MIS System TAF TSI ICT Navis TRACS Terminal Smart Logit SEA Logit 4SEE/ Logit D2D Navis Cosmos CATOS CITOS Mainsail /Genoa Breakbulk / terminal Management System CITIS System MACH System Port Infolink System	
Anonymised sensor data gateway etc Sea-trim system	Emissions footprint calculator systems

Step 3: Based on the results of Steps 1 and 2, select a set of application areas as candidates for greener transportation. The aim here was to cover all 9 corridors and all 7 ICT clusters.

It has to be mentioned that it is very difficult to acquire complete information on what ICT systems exist or do not exist in each of the 9 corridors, and ensure the homogeneity of such information.

For more information on application areas for smart ICTs refer to SuperGreen deliverable:

D4.2 - Define application areas for smart ICT (ver.1 & ver.2)

found at: http://www.supergreenproject.eu/

4.3 Potential for green supply chain management

Task 4.3 was based on the ICT cases and ICT applications examined in Task 4.2. The potential for improving the environmental performance of supply chains by means of ICT was evaluated in this task for each case and/or application.

First, the indicators were defined for the evaluation of the potential for green supply chain management. The indicators are based on the SuperGreen KPIs and on the usability and availability of ICTs from a supply chain perspective.

Then, the evaluation was carried out in two phases. In the first phase, the usability and availability of the ICTs was evaluated based on three criteria: Availability of ICT solutions; Visibility and availability of information; and Transport chain suitability. The evaluation was done using a scale 1-3. In the second phase, the evaluation concerned the environmental and cost efficiency aspects. The seven criteria used were: *transport avoidance; loading factor incl. return cargoes; cost efficiency of transport chains; service quality: transport; service quality: interface; environmental sustainability; and infrastructural sufficiency*.

Figure 5 below provides a schematic of the methodology followed for this task.

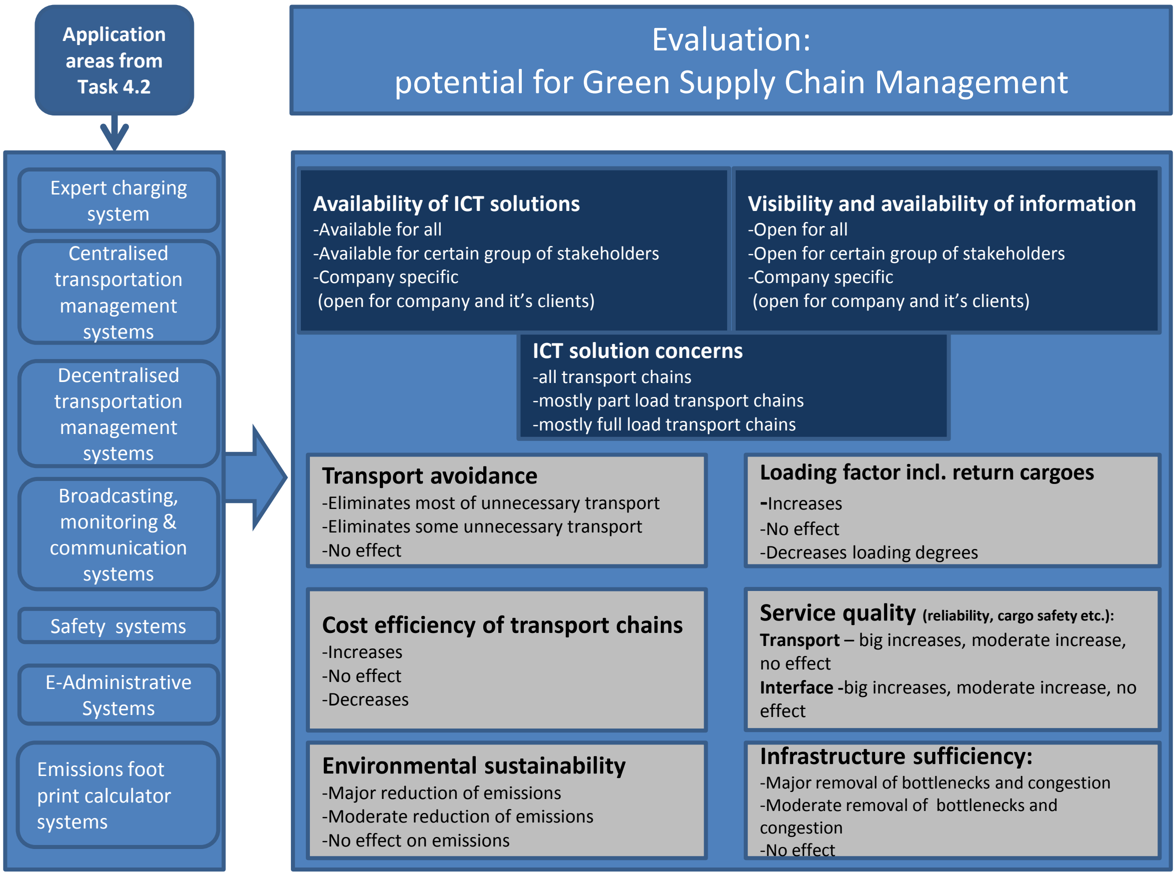


Figure 5. Methodology for Task 4.3

Several experts were interviewed in order to get an extensive view of the ICTs and a reliable assessment of the results. In total 54 different ICTs were evaluated, grouped in the 7 clusters presented in Section 4.2. Based on the assessment, the following applications achieved the highest ranking in the overall analysis for each cluster:

- Expert charging systems – Unified Electronic toll system (CHD)
- Broadcasting, monitoring & communication systems – Broadband communication

- Centralised transportation management systems – Traffic flow optimisation
- Decentralised transportation management systems – Intelligent Speed Adaption (ISA)
- Safety systems – Speed limiter
- e-Administration Systems – Port community systems
- Emission footprint calculator systems – Green Truck

The systems with the highest potential for each transport mode were then identified:

- Road: Navigation system for trucks
- Rail: Traffic flow optimisation (ERTMS)
- Inland Waterways: CHD
- Sea: Port Community Systems
- Intermodal: RFID

For more information on ICT applications for greening the supply chain management refer to SuperGreen deliverable:

D4.3 – Potential for green Supply Chain Management

found at: http://www.supergreenproject.eu/

4.4 Benchmark green corridors with smart ICT

Based on the results of Task 4.3, this task used the SuperGreen KPIs to benchmark the corridors identified in Task 2.1 and conduct sensitivity and 'what if' analyses of these cases.

Task 4.2 identified 15 'scenarios' to be further examined in WP4. The term 'scenario' corresponds to a specific corridor/mode/ICT combination. These scenarios are shown in the table below.

Table 8 Selected scenarios for ICT benchmarking

Scenario No.	CORRIDOR	MODE	ICT	CORRIDOR DESCRIPTION
1	Mare Nostrum	SCM	Tracking Units	The Mare Nostrum corridor includes Mediterranean and Black sea trade routes. There are nine countries involved in this approximately 6.000 kilometre purely short sea shipping corridor: Ukraine, Romania, Bulgaria, Turkey, Greece, Italy, France, Spain and Portugal.
2	Brenner	Road	Expert charging	The Brenner concerns freight transport from Berlin, Germany to Palermo, Italy and Athens, Greece through the Italian peninsula. It involves crossing of the Alps through the Brenner pass, as well as crossing of the Ionian and Adriatic seas
3	Brenner	Rail	ERTMS	
4	Two Seas	Road	Broadcasting	The Two Seas Corridor links the Baltic and the Mediterranean Seas. It connects Greece and Germany through several European countries such as Bulgaria, Serbia, Hungary, Slovakia, and Czech Republic. The corridor is rail and road-based.
5	Silk Way	Maritime	Emissions calc.	The Silk Way is a transport corridor using rail, short sea shipping and deep sea transport. The train service is not capable of transporting the same amount of goods in one shipment compared to a box vessel but the transport time is considerably shorter compared to deep sea transport.
6	Silk Way	Rail	ERTMS	
7	Edelweiss	Road	Emissions calc.	The Edelweiss corridor includes the Nordic triangle railway/road axis extended to St. Petersburg and Moscow. In this corridor road, rail and sea are available for freight transport.

8	Finis Terrae	Maritime	JUP- Single window system	The Finis Terrae corridor is linking the Iberian Peninsula to mainland Europe. Countries involved are Portugal, Spain and France. The corridor typically handles cargo from the western part of the Iberian Peninsula (Madrid/Lisbon), into Paris and towards central Europe, including the Benelux and Ruhr region.
9	Finis Terrae	Rail	ERTMS	
10	Strauss	IWT	RIS- River information system	The Strauss corridor crosses Europe transversally from the North Sea at Rotterdam to the Black Sea in Romania.
11	Strauss	IWT	Expert tolls	
12	Nureyev	Maritime	E-admin	The Nureyev corridor includes a short sea shipping route connecting Russia to Europe, as well as land based routes to and from ports at each end. During the winter especially in the Northern part of the corridor ice conditions can be rather difficult.
13	Nureyev	Maritime	Icebreaker assignment / IBNET	
14	Cloverleaf	Road	Platooning	The Cloverleaf corridor is passing through mainly the British part of the UK and through to Channel Tunnel to France via Calais and directly to Duisburg in Germany.
15	Cloverleaf	Road	Safety-speed control	

The work in Task 4.4 has been broken down into the following steps.

Step 1: Organisation of the ICT workshop (in Genoa).

Step 2: Assessment of the results of the above ICT workshop.

Step 3: Detailed description of the ICT systems under investigation (non-corridor specific). This included description of basic functionalities, cost information, funding mechanisms, and other technical performance characteristics. Already available descriptions from other tasks were considered as a starting point. The descriptions needed for this task were more detailed. Possible existing variants were also specified.

Step 4: Detailed investigation of the status of an ICT system on a corridor-specific basis. More specifically, the investigation looked into what extent and in what segments and/or transport chains of that corridor the ICT system under consideration: (a) existed, (b) did not exist but there was a plan for its application, or (c) did not exist and there was no plan. Other relevant information was also part of the investigation.

