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 II

Due date of deliverable: 15 Jan. 2013

Actual submission date: 17 Dec. 2012 (Revised: 25 February 2013)

Organisation name of lead partner for this deliverable: NTUA

Document ID number: **07-20-PP-2012-05-02-3**

REVISIONS/DOCUMENT HISTORY:

Index	Date	Authors	Reviewers	Subject
01	Dec. 13, 2012	G. Panagakos, NTUA	H. Moyano, PAG H. Psaraftis, NTUA	First complete draft
02	Dec. 17, 2012	G. Panagakos, NTUA	H. Psaraftis, NTUA E. Holte, MAR	Final draft
03	Feb. 22, 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
GP	George Panagakos	NTUA	Author
HM	Humberto Moyano	PAG	Contributor
HP	H. Psaraftis, T.Mpaliami	NTUA	Contributors
SF	Sara Fozza	DAPP	Contributor
CG	Chara Georgopoulou	DNV	Contributor
PZ	Panagiotis Zacharioudakis	NTUA	Contributor

Revision history

Rev.	Who	Date	Comment
1	GP	Dec. 17, 2012	Response to comments of internal reviewers
2	GP	Feb. 22, 2013	Response to comments from the Commission

Quality Control

	Name	Date
Checked by WP leader	Humberto Moyano, PAG	Dec. 16, 2012
Checked by internal reviewer	Even Ambros Holte, MAR	Dec. 17, 2012
Checked by internal reviewer	Harilaos Psaraftis, NTUA	Dec. 17, 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

CEF	Connecting Europe Facility
CMS	Corridor Management System
CNG	Compressed Natural Gas
CO_2	Carbon dioxide
CO_2-eq	Carbon dioxide equivalent unit
DEFRA	Department for Environment, Food and Rural Affairs (U.K.)
EDU	Equivalent Delivery Unit
EEIG	European Economic Interest Group
EIA	Energy Information Administration (USA)
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
EWTC	East-West Transport Corridor
GHG	Greenhouse gas
GPS	Global Positioning System
GSM-R	Global System for Mobile Communications - Railway
HFO	Heavy Fuel Oil
IQ-C	International Group for Improving the Quality of Rail Transport in the North-South-Corridor (Rotterdam-Genoa)
ISO	International Organisation for Standardisation
ITS	Intelligent Transport Systems
KPI	Key Performance Indicator
LCA	Life Cycle Assessment
LNG	Liquefied Natural Gas
LPG	Liquefied Petroleum Gas
LSP	Logistics Service Provider
MCR	Maximum Continuous Rating
MoU	Memorandum of Understanding
NOx	Nitrogen oxides (NO and NO_2)
PM	Particulate Matter
R&D	Research and Development
RNE	RailNetEurope
SOx	Sulphur oxides (SO_2 and SO_3)
TEN-T	Trans-European Transport Network
UIC	International Union of Railways

0 Introduction

The purpose of this document is to present in a user-friendly way those results of the SuperGreen project that have a practical value for the logistics business community. It is intended to be a companion document to Volume I of the Green Corridors Handbook.

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. More specifically the project aimed at:

- giving overall ***support and recommendations*** on green corridors to the EU's Freight Transport Logistics Action Plan;
- ***encouraging co-modality*** for sustainable solutions;
- ***benchmarking*** green corridors based on selected KPIs covering all aspects of transport operations and infrastructure (emissions, internal and external costs);
- conducting a programme of ***networking activities between stakeholders*** (public and private);
- ***delivering policy recommendations*** at a European level for the further development of green corridors; and
- providing ***recommendations concerning new calls for R&D*** proposals to support the development of green corridors.

It should be clarified right at the outset that this handbook does not seek to present all the work performed under SuperGreen, not even a summary of it. In addition to Volume I of this handbook, this information is publicly available – once approved by the European Commission – on the project's website, including the summary, which will be given in the project's final report. As for what should be expected from the website, Appendix I provides the project's structure along with its identity and partners. Each of the tasks appearing in the structure corresponds to at least one official project deliverable.

Instead, this handbook has been produced for the following reasons:

- to clarify the concept of 'green corridors' as much as possible;
- to encourage a standardised approach for developing and implementing a green corridor; and
- to assist the customers of freight transport operators who may wish to understand the repercussions for their supply chain.

These objectives have been translated into the following ten questions:

1. *What is a transport corridor?*
2. *What is a 'green' transport corridor?*

Plural rather than singular pronouns are used in forming these questions in order to stress the importance of collaboration in developing and implementing green transport corridors.

3. *Why do we need transport corridors?*
4. *How do we develop a green corridor?*
5. *How do we manage a green corridor?*
6. *How do we monitor performance?*
7. *How can technology help?*
8. *Do we need a new approach in doing business?*
9. *How do green corridors relate with the TEN-T?*
10. *Where can we get more information?*

Each one of the above questions is addressed by one of the following sections of this handbook.

A couple of comments on the scope of this document are necessary. Firstly, transport corridors serve both passengers and freight traffic. Although the characteristics of demand and the equipment used differ dramatically between these two functions, usually they share the same infrastructure. Trucks clash with buses and passenger cars for right of way. Slower freight trains run between faster passenger trains. Barges and freighters compete with passenger vessels in navigation channels, ports and locks. The handbook deals only with freight transport, but the quality of transport and logistics services is also affected by passenger transport competing for route capacity.

Secondly and in line with the SuperGreen project, the transport modes examined are limited to surface freight services. Aviation is outside the scope of this document, as is the use of pipelines for liquid cargoes.

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

1 What is a transport corridor?

Despite being used for years as a concept, there is no precise definition for a "transport corridor". The description that suits best the way the term is used in the present document is this of John Arnold in the World Bank publication *Best Practices in Corridor Management*:

> "[A transport corridor] has both a physical and functional dimension. In terms of physical components, a corridor includes one or more routes that connect centres of economic activity. These routes will have different alignments but with common transfer points and will be connected to the same end points. These routes are composed of the links over which the transport services travel and the nodes that interconnect the transport services. The end points are gateways that allow traffic with sources or destinations outside the corridor (and its immediate hinterland) to enter or exit the corridor.
>
> An international transport corridor connects one or more neighbouring countries. It may also connect countries that are separated by one or more transit countries or provide a landlocked country with access to the sea. Some corridors have a single mode or a single route, but most have multiple routes and modes. Some are relatively short and defined by a principal gateway like a port. Others are defined by the region they serve. Still others are defined as part of a network serving a larger region.
>
> While it is important to separate the concepts of economic corridors and transport corridors, the fact is that most transport corridors are developed to support regional economic growth. They provide transport and other logistics services that promote trade among the cities and countries along the corridor."

Corridor A, the corridor from Rotterdam to Genoa is a good example. It stretches from the sea ports of Rotterdam, Zeebrugge and Antwerp to the port of Genoa, right through the heart of the EU along the so-called "Blue Banana". This is the most heavily industrialised North-South route in Central Europe and connects Europe's prime economic regions.

Figure 1. Train Corridor A serving the "Blue Banana" region

The "Blue Banana" includes economically strong urban centres such as Rotterdam, Amsterdam, Duisburg, Cologne, Frankfurt, Mannheim, Basle, Zurich, Milan and Genoa. All these centres are served and connected by the corridor, also indirectly including London and Brussels. The countries directly involved are The Netherlands, Belgium, Germany, Switzerland and Italy.

This outstanding position together with the resulting fact that this corridor carries by far the greatest transport volume in Europe, makes the Rotterdam-Genoa route with its branch to Zeebrugge and Antwerp the pioneer for international rail freight transport in Europe.

For more information on international transport corridors refer to:

Arnold John (2005). *Best Practices in Corridor Management*, Trade Logistics Group, The World Bank, Washington, D.C., February 2005, found at:

http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2008/08/26/000333037_20080826030537/Rendered/PDF/451280WP0Box3310management01PUBLIC1.pdf

For more information on Corridor A visit: http://www.corridora.eu/corridor/leadership#top

2 What is a 'green' transport corridor?

In a strict sense, a precise answer to this question is not available, and in fact one of the most important contributions of ongoing research on the topic would be to develop an explicit and workable definition of the 'green corridor' term.

The concept was introduced in 2007 by the *Freight Transport Logistics Action Plan* of the European Commission. According to this document:

> "... transport corridors are marked by a concentration of freight traffic between major hubs and by relatively long distances ...
>
> ... Industry will be encouraged along these corridors to rely on co-modality and on advanced technology in order to accommodate rising traffic volumes, while promoting environmental sustainability and energy efficiency ...

*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".*

> ... Green transport corridors will … be equipped with adequate transhipment facilities at strategic locations … and with supply points initially for bio-fuels and, later, for other forms of green propulsion ...
>
> ... Green corridors could be used to experiment with environmentally-friendly, innovative transport units, and with advanced Intelligent Transport Systems (ITS) applications …
>
> ... Fair and non-discriminatory access to corridors and transhipment facilities should be ensured in accordance with the rules of the Treaty."

The *Freight Transport Logistics Action Plan* of the European Commission can be found at:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2007:0607:FIN:EN:PDF

Some years later, the Swedish Logistics Forum worked out a more structured definition. According to them:

"Green Corridors aim at reducing environmental and climate impact while increasing safety and efficiency. Characteristics of a green corridor include:

- sustainable logistics solutions with documented reductions of environmental and climate impact, high safety, high quality and strong efficiency,
- integrated logistics concepts with optimal utilisation of all transport modes, so called co-modality,
- harmonised regulations with openness for all actors,

- a concentration of national and international freight traffic on relatively long transport routes,
- efficient and strategically placed transhipment points, as well as an adapted, supportive infrastructure, and
- a platform for development and demonstration of innovative logistics solutions, including information systems, collaborative models and technology."

> For more information on the Swedish Logistics Forum's definition refer to:
>
> Kyster-Hansen et al., *Green Corridor Manual (draft) – Purpose, definition and vision for Green Transport Corridors*, Danish Transport Authority, 21.6.2011
>
> found at:
>
> http://www.ewtc2.eu/media/162523/ewtcii%20gcm%20-%20purpose%20definition%20vision.pdf

So, what makes a freight corridor green?

A careful examination of the abovementioned EU definition leads to the conclusion that, with the exception of its last phrase that concerns market access and relates to the efficiency of a corridor regardless of its colour, it can be decomposed into the following characteristics that distinguish a green corridor from its non-green counterpart:

a) Reliance on co-modality, which in turn requires:

- **adequate transhipment facilities at strategic locations; and**
- **integrated logistics concepts.**

b) Reliance on advanced technology, allowing:

- **energy efficiency; and**
- **use of alternative clean fuels.**

c) Development and demonstration capabilities of environmentally-friendly and innovative transport solutions, including advanced telematic applications.

The Swedish definition adds two more dimensions in their list of green corridor characteristics; those of harmonised regulations and collaborative business models. Provided that harmonised regulations along with the very significant interoperability issues (in terms of both infrastructure and vehicles) relate more to the efficiency rather than the environmental sustainability of the corridor, one can exclude them from the list of green prerequisites.

The collaborative business models also fall in a rather grey area, as they are usually needed in all types of transport corridors. However, they are much more important in formulating the integrated logistics concepts of the green corridors, and as such can be regarded as yet another prerequisite element:

d) Collaborative business models

The above discussion leads to the conclusion that:

A green corridor is efficient.

An efficient corridor is not necessarily green.

The characteristics that make an efficient corridor green are the four ones listed in the previous page in bold print.

3 Why do we need green corridors?

Those who follow the evolution of the EU transport policy cannot escape noticing that the corridor approach gains more and more importance as a response to the new and old challenges that the common transport policy faces in Europe.

- In March 2005, the European Commission and the railway sector agreed on a MoU referring to the implementation of ERTMS on 6 corridors to define a European migration strategy for the deployment of ERTMS.
- In October 2007, The European Commission published its "Freight Transport Logistics Action Plan", which introduced the concept of 'green corridors' as a means to improve the efficiency and sustainability of freight transport in Europe.
- In November 2010, the European Parliament and the Council adopted the EU Regulation No 913/2010 concerning a European rail network for competitive freight. This Regulation defines nine initial corridors, along which sufficient priority, among freight trains, is given to those crossing at least one border.
- In March 2011, the European Commission in describing its vision of future transport and the corresponding strategy for the next decade, included in the latest White Paper on transport 'multimodal freight corridors' as a means to improve governance and to support pilot projects for innovative and clean transport services.
- In October 2011, the European Commission published its proposal for a Regulation on the new TEN-T guidelines, which introduced the concept of 'core network corridors' as an instrument to facilitate the coordinated implementation of the parts of the TEN-T with the highest strategic importance (core network).

At a lower level, the initiatives listed below comprise only a selection among a wide range of corridor applications in Europe:

- In December 2002, Germany, Austria and Italy adopted the Brenner Action Plan aiming at a significant and sustainable increase in intermodal volume along the Brenner corridor, one of the most trafficked international transit corridors, where - on a length of only 448 km between Munich and Verona - three countries and thus railway infrastructures and the Alps are being bridged.
- In January 2003, the Ministries of Transport of The Netherlands, Germany, Switzerland and Italy agreed on a MoU establishing an international working group to develop a comprehensive action plan aiming at bringing about numerous quantitative and qualitative improvements on the rail corridor from Rotterdam to Genoa. The so-called Corridor A was born (refer also to Section 1).
- In 2006, 42 partners (local, regional and national authorities, universities, harbours and private stakeholders) from Denmark, Lithuania, Russia and Sweden joined forces to strengthen transport development along the so-called "East-West Transport Corridor - EWTC" through infrastructure improvements, new solutions

for business, logistics and cooperation between researchers. The success of EWTC led to the follow up project EWTC II, which aims at transforming the EWTC into a green corridor in line with the EU's policy.

