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TEN-T Core Network Corridors Scandinavian-Mediterranean Corridor

2nd phase

Final Report
on the Wider Elements of the Work Plan

Final Version: 12.07.2017

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Information on the current version:

The draft version of the Final Report on Wider Elements of the Work Plan was due to be submitted on 22.05.2017 together with the (draft) Final Report on the Elements of the Work Plan. After agreement of the Commission the delivery of both reports was divided and the deadline for the "Wider Elements" report was extended by one week.

Comments received from the Commission were (partly) included into the (2nd draft) Final Report on the Wider Elements of the Work Plan which was delivered on 06.06.2017.

Some items were left to be improved for the "final" Final Report on the Wider Elements which was submitted by the end of the reporting period end of June 2017. The present version of the Final Report dated 12.07.2017 allows for some final editorial improvements.

Disclaimer

1 Executive summary

The Report on Wider Elements of the Work Plan complements the Report on Elements of the Work Plan by focusing on the three wider elements:

- the corridor's potential of innovation deployment and its impact on the corridor overall performance, where the innovations are defined in Articles 31 to 33 of the TEN-T Regulation,
- the impact of climate change on the existing infrastructure and possible measures to enhance the resilience against climate change (see also Article 35),
- the impact of corridor deployment on the greenhouse gas emissions and noise and possibly other negative impacts on the environment and proposed measures to mitigate them (see also Article 36).

1.1 Analysis of the corridor's potential of innovation deployment and its impact on the corridor overall performance

Individual projects contribute to the deployment of innovations in the transport sector. In total, 174 of the 666 Scandinavian-Mediterranean TEN-T Core Network Corridor related projects are to be regarded as "innovative" according to the definition agreed with the Commission. Most innovation projects belong to the project categories Motorways of the Sea - MoS - (46 projects), maritime (38 projects), road (34 projects) and innovation (27 projects). In this context, innovation projects include any project dealing with innovative elements as defined in Articles 31, 32 and 33 of Regulation (EU) 1315/2013 as well as those innovations mentioned in the Issues Papers of European Coordinators[1].

The contribution of innovative projects to reducing the negative environmental impacts of transport is showcased by selected projects. They include the construction of a liquefied natural gas (LNG) powered hopper barge and an LNG-powered ice breaker, which reduce greenhouse gas and air pollutant emissions in comparison to conventional diesel-powered ships. The construction of fast electric charging stations on roads enables long distance trips with electric vehicles; aiding in overcoming a bottleneck in the diffusion of electric vehicles. The construction of an electrified road tests an alternative to batteries as electric power supply for heavy goods vehicles. An innovative approach to urban planning creates a noise barrier between a port and city by incorporating existing natural elements. A multimodal trip planner for freight services combines sharing of data, and thereby contributes to modal shift from road to rail and maritime transport.

1.2 Impact of climate change on the existing infrastructure and possible measures to enhance the resilience against climate change

The effects of climate change include increased temperatures and extreme weather events like storms, floods and droughts. These changes can increase weather-induced degradation of transport infrastructures if they are not adapted to the increased stress. Extreme weather events may destroy infrastructures that are not sufficiently protected. The Scandinavian-Mediterranean TEN-T Core Network Corridor reaches from Scandinavia to the Mediterranean Sea; therefore, the corridor countries face different weather conditions and different threats due to changes in the weather.

For corridor sections in the Scandinavian countries, highest risk levels arise from winter storms causing damages on the electric grid and possible accumulation of snow, which can hinder rail and road traffic. In parts of Sweden and Denmark storms create high risk of difficult conditions on sea and flooding at the coast. For corridor sections in Germany,

[1] https://ec.europa.eu/transport/sites/transport/files/themes/infrastructure/news/doc/2016-06-20-ten-t-days-2016/issues-papers.pdf

the risk is heightened that hotter summer temperatures and drought damage road and airport runway surfaces and decrease the stability of bridges through thermal expansion. Austrian and Italian alpine corridor sections face medium to high risks of permafrost degradation that endangers the earthworks under tracks and roads. On other corridor sections in Italy and on Malta increased precipitation poses medium to high risk of flooding railway tracks and roads. These risks and associated mitigation measures are included in respective national analysis and (partly) in corresponding national action plans.

We gained the impression that infrastructure managers are aware of both risks and measures and will incorporate them if it comes to maintenance, upgrade or new-building of respective infrastructure. Measures taken to increase the resilience of infrastructure against these weather effects include flood protection in ports as well as mountain valleys as shown by the case studies on the Lower Inn valley and in the Port of Hamburg.

1.3 Impact of corridor deployment on the greenhouse gas emissions and noise and possibly other negative impacts on the environment and proposed measures to mitigate them

Transport demand is predicted to increase on the Scandinavian-Mediterranean TEN-T Core Network Corridor until 2030 compared to the base data available for 2010. The resulting increase in greenhouse gas (GHG) and air pollutant emissions is smaller than the increase in transport performance, because average emissions per passenger-km and tonne-km are assumed to decrease until 2030 due to efficiency gains and changes in the energy mix. The total transport performance for passenger traffic rises by 36 index points and for freight by 69 index points in the twenty years until 2030. The CO_2 emissions from both road and rail transport are estimated to rise by 34 index points in the same time. The NOx emissions are estimated to decrease by 45 index points while particle emissions remain stable. In all emissions, road traffic plays the most dominant role.

In a Maximum Potential Modal Shift Scenario, requested by the Commission, available rail capacity in the year 2030 is used to shift passenger traffic and freight transport from road to rail. The resulting modal shift is a theoretical figure, which can serve as a notional target. With the maximum possible shift from road to rail, CO_2 emissions from both road and rail transport would be 51 index points lower compared to 2010. The NOx emissions would be 82 index points while particle emissions would be 80 index points lower compared to 2010 levels.

Innovative projects that contribute to reducing the negative environmental impacts of transport include 80 projects, which address decarbonisation directly. Out of these, 43 projects concern alternative fuels, 4 address efficiency improvements and 1 project addresses modal shift. The innovation case studies demonstrate how these projects reduce greenhouse gas emissions and other negative environmental impacts from transport.

For the reduction of noise, measures on hand are to improve the infrastructure (noise barriers, special road pavement, ...), protect the affected houses (special windows) or the operations (low noise brakes of rail freight wagons) where Germany and Austria agreed to allow operations of only "low noise wagons" from 2021.

2 Introduction

The TEN-T Regulation's Article 47(1)(a) to (e) and Article 47(3)(b) define the elements of the work plan which do compose also the "wider elements". According to a common understanding of the European Commission the three "wider elements" are

- the corridor's potential of innovation deployment and its impact on the corridor overall performance, where the innovations are defined in Articles 31 to 33 of the TEN-T Regulation,
- the impact of climate change on the existing infrastructure and possible measures to enhance the resilience against climate change (see also Article 35),
- the impact of corridor deployment on the greenhouse gas emissions and noise and possibly other negative impacts on the environment and proposed measures to mitigate them (see also Article 36).

This report presents the results on the analysis of these wider elements of the work plan.

The analysis follows the joint methodology developed by the cross-corridor working group on the wider elements of the work plan laid out in the „Trans-European transport network - Task 3b: Guidelines V7 of March 2017". The Working Group is made of the consultants TIS, M-FIVE, Prognos, Panteia, Ineco, TPlan, Stratec, Hacon and KombiConsult and is coordinated by TIS. The methodology was sent to the European Commission for agreement in January 2017 and was approved to be applied in mid March 2017. The terms "joint methodology" or "Task 3b Guidelines" are used simultaneously for the agreed methodology which is attached as an Annex 1.

3 Analysis of the corridor's potential of innovation deployment and its impact on the corridor overall performance

The joint methodology states that technological innovations improve the quality, safety and efficiency of transport. The introduction and uptake of new technologies help to lower the negative environmental impacts of transport by reducing or eliminating CO_2 and other emissions. Corridor projects contribute to the deployment of these innovations in transport.

3.1 Mapping and assessment of innovation projects

According to the Task 3b Guidelines, 'innovation projects' had to be identified on the basis of the Final Project List of the ScanMed Corridor, which was agreed by the Commission on 26th April 2017. Innovation projects in terms of Task 3b are not only those projects categorised as "Innovation" in the Project List, but any project dealing with innovative elements as defined in Articles 31, 32 and 33 of Regulation (EU) 1315/2013 as well as those innovations mentioned in the Issues Papers of European Coordinators[2].

The Issues Papers put the Trans-European Core Network Corridors in a wider perspective of European Policy objectives and seek to create synergies between the different fields for mutual benefit. The "issues" addresses are:

- Enabling multi-modality and efficient freight logistics;
- Boosting intelligent transport systems;
- Boosting new technologies and innovation;
- Effectively integrating urban nodes;
- Extending cooperation with third countries.

In order to achieve the wanted results the entire Project List was analysed with respect to the project title, project short description, maturity and other data as well as the knowledge base of the corridor consultants complemented by desk research. The mapping criteria provided in the joint methodology were applied if relevant for a project. The initial project category "innovation" – which included 27 projects – did not play a role here since the original categorisation allowed each project to be flagged into only one category, and the "classical" transport modes e.g. rail, road, maritime were applied first.

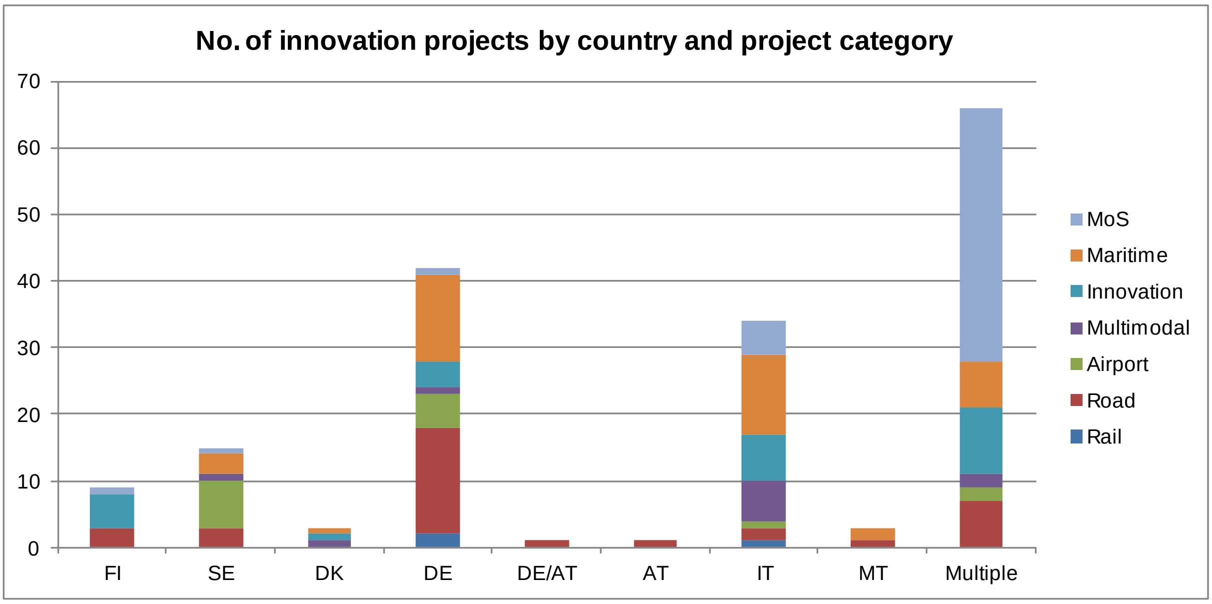
After having exercised the innovation assessment - strictly following the Task 3b Guidelines - 174 of the 666 ScanMed related projects are to be regarded as "innovative". Most innovation projects belong to the project categories Motorways of the Sea - MoS - (46 projects), maritime (38 projects), road (34 projects) and innovation (27 projects). Project categories that are underrepresented in view of innovation are airport (15 projects), multimodal (11 projects), rail (3 projects) as well as "rail ERTMS"[3], "rail+road" and "other" where no innovation project could be identified at all.

Figure 1 gives an overview of the innovation projects distinguished between the countries involved and project categories. Due to the high share of innovative MoS projects which are predestined for taking place in several Member States, multi-country projects show most innovations. Besides that, the distribution of innovation projects between the corridor countries is comparable to the distribution of all projects in the entire Corridor Project List.

[2] TEN-T Corridors: Forerunners of a forward-looking European Transport System, June 2016.

[3] According to Task 3b Guidelines, page 4: "ETCS level 2 is a common standard for CNC according to the KPIs, but not an innovation." Given that none of the rail ERTMS projects explicitly targets more than ETCS level 2, all of them were assessed "non-innovative".

Figure 1: Innovation projects by country and project category



Source: KombiConsult analysis, May 2017

Within the framework of the "wider elements" analysis, the scope of innovation projects can be characterised by innovation aspects as listed in Annex I of the Task 3b Guidelines which belong to three innovation areas:

- Telematic applications,
- Sustainable freight transport services,
- Other new technologies and innovation.

For each of these innovation areas and by mode of transport the innovation fields according to the TEN-T Regulation and the innovation tags following the terms used in the Issues Papers of the European Coordinators have been aligned with each other. Figure 2 shows the principle of this exercise whereas the details are provided in Annex 1.

For each of these innovation areas the coverage of related innovation aspects by projects has been analysed in order to identify potential gaps. The results of this absolute analysis are presented in the diagrams in Figure 3 to Figure 8, showing the number of projects and the total project costs by innovation aspect. Hereby, multiple allocation of projects to innovation aspects is included, both within and between innovation areas. Thus, in the right column of each diagram, the number of projects assigned to one or more innovation aspects (or their total project costs respectively) is shown. With regard to the financial analysis it has to be duly noted that the share of the projects' total costs belonging to the respective innovation aspect is not known.

In a second step, a relative analysis comparing the situation between core network corridors is foreseen to be executed by TIS. The results are however not available yet.