Step 5: Investigation of the potential impact of ICTs on the KPIs, with a focus on the KPIs found most important (based on the result of Step 2 and other opinion). A quantification of such impact was sought for, but in its absence, a qualitative assessment was made. The results of Task 4.3 were taken into consideration.

Step 6: Synthesis and interpretation of the results of the above steps.

For more information on benchmarking green corridors with smart ICT refer to SuperGreen deliverable:

Deliverable D4.4 - Benchmarking Green Corridors With Smart ICT (ver.1 & ver.2)

found at: http://www.supergreenproject.eu/

5 Recommendations for R&D calls

The work within WP5 – Recommendations for R&D Calls was carried out during the second and third year of the project. Its main objective was to identify and define recommendations for call for R&D proposals to the Commission, more specifically DG-MOVE and DG-RESEARCH. As such, one important question to answer is what makes a corridor green in terms of benchmarks and key performance indicators (KPIs), which is the subject of WP2. Another question is how available green technologies (WP3) and smart ICT solutions (WP4) may contribute to make existing corridors green or even greener? In case there are no such existing green technologies or smart ICT solutions available, there is a gap between what is available and what is needed to make the corridors green according to the required benchmarks. This gap makes the basis for potential future R&D recommendations. The conceptual approach of the work package is depicted in Figure 6 below:

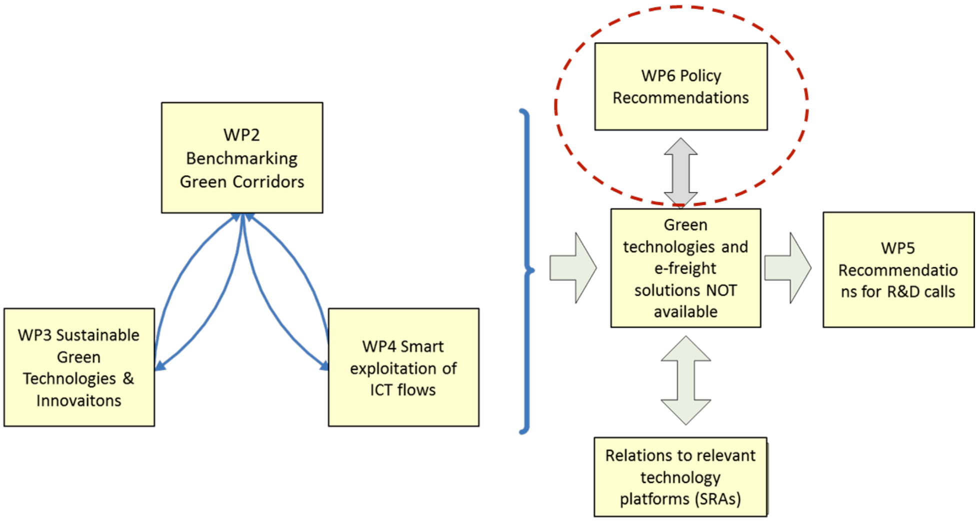


Figure 6. Conceptual approach for WP5

As presented below, the work within WP5 was carried out in two separate tasks, Task 5.1 and Task 5.2 respectively, with results reproduced in Deliverable D5.1 and Deliverable D5.2. Both deliverables were subject to submission of initial and second (i.e. final) versions. Since the work was carried out in parallel, a set of initial findings were initially developed before a final set of recommendations were established in the closing phase of the project. Further, the majority of findings were clustered around some certain development needs supporting the greening of corridors:

- Improvement of green supply chain design and management
- Harmonisation and development of ICT solutions and transport documents
- Harmonisation and development of policies and regulations
- Development and harmonisation of transport infrastructure

- Availability of quality personnel
- Development and harmonisation of transport technology, and
- Transparency of information and increased co-operation in co-modal supply chains.

In the following sections, the work within each task, including their main results, is presented in more detail.

5.1 Identification of unsolved bottlenecks

Task 5.1 focused on the identification of unsolved transport bottlenecks, and carried out a gap analysis regarding availability of alleviating technologies and ICT solutions. Building on key input from WP2, 3, and 4 respectively, the concluding remarks identify some key development needs in support of green corridor establishment.

In terms of **methodology** for the task the bottlenecks investigated were imported from WP2, meaning these were the same for both versions of deliverable D5.1 (i.e. D5.1v1 and D5.1v2). Between the two versions no more work was carried out for identifying new ones. However the original bottlenecks identified in WP2 were subject to a revision in order to make them more focused on cause and not so much on the effect(s).

For each bottleneck identified, WP3 and WP4 leaders revisited the material collected within their respective WPs and provided as specific information as possible with regards to mitigating ICT solutions and greening technologies. A template was developed in order to collect this information in a uniform manner. This information was to a large extent based on (but not limited to):

- The final round of selection of green technologies and ICT solutions, especially considering new technologies identified, and/or whether more detailed information to the already identified one was collected.
- The revised benchmarking exercise performed in the WP3 and WP4, and whether this provided any new information about development needs of different greening technologies and smart ICT solutions.
- In WP3 it was important to look for greening technologies that could significantly contribute to reduce the consequential impact of the bottleneck. (E.g. congestion in the biggest ports is probably a challenge that will remain for years. Identifying development needs with a potential mitigating effect on consequential impacts are thus important, e.g. development of LNG based power supply from shore to vessels in port reduces local emissions).

Since the bottleneck analysis represented a traditional "bottom-up" approach, a "top-down" approach was carried out through a requirement analysis of the revised TEN-T guidelines. This served as a supplement to the already existing analysis and for making a wider basis for the concluding remarks.

As of **key findings**, the concluding remarks of D5.1v2 indicate that more of the identified corridor bottlenecks could be improved by facilitating implementation and harmonisation of existing ICT-related measures, rather than of "hard" technologies. However, in many cases it's rather a matter of policies and harmonisation of regulations than a question of need for new developments. Hence, the list below reveals some of the key findings of the Task, being an important basis for the work carried out in T5.2:

Task 5.1 input to R&D recommendations
1. Within the ICT domain, a portfolio of systems and solutions already exists. However, there is still a need to further streamline and harmonise solutions to fulfil the overall requirements of co-modality and secure interoperability. Also in securing industry wide implementations, efforts should be devoted towards further investigating the usage of "cloud computing" as low cost and low threshold alternative for integration e-Transport systems (for both large and small actors). 2. There is a need for increased emphasis on implementation of available supply chain management systems and solutions throughout the chain. Further elaboration on actions and measures that could reduce obstacles and improve stakeholders' ability to adopt them should be strengthened. 3. Further efforts should be made for piloting of available technologies and solutions in regions to improve efficiency of border crossings. 4. There is a continuous need for further development of key technologies that improve green corridor benchmarks. Technology, necessary to pursue R&D efforts within energy and propulsion systems, cargo handling and transfer, fuels and sources of energy, vehicles, navigation technologies for energy efficiency, fleet optimisation, etc., should be further developed and implemented. Actions and measures that may reduce obstacles and improve stakeholders' ability to adopt them should be emphasised. 5. In support of energy efficient co-modal operations there is a need to develop a harmonised and commonly accepted carbon footprint calculator applicable for all transport modes. This also implies development of a standardised methodology for avoiding polarized results (i.e. favouring of modes). Also includes how emissions should be assessed: e.g. well-to-wheel or tank-to-wheel. 6. In support of safer, cleaner, and more reliable waterborne operations (including sea going and inland waterways), also, there is a need for developing financing and business models addressing fleet modernisation, a fact strengthening the role of waterborne transport within co-modal transport solutions. 7. Development of risk management and accidents averting practices, supporting the use of co-modal transport operations.

5.2 Defining and submitting R&D call recommendations

The work within Task 5.2 is based on the potential gaps and development needs as elaborated on in Task 5.1, and much focused on defining and submitting a set of R&D recommendations for future calls. All in support of co-modal transport operations and green corridors. The task results are presented in Deliverable D5.2, which has been submitted as an initial and second (i.e. final) version.

Targeting the European Commission, DG-MOVE and DG-RESEARCH, and more specifically the new Framework Programme for Research and Innovation - the Horizon 2020, the deliverables D5.2v1 and D5.2v2 present some initial and concluding recommendations for future R&D efforts (respectively). The recommendations are based on the work carried out throughout the project.

In terms of **methodology**, the results from Task 5.1 were imported and further elaborated on. Also, all Strategic Research Agendas[1] from relevant Technology Platforms were revisited and the main objective was to document the following elements:

- SRA work & related challenges
- SRA specific R&D recommendations
- Identify R&D GAPS and recommendations – hereunder providing an overview of the following.
    - identify on-going R&D activities that are specifically targeted for solving the identified bottlenecks, and
    - equally important if there is a lack of activities for solving the identified bottlenecks (i.e. disclosure of R&D gap).
- Compare and contrast the contents of the White Paper on Transport (2011) with the different SRAs of relevance, and identify possible gaps within R&D focus.

Also, for the final version of D5.2 a revision of relevant input provided by WP6 was carried out. It should be noted that the identified R&D recommendations are limited to the results from the SuperGreen corridor analyses, and from the analysis of other relevant sources as given in the reports.

As of **key findings,** the concluding remarks of Task 5.1 was imported, along with key elements from WP6, constituting some key aspects for the elaboration of the final recommendations for R&D activities in the final version of D5.2. The recommendations per se are provided on three different "levels".

Firstly, as a reflection of the relevant SRAs, R&D recommendations are provided individually for the relevant transport modes (in support of individual development needs). Secondly, R&D recommendations are provided with a co-modal focus supporting the development of more sustainable transport operations and green corridors. Finally, a set of call-texts supporting future development of Green Corridors was developed. Reflecting the SuperGreen Common Development Needs above, the call texts give specific examples and suggestions on how more generic recommendations from the project can be transformed into more concrete ones.

