SEVENTH FRAMEWORK PROGRAMME

THEME [7]

Theme Title: Transport (including Aeronautics)

SuperGreen

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All partners of the project consortium via a return email have approved the final version of this SuperGreen Deliverable.

DISCLAIMER

Table of contents

List of Tables

List of Figures

0 Executive Summary

This document is Deliverable D3.2 of the Task 3.2 "Define Application Areas for Green Technologies" of SuperGreen Project. It presents the results achieved during the whole working session (M1-M36) of Task 3.2.

The results achieved in the first phase of the project (M1-M18) represent the base of knowledge and the data structures to be used in the second phase of the WP to obtain the expected results (M19 – M36). The final results consist in the selection of the areas of application (i.e. segments/nodes or parts of corridors) for the green technologies proposed.

The main objective of Task 3.2 is the definition and population of a Technology vs Application Matrix giving primary indications about the possible application of sustainable technologies (or family of technologies) and an assessment of their potential to make corridors greener than with standard technologies and solutions, in order to indicate the importance of the technology for each application, i.e., a segment/node or a part of a corridor.

On the basis of the knowledge of the partners the technologies have been linked to the different sections of the following corridors: Brenner, Finis Terrae, Cloverleaf, Edelweiss, Nureyev, Strauss, Two Seas, Mare Nostrum and Silk Way. The technologies considered in Task 3.2 are the one identified in Task 3.1 and subdivided in the followings categories: engines and propulsion systems, fuels and energy sources, cargo handling and transfer technologies, cargo preparation technologies, heating and cooling technologies, innovative loading units and their treatment, vehicles, navigation technologies, best practices of technologies integration.

The result of this activity is a Technology vs Application Matrix that allows to select a set of most promising technologies to be better investigated for producing dedicated reports.

A web based repository (SuperGreen Knowledge Base) has been designed in order to collect the information such as the matrix and related data and to make them accessible using an appropriate wizard.

From the SuperGreen Knowledge Base it is also downloadable the Technology Card Report that represent the summarising document on main characteristics, applicability and benchmarking results for a selection of technologies considered as the most promising in the scope of the project.

1 Introduction

The purpose of this document is to describe the work done in SuperGreen Work Package 3 under Task 3.2 "Define Application Areas for Green Technologies".

This task is dedicated to develop a link between the technologies defined in Task3.1 and possible application in selected corridors or segments or nodes. This process is realised via information gathered from the Partners using adequate tools and collected in a Technologies vs Application Matrix. The results of the activity are analysed in order to develop specific reports for a selected subset of technologies that seems most promising for their application related the Corridors.

The information gathered within this process is made available via the SuperGreen Knowledge Base that allows browsing the results of the different activities performed in the Task.

The main activities of Task 3.2 can be summarised as follows (the scheduled time of the activities is related to the original Gantt reported in Technical Annex):

1. definition of the tools needed to collect information from the partners (M2-M3);
2. collection of information of the aforementioned matrix (M4-M6);
3. definition and population of the Technology vs Application Matrix (first phase: M7-M10; second phase: M27-M31);
4. creation (M13-M15) and population (first phase: M16-M18; second phase: M19-M36) of the SuperGreen Knowledge Base;
5. preparation of a brief report (Technology Card) for a selection of technologies (M32-M34).

In the following paragraphs the activities performed during the 3 years of the project are reported, with the corresponding actual periods of activity.

The design of the tools to be used to collect the information has been started at M4 and ended at M9. The result of this activity is a questionnaire to be submitted to partners in order to gather information about the technologies and their application. The structure of the defined questionnaire is reported in Appendix I. In Appendix II the Memo of Assistance to Questionnaire is reported. The information has been collected using the questionnaire between M9 and M11. The results of this activity consist of a set of fulfilled questionnaires that are reported in Appendix III. Section 4 describes the structure of the questionnaire and the main results deducted from the information collected. The structure of the questionnaire has been defined at the beginning of the Year 1 and then it has been updated in order to collect information referred to the final set of KPI identify in WP2.

The definition of the Technology vs Application Matrix has been developed since M7 and ended at M10 (in the first phase of the task) and from M27 to M31 in the second phase of the project. The objective of the Technology vs Application Matrix is to identify application areas of green technologies and assess their applicability for improving the green performance of the corridors and solving bottlenecks. The purpose of this tool is to

be an easy-to-use knowledge repository that informs about the possible applicability of innovative propulsion systems and engines, alternative fuels, cargo handling and transfer technologies, navigation technologies and other novel concepts on multimodal transport segments or nodes within the SuperGreen corridors. Section 5 of this report describes the structure of the Technology vs Application matrix and reports the most important results. A matrix has been filled in per each corridor and they are all reported in Appendix IV and V.

The design and implementation of the SuperGreen Knowledge Base started at M8 and has been completed at the end of the project. The repository has been populated with gathered information starting at M16, until M36. Gathered data are relevant to the technologies collected in Task 3.1 and the segments or nodes of the corridors defined in Task 2.4. The activities on the SuperGreen Knowledge Base have been running during the whole project lifetime in order to maintain and upgrade the site, to upload new information and products coming from the task and to manage the registering procedure.

The SuperGreen Knowledge Base is hosted at http://88.32.124.84/SuperGreen.

Section 6 of this report describes the key developing information of the site, the structure and the main functions of the repository.

Section 7 reports a result of the SuperGreen Knowledge Base, the Technology Cards. They represent a summarising document prepared for a selection of technologies on the main characteristics, their applicability on corridors and results of the benchmarking activity.

2 Objectives

2.1 Work Package 3 - Sustainable Green Technologies & Innovations

Work Package 3 aims at identifying, selecting and benchmarking Green Technologies, to be applied into specific Green Corridors for solving bottlenecks related to logistics operations. Technologies to be investigated include, among others, novel propulsion systems and engines, alternative fuels, cargo handling and transfer technologies, or any kind of novel concepts relevant for multimodal corridors.

It is a matter of providing a sound coverage of the most promising technologies, techniques and procedures to be applied in Green Corridors both over the different transport legs and at transhipment points, and assessing which of them would be useful to increase the sustainability of transport chains and logistics operations.

Transport operators, logistics service providers, terminal operators, shippers and policy makers would then benefit from a comprehensive analysis of the Green Technologies, with a comparison between them on different possible applications (selected Green Corridors), on the basis of a series of what – where – how use-case scenarios.

The analysis made, including the comparison with respect to the current baseline and any other information collected in the current work package will be made available by means of the SuperGreen Knowledge Base, which will be accessible to the users and the stakeholders by means of a user-friendly wizard.

2.2 Task 3.2 - Define Application Areas for Green Technologies

In Task 3.2 a Technology vs Application Matrix is defined and populated, giving the primary indications about the possible application of each technology (or family of technologies) and an assessment of their greening potential (to make corridors Greener than with standard technologies and solutions).

The activity of design and the population of the matrices for the selected SuperGreen Corridors have been completed and results reported in Appendix IV.

The main result is the ranking of each technology in terms of importance for each application (part of a corridor – segments and nodes), and for selected entries, a brief report will be prepared summarising the most relevant aspects such as:

- the section of the corridor that is suitable to be covered by the technology, detailing the specific activity (e.g., cargo loading or discharging, cargo transfer, transport, cargo conditioning – i.e., depending on the type of cargo might be a combination of temperature or atmosphere control, preparation and packaging, unitising of cargo, etc);
- the assessment of the greening potential and the expected impacts of the technology for the application, taking into account the geographical location of the identified corridors to better estimate the influence on quality of work and life of the concerned citizens, and other social aspects;

- the time to market (i.e. period of availability for the end-user).

The matrix, including any other related information, are stored into the SuperGreen Knowledge Base (http://88.32.124.84/SuperGreen), interfaced by a wizard to help the user in browsing the content and accessing to the whole knowledge stored there.

3 Methodology for Task 3.2

The methodology adopted in the present task has been planned as follows:

- assumption of the technologies defined in task 3.1;
- assumption of the application in terms of corridors and segments or nodes defined in the previous WP2;
- characterisation of a Technology vs Application Matrix (part of corridors – segments and nodes) to be populated on the basis of the collected expert judgment and on the basis of the results of the following items;
- definition of an appropriate questionnaire to be used to collect expert judgement in order to populate the aforementioned matrix;
- collection of the information from the partners using the defined questionnaire;
- preparation of a brief report summarising the most relevant aspects for the main entries of the matrix (i.e. the section of the corridor that is suitable to be covered by the technology, detailing the specific activity; the assessment of the greening potential and the expected impacts of the technology for the application; time to market; etc.).
- design and realisation of the SuperGreen Knowledge Base containing the information resulting from the previous activities interfaced by a wizard to help the user in browsing the content and accessing to the whole knowledge stored there.

The mentioned activities have been performed during the whole project lifetime in two different working sessions, accordingly with the following schedule:

- 1° session of work: M1-M18
- 2° session of work: M19-M36

The results of the aforementioned activities are summarised in the followings deliverables:

- D3.2 Define Application Areas for Green Technologies (R) (M18 version 1; M36 final): describing the methodology, the work carried out and the results of Task 3.2.
- D3.2A The SuperGreen Knowledge Base (P) (M18 version 1 - M36 final): A web based tool to make the results of this WP accessible to all stakeholders. It includes the information stored in the technology/application matrix.

4 Questionnaires

4.1 Structure of the Questionnaire

A questionnaire titled "A survey on the application areas for Green Technologies" has been prepared in order to assess the greening potential of each technology identified in Task 3.1, applicable to specific activities in each of the green corridors (Table 1).