Figure 2: Innovation areas, modes, innovation fields and tags following the Issues Papers' topics

Inno-vation Area	Mode (s)	Specific Innovation Field (Regulation 1315/2013)	Suggested Tag for PL (IP-specific topics)
TELEMATIC APPLICATIONS	Rail	ERTMS	ERTMS
		possibly also future wireless systems	Other telematics applications
	IWW	RIS	RIS
	Road	ITS	ITS
	Maritime	VTMIS	VTMIS
		e-Maritime services, including single-window services such as the maritime single window, port community systems and relevant customs information systems	Other telematics applications
	Air	Air traffic management systems, in particular those resulting from the SESAR system	SESAR (ATM)
	All	Applications that enable traffic management and the exchange of information within and between transport modes for multimodal transport operations and value-added transport-related services, improvements in safety, security and environmental performance, and simplified administrative procedures	Data sharing, cooperation systems and real-time predictive analysis for multimodal transport
SUSTAINABLE FREIGHT TRANSPORT SERVICES	All	Measures aiming to improve sustainable use of transport infrastructure, including its efficient management	Efficient management and governance structures
		Measures aiming to promote the deployment of innovative transport services, including through motorways of the sea and telematic applications	Innovative transport services
		and the development of the ancillary infrastructure necessary to achieve mainly environmental and safety- related goals of those services,	Safety & security
		as well as the establishment of relevant governance structures	Efficient management and governance structures
		Measures aiming to facilitate multimodal transport service operations, including the necessary accompanying information flows, and improve cooperation between transport service providers	Data sharing, cooperation systems and real-time predictive analysis for multimodal transport
		Measures aiming to stimulate resource and carbon efficiency, in particular in the fields of vehicle traction, driving/steaming, systems and operations planning	Low carbon & Decarbonisation
		Measures aiming to analyse and provide information on fleet characteristics and performance, administrative requirements and human resources	Data sharing, cooperation systems and real-time predictive analysis for multimodal transport
		Measures aiming to improve links to the most vulnerable and isolated parts of the Union, in particular outermost, island, remote and mountain regions	Integration of remote areas

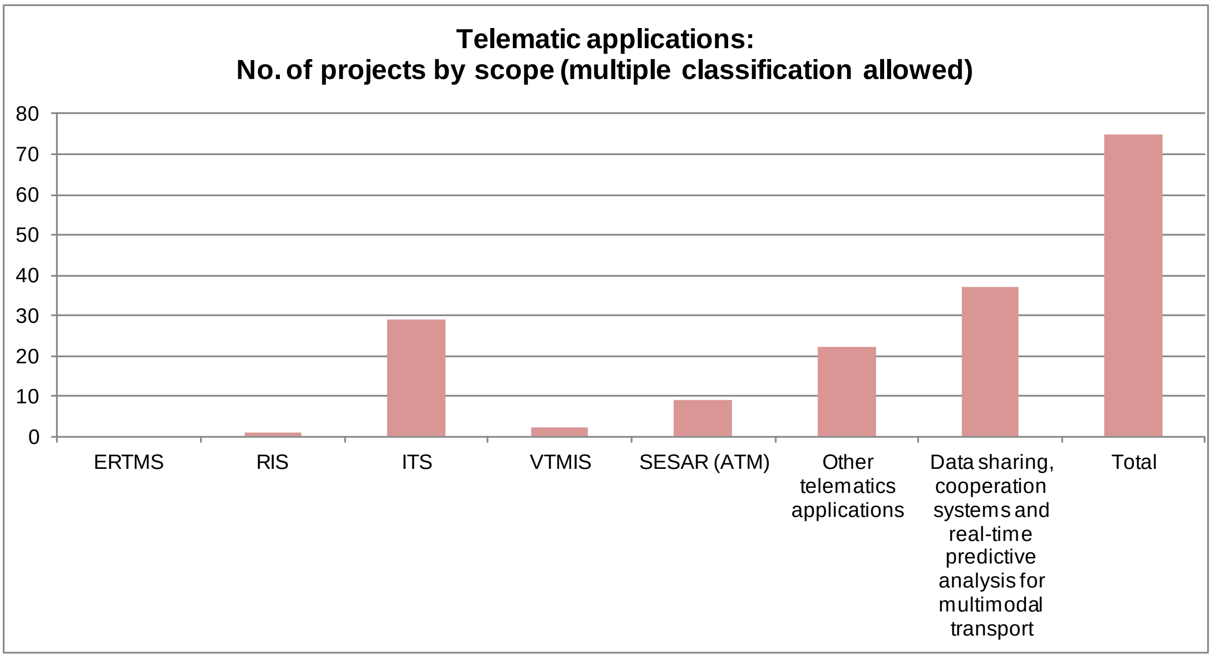
Inno-vation Area	Mode (s)	Specific Innovation Field (Regulation 1315/2013)	Suggested Tag for PL (IP-specific topics)
OTHER NEW TECHNOLOGIES AND INNOVATION	All	Measures aiming to support and promote the decarbonisation of transport through transition to innovative and sustainable transport technologies	Low carbon & Decarbonisation
		Measures aiming to make possible the decarbonisation of all transport modes by stimulating energy efficiency, introduce alternative propulsion systems and fuels, including electricity supply systems, and provide corresponding infrastructure	Low carbon & Decarbonisation
		N/A	Cybersecurity & data protection
		Measures aiming to improve the safety and sustainability of the movement of persons and of the transport of goods	Safety & security
		Measures aiming to improve the operation, management, accessibility, interoperability, multimodality and efficiency of the network, including through multimodal ticketing and coordination of travel timetables	Data sharing, cooperation systems and real-time predictive analysis for multimodal transport
		Measures aiming to promote efficient ways to provide accessible and comprehensible information to all citizens regarding interconnections, interoperability and multimodality	Data sharing, cooperation systems and real-time predictive analysis for multimodal transport
		Innovative Measures aiming to reduce external costs, such as congestion, damage to health and pollution of any kind including noise and emissions	Externalities reduction
		Innovative Measures aiming to introduce security technology and compatible identification standards on the networks	Safety & security
		Innovative Measures aiming to improve resilience to climate change	Climate change resilience & transport greening
		Innovative Measures aiming to further advance the development and deployment of telematic applications within and between modes of transport.	Other telematics applications
		N/A	Innovation disemination

Source: Annex I of the Task 3b Guidelines; IP = Issues Papers, PL = Project List

The coverage of innovation aspects for the innovation area "**telematic applications**" by projects and their total costs are shown in Figure 3 and Figure 4 respectively. For ERTMS, no project could be identified because the respective projects of the ScanMed Project List target only to ETCS level 2 which is not "innovative" according to the definition relevant for this assessment (see above). We might therefore state the deployment of ETCS Level 3 is a gap with respect to the ScanMed Corridor, but it needs to be considered that the Technical Specification on Interoperability for ETCS Level 3 is not yet agreed upon. In contrast, River Information Services, RIS, - which are involved in only one project - do not constitute a gap because Inland Waterways, IWW, do not belong to the scope of the ScanMed Corridor.

The respective management systems for the maritime sector, VTMIS, (2 projects) and air transport, SESAR, (9 projects) could be improved by more projects in order to assure the coverage of the entire corridor. For example, all existing SESAR related projects are located in Sweden, Germany and Denmark. For ITS, 'other telematic applications' and 'data sharing, cooperation systems and real-time predictive analysis for multimodal transport' no gaps can be identified.

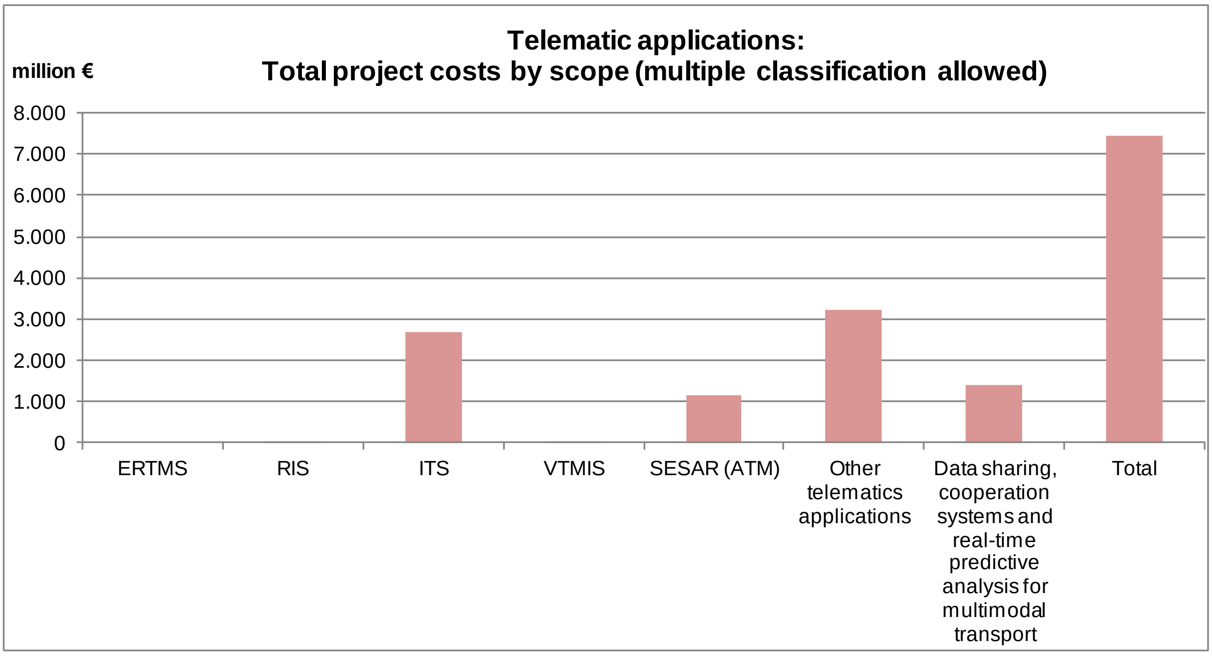
Figure 3: Telematic applications: Number of innovation projects



Source: KombiConsult analysis, May 2017

The 75 projects in the innovation area 'telematic applications' have a total (known) cost of €7.446m. The distribution of costs is basically following the number of projects with the exception of the categories 'other telematic applications' and 'data sharing ...' where the costs for 'other telematic applications' per project are significantly higher.

Figure 4: Telematic applications: Total costs of innovation projects

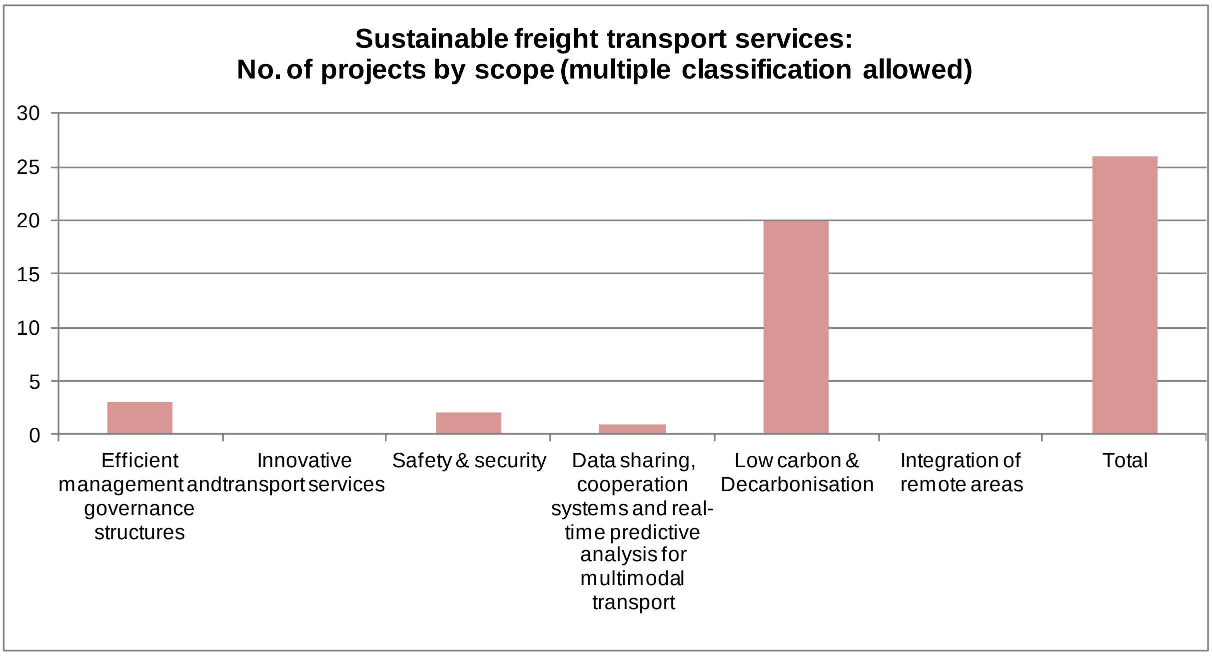


Source: KombiConsult analysis, May 2017

Projects of the innovation area '**sustainable freight transport services**' are rather rarely presented in the ScanMed Corridor Project List. Overall 26 projects were identified, most of them dealing with "low carbon & decarbonisation" (see Figure 5). If the non-presence of projects covering the other aspects is assessed as a shortcoming then we have a gap, in particular with respect to 'innovative transport services'. For integration of remote areas, where also no project could be found on the project list, it can be stated that on the ScanMed Corridor only Malta fulfils this criterion. On the other hand the inclusion of "innovative transport services" in the Project List was not a specific target since the list targets at infrastructure improvements.

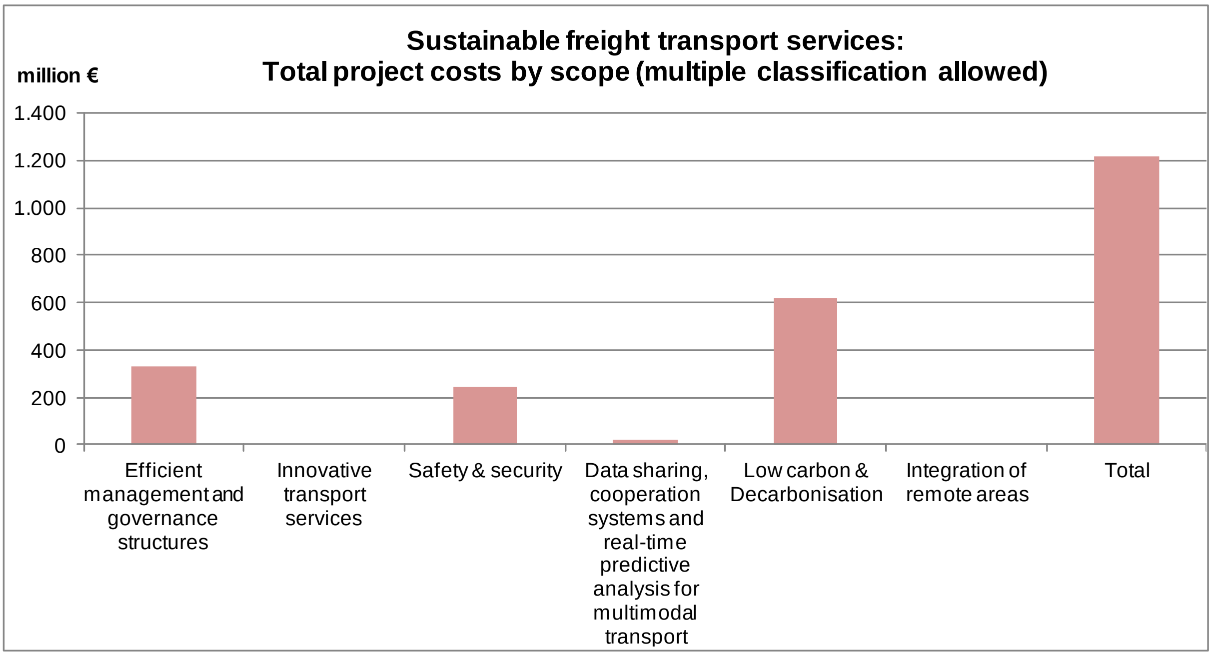
The total project costs (see Figure 6) show analogue results compared to the number of projects. The present list includes 26 projects of this area with cumulated costs of €1.215m.

