ERRAC Roadmap
WP1: The Greening of Surface Transport

Sustainable Design and procurement

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WP 01 The Greening of Surface Transport
Deliverable “Sustainable design and procurement”

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1. General background, targets, references

1.1 Background

Rail transport has the capability to play a key role in a sustainable transport system by offering efficient services with low environmental impact, and these strengths need to be articulated in the political decision-making process. Through the use of mechanisms such as fairer pricing and the internalising of external costs, modal shift to rail and innovative co-modality concepts become more achievable and offer sustainable solutions for the various challenges in the transport sector

The promotion of environmentally adapted and efficient rail transport of passengers and goods is a key objective in Europe. The overall environmental performance of railway transportation is affected by contributions over the whole life cycle of the vehicles; from production, operational performance to final disposal. When designing a vehicle for improved environmental performance many different aspects which are related to environmental impact are taken into account.

Today’s energy and environmental research places high emphasis on energy efficiency, environmental impact, alternative energy sources to be prepared for the reduced availability and finally disappearing of fossil fuels. Energy resources are getting scarce and legislation on emissions is getting stricter. Even though the railway is the most energy-efficient and green transport mode, research is needed on energy efficiency and eco-design to further improve the performance of rail.

Noise and vibration have to be considered in a system and holistic approach to reduce emissions and external perceived noise levels. A lot has been done but research efforts should go on: reducing noise from individual sources (freight trains, noise, emission reductions from diesel engines on trains, etc.), and introducing technologies for active noise and vibration control. Software tools will assist the development of methods to reduce noise at source, to derive technologies and to enhance system assessment and decision-making processes.

Becoming greener means that we have to consider the overall railway life cycle and especially the elimination of materials with a negative environmental impact. Measures to consider include closed cycle waste management systems for a high level of recycling, dealing with the historical legacy of existing infrastructure (e.g. creosote sleepers), promoting greener land use by reducing pollution from rail sources (e.g. chemical treatment against vegetation) and reducing the emissions of electromagnetic waves.

Sustainable procurement means careful consideration of environmental and societal aspects as well as the economic aspects when carrying out the investment process.
Organisations practising sustainable procurement meet their needs for goods, services, utilities and works not just on a simple cost-benefit analysis, but with a view to maximising net benefits for themselves and the wider world.

There is no single definition of sustainable procurement – not least because sustainability is a contested concept – and applications vary across organisational hierarchy and sector. However, there is a general acceptance that it involves a higher degree of collaboration and engagement between all parties in a supply chain. Many businesses have adopted a broad interpretation of sustainable procurement and have developed tools and techniques to support this engagement and collaboration.

It is important to note that railways are also affected *by* the environment, in addition to having effects *on* the environment. Over time, the way that railways manage natural hazards and weather events will change due to the impact of climate change. This roadmap therefore includes a section on Climate Change Adaptation, which summarises the issues and proposes a research agenda for the railway.

Finally, the topics on energy efficiency, noise and vibration are also included in this Roadmap. However, we need to highlight that ERRAC WG1 Greening of surface transport has already tackled these topics via the previous roadmaps “Energy Roadmap for the European Railway sector” and “Noise and Vibrations Roadmap” (both available on the ERRAC website (www.errac.org)). These reports did not include, proposals for procurement and design, and therefore for completeness, energy, noise and vibration issues relevant to procurement are also included here.

1.2 Policy drivers and constrains

In the coming decades up to 2030 and beyond, the European transport sector is likely to face a set of important challenges that will profoundly affect the European transport system as we know it today. This necessarily also includes the rail transport sector.
Policy decisions on infrastructure investment, taxation or research and development have very long-term effects. Thus, the political choices made in the coming years are the ones that will to a very large extent influence the situation of the sector, its modal share, emissions and its ability to respond to transport demand in the future. Therefore, while bearing in mind a long-term perspective of where the European Union should head, e.g. the modal shift from road to rail in order to meet the Lisbon target of sustainable economic growth and a 20%

reduction of CO2 emissions by 2020, it is concrete policy decisions that are needed at present.
The objectives of EU environmental policies are to preserve, protect and improve the quality of the environment, to protect human health and to utilise natural resources prudently and rationally. These policies are based on the precautionary principles that preventive action should be taken, that environmental damage should as a priority be rectified at source and that the polluter should pay.

Eurovignette directive (2006/38/EC)

Via this directive, the European Union aims at eliminating distortions of competition between transport undertakings in the Member States, the proper functioning of the internal market and improved competitiveness all depend on fair mechanisms being established to charge hauliers for the cost of infrastructure use.

A fairer system of charging for the use of road infrastructure, based on the ‘user pays’ principle and the ability to apply the ‘polluter pays’ principle, for instance through the variation of tolls to take account of the environmental performance of vehicles, is crucial in order to encourage sustainable transport in the Community.
The objective of making optimum use of the existing road network and achieving a significant reduction in its negative impact should be achieved in such a way as to avoid double taxation and without imposing additional burdens on operators, in the interests of sound economic growth and the proper functioning of the internal market, including outlying regions.