Table 1: Considered Corridors

ACRONYM	BRIEF DESCRIPTION- BRANCHES	NICKNAME
BerPal	Malmö-Trelleborg-Rostock/Sassnitz- Berlin-Munich-Salzburg-Verona-Bologna-Naples-Messina-Palermo Branch A: Salzburg-Villach-Trieste (Tauern axis) Branch B: Bologna-Ancona/Bari/Brindisi-Igoumenitsa/Patras-Athens	Brenner
MadPar	Madrid-Gijon-Saint Nazaire-Paris Branch A: Madrid-Lisboa	Finis Terrae
CorMun	Cork-Dublin-Belfast-Stranraer Branch A: Munich-Friedewald-Nuneaton Branch B: West Coast Main line	Cloverleaf
HelGen	Helsinki-Turku-Stockholm-Oslo-Göteborg-Malmö-Copenhagen (Nordic triangle including the Oresund fixed link)- Fehmarnbelt - Milan - Genoa	Edelweiss
RotMos	Motorway of Baltic sea Branch: St. Petersburg-Moscow-Minsk-Klapeida	Nureyev
RhiDan	Rhine/Meuse-Main-Danube inland waterway axis Branch A: Betuwe line Branch B: Frankfurt-Paris	Strauss
AthDre	Igoumenitsa/Patras-Athens-Sofia-Budapest-Vienna-Prague-Nurnberg/Dresden-Hamburg	Two Seas
SinOde	Odessa-Constanta-Bourgas-Istanbul-Piraeus-Gioia Tauro-Cagliari-La Spezia-Marseille-Barcelona-Valencia-Sines Branch A: Algeciras-Valencia-Barcelona-Marseille-Lyon Branch B: Piraeus-Trieste	Mare Nostrum
CNHam	Shanghai-Le Havre/Rotterdam-Hamburg/Göteborg-Gdansk-Baltic ports-Russia Branch:Xiangtang-Beijing-Mongolia-Russia-Belarus-Poland-Hamburg	Silk Way

The questionnaire has been provided to partners with a personalised collection of technologies from different categories (engines & propulsion, cargo handling, fuels, etc.). The partners have had to ignore the categories that were not referred in their specific technologies collection table. For all the specific technologies identified for every category, the partner had to fill the questions' template. One questionnaire for each technology has to be fulfilled.

The structure of the questionnaire can be subdivided in the following sections:

- Section 1: <<Engines & Propulsion Systems>>
- Section 2: <<Fuels & Sources of Energy>>
- Section 3: <<Cargo Handling & Transfer >>
- Section 4: <<Heating & Cooling >>
- Section 5: <<Innovative Units & Treatment >>
- Section 6: <<Vehicles >>
- Section 7: <<Navigation Technologies >>
- Section 8: <<Best Practices >>

The section related to the Cargo Preparation Technologies has not been considered due to the fact that at the end of the first round of data collection no technologies have been included in it.

For each section the impact of the considered technology is rated with reference to the following areas (1=min, 5=max):

- **Economy and Efficiency**: Absolute and relative costs for transferring goods, considering: (i) type & (ii) quantity of goods, (iii) type of activity at nodes, (iv) mode of transport used for each link, (v) distance for each link and (vi) average speed for each link.
- **Service Quality**: The following issues are concerned: (i) transport time, (ii) reliability (time precision), (iii) ICT applications, (iv) frequency of service and (v) cargo security & (vi) safety.
- **Environmental Sustainability**: Impact towards greenhouse gas emissions (carbon footprint) and polluters is considered.
- **Infrastructural Sufficiency**: In this area, congestion cost, as the external cost of delays, and traffic bottlenecks are considered.
- **Social Issues**: Extensive corridor land use, neighbouring to sensitive areas, social issues that arise due to traffic safety or noise are considered.

For each section the technology has to be ranked according to the aspect towards its maturity (> 5 years; 1 to 5 years; < 1 year).

Based on the above consideration the greening potential of the technology is ranked for each of the considered corridors and branches:

- indicating whether the technology can be applicable or not,
- rating the applicability of the technology to the whole corridor, i.e. write 20% if the technology can be applied only at the 20% of the corridor.
- comment the selections indicating the parts of the corridor that can/cannot be altered to accommodate this technology.

The template of the questionnaire is reported in Appendix I. A text of Assistance to the questionnaire circulated among the partners with the scope of providing assistance and further explanations and to facilitate the partners that had to respond to the questionnaire reported in Appendix II.

4.2 Results from the Questionnaire

The questionnaire has been received from the following Partners:

- HSSA: Hellenic Shortsea Shipowners Association
- PSAS: PSA Sines
- SCH: DB Schenker AG
- VRG: VR Group

The results of these activities are summarised in terms of number and type of technologies assessed in Table 2. Considering the total of technologies 175 questionnaires have been compiled with the following subdivision related to the sections:

- Engines & Propulsion Systems: 20;
- Fuels & Sources of Energy: 39;
- Cargo Handling & Transfer: 43;
- Heating & Cooling: 3;
- Innovative Units & Treatment: 10;
- Vehicles: 26;
- Navigation Technologies: 25;
- Best Practices: 9;

and the following subdivision related to the partners:

- HSSA: Hellenic Shortsea Shipowners Association: 46;
- PSAS: PSA Sines: 46;
- SCH: DB Schenker AG: 51;
- VRG: VR Group: 32.

During the second phase of the project a new version of the questionnaire template has been prepared using the web based tool (SuperGreen Knowledge Base) because the previous one was considered superseded.

The first template, in fact, was defined at the beginning of the project when the set of KPIs and Corridor selection were not finalised. The new template is described in Paragraph 6.8.

Table 2: Questionnaire Summary

PARTNER	SECTION	N° of technologies analysed	TOT
HSSA: Hellenic Shortsea Ship.Ass.	Engines & Propulsion Systems	6	46
	Fuels & Sources of Energy	11	
	Cargo Handling & Transfer	15	
	Heating & Cooling	0	
	Innovative Units & Treatment	0	
	Vehicles	6	
	Navigation Technologies	8	
	Best Practices	0	
PSAS: PSA Sines	Engines & Propulsion Systems	5	46
	Fuels & Sources of Energy	10	
	Cargo Handling & Transfer	13	
	Heating & Cooling	0	
	Innovative Units & Treatment	2	
	Vehicles	0	
	Navigation Technologies	14	
	Best Practices	2	
SCH: DB Schenker AG	Engines & Propulsion Systems	9	51
	Fuels & Sources of Energy	0	
	Cargo Handling & Transfer	15	
	Heating & Cooling	3	
	Innovative Units & Treatment	5	
	Vehicles	16	
	Navigation Technologies	0	
	Best Practices	3	
VRG: VR Group	Engines & Propulsion Systems	0	32
	Fuels & Sources of Energy	18	
	Cargo Handling & Transfer	0	
	Heating & Cooling	0	
	Innovative Units & Treatment	3	
	Vehicles	4	
	Navigation Technologies	3	
	Best Practices	4	

5 Technology vs Application Matrix

5.1 Purpose

The objective of the Technology vs Application Matrix is to identify the application areas of green technologies and assess their usability for improving the green performance of the transports and logistics operations in studied corridors. The purpose of this matrix is to inform about the possible application of the defined technologies (innovative propulsion systems and engines, alternative fuels, cargo handling and transfer technologies, navigation technologies and other novel concepts) on multimodal transport segments or nodes within the SuperGreen corridors. All the aforementioned information is available by means of an the SuperGreen Knowledge Base.

5.2 Design of the Technology vs Application Matrix

5.2.1 First work session (M1-M18)

Nine sets of forms to be filled in by Partners have been defined (one for each corridor) in order to compile the Technology vs Application Matrix. Each set is an excel file that contains the information related to the specific corridor and it is composed by the following spreadsheets:

- A cover that contains a scheme of the corridor (represented in a multimodal map) and some tables containing the complete list of the segments and nodes of the corridor, identified by a code and a simple description. For each segment the branch of reference (i.e. Main Corridor, Branch A and Branch B) is also included. In Figure 1 the cover sheet related to the Brenner Corridor is reported.
- A spreadsheet for each category of technology to be analysed within the corridor. It contains the technologies that have been considered belonging to the first three levels of classification assigned within Task 3.1 (very important, important, low importance for the corridor) and it gives information about applicability and influence on KPIs for each of them.

The structure of the spreadsheet related to each category of technologies is composed by the following columns:

ID	Identification code of the selected technology
Category	Category of the selected technology
Technology Name	Name of the selected technology
Transport Mode	Transport mode of possible application
Description	Extended description for the technology
Applicability	Applicability of the technology on the corridor with the following possibilities: - technology applicable on the whole corridor, - technology applicable on Main corridor/branch A/branch B (depends on the corridor), - technology not relevant for the whole corridor,

- technology applicable in specific links or nodes (in this case the list of segments and nodes and details are necessary).

Influence on KPIs — Influence of the technology on KPI expressed on a scale between -2 and +2 with the following meanings:

- -2 means a very bad influence of the technology on a KPI
- -1 means a bad influence of the technology on a KPI
- 0 means the technology is not relevant for a KPI
- 1 means a good influence of the technology on a KPI
- 2 means a very good influence of the technology on a KPI

Branch		Segment
MC1	Main Corridor	Malmö-Trelleborg
MC2	Main Corridor	Trelleborg-Rostock
MC3	Main Corridor	Trelleborg-Sassnitz
MC4	Main Corridor	Rostock- Berlin
MC5	Main Corridor	Sassnitz-Berlin
MC6	Main Corridor	Berlin-Nurnberg
MC7	Main Corridor	Nurnberg-Munich
MC8	Main Corridor	Munich-Salzburg
MC9	Main Corridor	Salzburg-Verona
MC10	Main Corridor	Verona-Bologna
MC11	Main Corridor	Bologna-Rome
MC12	Main Corridor	Rome-Naples
MC13	Main Corridor	Naples-Messina
MC14	Main Corridor	Messina-Palermo
MC15	Main Corridor	Naples- Villa San Giovanni
MC16	Main Corridor	Messina - Villa San Giovanni
BA1	Branch A	Salzburg-Villach
BA2	Branch A	Villach-Trieste
BB1	Branch B	Bologna-Ancona
BB2	Branch B	Ancona-Bari
BB3	Branch B	Bari-Brindisi
BB4	Branch B	Ancona-Brindisi
BB5	Branch B	Ancona-Igoumenitsa
BB6	Branch B	Ancona-Patras
BB7	Branch B	Bari-Igoumenitsa
BB8	Branch B	Bari-Patras
BB9	Branch B	Brindisi-Igoumenitsa
BB10	Branch B	Brindisi-Patras
BB11	Branch B	Igoumenitsa-Thessaloniki
BB12	Branch B	Patras-Athens