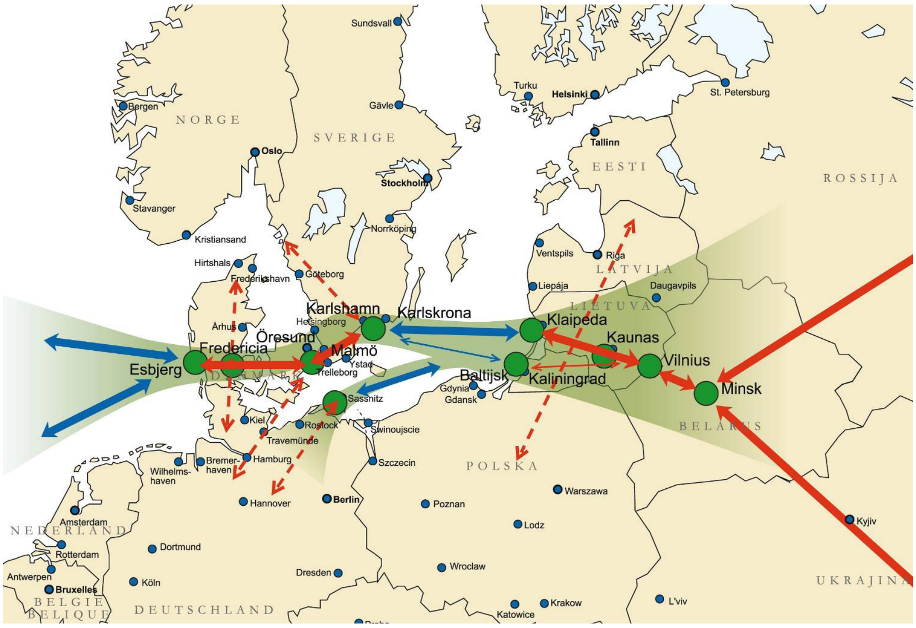


Figure 2. The East-West Transport Corridor

- In 2008, the Swedish “Green Corridors” initiative was introduced focusing on transport routes and collaboration among shippers, forwarders, industry and haulers in order to optimise the use of available transport capacity. Today the project collaborates with the governments of Denmark, Finland and Norway.

- In 2009, the Scandria project was introduced, covering the corridor from Region of Halland, via Zealand to Mecklenburg-Vorpommern and Berlin. The project cooperates with SoNorA, which extends coverage from Berlin to the Adriatic Sea.

- In 2009, the TransBaltic project was also introduced covering corridors across the Baltic Sea. Its overall objective is to provide incentives for the creation of a comprehensive multimodal transport system in the Baltic Sea Region.

There are a number of good reasons for making green corridors so popular:

- The consolidation of large volumes of freight for transport over long distances improves the competitiveness, and thus the possibilities of engagement, of modes like rail and waterborne transport, which are environmentally friendlier than trucks.

- The shift of cargoes away from European roads will alleviate the serious congestion problem that this transport mode faces, producing positive externalities to the other users of the road network through improvements in reliability and

> A **positive externality** is a benefit that is enjoyed by a third-party as a result of an economic transaction, in which this party was not involved as either a buyer or seller. Individuals who benefit from positive externalities are considered to be free-riders.

reduction of transport time.

- Additional environmental and financial (through lower operating costs) gains can also result from optimisation in terms of energy use and emissions, further enabled by the scale and length of such freight corridors.

- The international character of the corridors (involve at least three Member States) addresses the fragmented nature of transport networks, especially rail, dealing with the haunting interoperability issues in geographical terms. At the same time, focusing on a subset of the network improves the chances of identifying workable solutions by limiting the overwhelming scale of the problem.

- The realisation of international multimodal corridors cannot be implemented without appropriate corridor structures. These structures will bring together the Commission, Member States, the regions, the local authorities, but also the infrastructure owners and managers, transport operators, shippers, financiers and, when appropriate, neighbouring countries. The involvement of such structures is absolutely necessary in promoting multimodal logistics, where lack of coordination comprises probably the most persisting problem.

- The establishment of corridors that enhance the efficiency of transport modes (alone and in combination) through better utilisation of resources will limit the considerable investments needed for expanding the capacity of the transport networks in an environment of budgetary consolidation and increasing public opposition to major transport infrastructure projects especially in the vicinity of urban areas.

4 How do we develop a green corridor?

Corridors are rarely developed as 'greenfield' projects. Most have been developed from existing routes, many of which date back to ancient trading routes, e.g. the Silk route. Nearly all evolved from existing land-based multimodal transport networks. Coastal and shortsea routes are less common but important for archipelagic countries. Inland water routes are less common although important in riverine countries. Ocean routes are not usually included in the definition of the corridor because there is little need to develop the links on these routes. However, seaports are included since they serve as the international gateways.

In contrast with 'brownfield', a **'greenfield'** project is a term used in construction and development to refer to land that has never been used before, where there is no need to demolish or rebuild any existing structures.

The development of a corridor is closely related to the functions it serves. Having examined a number of international transport corridors, Arnold (2005) concludes that there are three general functions requiring management oversight:

- **Infrastructure and facilities**, including links and nodes along the routes, are developed and funded primarily by the public sector but increasingly constructed and maintained by the private sector. Management's role is to guide the planning and procurement of these assets. Its goal is to insure that these assets are:

  - ✓ designed to provide efficient movement of cargo along the infrastructure and through the facilities;
  - ✓ constructed and maintained so as meet required standards;
  - ✓ of sufficient capacity to meet projected demand;
  - ✓ used efficiently; and
  - ✓ fully utilised.

- **Transport and logistics** services. Increasingly these activities are undertaken by the private sector in a competitive market with costs recovered through user charges. The objective of the managers of individual services is to capture significant market share by offering a competitive combination of cost, time and reliability. To the extent that corridor management is responsible for overseeing these services, its objective should be to promote more efficient services, usually by encouraging competition but often by allowing vertical and horizontal integration.

- **Regulatory procedures** that affect the movement of goods in the corridor and the transport and logistics providers operating in the corridor. Rarely is corridor management involved in the enforcement of the regulations or even in the enactment of these regulations. Instead it performs an advocacy role discouraging excessive regulation and reforming regulation that leads to inefficiencies. The management can encourage reform by supporting efforts to harmonise procedures across borders, to simplify documentation and procedures, and to enhance transparency.

These corridor functions require different management approaches. The first one involves the public sector, the second the private sector, and the third both. One involves provision of assets in a market with limited competition and partial cost recovery, another provision of services in a competitive market with full cost recovery, while the third deals with enforcement of laws/regulations and tax collection. It is difficult to imagine a management structure that encompasses all three.

More recently, Engström (2011) reports that the Swedish Transport Administration views green corridors projects/initiatives as being divided into three main categories that interact and complement each other. These categories promote the view of logistics/transports as a system of integrated services and properties aiming at increased efficiency and a reduced negative ecologic impact. The three parts are:

- **Corridors (links and nodes):** A corridor project is a geographic subset of a designated main European Green Corridor. It is based on the needs of an efficient transport infrastructure in a physical and/or communicative aspect. A corridor project promotes optimal use of transport modes including transhipment nodes (hubs, cross docks etc). It can be of either a national or international character.
- **Transport technologies:** Projects related to transport technologies encompass features and properties of various types of equipment used in transport operation. The main focus is on the different transport modes, transport/load units and transfer/reloading of goods between different modes. Examples are technologies related to trucks, trailers, railway engines, rail wagons, ships, port handling, containers, packaging, cranes, stackers etc.

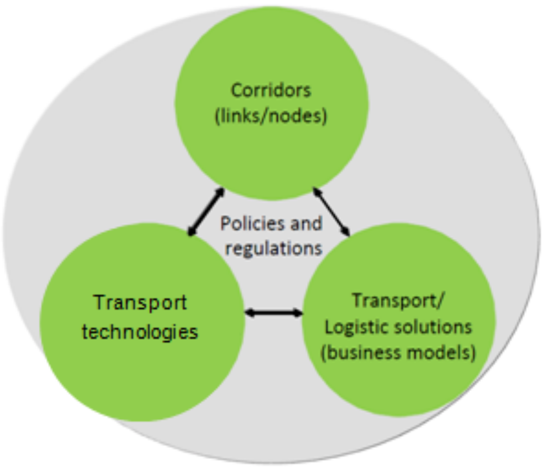


Figure 3. The three pillars of green corridors [Source: Engström (2011)]

- **Transport/logistics solutions:** Refers to complete solutions which integrate different partners and stakeholders mutually forming a business case that promotes efficiency and lowers environmental impact. In general terms, it is a complete freight logistic/ transport setup that meets a shipper's demand often linked to a new business model.

Although not seen as a 'pillar' in the Swedish schematic, the underlying policies and regulations are also recognised as a prerequisite for the implementation of green corridors.

Based on these functions, Arnold (2005) distinguishes between three general models that have been applied in corridor development:

Disjointed incrementalism: Viewed as part of a general development model, this approach is characterised by a project focus. Governments undertake improvements in the corridor infrastructure based on local requirements and problems. This model has been most effective in providing improvements in infrastructure. However, it lacks a formal corridor organisation or other mechanism to identify and prioritise initiatives.

Legislative development: This is characterised by the use of legislation to provide formal recognition of the importance of corridors, designation of specific routes, harmonisation of standards, simplification of cross-border movements and funding for corridor infrastructure. Implementation is left to individual jurisdictions and government agencies. Coordination is undertaken at the regional or ministerial level and is characterised by formal meetings to review progress made by others. Development of services on the corridor is left to private sector competition. Improvements in infrastructure are undertaken by government agencies responsible for transport. This approach is effective in targeting funding infrastructure and reducing formal impediments to movement of goods on these corridors.

Consensus-building: This approach uses a regional institution to mobilise stakeholder support for improvements in the corridor and to push for trade facilitation reforms including improving border-crossing procedures. Its primary function is to provide information to stakeholders, including government agencies, concerning current performance, needs for improvement, and success of previous initiatives. The success of this model depends on the active participation of public and private sector stakeholders in a partnership to address issues related to regulation, investment and quality of service.

Bringing this taxonomy into the current European environment, one could distinguish between two models:

Top-down: It corresponds to Arnold's legislative development model. It has been followed in all corridor development initiatives of the European Commission, such as the RNE corridors, the ERTMS corridors, the rail freight corridors of Regulation No 913/2010 and, more recently, the proposed TEN-T core network corridors. In a smaller scale, the Brenner corridor is a good example of a top-down model application.

Bottom-up: It corresponds to Arnold's consensus-building model. All Scandinavian projects such as the EWTC II, Scandria, TransBaltic, and Bothnian corridors comprise applications of this type of model.

No European equivalent to Arnold's disjointed incrementalism model is necessary, as activities such as priority setting and project identification under this model are more or less left uncoordinated, which is not the normal case of infrastructure development in Europe.

So, which is the best model?

The comparison between these models is in essence meaningless. Their distinction basically relates to the origin of the initiative. In the top-down model the initiative comes from regional organisations, national governments or even local authorities. On the contrary, it is the transport and logistics companies themselves who take the initiative in the bottom-up model.

Nevertheless, as the corridor structures mature, their success will depend on whether they exhibit features like:

- the cooperation between public and private sectors; and
- the active participation of stakeholders.

In this respect, in the long run the two models will have to converge.

If the idea of a green corridor is more popular among private businesses, the bottom-up approach should be followed. The idea is cultivated among all types of stakeholders and once sufficient support is secured, the public sector is engaged. In any event, its involvement is necessary for signing the necessary bilateral or multilateral agreements.

If, on the other hand, the idea is originated in the ministerial offices or among infrastructure managers closely related to national governments, the top-down model seems to be more appropriate. Intensive information campaigns are needed to engage the private sector in the process as early as possible.

For more information on corridor functions and development models refer to:

Arnold John (2005). *Best Practices in Corridor Management*, Trade Logistics Group, The World Bank, Washington, D.C., February 2005,

found at:

http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2008/08/26/000333037_20080826030537/Rendered/PDF/451280WP0Box3310management01PUBLIC1.pdf

5 How do we manage a green corridor?

5.1 Corridor governance structures

Regardless of the functions it serves or the development model it has followed, a corridor needs an organisation engaged in the promotion and coordination of its development and operation. Successful corridors share the following characteristics:

- there has been strong political support for their development, necessary for improving policies and procedures and for addressing harmonisation issues at a regional level;
- there has been strong market support for their development;
- a corridor organisation provides a point of coordination for stakeholder efforts and a forum for identifying major impediments; and
- a corridor organisation provides coordination of the financing schemes.

A first attempt of the European research community to formulate an open Corridor Management System (CMS), linking the actors of an intermodal chain of transport, was done by the BRAVO project and concerned the Brenner Corridor. The project first assessed the "Full integrator model", which gives all parties free access to all components of the CMS. After rejecting this model due to legal and institutional considerations and the existing competition between actors, the project suggested as the most suitable management structure a combination of an "open platform" integrating all actors in a non-discriminating way (e.g. guided "Round table") for the strategic and long-term tasks and a "restricted platform" for operational and commercial tasks.