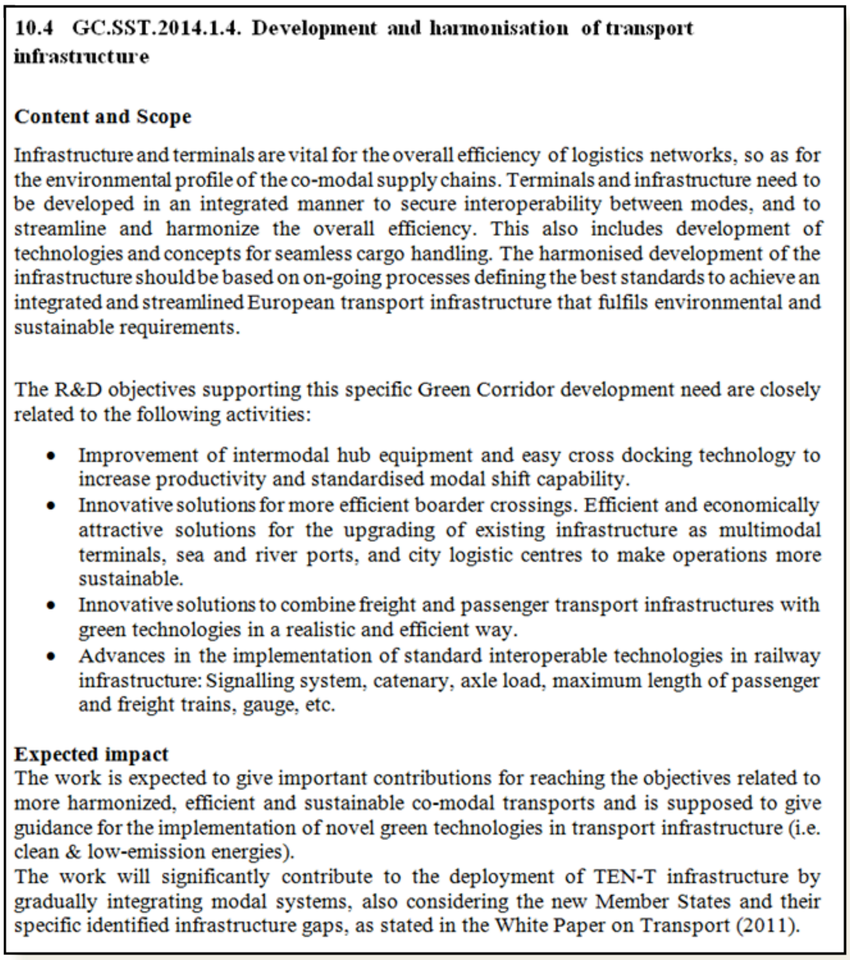
Moreover, the SuperGreen common development needs imported from WP2 represent an effort to advance and initiate intermodal R&D activities supporting the improvement of

[1] Waterborne, European Intermodal Research Advisory Council (EIRAC), European Rail Research Advisory Council (ERRAC), and the European Road Transport Research Advisory Council (ERTRAC). The recent launch of the SRA for Inland Waterway Transport has also been revisited.

more sustainable intermodal operations on a corridor and Pan-European basis. When summarising the results from the analysis on further focus areas for transport related R&D activities, some of the identified points are:

- There must be an increased focus on rectifying the evident lack of data and reliable tools enabling proper benchmarking exercises within the transport domain.
- A further strengthening of efforts securing integration and implementation of harmonised ICT solutions, also developing new ones (e.g. Single Window concepts).
- Increased focus on corridor and case-by-case specific analysis, both in terms of requirements and tailored solutions.
- Performance of impact studies for assessing potential environmental and cost savings when introducing new ICT and technology solutions
- Further development of freight flow optimisation and traffic management tools
- Efforts to enhance cargo interchange between transport modes, including expansion of the technology uptake by industry.
- Actions to improve the energy efficiency among transport operations and reducing dependency on fossil fuels.
- Development of harmonised transport documents

An example of a SuperGreen call text is provided below.



10.4 GC.SST.2014.1.4. Development and harmonisation of transport infrastructure

Content and Scope

Infrastructure and terminals are vital for the overall efficiency of logistics networks, so as for the environmental profile of the co-modal supply chains. Terminals and infrastructure need to be developed in an integrated manner to secure interoperability between modes, and to streamline and harmonize the overall efficiency. This also includes development of technologies and concepts for seamless cargo handling. The harmonised development of the infrastructure should be based on on-going processes defining the best standards to achieve an integrated and streamlined European transport infrastructure that fulfils environmental and sustainable requirements.

The R&D objectives supporting this specific Green Corridor development need are closely related to the following activities:

- Improvement of intermodal hub equipment and easy cross docking technology to increase productivity and standardised modal shift capability.
- Innovative solutions for more efficient boarder crossings. Efficient and economically attractive solutions for the upgrading of existing infrastructure as multimodal terminals, sea and river ports, and city logistic centres to make operations more sustainable.
- Innovative solutions to combine freight and passenger transport infrastructures with green technologies in a realistic and efficient way.
- Advances in the implementation of standard interoperable technologies in railway infrastructure: Signalling system, catenary, axle load, maximum length of passenger and freight trains, gauge, etc.

Expected impact
The work is expected to give important contributions for reaching the objectives related to more harmonized, efficient and sustainable co-modal transports and is supposed to give guidance for the implementation of novel green technologies in transport infrastructure (i.e. clean & low-emission energies).
The work will significantly contribute to the deployment of TEN-T infrastructure by gradually integrating modal systems, also considering the new Member States and their specific identified infrastructure gaps, as stated in the White Paper on Transport (2011).

Figure 7: SuperGreen Call text on "Development and harmonisation of transport infrastructure

For more information on the process of defining the SuperGreen R&D recommendations, please refer to deliverables:

D5.1 – Identify unsolved bottlenecks

D5.2 – Define and submit R&D Recommendations

found at: http://www.supergreenproject.eu/

6 Policy implications

WP6 is the part of SuperGreen that focused on policy implications. Its objectives were to:

- assist the Commission in integrating green corridor considerations into the EU Freight Transport Logistics Action Plan;
- examine the implications of related regulatory policies on possible solutions proposed by the project;
- examine possible implications of the work produced during the project on regulatory policies;
- examine possible interactions of distinct policies among one another and identify ways to resolve possible conflicts, bottlenecks and other problems;
- provide assistance to the Commission in the formulation and harmonisation of policies on green corridors in both pan-European and regional levels and also as regards corridors between Europe and other parts of the world.

The package contained two tasks:

- **Task 6.1 Analysis of regulatory framework**, providing an overview of the regulatory framework that needs to be taken into consideration when developing green corridors; and
- **Task 6.2 Policy recommendations**, in relation to:
  (i) the corridor approach,
  (ii) quality in transport operations,
  (iii) innovative technologies and practices,
  (iv) integration of smart ICT applications, and
  (v) simplification of administrative procedures.

6.1 Analysis of regulatory framework

The method foreseen in the DoW for Task 6.1 was literature survey. A list of seven EU policy documents concerning all transport modes were suggested in the DoW as the basis for the analysis. Instead, a total of 35 policy documents, mostly of the EU but also of other international organisations, were reviewed. Among them, the 2011 White Paper on transport enjoyed a prominent position due to its significance. The analysis was performed in eight themes: Strategic issues; Policy issues; Infrastructure; Logistics; Road transport; Rail transport; Maritime transport and ports; and Inland waterway transport.

The analysis concluded that in general, significant progress has been made by the European Commission during the last decade in creating a legal framework conducive to the needs of a modern European transport system. However, much remains to be done. Pending regulatory and market issues, most relevant to green corridor development, are:

Liberalisation of transport operations: Despite progress made, some transport market segments are not yet fully and de facto liberalised. This is the case for the port services market, which in some cases remains in the hands of local monopolies. In road transport, access to the national markets of Member States by hauliers established in another Member State (‘cabotage’) may only be carried out “on a temporary basis”. Furthermore, in markets which have already been opened up to competition by EU legislation, inherited national regulations and market structure create obstacles to the entrance of new players. This is particularly the case for rail freight transport, which has been open to competition since January 2007.

Internalisation of external costs: Many of the external costs of transport today are still not internalised. Where existent, internalisation schemes are sometimes not coordinated among modes and Member States. With the recent release of the new White Paper, the European Commission sets year 2020 as the deadline for the full and mandatory internalisation of external costs for all modes with emphasis on road and rail transport.

Creation of a European transport network: Transport infrastructure has been historically designed to serve national rather than European goals and cross-border links constitute bottlenecks that are likely to become increasingly costly as the EU economy continues integrating. The recently introduced concept of a dual layer planning approach with a 'core network' as the top layer is an effort by the Commission to address this problem and create a transport network with true European added value.

The corridor approach: Particularly important for green corridor development is the fact that the corridor approach is seen as the basic instrument for core network implementation, on the grounds that the consolidation of large volumes for transfer over long distances is key to efficient intra-EU freight transport. These long-hauls along specially developed freight corridors can be optimised in terms of energy use and emissions, and become attractive to operators for their reliability, limited congestion and low operating and administrative costs.

Interoperability and co-modality: Market integration both within and between transport modes is still far from being achieved. Intermodal infrastructure is not sufficiently developed and exchanging data between the modes is difficult because of the co-existence of non-compatible modal ICT systems. Reliance on advanced ICT applications has an essential role to play in the greening of transport. Traffic management, congestion relief on freight corridors and in cities, promotion of co-modality, in-vehicle safety systems, real time traffic information and an open in-vehicle platform to integrate applications are among the priority issues identified.