Node	
N1	Trelleborg
N2	Malmo
N3	Sassnitz
N4	Rostock
N5	Berlin
N6	Nurnberg
N7	Munich
N8	Salzburg
N9	Villach
N10	Trieste
N11	Verona
N12	Bologna
N13	Ancona
N14	Bari
N15	Brindisi
N16	Rome
N17	Naples
N18	Villa San Giovanni
N19	Messina
N20	Palermo
N21	Igoumenitsa
N22	Thessaloniki
N23	Patras
N24	Athens

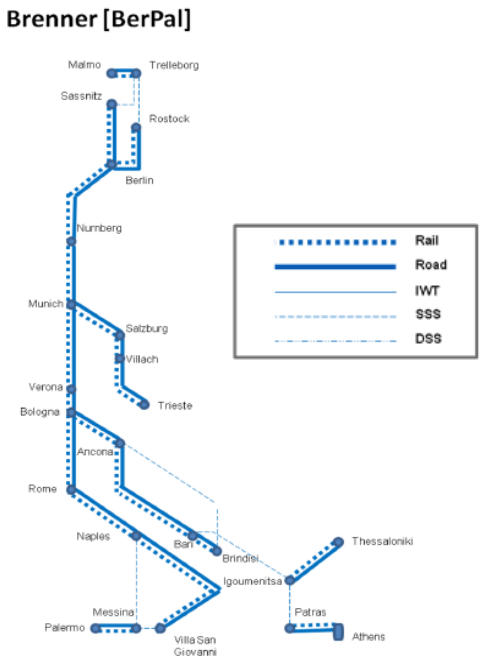


Figure 1: Brenner Corridor – Technology vs Application Matrix Cover Page

In Figure 2 the sheet related to "Engines and Propulsion Systems" of the Brenner Corridor as an example is reported.

ID	Cat.	Technology Name	Transport Mode	Description	Applicability				Influence on KPIs					
					MC	BA	BB	Detailled segments and nodes	CO2	SOx	Cost	Time	Freq.	Rel.
EN02	A	Directly driven propeller	Maritime	Slow speed engine directly connected to propeller shaft, 20 year life time, running 5500 h/a.	X		X	Technology applicable on all sea segments of the corridor: BB4, BB5, BB6, BB7, BB8, BB9, BB10, MC15, MC16, MC3, MC2	2	2				
EN03	A	Mechanically connected propeller	Maritime	Medium speed engine connected by a reduction gear to the propeller shaft, 20 year life time, running 5500 h/a	X		X	Technology applicable on all sea segments of the corridor: BB4, BB5, BB6, BB7, BB8, BB9, BB10, MC15, MC16, MC3, MC2	2	2				
EN07	A	Diesel-mechanic propulsion with high speed engine	Maritime	High speed engine connected by a reduction gear to the propeller shaft, 20 year life time, running 5500 h/a.	X		X	Technology applicable on all sea segments of the corridor: BB4, BB5, BB6, BB7, BB8, BB9, BB10, MC15, MC16, MC3, MC2	2	2				
EN16	A	Full/parallel hybrid	Road	Electrical support of engine power by saving and re-use of break-energy; combination of 6 cylinder engine plus electrical engine	X	X	X	Technology applicable in specific links: MC8, MC9, MC11, BA1, BA2, BB11. Technology applicable in specific nodes: All nodes of the corridor	1	1	-2			
EN21	A	Nauticlean S System	Inland Waterways	It consists of two reactors with a selective-catalytic reduction (SCR)				Technology not relevant for the whole corridor						
EN06	B	Mechanical azimuthing thrusters	Maritime	The engine runs generator. An electric motor is located inside the ship where it runs propeller shaft. 20 year life time, running 5500 h/a.	X		X	Technology applicable on all sea segments of the corridor: BB4, BB5, BB6, BB7, BB8, BB9, BB10, MC15, MC16, MC3, MC2	2	2	-1			
EN 15	C	PG Engine Diesel Locomotives	Railway	A propulsion system for a four-axle, standard-gauge, centre-cab locomotive using a liquefied petroleum gas (LPG) engine instead of conventional diesel				Technology not relevant for the whole corridor						

Applicability
MC: *Main Corridor* ; BA: *Branch A* ; BB: *Branch B*

Influence on KPIs
-2 means a very bad influence of the technology on a KPI
-1 means a bad influence of the technology on a KPI
0 means the technology is not relevant for a KPI
1 means a good influence of the technology on a KPI
2 means a very good influence of the technology on a KPI

Figure 2: Brenner Corridor – Technology Spreadsheet - Engines and propulsion systems

With reference to the technologies identified within the first round of data collection of Task 3.1 (First Round of Data Collection, Deliverable D3.1 - first issue (M1-M12)), a Technology vs. Application matrix is filled per each corridor. .
The technologies considered as input of the matrices are the ones selected as "Very important", "Important" and "Low Importance" (i.e. technologies belong to category A, B and C).

5.2.2 Second work session (M19-M36)

During the second phase of the project new Technology vs Application Matrices have been filled in with reference to technologies identified within the second and third round of data collection performed in Task 3.1 (deliverable D3.1 – third issue (M1-M36).

Within the second work session an improvement on the matrix template has been implemented in order to help partners involved in the population of the matrix and partners involved in the population of the data base.The new template, in fact, reports in column the list of links and nodes of each corridor. Therefore a dedicated file per each corridor has been prepared for this activity.The structure of the matrix is reported in the following Figure 3.

Corridor Name					List of link divided per mode of transport	List of Nodes
Category	ID	Cat.	Technology Name	Transport Mode		
Technologies					Application of the techs on Links	Application of the techs on Links

Figure 3: Structure of the Technology vs. Application Matrix Used Within the Second Work Session

5.3 Population of the matrix

The population of the matrix is based on the material and information provided by SuperGreen Project Partners (operators and cargo owners), on information collected during the Second Plenary Workshop held in Genoa on 12st September 2011 (for the first set of technology identified within Task 3.1) and on the data collected during interviews with experts and stakeholders working on the corridors. The matrix constitutes a knowledge tank, which have been made accessible to the users and the stakeholders by means of the SuperGreen Knowledge Base.

The scope of the work of this activity is to indicate the importance of the technology for each application or nodes and segments of each corridor. Expert judgment of the Partners has been adopted in order to adapt the available data to the level of detail considered on the matrix (i.e. from branches to segments and/or nodes). Feedback on the possible application of each technology on the corridors have been collected through the use of the questionnaires (first and second version, see Chapter 4 and Paragraph 6.8).

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

- Assignement of the matrices on geographical basis: each matrix is referred to one corridor; matrices have been assigned to partners involved in the the task on the basis of their knowlegment of the corridor. In this step he analysis takes also in consideration aspects referred to the characteristics of the technology and of the infrastructure (e.g. no application of electric traction locos on line not fitted for this kind of traction) or the presence of limitation in the application of the technology on the corridor (e.g. due to policy regulations).
- Assignement of technologies on the basis of the transport mode: in order to verify the data collected, all the matrices have been reviewed by partners involved in the task on the basis of their expertise on the mode of transport.
- Verification of the data collected: the final review of the data collected with the matrices has been performed with the support of the questionnaires available to internal and external partners of the project through the SuperGreen Knowledge Base (Paragraph 6.8)

The results of the data collection performed through the Technology vs. Application Matrix are reported in Appendix IV and V.

6 Definition and implementation of the SuperGreen Knowledge Base

6.1 Generalities

The SuperGreen Knowledge Base (a web-based repository) has been developed in order to collect the information resulting from the previous activities. The interface has been realized using a wizard to help the user in browsing the content and accessing to the whole knowledge stored there.

The SuperGreen Knowledge Base is stored at the following web address: http://88.32.124.84/SuperGreen/Default.aspx. The Home-page is represented in Figure 4 and appears before log-in of the user.

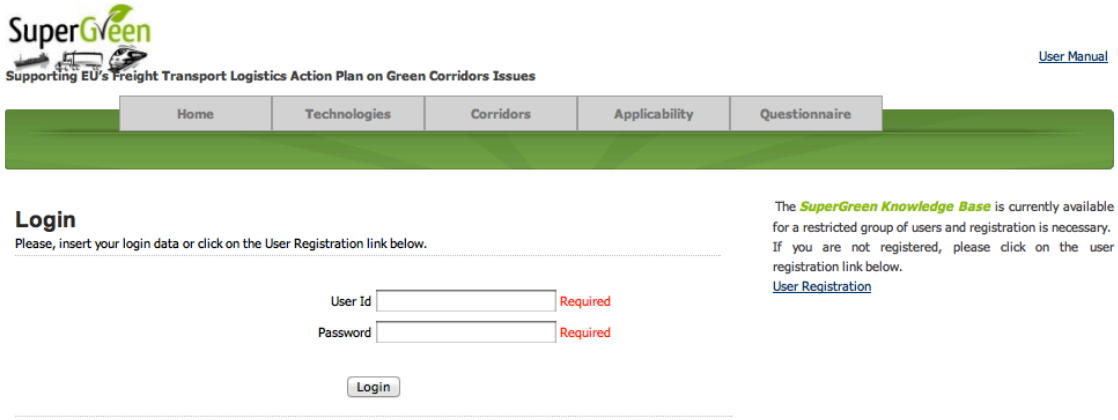


Figure 4: Home Page – before log-in

Registration to access to the SuperGreen Knowledge Base is mandatory and free of charge (see Paragraph 6.3).

After the log-in the home page appears as reported in the following Figure 5.

Figure 5: Home Page – after log-in

The home page contains a short description of project and is structured in 5 sections:

- "Home",
- "Technologies",
- "Corridors",
- "Applicability",
- and "Questionnaire".

Each section is selectable clicking on the gray tab-sheet (see next paragraphs).

The repository has been developed using:

- DataBase: Microsoft SQL Server 2008 Express
- Environment: Microsoft Visual Studio Web Developer 2010 Express
- Server Web: Microsoft Windows XP con IIS ver.5.1 e ASP.NET ver.4.0 (web pages written using C#)

The design, implementation and upload online of the SuperGreen web-site required the realisation of a virtual machine, used as server and equipped with Microsoft Windows XP Professional Service Pack 3. That machine has been equipped with web server Internet Information Services vers. 5.1 configured to execute web-page ASP.NET release 4.0 (as needed by NET Framework 4.0).