REACH regulation (EC 1907/2006)

REACH is the European Community Regulation on chemicals and their safe use. It deals with the Registration, Evaluation, Authorisation and Restriction of Chemical substances. The law entered into force on 1 June 2007.
The aim of REACH is to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. At the same time, REACH aims to enhance innovation and competitiveness of the EU chemicals industry. The benefits of the REACH system will come gradually, as more and more substances are phased into REACH.
The REACH Regulation places greater responsibility on industry to manage the risks from chemicals and to provide safety information on the substances. Manufacturers and importers are required to gather information on the properties of their chemical substances, which will allow their safe handling, and to register the information in a central database run by the European Chemicals Agency. The Agency acts as the central point in the REACH system: it manages the databases necessary to operate the system, co-ordinates the in-depth evaluation of suspicious chemicals and is building up a public database in which consumers and professionals can find hazard information.

The Regulation also calls for the progressive substitution of the most dangerous chemicals when suitable alternatives have been identified.

RoHS Regulation (2002/95/EC)

The Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment commonly referred to as the Restriction of Hazardous Substances Directive or RoHS) was adopted in February 2003 by the European Union. The RoHS directive took effect on 1 July 2006, and is required to be enforced and become law in each member state. This directive restricts the use of six hazardous materials in the manufacture of various types of electronic and electrical equipment. It is closely linked with the Waste Electrical and Electronic Equipment Directive (WEEE).

WEEE Directive (2002/96/EC)

The purpose of this Directive is, as a first priority, the prevention of waste electrical and electronic equipment (WEEE), and in addition, the reuse, recycling and other forms of recovery of such wastes so as to reduce the disposal of waste. It also seeks to improve the environmental performance of all operators involved in the life cycle of electrical and electronic equipment, e.g. producers, distributors and consumers and in particular those operators directly involved in the treatment of waste electrical and electronic equipment.

Battery directive (2006/66/EC)

The primary objective of this Directive is to minimise the negative impact of batteries and accumulators and waste batteries and accumulators on the environment, thus contributing to the protection, preservation and improvement of the quality of the environment.
Specific rules are identified in the directive in order to prevent waste batteries and accumulators from being discarded in such a way as to pollute the environment, and to avoid end-user confusion about the different waste management requirements for different batteries and accumulators.

<u>Other directives relevant for this topic:</u>

- **Ambient air quality directive (2008/50/CE) + Directive 97/68/CE & modifications**
- **Noise directive (2002/49/CE) + TSI (Directive 2001/16/CE)**
- **Waste directive (2008/98/CE)**
- **Industrial emission directive (2010/75/UE)**
- **EMC Directive (2004/40/CE)**
- **Fluorinated gases regulation (CE n°842/2006)**
- **Eco-conception directives (2005/32/CE & 2009/125/CE)**

1.3 Megatrends

Adaptation to Climate Change

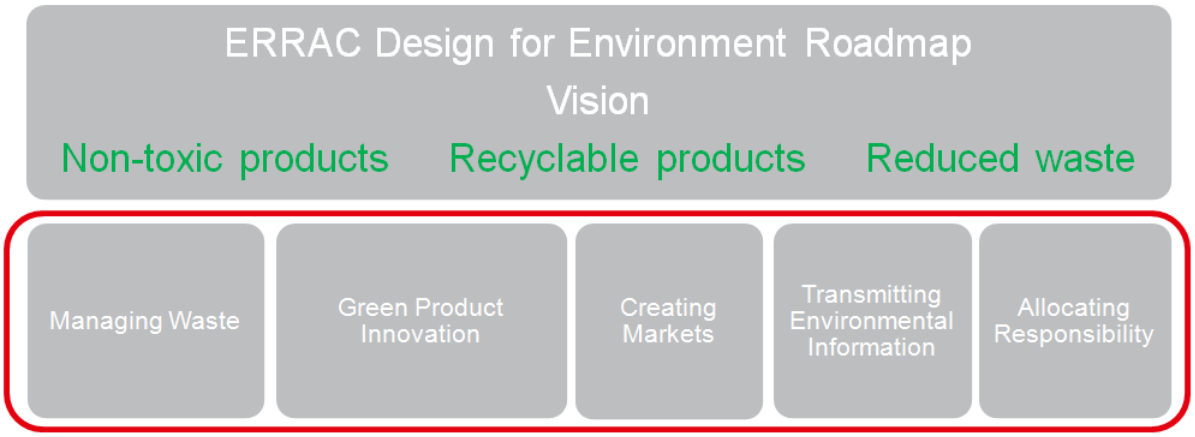
The topic of climate change has led, broadly speaking, to two different approaches. The first is “mitigation” – i.e. the reduction of “greenhouse gases” (carbon dioxide, methane and others) that have been recognized in the scientific community as causing climate change. The other is “adaptation” – i.e. changing, or adapting, to the new weather and climate paradigm.
In the railway sector, as in almost every sector apart perhaps from agriculture and water, by far the most attention has been paid to mitigation. However in more recent years more attention has been paid to adaptation, perhaps because the impacts of climate change are becoming more pronounced and more visible. Many countries, particularly in Europe, are developing climate change mitigation & adaptation plans.
In the European rail sector, Infrastructure Managers are being asked to provide their governments with information on how they will safeguard the nation’s railway infrastructure, and several are going beyond what is being requested of them, and are launching groundbreaking studies and strategies into this topic. Railway Operators also have a strong interest in climate change adaptation, since rolling stock will need to adapt to the weather conditions in the future climate and weather scenarios.

1.4 Incentives

REACH authorisation provision are incentive measures to supporting the reduction of hazardous substances in all sectors.