Figure 5: Sustainable freight transport services: Number of innovation projects



Source: KombiConsult analysis, May 2017

Figure 6: Sustainable freight transport services: Total costs of innovation projects



Source: KombiConsult analysis, May 2017

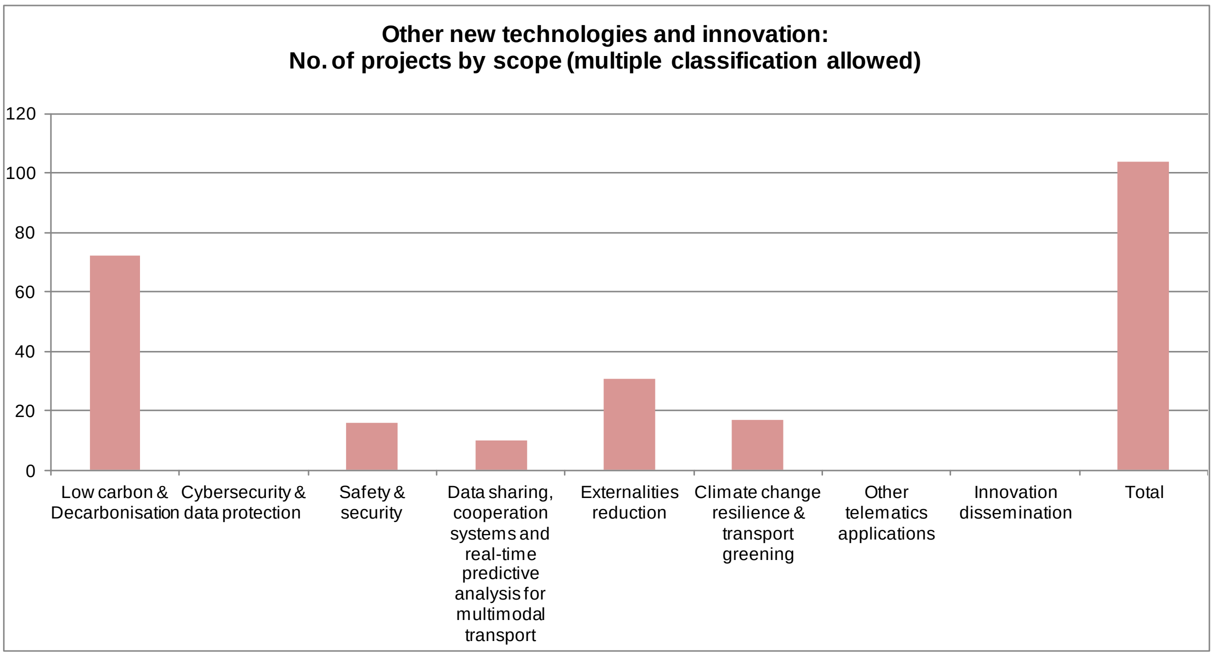
Most of the projects in the third innovation area '**other new technologies and innovation**' are related to the environment, in particular they contribute to low carbon & decarbonisation, externalities reduction as well as climate change resilience & transport greening. 16 projects are allocated to safety & security whereas cybersecurity & data protection is not explicitly mentioned and can therefore be identified as a gap.

The telematics related aspects data sharing, cooperation systems and real-time predictive analysis for multimodal transport as well as other telematics applications are covered by a few or even no projects. Another gap can be stated in the case of innovation dissemination with zero coverage.

The diagrams on number of innovation projects and total project costs are included in Figure 7 and Figure 8.

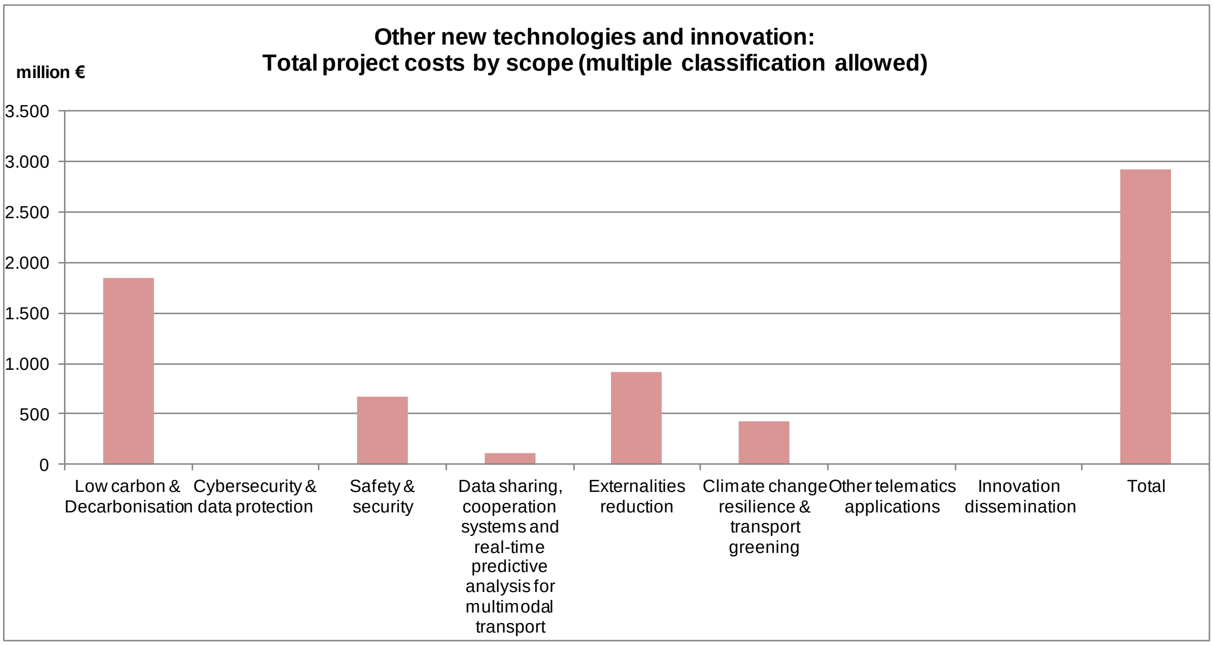
The 104 projects in this area provide for cumulated costs of €2.926m.

Figure 7: Other new technologies and innovation: Number of innovation projects



Source: KombiConsult analysis, May 2017

Figure 8: Other new technologies and innovation: Total costs of innovation projects



Source: KombiConsult analysis, May 2017

3.2 Innovation case studies

According to the joint methodology each corridor should present 3-5 case studies selected from the Project List (PL). The criteria to select these projects are the following:

- Relation with environmental impacts mitigation: Projects shall have a strong relation with the mitigation of environmental impacts; accordingly they should be mapped in one of the following aspects (those with higher priority presented first):
    - All those which "Suggested Tag for PL" is "Low carbon & Decarbonisation" or "Externalities reduction",
    - All which "Suggested Tag for PL" is "Innovative transport services",
    - All which "Innovation Area" is "Telematic Applications".
- Diversity of categories: If possible the case studies shall be distributed within at least 2 different innovation aspects.
- Diversity of Member States: Country coverage shall be as wide as possible.

The following figure and tables present selected case studies of innovations that contribute to the mitigation of negative environmental impacts of transport.

Since the format of how to present the case studies is not included in the joint methodology we have provided our example to the other consultants on 19.05.2017 and since we did not get a feedback we think it will be used widely.

Figure 9: Overview of innovation case studies and their impact

Node/ Section	Project Title	Duration and Cost	Low carbon & Decarbonisation or Externalities reduction	Innovative transport services	Telematic Appli-cations
Bremen, Bremer-haven	LNG Klappschute: construction of a hopper barge with an LNG unit	01/2014-06/2017 €4.9m	X		
Austria, Italy	Electric Vehicle Arteries (EVA+)	07/2016-12/2018 €8.47	X		X
La Spezia	Port – City interaction and environmental projects	10/2015-01/2018 €4m	X		
Arlanda – Rosers-berg	eRoadArlanda	2015-2018 €6.8m	X	X	X
Baltic Sea	LNG Icebreaker IB Polaris	03/2015-9/2016 €123m	X		X
ScanMed and other corridors	WiderMOS	01/2013-12/2015 €5.94m	X	X	X

Source: KombiConsult analysis, May 2017

Project title	**LNG Klappschute: construction of a hopper barge with an LNG unit**	
Node/Section	Bremen, Bremerhaven	
Project promoter	Bremenports GmbH & Co. KG	
Project description	Construction of a hopper barge with Liquefied Natural Gas power unit	
	Start: 01/2014	End: 06/2017
Total cost in Million Euro	4,90 (34% EU funding, 63% private funding)	

The pilot study features the technical design and construction of an LNG propulsion system for a new hopper barge in the ports of Bremen and Bremerhaven, Germany.

The ship's hull was built by Shipyard Constructions Hoogezand Nieuwbouw B.V. (SCHN) in Foxhol, Netherlands. It was launched on March 31st 2016. The ship has been equipped by Sandfirden Technics B.V. from Den Oever, Netherlands, with two natural gas engines, one diesel engine and electric batteries to supply energy for propulsion and on-board electric systems and is operational.

Its **contribution to innovation deployment** is to replace diesel, which is the standard energy carrier in ocean and inland shipping, with liquefied natural gas (LNG). In comparison to diesel, LNG reduces CO_2 and nitrogen oxide emissions and eliminates emissions of sulphur oxide and particulate matter. Thereby, the use of LNG as a shipping fuel contributes to the European Union goal to reduce shipping emissions by 40% in 2050 compared to 1990 levels.

Barriers constraining the deployment of alternative clean fuels include the high costs of vehicles and the lack of recharging and refuelling stations. The hopper barge is being bunkered in Bremerhaven by truck. Mobile „truck-to-ship" bunkering stations are being used at ports that do not have fixed LNG bunkering facilities.

The high demand for dredging in the sandy North Sea and inland ports speaks for the **transferability of the innovation** to other ports. In addition to investment in new ships, this requires the supply of mobile or fixed LNG bunkering stations. Barges used for regular dredging at the port remain in close proximity to the port and have predictable fuel demand. Therefore, transferring the innovation to other ports does not require coordination of LNG supply across ports.

The **scalability of the innovation** is limited to advances made in the technology of LNG propulsion systems that can be applied in the construction of other ships. Wider network effects arise, if the demand for LNG at the port of Bremerhaven contributes to the overall development of refuelling infrastructure.

Source: Prognos/Uniconsult, May 2017

Project title	**Electric Vehicle Arteries (EVA+)**	
Node/Section	Austria, Italy	
Project promoter	Enel SpA	
Project description	Creation of fast charging infrastructure for electric vehicles on key roads and motorways in Italy and Austria	
Project dates	Start: 07/2016	End: 12/2018
Total cost in Million Euro	8,47 (50% EU funding, 50% private funding)	

The Action entails a set of preparatory studies, a pilot implementation of 200 multi-standard fast chargers (CSS Combo 2, CHAdeMO or AC charging) and a Real Life Trial of Electric Vehicles on the Core Network in Italy and Austria along a major section of four multimodal Core Network Corridors. The objective of the Action is to kick start long-distance electric mobility journeys in both countries, as well as connecting main urban nodes with TEN-T Corridors, while ensuring fast charging interoperability and roaming with other EU countries.

Its **contribution to innovation deployment** is to provide the main road infrastructure in Italy and Austria with fast chargers enabling long distance trips with electric vehicles, contributing to the European Union goal to CO_2 emissions by 40% in 2050 compared to 1990 levels, as well as to reduce significantly local emissions. Moreover, by reducing significantly the range anxiety of users, the presence of a capillary and interoperable charging infrastructure will foster the market take up of electric vehicles.

Barriers constraining the deployment of alternative clean fuels include the high costs of vehicles and the lack of recharging and refuelling stations. As the project directly addresses the second barrier, the first one is tackled as well by EVA+, as well as by the technological progress expected in batteries and the strategic policy approaches undertaken by many EU countries, regional and local authorities.

A further barrier to the deployment is the relationship with the motorway infrastructure managers: as the charging spot will be installed along the national motorway network in Italy, some elements of the collaboration between project promoter and infrastructure manager, mainly concerning the land use, have not been clarified yet.

As the project addresses a significant stretch of road infrastructure along the corridor, the **transferability of the innovation** addresses on one side other territories along the corridor and across the TEN-T with similar infrastructure and mobility flows. Moreover, in order to reach a more homogenous coverage of the territory the network will be expanded to the comprehensive network as long as the demand for electric mobility will grow.

The **scalability of the innovation** is very high, as the market of charging technologies is nowadays at an early stage and the production capacity still limited. By the implementation of 200 charging points, technology as well as knowledge (of end users as well) will improve and a critical mass will be reached for production.

Concerning the **contribution of the project to the mitigation of climate impacts**, although not directly measurable, the role of EVA+ is very relevant in terms of the reduction of local and global emissions related to road transport. In fact, the presence of the infrastructure will allow a higher share of electric vehicles on the road network both for short/medium distances, but especially for longer trips.

As local emissions (PN, NOx, etc.) are zero, the positive effect can be quantifiable in terms of number of internal combustion engine vehicles substituted by electric ones

(EV) and, with adequate proportion, by plug-in electric hybrid vehicles (PHEV).

Concerning GHG emissions including CO_2, although scientific studies diverge in terms of global impact generated in the well-to-wheel cycle (WTW), we can state that:

a) tank-to-wheel (TTW) emissions of e-vehicles are equal to zero;

b) since the WTW impact depends on the share of renewable energies included in the energy generation mix used, the high and continuously growing proportion of renewable sources in the national energy mix in Austria and Italy can guarantee a significant benefit in terms of decrease of GHG emissions.

More precise estimations of impacts might be calculated taking into consideration some factors at the moment not quantifiable such as the share of EV and PHEV on total vehicles, their share within the traffic flows along the infrastructure covered by EVA+ services, the amounts of electricity provided as well as the expected energy mix and integration of renewable energies at least.

Source: GruppoCLAS, June 2017

Project title	**PORT- CITY INTERACTION AND ENVIROMENTAL PROJECTS**	
Node/Section	La Spezia Port, Italy	
Project promoter	La Spezia Port Authority (now Autorità di sistema portuale del Mar Ligure orientale)	
Project description	Construction of a green zone between port area and city	
Project dates	Start: 10/2015	End: 01/2018
Total cost in Million Euro	4 (100% State funding)	

The project is dedicated to the functional, architectural and landscape requalification of the interface urban relations between the Port of La Spezia and the city. In particular the project consists in two actions, one dedicated to the reduction of noise generated by the railway line, the second focused on road container transport. The intervention consists in the construction of innovative noise reduction barriers in order to improve the relation between the port and the city and increase the liveability of the urban environment.

Its **contribution to innovation deployment** is in the specific planning approach which takes into account different elements for the better integration of port infrastructure and urban space, valorising the existing natural elements (row of trees, very important under the landscape point of view), and inserting further elements preserving the integrity of the existing vegetation, maintaining the visual connection between port and city, and allowing the presence of vertical vegetation.

Barriers constraining the deployment of the solution are related to the need for specific planning, resulting in higher costs of realization. However, the project challenge is to mitigate a broader set of externalities generated by the port activities besides noise, including the visual elements and the conflicts between port and city landscapes, and improving the acceptance by citizens.

The **transferability of the innovation** is on one side focusing at city level, as the solution adopted can be further applied in the framework of a more comprehensive redefinition of the relationships between port and city; at the same time, considering that several ports especially in the Mediterranean sea are facing similar problems, due to the historical role of the port in the local economies and the strong urban integration of the activities into the urban tissue, the approach and solutions proposed can be replicated in several different contexts in order to improve the quality of life for citizens without harming the competitiveness of the infrastructure.

The **scalability of the innovation** is limited if considering the realization phase, while the strategic objectives, methodology and approach can by systemized and applied to different contexts with similar necessities.

Concerning the contribution to the mitigation of climate impacts, the project addresses mainly acoustic emissions. However, the innovative approach aiming at preserving and integrating the existing green barriers (basically trees) will have positive effects on local and global emissions, and even more relevant are the expected benefits in contributing to a better integration of port related activities and the city enhancing the livability of the urban space.

Source: GruppoCLAS, June 2017

Project title	**eRoadArlanda**	
Node/Section	Arlanda Cargo Center – Rosersberg logistic park	
Project promoter	Transport Administration, Vinnova & Energy Authority	
Project description	Building test track, develop and evaluate the technique and create a basis for implementing electric roads in the Swedish road system	
Project dates	Start: 2015	End: 2018
Total cost in Million Euro	6,8 (70% public, 30% private)	

In June 2013 a project called "Elvägsupphandlingen" was started. The purpose of the project is to create a basis for decisions about further development and implementation of electric roads for heavy vehicles. A pre-commercial tender resulted in two pilot projects using different technologies. Swedish Transport Administration, Swedish Energy Authority and Vinnova partly finance the projects with a total of €12.6m. eRoadArlanda is one of the two projects and the responsible consortium for the project is RUAB (Rosersberg Utveckling AB). Among the members in the consortium are PostNord, KTH and DAF.

eRoadArlanda features the construction of a 2 km electrified test track between Arlanda Cargo Center and Rosersberg logistic park. Its **contribution to innovation deployment** is to test an alternative to batteries for electric vehicles. Its conductive technology that is being tested with electricity being fed through rail in the ground.