The language used to build the web-application is C#. In the web-server a data-base has been realised using Microsoft SQL Server 2008 Express Edition.

The tool used to implement the web application is Microsoft Visual Studio Web Developer 2010 Express Edition. A further application used to implement the functionalities of the SuperGreen Knowledge Base is MapServer, a freeware map creator software.

The functionalities implemented in the tool are the following:

- Registering form and log-in to the member area
- Representation of the map of corridors
- Representation of the technologies
- Representation of the Technologies vs Applications Matrix
- Questionnaires to check and validate the data collection.

The details are described in the followings paragraphs.

6.2 Log-in to the member area

The log-in form is located in the home page of the repository (Figure 4) If the user is already registered, he can log to the web site by compiling the form with:

- user name;
- password.

After having filled the fields the button **login** has to be clicked.

Otherwise the user needs to register himself by clicking on the **User registration** link and compiling the form represented in Figure 7.

6.3 Registering form and procedure

Before accessing the registering form, the disclaimer of the project needs to be read and signed. (Figure 6).

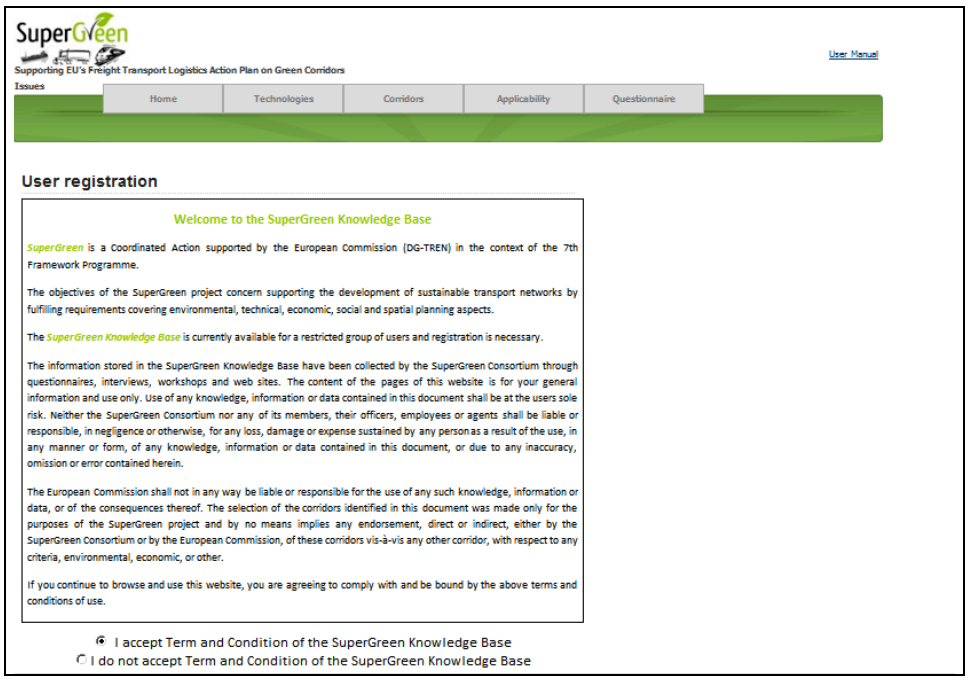


Figure 6: User Registration - Disclaimer

The registering form is composed as represented in Figure 7 and consists of 5 different fields to fill-in:

- User Name
- First Name
- Surname
- Company;
- Email.

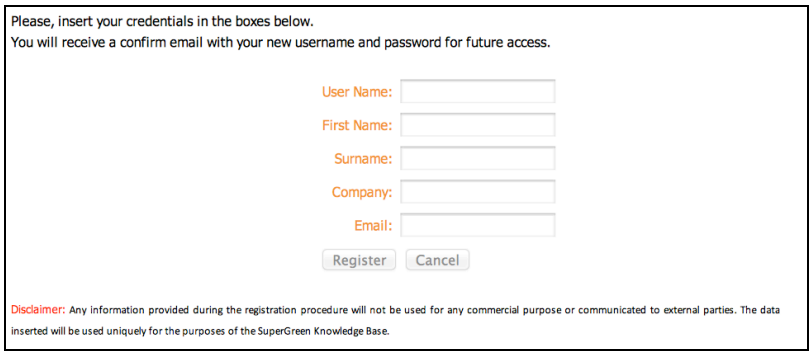


Figure 7: Registration Form

The page starts with instruction on the use of the page "Please, insert your credentials in the boxes below".

After filling-in the fields the user can submit the data using the **Register** button or cancel the data using the **Cancel** button.

After the submission of the information the user receives an e-mail at the submitted e-mail address containing the password to be used associated to the correspondent user name (Figure 8).

Hi (name) (surname),
thank you for your registration!

These are your registration data:

Name: (name)
Surname: (surname)
Company: (company name)
Email: account@provider.com

and your login parameters are:

UserId: (username)
Password: (random alphanumeric string)

Figure 8: Example of Confirmation Email for Registration

6.4 Representation of the technologies

Using the tab **Technologies** the SuperGreen Knowledge Base shows a table per each technology with all the data and characteristics collected by the SuperGreen Consortium. The data are available after selecting one or more modes of transport and then one of the following technology category:

- Engines and Propulsion Systems
- Fuels and sources of energy
- Cargo Handling and transfer
- Cargo Preparation
- Heating and Cooling
- Innovative units and treatment
- Vehicles
- Navigation technologies
- Best Practices

Results of the selection are reported in the following Figure 9 and Figure 10.

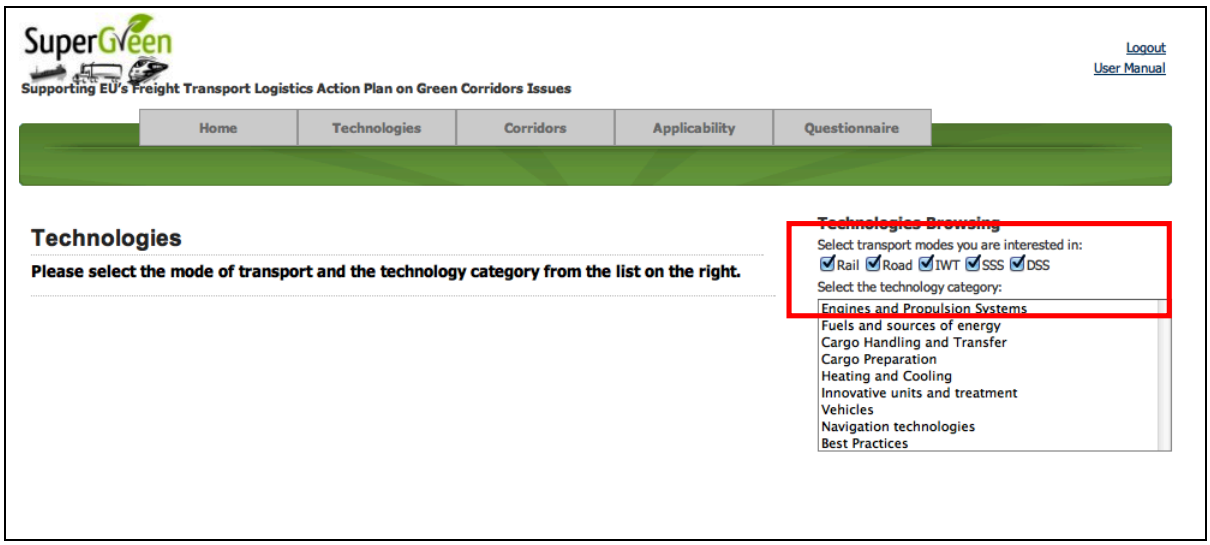


Figure 9: Section of the Mode of Transport

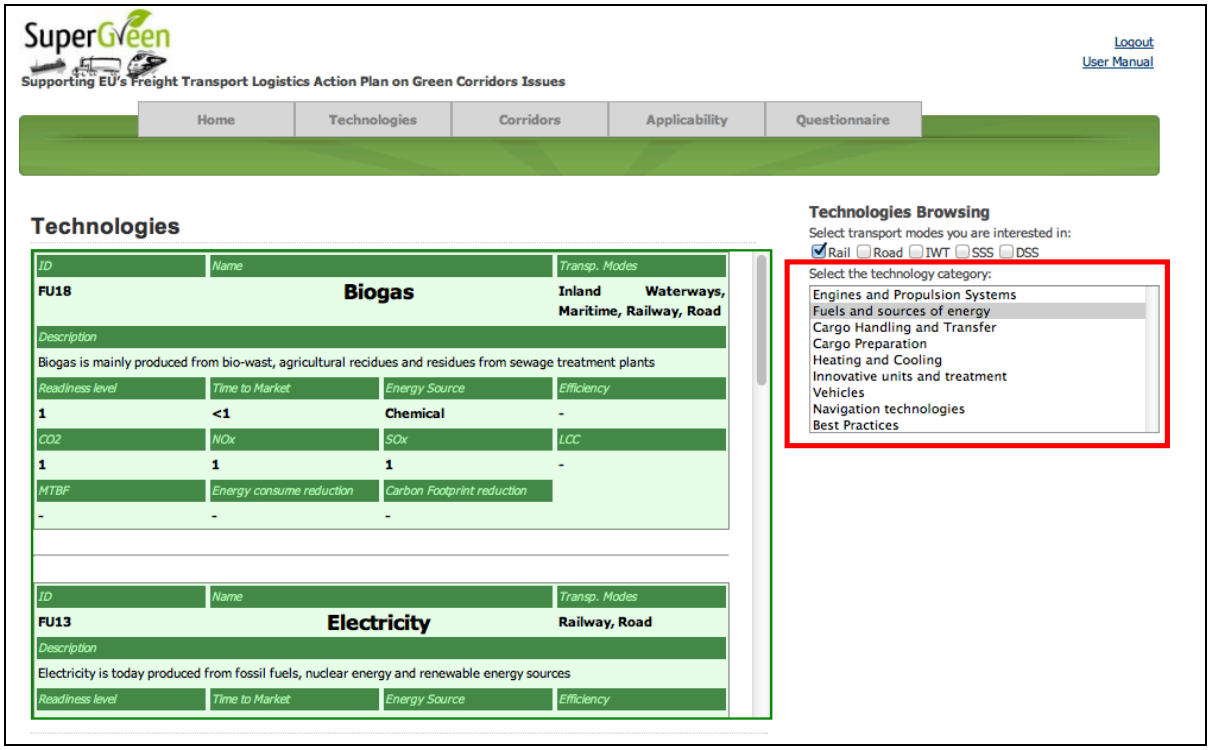
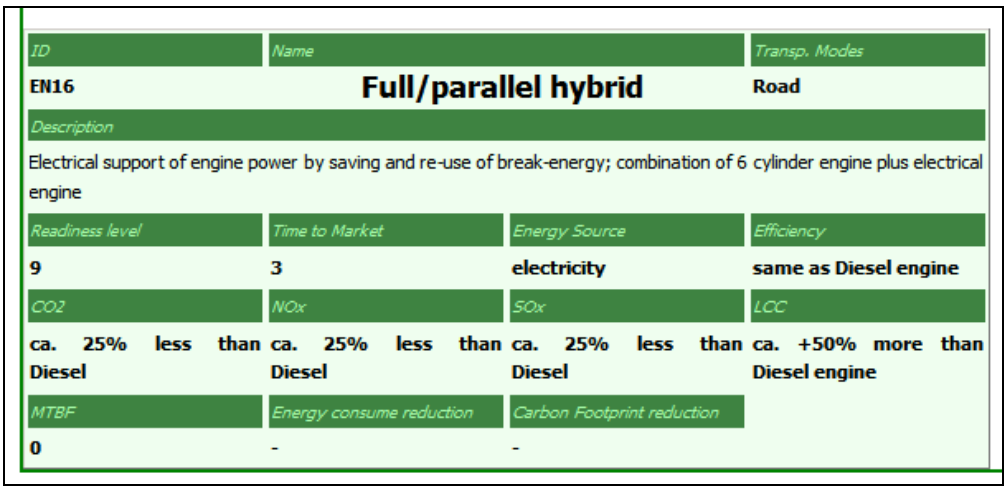