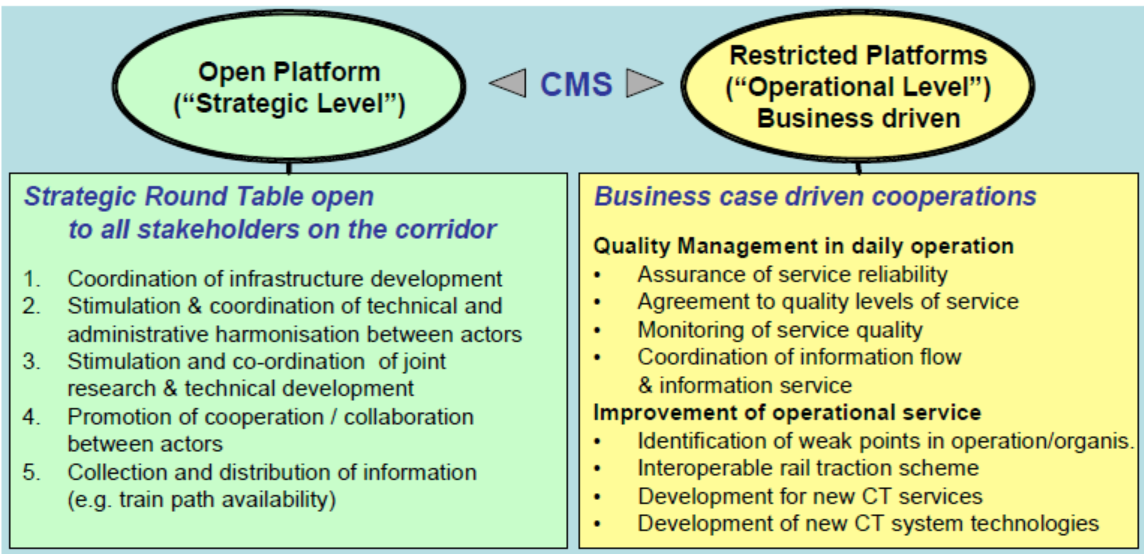


Figure 4. BRAVO Corridor Management Scheme [Source: Mertel et al. (2007)]

For more information on the BRAVO Corridor Management Scheme refer to:

Mertel R. and Sondermann K-U. *Final Report for Publication*. BRAVO project, 6.12.2007 found at:

http://www.transport- research.info/Upload/Documents/201010/20101007_161556_82086_BRAVO%20-%20Final%20Report.pdf

The management organisation of ERTMS Corridor A (Rotterdam-Genoa) is more structured. On 9 January 2003 the transport ministers of Germany, Italy, the Netherlands and Switzerland signed a joint MoU in Lugano aimed at enhancing the quality of cross-border freight transport by rail on the Rotterdam-Genoa corridor. The ministers entrusted the **I**nternational Group for Improving the **Q**uality of Rail Transport in the North-South-**C**orridor or Corridor A (IQ-C) with the task of implementing a package of specific measures that were defined following a prior analysis of the main problems hampering rail freight transport along the North-South-Corridor.

In 2006, the organisation for the deployment of ERTMS/ETCS in the corridor was established. The Infrastructure Managers set up the Management Committee to steer the overall improvement programme integrating all ERTMS and other activities of IQ-C, whereas the Ministries created the Executive Board supervising the ERTMS implementation on the corridor. Since 2008, the IQ-C Working Group of the Ministries of Transport and the ERTMS Executive Board are working together in very close cooperation and coordinate their actions and time schedules. The same year, the Infrastructure Managers of the corridor founded the EEIG "Corridor Rotterdam-Genoa EWIV", which enabled them to act as a legal entity, financially borne by its members and associates.

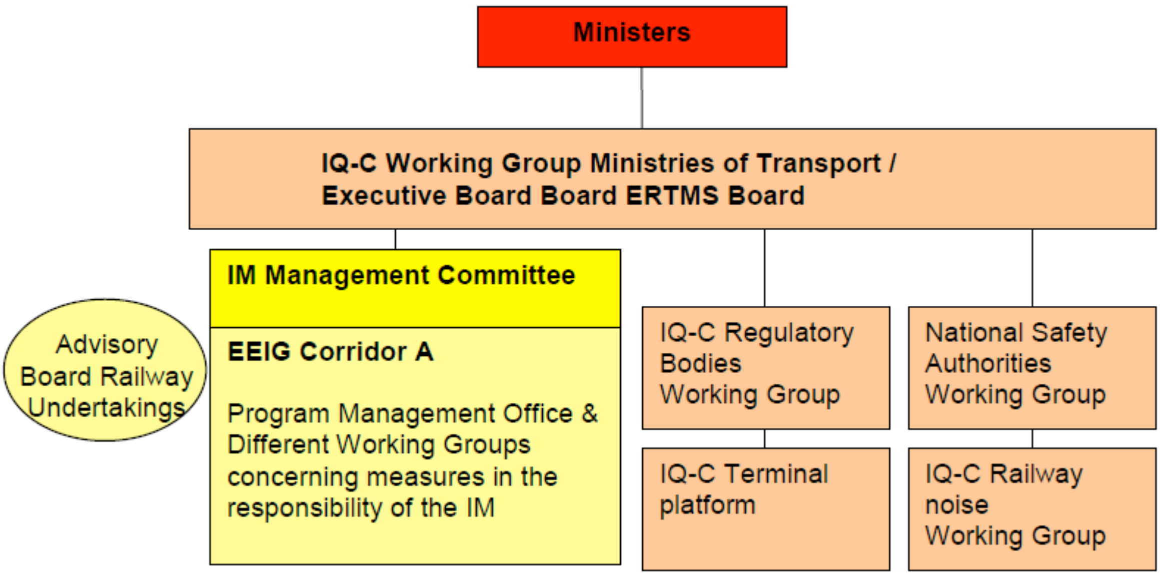


Figure 5. The management structure of Corridor A [Source: Corridor A / IQ-C (2011)]

On the side of Infrastructure Managers, the Program Management Office is implemented and works as one common corridor management board, which develops, steers, monitors and reports all corridor activities as an integrated action. Since 2009, the corridor organisation includes a 'Terminal platform' and a Working Group on Railway noise as additional parts of the organisation [Corridor A / IQ-C (2011)].

For more information on the Corridor A management structure refer to:

Corridor A / IQ-C (2011). *6th Progress Report*. Executive Board ERTMS Corridor A and International Group for Improving the Quality of Rail Transport in the North-South Corridor. August 2011, found at:

http://www.bav.admin.ch/verlagerung/01510/02367/index.html?lang=de

This structure is basically identical to the one stipulated by Regulation EU 913/2010 establishing the Rail Freight Corridors. The Executive Board is composed of representatives of Member States. The Management Board is formed by the Infrastructure Managers and where relevant the Allocation Bodies. It is clearly stated that Railway Undertakings cannot be members of the Management Board, which can be an independent legal entity such as an EEIG. The Management Board has to set up two Advisory Groups, one consisting of managers and owners of the terminals of the freight corridors, the other representing Railway Undertakings using or interested in using the corridor. To simplify communication with applicants and other interested parties, the Regulation provides for the establishment of a corridor one-stop-shop.

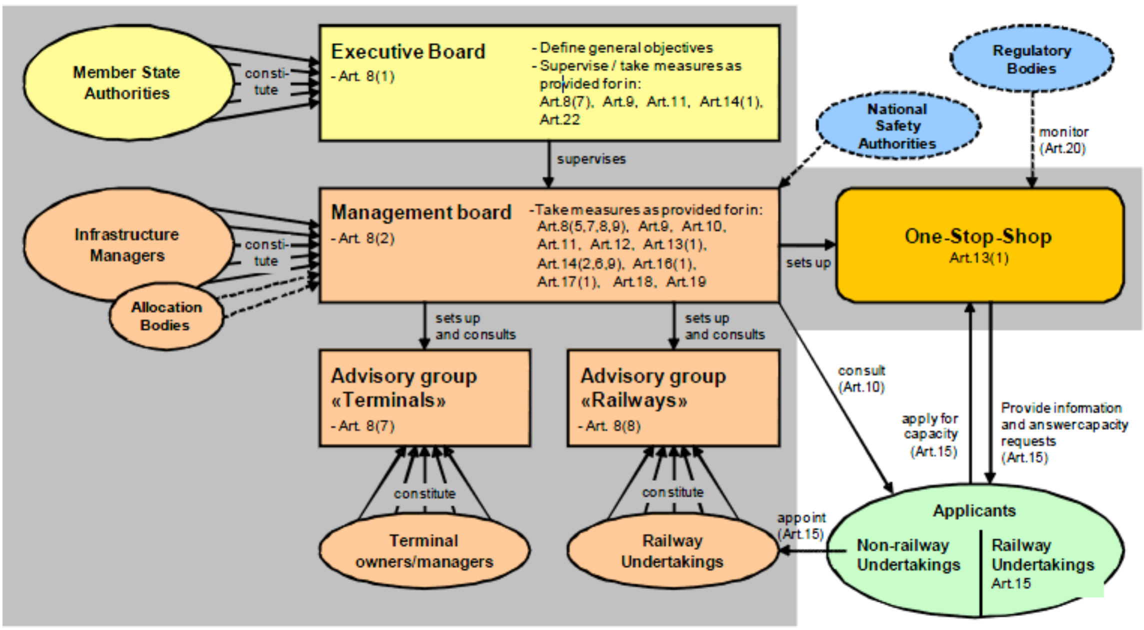


Figure 6. Governance structure of a Rail Freight Corridor [Source: EC (2011e)]

For more information on the governance structure of the Rail Freight Corridors refer to:

Handbook on the Regulation concerning a European rail network for competitive freight (Regulation EC 913/2010). DG MOVE staff working document, 30.6.2011, found at:

http://ec.europa.eu/transport/modes/rail/infrastructures/doc/draft_rfc_handbook_2010_12_07.pdf

In 2011 the Commission published its 'new TEN-T guidelines' introducing the core network corridors. In terms of governance, the proposed new Regulation suggests European Coordinators, acting in the name and on behalf of the Commission, to facilitate the coordinated implementation of the core network corridors. Furthermore, for each core network corridor, the Member States concerned shall establish a corridor platform responsible for defining the general objectives of the corridor and for preparing and supervising the relevant measures. The corridor platform shall be composed of the Member State representatives and other appropriate public and private entities, and will be chaired by the European Coordinator[1].

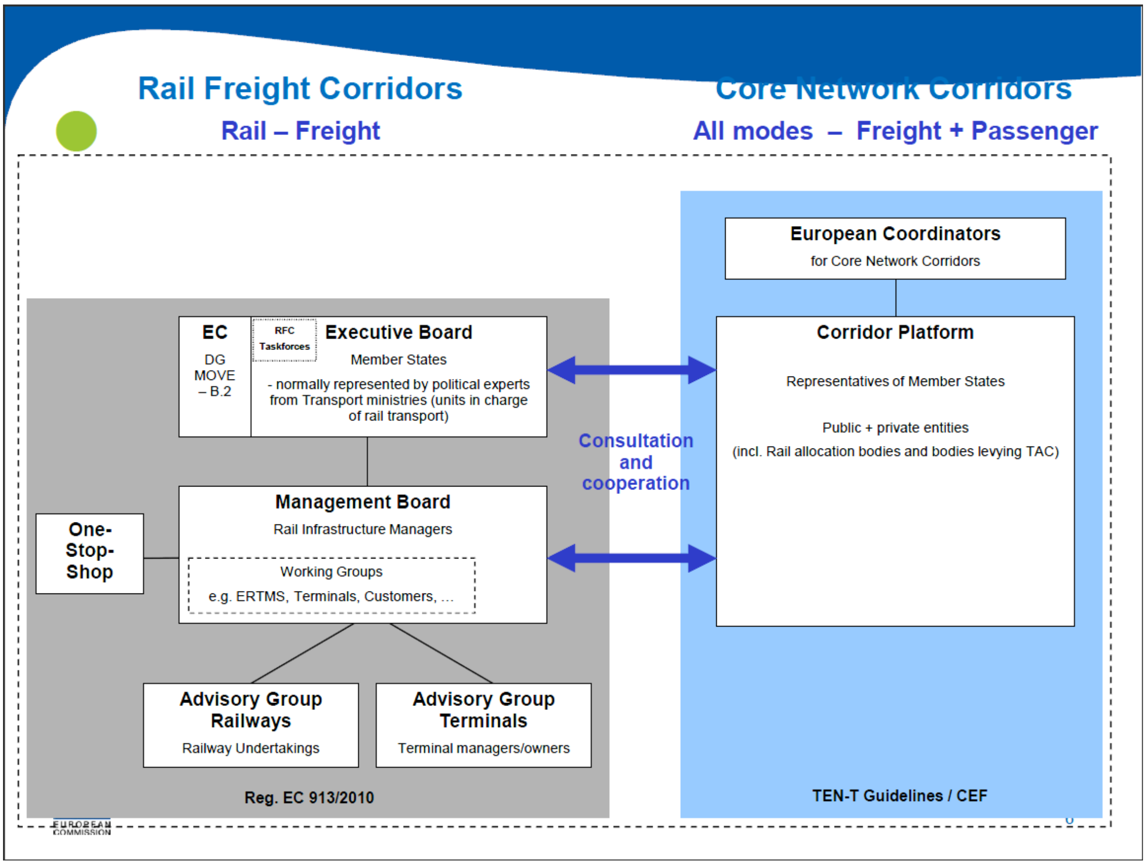


Figure 7. Governance structure of the TEN-T core network corridors [Source: Rousseaux (2012)]

[1] The corridor platform provision has been removed by the General Approach of the European Council of 28 March 2012 [Council (2012)].

As shown in Appendix II, there is a great deal of overlap between the rail freight corridors of Regulation No 913/2010 and those comprising the core network. It is envisaged that, in order to avoid duplication of bodies, the governance structures of the rail freight corridors will be extended somehow to cover the respective core network corridors, too. On the other hand, Section 9 of this handbook provides evidence of the close conceptual relationship between the proposed TEN-T core network corridors (as regards freight) and the green corridors. It follows that the governance structure of green corridors cannot be very different from the one proposed for the core network corridors, which will probably be identical to the managing structure of the rail freight corridors.

For more information on the proposed governance structure of the TEN-T core network corridors refer to:

Proposal for a Regulation of the European Parliament and of the Council on Union guidelines for the development of the trans-European transport network, COM(2011) 650/2, Brussels, 19.10.2011, found at:

http://ec.europa.eu/transport/themes/infrastructure/connecting/doc/revision/legislative-act-ten-t-revision.pdf

5.2 The implementation plan

Arnold (2005) considers two phases in the development of a transport corridor:

Phase 1: Organisation of a coherent set of routes providing services in a competitive manner; and
Phase 2: Gradual improvement in the efficiency of these services.

The initial phase occurs in response to market forces but depends on the public sector for basic infrastructure as well as coherent regulatory structure and procedures to create the conditions for accelerating growth of the traffic. The time to complete this phase depends on the efforts to prepare and implement the regulatory environment. The second phase is a continuing effort following the introduction of a basic framework. The development through both phases is sustained by three complementary actions:

- a long-term plan;
- a series of parallel measures; and
- a programme for monitoring performance.