*In the EU transport policy documents, the term **co-modality** is used to refer to the "use of different transport modes on their own and in combination" in the aim of obtaining "an optimal and sustainable utilisation of resources".*

The transport modes: The emphasis placed by the EU transport policy documents on setting emission standards, deployment of ITS, and improvement of safety is common for all transport modes. Issues of particular importance for SuperGreen include:

- Regulation 913/2010, which aims to establish a European rail network where sufficient priority is given to international freight trains. The following are important features:
    - the defining criterion (crossing by the freight corridor of the territory of at least three Member States, or of two Member States if the distance between the terminals served by the freight corridor is greater than 500 km);
    - the capacity allocation procedure aiming at increased freight transport;
    - the governance rules emphasising the necessary coordination of all parties involved;

  - the requirement to meet technical specifications related to interoperability (ERTMS); and
  - the performance monitoring provisions, with emphasis placed on journey time, reliability and user satisfaction.
- The intention of the new White Paper to further develop the 'European maritime transport space without barriers' into a 'Blue Belt' of free maritime movement in and around Europe so as to use waterborne transport to its full potential.

> For more information on the EU regulatory framework refer to SuperGreen deliverable:
>
> D6.1 – Analysis of the Regulatory Framework
>
> found at: http://www.supergreenproject.eu/

6.2 Policy recommendations

The method selected for Task 6.2 consisted of:

- the compilation of an initial list of potential recommendations based on all previous project activities and suggestions by the project partners; and
- the finalisation of recommendations after incorporating stakeholder feedback.

The first of the two foreseen versions of Task 6.2 report concluded with 31 *potential* policy recommendations. Subsequently, 15 among them met the joint approval of the consortium partners, the Advisory Committee members and stakeholders that have participated in a specially arranged session of the TRA2012 conference. They were supplemented by another 5 stemming from the project's work on green technologies and smart ICTs. The resulting final recommendations are briefly presented below according to the targeted recipient. In addition, a set of recommendations was produced concerning green corridor governance and operational issues.

Recommendations to the European Commission:

1. Continue using the corridor approach as a useful tool in achieving the ambitious targets of the common transport policy in Europe.
3. Multimodal corridors can be viewed as vehicles for addressing wider objectives of the European transport policy, like modal integration, simplification of administrative formalities, internalisation of external costs and the harmonisation of safety, security and social legislation.
4. The EU should facilitate good practice in relation to the involvement of the greater public in transport planning at lower than European levels.
5. In prioritising investments, the rule of maximising European added value can be accompanied by the following order of interventions:

   (a) measures affecting transport demand, modal choice, and behaviour;
   (b) measures improving the efficiency of using existing infrastructure (e.g. through ICT applications);
   (c) upgrading existing infrastructure; and
   (d) building new infrastructure and major rehabilitation of the existing one.

6. The work performed on standardised estimation of transport-related external costs, with emphasis on measuring and allocating CO_2 and other emissions, needs to be continued until a universally acceptable methodology is reached.
7. The Life Cycle Assessment methodology needs to be introduced in decision making.
8. At least one certified carbon and environmental footprint calculator needs to be developed and the relevant action of the 2011 White Paper is fully supported.
9. The European Commission can assess the possibility of developing policies that actively encourage the creation of freight villages and urban distribution centres strategically located to serve as many modes as possible.
10. Policy initiatives at the Union or corridor level are recommended for collecting the statistical information needed to monitor service quality indicators.
11. Develop fuel consumption standards for trucks.
12. Introduce a common standard for modular logistics units enabling efficient loading and facilitating the development of open and shared logistics networks. Allow 44-ton articulated vehicles when carrying a 45 ft pallet wide container.
13. Enhance information sharing at a global scale, as this is a basic pillar of supply chain integration.
14. The work being performed on the e-freight initiative needs to be continued until a standard digital single European transport document is in operation through a single window and a one stop administration shop.
15. Identify bottlenecks (including administrative) and monitor their mitigation efforts.
16. Develop and bring alternative fuels to market.
20. Continue the effort of developing interoperable and interconnected ICT applications in Europe.

Recommendations to the European Parliament:

2. The TEN-T core network corridors can be transformed to green corridors through the promotion of state-of-the-art technologies, the deployment of ITS and the availability of alternative fuels along the routes.

Recommendations to the private sector:

17. Take advantage of numerous available energy efficient technologies.
18. Employ integrated logistics concepts through innovative business models.
19. Develop and deploy ICT applications supporting integrated logistics solutions.

Recommendations on governance and operational issues:

A structure along the lines suggested by Regulation (EU) No 913/2010 for the rail freight corridors is suggested for the governance of green corridors. Such a structure would feature:

- an Executive Board composed of representatives of the Member States involved;
- a Management Board formed by the managers of the corridor's main infrastructures;
- an Advisory Group composed of transport operators using the corridor;

- an Advisory Group consisting of managers and owners of the terminals along the corridor; and
- a corridor one-stop-shop to serve as a contact and information dissemination point.

On the operational side, an implementation plan needs to be drafted consisting of a number of documents. Following a detailed description of the specific routes comprising the corridor, a transport market study is needed to assess customer needs and bottlenecks, and to define the objectives to be pursued.

Furthermore, the transport market study should provide information on the actual volumes and types of goods using the selected routes based on which, a set of typical transport chains (unimodal/multimodal combinations of routes/cargoes/ loading units) should be selected to be used for performance monitoring in subsequent years. For the selected chains, the study should provide data on all KPIs to be used for monitoring performance, plus the method for combining these indices to come up with corridor level indicators. Estimates of the modal split should also be provided by the study.

A method developed for the World Bank is suggested for estimating the chain-level KPIs, as it allows consideration of the cost and time associated with both the links and nodes of a transport chain. The weights needed for aggregating chain-level KPIs into corridor-level ones depend on the relative significance of each chain in the route it belongs and in the entire corridor. As such, they have to be determined by the transport market study.

For more information on policy recommendations refer to SuperGreen deliverables:

D6.2 – Version 1 (2012) – Policy Recommendations

D6.2 – Version 2 (2013) – Policy Recommendations
(upon approval by the Commission)

found at: http://www.supergreenproject.eu/

The project's recommendations on governance and operational issues are presented in more detail in Volume II of the present handbook, also found (upon approval by the Commission) at the SuperGreen website: http://www.supergreenproject.eu/

7 Dissemination and awareness raising

One of the main objectives of SuperGreen project, being a Coordination and Support Action, was the creation of permanent liaisons between the consortium and external stakeholders directly interested in the topics addressed. As part of the main project achievements SuperGreen created awareness about the activities performed and the achieved results, obtaining useful inputs and feedback from external experts, while also fostering the implementation of methodologies and recommendations developed.

All the dissemination tools and activities which have been developed, implemented and applied during SuperGreen lifetime are reported below:

- A dedicated project website (www.supergreenproject.eu) has been developed allowing for fast and easy communication of the most relevant information and news to a wide audience.
- A Green Corridors Group has been created at the professional network LinkedIn (with more than 200 members all over the world).
- A newsletter has been issued at the end of each project year to inform interested stakeholders about the key achievements of SuperGreen and the next activities planned.
- The 'Friends of SuperGreen' mailing list, maintained by the Coordinator, was created with more than 100 members who are informed about events of the project.
- Public workshops and events have also been organised with the main purpose of getting potential stakeholders directly involved in the work, but also for soliciting feedback about the activities performed by the Consortium. As part of these events, dedicated press releases have been prepared and distributed to a list of relevant press contacts for publication in specialised newspapers and magazines.
- Representatives of the SuperGreen Consortium have also attended more than 45 external public events presenting the activities performed and the results achieved by the project (e.g. TRA Conference 2012, Green Corridors Conference, TransIt conference, TEN-T days conference, SoNorA conferences, etc.).
- Finally, the most relevant achievements have been addressed to qualified scientific publications through the preparation of dedicated articles and papers.

In particular, the following articles about SuperGreen activities have been published on specific logistics journals:

- "*Green Corridors in European Surface Freight Logistics*", Psaraftis, H.N., A. Minsaas, G. Panagakos, C. Pålsson, and I. Salanne, to appear in "Global Logistics", J. Bookbinder (ed.), Springer.
- "*The SuperGreen project and green corridor benchmarking*" Panagakos G., Psaraftis H., Minsaas A., Ilves I., Salanne I. The research group transport Logistics at the Technical University of Applied Sciences Wildau, is currently planning the publication of a book about European corridor projects. The book will be published within the transport logistics series of the "Wildauer Schriftenreihe" (ISBN 978-3-936527-xx).

- ”*Benchmarking of green corridors*” Panagakos G., Psaraftis H. Article to be published at the GreenPort Journal winter issue 2012.

Four papers have been prepared and accepted by the TRA Conference 2012 organisation and then published on Procedia - Social and Behavioral Sciences, Transport Research Arena - Europe 2012:

- Aditjandra, P., Zunder,T., Islam,D and E. Vanaale (2012) "*Investigating Freight Corridors Towards Low Carbon Economy: Evidence from the UK*", Procedia - Social and Behavioral Sciences, Special Issue: Proceeedings of Transport Research Arena 2012, Volume 48, 2012, Pages 1865-1876.
- Clausen, U., Geiger,C. and C. Behmer (2012), "*Green Corridors by Means of ICT Applications*", Procedia - Social and Behavioral Sciences, Special Issue: Proceeedings of Transport Research Arena 2012, Volume 48, 2012, Pages 1877-1886.
- Fozza,S. and V. Recagno (2012), "*Sustainable Technologies and Innovation for Green Corridors: Survey and Application*", Procedia - Social and Behavioral Sciences, Special Issue: Proceeedings of Transport Research Arena 2012, Volume 48, 2012, Pages 1753-1763.
- Psaraftis,H.N and G. Panagakos (2012), "*Green Corridors in European Surface Freight Logistics and the SuperGreen Project*", Procedia - Social and Behavioral Sciences, Special Issue: Proceeedings of Transport Research Arena 2012, Volume 48, 2012, Pages 1723-1732.