Substances of Very High Concern (SVHC) are required to be substituted for other substances in the short or medium term, unless it can be demonstrated that the use of SVHC substances provide more socio-economic advantages than disadvantages and that substitution is not feasible

2. Target and Goals of Research



3. Past projects and recent developments

3.1 Procurement guidance

REPID

The project REPID “Rail sector framework and tools for standardising and improving usability of Environmental Performance Indicators and Data formats” was submitted under the 5th Framework programme.

The purpose of the REPID project was to ensure that the results from the EU funded project RAVEL were made available to the European railway sector. The project aimed at establishing a framework for managing and communicating environmental performance indicators and improving the environmental competitiveness of the Rail sector compared to other transportation modes.

REPID developed a methodology of how to handle environmental requirements in the rail design (design for Environment) as well as in railway procurement projects.

Prosper II

The PROSPER II project (Procedures for Rolling Stock Procurement with Environmental Requirements phase II), was finalised in July 2005. The project was carried out in close cooperation betweenrailway operators and manufacturers and employed a feedback process which was open to the whole railway industry.

The PROSPER project was designed towards developing a commonly agreed approach for handling environmental aspects at procurement level within the whole rail sector. The main outcome of the project is the UIC leaflet “Environmental Specifications for new Rolling Stock”, which contributes to harmonisation of the environmental procurement framework in the rail sector at European, and in the long-term global level. By doing so the process of procurement will become more efficient, enabling railways to procure new rolling stock with a sound environmental performance more cost effectively.

InfraGuider [http://infraguider.eu]

InfraGuider was a Coordinated Action funded by the European Commission under the 7th Framework Programme for Research and Development. The full name is "Infrastructure Guidelines for Environmental Railway Performance". It ended in 2010.

The main objective of InfraGuidER was to create an efficient and profitable exchange of know-how, experience, insight and research results among different actors and experts of Railways research focusing on the Railway Infrastructure Environmental Impact Evaluation.

- The current state of environmental performance within the railway sector, and to highlight the criticalities to become effective and practical for the internal Environmental Management system implemented by railway companies and suppliers;
- The infrastructure functional subsystems and interfaces from the environment point of view;
- The balance of goods in terms of material flow, environmental key performance indicators EPIs and relevant ranking.

3.2 Chemical substances

Railway Industry Substance List (www.unife-database.org)

The Railway Industry Substance List provides a comprehensive and accurate list of the prohibited and declarable chemicals used specifically by the railway industry. The overarching objective of the database is to provide information to suppliers and sub-suppliers on materials and substances that are prohibited by European and international legislation. The list defines and categorises substances and furthermore provides the locale of where restrictions must be considered.

The list was initiated as a result of the European REACH regulation (EC 1907/2006) that entered into force on 1st June 2007 and has reinforced the legal provisions for manufacturers, downstream users and importers of substances.

UNIFE members have taken all reasonable efforts to complete and regularly update the Railway Industry Substance List, with reviews occurring at least twice a year.

Sustainable Wooden Sleepers

In 2011 UIC and its members launched a study into Sustainable Wooden Railway Sleepers (SuWoS). The project was driven by a possible future ban on creosote, but with many IMs wanting to retain wood as a basic material for sleepers, at least in some particular applications.
The legal position is that EU Member States can decide whether or not the use of creosote is permitted within this member state. However, Those Member States authorizing such products shall no later than 31 July 2016 submit a report to the Commission justifying their conclusion that there are no appropriate alternatives and indicating how the development of alternatives is promoted.

The UIC project is to assess the environmental impact of alternative (without creosote) preservation technologies of wooden railway sleepers and a feasibility study of common pilot/test projects. The project so far has carried out a questionnaire of IMs to find out the extent to which they are using creosote sleepers, to find out the ways in which creosote sleepers are disposed of, and whether they have already good alternatives. The wood preservation industry is involved and has been asked for status on alternatives. The project will conclude in the summer of 2012.
There are alternatives in-test at the moment. For example, DB are currently testing a creosote alternative known as “SleeperProtect” is a preparation on basis of natural, drying oils containing dissolved copper soaps and organic biocides The oil-based preparation contains no organic solvents, no water and no components of creosote. All active ingredients of SleeperProtect are supported according to the Biocidal Products Directive, the approval of active ingredients and the preparation is ensured. The toxicological profile is uncritical.

3.3 Recyclability and recoverability

Recyclability and recoverability calculation

Recycling of productions is an important parameter for the public and at political level. Although there is no regulation in force for the railways sector, the recycling, recovery and environmentally sound disposal of railway vehicles are priorities of rail research. The sector has identified an urgent need for guidance on processing railway vehicles at the end of service life.

In 2011, The Life Cycle Assessment Topical Group in UNIFE has dedicated its full attention to the development of the Recyclability and recoverability calculation

method for rail rolling stock. The document aims to define a common approach for the calculation of recyclability and recoverability rates within the railway industry. Furthermore the document presents a common rail industry method in order to make recyclability and recoverability figures comparable and transparent.

The document was proposed to become a UIC/UNIFE Technical Recommendation in the near future.

3.4 Climate Change Adaptation

The railway and research communities have produced a wide number of studies looking at extreme weather events, resilience in general, and adaptation to climate change. This section provides an overview of existing relevant research (EU funded and railway-funded projects), and describes a new proposed FP7 project.

A new research project, RESILIENT, addresses the call FP7-SST-2012-RTD-1 “The role of rail in the European Transport system in response to major disruptions”, and seeks to identify how the rail sector can play a significant part in ensuring the European transport system is resilient to major shocks, through the identification of common impacts, the scoping of improvements in the resilience of rail and a future role of rail in the European transport system.