Electric vehicles have today a short range and therefore it is suitable to have a combination of batteries and power supply during travel. Power supply during travel will be used on the roads with high traffic and travel; on roads with low traffic it will be done with batteries. The presented solution is a rail sunken in the ground which is connected to the electric mains and a moving arm mounted on the vehicles that detects where the rail is. The system will be constructed to operate with heavy vehicles but will also function for cars and buses.

Because the rail is sunken down and connected to a protective layer it is impossible for people and animals to touch the rail just by stepping on it. Only small sections are electrified in association with a passing vehicle. This means that nothing would happen if a person touches the rail until a vehicle is very close and therefore the risk would be higher to get hit by a vehicle than to get a shock. The system is provided with a function that indicates potential errors and then orders to shut down the malfunctioning section.

Snow, rain and ice is no direct problem as long as there is high traffic since the traffic keeps it clean and throws the water away from the rail. If it is necessary to use a plough car it can be adjusted with a device that cleans the rail as well. Another potential problem is that ice can form on the rail during low traffic that forms an insulating layer. A patented solution was tested during 2012-2013 with good results.

Source: Ramböll Sweden, May 2017

Project title	**LNG Icebreaker IB Polaris**	
Node/Section	Baltic Sea	
Project promoter	Finnish Transport Agency and Arctia Ltd.	
Project description	Construction of the LNG powered icebreaker	
Project dates	Start: 03/2015	End: 09/2016
Total cost in Million Euro	123 (EU funding 20 %, state funding 80 %)	

IB Polaris is the first LNG powered icebreaker in the world. It joined Arctia's fleet in September 2016. Arctia provides icebreaking services and specialized multipurpose vessel services in polar areas. Polaris is the eighth heavy icebreaker in the company's versatile fleet. Polaris was built and delivered by Arctech at the Helsinki Shipyard. Arctech was responsible for the vessel's design on both basic and detailed level, sourcing of equipment and components, outfitting, commissioning, as well as testing and delivery. Polaris has been designed for demanding icebreaking operations in the Baltic Sea and it is fitted for oil recovery and emergency towing.

The technical specifications of the icebreaker Polaris are based on the requirements for year-round seaborne transport as defined by the Finnish Transport Agency (FTA). The building process was co-financed by the EU, through the WINMOS programme. FTA is the responsible authority for safeguarding winter traffic to and from all Finnish winter ports, on the coasts of the Baltic Sea. Its main task is fairway icebreaking on the Baltic Sea.

IB Polaris is able to use both liquefied natural gas (LNG) and low sulphur diesel oil as fuel. The use of LNG significantly reduces carbon emissions, making IB Polaris also the most environmentally friendly diesel electric icebreaker in the world. The special hull form and propulsion arrangement minimize ice resistance and maximize the icebreaking capacity. The vessel is equipped with three Azipod propulsion units rotating 360 degrees, which enable excellent manoeuvring qualities. Its icebreaking capacity is 1.2 meters at a speed of 6 knots. Lamor delivered the in-built oil recovery system, which enables Polaris to collect 1,015 m^3 oil with a rate of 200 m^3/h in harsh weather and ice conditions.

The icebreaking capacity is decreasing in Finland, while the vessel traffic is increasing on the Baltic Sea. Polaris will ensure efficient winter navigation for the next coming years, which is of high importance for the trade between the Northern and the more Central part of the European Union.

The **contribution to innovation deployment** of Polaris is to replace diesel, which is the standard energy carrier in ocean shipping, with liquefied natural gas (LNG). When using only LNG, the sulphur and particulate emissions of the vessel are close to zero, nitrogen emissions decrease by 60 % and the CO_2 emissions by 25 %. In 2016, Polaris used 81.2 tonnes of LNG, which reduced significantly the use of diesel. Therefore, the use of LNG as a shipping fuel contributes to the European Union goal to reduce shipping emissions by 40% in 2050 compared to 1990 levels. The new vessel also burns less fuel than the older vessels. Due to the zero emission principle design, no waste or polluting substance will be discharged in the sea. All solid and liquid waste will be stored on board and unloaded ashore.

The used technology is **transferable** for the new icebreakers and other vessel types. The lack of refuelling stations might constrain the deployment of alternative cleaner fuels.

Source: Ramböll Finland, May 2017

Project title	**WiderMOS**	
Node/Section	ScanMed and other Corridors	
Project promoter	La Spezia Port Authority and others	
Project description	Improve long term effective and sustainable connection between the sea and other transport modes by developing new port/ship/train interfaces. E.g. five pilot projects, policy supporting activity.	
Project dates	Start: 01/2013	End: 12/2015
Total cost in Million Euro	5.94 (EU funding 50 %)	

Within the WiderMos project stakeholders from the transport industry have developed tools to connect (short sea) shipping and hinterland transport. The tools are designed to efficient port to rail logistics, customs fast lane via rail, customs fast lane via truck, intermodal customs fast lane, door to door logistics chain planning and execution and efficient overseas logistics corridors.

The project's **contribution to innovation deployment is in the specific approach to involving the direct infrastructure users in the project suc**h as the intermodal operators and port / terminal operators. Results of the previous 7th framework programme projects could be integrated into the new IT tools which have demonstrated their deployment in real-life cases for intermodal transport between Italy and Norway (to mention the part relevant for the ScanMed Corridor). Although designed is a data sharing mechanism the tools could also demonstrate a modal shift impact since freight was modally shifted off the road to an integrated road - rail - ferry service. With the tools the gain in CO_2 and other GHG emissions could be demonstrated. The multimodal trip planner for freight services was also used to sharing time-table information between different applications.

Within the WiderMOS project the IT solutions were demonstrated on a corridor stretching between Verona in Italy and Göteborg in Sweden. For the physical transport, the road routing follows the motorway via Austria – München – Nürnberg – Hannover – Hamburg – København – Malmö – Göteborg, while the alternative modally shifted route comprises of short legs of pre- and on-carriage by road, a freight train on the route Verona – Kiel and a ferry connection Kiel – Göteborg. Considering a single truck with about 25 tons of load, about 12,312 kWh of energy would be used and the CO_2-equivalent of 3.187 tons would be emitted. In contrast to that the combined rail/ferry service with 1,354 km by train and 437 km by ferry would consume 7,981 kWh of energy and produce 2.152 tons CO_2-equivalents. Thus, the modal shift would result in a reduction by about 32.5%. We have used the tools developed in the project and supplied via the webpage of Kombiverkehr. The emissions are calculated by a rapid assessment in line with the DIN EN 16258 for transport services and the Well-to-Wheel concept.

If we **scale up** the effect from a single truck to a daily pair of trains on an annually basis (data validated by real traffic shift for time period 11/2014-10/2015) the figures are as follows:

	Combined truck - train - ferry service	Direct truck service (25 tons; EURO V)
Distance (km)	1.354 (train) & 437 (ferry)	1.748 (truck)
Energy (kWh)	**7.981**	**12.313**
CO_2-equivalent (t)	**2,152**	**3,187**
Scale-up		
ø utilisation (units/departure)	27	
Departures per week	10	
Effective weeks per year	45	
Total truck trips	11.700	
Energy (kWh)	**93.374.167**	**144.061.843**
CO_2-equivalent (t)	**25.178**	**37.288**
Reduction potential	**-32,5%**	

Source: KombiConsult analysis June 2017, based on Port of Kiel, Port of Rostock, Kombiverkehr final presentation at WiderMos final conference, Athens, December 2015; www.Kombiverkehr.de

Within this calculation an average Baltic Sea RoPax ferry was used. If we consider that Stena line is supplying one of the most energy efficient and clean ferries, the Stena "Germanica", on the route the combined route's ecologic saving is even higher. Since "Stena "Germanica" is propelled with methane rather than marine Diesel.

Barriers constraining the further deployment of the specific solution were not experienced in the project and are not known.

The **transferability of the innovation** is possible through the involvement of intermodal operators and ports in the project which could expand the geographic scope to other freight lanes and ports and the entire network of operations after the end of the project.

Source: KombiConsult, June 2017

4 Impact of climate change on the existing infrastructure and possible measures to enhance the resilience against climate change

The effects of climate change include increased temperatures and extreme weather events like storms, floods and droughts. These changes can increase weather-induced degradation of transport infrastructures if they are not adapted to the increased stress. Extreme weather events may destroy infrastructures that are not sufficiently protected.

According to the joint methodology a common structure for the table to be used for collecting mode specific climate impacts, their vulnerability, and exposure as well as risk assessment was applied.

The ScanMed consortium partners were responsible for analysing the national action plans of Norway, Sweden, Finland, Denmark and Malta, while the analysis for Germany was shared with Rhine-Alpine, Austria with Rhine-Danube and Italy with the Mediterranean Corridor consortium. The summary is provided in Annex 2 which is the same for all corridors. The application of the country results on the respective corridor sections and nodes was to be made by each consortium for the relevant corridor alignment.

4.1 Analysis of exposure and vulnerabilities

The Scandinavian-Mediterranean TEN-T Core Network Corridor reaches from Scandinavia to the Mediterranean Sea, therefore the corridor countries face different weather conditions and different threats due to changes in the weather.

Based on the analysis of the respective national action plans an assessment of the exposure of the corridor's infrastructure to climate impacts and a qualitative assessment of the risks was carried out by the national experts.

Table 1 to Table 8 present the impacts that climate change has on the weather and how this weather affects corridor infrastructure by country and mode.

Table 1: Impacts of climate change on corridor infrastructure in Finland

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Finland	Rail	Increased Precipitation and flooding	Stability of railroad embankments	Whole ScanMed corridor, but especially older rail sections	Low
Finland	Rail	Increased heat and temperature variations	Rail buckling, failure of electronic equipment	Whole ScanMed corridor	Low

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Finland	Rail	Temperature variations, freezing, frost and snow storms	Slippiness and failures of equipments, maintenance	Whole ScanMed corridor, but the impacts are greater on the northern Finland. Less snow than today in southern Finland	Medium
Finland	Rail	Storms	Fallen trees on tracks	Whole ScanMed corridor	Low
Finland	Rail and road	Sea level raise	Flooding	On the coasts, but especially in the Helsinki and Turku regions	Low
Finland	Road	Increased Precipitation, storms and flooding	Stability of road structures, fallen trees	Whole ScanMed corridor, but especially older road sections	Low
Finland	Road	Temperature variations	Road structure damages (less in southern Finland), on the other hand less frost damages	Less frost damages in southern Finland	Low
Finland	Maritime	Storms	Navigation and maintenance	Whole coast in South Finland, Baltic Sea	Low

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Finland	Maritime	Extreme weather events, ice conditions (especially hommocked ice)	Traffic safety and functionality, traffic management devices	All ScanMed ports, Baltic Sea	Na
Finland	Maritime	Increased temperature	Less ice with less need for icebreaking	All ScanMed ports, Baltic Sea	Na
Finland	Aviation	Changes in rainfalls, floods, medium temperatures, soil and groundwater conditions	Maintenance of the infrastructure, equipments	All ScanMed airports	Na

Source: Ramböll Finland analysis, June 2017

Table 2: Impacts of climate change on corridor infrastructure in Sweden

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Sweden	Road	Increased Precipitation	Undermining and landslides	parts of E6 West coast	Medium
Sweden	Rail	Increased Precipitation	Undermining and landslides	Parts of Västkust-banan	Medium
Sweden	Rail	Incerased summer temperature	Rail buckling	entire railway system	Low
Sweden	Road	Sea Level Rise	Flooding	Parts of E6 (2 km)	Medium
Sweden	Rail	Sea Level Rise	Flooding	Parts of Västkust-banan (2 km)	Medium

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Sweden	Road	Floods	Mud slides (Göta Älv), flooding of roads and flooding of urban core nodes Göteborg (Göta Älv)	Göta Älv, Parts of E6 (3 km) and E4 (4 km)	Medium
Sweden	Rail	Floods	Mud slides (Göta Älv) and flooding	Göta Älv, (7 km from smaller rivers)	Medium
Sweden	Road	Storms	Possible accumulation of snow due to hard winds	Skåne	High
Sweden	Rail	Storms	Damages on the electric grid and possible accumiation of snow due to hard winds	Skåne	High
Sweden	Maritime	Storms	Hard wind conditions and rough seas.	Ports of Stockholm	Low
Sweden	Maritime	Storms	Hard wind conditions and rough seas.	Ports of Göteborg	Medium
Sweden	Maritime	Storms	Hard wind conditions and rough seas.	Ports Malmö and Trelleborg	High
Sweden	Rail	Water level rise Lake Mälaren	Flooding of metro system	Core node Stockholm	Medium
Sweden	Rail	Water level rise Lake Vänern	Mud slides	E6 Gothenburg	Medium
Sweden	Road	Water level rise Lake Vänern	Mud slides	Västkust-banan Gothenburg	Medium

Source: Ramböll Sweden analysis, May 2017

Table 3: Impacts of climate change on corridor infrastructure in Norway

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Norway	Road	Increased occurrence of extreme rain	Temporary flooding	Parts of E6 Oslo to Swedish boarder	Medium
Norway	Road	Increased frequency of heavy Winterstorms	Temporary traffic delays. (NO is generally well prepared for snowy conditions)	E6 Oslo - Swedish boarder.	Low
Norway	Rail	Increased summer temperature	Reduced speed and rail buckling	Applicable from Oslo to Swedish boarder.	Low
Norway	Rail	Increased summer temperature	Failure of electronic equipment (signal systems)	Applicable from Oslo to Swedish boarder.	Low
Norway	Rail	Flood, river Tista (Halden) combined with westerly winds and high tide	Damage on infrastructure such as signals, power cables and rail track switches	Halden station and night parking for trains	Low
Norway	Rail	Increase and more frequent storms	Infrastructure damage. Falling trees damaging overhead wires	Applicable from Oslo to Swedish boarder.	Medium
Norway	Aviation	Increased frequency of heavy winter storms	Temporary delays (OSL is already well prepared for harsh winter conditions)	Oslo Airport (OSL)	Low

Source: Ramböll Norway analysis, May 2017

Table 4: Impacts of climate change on corridor infrastructure in Denmark

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Denmark	Road	Extreme rain	Damages and flooding	low areas	Medium
Denmark	Rail	Extreme temperature	Rail buckling	sun exposed stretches	Medium
Denmark	Port	Sea Level Rise	flooding	CMP	Low
Denmark	Airport	Extreme rail	Flooding	CPH	Low

Source: Ramböll Denmark analysis, May 2017

Table 5: Impacts of climate change on corridor infrastructure in Germany

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Germany	Road	more frequent/ more intensive rainfall	affects road traffic, e.g. through poor vision and wet roads; landslides and undercutting lead to destabilisation and destruction of road sections; increasing soil moisture can affect stability of bridges and tunnels	All regions, but only local occurren-ce	Medium
Germany	Road	more frequent/ more intensive storms	damage on roads	All regions, but only local occurren-ce	Low
Germany	Road	increasing thunderstorms	failure of or damage on signals or other electronic traffic management systems	All regions, but only local occurren-ce	Medium
Germany	Road	prolonged heat in summer, drought	damage on material and structure of road surface; forest and embankment fires; affect on stability of bridges (thermal expansion)	All regions, in particular in South and East Germany	Medium
Germany	Road	rising temperatures in winter	less frequent and less serious frost damage to roads and bridges	All regions	No risk
Germany	Road	flooding		Regions in North Germany	Medium
Germany	Rail	more frequent/ more intensive rainfall	landslides and undercutting lead to destabilisation and destruction of rail sections; increasing soil moisture can affect stability of bridges and tunnels	All regions, but only local occurren-ce	Medium