One paper has been prepared and presented at the European Transport Conference, Glasgow - October 2012:

- Chara A. Georgopoulou, Nikolaos M. P. Kakalis, Sara Fozza, Valerio Recagno, Atle Minsaas, Even Ambros Holte (2012), "*Assessing the sustainability potential of EU transport networks*"

> For more information on dissemination activities refer to SuperGreen deliverable:
>
> D7.6 – Final Dissemination Report
>
> found at: http://www.supergreenproject.eu/

Appendix I. Changes and their effects

Business environment

		Efficiency	Service quality						Environmental sustainability				Infr. Suff.		Social issues			
No.	Change	Transport cost	Transport Time	Reliability	Frequency	ICT applications	Cargo damages	Cargo theft etc.	CO2-eq.	SOx	NOx	PM	Congestion	Bottlenecks	Land use	Accidents	Noise	Fiche and measure number
1	Population size	+ / -	-	+					-	-	-	-	-	-		-	-	2/1, 48/1
2	Ageing population	+ / -														-		2/2, 11/1, 48/2
3	Net migration to the EU	-																11/2
4	Increasing mobility of workers	-																11/3
5	Urbanisation and city sprawl	++ / --	++ / --		++				++ / --	++ / --	++ /--	++ /--	+++	+	+++	+++	+++	2/3, 11/6
6	Increasing individualisation	+	-	+	+	+			+	+	+	+	+			+	+	2/4
7	Proliferation of electronic business	+ / -	-	+	+	+			+ / -	+ / -	+ / -	+ / -	+ / -			+ / -	+ / -	1/5, 2/5
8	Increasing economic activity	++	+		+				++	++	++	++	++	++	++	++	++	2/10, 48/3
9	Globalisation	+						+	+	+	+	+	+	+				2/12, 11/7, 48/4
10	Technological convergence (productivity)	+						+	+	+	+	+	+	+				48/5
11	EU enlargement	++ / --	+	-					++	++	++	++	++	++		++	++	2/13, 48/16
12	EU integration	++	+	-	+				++	++	++	++	++	++		++	++	2/11, 11/8
13	Increasing scarcity of fossil fuels	+++	-		-				-	-	-	-	-	-		-	-	2/14, 11/5, 48/8, 48/9
14	Increasing social and environmental consciousness								--	--	--	--	--	-		--	--	2/6, 11/4, 48/7
Legend: +/- = moderate increase/decrease; ++/-- = significant increase/decrease; +++/--- = very significant increase/decrease (and combinations thereof)																		

Appendix I. Changes and their effects (continued)

Trends in logistics

		Efficiency	Service quality						Environmental sustainability				Infr. Suff.		Social issues			
No.	Change	Transport cost	Transport Time	Reliability	Frequency	ICT applications	Cargo damages	Cargo theft etc.	CO2-eq.	SOx	NOx	PM	Congestion	Bottlenecks	Land use	Accidents	Noise	Fiche and measure number
1	Spatial concentration of production and inventory	++	+		++	+			++	++	++	++	++	++		+	+	2/20, 48/5
2	Wider sourcing of supplies and wider distribution of goods	++	+		++	+			++	++	++	++	++	++		+	+	2/21
3	Supply chain integration	+/--	--	++		+++	--		--	--	--	--	--				--	2/22, 9/5
4	Information sharing	+/-	-	++		+++	--							--				2/25
5	Improving responsiveness to customer requirements (agility/adaptability)	+	-	++	++	++	-		+	+	+	+	+			+	+	2/23
6	Increasing direct deliveries	+	-	+	+	+			+	+	+	+	+			+	+	2/26
7	Increasing transport emissions								++	++	++	++						2/15
8	Reverse logistics	+/-	+			+			+	+	+	+	+			+	+	2/24
9	Containerisation	---	---	++	++	+++	---	---	+	+	+	+		---		-		42/9
10	Hub & spoke system	--	++		+	++			+/--	+/--	+/--	+/--		+			+	42/8

Legend: +/- = moderate increase/decrease; ++/-- = significant increase/decrease; +++/--- = very significant increase/decrease (and combinations thereof)

Appendix I. Changes and their effects (continued)

Public policies (1 of 2)

		Efficiency	Service quality						Environmental sustainability				Infr. Suff.		Social issues			
No.	Change	Transport cost	Transport Time	Reliability	Frequency	ICT applications	Cargo damages	Cargo theft etc.	CO2-eq.	SOx	NOx	PM	Congestion	Bottlenecks	Land use	Accidents	Noise	Fiche and measure number
1	Liberalise transport operations	-- (-)	-- (-)	++ (+)	++	++			-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	-		-- (-)	-- (-)	11/20, 24/1, 26/3, 29/4, 40/9, 42/1, 47/8
2	Internalise external costs	++				++			--	--	--	--	--	-			--	2/19, 11/17, 12/8, 12/11, 16/1, 16/2, 16/4, 17/1, 17/2, 18/1, 26/19, 27/16, 29/26, 29/27, 39/16, 42/2, 44/1, 47/7, 48/15, 57/3,
3	Set energy consumption/ emission/noise standards & other regulatory measures	+							--	--	--	--					--	1/2, 2/7, 11/22, 16/3, 18/2, 26/6, 27/6, 39/14, 42/4, 42/5, 53/4
4	Tighten up and harmonise safety standards	+		+			-									---		3/1, 26/13, 29/10, 29/22, 29/25
5	Tighten up security standards	+ / -	+	+		+		--						(+)				12/9, 20/21, 26/14, 26/15, 57/7
6	Standardise transport units and vehicles	+ / --	--	++			-		- (+)		- (+)	- (+)	(+)	-		- (+)	(+)	6/1, 9/3, 20/23, 20/24, 20/25, 29/17, 39/15, 42/7, 42/13, 59/9
7	Harmonise infrastructure (interoperability)	+ / --	--	++		++			--	--	--	--		---				2/17, 11/23, 26/1, 29/5, 29/6, 29/12, 29/23, 48/14, 56/2, 56/3, 59/8
8	Harmonise rules and enforcement	-		+			-		-	-	-	-		-		-	-	24/2, 24/3, 25/2, 25/3, 25/4, 25/5, 27/5, 29/1, 29/13, 29/14, 29/24, 29/29, 32/1, 33/1, 33/2, 35/1, 57/1, 57/2, 57/4,
9	Standardise liability and documentation for multi-modal transport	-							(-)	(-)	(-)	(-)	(-)			(-)	(-)	20/18, 20/19, 20/20, 29/3, 52/2, 59/6
10	Simplify administration	--	--			+++								---				2/16, 11/21, 13/1, 13/2, 13/3, 13/5, 13/6, 13/7, 13/8, 13/9, 20/16, 20/22, 22/3, 27/3, 29/9, 29/11,

Legend: +/- = moderate increase/decrease; ++/-- = significant increase/decrease; +++/--- = very significant increase/decrease (and combinations thereof)

Appendix I. Changes and their effects (continued)

Public policies (2 of 2)

		Efficiency	Service quality						Environmental sustainability				Infr. Suff.		Social issues			
No.	Change	Transport cost	Transport Time	Reliability	Frequency	ICT applications	Cargo damages	Cargo theft etc.	CO2-eq.	SOx	NOx	PM	Congestion	Bottlenecks	Land use	Accidents	Noise	Fiche and measure number
11	Create freight-oriented corridors	-	---	+++		++	-	-	(--)	(--)	(--)	(--)	(--)	---		(--)	(--)	11/14, 20/28, 21/1, 21/4, 21/5, 26/2, 30/1, 40/4, 42/10
12	Develop green corridors	-		++		++	-	-	--	--	--	--	--	--		--	--	11/11, 20/26, 20/27
13	Employ a spectrum of instruments to fund infrastructure and other actions	-- (-)	-- (-)	++ (+)					-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	++	-- (-)	-- (-)	11/15, 12/2, 14/4, 20/29, 20/33, 22/4, 22/5, 23/1, 26/7, 27/1, 27/2, 29/8, 29/15, 29/21, 42/14
14	Bring ICT applications to market (ITS, ERTMS, RIS, e-maritime, e-freight, e-customs)	--	--	++		+++	-		--	--	--	--	--	-		--		26/11, 26/21, 26/22, 27/15, 31/1, 31/2, 31/3, 34/1
15	Enhance education and training	-	-	+		+	-		-	-	-	-		-		-		9/9, 20/9, 22/7, 25/1, 26/10, 27/8, 27/9, 29/2, 29/16, 59/5
16	Ensure satisfactory working conditions	-		+			-		-	-	-	-				-		11/22, 26/9, 29/2, 29/14
17	Support research & development	--	-	+		+++			---	---	---	---	-	-		---	---	9/7, 9/8, 11/19, 26/16, 26/17, 27/7, 37/2
18	Educate, inform and involve the greater public in transport policies (incl. labelling)	-	-	+		++	-	-	-	-	-	-	-	-		--	-	1/3, 11/24, 20/10, 20/13, 20/14, 20/31, 26/12, 27/10, 39/4, 47/2, 47/5, 53/5, 59/1, 59/2, 59/3
19	Monitor and publish service quality indicators	-	--	++		++	-		-	-	-	-	-	-		--	-	20/8, 20/11, 20/12, 20/15, 20/32, 21/2, 27/4, 27/11, 27/12, 59/4
20	Promote international cooperation with EU neighbouring countries	(-)	(-)	(+)										(-)				11/25
21	Green public procurement								-	-	-	-					-	

Legend: +/- = moderate increase/decrease; ++/-- = significant increase/decrease; +++/--- = very significant increase/decrease (and combinations thereof)

Appendix I. Changes and their effects (continued)

Operations

No.	Change	Efficiency	Service quality						Environmental sustainability				Infr. Suff.		Social issues			
		Transport cost	Transport Time	Reliability	Frequency	ICT applications	Cargo damages	Cargo theft etc.	CO2-eq.	SOx	NOx	PM	Congestion	Bottlenecks	Land use	Accidents	Noise	Fiche and measure number
1	Optimise fleet and terminal operations	--	-	+	+	++			--	--	--	--	--	-		--	--	39/10, 43/9, 43/10, 43/11, 50/17, 57/10
2	Slow steaming	--	++		--				--	--	--	--						50/18
3	Eco driving	-	+						-	-	-	-				-	-	4/1
4	Introduce a container pool system	-				++			-	-	-	-		-				59/10
5	Introduce combined transport solutions	-	-	+					-	-	-	-	-	--		-	-	42/6
6	Introduce the Life Cycle Cost (LCC) methodology in decision-making	-				+			-	-	-	-					-	28a/8, 28a/9
7	Enhanced training on environmental transport	-	-	+		+	-		-	-	-	-		-		-		37/1, 40/8