The level and depth of research requires support and input from a range of European stakeholders including the ‘problem owners’ (railway operators), industry and researchers currently leading relevant projects in this field, such as EWENT and FUTURENET. The table below provides the key relevant projects.

EWENT www.ewent.vtt.fi	The EWENT project takes a risk management approach to the impact of extreme weather events on the reliability and safety of European passenger and freight transport networks. The results serve to inform adaptation strategies. The EWENT project has identified the most harmful weather phenomena across Europe. RESILIENT is able to take the analysis one step further relying on EWENT’s results on critical phenomena in terms of harmful impacts and socio-economic losses. The risk management options and strategies of EWENT offer a springboard to RESILIENT to sketch more targeted risk management measures.
WEATHER www.weather-project.eu	The WEATHER project is researching the potential economic costs of climate change on transport. This project uses relevant case studies such as the flood in Eastern Germany in 2002 to investigate the current impact of weather on transport systems. Using records from insurance companies, general figures are given for the impact of different types of weather on different modes.

	This gives some idea of the relative resilience of different modes of transport to extreme events. For rail delays the effects of different events such as winter storms and avalanches are given as capital, operational and user costs. Some preliminary extrapolation of these figures has been conducted to arrive at initial projections of costs due to changes in the frequency of extreme events.
FUTURENET (Future Resilient Transport Networks) www.arcc-futurenet.org	The FUTURENET project is determining the real-world effect of different types of disruptive weather in terms of spatial and temporal extent over a relatively large area. This project looks at the most heavily used rail section in the UK, the West Coast Mainline, and analyses the sections of track.
ARISCC www.ariscc.org	The UIC project ARISCC (Adaptation of Railway Infrastructure to Climate Change) explored in detail the strategies of European railways on natural hazard management, and found out which of them were developing strategies for climate change adaptation. The ARISCC project produced a wide number of good practice case studies in the management of a wide range of weather and climate related natural hazards such as flooding, severe storms, landslides, rock fall and avalanches. Using this as a basis, ARISCC produced a guidance document on how to integrate long-term climate forecasts into natural hazard management. All the results of ARISCC, including a case-study database, are available at http://ariscc.org

Other projects relevant to the topic of infrastructure, resilience to weather and extreme events, are:
ECONET (www.econet-project.eu). This project is conducting a similar analysis of the impact of weather and climate on transport to the EWENT and WEATHER projects, in this case for inland waterway transport.
The ARCADIA (University of Newcastle, UK) project looks at the interdependencies of different types of infrastructure in South East England, including energy. Simulations of different types of extreme events such as floods and heat waves are being used with macro-economic models to determine how economic costs propagate through the economy in space and time.
The ITRC (University of Newcastle, UK) project has expanded the work above to look at the interdependencies of different types of infrastructure for the whole of Great Britain.

In aviation, FLYSAFE (www.eu-flysafe.org) looks at the main causes of accidents, which includes atmospheric conditions. This focuses on providing accurate weather information to aircraft so that accidents may be reduced using Weather Information Management Systems (WIMS).
The INTRO (www.intro.fehrl.org) project looks at the effectiveness of real-time warning systems to reduce the impact of unexpected changes in weather. It may also be possible to look from an adaptive perspective and try to capitalise on the benefits brought about by certain weather conditions.
CREDOS, looks at improving air travel by using the reduced wake turbulence at times of cross wind to reduce separations for departures.
Increasingly wireless technology can be used to provide increased data on the location and conditions that vehicles are travelling in, such as the CARLINK project.

3.5 Noise and vibrations

Acoutrain

The overall goal of the ACOUTRAIN project is to promote interoperable rail traffic in Europe by reducing costs and time of certification for acoustic performance. This will be achieved by the following high level objectives:
1) Dramatically reduce time and cost of the TSI noise conformity assessment procedure:
2) Harmonise the process for noise conformity assessment across Europe by providing standard procedures;
3) Clarify the application of the simplified evaluation method introduced by the partial revision of the TSI Noise by providing specific examples;
4) Investigate a widening of the scope for the certification procedure and explore synergies with the END noise mapping;
5) Establish a method for separation of infrastructure and rolling stock noise contributions.

RIVAS- Railway Induced Vibration Abatement Solutions

RIVAS aims at reducing the environmental impact of ground-borne vibration while safeguarding the commercial competitiveness of the railway sector. For several areas of concern vibration should be reduced to near or even below the threshold of perception. The project's goal is therefore to provide the tools to solve vibration problems for surface lines by 2013.
It therefore aims to contribute to relevant and world leading technologies for efficient control of people's exposure to vibration and vibration-induced noise caused by rail traffic.

RIVAS will focus on low frequency vibration from open lines, which is a concern mainly for freight traffic. However, it can be anticipated that RIVAS results will also be applicable to suburban, regional and high-speed operations.

3.6 Energy efficiency

Railenergy (2006 – 2010)

The overall objective of Railenergy was to cut the energy consumption in the railway system thus contributing to the reduction of life cycle costs of railway operation and the carbon dioxide emissions.

Railenergy has elaborated five strategic assessment reports to capture the conclusions of the R&D efforts performed by all partners during the project period.