Figure 10: Selection of the Technology Category

The data available per each technology are (Figure 15):

- Brief description of the technology,
- Readiness level,
- Time to market,
- Energy source,

- Efficiency,
- CO2 emissions,
- NOx emissions,
- SOx emissions,
- Life Cicle Cost,
- Mean Time Between Failure,
- Energy Consume reduction,
- Carbon Footprint reduction.



ID	Name		Transp. Modes
EN16	**Full/parallel hybrid**		Road
Description			
Electrical support of engine power by saving and re-use of break-energy; combination of 6 cylinder engine plus electrical engine			
Readiness level	Time to Market	Energy Source	Efficiency
9	3	electricity	same as Diesel engine
CO2	NOx	SOx	LCC
ca. 25% less than Diesel	ca. 25% less than Diesel	ca. 25% less than Diesel	ca. +50% more than Diesel engine
MTBF	Energy consume reduction	Carbon Footprint reduction	
0	-	-	

Figure 11: Technology Characteristics

6.5 Representation of the map of corridors

Using the tab **Corridors** the user can access the part of the displaying the Corridors. In the upper right part of the page there is a form that allows the user to select corridors and transport type to be represent in the map.

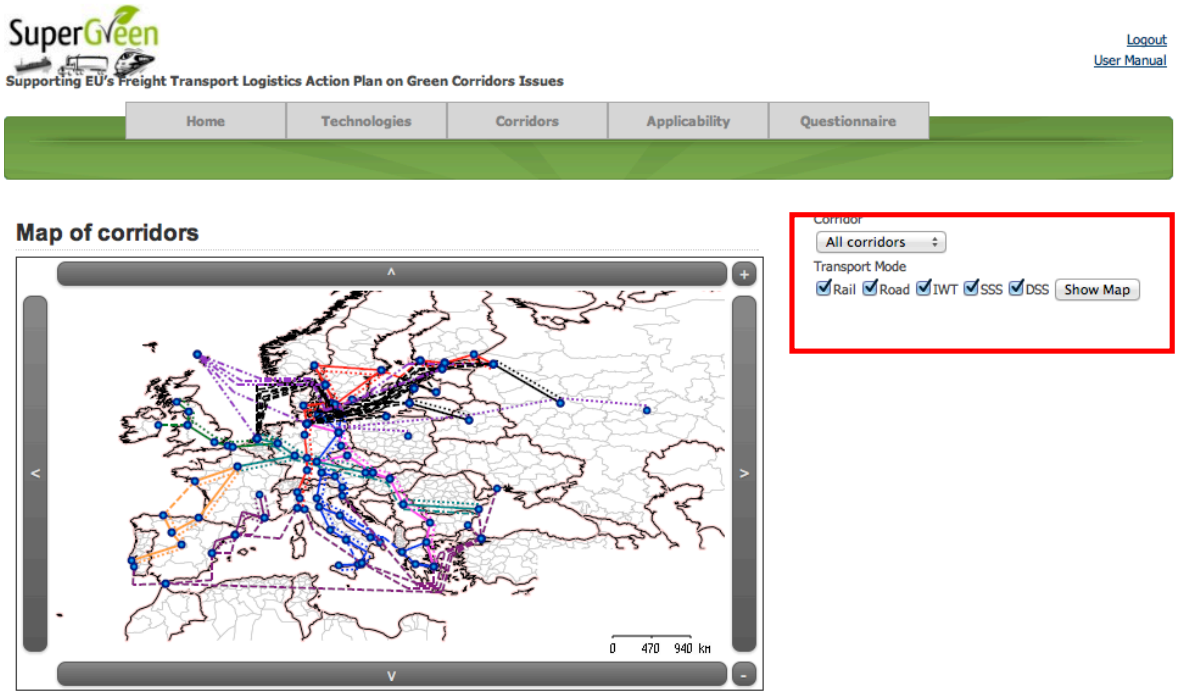


Figure 12: Corridors Section Default Screen

Using a drop-down menu (Figure 13) the user can choose between the following corridors:

- Brenner
- Finis Terrae
- Cloverleaf
- Edelweiss
- Nureyev
- Strauss
- Two Seas
- Mare Nostrum
- Silk Way

Figure 13: Corridor Selection

And between the followings transport types using the proper buttons:

- Rail;
- Road;
- IWT;
- SSS;
- DSS.

When a corridor is selected, the map is automatically scaled to show the entire corridor, and the tool displays four tables:

- The first one (on the right of map) contains the corridor node list (Figure 14), each one is identified by 3 fields (id, node, select); it is possible to select one or more nodes and correspondingly they are displayed in yellow colour on the map (Figure 15);
- The second one (on the right of the first table) contains the corridor link list (Figure 14), each one is identified by 4 fields (id, origin, destination, select); it is possible to select one or more links and correspondingly they are displayed in yellow colour on the map (Figure 15);
- The third one (reported below the map) shows - per each selected transport node and per each selected link - the applicable technologies referred to transport mode and technology category (Figure 16);
- The fourth one (reported below the third table) shows - for each transport mode and for each node that are selected - the technology categories and technologies that are applicable (Figure 16).