Regulation No 913/2010 combines all these into a set of documents (refer to Figure 8) collectively called 'Implementation Plan'. Although it was designed for a rail corridor, its features are equally useful for a multimodal corridor which, in most of the cases includes rail lines anyway.

Corridor description: As a first step, it is important to describe in detail the specific routes that comprise the corridor under examination. Each route corresponds to only one mode (routes between the same origin-destination pairs served by different modes are considered different routes). For each route, the following information is needed: beginning and ending points, main links between these points (railway lines, segments of highways, sections of waterways), their associated infrastructures, and designated terminals. The technical characteristics defining the capacity and modus operandi of each piece of infrastructure also need to be specified.

Transport market study: It serves as the basis for the assessment of customer needs and bottlenecks impeding the development of traffic along the corridor. The views of all actors involved (shippers, freight forwarders, logistics service providers, railway undertakings and other transport operators, managers all types of infrastructure, terminal owners etc.) should be reflected. In addition, the study should provide information on the actual volumes and types of goods using each of the selected routes. Based on this information, a set of typical transport chains (unimodal/multimodal combinations of routes/cargoes/ loading units) using the corridor should be selected to be used for performance monitoring in subsequent years[2]. This set will be the equivalent of the basket of goods/services used by the national statistics bureaus to calculate the consumer price index. For the selected chains, the study should provide data on all KPIs to be used for monitoring performance (refer to Section 6), plus the method for combining these indices to come up with corridor level indicators. The study should also provide estimates of the modal split along the corridor.

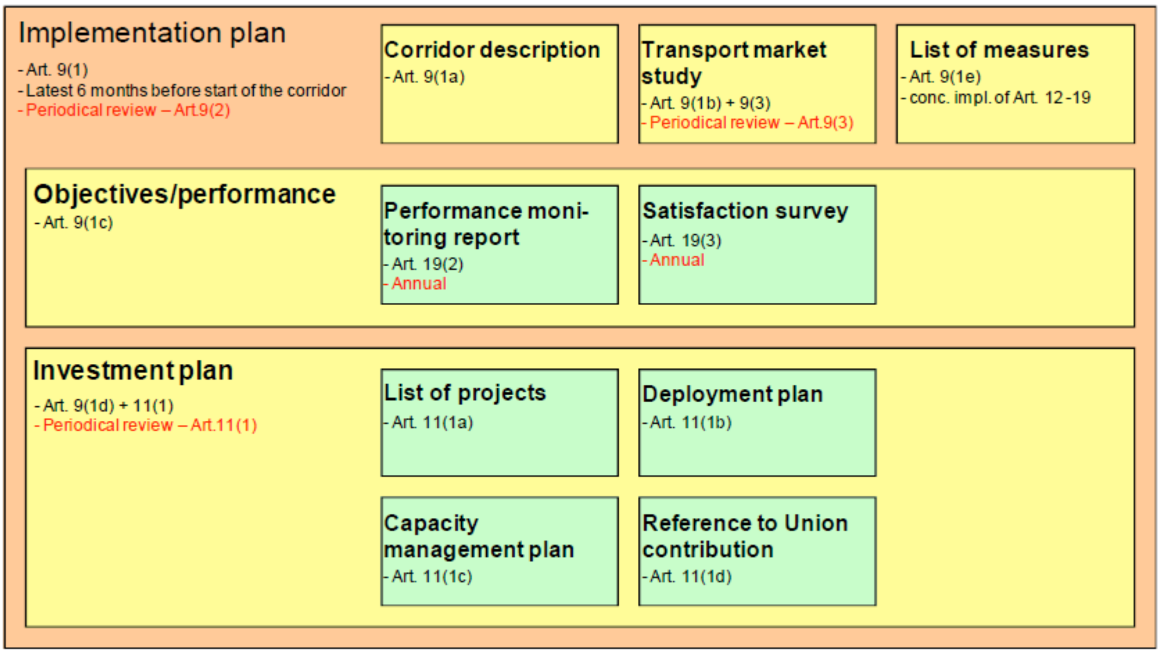


Figure 8. Parts of the Implementation Plan [Source: EC (2011e)]

Objectives: Based on the bottlenecks and the user needs identified in the transport market study, the corridor management will define the objectives of the corridor, and the indicators (KPIs) used for monitoring their achievement.

The remaining documents of the implementation plan (except performance monitoring) can be based on the respective provisions of the handbook on Reg. 913/2010 with the necessary adjustments to cover all transport modes.

[2] In this respect, the methodology presented here diverges from the handbook on Reg. 913/2010.

6 How do we monitor performance?

6.1 The Key Performance Indicators

It is important to understand that the indicators used for monitoring the performance of a green corridor are selected by the corridor management based on the objectives being pursued.

Following a cumbersome methodology that heavily involved stakeholders, SuperGreen has concluded in the following KPIs:

- **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.

Others suggest different indicators. Arnold (2005) proposes the use of cost, time, reliability and flexibility (C/T/R/F). The management of Corridor A (Rotterdam-Genoa) has selected indicators concerning traffic volume, modal split, punctuality and commercial speed. The defined quality objectives of the BRAVO project (Brenner corridor) were punctuality, reliability, flexibility, customer information, employment rate of agreed rolling stock, and reliability of transport documents.

> For more information on the selection of KPIs refer to:
>
> Pålsson et al (2010). *Definition of benchmark indicators and methodology*. SuperGreen project Deliverable D2.2, found at:
>
> http://www.supergreenproject.eu/

Once the indicators have been selected, the corridor performance can be monitored periodically (on an annual basis according to Reg. 913/2010) as follows:

- **Step 1:** Estimate KPI values for each and every chain included in the representative set of typical transport chains determined in the transport market study.
- **Step 2:** Aggregate these values into corridor level KPIs by using weights and methods specified in the transport market study.

6.2 Estimating KPI values

As a general rule, the reported values should be:

Consistent: The methodology employed should be consistent to allow for meaningful comparisons over time. Any changes to data, system boundaries, methods or any other relevant factor in the time series has to be clearly documented.

Transparent: All relevant issues need to be addressed in a factual and coherent manner. The underline assumptions, calculation methodologies and data sources used have to be disclosed.

Accurate: Ensure that uncertainties are reduced as far as practicable. Values reported should be of sufficient accuracy to enable users to make decisions with reasonable assurance as to the integrity of the reported information.

Some KPI-specific considerations are mentioned below:

Transport cost and time

The costs include the out-of-pocket costs plus either the insurance costs or any loss or damage to cargo while en-route. Average costs are reported.

The costs incurred in a transport link are usually described as a combination of a fixed cost (in €/tonne) and a variable cost (in €/tonne-km) that depends on the distance travelled. Arnold (2005) uses the graph of Figure 9 to calculate the total cost for moving a cargo over a distance x_3 comprising of three links.

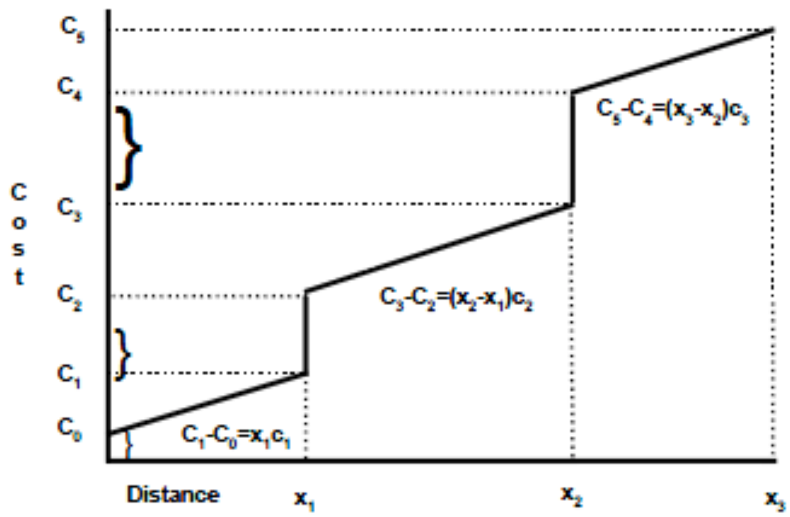


Figure 9. Transit cost for a transport chain

The sloping lines in Figure 9 represent the costs incurred while transiting a link with the slope proportional to the average variable cost, c_j. The vertical lines represent the costs incurred at the node and any fixed costs associated with using the subsequent link. A variety of activities can occur at these nodes, some required and others discretionary. One required activity is the transfer of cargo between transport units where there is a change of mode, physical constraints or regulatory requirements. Another is the inspection of the vehicle and its cargo occurring at the boundaries between jurisdictions. The most common discretionary activities occurring at the nodes are storage, intermediate processing, consolidation/deconsolidation, repackaging and labelling. It is important to exclude these activities when evaluating the performance of a transport chain[3]. The components of these costs can be presented explicitly as shown in Figure 10.

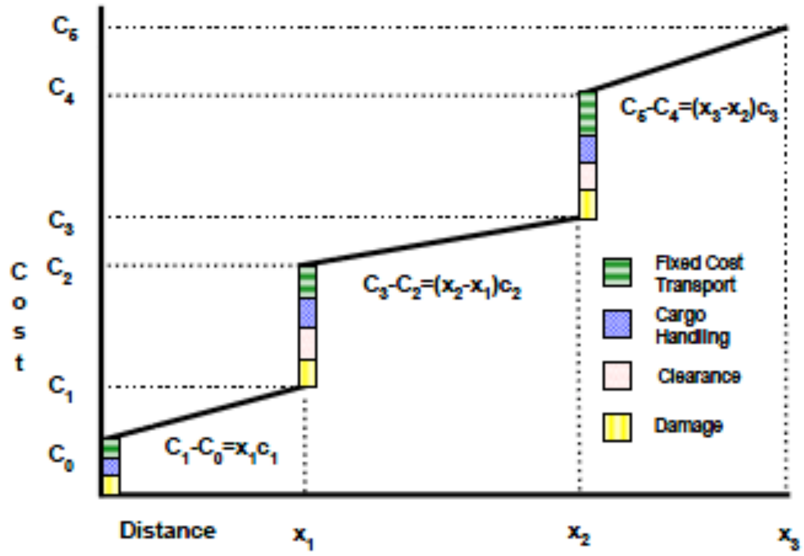


Figure 10. Cost components of a transport chain

For the transport chain of Figure 10, the average cost that needs to be reported is given by C_5/x_3, provided that cost figures along the Y-axis are specified in €/tonne.

Where there are alternative chains including modal combinations for the same origin-destination pair, the costs can be compared as shown in Figure 11. In this example, the first chain (service) is more costly over the entire length of the route. In other situations one service might be more expensive over a certain portion of the route but not over the other in which case the lines might cross.

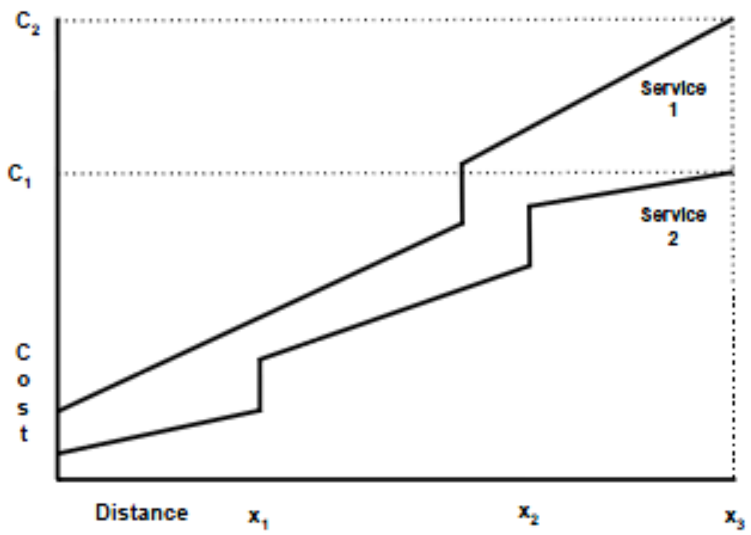


Figure 11. Transit costs for multiple chains (services)

[3] There are situations in which storage and/or consolidation/deconsolidation are complements to a required change of transport unit, in which case they should be included in the evaluation of the chain performance.

Transport time is defined as the time to complete all the essential activities in moving from the beginning to the end of the transport chain including delays associated with the frequency of services and congestion at the nodes. This time can be presented as a function of distance along the chain using a graph of the type shown in Figure 12.

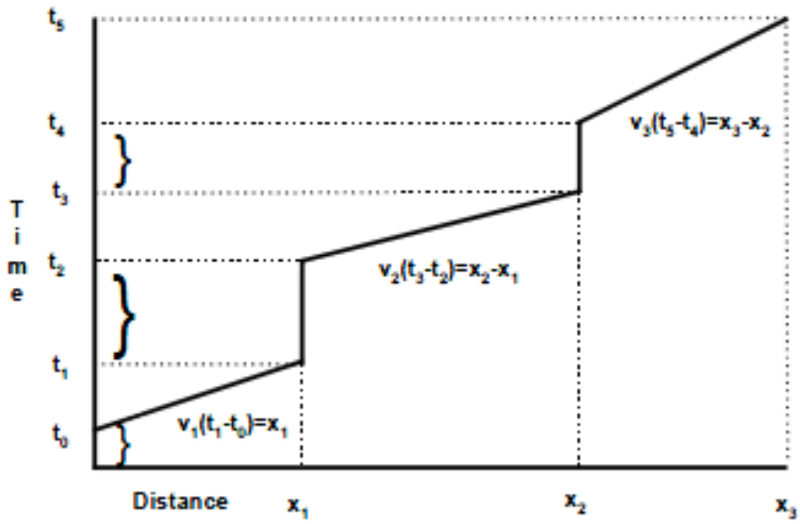


Figure 12. Transport time for a chain

The sloping lines represent the time spent moving along a link with the slopes being inversely proportional to the average link speed, v_j. The vertical segments represent the time spent at the nodes that connect these links. As with costs, the graph can be modified to display only the non-discretionary components shown in Figure 13.