The main report contains the Railenergy strategic assessment methodology and framework that has been developed and applied throughout the project. The assessment is built on the approach which consists of three levels: a technical level, an operational level and finally an economic/strategic level.

Railenergy made an assessment of EE technologies available and recommends the implementation of EE technologies and components. Railenergy provided the input for the joint UIC/ UNIFE Technical Recommendation “Specification and Verification of energy consumption for railway rolling stock”. (see chapter 3.2)

TRAINER (2007-2009)

The European research project TRAINER "TRAining programmes to INcrease Energy-efficiency by Railways" www.iee-trainer.eu aimed to improve the energy efficiency of the train drivers.

ECORAILS (2009-2011)

The European research project ECORailS www.ecorails.eu "Energy Efficiency and Environmental Criteria in the Awarding of Regional Rail Transport Vehicles and Services" aimed to develop energy efficiency and environmental criteria for the public transport administrations markets.

OSIRIS

The project aims at enabling a reduction of the overall energy consumption within Europe’s urban rail systems of 10% compared to current levels by 2020.

The key objectives of the projects are:

- Define a series of standardised duty cycles and key performance indicators for urban rail systems;
- Develop a holistic model framework assembling existing proprietary traction and power network simulation modules into a complete urban rail system model (i.e., the OSIRIS tool). It will include all the primary parameters that influence energy consumption, as well as their inter-dependencies. As part of the project, a model of thermal energy exchanges within trains, tunnels and stations will be developed as well;
- Propose Technical Recommendation for the use of onboard energy storage systems, addressing the issue of assessment and mitigation of safety risks for the customer and operation staff;
- Assess and compare the overall energy saving potential when applying new technologies or operational modes; and implementing them over both existing and new equipment.

3.7 Air pollution / quality

CleanER-D (2009 - 2013)

CleanER-D (www.cleaner-d.eu) is a partly European Commission funded project that aims to develop, improve and integrate emissions reduction technologies for diesel locomotives and rail vehicles. It has a scientific part which focuses on the socio-economic and environmental aspects and future technologies for diesel applications. Emissions of Nitrogen Oxides and particulates of the railway sector have already decreased by ~ 35% from 1990 to 2008 and are expected to further decrease. In order to meet the new emissions limits, the sector needs advanced green vehicles. Therefore, in CleanER-D dynamic and innovative solutions for future diesel applications will be evaluated. Keeping this in mind, the project will analyse hybrid technologies and their contribution to the reduction of energy consumption and CO2 emissions.

TRANSPHORM (2010-2013)

The EU project TRANSPHORM (2010-2013) http://www.transphorm.eu/ will develop and apply tools for assessing policies and measures aiming to reduce health risks due to PM emissions by the transport sector. It will develop detailed scenarios of future transport emissions of PM and methods to calculate the health risks of exposure to PM.

4. Standards / Recommendations

4.1 Procurement Guidance

UIC Code 345 Title: Environmental specifications for new rolling stock
The report addresses all relevant aspects for the integration of environmental aspects into the procurement process: from invitations to tender to evaluating tenders with regard to their environmental performance. The report is derived from the UIC project PROSPER ("Procedures for Rolling Stock Procurement with Environmental Requirements").
It is the aim of this report to contribute to harmonisation of the environmental procurement framework in the rail sector at European, and in the long-term global level. By doing so the process of procurement is to become more efficient, enabling new rolling stock with a sound environmental performance to be procured more cost effectively.

Other documents related to this issue:

TC256/SC3/WG45 "Environmental conditions"

UIC Code 330 Title: Environmental performances indicators

This leaflet contains definitions for six environmental key performance indicators - or "KPIs" - for railway companies (operators, infrastructure managers or integrated companies) as well as explanations on how to produce them. The six indicators are:

- Share of renewable energy (energy mix and bio-diesel),
- Greenhouse gas emissions (CO2),
- Local air pollution (PM and NOx)
- Noise emissions,
- Land take (area).

The chosen indicators serve to compare the environmental performance of railways and other modes of transport, and enable monitoring of rail transport's share of renewable energy sources, energy consumption, CO2 emissions, air pollution, noise exposure and land take. This leaflet is valid for use by all UIC member companies. Due to the strict legislative framework in Europe, several references are made to EU legislation (e.g. for air pollution and noise).
Important system boundaries as well as explanations for data processing are defined for each indicator. Furthermore the reference variables needed to implement the key environmental indicators are specified in detail.
The data collection and data quality process is divided into three levels: basic, simple and advanced - enabling all railway companies to set up appropriate systems with environmental indicators to monitor their corporate environmental

impact and demonstrate environmental improvements or advantages compared to other modes of transport.
It is recommended to gradually improve the data quality according to the principles in this leaflet - for the benefit of the individual railway company as well as that of the international railway community.

4.2 Chemical Substances

The Railway Industry Substance List provides recommendations for the railway industry on chemical substances (see section 3.2)

4.3 Recyclability and recoverability

UNI-LCA-001:00: Railway rolling stock - Recyclability and Recoverability Calculation method

This report aims to define a common approach for the calculation of recyclability and recoverability rates and should only be applied for product information with scope to B2B information. Furthermore the report presents a common methodology in order to make recyclability and recoverability figures comparable and transparent within the railway industry.
The calculation method is based on ISO standard 226281, however further development has been done on the calculation formula to consider the efficiency of the recycling and recovery technologies of various materials at the different stages of the recycling process of the rolling stock.
The approach of the document is practical and based on automotive recycling processes. Starting with the description and definition of recycling terms used by the recycling industry in general, the method follows the railway specific requirements of necessary material information. The method of calculation is partly covered by ISO 22628. However, pre-treatment and dismantling calculations are adapted and consider recycling and recovery properties of the materials specific to these stages. At each stage individual material flows are split into materials for recycling and materials for recovery, depending on the availability of appropriate technology for recycling and/or recovery. Therefore knowledge of materials and dismantling of rolling stock or equipment is essential. The entire supplier industry needs to be involved because material information is crucial when applying the calculation method. The harmonized calculation method for recycling characteristics of rolling stock shall prevent misleading data gaps and contradictions.