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Germany	Rail	more frequent/ more intensive storms	damage on railway tracks and power lines	All regions, but only local occurren-ce	Medium
Germany	Rail	increasing thunderstorms	failure of or damage on signals or other electronic traffic management systems	All regions, but only local occurren-ce	Medium
Germany	Rail	prolonged heat in summer, drought	damage on material and structure of rails; forest and embankment fires; affect on stability of bridges (thermal expansion)	All regions, in particular in South and East Germany	Medium
Germany	Rail	flooding		Regions in North Germany	Medium
Germany	Mari-time	rising sea level	static stress and damages on port facilities; interruption of port operations	Bremen, Hamburg, Lübeck, Rostock	Medium
Germany	Mari-time	increasing storm surges	damages on port facilities	Bremen, Hamburg	Medium
Germany	Mari-time	increasing storm surges	damages on port facilities	Lübeck, Rostock	Low
Germany	Avia-tion	prolonged heat in summer	damage on material and structure of runways	all regions	Medium

Source: KombiConsult analysis, June 2017

Table 6: Impacts of climate change on corridor infrastructure in Austria

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Austria	Rail	Increased heat stress	Damage to materials and structure, as well as rail buckling	Kufstein - Innsbruck	Low
Austria	Rail	Heat waves	Failure of electronic equipment (signal systems)	Kufstein - Innsbruck	Low
Austria	Rail	Potential increase in heavy precipitation	Washouts threaten the stability of railroad embankments	Kufstein - Innsbruck	Medium
Austria	Rail	Floods	Washouts threaten the stability of railroad embankments	Inn valley between Kufstein and Innsbruck	Medium
Austria	Rail	Increase and more frequent storms	Damage on infrastructure such as signals, power cables	All regions	Medium
Austria	Rail	Permafrost degradation	Decrease of stability, landslides, damage or destruction of exposed infrastructure	Alpine regions (Inn valley)	Medium
Austria	Rail	Increase of frequency of avalanches	Damage on infrastructure	Brenner area	Medium

Source: KombiConsult analysis, May 2017

Table 7: Impacts of climate change on corridor infrastructure in Italy

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Italy	Rail	Increased summer temperature	Melting / Rail buckling, Electric system failure, increased vegetation dessication of track earthworks --> water infiltration / collapse, Fire	All network, except Brenner-north of Verona	High
Italy	Rail	Increased Winter Temperatures	snowfalls, rail contraction, catenaries, ice in electric systems	Transalpine railways	Low
Italy	Rail	Increased Precipitation and Floods	flooding of the network / strain on drainage system, damage to earthworkstrack circuit problems	Pô valley, Adige, Tevere, Arno, East coast railway (ferrovia adriatica), West coast railway	High
Italy	Rail	Increased and more frequent extreme winds	blowing over in high cross-wind, dewirement, overturning derailment, network disruption	All network	Low
Italy	Rail	Sea Level Rise and sea storm surges	flooding of track	Adriatic sea, Tyrrhenian sea, East coast railway (ferrovia adriatica), West coast railway	High
Italy	Rail	Permafrost degradation and thawing	falling rocks and rockslides, stability of hillsides,	Transalpine railways	Medium

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Italy	Road	Increased summer temperature	road surface buckling, road surface softening and rutting, bleeding of asphalt, Fire	All network	High
Italy	Road	Increased Winter Temperatures		Transalpine railways	Low
Italy	Road	Increased Precipitation and Floods	visibility distance, road friction, road obstruction, closure of roads, congestion, erosion of roadside	Pô valley, Adige, Tevere, Arno	High
Italy	Road	Increased and more frequent extreme winds	visibility distance, road friction, road obstruction, infrastructure damage	All network	Medium
Italy	Road	Sea Level Rise and sea storm surges	coastal erosion	Central and South Thyrrenian Coast, Ionian and Mediterrane an	High
Italy	Road	Change in frequency of Winter Storms	visibility distance, road friction, road obstruction, infrastructure damage	ew.	Medium
Italy	Road	Permafrost degradation and thawing	falling rocks and rockslides, stability of hillsides,	Transalpine E45	High

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Italy	Maritime	Increased and more frequent extreme winds, High amplitude wave	safe navigation interruption, ship sinking	All ports, but little relevant for the Mediterranean sea compared to other contexts (e.g. northern range ports)	Low
Italy	Maritime	Sea Level Rise and sea storm surges	Infrastructure damage, cargo loss	Applicable to all ports along the corridor	High
Italy	Aviation	Increased Precipitation and Floods	clood ceiling, Infrastructure damage, turbulence	Applicable to following airports: Bologna, Rome, Naples, Palermo	High
Italy	Aviation	Sea Level Rise and sea storm surges	Infrastructure damage	Applicable to following airports: Rome, Palermo	Medium
Italy	Aviation	Increased and more frequent extreme winds	Turbulence	Applicable to all airports along the corridor	Medium
Italy	Aviation	Change in frequency of Winter Storms	Jetstream change, ice, turbulence	Applicable to following airport : Bologna	Medium

Source: GruppoCLAS analysis, May 2017

Table 8: Impacts of climate change on corridor infrastructure in Malta

Member State	Mode	Climate Impact	Vulnerability	Exposure	Qualitative Risk Assessment
Malta	Road	Sea level rise	Erosion of coastal infrastructure	Coastal road network	Low
Malta	Port	Sea level rise	Erosion of coastal infrastructure	Port of Valletta, Port of Marsaxlokk, Port of Cirkewwa and Mgarr	Low
Malta	Road	Flooding	Floods	Road sections in valley systems or low lying areas	Medium
Malta	Port	Flooding	Floods	Port of Valletta, Port of Marsaxlokk, Port of Cirkewwa and Mgarr	Low
Malta	Airport	Flooding	Floods	Luqa Airport	Low

Source: KombiConsult/Maria Attard analysis, May 2017

With the respective national action plans we found a sound basis for the analysis of the corridor infrastructure. We conclude that the infrastructure managers are basically aware of the risks and that these risks are taken into account when providing maintenance, upgrade or building new infrastructures.

4.2 Resilience Case Studies

According to the joint methodology each corridor should present 3-5 case studies. For each of the projects selected the teams shall revise all information available to check whether:

- The project shows awareness about the level of risks associated with climate change that it is exposed to;
- The project has taken any measures to address those risks and to increase resilience;
- In case measures were taken, summarize:
  - The type of activities being undertaken,
  - The estimated investment in these measures.

Project title	**Flood protection project Lower Inn Valley**
Node/Section	Innsbruck - Kufstein, section Brixlegg/Kramsach - Kufstein
Project promoter	Land Tirol (with financial contribution of ASFINAG)
Project description	Construction of walls, dams and retention areas to protect the A12 motorway and adjacent built-up areas to be prepared for the "100 years' floods".
Project dates	Start: early 2019 (tbc) End: late 2023 (tbc)
Total cost in Million Euro	250 (ASFINAG share under negotiation)

The overall project "Flood protection project Lower Inn Valley" has been subdivided in three sections (Rum – Terfens/Weer; Pill/Vomp – Münster/Reith i.A.; Brixlegg/Kramsach – Kufstein). In the lower section Brixlegg/Kramsach – Kufstein measures are needed only between Brixlegg/**Kramsach and Angath; downstream from Angath no intervention is needed.**

The considered project section Brixlegg/Kramsach – Angath has been designed to protect built-up areas (about 2,200 houses) in the densely populated Lower Inn Valley and the A12 motorway from floods, which are becoming more frequent, due to climate change. This project section comprises 18 km of dams and walls as well as 3 retention basins with a total volume of 8.5 million m^3.

The general planning of this project section is finished, implementation may start after organisational and administrative activities, as well as the current negotiations on sharing the costs are finished, which may be expected for early 2019.

By active flood control, the retention effects have been optimised, so to not deteriorate the flow conditions for downstream riparian stakeholders. This means that inlet weirs to the basins are opened as late as possible so that they get filled only when water level in the Inn river would exceed a limit that would cause damage downstream, and outlet weirs only after the level of Inn has fallen below this limit.

The project is needed to cope with growing frequencies and increasing intensities of flood, as a consequence of climate change.

It will decisively contribute to avoid interruptions of the A12 motorway, at times of inundations.

The principle of this project can be transferred to the entire transport network, as far as transport or other infrastructure is exposed to the danger of floods. This is not limited to mountainous areas.

Source: KombiConsult/Helmut Adelsberger analysis, June 2017

Project title	**Flood protection project "Private Flood Protection Port of Hamburg"**
Node/Section	Hamburg (Port of Hamburg)
Project promoter	Private consortium (with financial contribution of HPA)
Project description	Adaption and construction of facilities as well as structural measures on buildings and factory equipment which serve the flood protection (storm tides) within non-public areas of the Port of Hamburg so that these facilities are prepared for the "200 years' floods".
Project dates	Start: since 2008 End: 2018
Total cost in Million Euro	76 (provisional estimate, subject to final account)

The overall project "Private Flood Protection Port of Hamburg" takes place on the so-called Polders within the Port of Hamburg which are at risk to be affected by storm tides (referring to the design-basis water level). Polders are privately owned areas within the river basin. Polders are not located within the publicly flood protected areas. Most of the maritime handling facilities are located on Polders.

The project comprises two main categories of flood protection measures. The first category is addressed to the adaption and construction of facilities which serve the flood protection (storm tides). Such facilities are dykes, dwelling mounds and flood protection walls with gates, ramps, pipe and cable cuts, shoreline buildings necessary for the stability of existing flood protection facilities, buildings for the reduction of waves' impact on flood protection facilities as well as emergency platforms and escape routes for new flood protection facilities.

The second category is addressed to structural measures on buildings and factory equipment which serve the flood protection (storm tides). Such structural measures comprise the sealing and strengthening against water pressure from storm tides; lifting up, sealing, encapsulating of waste pipelines and the installation of backwater protection facilities as well as emergency platforms and escape routes for such new property protection facilities.

Storm tides are becoming more frequent and stronger, due to climate change. On the above mentioned measures about 76 million Euros will be spent of which 38 million are from private and 38 million from public source, at present.

For many affected areas, the general planning is finished and measures have been implemented respectively will be implemented soon. However, the project is subject to the participation of various private owners and their financing commitments. It is expected, that 80% of the Polders will be provided with up-to-date flood protection facilities until the middle of the year 2018.

The project is needed to cope with growing frequencies and increasing intensities of storm tides, as a consequence of climate change. It will decisively contribute to avoid interruptions of the port activities, at times of storm tides.

The principle of this project can be transferred to the entire transport network, as far as transport or other infrastructure is exposed to the danger of storm tides.

Source: Uniconsult, June 2017

Project title	**Bologna adaptation plan for a resilient city**	
Node/Section	Bologna Urban node	
Project promoter	Comune di Bologna (with financial contribution of LIFE)	
Project description	BLUEAP - Bologna adaptation plan for a resilient city, development and adoption of an adaptation plan to climate change for the city of Bologna	
Project dates	Start: 2012	End: 2015
Total cost in Million Euro	N. A.	

The project BLUEAP - Bologna adaptation plan for a resilient city stated as main objective the development and adoption of an adaptation plan to climate change for the city of Bologna. Special relevance has been given to the definition of measures to prevent and mitigate hydro-geological risks harming the urban environment as the main urban infrastructures (including the airport and its area).

The preparation studies identified three main categories of climate change related risks: drought and water shortage, waves of heat in urban areas, unconventional events and hydro-geological risk.

In particular, the analyses highlighted on one side the need for specific intervention on the water management infrastructure, on the other side the need for monitoring and improvement of the road transport network in order to mitigate the impact of floods and landslides especially in the hilly part of the metropolitan area.

The plan includes the identification and adoption of strategies and measures for the water flows management, including infrastructural measures. In particular, a range of measures is dedicated to the extreme raining events and hydro-geological risk management.

The measures set in the plan are expected to contribute to the overall climate change resilience of the urban area and its infrastructure, with particular reference towards the risks of floods and the deterioration of the local road network. Positive impacts of the improved resilience will reflect on the railway and motorway infrastructure, a fundamental node for the corridor and national networks, as well as on the airport and its area, particularly vulnerable towards hydro-geological risks.

Source: GruppoClas, June 2017

5 Impact of corridor deployment on the greenhouse gas emissions and noise and possibly other negative impacts on the environment and proposed measures to mitigate them

5.1 Transport activity and emissions

Transport demand is predicted to increase on the Scandinavian-Mediterranean TEN-T Core Network Corridor until 2030 compared to the base year 2010. The transport market study from 2014 shows the predicted rise in transport volumes on the different corridor sections. It is important to recapitulate that the transport market study referred to the most recent available “as is” traffic which was available for the year 2010 in the required level of detail and quoted the relevant national or project related market forecasts which were either extra or intra-polated to the common target year 2030. Since the objective was to provide a reference for the infrastructure capacity need the total traffic – being local, regional, domestic or international – was taken into account, since the consideration of only the cross border transport would have provided a wrong impression of the transport demand. Table 9 presents estimates of performance in passenger and goods transport based on these flows. The total passenger traffic will raise by 1.6% (average annual growth) between 2010 and 2030, while the freight traffic is supposed to raise by 2.7%.

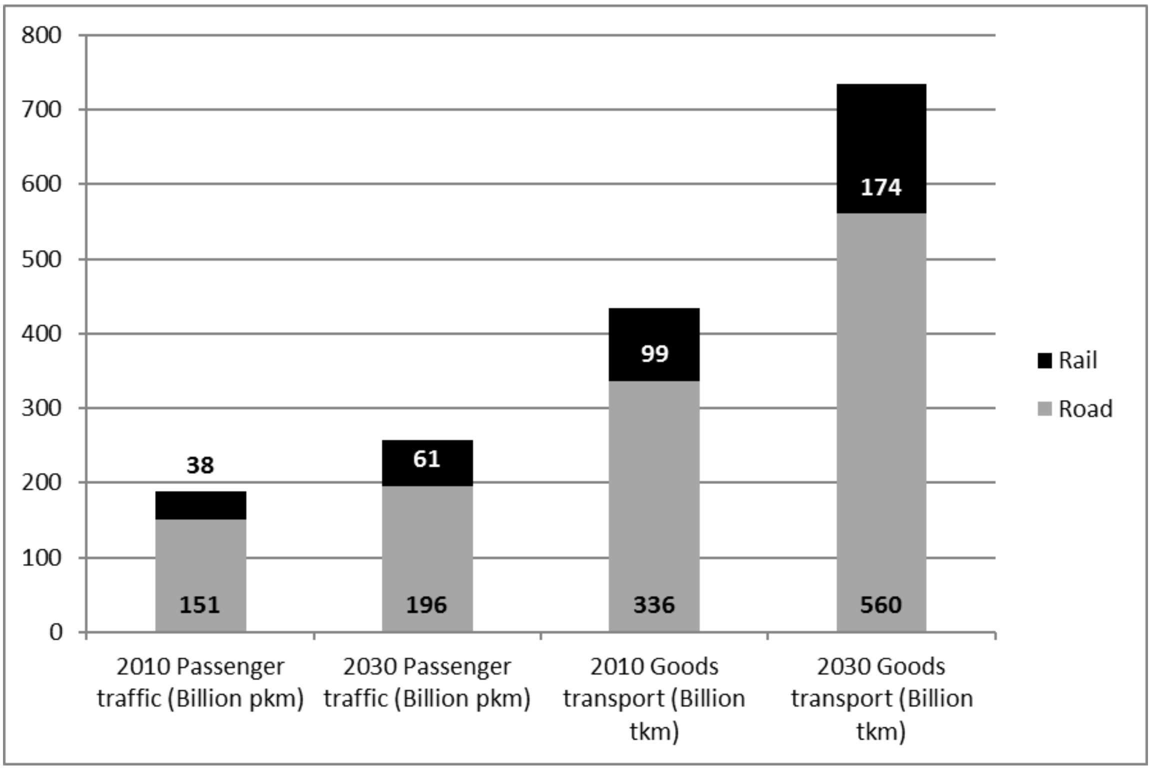
Table 9: Evolution of passenger and goods transport performance on the ScanMed corridor 2010/2030