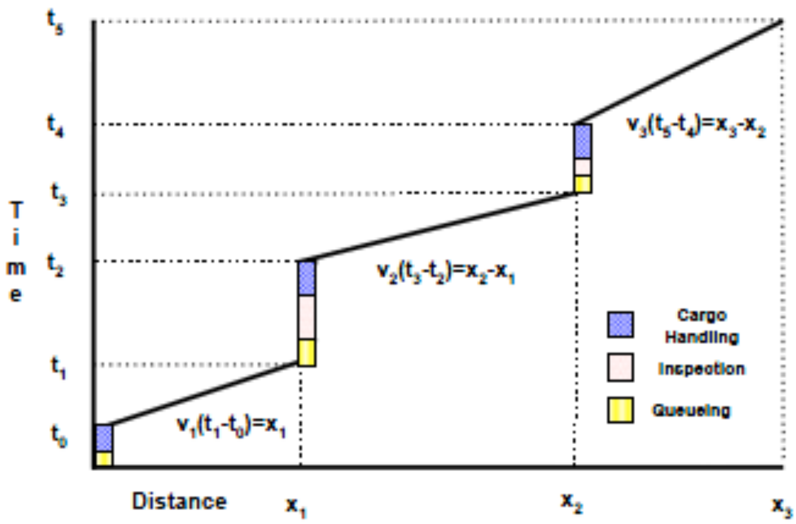


Figure 13. Time components of a transport chain

The performance of the services on a transport chain can be improved by reducing time either on the links or at the nodes. Time on a link can be shortened by improving infrastructure, better traffic management or a change in the regulations affecting use of infrastructure, e.g. limits on type of vehicle, speed and frequency of service. The times at nodes can be reduced by introducing new technologies and equipment, improving management of services, simplifying procedures and providing additional facilities to handle the traffic without significant delays. These improvements can be modelled, as shown in Figure 14 with the dashed lines showing the changes that have occurred. The reduction in slope indicates where average travel speed on a link has increased, $x[1/t'_1 - 1/t_1]$ whereas the shortening of the vertical lines indicates where time at the nodes has been reduced, $(t_4 - t'_4) - (t_1 - t'_1)$.

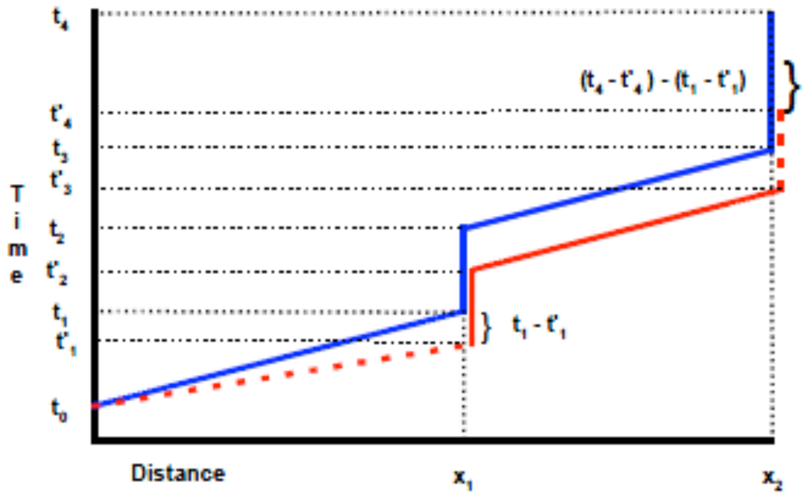


Figure 14. Modelling improvements in service

The impact of improvements in both time and cost can be modelled by combining the time and cost relationships using the graph shown in Figure 15. In this example, it is assumed that the improvements at node x_1 increased the costs by 25% and that the increase in average speed in the last link increased the transport cost for that link by 50%. The effect of these improvements is to shift the cost and time from c_5, t_6 to c_6, t_5 respectively. This improvement is attractive for shipments where the value of time is greater than $(c_6-c_5)/(t_6-t_5)$.

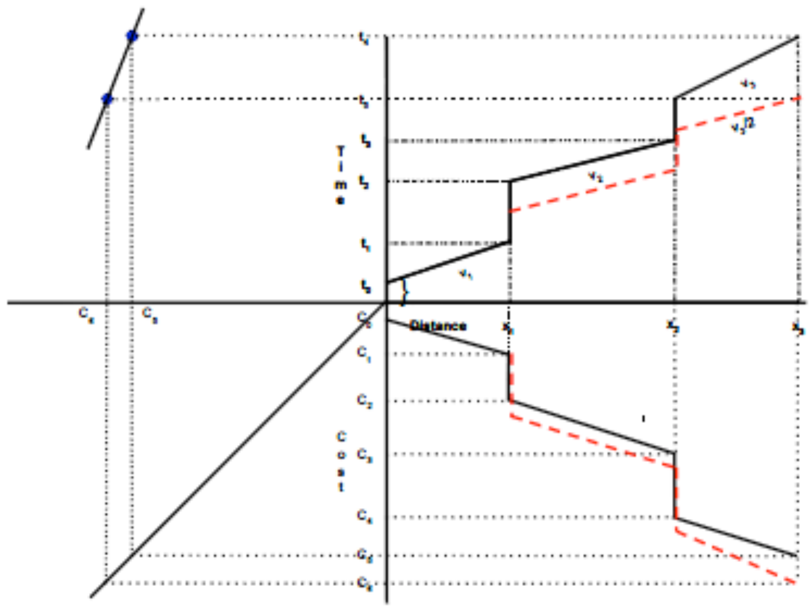


Figure 15. Relationship between changes in time and cost

For more information on calculating transport cost and time indicators refer to:

Arnold John (2005). *Best Practices in Corridor Management*, Trade Logistics Group, The World Bank, Washington, D.C., February 2005,

found at:

http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2008/08/26/000333037_20080826030537/Rendered/PDF/451280WP0Box3310management01PUBLIC1.pdf

Reliability and frequency of service

Because of increasing attention to the timeliness of shipments and the importance of order fulfilment as a component of competitive advantage, it is necessary to consider not only the average time and cost for movement through a corridor but also the reliability in meeting delivery times. For the purposes of this discussion, reliability is measured in percentage of consignments delivered within an acceptable time window that has been defined by the corridor management a priori.

Delays are due to a combination of controllable factors, such as condition and availability of equipment, coordination of sequential activities, and labour productivity and uncontrollable market and environmental factors such as fluctuations in demand, level of background traffic and weather conditions. Although not required for calculating the KPI, knowing the reasons for the delays is vital for their mitigation.

As with reliability, the frequency of the various services in a transport chain results directly from surveys among the relevant service providers.

CO_2 and SOx emissions

When it comes to emissions, the definition of system boundaries is crucial in fulfilling all three criteria mentioned above (consistency, transparency and accuracy). Swahn (2010) defines four system boundaries (refer to Figure 16):

- **System boundary A** includes traffic and transport related activities regarding engine operation for the propulsion and equipment for climate control of goods, as well as losses in fuel tanks and batteries. This includes the traffic-related terminal handling, i.e. when goods do not leave their vehicle/vessel.
- **System boundary B** includes in addition the supply of energy from energy source to the tank, battery and electric motor (trains). This is the minimum required system boundary for performance of comparisons between different modes of transport.
- **System boundary C** includes in addition to the above traffic infrastructure operation and maintenance.
- **System boundary D** includes in addition to the above vehicle, vessel, load units production and scrapping (life cycle approach).

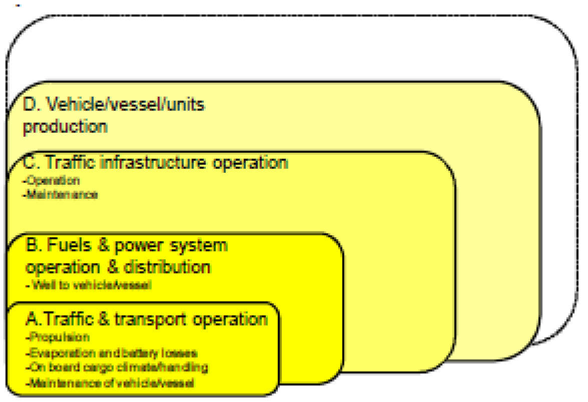


Figure 16. Definition of system boundaries [Source: Swahn (2010)]

In LCA for transport, a well-to-wheel approach is used. The total carbon footprint is considered; from the feedstock or fuel production to the vehicle operation.

Although the introduction of the Life Cycle Assessment (LCA) methodology in decision making happens to be one of the policy recommendations that resulted from the SuperGreen project, it is essential to keep things as simple as possible in the early stages of a green corridor development. It is for this reason that the system boundary B is recommended to begin with. Later on, the boundary can be expanded to reach level D.

Another comment relates to the type of carbon emissions measured. In discussions of emissions, lots of terms are used – carbon emissions, carbon dioxide, greenhouse gases (GHG). In fact, climate change is caused by a range of gases, known collectively as 'greenhouse gases'. Of these, the most common is carbon dioxide (CO_2), which is why it's the most talked about. However, other greenhouse gases are emitted from vehicle exhausts (i.e. nitrogen dioxide and methane), and their reporting is also valuable. The choice between CO_2 and CO_2-eq (where the 'eq' stands for 'equivalent' simply meaning a unit for all GHGs expressed as if they had the same climate change effects as CO_2) depends on the availability of data and/or the capabilities of the emissions calculator used.

In general, a specialised emission calculator is needed for estimating the emission KPIs. In SuperGreen we have used the web-based tool EcoTransIT World but, as long as certified footprint calculators are not available, any other model could be used in its position, provided that a relevant qualification escorts the results. User specified inputs are preferred to the model's default values, only when they are adequately verified and there is consistency across all chains examined. Otherwise, it is safer to use the default values of the model.

For more information on EcoTransIT World visit:

http://www.ecotransit.org/

It is important to note that in a multi-load multi-drop vehicle trip the allocation of emissions to specific loads becomes quickly almost unworkably complex, requiring far more data than is likely to be available. A simplification is suggested by DEFRA (UK) according to which, emissions are allocated on the basis of the number of EDUs (Equivalent Delivery Units) transported for each customer. Generally speaking, the choice of EDU should reflect the limiting factor on the loading of the vehicle. If the load is typically limited by volume, then a volume-based EDU such as pallets or cube should be used. If the load is more often limited by weight, then a weight-based EDU such as tonnes will be more appropriate and provide more accurate results.

For more information on emission allocation refer to:

DEFRA (UK). Guidance on measuring and reporting Greenhouse Gas (GHG) emissions from freight transport operations, found at

http://archive.defra.gov.uk/environment/business/reporting/pdf/ghg-freight-guide.pdf

Finally, it is noted that graphs such as those for cost and time (Figures 9 and 12) can be used for combining emissions generated while transiting a link with those produced at a node.

6.3 Aggregating KPI values

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. These weights should be relatively fixed to permit historical comparisons. However, periodical adjustments are needed to account for changes in the composition of cargoes and transport chains using the corridor.

It is noted that normally the weights for aggregating unit costs, CO_2 and SOx emissions should be in tonne-km units. Transport time can only be aggregated if expressed as average speed, unless all chains examined concern a single origin-destination pair. The volume of cargo is probably the most suitable weight for aggregating transport time (or speed) and reliability. As for frequencies, one needs to be careful to avoid adding pears with apples. As a general rule of thumb, in serial services it is the least frequent one that determines the frequency of the chain.

The method described above permits monitoring of the performance of a single corridor over time. It is not suitable for comparisons between corridors, as it does not consider differences in corridor characteristics that can be decisive in the overall performance of a corridor.

This statement does not include the parameters determined by the handbook on Reg. 913/2010 concerning railway transport, as they have been aligned with the reports on train performance management of RNE in order to ensure a consistent quality of performance monitoring reports.

As a final note, one can mention that in case cost figures cannot be produced by the transport market study for whatever reasons, the cost indicator can be replaced by the volume of cargo moved along the corridor. In such case, cargo volume serves as a proxy for describing the efficiency of the corridor.

6.4 Data verification

Before closing the performance monitoring section, it is necessary to alert the reader on the data verification issue. Verification is an independent assessment of the accuracy and completeness of data. Confidence on the quality and integrity of the data supports internal operations and decision making, by revealing existing problems or points for potential improvement. It can, thus, lead to improved performance, reliability and quality of operations. Another common reason for verifying data is to increase external stakeholder confidence. For example it may reassure a transport operator that they can include the green corridor data in what they report about their services, by demonstrating:

- credibility and reliability of the corridor data;
- consistency and accuracy of performance monitoring approach; and
- completeness of assessment.

Furthermore, verification can provide confidence that the data reported is fit for the purpose for which it is intended, for example, target setting or service benchmarking.

In general, it is not always necessary to get an external party to verify the reported data if reasonable and transparent processes are established. However, in the case of monitoring a complex system such as a transport corridor, the engagement of an external verifier seems unavoidable. In such cases it is particularly important to be sure that the reported information is genuine and based on a consistent and accurate approach to measurement over time.

It is, thus, suggested the verification to be undertaken by a third party accredited by an internationally recognised body. Especially for GHG emission reporting, there are a number of internationally recognised standards and protocols that can be applied, like:

- ISO14064 – Greenhouse gas accounting
- ISO14065 – Requirements for greenhouse gas validation and verification bodies for use in accreditation or other forms of recognition.

7 How can technology help?

It was concluded in Section 2 that advanced technology in the form of:

- alternative clean fuels,
- energy efficiency improvements, and
- smart telematic applications

is a prerequisite for greening a freight corridor. An important activity of the SuperGreen project concerned the selection of technologies[4] suitable for improving the performance of logistics chains with regard to energy efficiency, emissions reduction, quality of service and reliability. More than 200 candidate green technologies were identified, analysed and classified on the basis of their sustainability potential. Among them, about 60 have been selected as relevant for the SuperGreen purposes. Only a handful of them will be briefly presented here on a purely indicative basis.

7.1 Use of alternative clean fuels

The transport sector is heavily dependent on oil. Alternative long-term options for substituting oil as energy source for propulsion in transport are electricity, hydrogen, and liquid biofuels, supplemented by natural gas and LPG.