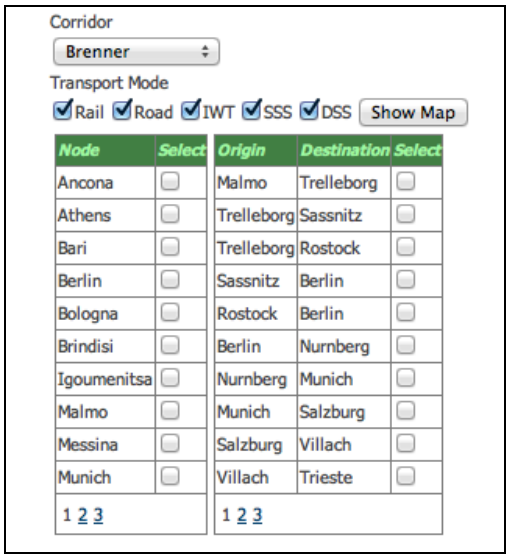


Figure 14: Tables showing the Node and Link Lists

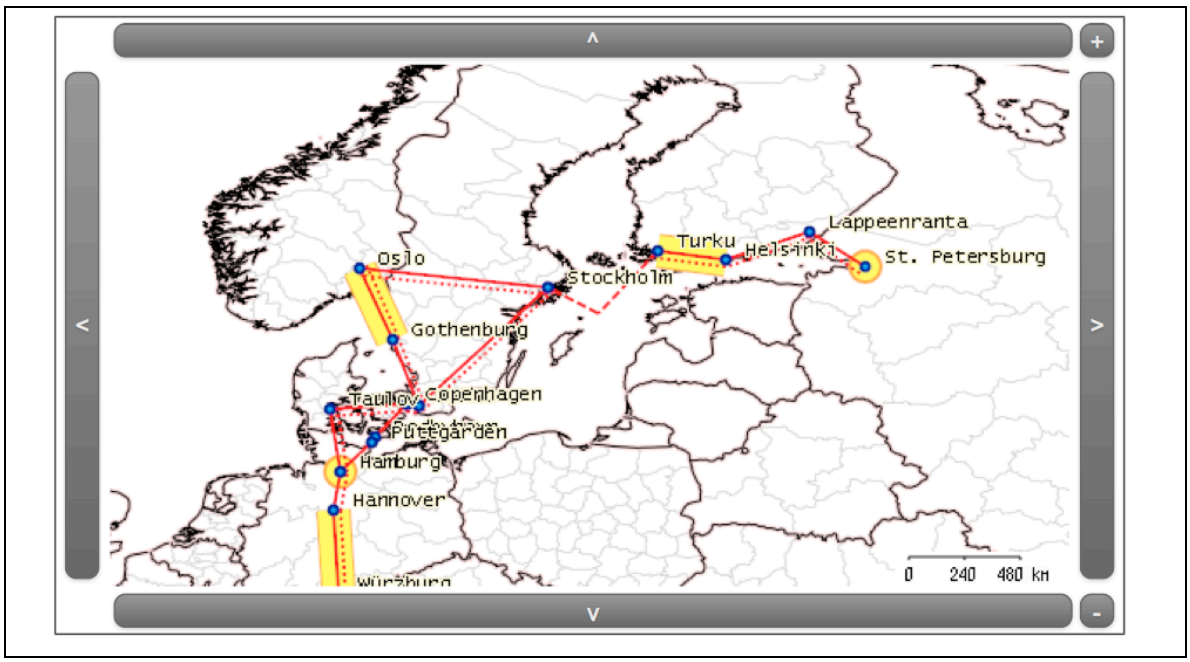


Figure 15: Map of Selected Nodes and Links of a Corridor

Applicable Tecnologies to Selected Arcs

Origin	Destination	Mode	Technology Category	Applicable Technology
Helsinki	Turku	Railway	Best Practices	Carbon-free rail freight transport
				TDS
				Traffic Flow Management
				Traffic Management System
			Engines and Propulsion Systems	LPG Engine for Diesel Locomotives
			Fuels and sources of energy	Electricity
				Fuel cell hybrid system
			Innovative units and treatment	APU (Auxiliary Power Unit)
				Braking energy recovery
				Onboard energy storage systems
			Navigation technologies	Global Navigation Satellite Systems or GNSS
				Train Control System
				WiMax - Worldwide Interoperability for Microwave Access
			Vehicles	Brake energy recovery system
				Electric Locomotive
				Hybrid Locomotive
		Road	Engines and Propulsion Systems	Diesel turbo compound
				Full/parallel hybrid
			Fuels and sources of energy	Electricity
				Ethanol and bio-diesel
				Fuel cell hybrid system
				HFO (Reference)
				Hydrogen
				Ultra-low sulphur diesel
			Navigation technologies	Global Navigation Satellite Systems or GNSS
				Predictive cruise control (PCC)
				WiMax - Worldwide Interoperability for Microwave Access
			Vehicles	Aerodynamic drag improvements
				Electric vehicles
				Euro VI vehicles
				Hybrid Truck
				Low rolling resistance tires

Figure 16: List of Technologies Applicable on Selected Links

6.6 Representation of the Technology vs Application Matrix

Using the tab **Applicability** the SuperGreen Knowledge Base shows the applicability of the technology on a pre-selected corridor.

The selection of the mode of transport, technology and corridor is necessary to see the results of the Technology vs Application matrix.

After the selections, the SuperGreen Knowledge Bases offers automatically the map of Europe with the possible corridor highlighted in green and a table that reports the selections made. Further, the list of nodes and links (Figure 17) highlighted in different colours is reported:

- *Green*: the SuperGreen Consortium considers the technology as applicable on the nodes/links;
- *Red*: the SuperGreen Consortium considers the technology as not applicable on the nodes/links.

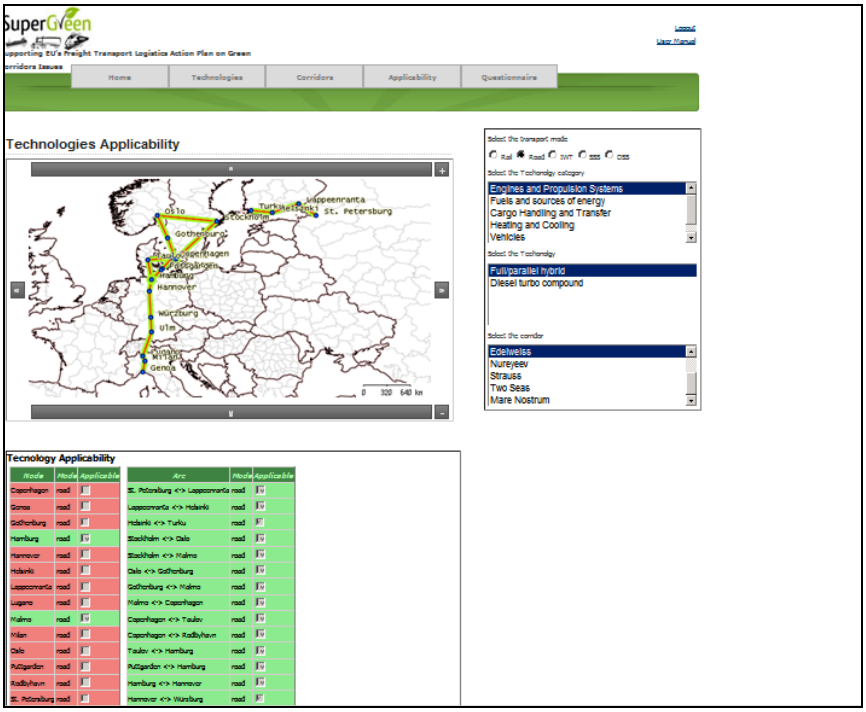


Figure 17: Map of the Technology Applicability

6.7 Population of the SuperGreen Knowledge Base

6.7.1 First work session (M1-M18)

The tool has been populated with data collected in Task 2.1 (Selection of Corridors) and in Task 3.1 (Identify Green Technologies).

The data stored in the web tool coming from Task 3.1 are referred to the corridors:

- 9 corridors;
- 124 segments;
- 89 terminals.

The data stored in the SuperGreen Knowledge Base coming from Task 3.1 are referred to the list of technologies collected during the first round collection performed.

6.7.2 Second work session (M19-M36)

During the second phase of the task, all the data collected with the Technology vs Application Matrix have been stored in the SuperGreen Knowledge Base.

Information have been filled in with reference to:

- 9 corridors: all nodes and links;
- 9 technology categories;

- 104 technologies: all the technologies identified as Very Important, Important and Low Importance (Task 3.1 – Deliverable 3.1)
- 5 transport modes.

6.8 Validation and update of the information collected

The **Questionnaire** section has been developed to collect feedback on technologies, on their influence on the KPIs defined in the scope of the project and on their applicability on the corridors (nodes + links).

The needed steps to fill in the questionnaire are (Figure 18):

- Selection of the transport mode,
- Selection of the technology category,
- Selection of the technology.

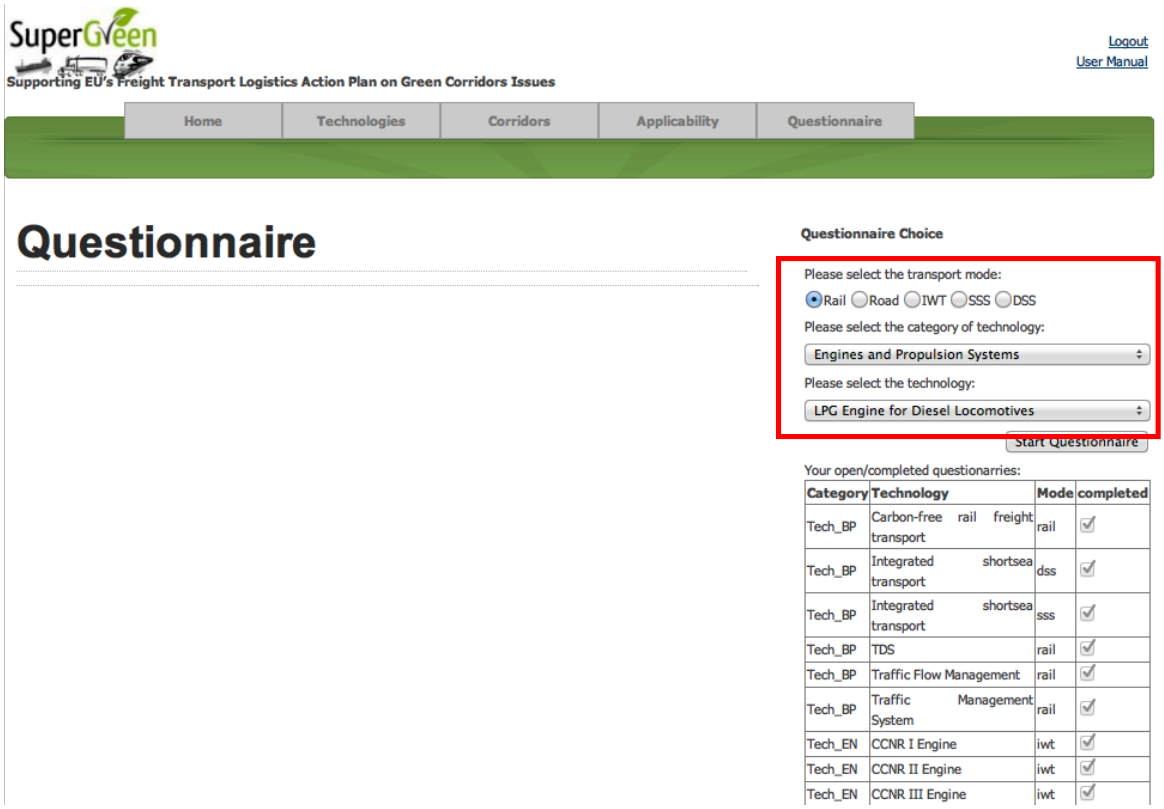


Figure 18: Default Screen of the "Questionnaire" section

The questionnaire section is composed of one page dedicated to the evaluation of the influence on KPIs and then one page to express the feedback on the applicability of technology on each selected corridor.

In the right part of the default screen a table provides data relative to the technology characteristics (Figure 19).

In the left part, few indications on the questionnaire are reported.