Legend: +/- = moderate increase/decrease; ++/-- = significant increase/decrease; +++/--- = very significant increase/decrease (and combinations thereof)

Appendix I. Changes and their effects (continued)

Infrastructure development

		Efficiency	Service quality						Environmental sustainability				Infr. Suff.		Social issues			
No.	Change	Transport cost	Transport Time	Reliability	Frequency	ICT applications	Cargo damages	Cargo theft etc.	CO2-eq.	SOx	NOx	PM	Congestion	Bottlenecks	Land use	Accidents	Noise	Fiche and measure number
1	Increasing congestion	+	+	-					+	+	+	+	+				+	48/13
2	Upgrade existing infrastructure	-- (-)	-- (-)	++ (+)					-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	-- (-)		-- (-)	-- (-)	10/3, 11/13, 12/7, 13/10, 22/2, 27/13, 28a/1, 28a/3, 28a/4, 28a/6, 40/5, 40/6, 42/12, 50/1
3	Expand infrastructure	-- (-)	-- (-)	++ (+)	+				-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	++	-- (-)	-- (-)	11/10, 21/3, 22/2, 27/14, 40/1, 40/2, 48/12, 57/11
4	Create a core network of high EU added value	-- (-)	-- (-)	++ (+)	+				-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	++	-- (-)	-- (-)	10/1
5	Promote intermodal freight villages (including urban distribution centres)	--	--	++	+	+++	(+)	--	--	--	--	--	--	---	++	--	--	1/6, 11/9, 21/6, 40/1, 42/11, 53/1, 59/7
6	Construct dedicated freight rail lines	- (+)	---	+++	+++	++			--	--	--	--	--	---	++	--	--	29/7, 40/3
7	Create dedicated parking areas for trucks with appropriate security levels							--										56/1
8	Designate unloading places for delivery vehicles in dense urban areas	-	-						-	-	-	-	-				-	1/1, 53/6
9	Reduced public expenditures on transport infrastructure	+	+	-					+	+	+	+	+	+		+	+	2/27
10	Ensure adequate public and private funds	-- (-)	-- (-)	++ (+)					-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	-- (-)	++	-- (-)	-- (-)	10/4, 26/18, 29/18, 29/19, 29/20, 29/28, 47/3
11	Adopt common methodologies in project appraisal	-	-	+					-	-	-	-	-	-		-	-	11/12

Legend: +/- = moderate increase/decrease; ++/-- = significant increase/decrease; +++/--- = very significant increase/decrease (and combinations thereof)

Appendix I. Changes and their effects (continued)

Technology development

		Efficiency	Service quality						Environmental sustainability				Infr. Suff.		Social issues			
No.	Change	Transport cost	Transport Time	Reliability	Frequency	ICT applications	Cargo damages	Cargo theft etc.	CO2-eq.	SOx	NOx	PM	Congestion	Bottlenecks	Land use	Accidents	Noise	Fiche and measure number
1	Develop ICT solutions for vehicles/vessels and infrastructure	--	--	++		+++	-		--	--	--	--	--	-		--		1/4, 2/9, 3/1, 9/2, 10/2, 11/16, 11/18, 12/10, 13/4, 14/2, 20/1, 20/2, 20/3, 20/4, 20/5, 20/6, 20/7, 29/31, 34/1, 40/7, 42/3, 48/11, 52/1, 53/7
2	Reduce forces on vehicles/ vessels	--							--	--	--	--						39/1, 39/5, 39/6, 43/7, 50/14
3	Increase efficiency of propulsion systems	--							--	--	--	--						14/3, 28b/2, 39/2, 39/8, 43/2, 43/5, 43/6, 50/5, 50/6, 50/7, 50/14, 57/5
4	Use alternative fuels	+							---	---	---	---					--	9/1, 9/6, 10/3, 28b/1, 39/3, 39/11, 39/12, 43/8, 47/4, 50/4, 53/2
5	Improve after-treatment of exhaust gases of existing and new generation fuels	+							--	--	--	--						28b/3, 50/8, 50/9, 50/10, 50/11, 50/12, 50/13
6	Improve environmental performance of auxiliary systems	+							-	-	-	-						28b/4, 39/7, 43/1, 43/3
7	Vehicle/vessel capacity optimisation	--							--	--	--	--	--	-		--	--	43/4, , 50/15, 50/16
8	Develop more efficient cargo handling and transport technologies	--	--			++			--	--	--	--	--	--		--	--	2/8, 9/4
9	Optimise vehicle and infrastructure characteristics in relation to noise generation	+															--	18/3, 28a/7, 53/3
10	Develop new methods for structural assessment of existing infrastructure	-							-	-	-	-		-			-	28a/2, 28a/5, 28a/10, 28a/11
11	Enhance training on environmental transport	-	-	+		+	-		-	-	-	-		-		-		37/1

Legend: +/- = moderate increase/decrease; ++/-- = significant increase/decrease; +++/--- = very significant increase/decrease (and combinations thereof)

Appendix I. Changes and their effects (continued)

International regulations

		Efficiency	Service quality						Environmental sustainability				Infr. Suff.		Social issues			
No.	Change	Transport cost	Transport Time	Reliability	Frequency	ICT applications	Cargo damages	Cargo theft etc.	CO2-eq.	SOx	NOx	PM	Congestion	Bottlenecks	Land use	Accidents	Noise	Fiche and measure number
1	Support fair international trade	-		+			--		-	-	-	-				--		12/1, 12/3, 12/4, 22/6, 47/1
2	Adopt EEDI	+	+		-				- (+)	- (+)	- (+)	- (+)						8/1, 8/2, 12/5, 39/9, 58/1
3	Internalise the external costs of GHG emissions from ships	+							-	-	-	-						8/1, 8/2, 12/5, 39/9, 54/1
4	Strengthen restrictions on NOx and SOx	++							(+)	- (+)	- (+)	(+)	(+)			(+)	(+)	12/6, 41/1, 50/2
5	Establish a mandatory Polar Code	--	--	+	++	++	--		--	--	--	--				---		7/1
6	Enhance international security	+ / - (++)	+ (++)	+		+		--						(+)				48/17, 51/1
7	Establish global standards for ICT applications in shipping	--	--	++		+++	-		--	--	--	--	--	-		--		47/9
8	Establish global standards for IWT-engines	-							-	-	-	-						57/5
9	Upgrade EU status in IMO	(+)					(-)	(-)	(-)	(-)	(-)	(-)				(-)		11/26, 26/23, 29/30, 47/6
Legend: +/- = moderate increase/decrease; ++/-- = significant increase/decrease; +++/--- = very significant increase/decrease (and combinations thereof)																		

Appendix II. The most relevant technologies

A. *Engines and propulsion systems*

ID	Category	Technology Name	Transport Mode	Description
EN02	A	Directly driven propeller	Maritime	Slow speed engine directly connected to propeller shaft, 20 year life time, running 5500 h/a.
EN03	A	Mechanically connected propeller	Maritime	Medium speed engine connected by a reduction gear to the propeller shaft, 20 year life time, running 5500 h/a
EN07	A	Diesel-mechanic propulsion with high speed engine	Maritime	High speed engine connected by a reduction gear to the propeller shaft, 20 year life time, running 5500 h/a.
EN16	A	Full/parallel hybrid	Road	Electrical support of engine power by saving and re-use of break-energy; combination of 6 cylinder engine plus electrical engine
EN21	A	Exhaust abatement system	Inland Waterways	Emission reduction system comprising a reactor for selective catalytic reduction of NO_X and a reactor containing a particulate matter filter for reduction of particulate matter
EN39	A	Gas engines	Inland Waterways	Engines running on natural gas (different solutions available, pure gas engines, gas-diesel engines, dual fuel engines)
EN06	B	Mechanical azimuthing thrusters	Maritime	The engine runs generator. An electric motor is located inside the ship where it runs propeller shaft. 20 year life time, running 5500 h/a.
EN18	B	Fuel cell technology	Road	> 3,5 ton transporter running on renewable fuel cell technology
EN 15	C	PG Engine Diesel Locomotives	Railway	A propulsion system for a four-axle, standard-gauge, centre-cab locomotive using a liquefied petroleum gas (LPG) engine instead of conventional diesel
EN42	C	CCNR I Engine	Inland Waterways	Most existing engines comply with CCNR I Standard
EN45	C	CCNR II Engine	Inland Waterways	Today new engines have to comply with CCNR II standard
EN48	B	CCNR III Engine	Inland Waterways	Still under negotiation
EN51	B	CCNR IV Engine	Inland Waterways	Still under negotiation
EN54	C	Kaplan propeller in nozzle	Inland Waterways	Nozzle around Kaplan propeller creates additional thrust; highly effective at large propeller loads, Source DST;
EN57	C	High screw propellers	Inland Waterways	Nozzle around high skew propeller creates additional thrust; highly effective at large propeller loads, Source DST;
EN61	C	Contra rotating propeller	Maritime	Thrust system consisting of a pair of propellers behind each other which rotates in opposite directions, so that the aft propeller recovers some of the rotational energy in the slipstream from the forward propeller

ID	Category	Technology Name	Transport Mode	Description
EN62	C	Diesel turbo compound	Road	Turbo compound systems can be used to affect engine operation using the energy in exhaust gas that is driving the available turbocharger. A first electrical device acts as a generator in response to turbocharger rotation. A second electrical device acts as a motor to put mechanical power into the engine, typically at the crankshaft. Apparatus, systems, steps, and methods are described to control the generator and motor operations to control the amount of power being recovered. This can control engine operation closer to desirable parameters for given engine-related operating conditions compared to actual.
EN11	B	Diesel-Electric propulsion with dual fuel engine	Maritime	Medium speed engine using LNG (Liquefied Natural Gas) as primary fuel and HFO (Heavy Fuel Oil) or MDO (Marine Diesel Oil) as pilot fuel. The engine runs generator. An electric motor runs propeller shaft. 20 year life time, running 5500 h/a.
EN24	B	Improved Gas Engine	Road	Integrated approach using electronic valve motion management, enhanced cylinder head cooling, near-to-valve port fuel injection system, advanced integrated control