Natural gas is a cleaner alternative to diesel fuel oil, offering environmental (lower emissions) and financial (lower price and taxation) benefits. As a fuel, it is compressed (CNG) or liquefied (LNG) and it is characterised by high methane concentration and close to zero sulphur and PM content.

LNG for shipping is a proven and safe technology and an alternative to after-treatment systems for reduced SOx, NOx and PM emissions. LNG is currently (July 2012) used by 34 vessels and the new-building order book consists of approximately the same number of ships. The interest on LNG is expected to increase in the future due to the environmental regulations on sulphur and carbon emissions, as well as the associated lower fuel consumption.

The estimated CO_2 emissions reduction compared to diesel oil is 20-25%. Using LNG as a marine fuel, NOx emissions are reduced by 90%, and SOx and PM emissions are eliminated.

The main engine specific fuel consumption is lower for the LNG case (including the pilot fuel) compared to marine diesel oil (3.5% at maximum continuous rating, MCR). Large vessels can benefit more from LNG compared to small ones, due to economies of scale in the installation. In addition, LNG-fuelled engines are less noisy than their Heavy Fuel Oil (HFO) counterparts.

On the negative side, the cryogenic LNG fuel tanks required may result in a reduction in cargo capacity; however this depends on the type of vessel and the system design.

---

[4] For the purpose of this handbook, the term ‘green technologies’ includes ICT applications. In SuperGreen, ICTs were examined by a different work package.

The price of LNG varies from country to country. Based on the fuel price projections of EIA and IHS up to 2030, it is estimated that, for a typical ship and a lifecycle perspective, LNG is expected to be a better option than HFO with scrubber, whereas marine gas oil is expected to be the most expensive alternative[5]. However, these estimations could change, as there is high uncertainty about the future fuel prices and the LNG prices could continue to develop in a different way at different regions of the globe, depending on the local market trends, politics and the future global economy growth.

The **Viking Lady** is an offshore supply commercial vessel that has a dual fuel LNG/diesel engine and fuel cell technology used for propulsion. It has been claimed to be the most environmentally friendly vessel ever built[6]. She has a gross tonnage of 6,100t and deadweight of 5,900t. The vessel's power requirements are covered by LNG and a molten carbonate fuel cell (which generates 320kW of power). In total, the fuel consumption and the carbon dioxide emissions are reduced by 20 to 30%. The sulphur oxide emissions are reduced by 100% and the nitrogen oxide ones by 85%. The technology used in the vessel is an outcome of the FellowSHIP project, a joint R&D project by DNV, Eidesvik and Wärtsilä initiated in 2003.

Figure 17. The 'Viking Lady' offshore supply vessel

For more information on the use of LNG as a marine fuel refer to the sites of DNV and Germanischer Lloyd at:

htttp://www.dnv.com
http://www.gl-group.com/en/lng.php

[5] http://blogs.dnv.com/lng/

[6] http://www.ship-technology.com/projects/viking-lady/

For more information on the 'Viking Lady' offshore supply vessel refer to the site of Ship-technology.com at:

http://www.ship-technology.com/projects/viking-lady/

7.2 Energy efficiency improvements

Energy savings is one of the most cost effective ways to reduce emissions of GHG and other pollutants, and to enhance security of energy supply. Transport – which accounts for 32% of final energy consumption of the EU – is a key area for energy savings. Although deepening modal integration and improving load factors would reduce energy, there is still ample room for efficiency improvements within each transport mode.

Aerodynamic drag improvements of a truck can lead to substantial reductions in energy consumption and emissions. There are many technical features that are either available or under development to reduce the drag coefficient of a heavy-duty truck. They include: reduced tractor to trailer gap, trailer side skirts and undercarriage skirts, a boat tail, integrated tractor roof fairings, aerodynamic mirrors, replacement of mirrors with cameras, fuel tank fairings, bumper fairings, wheel fairings, and hidden vertical exhaust stacks.

Initiated by the US EPA in 2004, the **SmartWay Transport Partnership** brings together fleets, technology providers, and retailers to implement fuel savings and GHG reducing strategies. The programme aims to reduce fuel consumption by 150 million barrels of oil per year and 33 to 66 million tons of CO_2 as well as conventional pollutants. The programme has focused on identifying and promoting products and practices that reduce conventional and climate change emissions. It has certified vehicles and equipment such as tractors, trailers, idle reduction, and aerodynamic retrofit kits that meet SmartWay goals.

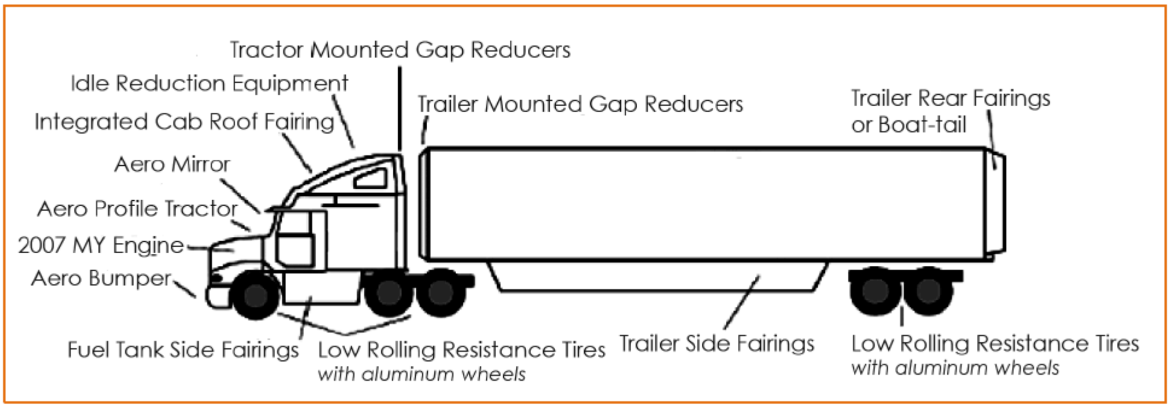


Figure 18. SmartWay^{TM} equipment standards [NESCCAF (2009)]

NESCCAF (2009) results show that the reduction in drag coefficient from 0.6298 to 0.5 provides an 8% fuel and CO_2 savings[7], while the reduction in rolling resistance coefficient

[7] Truck streamlining includes fully aerodynamic mirrors, cab side extenders, integrated sleeper cab roof fairings, aerodynamic bumper, and full fuel tank fairings. Trailer streamlining includes a side skirt fairing, and either a trailer gap fairing or a rear-mounted trailer fairing such as a boat tail.

from 0.0068 to 0.0055 provides an additional 6% saving[8]. The combined benefit is a 14% fuel savings and CO_2 reduction. This estimate is based on the best currently available aerodynamic and rolling resistance technologies. Furthermore, it has been estimated that the introduction of more advanced technologies in this area may add an extra 10-11% energy saving potential.

The **hybrid diesel-electric motor** for trucks is another recent development in the area of improving energy efficiency. It combines the conventional diesel engine with an electrical motor for auxiliary power generation, resulting in fuel economy and reduction of CO_2 emissions. The hybrid system includes lithium-ion batteries, which are recharged through regenerative braking. During braking, the vehicle's kinetic energy is captured and regenerated to charge the hybrid batteries rather than being absorbed by the foundation brakes and lost as heat.

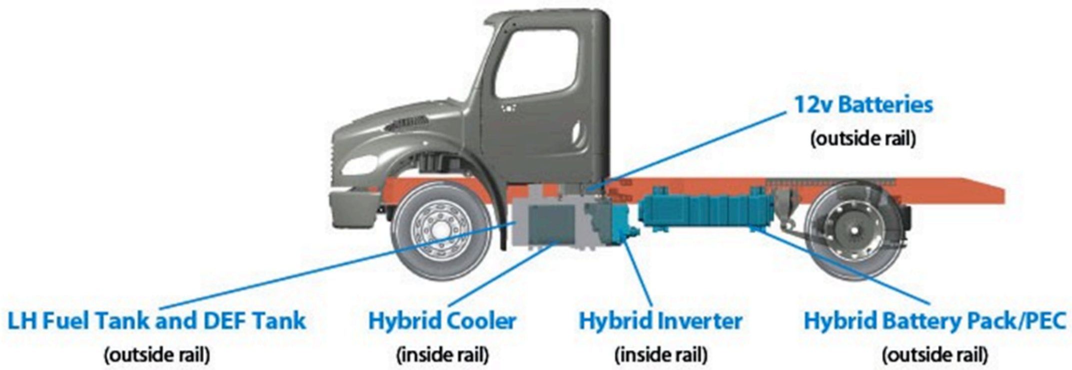


Figure 19. The hybrid diesel-electric truck

Another, usually optional, feature is the Electronic Power Take Off (EPTO) capability. When the service brake is applied, at a stop light for example, the engine turns off. When the service brake is released, the engine restarts. This feature provides up to 8% additional fuel savings.

Despite higher estimates for other uses, when it comes to long haul applications, the hybrid diesel-electric truck is expected to produce fuel savings in the area of 5.5-6.0% [NESCCAF (2009)]. In addition to the improvement in fuel economy during the long-haul drive cycle, a hybrid can be used to handle hotel loads such as heating, cooling, and electricity when the vehicle is stationary. Instead of idling all night, the engine can be run for a few minutes each hour to charge the battery pack. This hotel load reduction nearly doubles the fuel consumption benefit of hybridising a tractor-trailer, increasing its fuel consumption benefit to 10%.

For more information on energy efficiency improvement measures on trucks refer to:

NESCCAF. *Reducing heavy-duty long haul combination truck fuel consumption and CO2 emissions*. October, 2009.

[8] Rolling resistance reduction is achieved through wide base single tires and aluminum wheels.

For more information on hybrid diesel-electric trucks visit:

http://www.freightlinertrucks.com/Trucks/Alternative-Power-Trucks/Hybrid-Electric

The **regenerative braking** mentioned for trucks **is also used in train transport**. It is a mature and relatively standard technology in new trains. A conventional electric train braking system uses dynamic braking, in which the train kinetic energy is dissipated as waste, like heat. With the use of regenerative braking, the current in the electric motors is reversed, slowing down the train, while the motors generate electricity and return it to the power distribution system. This electricity can be used to power other trains, or to offset power demands of other loads, like lighting. Friction brakes are still needed as backup in the case that the regenerative brakes fail. However, the power recovered via regenerative braking can only be used simultaneously. In order to recover this energy at a different phase in time, an energy storage system is required. Super-capacitors, batteries, and/or flywheels can serve as energy storage systems. In addition to energy saving, regenerative braking lowers the wear of mechanical brakes and, as a consequence the down-time of the train.

The method's final effect on CO_2 emissions depends on how the trains are employed, and on the generation mix of the electricity used. It can lead to substantial CO_2 emission reductions, especially when applied to full stop service commuter trains (8–17%) and to very dense suburban network trains (~30%). Regenerative braking applied to freight trains can also lead to CO_2 emission reductions, albeit considerably lower than for full stop service trains (~5%). This is due to the high average weight of freight trains and the fact that only the locomotive axles are powered. The main share of braking is done by the mechanical brakes located on the freight cars, and only a small share originates from the locomotive itself [UIC (2002)].

For more information on regenerative braking in railway transport visit:

http://climatetechwiki.org/technology/regenerative_braking_in_trains

7.3 Integrated ICT solutions for infrastructure, vehicles and equipment

ICT systems play a catalyst role in the development and evolution of transport operations, as they identify and alleviate bottlenecks and release latent demand and supply for transport services exploiting in full the capacity of infrastructure, vehicles and equipment.

In this respect, they improve the efficiency of using the transport infrastructure and equipment, reduce transport costs, improve the quality of transport services, and enhance the environmental sustainability of the sector through improved traffic management, reduced congestion and emissions, optimisation of operations, lower externalities etc.

These positive effects are maximised when ICTs feature the following characteristics:

- **Compatibility:** The systems should be compatible with existing ICT applications in the transport chain.
- **Integration:** The systems should be integrated providing the ability of a smooth information flow along the transport chain.

- **Intelligence:** The systems should incorporate algorithms to increase efficiency and reduce cost (expert systems – decision support systems). Raw information is always useful but it is processing and manipulation that add value to the system.

- **Adaptability:** The systems should acquire a dynamic character in order to expand their range of application.

In rail transport, interoperability is sought through the **European Railways Traffic Management System** (ERTMS). Today, ERTMS encompasses two main components:

- GSM-R, the radio system used for exchanging voice and data information between the track and the train;

- ETCS, the European Train Control System, harmonising the speed control systems. It is made up of an on-board and a trackside module.

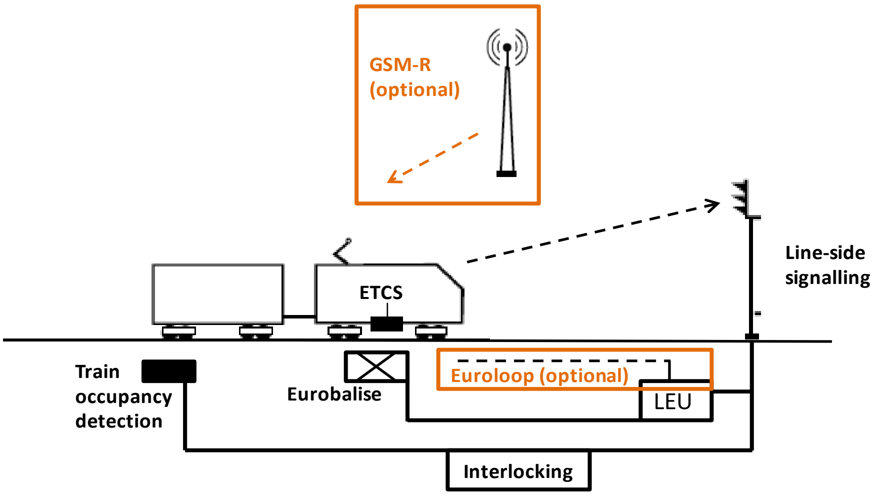


Figure 20. GSM-R and ETCS

Signalling systems bring about considerable economic advantages because they allow more trains to operate safely on a given section of track than would otherwise be possible with other methods of safe working. ERTMS will replace the many incompatible systems that exist on the European network by a single system which is more modern, more sophisticated, safer and compatible at EU level.