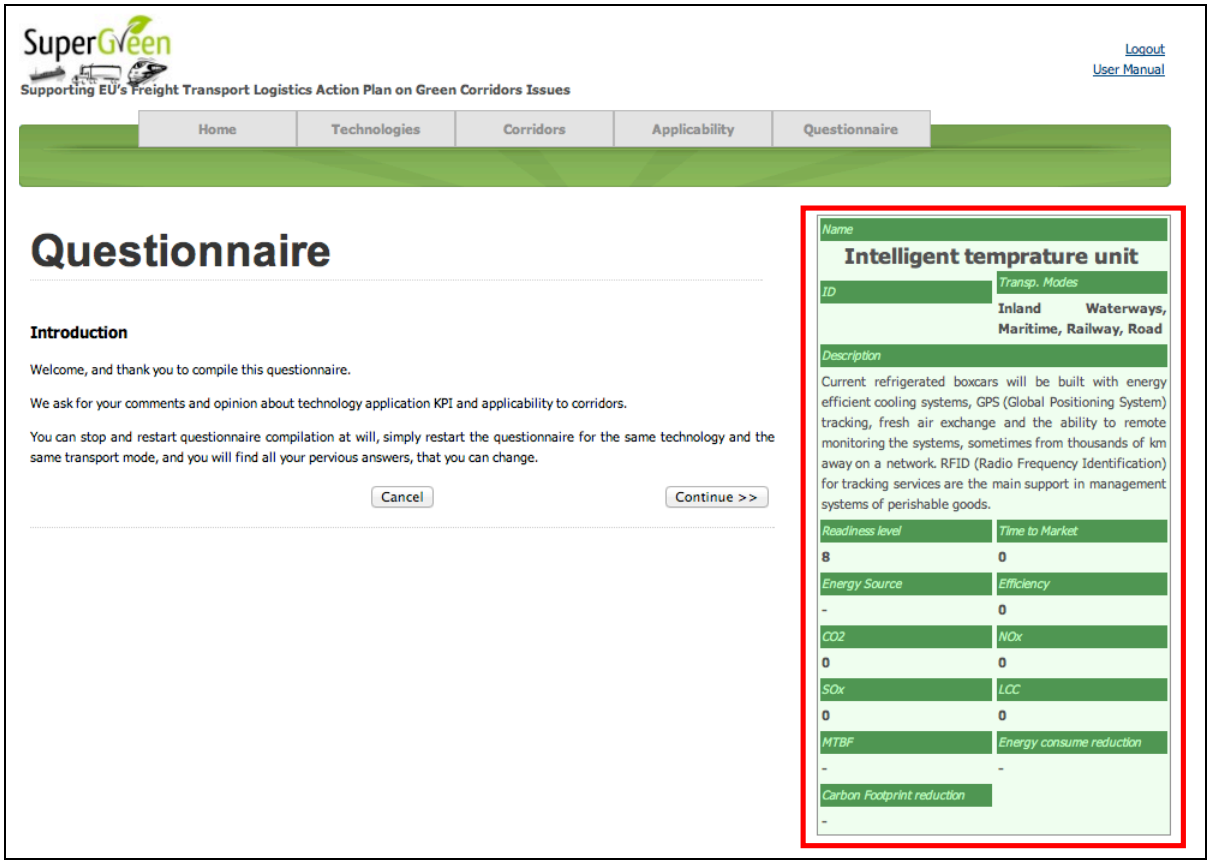


Figure 19: Introduction to the Questionnaire

In the second page of the questionnaire (Figure 20), the table in the right part of the screen shows the data of the technology (these data are reported in each of the following pages).

In the left part, it is possible to write a comment on the technology and express an opinion on the influence of the technology on KPIs.

The available opinions are (Figure 20):

- *Unknown*: the influence of the technology on that KPI is not known,
- *Pejorative*: the influence is negative,
- *Unchanged*: no influence,
- *Better*: the influence is positive,
- *Very high*: the influence is very positive.

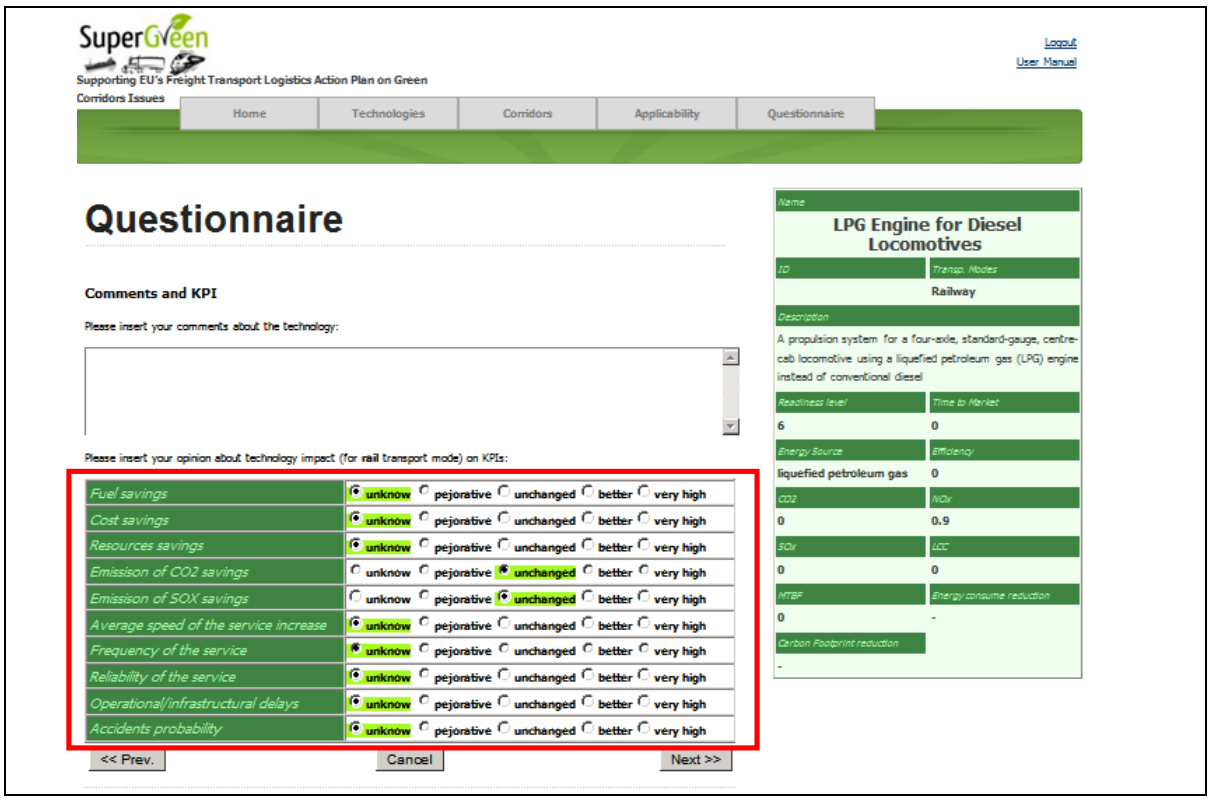


Figure 20: Questionnaire: Feedback on the Technology Influence on KPIs

From the third page on, the technology applicability on each corridor is reported to let the user express a feedback on that (Figure 21).

Below the map, two tables are reported, respectively one with the list of nodes and the other with the list of links. The intent of these tables is to insert the user's opinion on technology applicability.

The list of nodes and links are highlighted in:

- *Green*: the SuperGreen Consortium considers the technology as applicable on the nodes/links;
- *Red*: the SuperGreen Consortium considers the technology as not applicable on the nodes/links.

The available opinions are (Figure 21):

- *No opinion*: the user does not have an opinion on the technology applicability,
- *Is applicable*: the technology is applicable on node/link,
- *Is not applicable*: the technology is not applicable on node/link.

Moreover, it is possible to select the same opinion for all the links/nodes of the corridor:

- The technology *is applicable* on all the nodes/links,

- The technology *is not applicable* on all the nodes/links.

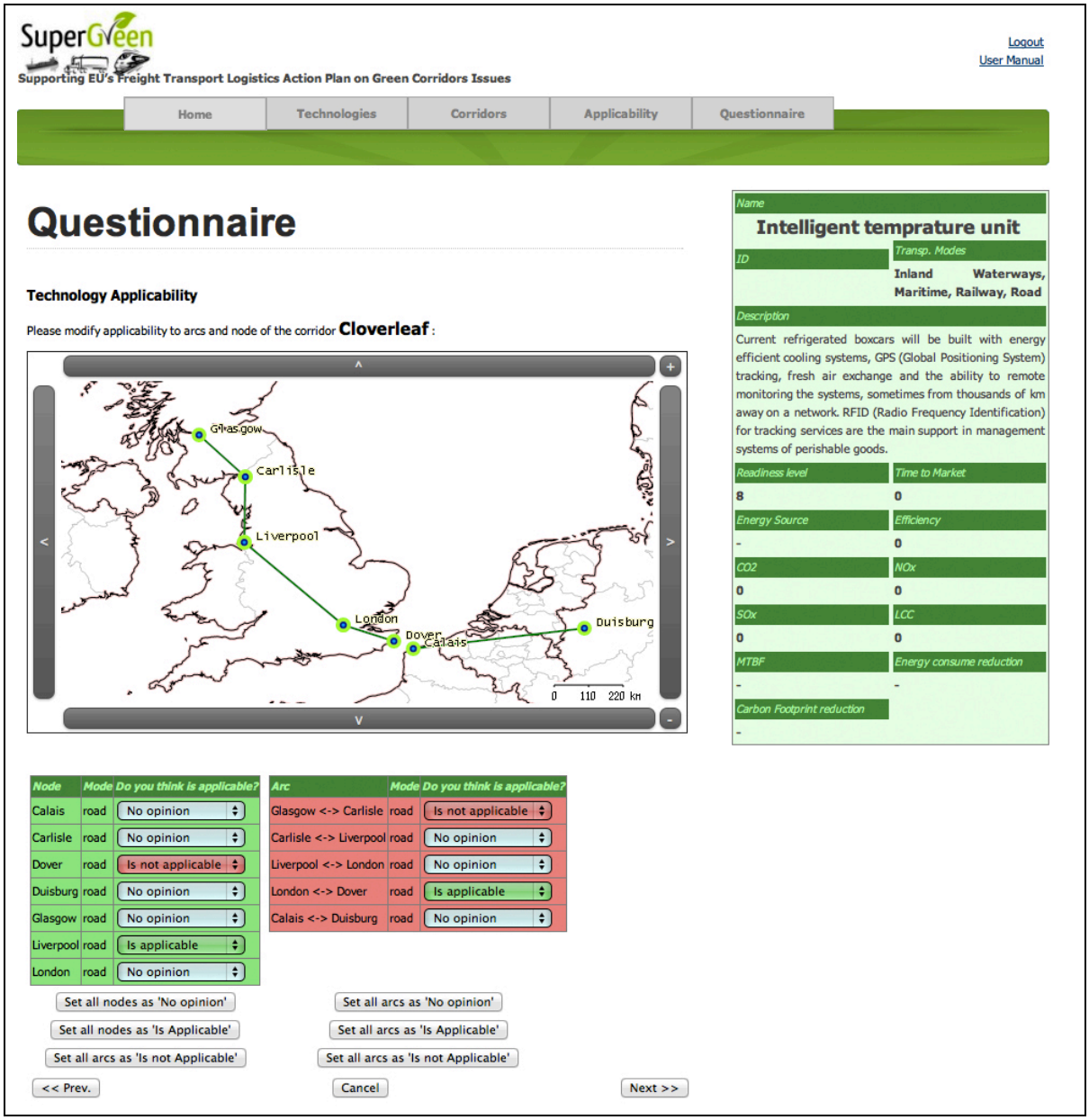


Figure 21: Questionnaire: Opinion on technology applicability

In the following **Table 3** the list of questionnaires filled in by partners is reported. Partners involved in the project filled in questionnaires according to their expertise in a specific transport mode sector. Feedbacks on most of technologies have been collected through the questionnaires.