B. Fuels and sources of energy

ID	Category	Technology name	Transport Mode	Description
FU02	A	Ethanol and bio-diesel	Maritime Road	Investigation about using alternative fuels.
FU03	A	CGN (compressed natural gas)	Multimodal	Cleaner fuel for yard handling equipment (Prime movers)
FU08	A	LNG	Multimodal	Liquefied natural gas
FU18	A	Biogas	Multimodal	Biogas is mainly produced from bio-waste, agricultural residues and residues from sewage treatment plants
FU25	A	Sky sails system	Maritime	It uses large towing kites for the propulsion of the ship. The tractive forces are transmitted to the ship via a highly tear proof, synthetic rope.
FU05	B	AMP	Maritime	Alternative Maritime Power is a shore-side power source, that transforms the shore-side power voltage to match the vessel power system
FU06	B	Wind energy	Maritime Inland Waterways	Wind turbines which will generate clean energy to power 14 Container Terminal Quay cranes, reefer containers, repair workshops and other power consumption needs
FU13	B	Electricity	Road Railway	Electricity is today produced from fossil fuels, nuclear energy and renewable energy sources

ID	Category	Technology name	Transport Mode	Description
FU26	B	Waste heat recovery system	Maritime	It passes exhaust gases from the ship's main engine through a heat exchanger to generate steam for a turbine driven generator the electrical power generated assists ship propulsion or supplies shipboard services.
FU01	C	Ultra-low sulphur diesel	Maritime Inland Waterways Railway Road	Switch from industrial diesel oil (IDO 0,5% sulphur) to ultra-low sulphur diesel (ULSD 0,005%) for PMs and RTGs.
FU04	C	Solar power network	Multimodal	A 6.600 square-meter solar panel able to generate clean energy which will reduce reliance on oil and cut electricity-related greenhouse gas emissions
FU07	C	HFO	Maritime Railway Road	Heavy fuel oil
FU14	C	Hydrogen	Road Inland Waterways	Hydrogen is today mainly produced from steam reforming of fossil gas - some production from electricity and renewable sources
FU23	C	Nuclear Power	Inland Waterways Maritime	Nuclear Power
FU30	C	Flettner rotor	Maritime	It is a vertical cylinder rotating around its axis that converts prevailing wind into propulsive energy.
FU29	C	Fuel cell hybrid system	Multimodal	Develop fuel-cell systems that are capable of meeting the demands of heavy-duty transport for road, rail and marine applications. These systems will be:-Highly efficient, above 60%-Power dense,-Powerful units of 200kW plus,-Durable, robust and reliable. The two FC technologies considered are: -Polymer Electrolyte Fuel Cell (PEFC) technology and -Solid Oxide Fuel Cell (SOFC) technology. The scientific and technological approach is based on: -FC CLUSTERING -FC HYBRIDISATION

C. Cargo handling and transfer

ID	Category	Technology Name	Transport Mode	Description
HT01	A	Diesel to electric power convertor (RTGs)	Maritime Multimodal	RTGs fitted with electrical components in place of traditional hydraulic parts. Conversion will eliminate black emissions and lower noise levels of engines

ID	Category	Technology Name	Transport Mode	Description
HT03	A	Hybrid hydraulic drive Terminal tractors	Maritime	Storing braking energy into hydraulic system for acceleration and system
HT07	A	Low emission engines	Multimodal	Euro III/ IV compliant engines burn diesel more efficiently, reducing emission of CO_2 and providing up to 5% reduction on fuel consumption
HT10	A	Horizontal container (un)loading	Railway	Metrocargo is an innovative solution for containers cargo handling in overhead electrified railways, it's a containers horizontal movement system from an automated platform to train wagons. This technology is ready to experimentation. Metrocargo will be tested on new Maersk's Platform in Vado Ligure (SV), Italy.
HT06	B	MP-RTGs	Multimodal	Mains-powered RTGs transfer the power generation from the engine of the yard crane to a far more efficient power station. Power station can be up to 40% more efficient than equipment engine.
HT11	B	Cargo Cassette and Translifter	Maritime	Wheel less cargo cassette is a loading platform which is used together with a translifter in a cassette system. Translifter is a steerable lifting trailer which together with cassettes replaces roll trailers in Ro-Roand StoRo handling.
HT28	B	Automatic RoRo cargo unit handling	Multimodal	The concept is based on self (un)loading of units using a roll-on/roll-off system with a special train of platform cars, called a train loader. The performance of a train loader is often limited by the operation of the stockpile and reclaim system and the capacity of the train loader surge bin. While both are separate systems, they operate in concert to achieve a given performance. Poorly designed reclaim systems, or insufficient train loader surge capacity can significantly downgrade train-loading performance.
HT24	C	FCT	Maritime	The Floating Container Terminal collects and distributes containers originating from small calls, and bundles these currents with containers
HT08	B	ZF transmission systems	Multimodal	Installation in the new PM (prime movers) of new transmission system operating based on Automatic-Manual transmission concept. Reduction of fuel consumption by 10% when compared with older existing transmission systems
HT09	B	Green schemes to improve RTGs emissions and noise	Multimodal	Addition of a super-capacitor on RTGs. When RTGs engine is running, it charges the super capacity at the same time, and when super capacitor is fully charged, it will supply
HT20	B	Barge Express (BEX)	Inland Waterways	BEX is an integrated concept for large scale barge container transport aiming at automated handling at barge terminals
HT36	B	FlexiWaggon	Railway	Flexiwaggon can combine lorries, buses, cars, containers on one and the same waggon. Individual loading and unloading of waggons. Loading and unloading is done horizontally which means no consideration is necessary for overhead contact lines. The emissions will be reduced by 75%, including carbon dioxide emissions
HT05	C	Timing device for engine start-stop	Multimodal	Applied on yard equipment (Straddle carriers) to shut down the engine after a period of inactivity. This is a timing device that controlls engine shutdown and start-up depending on activity level.

ID	Category	Technology Name	Transport Mode	Description
HT32_a	C	River-Sea Push Barge System	Maritime	The river-sea push barge is a transport system in which one and the same push barge is used for the sea- and the river leg in a transport chain.
HT33	C	Combined Traffic Carrier Ship/Barge (CTCB)	Maritime	A shortsea concept based on a new type of shortsea vessel: the Trans Sea Lifter (TSL). This vessel is able to carry floating unit load carriers, in particular barges generally used in inland navigation, between inland waterways that are separated by the open sea.
HT34	C	Intermodal loading unit	Multimodal	New technical solutions for intermodal loading units including containers, dedicated adaptors and mobile internal fixtures in order to shift the main transportation route for goods from the road onto rail and inland waterways in a sustainable way. The technical activities will be focused on the development and design of large ISO containers and ISO compatible roll-off containers with the dimensions of 2 550 x 2 900 x 7 450 mm. These dimensions comply with the recommended directive of the European Commission for intermodal loading units.

D. *Cargo Preparation*

ID	Category	Technology Name	Transport Mode	Description
CP01	C	Cardboard pallets	Multimodal	ecological and sustainable being made of recycled materials and completely recyclable, have low weight but good strength
CP02	C	Modularized Boxes	Multimodal	Containers modularized and standardized worldwide in terms of dimensions, functions and fixtures. Easy to handle, store, transport, interlock, load, unload, construct and dismantle, compose and decompose. Environment friendly materials with minimal off-service footprint.
CP03	C	Passive controlled atmosphere system	Multimodal	Passive controlled atmosphere system in which the fruit itself creates the desired environment. Lower oxygen levels slow down the respiration process of the fruits.
CP04	C	Cargo hold tank coatings	Multimodal	Innovative cargo hold tank coatings to reduce abrasion and corrosion.
CP05	C	Software for optimal pallet configuration	Multimodal	Software for optimal pallet configuration to reduce shipping costs. The user enters primary package or box dimensions and rapidly assembles optimal pallet configurations.

E. *Heating and cooling*

ID	Category	Technology Name	Transport Mode	Description
HC02	B	Intelligent temperature unit	Multimodal	Current refrigerated boxcars will be built with energy efficient cooling systems, GPS (Global Positioning System) tracking, fresh air exchange and the ability to remote monitoring the systems, sometimes from thousands of km away on a network. RFID (Radio Frequency Identification) for tracking services are the main support in management systems of perishable goods.
HC03	B	Temperature control units	Road	CryoTech: Liquid CO2 modules for temperature for multi temperature control (cooling/heating)
HC04	B	RFID tag antenna with temperature alarm sensor	Multimodal	RFID tag antenna with ultra-low cost temperature alarm sensors which is capable of detecting temperature violations above a critical temperature threshold.
HC05	C	Natural refrigerants	Multimodal	Natural refrigerants are chemicals which occur in nature's bio-chemical processes. They do not deplete the ozone layer and make negligible contribution to global warming. Their high efficiency means they make a much lower, indirect contribution to global warming than many synthetic refrigerants.
HC06	C	Systems to Reduce Heating Costs in Cold Climates	Multimodal	The project will investigate two cooling approaches during the compression process. In one approach, relatively large amounts of oil are injected into the compressor to absorb heat generated throughout the compression stage. In the second approach, a mixture of liquid and vapor refrigerant from the expansion stage is injected at various points during compression to provide cooling. The added steps improve the compression process while also reducing energy losses due to friction in the expansion stage.
HC07	C	Software program QUEST	Maritime	QUEST is a CO2 emission friendly software with focus on maintaining a constant cargo temperature. It regulates the return air temperature and allows the supply air temperature to fluctuate without exposing the cargo to chill damages.
HC08	C	Truck Refrigeration Unit TDJS35HP	Road	Truck refrigeration unit enables simultaneous temperature control of two separate cargo compartments with different temperature settings entirely by heat pump.