4.4 Climate Change Adaptation

Currently there are no guidelines or standards in this area.

4.5 Noise and vibrations

Planned **TecRec “Low Vibration Vehicle”**

Noise and Vibrations have been identified to be major challenges for the European railway system with the sector constantly increasing its transport volume. Shifting more transport to rail and increasing the market share of the sector can only be achieved with sustainable noise and vibration mitigation measures. These effects are on one hand the infrastructure and on the other hand the rolling stock causing the vibration transmitted by the rail/wheel interaction.

The specification for low vibration vehicle is planned as outcome of the FP 7 project “RIVAS”.

4.6 Energy Efficiency

TecRec[1] 100_001 Title: Specification and verification of energy consumption for Railway rolling stock

The criterion for the energy consumption of rolling stock is the total net energy consumed – either at pantograph or from the fuel tank – over a predefined service profile, which is either taken from the future operation of the train, or according to a standardised typical profile valid for the specific service category of trains. This will assure that results are directly comparable or representative for the real operation of the train.
The general purpose of this TecRec is to provide a framework that will enable to generate comparable energy performance values for trains and locomotives on a common basis and thereby support benchmarking and improvement of the energy efficiency of rail vehicles.
The purpose of this document is not to allow for comparison of energy consumption with other modes of transportation, or even for comparison between diesel and electric traction, as it only deals with the energy consumption of the vehicle itself.

[1] The TecRec are the tool to release joint UIC / UNIFE Standards, which will first apply to the railway sector in Europe and its interfaces with other subsystems.

CENELEC[2] EN 50463 Title: Railway applications - Energy measurement on board trains

This European Standard applies only to newly manufactured static energy meters of accuracy class 1, for the measurement on board, of alternating current electrical energy or direct current electrical energy used for traction applications operating at the following supply voltages:
• 25 kV (single phase) at 50 Hz,
• 15 kV (single phase) at 16,7 Hz,
• 3 kV, 1,5 kV and 0,75 kV d.c.
It applies only to static meters consisting of a measuring element and register(s) enclosed together in a meter enclosure. It does not apply to: a) portable meters; b) data interfaces with on board systems; c) data management system; d) data interfaces with telecommunication system; e) on-board global measurement systems; additionally, if voltage and current transducers are considered of accuracy class 0,5. If these transducers are multi-service, specific and separate outputs will be considered.

UIC Code 930 Title: Exchange of data for cross-border railway energy settlement

Infrastructure Managers in Europe are required to operate in a neutral and non-discriminatory manner, thereby contributing to the development of a competitive and efficient railway market. In the railway sector, metering points for rolling stock are not connected to the grid in a fixed location - they can move. Given the increasing liberalisation of the railway sector in Europe, train movements between different Infrastructure Managers will rise and this demands interoperability as well. A growing number of traction units are equipped with metering systems for the collection of energy consumption and location data. For cross-border traffic exchanging data is vital to avoid the need to have different metering systems fitted to suit national specifications. The aim of Infrastructure Managers is to be able to account for the costs of traction energy consumed by Railway Undertakings. Railway Undertakings are set to benefit from the collection of this energy consumption data, since it will allow them to identify energy saving measures and subsequently reduce their energy costs. In order to fulfil this aim Infrastructure Managers have established a standard for exchanging data, such as energy consumption and location data, from traction units operating in cross-border traffic. This leaflet establishes the necessary framework for the exchange of data for cross-border railway energy settlement. This UIC Leaflet will be adapted to comply with ERA TSI and CENELEC norms.

[2] European Committee for Electrotechnical Standardization

Planned TecRec – Technical recommendation for the use of onboard energy storage systems
This TecRec will be developed within the Osiris project which started in January 2012.

5. Priority Areas

5.1 General Procurement Guidance

Following the literature review, discussions with stakeholders and railway companies, we can conclude that Rolling Stock Procurement sector is the most advanced when it comes to standardized environmental procurement in the railway sector. For procurement in areas beyond rolling stock, which forms the majority of procurement spend, with the exception of some quite specific issues (e.g. the use of creosote on sleepers), we have not found many examples where railways see a business or environmental need to collaborate on procurement and design topics for environmental reasons.

Therefore the research topics and proposals in this Roadmap focus on rolling stock procurement. However, the UIC and the European Rail Procurement Council (ERPC) will continue to coordinate the ERPC Sustainability Group, and it may be that railways can agree on some environmental design and research goals in other procurement areas. This should be a regular agenda item at ERRAC meetings and discussions, so that when and if research topics arrive, they can be addressed in a structured way to the EC and other stakeholders.

Nevertheless, one key research area had full support from the sectors representatives which is:

- Eco-design label for Rolling Stock

The sector is considering the development of recognized, clear and transparent Environmental performance communication based on life cycle thinking and assessment.