According to the SuperGreen results, ERTMS can:

- reduce transport time up to a maximum of 70%;

- reduce headways between trains up to 110 seconds;

- increase density of traffic (trains per hour) by 12%;

- increase reliability to over 98%;

- decrease freight insurance fees by up to 90%;

- enable up to 40% more capacity on currently existing infrastructure; and
- enhance transportation modal shift towards rail.

Another successful application is the **on-board telematic units** that have been introduced in road vehicles during the last decade to control, report, command or record events. These ICTs are cellular- and satellite-based solutions providing information on the location and condition of the vehicle, the driver and the cargo (e.g. actual driven miles, fuel consumption, actual route information, load, revolving-driver behaviour, ignition, speed, green driving, idling fees and emissions fees).

Figure 21. The Schenker Smartbox tracking log

It has been estimated that on-board telematic systems can:

- reduce costs, e.g. insurance fees by 30% to 70%;
- reduce the number of trailers required by 10%;
- increase trailer fleet utilization by 15%;
- improve bottom line performance of large transport companies by an estimated average €500,000 per year;
- enhance security and cargo integrity;
- improve preventative maintenance;
- improve driver retention; and
- reduce indirect environmental costs.

For more information on green technologies and smart ICT applications refer to SuperGreen deliverables:

D3.3 – Version 2 (2013) - Benchmarking Green Corridors with Green Technologies

D4.4 – Version 2 (2013) - Benchmarking Green Corridors with smart ICT

found at:

http://www.supergreenproject.eu/ (upon approval by the Commission)

8 Do we need a new approach in doing business?

Another characteristic of a green corridor is the availability of integrated logistics solutions through innovative business models.

In a highly competitive environment, companies for years have tried to strengthen their market position through vertical and horizontal integration. Vertical integration offers advantages to shippers who want to contract for door-to-door services rather than a sequential series of services. Horizontal integration offers economies of scale in the marketing and information services necessary to achieve efficient utilisation of transport equipment.

However, the development of sustainable integrated logistics solutions appears to suffer from persistent coordination problems mainly due to unequal distribution of costs and benefits, free rider behaviours, risk-averse behaviours, lack of resources and other strategic considerations.

Today, the creation of alliances and collective actions even among competing firms in the framework of innovative business models supported by advanced ICT applications appear quite promising.

Synchromodality is an excellent example of integrated logistics in practice. From a shipper's perspective, synchromodal transport means that a shipper agrees with a Logistics Service Provider (LSP) on the delivery of products at specified costs, quality, and sustainability but gives the LSP the freedom to decide on how to deliver according to these specifications. This freedom gives the LSP the possibility to deploy different modes of transportation flexibly. The decision to switch among different modes of transportation may depend on actual circumstances such as traffic information, instant availability of assets or infrastructure and all other factors that have a bearing in performing a transport contract. Actual transport of goods can thus easily be shifted among different modes, enhancing the efficiency of transport operations.

Synchromodal transport enables shippers to operate more sustainably, at lower costs and at higher quality. It requires, however, several changes in the usual business practices. A well defined network of hinterland connections is an important prerequisite. Advanced information systems, infrastructures, smart coordination mechanisms, enabling policies, and legal possibilities permitting flexible use of different modes are necessary to deliver maximum value to the shipper and/or the end customer.

For more information on synchromodality visit:

http://www.dinalog.nl/en/themes/synchromodal_transport/

Circle Lines is a related business model developed, tested and implemented by the Port of Amsterdam during the period 2008-2012. It was financed by the Dutch Ministry of Economic Affairs, 3 provinces and 7 municipalities.

Circle Lines is a new logistics business model aiming at enhancing the sustainability of container transportation between seaports and their hinterlands. It is an innovative approach whereby all parties involved in the logistics chain run a door-to-door transportation chain together.

The model builds upon proven good operational practices that recently have been developed and successfully put in practice by large players in the European ports and logistics sector for parts or the entirety of a transport chain. All companies involved have made sure that hinterland locations are seamlessly connected to the maritime logistics and container terminal operations.

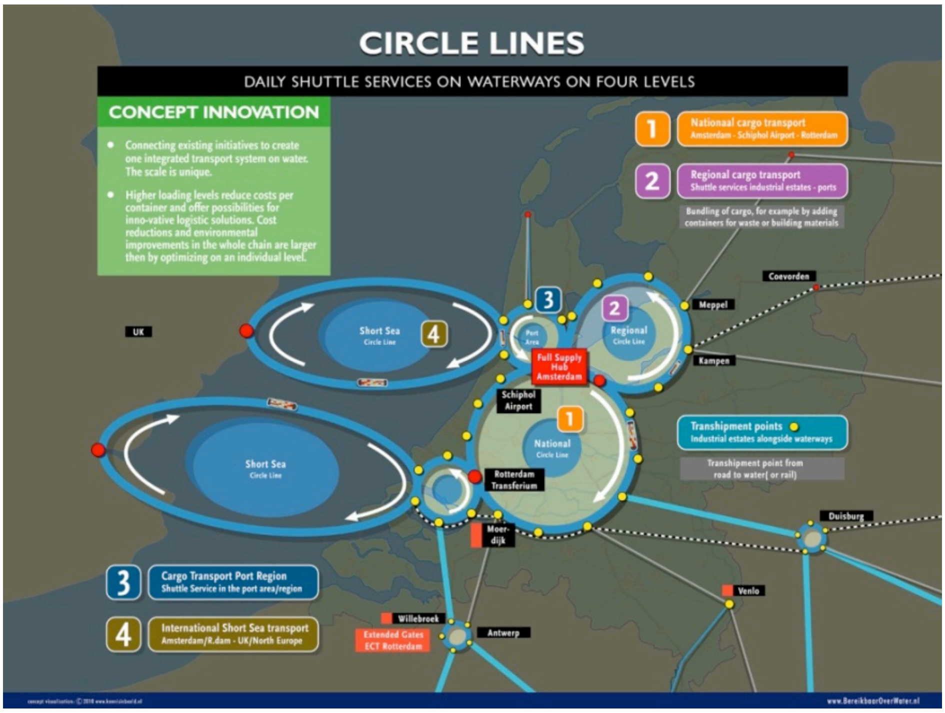


Figure 22. Schematic of the Circle Lines business model
[Source: Journée (2012)]

Within a chain, each Circle Line is a cooperation of companies performing a specific task. The new system is all about 'circle-shaped' shuttle services (Circle Lines) between transhipment locations where cargo is collected, bundled and transferred. The (daily) shuttle services between these transhipment locations are maintained using inland navigation and/or train and/or coastal navigation. For door-to-door transportation between transhipment locations and end users, trucks are used in most cases. The result is a transport cooperation whereby trucks, ships and trains make one "intercity service" offering set timetables, fixed transportation rates and guaranteed deliveries. Bundling cargo improves loading factors and reduces transport costs and environmental impacts considerably. Costs are further reduced by digitising all transport documents. This is important for cases where administration costs comprise a large percentage of total costs (can be almost 50%). It also reduces failures (e.g. containers delivered to the wrong address) and the related repair costs, which can be as high as 30% of total operating costs for some logistics companies.

The model requires advanced information systems. The recently combined port community systems of the ports of Amsterdam and Rotterdam (Portbase) are connected to five large Rhine container and inland terminal companies through a newly developed hinterland IT support system. A fully digital planning tool was, thus, created covering the entire logistic chain: the seaside, the port community and the hinterland part. Furthermore, a number of awareness creation and management tools have been developed to support the new business model.

It has to be mentioned that the involvement of a shipper with a large cargo stream is important for the initiation of the system. Mutual trust is another element for success.

Currently, a number of daily services function in a Circle Lines setup. The attraction of new cargoes, such as waste in containers, contributes in achieving high loading factors.

The pilot results of the Circle Lines model are impressive: up to 50% cost reductions, 20-80% CO_2 emission reduction, compared to truck only operations, and 98% reliability in terms of timely deliveries, compared to 70% for road transport (due to congestion problems).

9 How do green corridors relate with the TEN-T?

In October 2011, the Commission proposed a legislative package to define a new policy framework for the trans-European transport network (TEN-T). The package includes a proposal for Regulations on new Union Guidelines for the development of the TEN-T (time horizon: 2050) and for establishing the Connecting Europe Facility (CEF), which will govern EU funding until 2020.

The TEN-T Guidelines [EC (2011d)] as the first component of the package establish the policy basis by defining network plans including infrastructure standards, objectives and priorities for action. A dual layer network structure has been introduced, consisting of a comprehensive and a core network. The comprehensive network constitutes the basic layer of the TEN-T and is, in large part, derived from the corresponding national networks. The core network, on the other hand, overlays the comprehensive network and contains its strategically most important parts. The core network is the result of a genuine European network planning methodology that combines geographical and economic criteria. It builds on the key nodes of political, economic, cultural and transport-related importance and links them through all available transport modes.

The functions of the comprehensive and the core network complement each other: whereas the purpose of the comprehensive network is to serve accessibility functions and ensure a balanced infrastructure endowment throughout the Union, the core network pioneers the development of a sustainable mobility network. It shall be completed as a priority, by 2030. The new policy basis provides more clarity with regard to the identification of a broad range of "projects of common interest" (including the closing of missing physical links, infrastructure upgrading to target standards, ITS or innovative equipment).

To facilitate implementation of the core network, the Guidelines introduce the instrument of "core network corridors" – a coordination tool aiming at coherent project implementation and at promoting technological, operational and governance-related innovation. The core network corridors also aim to strengthen a "systems" approach that links transport infrastructure development with related transport policy measures. Eventually, this approach seeks to promote higher resource efficiency to achieve the EU carbon emissions' reduction objectives in the transport sector. Due to the broad range of measures addressed with the new Guidelines, many different actors will have to contribute to their implementation. The proposed corridor governance structures intend to foster cooperation of the various actors. Existing activities such as the rail freight corridors introduced with Regulation No 913/2010 will form an integral part of core network corridor developments.

Vis-à-vis the TEN-T guidelines, the proposed Connecting Europe Facility as the financing instrument sets out funding priorities for the period 2014 – 2020 and the corresponding rules. It defines a geographical basis for the corridor approach and pre-identifies the most mature projects along those corridors.

Annex I to the proposed Regulation establishing the Connecting Europe Facility [EC (2011c)], which will co-finance EU priority infrastructure in transport, energy and digital broadband, lists 10 core network corridors, which form part of the TEN-T core network.

SuperGreen as a tool to support the new TEN-T policies

Figure 23 depicts the land part of the core network plotted against the 9 SuperGreen corridors. The geographic overlap is impressive, even after accounting for the fact that the priority projects of the TEN-T were taken into consideration, among several other criteria, when selecting the SuperGreen corridors in June 2010.

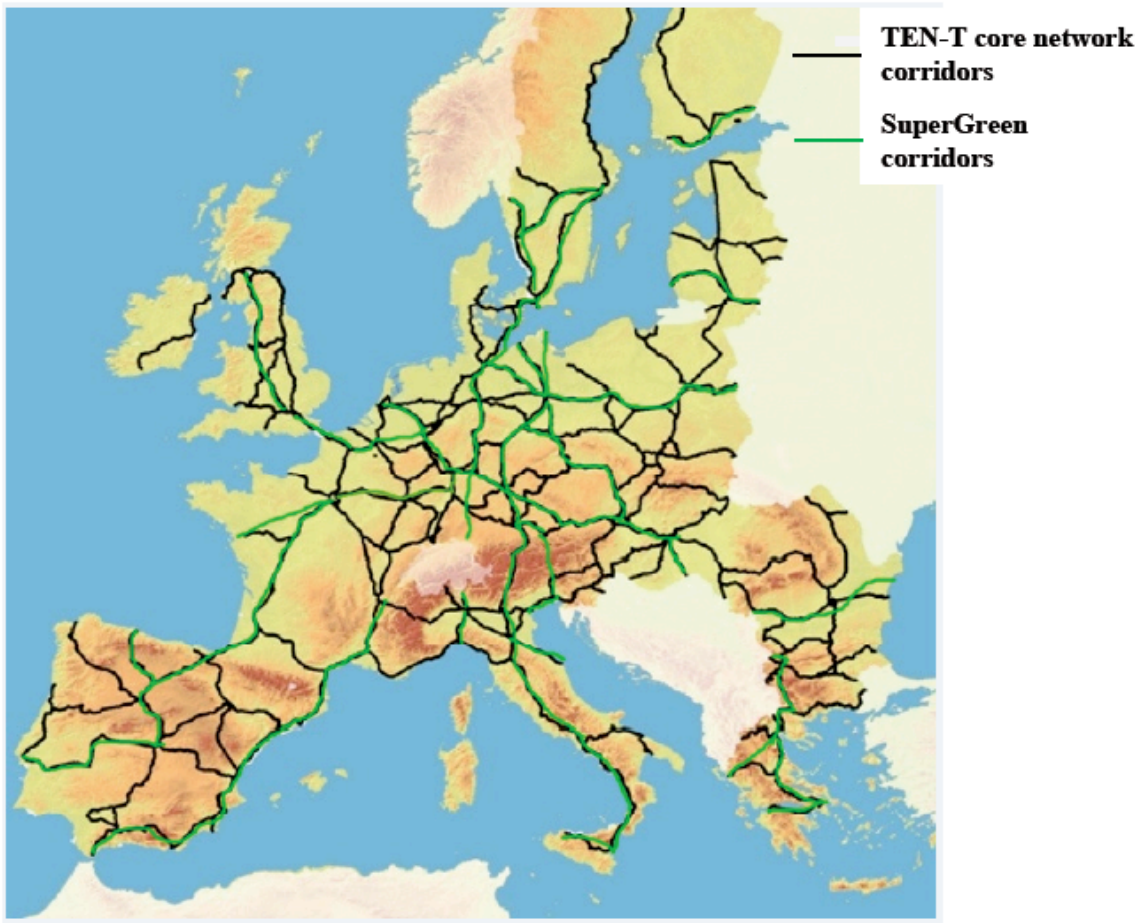


Figure 23. The SuperGreen and TEN-T core network corridors

With regard to the relation between these two sets of corridors, a key question to address is whether the proposed TEN-T corridors exhibit the green characteristics identified in Section 2.