F. *Innovative units and treatment*

ID	Category	Technology Name	Transport Mode	Description
LU13	B	Braking energy recovery	Railway	Recovery of dynamic braking energy and restitution to national grid / Reversible DB Substation

ID	Category	Technology Name	Transport Mode	Description
LU14	B	Onboard energy storage systems	Railway	Supercaps, batteries, flywheels, hybrid storage; A flywheel is a mechanical device with a significant moment of inertia used as a storage device for rotational energy. Flywheel energy storage, or the rotational energy of a flywheel, and rechargeable electric traction batteries are also used as storage systems. Batteries are electrochemical energy storage systems. A supercapacitor is a tool offering very high electrical capacitance in a small package. A hybrid train is a locomotive, railcar or train that uses an onboard rechargeable energy storage system (RESS), placed between the power source (often a diesel engine prime mover) and the traction transmission system connected to the wheels
LU11	C	APU (Auxiliary Power Unit)	Railway	An auxiliary power unit (APU) is a device on a locomotive whose purpose is to provide energy saving and to reduce the polluting emissions. Locomotive engines cannot use antifreeze in their cooling systems for technical reasons related to reactions of antifreeze chemicals on internal engine parts. Therefore, during cold weather, a locomotive engine must either be working to transport freight or idling to prevent freezing. The APU keeps the main engine warm, reducing fuel consumption and emissions while the main engine is shut down and also APU reduces railway noise levels
LU02	C	SECU unit	Multimodal	The SECU (Stora Enso Cargo Unit) is ISO certified for 93.5 gross tonnes. The dimensions are 3.6 x 3.6 x 13.8 m
LU03	C	Loading plate	Maritime	Actiw LoadPlate was developed to meet customer demands for quick loading of standard cargo space: sea containers, trailers. Solution is suitable for loading difficult cargo that is hard to containerise.
LU04	C	Trailer stand	Maritime	Simple system to lash trailers
LU05	C	2,5 wide container	Multimodal	Allows two pallets to be loaded side by side

G. *Vehicles*

ID	Category	Technology Name	Transport Mode	Description
VE02	A	Electric Locomotive	Railway	NS 999 is an entirely electric locomotive that uses a lead-acid energy storage system without the use of a diesel engine and with zero exhaust emissions.
VE03	A	Hybrid Truck	Road	Support engine plus auxiliary drive to operate an elevating platform of the truck; combination of 6 cylinder engine plus electrical engine
VE09	A	Electric vehicles	Road	Battery-electric vehicles

ID	Category	Technology Name	Transport Mode	Description
VE10	A	Euro VI vehicles	Road	Euro VI is compulsory for new trucks from 2013, replacing Euro V
VE01	B	Hybrid Locomotive	Railway	Hybrid Locomotive was developed with the goal of creating the cleanest, most fuel-efficient high-horsepower diesel locomotive ever built.
VE22	B	Road-rail cargo interchange	Railway	The Flexiwagon rail project will allow containers to be moved by road and by train by loading trucks onto railcars.
VE25	B	Brake energy recovery system	Railway	Reversible DC Substation for recovering of dynamic braking energy and restitution to national grid
VE29	B	Aerodynamic drag improvements	Road	Aerodynamic mirrors, cab side extenders, integrated cab roof fairings, aerodynamic front bumper, full fuel tank fairings, trailer side skirt fairings, trailer gap fairing, rear mounted trailer fairing. Ref to the "Reducing heavy -duty long haul combination truck fuel consumption and CO_2 emissions report" http://www.nescaum.org/documents/heavy-duty-truck-ghg_report_final-200910.pdf/
VE33	C	Low rolling resistance tires	Road	Tires which are designed to minimize the energy wasted as heat as the tire rolls down the road
VE35	B	Electrification of Trucks on Highways	Road	The eHighway concept introduces the idea of diesel-electric hybrid trucks which can work like a electric trolley when overhead electric lines are available and work as a diesel
VE04	C	Fuel Cells	Road	3,5 ton F-Cell Sprinter is a transporter running on renewable fuel cell technology.
VE20	C	River-Sea Push Barge System	Inland Waterways	The river-sea push barge is a transport system in which one and the same push barge is used for the sea- and the river leg in a transport chain.
VE21	C	Combined Traffic Carrier Ship/Barge (CTCB)	Maritime, Inland Waterways	A shortsea concept based on a new type of shortsea vessel: the Trans Sea Lifter (TSL). This vessel is able to carry floating unit load carriers, in particular barges generally used in inland navigation, between inland waterways that are separated by the open sea.
VE31	C	Innovative bogie	Railway	New-generation of powered bogie with axles directly driven by synchronous motors is already available for light rail vehicles. Traction, running gear and braking technologies are combined in the bogie in order to form a highly integrated mechatronic system.
VE32	C	Friction control measure	Railway	Some energy expended by the train is lost to wheel-to-rail friction. Reductions in wheel-to-rail resistance can be made via improved lubrication. Efficient lubrication systems, such as top-of-rail lubrication systems, reduce wheel and rail wear and reduce fuel consumption

H. Navigation technologies

ID	Category	Technology Name	Transport Mode	Description
NA02	A	Automatic Identification System (AIS)	Maritime	Ship-to-ship, ship-to-shore and shore-to-ship system. Main purpose is collision avoidance, ship tracking and tracing. Works on VHF (Very high frequency, 30–300 MHz) radio frequency.
NA15	A	WiMax	Maritime Railway Road	Worldwide Interoperability for Microwave Access. Long range, high bandwidth wireless Internet
NA01	B	Train Control System	Railway	Train control and tracking system based on a special GPRS method.
NA05	B	ECDIS	Maritime	An Electronic Chart Display and Information System (ECDIS) is a computer-based navigation information system that can be used as an alternative to paper nautical charts. Integrates position information from GPS and other navigational sensors (radar, AIS). It may also give Sailing Directions and fathometer.
NA12	B	GEO satellites	Maritime	Geosynchronous Satellite whose orbital track on the Earth repeats regularly over points on the Earth over time. If such a satellite's orbit lies over the equator and the orbit is circular, it is called a geostationary satellite.
NA13	B	LEO satellites	Maritime	A low Earth orbit (LEO) is generally defined as an orbit within the locus extending from the Earth's surface up to an altitude of 2,000 km. Given the rapid orbital decay of objects below approximately 200 km, the commonly accepted definition for LEO is between 160 - 2,000 km (100 - 1,240 miles) above the Earth's surface.
NA14	B	Inmarsat	Maritime	British satellite telecommunications company, offering global, mobile services. It provides telephony and data services to users worldwide, via portable or mobile terminals which communicate to ground stations through eleven geosynchronous telecommunications satellites.
NA16	B	ATM	Inland Waterways	The advising Tempomaat (ATM) is a computer program advising the skipper on the most economical combination of route and speed, enabling the vessel to arrive on time with a most efficient use of fuel leading to a reduction of fuel consumption and emissions.
NA17	B	River Information Services (RIS)	Inland Waterways	River Information Services (RIS) are customized information services for inland waterway transport and make it possible to coordinate logistical processes with actual transport situations on a constant basis. RIS play a key role in making cargo transport and passenger services on waterways more efficient leading to a reduction of fuel consumption by approximately 5 %, while at the same time increasing traffic safety.

ID	Category	Technology Name	Transport Mode	Description
NA18	B	Predictive cruise control (PCC)	Road	The PCC assistance system uses map and satellite-based route previews and saves substantial amounts of fuel. Unlike a conventional cruise control system that tries to maintain a preset speed, regardless of how the terrain changes, the PCC system looks for its route a mile in advance and adjusts engine output to the uphill and downhill gradients ahead. Based on this information, the on-board computer calculates the optimum speed to use the momentum of the truck to maximize fuel economy.
NA07	C	Global Navigation Satellite Systems or GNSS	Maritime Railway Road	Global Navigation Satellite Systems (GNSS) is the standard generic term for satellite navigation systems ("sat nav") that provide autonomous geo-spatial positioning with global coverage. GNSS allows small electronic receivers to determine their location (longitude, latitude, and altitude) to within a few metres using time signals transmitted along a line-of-sight by radio from satellites.
NA11	C	LRIT	Maritime	The Long Range Identification and Tracking (LRIT) of ships. It consists of the ship borne LRIT information transmitting equipment, Communications Service Providers (CSPs), Application Service Providers (ASPs), LRITDataCenters, the LRIT Data Distribution Plan and the International LRIT Data Exchange.
NA15	B	WiMax - Worldwide Interoperability for Microwave Access	Maritime	Long range, high bandwidth wireless Internet

I. *Best practices*

ID	Category	Technology Name	Transport Mode	Description
BP04	A	Traffic Flow Management	Railway	A system for online optimization of rail traffic flow to have minimum delays and minimum energy consumption, developed by Emkamatik on behalf of SBB
BP07	A	Carbon-free rail freight transport	Railway	DB Schenker Rail replaces the electricity required for your freight transport with regenerative energy that comes 100% from renewable sources in Germany. This helps to avoid carbon emissions right from the outset. Even the smallest quantities can be transported in this way without carbon emissions, on a national and international scale.
BP02	B	TDS	Railway	Train Control System based on a GPS application method
BP03	B	GEKKO	Railway	A system to provide guidance to energy efficiency driving and timetable optimization, developed for Danish State Railways

ID	Category	Technology Name	Transport Mode	Description
BP08	B	Integrated shortsea transport	Maritime	The concept of Coaster Express (CoEx) is a short sea transport concept directed to bundling the transport flows, scaling-up the short sea facilities and standardization and automation of the transition processes.
BP35	A	EREX (ERESS)	Railway	The Erex system, has been designed by the European Railway Energy Saving Solution (ERESS), to help railways to save money and reduce CO2 emissions by providing exact energy consumption data. It provides an efficient, reliable, and flexible energy settlement process, enabling railway undertakings to understand their use of energy and thereby save energy and costs. Erex has been configured with a virtual platform with almost unlimited capacity.