At the end of the questionnaires phase, the information on the applicability of the technologies on corridors (i.e. links + nodes), previously stored in the SuperGreen Knowledge Base, have been updated according to the results of the questionnaires when necessary.

Table 3: Questionnaires Filled In By Partners

	Transport Mode					
Tech Category	rail	road	iwt	sss	dss	*Total*
Best Practices	7	-	-	4	-	11
Cargo Preparation	1	-	-	1	-	2
Engines & Propulsion Systems	6	4	8	5	-	23
Fuels and Energy Sources	5	5	4	8	2	24
Cargo Handling Systems	3	3	2	3	1	12
Heating and Cooling Technologies	8	6	6	10	6	36
Innovative Units and Treatment	2	-	-	-	-	2
Navigation Technologies	3	2	2	13	-	20
Vehicles	6	6	-	1	1	14
Total	41	26	22	45	10	144

6.9 Presentation of the results

A Technology Card has been prepared to present the main characteristics and benchmark results for a selection of technologies classified as the most promising ones in the scope of the project.

In the following Figure 22 the page of the SuperGreen knowledge Base dedicated to the creation of the report on technologies (i.e. Technology Cards) is reported. More explanation and details on the preparation of the Technology Cards are reported in next Section 7.

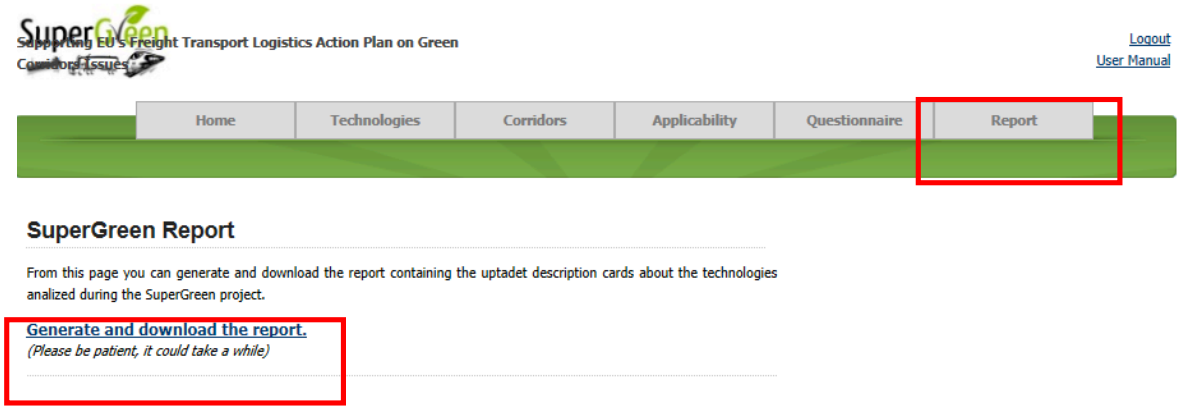


Figure 22: Generation and Downloading of the Technology Cards Report

7 Technology cards

In order to summarise the main characteristics, applicability and results of the benchmark activities, a Technology Card has been prepared for a selection of technologies and it is downloadable from the SuperGreen Knowledge Base. This document includes, in fact, results of Task3.2 and Task3.3 – Benchmark Green Corridors with Green Technologies. More details on the creation of the benchmark are reported in D3.3 developed within the scope of Task 3.3. This section is only dedicated to the description of the content of the Technology Cards.

Each technology card is composed by the following parts:

- *The description of the technology* with main data anche charcateristics*;*
- *High Level Benchmark*: This section reports the influence of the technology on KPI; the influence is reported on the basis of a colour legend (qualitative analysis) and with specific data, if available (quantitative analysis). In order to better analyse the influence of the technology on KPI, the KPI factorization has been considered. So the results are reported with reference to the KPI factors:
    - Cost for operation;
    - Capital expenditures (CAPEX);
    - Fuel savings;
    - CO2 emissions savings;
    - SOX emissions savings;
    - Operational or infrastructural delays;
    - Frequency of service;
    - Improvement of reliability;
- *Technology Benchmark and SuperGreen KPI*: in this section the results of the benchmark performed with reference to specific scenarios are reported. In this case the benchmark has been done with respect to the baseline performances (i.e. performances of the current technology applied on the corridors) on specific links/nodes of a corridor. The results are reported with reference to the benchmark of Green Corridors made in WP2 (for more details please see D2.4 developed in the scope of WP2) and with reference to the following list of KPI:
    - Cost;
    - CO2 emissions;
    - SOX emissions;
    - average speed;
    - frequency;
    - reliability.

- *Technology Applicability per Corridor*: in this section the results of the Technology vs. Application Matrix are reported including a short description of the applicability of the technology on each corridor.
- *Technology Notes*: a description of a current application of the technology with data on the performance is reported if some example of the application are currently available.

A technology card has been filled in for the following technologies selected as the most promising in the scope of the project (**Table 4**). The results of this activity are reported in Appendix VI.

Table 4: List of Technology Cards

Category	ID	Technology Name	Transport Mode
Engines & propulsion systems	EN11	Dual fuel engine	Maritime
	EN16	Full/parallel hybrid	Road
	EN18	Fuel cell technology	Road
	EN21	Exhaust Abatment System	Maritime
			Maritime
	EN06	Azimuthing thrusters	Maritime
	EN39	Gas engines	Maritime
	EN48	CCNR III Engine	Inland Waterways
	EN51	CCNR IV Engine	Inland Waterways
	EN61	Counter rotating propeller	Maritime
Fuels and energy sources	FU02	Ethanol and bio-diesel	Maritime
			Road
	FU03	CGN (compressed natural gas)	Multimodal
	FU08	LNG	Multimodal
	FU18	Biogas	Multimodal

Table 4: List of Technology Cards

Category	ID	Technology Name	Transport Mode
	FU05	Alternative maritime power (AMP)	Maritime
	FU06	Wind energy	Multimodal
			Inland Waterways
	FU13	Electricity	Road
			Railway
	FU25	Sky sails system	Maritime
	FU26	Waste heat recovery system	Maritime
Cargo handling systems	HT01	Diesel to electric power convertor (RTGs)	Multimodal
	HT03	Hybrid hydraulic drive Terminal tractors	Maritime
	HT07	Low emission engines	Multimodal
	HT08	ZF transmission systems	Multimodal
	HT09	Green schemes to improve RTGs emissions and noise	Multimodal
	HT10	Horizontal container (un)loading	Multimodal
	HT06	MP-RTGs	Multimodal
	HT11	Cargo Cassette and Translifter	Maritime
	HT36	FlexiWaggon	Railway
Heating and Cooling	HC04	RFID tag antenna with temperature alarm sensor	Multimodal
Vehicles	VE02	Electric Locomotive	Railway
	VE03	Hybrid Truck	Road

Table 4: List of Technology Cards

Category	ID	Technology Name	Transport Mode
	VE09	Electric vehicles	Road
	VE10	Euro VI vehicles	Road
	VE01	Hybrid Locomotive	Railway
	VE29	Aerodynamic drag improvements	Road
	VE33	Low rolling resistance tires	Road
	VE35	Electrification of Trucks on Highways	Road
Navigation technologies	NA15	WiMax	Maritime
			Road
			Railway
	NA12	GEO satellites	Maritime
	NA16	Route optimisation system (scheduling)	Inland Waterways
			Maritime
	NA17	River Information Services (RIS)	Inland Waterways
Best practices / Technology integration	BP04	Traffic Flow Management	Railway
	BP07	Carbon-free rail freight transport	Railway
	BP02	TDS	Railway
	BP03	GEKKO	Railway
	BP08	Integrated shortsea transport	Maritime
	BP13	EREX (ERESS)	Railway
Innovative units and treatment	LU13	Braking energy recovery	Railway
	LU14	Onboard energy storage systems	Railway

8 Conclusions

The activities of Task 3.2 "Define Application Areas for Green Technologies" have been mainly dedicated to achievement of the following objectives:

- definition of the tools needed to collect information in order to define the link between the technologies and the application in the corridors developing a questionnaire to be submitted to partners;
- collation the information using the aforementioned questionnaire templates needed to define a Technologies vs Application Matrix and then validate and update the data collected;
- definition of the Technology vs Application Matrix and population;
- design, development, upload and maintenance of the SuperGreen Knowledge Base.

In order to evaluate the applicability of the most promising technologies to the corridors or parts of them (segments and nodes) a Technology vs Application Matrix has been developed and filled in with data coming through questionnaires, workshops, expert judgement.

Information collected on 104 technologies identified as the most promising within the scope of the project have been then filled in the SuperGreen Knowledge Base, developed to store the information resulting from all the activities of Task 3.2.

The interface has been realized using a wizard to help the user in browsing the content and accessing to the whole knowledge stored there.

A dedicated session, "Questionnaire", has been also developed to collect feedback from internal and external partners of the project in order to validate and update, if necessary, the data collected within the scope of the project.

As final result of the task, a report for the most promising technologies is downloaded from the SuperGreen Knowled Base. The report reports data and characteristics on technologies and results on the benchmark activity.

Appendix I: Structure of the Questionnaire

Appendix II: Memo of Assistance to Questionnaire

Appendix III: Fulfilled Questionnaires

Appendix IV: Technologies vs Applications Matrix (First Work Session)

APPENDIX V: Technology Vs Application Matrix (Second Work Session)

APPENDIX VI: Technology Cards