An “easy to handle” environmental label could be established, allowing quick analysis and comparison based on a set of key criteria covering Materials and Recyclability. The eco-label should be officially recognized in order to ensure accuracy and validity with the objective to prepare an official EU eco-label for Rolling Stock and other railway products according to EC Regulation No 1980/2000 and EN ISO 14024:2000.

A research program should be launched to increase the cooperation of the stakeholders to develop a sector-wide agreed label for rolling stock which gives transparent information concerning the above mentioned environmental aspects.

5.2 Chemical substances

At the European level health and environmental risks caused by chemical substances are a high priority. There is growing pressure from the European Commission to restrict the use of hazardous materials. However, Railways are not considered as being in the focus of these concerns. Nevertheless, our sector should also improve in this respect. There are some key areas identified by the sector where improvements could be foreseen in the coming years. Whether the solutions for this items have to come only from the sector or resolutions can be implemented for rail application coming from other industries should be analyzed by the sector representatives.

The following subjects were raised as high importance for the railway community:

- Creosote or wooden sleeper alternatives - composite sleepers/ alternative substructure

The use of concrete sleepers has rapidly grown in Europe during the last few years; however wooden sleepers are still widely used, principally for technical reasons (resiliency, impact resistance, lower weight, etc). Creosote has been used in the rail industry since the early days to protect these wooden sleepers and therefore extend their lifetime by 10 to 30 years, depending on the wood and the degree of impregnation. In addition, given their long life expectancy, creosote wooden sleepers are generally considered cheaper than other type sleepers. Due the negative external effects in mind most infrastructure managers are progressively replacing creosote impregnated wood by some other material, when and where this is feasible. In particular, with the present knowledge of alternatives, due to the fragility of some (sub) structures or the nature of the ground, it is not always currently possible to replace wooden by other types of sleepers.

To reduce any negative external effects from the use of creosote in wooden sleepers, solutions should be looked for and collectively discussed.

Various alternatives are promising but more research is needed, alternatives have been analysed in recent years, such as concrete sleepers, wooden sleepers, impregnated with “ecological” products, (wood polymer) composite sleepers, and steel sleepers. The railway sector is willing to use alternatives to creosote when these are technically reliable. An extensive research programs is suggested to be launched in order to collect as much reliable information on alternatives to creosote sleepers as possible.

- Availability of materials currently used in 20 years time – if not, ideas for alternatives

The availability of some of the recently used materials is finite. In 20 years time, the railway sector like many others may face to lack of accessibility of proven materials currently used. In order to avoid lack of resources, new substitutes have to be investigated and implemented.

This predicament is not specific to the railway industry. The aviation as well as the automotive industries are ahead of the exploitation of new materials for their products. The railway sector should follow the developments done by other industries and should accommodate them to the railway application.

The rail specific research project should focus on providing evidence that new or composite materials would fit to the specific safety requirements of the railways.

- Identification of components with special concerns in REACH

The European regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH, EC1907/2006), that entered into force on 1st June 2007 addresses the production and use of chemical substances, and their potential impacts on both human health and the environment. REACH has reinforced legal provisions for manufacturers, downstream users and importers of substances, substances contained in preparations and substances contained in articles. The time frame for the implementation of these new requirements is 2009-2018.

The research programs dealing with alternatives for hazardous substances are also not specific to the railway industry and high attention should be given to the activities done by other industries to comply with the European legislation and its environmental goals.

1. investigate alternatives with same performances & life expectation

The specificity of the railway sector is the long life duration of products and the high technical requirements for ensuring reliability and safety. When considering replacement materials, this specificity has to be criteria for research.

2. Standard to identify and replace hazardous substances for rail

The creation of the UIC/UNIFE Technical Recommendations shows that implementing standardisation activities in cooperative research projects are well received by the sector; good cooperation is developed amongst the stakeholders and the results are often implemented CEN/CENELEC standards.

- Vegetation control

Railway companies very much support a more sustainable use of pesticides and have already implemented internal measures and management systems to reduce at minimum the use of pesticides to maintain tracks. However, the deployment of track protection products within the immediate railway track area is necessary for safety reasons.

Based on recent investigations carried out by the sector, vegetation control on railway track needs application of plant protection products because non-chemical methods do not yield satisfactory results.

1. Pesticides alternatives

Research programs could deal with evaluating of possible substitute materials developing by the agricultural industry and assessing potential implementation in the railway field.

2. Design of platforms

5.3 Recyclability and recoverability

The end of life treatment of products and reduction of waste in general are key priorities on the environmental agenda. Recyclability means that used materials are re-used into new products to prevent waste of potentially useful materials, reduce the consumption of fresh raw materials and reduce energy usage. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources.

The following research areas were identified:

- Industrial processes to eliminate dangerous waste cost-effectively
- Design of products with consideration of elimination constraints
- Recognising the value of already existing infrastructure
- Cradle to cradle approach
- Research on bio-degradable materials for railway (long term strategy)

The difficulty of this topic is that the wrong choices can produce by transfer a worse environmental impact; i.e. the difficulty is being able to evaluate the impacts. Knowledge development is needed to allow railway experts to evaluate correctly the environmental impacts.

The increasing amount of waste is a threat for the present society. Year by year and the waste produced per person or per company augment. One possible solution to reduce waste production by the industry is to use biodegradable materials. Biodegradable matter is generally organic material such as plant and animal matter and other substances originating from living organisms, or artificial materials that are similar enough to plant and animal matter to be put to use by microorganisms.