	2010		**2030**		**2030/2010**	
	Passenger traffic (Billion pkm)	Goods transport (Billion tkm)	Passenger traffic (Billion pkm)	Goods transport (Billion tkm)	Passenger traffic (evolution in % p.a.)	Goods transport (evolution in % p.a.)
Road	151	336	196	560	1.3%	2.6%
Rail	38	99	61	174	2.5%	2.9%
Total	**189**	**434**	**257**	**734**	**1.6%**	**2.7%**

Source: Prognos analysis, May 2017; evolution expressed as average annual growth

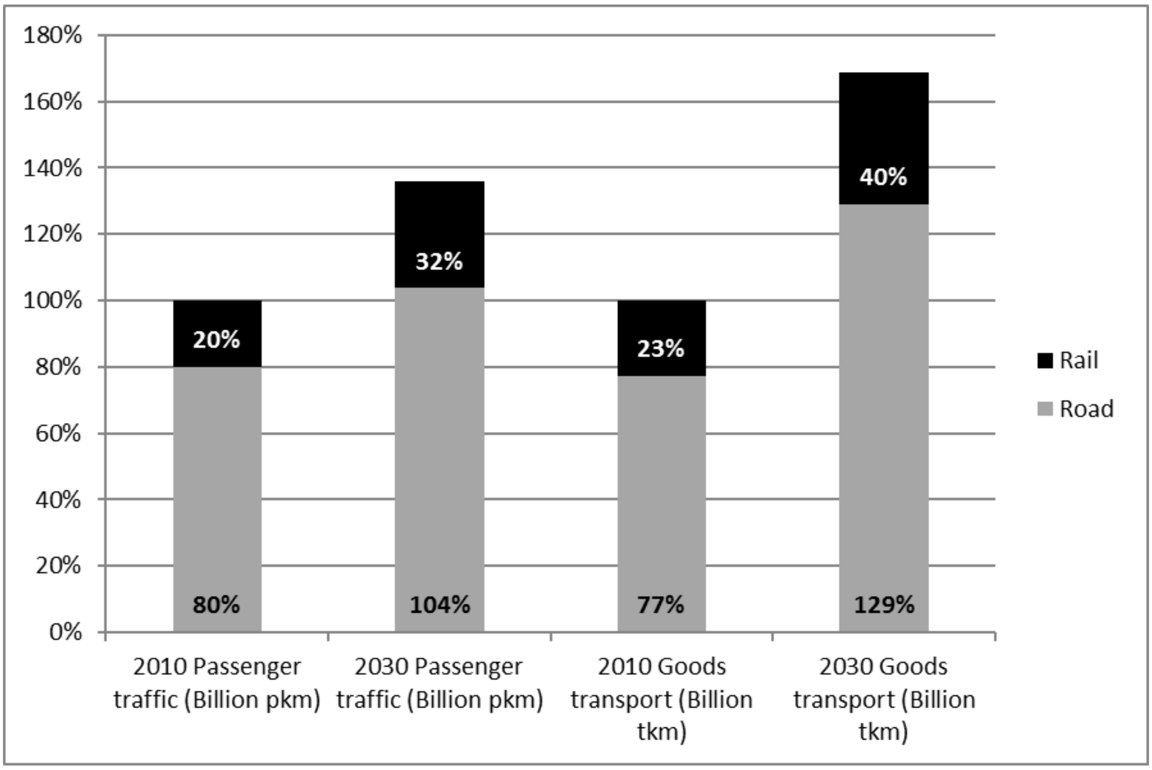
Figure 10 shows the share of both passenger and freight traffic in passenger- (pkm) and tonne kilometres (tkm) in the years 2010 and 2030 respectively. Road freight traffic performance will even improve its dominant role. It will increase by 52 index points. Table 10 shows the estimates of performance in passenger and goods transport aggregated by corridor country.

Figure 10: Evolution of transport performance on the ScanMed corridor 2010/2030



Source: KombiConsult analysis, May 2017

Figure 11: Evolution of transport performance on the ScanMed corridor 2010/2030 (Index 2010 = 100)



Source: KombiConsult analysis, May 2017

Table 10: Evolution of passenger and goods transport performance on the ScanMed corridor by corridor country 2010/2030

	2010		2030	
	Passenger traffic (Billion pkm)	Goods transport (Billion tkm)	Passenger traffic (Billion pkm)	Goods transport (Billion tkm)
		Road		
Finland	3.4	2.8	4.6	3.0
Norway	1.3	1.7	1.6	2.1
Sweden	19.8	31.6	23.7	37.7
Denmark	10.2	10.3	12.8	12.9
Germany	39.2	152.2	60.6	313.1
Austria	1.3	6.3	1.7	8.2
Italy	75.8	130.0	90.4	182.3
Malta	0.0	0.6	0.6	0.9
Total	**151.1**	**335.5**	**196.0**	**560.2**
		Rail		
Finland	1.2	1.0	1.6	1.4
Norway	1.4	1.0	1.7	1.2
Sweden	12.8	7.4	15.4	8.9
Denmark	6.7	2.0	8.3	3.6
Germany	7.5	39.9	12.8	93.6
Austria	1.6	4.4	2.0	5.6
Italy	6.7	42.6	19.7	59.7
Malta	0.0	0.0	0.0	0.0
Total	**37.8**	**98.4**	**61.4**	**174.0**

Source: Prognos analysis, May 2017

Multiplied with the average emission factors for passenger cars, trucks and trains in Annex IV of the Task 3b Guidelines, the transport performance estimates yield the corridor traffic emissions shown in Table 11 and Table 12.

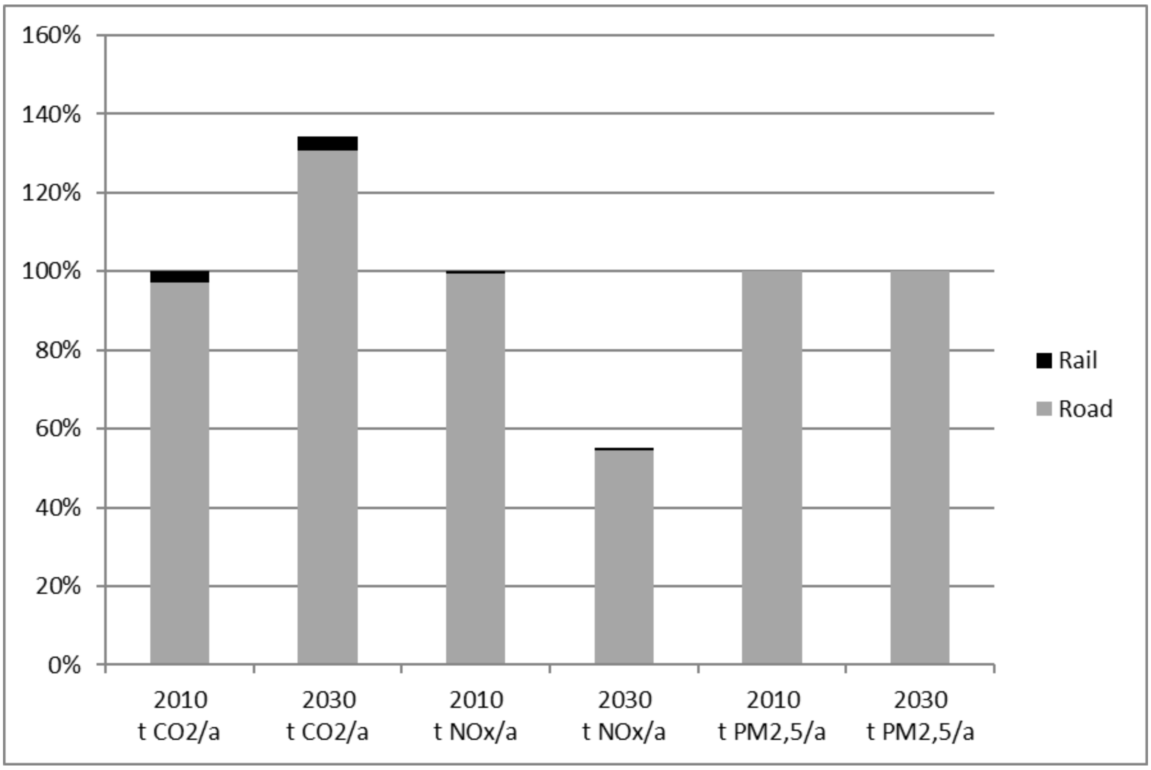
Table 11: Estimated emissions from transport on the ScanMed corridor 2010/2030

	2010			2030			2030/2010		
	t			t			evolution in %		
	CO2/a	NOx/a	PM2,5/a	CO2/a	NOx/a	PM2,5/a	CO2/a	NOx/a	PM2,5/a
Road	58,355	166	5	78,610	91	5	1.5%	-3.0%	0.2%
Rail	1,773	1	0	2,118	1	0	0.9%	0.0%	0.0%
Total	**60,129**	**167**	**5**	**80,728**	**92**	**5**	**1.5%**	**-2.9%**	**0.2%**

Source: Prognos analysis, May 2017; evolution expressed as average annual growth

The increase in emissions from 2010 to 2030 is smaller than the increase in transport performance, because it is assumed that average emissions per passenger km and tonne km will be lower due to efficiency gains and changes in the energy mix. The total transport performance for passenger traffic rises by 36 index points and for freight by 69 index points in the twenty years until 2030. The CO_2 emissions from both road and rail transport are estimated to raise by 34 index points in the same time. The NOx emissions are estimated to decrease by 45 index points while the particle emissions are stable. In all emissions, the road traffic plays the most dominant role.

Figure 12: Evolution of estimated emissions from transport on ScanMed corridor 2010/2030 (Index 2010 = 100)



Source: KombiConsult analysis, June 2017

Table 12: Evolution of estimated emissions from transport on the ScanMed corridor by corridor country 2010/2030

	2010			2030		
	t CO2/a	t NOx/a	t PM2,5/a	t CO2/a	t NOx/a	t PM2,5/a
Road						
Finland	860.8	1.9	0.1	966.3	1.0	0.1
Norway	387.3	1.0	0.0	419.8	0.5	0.0
Sweden	6,461.2	16.9	0.5	6,918.4	7.7	0.4
Denmark	2,757.4	6.4	0.2	3,081.0	3.3	0.2
Germany	21,390.7	68.5	1.8	36,405.8	43.5	2.2
Austria	835.9	2.8	0.1	966.8	1.2	0.1
Italy	25,593.8	68.3	1.9	29,678.1	33.6	1.8
Malta	67.9	0.3	0.0	173.5	0.2	0.0
Total	**58,355.1**	**165.9**	**4.5**	**78,609.5**	**91.0**	**4.7**
Rail						
Finland	28.6	0.0	0.0	26.4	0.0	0.0
Norway	31.4	0.0	0.0	26.3	0.0	0.0
Sweden	263.1	0.1	0.0	217.9	0.1	0.0
Denmark	113.0	0.1	0.0	107.3	0.0	0.0
Germany	617.0	0.3	0.0	957.1	0.4	0.0
Austria	77.0	0.0	0.0	68.6	0.0	0.0
Italy	640.2	0.3	0.0	714.6	0.3	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0
Total	**1,770.3**	**1.0**	**0.1**	**2,118.3**	**0.9**	**0.1**

Source: Prognos analysis, May 2017

The joint methodology also suggests to calculate the cost from transport emissions using multipliers available for the year 2010. The detailed multipliers are included in Annex IV of the joint methodology. If they are applied to the respective amounts of emissions estimated for the years 2010 and 2030 respectively, the cumulated cost for emissions from rail and road transport on the Scandinavian-Mediterranean TEN-T Core Network Corridor can be accounted to be €6,766m in 2010 and €12,873m in the year 2030 as shown in Tables 13 and 14.

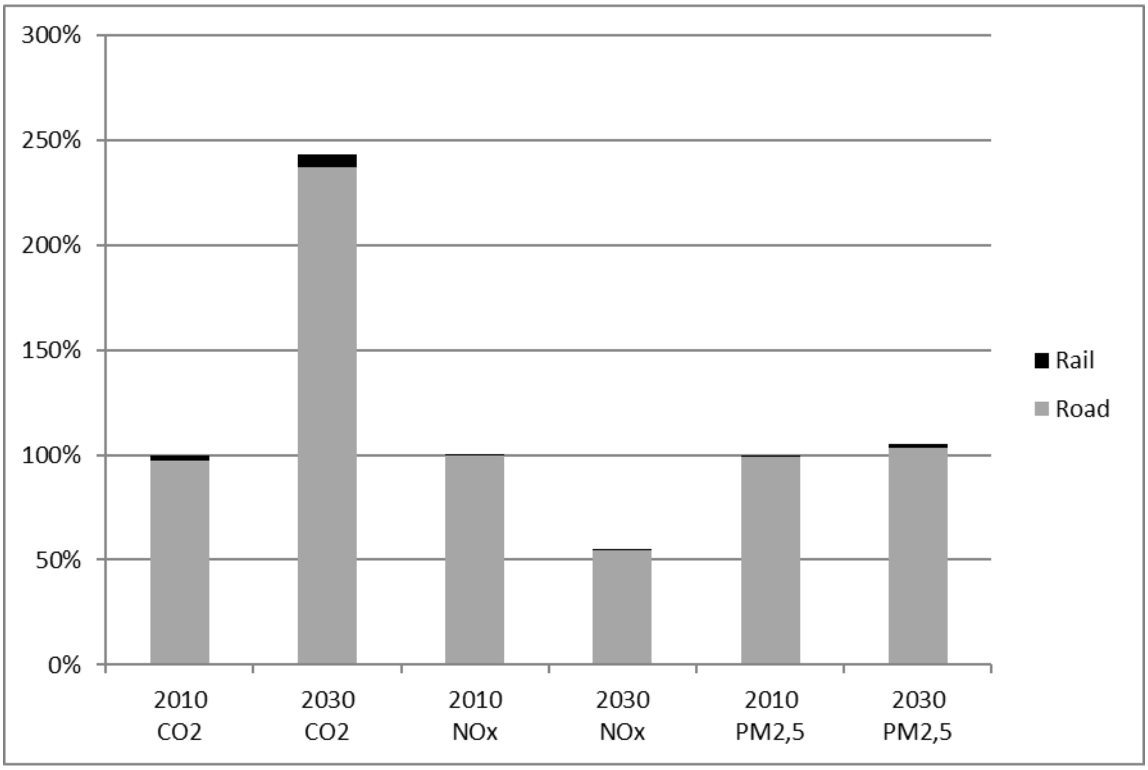
Table 13: Evolution of estimated cost from transport emissions (in thousand €) on ScanMed corridor 2010/2030

	2010			2030			2030/2010		
	in thousand €			in thousand €			evolution in %		
	CO2	NOx	PM2,5	CO2	NOx	PM2,5	CO2	NOx	PM2,5
Road	4,668	1,766	178	11,398	968	186	4.6%	-3.0%	0.2%
Rail	142	10	2	307	10	3	3.9%	-0.1%	1.3%
Total	4,810	1,776	180	11,706	978	189	4.5%	-2.9%	0.2%
Total	**6,766**			**12,873**			**3.3%**		

Source: Prognos analysis based on 2010 cost factors, year 2030 factor only for CO2, May 2017; evolution expressed as average annual growth

The cost of emissions from transport on the Scandinavian-Mediterranean TEN-T Core Network Corridor are supposed to raise by 90 index points in the time period 2010 to 2030. The largest increase is resulting from CO_2 emissions where we account "double" effect since the emissions (expressed in tons) will raise and the joint methodology provides for (higher) specific cost values for the year 2030, thus the costs will raise by 140 index points. For NOx and particles, the cost values for 2010 have also been applied to the 2030 emissions since no updated figures are available. Under these conditions, the cost of NOx emission decline by 44 points while the one of particles will increase by 4 points.