The Guidelines include several references to multimodality. In fact, there is an entire section (Section 6) devoted to the 'infrastructure for multimodal transport' that refers to the comprehensive network and includes logistic platforms. When it comes to the core network, Article 48 is crystal clear:

> "... Core network corridors shall be based on modal integration, interoperability, as well as on a coordinated development and management of infrastructure, in order to lead to resource-efficient multimodal transport… Multimodal infrastructure within core network corridors shall be built and coordinated, wherever needed, in a way that optimises the use of each transport mode and their cooperation."

Furthermore, the proposed revision of the TEN-T Guidelines:

- Provides for the interconnection between rail and, as appropriate, inland waterway, air, maritime and road infrastructure for freight transport in the urban nodes (Article 36).

- Sets the deployment of ITS as a priority for all transport modes even for the comprehensive network (Articles 10, 13, 17, 21, 26, 30, 34 and 37). The core network infrastructure is obliged to meet all requirements set out for the comprehensive network without exception (Article 45).

- Sets the promotion of state-of-the-art technological development as a priority even for the comprehensive network (Articles 10 and 39).

- Requires full electrification of the railway lines and availability of alternative fuels for the road, inland navigation and maritime transport infrastructure for the core network (Article 45).

- Draws the attention of the Union, Member States and other project promoters to projects of common interest which provide efficient freight transport services that contribute to reducing carbon dioxide emissions (Article 38).

- Realising the extensive need for collaboration among a multiplicity of actors, proposes a governance scheme which involves a 'corridor platform' composed of Member State representatives and other appropriate public and private entities in addition to a European Coordinator who will chair the platform. This platform shall be appropriately coordinated with the one specified by Regulation 913/2010 for the European rail network for competitive freight.

In addition, the proposed Regulation on the the Connecting Europe Facility provides increased funding rates for projects contributing to GHG emission reduction (Article 10, par.5):

> "Co-financing rates mentioned above may be increased by up to 10 percentage points for actions having cross-sector synergies, reaching climate mitigation objectives, enhancing climate resilience or reducing the greenhouse gas emissions..."

It follows that the TEN-T proposal includes the elements necessary to promote sustainable transport in the broad sense. Its declared objective is to provide the infrastructure basis for the achievement of the Transport Policy Objective set out in the White Paper (meeting mobility needs while reducing GHG emissions). Core network corridors – where the EU's coordination and funding action will be concentrated – are foreseen to pioneer such a development. The existing Green Corridors, initiated by some Member States can be seen as a nucleus (to be integrated into the broader context of the Guidelines), and the benchmarking methodology developed with the SuperGreen Project will be a very useful tool to optimise planning and implementation.

At the current stage, the final decisions of the European Union institutions on the new TEN-T framework are still pending. From the perspective of the SuperGreen project, it is hoped that the results can contribute to realising the vision of gradually developing a sustainable TEN-T overall.

We hope that
SuperGreen
has contributed to that.

10 Where can we get more information?

Arnold John (2005). *Best Practices in Corridor Management*, Trade Logistics Group, The World Bank, Washington, D.C., February 2005.

Butcher Louise (2012). *Trans-European Transport Networks (TEN-T),* Library of the House of Commons, Standard Note SN478, 7.2.2012.

Corridor A / IQ-C (2011). *6th Progress Report*. Executive Board ERTMS Corridor A and International Group for Improving the Quality of Rail Transport in the North-South Corridor. August 2011.

Council of the European Union (2012). *General approach on the Proposal for a Regulation of the European Parliament and of the Council on Union guidelines for the development of the trans-European transport network,* 8047/12, Brussels, 28.03.2012.

DEFRA (UK). Guidance on measuring and reporting Greenhouse Gas (GHG) emissions from freight transport operations.

Engström Rikard (2011). *The Swedish Green Corridor Initiative – History, Current Situation and Thoughts about the Future.* Proceedings of the 8th SoNorA University Think Tank Conference, Szczecin, Poland, 16.6.2011.

European Commission (2011a). *WHITE PAPER. Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system.* COM(2011) 144, Brussels, 28.3.2011.

European Commission (2011b). *Commission Staff Working Document Accompanying the White Paper – Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system.* SEC(2011) 391, Brussels, 28.3.2011.

European Commission (2011c). *Proposal for a Regulation of the European Parliament and of the Council establishing the Connecting Europe Facility*, COM(2011) 665/3, Brussels, 19.10.2011.

European Commission (2011d). *Proposal for a Regulation of the European Parliament and of the Council on Union guidelines for the development of the trans-European transport network*, COM(2011) 650/2, Brussels, 19.10.2011.

European Commission (2011e). *Handbook on the Regulation concerning a European rail network for competitive freight (Regulation EC 913/2010).* DG MOVE staff working document, 30.6.2011.

European Commission (2007). *Freight Transport Logistics Action Plan.* Communication from the Commission COM(2007) 607, Brussels, 18.10.2007.

Journée Herman (2012). *Seaports-Inland ports: Key role in Greening Hinterland Logistics.* Presentation at the GreenPort 2012 Congress, Marseille, France, 4.10.2012.

Kyster-Hansen H., Thisgaard P., Henriques M. and Niss M.-K. (2011), *Green Corridor Manual (draft) – Purpose, definition and vision for Green Transport Corridors*, Danish Transport Authority, 21.6.2011.

Mertel R. and Sondermann K-U. (2007). *Final Report for Publication*. BRAVO project, 6.12.2007.

NESCCAF (2009). *Reducing heavy-duty long haul combination truck fuel consumption and CO2 emissions*. October, 2009.

Pålsson et al (2010). *Definition of benchmark indicators and methodology*. SuperGreen project Deliverable D2.2, Document number: 02-22-RD-2010-16-01-4.

Rousseaux Patrick (2012). *Rail freight corridors*. Presentation at the RNE Business Conference, Frankfurt, Germany, 10.5.2012.

Swahn Magnus (2010). *How to evaluate transport's environmental performance*. Article at GreenPort Journal, June 2010.

UIC (2002). *Regenerative braking in freight trains*. Available at http://www.railway-energy.org/static/Regenerative_braking_in_freight_trains_43.php

PLUS

in all SuperGreen Deliverables

found at:

http://www.supergreenproject.eu/

Appendix I. The SuperGreen project

Project identity

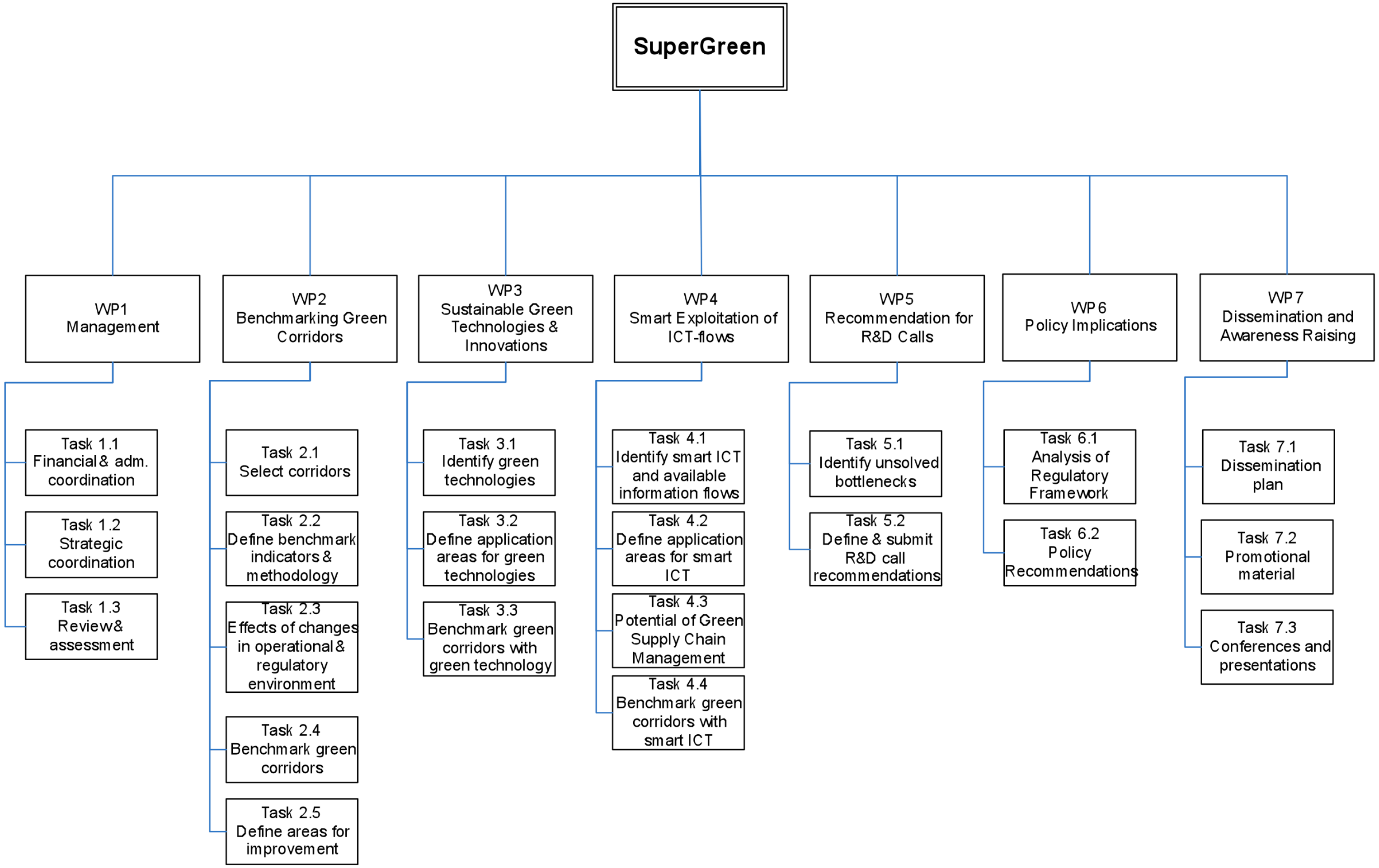
- **Project full title:** **Supporting EU's Freight Transport Logistics Action Plan on Green Corridors Issues**
- **Type of project:** **Coordination and Support Action**
- **Financed through:** **7th Framework Programme**
- **Duration:** **3 years**
- **Official start:** **15 Jan. 2010**
- **Consortium:**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

Project 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

Appendix I. The SuperGreen project (continued)

Project structure



Appendix II. TEN-T core network vs. other corridors

TEN-T core network corridor			Rail Freight Corridor	ERTMS Corridor	RNE Corridor
1	Baltic-Adriatic Corridor	Helsinki – Tallinn – Riga – Kaunas – Warszawa – Katowice Gdynia – Katowice Katowice – Ostrava – Brno – Wien Katowice – Žilina – Bratislava – Wien Wien – Graz – Klagenfurt – Villach – Udine – Venezia – – Bologna – Ravenna	5	-	7
2	Warszawa – Berlin – Amsterdam/Rotterdam – Felixstowe – Midlands	BY border – Warszawa – Poznań – Frankfurt/Oder- - Berlin – Hannover – Osnabrück – Enschede – Utrecht – - Amsterdam/Rotterdam – Felixstowe – - Birmingham/Manchester – Liverpool	8	F	3
3	Mediterranean Corridor	Algeciras – Madrid – Tarragona Sevilla – Valencia – Tarragona Tarragona – Barcelona – Perpignan – Lyon – Torino – Milano - Venezia – Ljubljana – Budapest – UA border	6	D	8 6 Eastern branch
4	Hamburg – Rostock – Burgas/TR border – Piraeus – Lefkosia	Hamburg / Rostock – Berlin – Praha – Brno – - Bratislava – Budapest – Arad – Timişoara – Sofia Sofia – Burgas/TR border Sofia – Thessaloniki – Piraeus – Limassol – Lefko	7	E	9 10 Southern branch
5	Helsinki – Valletta	Helsinki – Turku – Stockholm – Malmö – - København – Fehmarn – Hamburg – Hannover Bremen – Hannover – Nürnberg – München – - Brenner – Verona – Bologna – Roma – Napoli – Bari Napoli – Palermo – Valletta	3	B	1, 4

Appendix II. TEN-T core network vs. other corridors (continued)

TEN-T core network corridor			Rail Freight Corridor	ERTMS Corridor	RNE Corridor
6	Genova – Rotterdam	Genova – Milano/Novara – Simplon/Lötschberg/Gotthard – - Basel – Mannheim – Köln Köln– Düsseldorf – Rotterdam/Amsterdam Köln– Liège – Bruxelles/Brussel– Zeebrugge	1	A	2
7	Lisboa - Strasbourg	Sines / Lisboa – Madrid – Valladolid Lisboa – Aveiro – Oporto Aveiro – Valladolid – Vitoria – - Bordeaux – Paris – Mannheim/Strasbourg	4	-	6 Western branch
8	Dublin – London – Paris – Bruxelles	Belfast – Dublin – Holyhead – Birmingham Glasgow/Edinburgh – Birmingham Birmingham – London – Lille – Brussel/Bruxelles Dublin/Cork/Southampton – Le Havre – Paris London – Dover – Calais – Paris	-	-	-
9	Amsterdam – – Basel/Lyon - – Marseille	Amsterdam – Rotterdam – Antwerp – – Brussel/Bruxelles – Luxembourg Luxembourg – Dijon – Lyon Luxembourg – Strasbourg – Basel	2	C	5
10	Strasbourg – – Danube Corridor	Strasbourg – Stuttgart – München – Wels/Linz Strasbourg – Mannheim – Frankfurt – Würzburg – - Nürnberg – Regensburg – Passau – Wels/Linz Wels/Linz – Wien – Budapest – Arad – Brašov – Bucurešti – Constanta - Sulina	-	-	-