The railway sector has very strict crash safety and fire safety requirements which challenge the industry to introduce new materials easily on the market. However, the sector believes that biodegradable materials could be beneficiary for the future trains and research programs should be launched in the long-term.

5.4 Climate Change Adaptation

From the review presented above, and the experience of UIC, CER and UNIFE and its members, it is clear that the railways in Europe are at an early stage of what

will be a multi-year process of assessing, understanding, planning and costing-out, how climate change will affect existing railway infrastructure and operations.

We consider that it is too early at this stage to propose new technical research projects for Climate Change Adaptation for the European railway. However, the following process is recommended to develop research needs and proposals:

- European railways should proactively gather information from railways that routinely operate in countries with what Europeans would call “extreme” weather conditions – for instance Siberian Russia, where extreme heat and extreme cold can occur in any given year. This can and should provide good advice and technical solutions, thus perhaps avoiding the need for new original research.

- Railways should continue to engage in the EC Adaptation Steering Group, and other bodies such as the UNECE Adaptation Expert Group. These forums are ways for the railway community to learn from other sectors, and give their own feedback. Other sectors (maritime, road, energy), may have developed research or technical solutions that could be applicable to railways.

- Adaptation become a recurring agenda item for ERRAC, so that perhaps every 2 years the railways conduct an assessment of the state of knowledge on climate change adaptation, and invite the railways to propose research topics, which can then be developed further.

- There should be a systematic technical review of UIC Leaflets and other technical standards, to check that they comply with the temperature and other weather implications of long-term climate change.

The recommendations proposed above should enable the railway sector to map out a research agenda in future years, while at the same time avoiding the repetition of research and technical solutions that might be available from other regions of the world, or other sectors of the economy.

6. ERRAC Roadmap the Greening of Surface Transport – Roadmap Overview

In this field, the railway industry is not a driver; the sector follows the trends coming from the other transport sectors e.g. automotive or aviation industry. However, the following research subjects which are more rail specific should be researched by the sector:

System	**Climate change adaptation** *Adaptation of the existing railway system to the new climate conditions*	CSA	2020	3
System	**Optimise environmental and sustainable impacts of the Life Cycle of subcomponents** *Design procurement installation maintenance operations and disposal*	R&D	2020 - 2030	2
System	**Identification of components with special concerns in REACH** *investigate alternatives with same life duration*	R&D	2020 - 2030	3
Rolling Stock	**Eco-design label for rolling stock** *Based on key criteria covering significant environmental aspects: Energy-CO2, Materials, Noise*	R&D	2020	3
Infra-structure	**Creosote or wooden sleeper alternatives** *Composite sleepers or Alternative substructure*	R	2015	3

Technical Recommendation (TecRec)

A TecRec is a voluntary UIC/UNIFE recommendation for the sector of which, the primary field of application will be the European rolling stock domain and its interfaces with other subsystems, and is the preferred solution by both partners for, in particular:

- Product and interface standards such as standardization of component interfaces
- Publication of results of common research programs
- Acceleration and better influence over the European Standardization works

Pending the publication of a European standard a TecRec will serve as a common comprehensive standard, approved by UIC and UNIFE and therefore recognized as a voluntary sector standard aimed at speeding up the standardization process and thereby improving the competitiveness of the European railway system.

The general hierarchy within which a TecRec sits is in order of prevalence:

1. EN elaborated by CEN/CLC
2. TecRec elaborated by UIC and UNIFE
3. Standards elaborated by UIC (leaflets)

UIC leaflets

Within the context of its primary mission of "standardisation and improvement of location and operating conditions of railways with a view to international traffic", the UIC has developed common measures, specifications and recommendations aimed at facilitating international rail traffic.

The UIC Leaflets are professional documents, the application of which is either obligatory or recommended. They are the result of international cooperation between experts of the member railway networks of the UIC, more often than not in collaboration with other experts in the industry, standardisation organisms, etc. Their content makes them of global value and they are a reference for the entire railway community. They aim at unifying or standardising the construction measures as well as the railway operating procedures with a view to facilitating international traffic. They also allow members to rationalise their operations and to lower their costs.

The UIC Leaflets are applied, according to their content, by railway undertakings, infrastructure managers, industry, public works undertakings, etc. The measures they contain are often integrated in national norms, European norms and global invitations to tender for railway equipment.

They therefore contain the technical requirements which must be respected to facilitate the exchange of equipment between the networks, as well as cross-border transport.

The UIC Leaflets are not norms, since the measures that the UIC decrees are only obligatory for its members.

The UIC Leaflets are not law as they are decreed by those railway undertakings which are members of the UIC and not by national legislative bodies.

The UIC Leaflets coexist with the national and international laws. In this context, it should be noted that they often act as a reference and technical basis for drafting the norms and regulations decreed by authorised organisms in Europe (CEN, AEIF, etc.)

8. List of abbreviations

CENELEC	European Committee for Electrotechnical Standardization
WEEE	Waste Electrical and Electronic Equipment
ERA	European Railway Agency
ERRAC	The European Rail Research Advisory Council
ERPC	The European Rail Purchasing Council
RIVAS	Railway Induced Vibration Abatement Solutions
TecRec	Technical Recommendation
TSI	Technical specification for interoperability
UIC	International Union of Railways
UNIFE	Association of the European Rail Industry