Figure 13: Evolution of estimated cost of emissions from transport on the ScanMed corridor 2010/2030 (Index 2010 = 100)



Source: KombiConsult analysis, June 2017

Table 14: Evolution of estimated cost from transport emissions (in thousand €) on the ScanMed corridor by corridor country 2010/2030

	2010			2030		
	in thousand €					
	CO2	NOx	PM2,5	CO2	NOx	PM2,5
	Road					
Finland	68.9	20.0	2.3	140.1	10.8	2.2
Norway	31.0	10.3	1.1	60.9	4.9	1.0
Sweden	516.9	179.8	18.8	1,003.2	82.1	16.2
Denmark	220.6	67.9	7.6	446.7	35.5	7.2
Germany	1,711.3	729.0	69.6	5,278.8	463.2	86.9
Austria	66.9	29.6	2.8	140.2	12.3	2.3
Italy	2,047.5	726.3	75.4	4,303.3	357,6	69.8
Malta	5.4	2.7	0.2	25.2	2.0	0.4
Total	**4,668**	**1,765.7**	**177.8**	**11,398.4**	**968.4**	**185.9**
	Rail					
Finland	2.3	0.2	0.0	3.8	0.1	0.0
Norway	2.5	0.2	0.0	3.8	0.1	0.0
Sweden	21.0	1.5	0.3	31.6	1.0	0.3
Denmark	9.0	0.6	0.1	15.6	0.5	0.1
Germany	49.4	3.5	0.8	138.8	4.5	1.3
Austria	6.2	0.4	0.1	10.0	0.3	0.1
Italy	51.2	3.7	0.8	103.6	3.4	0.9
Malta	0.0	0.0	0.0	0.0	0.0	0.0
Total	**141.6**	**10.1**	**2.2**	**307.2**	**10.0**	**2.8**

Source: Prognos analysis based on 2010 cost factors, year 2030 factor only for CO2, May 2017

Costs for other emissions including noise cannot be provided in the same way since the emissions are not known in the level of detail throughout the corridor.

Nevertheless it can be stated that for the reduction of noise the measures on hand are to improve the infrastructure (conventional or lower noise barriers, special pavement of road, ...), protect the affected houses (special windows) or the operations (low noise brakes of rail freight wagon) where Germany and Austria agreed to allow operations of only "low noise wagon" from 2021.

5.2 Mitigation through Modal Shift

The Maximum Potential Modal Shift Scenario, requested by the Commission and laid out in the Task 3b Guidelines is a hypothetical scenario, in which available rail capacity is used to shift passenger and goods transport from road to rail. In order to implement this scenario design using the information available from the transport market study from 2014, the following steps were carried out:

First, the theoretical capacity of each rail section on the corridor was determined for the year 2030. To be consistent with the 2014 transport market study, the same classification into 43 sections (S1, …, S43) was used. The theoretical capacity was derived from the number of tracks that will be available in 2030, taking into consideration the completion of known rail infrastructure projects until then. As a simple rule, the maximum capacity for a line with one track was set at 80 trains per day to ensure acceptable operational quality. For a line with two tracks, the maximum capacity was set at 120 trains per day. This daily capacity was multiplied with 280 operating days to arrive at the theoretical annual capacity in the year 2030.

Second, the forecasted number of trains on each corridor section in 2030 was taken from the 2014 transport market study and subtracted from this theoretical capacity. The remainder represents the unused and therefore available 'extra' capacity. Overall, 31 sections were identified to have such 'extra' capacity. The identified 'extra' capacity needed to be split between passenger traffic and freight transport. This was done according to the forecasted ratio between passenger and freight trains in 2030 to preserve the train mix on the corridor. For example, a rail section with an 'extra' capacity of 4,430 trains per year in 2030 and a ratio of 60% passenger transport and 40% freight transport could be used to add 2,658 passenger trains and 1,772 freight trains accordingly.

Third, on each section with 'extra' capacity, passengers and goods were then shifted from road to rail transport until either traffic on road fell to zero or the 'extra' capacity on rail was used up. Coming back to the example, the rail section with 'extra' capacity of 2,658 passenger trains and 1,772 freight trains could be used to shift up to 318,960 passengers (2,658 passenger trains x 120 passengers per train) and up to 880,684 tonnes of freight (1,772 freight trains x 497 tonnes per train) from road to rail. If the road section parallel to this rail section had lower traffic volumes, then all of this traffic would be shifted away from road. If the parallel road section had higher traffic volumes, then all of the 'extra' capacity would be used up and some traffic would remain on road.

It is important to point out, that the derivation of 'extra' rail capacity based on the number of tracks of the corridor sections disregards train mix, train speeds, signalling systems, the capacity of nodes and other exceptional circumstances. The 'extra' rail capacity is therefore a highly theoretical figure. Furthermore, the Maximum Potential Modal Shift Scenario does not consider demand parameters; therefore, the resulting performance and emissions figures represent notional targets that cannot be interpreted as the impact of the work plan.

Table 15: Passenger and goods transport performance on the ScanMed corridor under the Maximum Potential Modal Shift Scenario and the Forecast for 2030

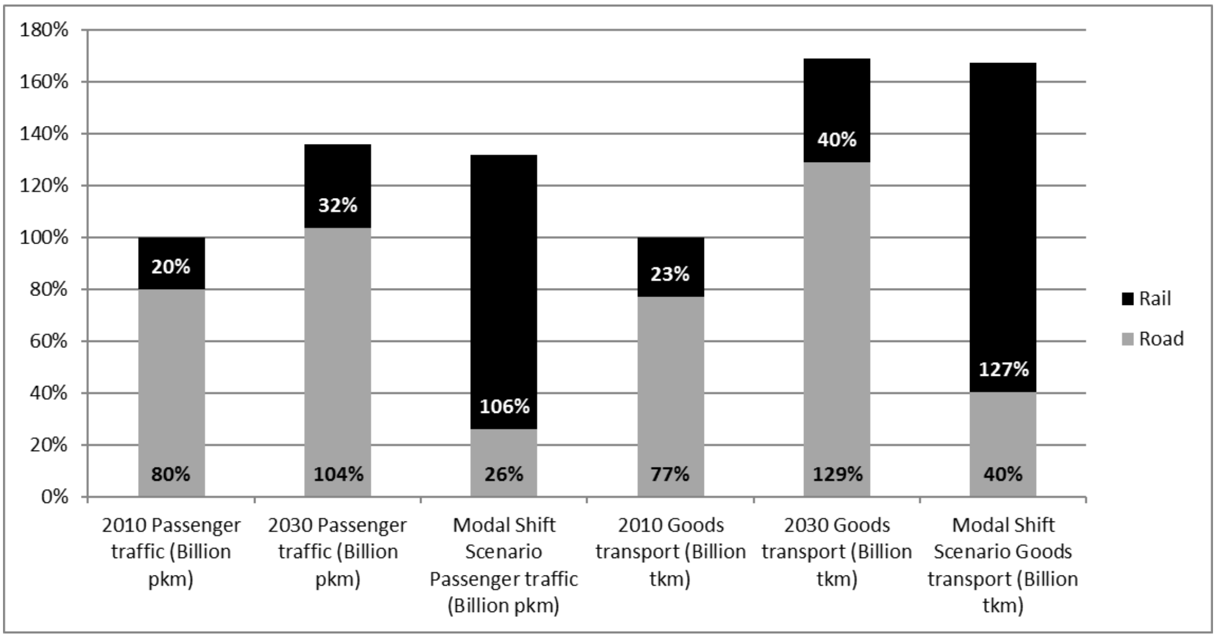
	Maximum Potential Modal Shift Scenario		**2030 Forecast**		**Scenario/Forecast**	
	Passenger traffic (Billion pkm)	Goods transport (Billion tkm)	Passenger traffic (Billion pkm)	Goods transport (Billion tkm)	Passenger traffic (difference in %)	Goods transport (difference in %)
Road	49	176	196	560	-75.0%	-68.5%
Rail	200	551	61	174	225.9%	216.5%
Total	**249**	**727**	**257**	**734**	**-3.2%**[4]	**-1.0%**[3]

Source: Prognos analysis, May 2017; differences in total performance between 2030 Forecast and Maximum Potential Modal Shift Scenario are explained by differences between rail and road section lengths

4 Of course, the total volume of passengers and goods is independent of mode choice. The small differences in total performance between the 2030 forecast and the modal shift scenario of -3.2% for passenger transport and -1.0% for goods transport are due to the differences in rail and road section lengths.

Table 15 shows the modal shift between the Maximum Potential Modal Shift Scenario and the 2030 forecast. Through the use of available 'extra' capacity, rail transport performance on the Scandinavian-Mediterranean TEN-T Core Network Corridor could be increased to 200 billion passenger kilometres and to 551 billion tonne kilometres. For passenger traffic by rail, this would represent an increase of 86 index points compared to 2010 and 74 index points compared to the 2030 forecast as Figure 14 shows. Since the total passenger volume does not differ between the forecast and the scenario, passenger traffic on road would decrease by 54 index points compared to 2010 and 78 index points compared to 2030. In terms of modal shares, the Maximum Potential Modal Shift Scenario would increase the share of rail in passenger transport to 80% from 20% in 2010 and 24% in the 2030 forecast. For goods transport, the Maximum Potential Modal Shift Scenario would mean an increase of rail transport performance by 104 index points compared to 2010 and 87 index points compared to the 2030 forecast from the transport market study. Correspondingly road transport performance would decrease by 37 index points compared to 2010 and 89 index points compared to the 2030 forecast. Looking at modal shares, the Maximum Potential Modal Shift Scenario would increase the share of rail in goods transport to 76% from 23% in 2010 and 24% in the 2030 forecast.

Figure 14: Comparison of passenger and goods transport performance on the ScanMed corridor in 2010 with the Maximum Potential Modal Shift Scenario and the Forecast for 2030



Source: KombiConsult and Prognos analysis, May 2017; differences in total performance between 2030 and the Modal Shift Scenario are explained by differences between rail and road section lengths

Table 16 presents the passenger and goods transport performance under the Maximum Potential Modal Shift Scenario by country next to the forecast values for 2030 based on the transport market study as reference.

Table 16: Passenger and goods transport performance on the ScanMed corridor under the Maximum Potential Modal Shift Scenario and the Forecast by corridor country for 2030

	Maximum Potential Modal Shift Scenario		2030 Forecast	
	Passenger traffic (Billion pkm)	Goods transport (Billion tkm)	Passenger traffic (Billion pkm)	Goods transport (Billion tkm)
		Road		
Finland	0.5	2.6	4.6	3.0
Norway	0.0	0.0	1.6	2.1
Sweden	23.7	37.7	23.7	37.7
Denmark	9.1	9.2	12.8	12.9
Germany	2.4	102.4	60.6	313.1
Austria	1.5	6.2	1.7	8.2
Italy	11.0	17.2	90.4	182.3
Malta	0.6	0.9	0.6	0.9
Total	**49.0**	**176.3**	**196.0**	**560.2**
		Rail		
Finland	3.8	1.4	1.6	1.4
Norway	58.5	2.2	1.7	1.2
Sweden	15.4	8.9	15.4	8.9
Denmark	9.7	4.5	8.3	3.6
Germany	32.2	347.1	12.8	93.6
Austria	2.1	6.2	2.0	5.6
Italy	78.6	180.3	19.7	59.7
Malta	0.0	0.0	0.0	0.0
Total	**200.1**	**550.7**	**61.4**	**174.0**

Source: Prognos analysis, May 2017;

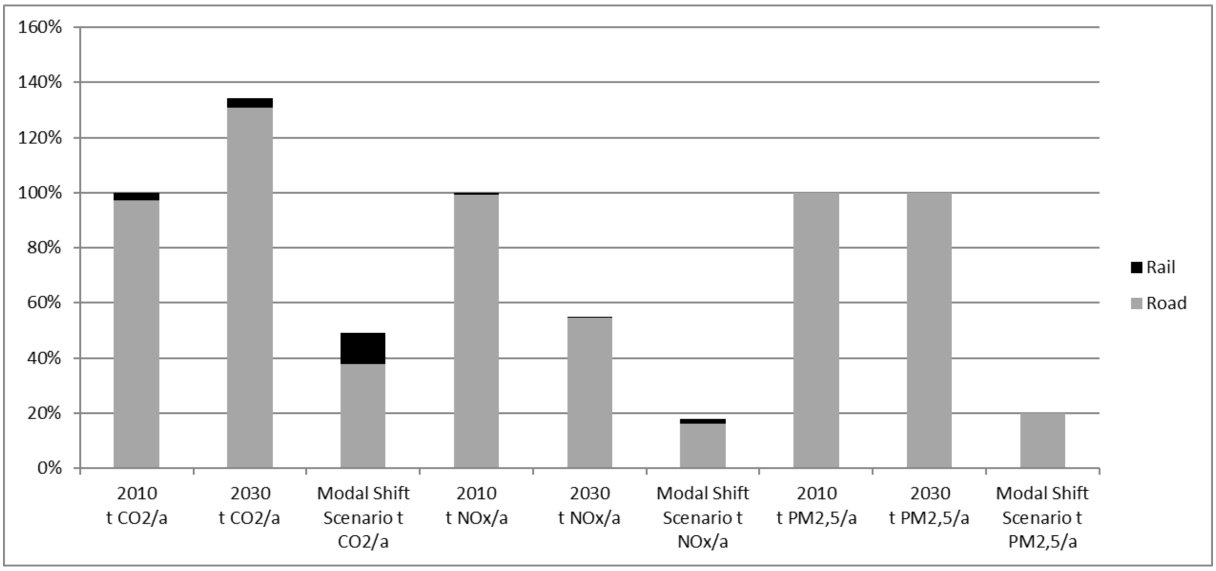
Multiplied with the average emission factors for passenger cars, trucks and rail shown in the Task 3b Guidelines, the transport performance estimates under the Maximum Potential Modal Shift Scenario yield the corridor traffic emissions shown in Table 17 and Table 18. Under the Maximum Potential Modal Shift Scenario, total emissions are lower compared to the 2030 forecast based the transport market study, because emissions per passenger- and tonne kilometre are lower for rail traffic than for road traffic. Therefore, the large shift from road to rail implies a substantial reduction of overall emissions from transport on the corridor. In detail, CO_2 emissions would be 51 index points lower compared to 2010 and 85 index points lower compared to the 2030 forecast. For NOx the difference would be 45 index points compared to 2010 and 82 index points compared to 2030. For emissions of particles, the difference would be 80 index points compared to 2010 and compared to 2030. Across all emission types, the reduction measured in index points are almost identical, because they are functions of the same reduction on road traffic and increase in rail traffic. The small differences are the result of variation in the relative role of passenger traffic and goods transport for each emission type.

Table 17: Estimated emissions from transport on ScanMed corridor under the Maximum Potential Modal Shift Scenario and the Forecast for 2030

	Maximum Potential Modal Shift Scenario			2030 Forecast			Scenario/Forecast		
	t			t			difference in %		
	CO2/a	NOx /a	PM2,5 /a	CO2/a	NOx /a	PM2, 5/a	CO2/a	NOx/a	PM2,5/a
Road	22,777	27	1	78,610	91	5	-71.0%	-70.6%	-70.9%
Rail	6,758	3	0	2,118	1	0	219.0%[5]		
Total	**29,535**	**30**	**2**	**80,728**	**92**	**5**	**-63.4%**	**-67.7%**	**-66.6%**

Source: Prognos analysis, May 2017

Figure 15: Estimated emissions from transport on the ScanMed corridor in 2010 and under the Maximum Potential Modal Shift Scenario and the Forecast for 2030



Source: KombiConsult and Prognos analysis, May 2017

5 The relative increase of emissions in rail is equal to 358.6% and identical across all emission types, because passenger and freight transport have identical emission factors. The small differences for rail and total emissions across emission types result from the differences in emission factors for passenger and freight vehicles.

Table 18: Estimated emissions from transport on ScanMed corridor under the Maximum Potential Modal Shift Scenario and the Forecast for 2030 by corridor country

	Maximum Potential Modal Shift Scenario			2030 Forecast		
	t CO2/a	t NOx/a	t PM2,5/a	t CO2/a	t NOx/a	t PM2,5/a
			Road			
Finland	306.7	0.4	0.0	966.3	1.0	0.1
Norway	0.0	0.0	0.0	419.8	0.5	0.0
Sweden	6,918.4	7.7	0.4	6,918.4	7.7	0.4
Denmark	2,201.3	2.4	0.1	3,081.0	3.3	0.2
Germany	9,229.0	11.6	0.6	36,405.8	43.5	2.2
Austria	770.3	0.9	0.0	966.8	1.2	0.1
Italy	3,178.1	3.5	0.2	29,678.1	33.6	1.8
Malta	173.5	0.2	0.0	173.5	0.2	0.0
Total	**22,777.3**	**26.7**	**1.4**	**78,609.5**	**91.0**	**4.7**
			Rail			
Finland	46.8	0.0	0.0	26.4	0.0	0.0
Norway	546.8	0.2	0.0	26.3	0.0	0.0
Sweden	217.9	0.1	0.0	217.9	0.1	0.0
Denmark	127.8	0.1	0.0	107.3	0.0	0.0
Germany	3,413.5	1.5	0.1	957.1	0.4	0.0
Austria	74.7	0.0	0.0	68.6	0.0	0.0
Italy	2,330.4	1.0	0.1	714.6	0.3	0.0
Malta	0.0	0.0	0.0	0.0	0.0	0.0
Total	**6,757.7**	**3.0**	**0.2**	**2,118.3**	**0.9**	**0.1**

Source: Prognos analysis, May 2017

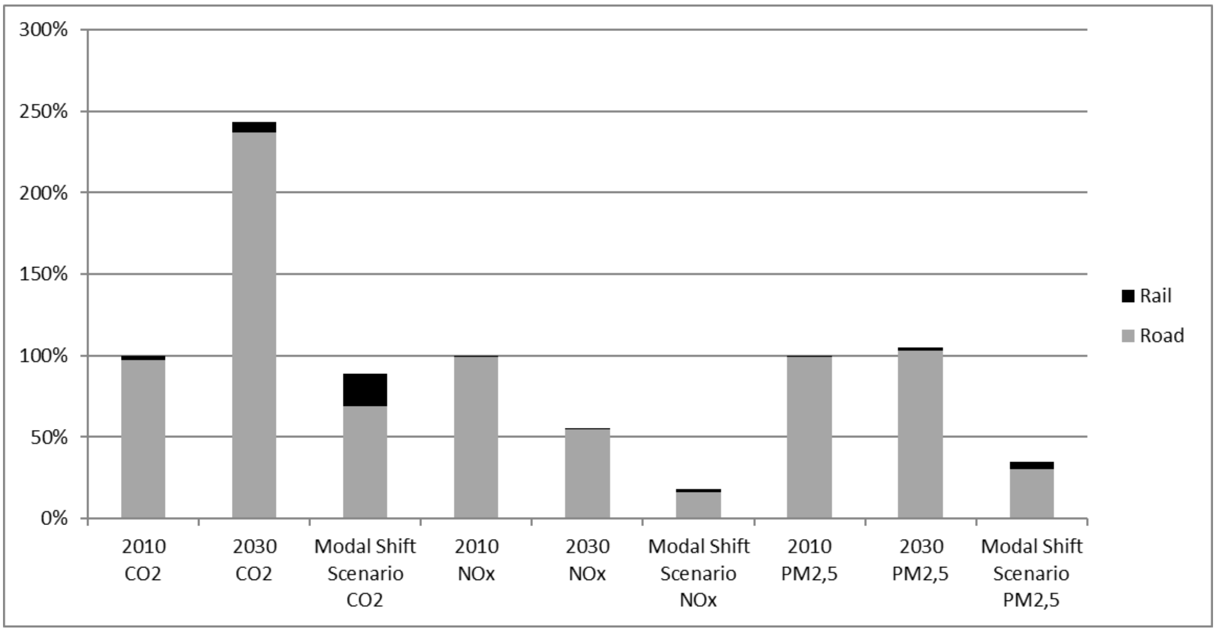
The joint methodology also suggests to calculate the cost from transport emissions using multipliers available for the year 2010. The detailed multipliers are included in Annex IV of the joint methodology. Applying these factors to the emission estimates for the Maximum Potential Modal Shift Scenario yields an estimate of total costs for corridor emissions of 4,662m € as Tables 19 and 20 show. This is a reduction of 31 index points compared to 2010 and 121 index points compared to the 2030 forecast.

Table 19: Estimated cost from transport emissions (in thousand €) on ScanMed corridor under the Maximum Potential Modal Shift Scenario and the Forecast for 2030

	Maximum Potential Modal Shift Scenario			2030 Forecast			Scenario/Forecast		
	in thousand €			in thousand €			difference in %		
	CO2	NOx	PM2,5	CO2	NOx	PM2,5	CO2	NOx	PM2,5
Road	3,303	284	54	11,398	968	186	-71.0%	-70.6%	-70.9%
Rail	980	32	9	307	10	3	219.0%		
Total	4,283	316	63	11,706	978	189	-63.4%	-67.7%	-66.6%
Total	**4,662**			**12,873**			**-63.8%**		

Source: Prognos analysis, May 2017

Figure 16: Estimated cost from transport emissions (in thousand €) on ScanMed corridor in 2010 and under the Maximum Potential Modal Shift Scenario and the Forecast in 2030



Source: KombiConsult and Prognos analysis, May 2017

Table 20: Estimated cost from transport emissions (in thousand €) on ScanMed corridor under the Maximum Potential Modal Shift Scenario and the Forecast for 2030 by corridor country

	Maximum Potential Modal Shift Scenario			2030 Forecast		
	in thousand €					
	CO2	NOx	PM2,5	CO2	NOx	PM2,5
	Road					
Finland	44.5	3.9	0.7	140.1	10.8	2.2
Norway	0.0	0.9	0.0	60.9	4.9	1.0
Sweden	1,003.2	82.1	16.2	1,003.2	82.1	16.2
Denmark	319.2	25.3	5.1	446.7	35.5	7.2
Germany	1.338.2	123.8	22.3	5,278.8	463.2	86.9
Austria	111.7	9.7	1.8	140.2	12.3	2.3
Italy	460.8	37.7	7.4	4,303.3	357,6	69.8
Malta	25.2	2.0	0.4	25.2	2.0	0.4
Total	**3,302.7**	**284.4**	**54.1**	**11,398.4**	**968.4**	**185.9**
	Rail					
Finland	6.8	0.2	0.1	3.8	0.1	0.0
Norway	79.2	2.6	0.7	3.8	0.1	0.0
Sweden	31.6	1.0	0.3	31.6	1.0	0.3
Denmark	18.5	0.6	0.2	15.6	0.5	0.1
Germany	495.0	16.1	4.5	138.8	4.5	1.3
Austria	10.8	0.4	0.1	10.0	0.3	0.1
Italy	337.9	11.0	3.1	103.6	3.4	0.9
Malta	0.0	0.0	0.0	0.0	0.0	0.0
Total	**979.9**	**32.0**	**8.9**	**307.2**	**10.0**	**2.8**

Source: Prognos analysis, May 2017

5.3 Mapping of projects

In step 1.3 of the Task 3b Guidelines (see chapter 3.1), the innovation projects were assessed with regard to their direct contribution to decarbonisation of the transport sector. Projects fulfilling this criterion can be classified as follows:

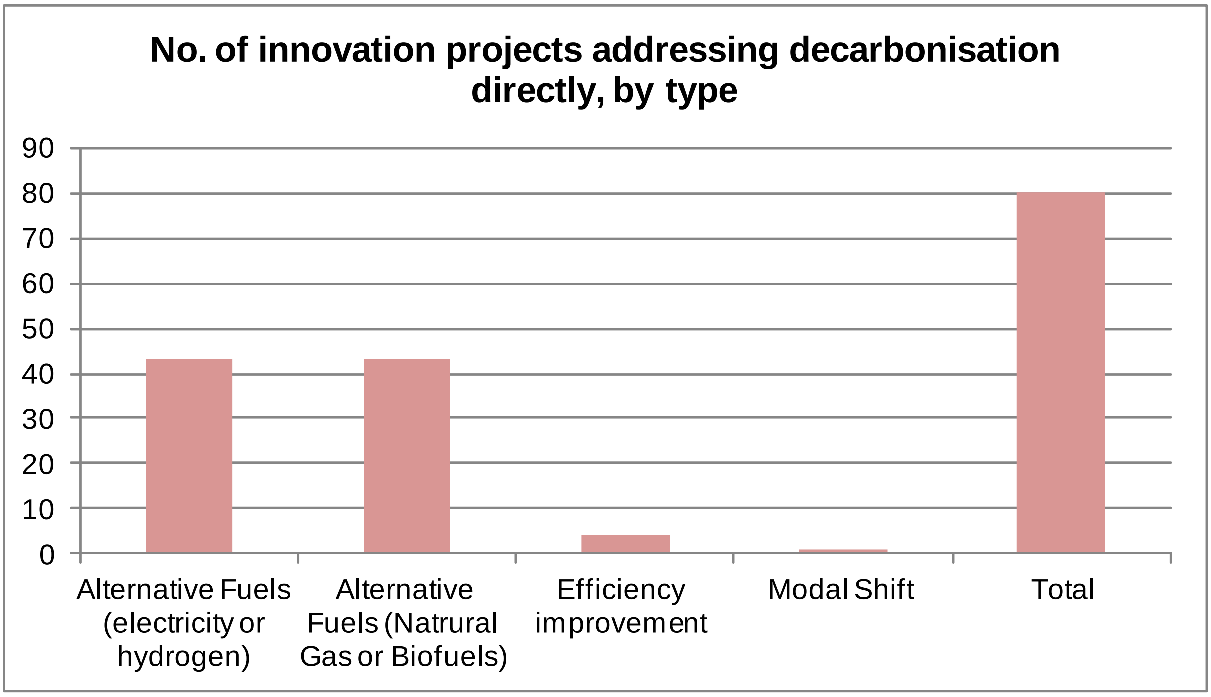
- Alternative fuels (electricity or hydrogen),
- Alternative fuels (Natural Gas or Biofuels),
- Efficiency improvement,
- Modal Shift.

The joint methodology states that nearly every project could have a positive impact on GHG emission reduction and that the assessment should focus on "substantial direct impact". However, a sound definition of this term is missing so that projects were assessed conservatively, resulting in 80 projects that address decarbonisation directly.

Both subcategories of alternative fuels are covered by 43 innovation projects each. Four projects deal with efficiency improvement and one project addresses modal shift (see Figure 17).

In the course of the mapping exercise under this chapter 'mitigation of environmental impacts', in particular the modal shift criterion seems to be widened compared to the assessment in chapter 'Innovation' so that the low coverage does not necessarily reflect the scope of the innovation projects.

Figure 17: Number of innovation projects addressing decarbonisation of the transport sector



Source: KombiConsult analysis, May 2017

Most of the 80 projects which contribute to decarbonisation are assigned to the innovation area "other new technologies and innovation" (72 projects), 20 projects are assigned to sustainable freight transport services and another project to telematics applications (including double allocations).

5.4 Project Contribution to mitigation of environmental impacts

The joint methodology of the Task 3b Guidelines is foreseeing a step 3.5 which is to assess how the projects selected as innovation case studies (in step 1.3) can contribute to reduce negative environmental impacts in their specific area of intervention. The joint methodology suggests that Cost Benefit analysis (CBA) or similar documents are analysed with respect to identify the projects' contribution to mitigation of environmental impacts.

A request to receive such documents from the CEF-financed projects was sent via the European Commission to the executive agency. The agency replied that the documents and their content is subject to business secrecy of the respective project promoters who should be contacted directly. Since the direct contact responsible for the projects were not provided for the same reason a request was sent to the Commission. Finally, the stakeholders were not contacted.

Based on the case studies themselves, a qualitative assessment can be made about how the selected projects contribute to mitigating the negative environmental effects of transport. Four of the six selected projects promote the uptake of alternative clean fuels that lower greenhouse gas emissions and air pollution in comparison to the standard fuels gas and diesel that they can replace.

The two case studies "LNG Klappschute: construction of a hopper barge with an LNG unit" and "LNG Icebreaker IB Polaris" show how LNG is used as an alternative to diesel fuel for ships. In comparison to diesel, LNG reduces CO_2 (up to 20%) and nitrogen oxide emissions. At present, about 1 billion tons of CO_2 are emitted by ships. Applying LNG on the entire world fleet, CO_2 emissions could be reduced by about 200 million tons of CO_2. Furthermore, the use of LNG eliminates emissions of sulphur oxide and particulate matter.

The two projects "Electric Vehicle Arteries (EVA+)" and "eRoadArlanda" showcase different technological approaches to promoting electric power in road transport. "EVA+" contributes to the provision of fast charging infrastructure for battery electric vehicles and "eRoadArlanda" tests an electrified road as an alternative technology to electric batteries for heavy goods vehicles. Both projects aim at overcoming the problem of limited range that electrically powered vehicles face. Road transport, including passenger cars and commercial vehicles, accounted for 833 mio. tonnes of CO_2, CH_4 and N_2O emissions or 20% of all greenhouse gas emissions in the EU in 2014.[6]

The "WiderMOS" project shows the potential for reducing greenhouse gas emissions through modal shift of goods transport from road to combined rail and ferry transport. Thereby, this project also contributes to mitigation of the negative environmental impact of road transport.

5.5 CNC contribution to mitigation policies

The Task 3b Guidelines suggest as a final step 3.6 to use the information from the modal shift estimate calculated under the Maximum Potential Modal Shift Scenario and the assessment of the case studies to provide an overall estimate of how corridor implementation can contribute to decarbonize transport.

The outcome of the Maximum Potential Modal Shift Scenario that greenhouse gas emissions on the corridor would be reduced by 51 index points for CO_2, 45 index points for NOx and 80 index points for particles compared to 2010 if the available 'extra' rail capacity was used to shift traffic from road to rail is a theoretical scenario. The result therefore represents a notional target that cannot be interpreted as the impact of the work plan.

At the same time, the Maximum Potential Modal Shift Scenario does not take into account all of the ways in which individual projects contribute to decarbonizing transport. The promotion of alternative clean fuels in shipping and road transport lower greenhouse gas emissions as showcased by the selected case studies.

6 List of Annexes

Annex 1: Trans-European transport network, Task 3b: Guidelines, Working Group: TIS, M-FIVE, Prognos, Panteia, Ineco, TPlan, Stratec, Hacon Coordinated by TIS, March 2017.

Annex 2: Country Tables and References used

6 European Environment Agency, Annual European Union greenhouse gas inventory 1990–2014 and inventory report 2016 (EEA Report No 15/2016), June 2016