Living in a sustainable world focused on electrified rail

Final Report Summary - LIVINGRAIL (Living in a sustainable world focused on electrified rail)

Executive Summary:
The Core objective of the LivingRAIL project is to develop a Vision for the future of the rail sector in Europe in 2050 supported by a roadmap of measures and policy actions to achieve the white paper targets of a 50% mode share of the railways in key passenger and freight markets by 2050. The project was carried out between December 2012 and May 2015 by eight European partners, coordinated by the Fraunhofer-Institute for Systems and Innovation Research ISI.

The 2050 vision developed by the LivingRAIL team with the help of external experts from the transport sectors, from academia and public administration expresses a wishful future rather than an expected trend scenario. The Vision 2050 sets the changes which we believe need to take place in order to give the realisation of the White Paper mode shift targets set out by the Commission in 2011 a chance to become true.

As the targets are radical by demanding for a three to five fold increase of passenger and freight volumes by rail across the EU and even beyond an eightfold increase peripheral regions, the necessary changes in railway supply, policy, spatial structures and user preferences are alike. Accordingly, we do in no way believe the situation described in our 2050 Vision and on the way to then will happen automatically. Strong drivers and action on a variety of activity fields is needed; these measures will be described in later stages of the LivingRAIL project.

Relevant practices: Good practice in a wide field of rail related policy and technology fields already now shows that shifts towards sustainable modes are possible. Successful schemes, however, need the collaboration of several actors and strong project promoters. An online repository of over 70 case studies is accessible via the LivingRAIL website.

The Vision 2050: Today, 2050, the majority of regional and long-distance passenger trips and medium to long distance freight
movements are done by rail on mainly electrified networks. For high density areas the share of rail travel approaches 60% and even more in large agglomerations, while low density and peripheral regions with still more car dependence have achieved a 40% market share for the railways. Passengers and industry put much value on sustainable lifestyles and enjoy seamless and high quality Europe-wide rail services.

The Railmap: The LivingRAIL railmap is composed of 62 single measures, which partly describe larger activities and strategies, and partly refer to more detailed interventions. Most of the measures need to be started in the short or at least in the medium run. Effectiveness and efficiency considerations clearly point to network extension and upgrading measures to be fostered with most urgency, this is relevant to enable the rail system to cater the three to five fold demand increase expected by 2050. Second come railway and policy reforms, integrated planning and services. Flanking measures making railways and policy capable to act, and providing users with the right incentives to decide for rail, are equally important. Fiches of measures covered by the Railmap are accessible via the LivingRAIL website.

Sustainability and financial assessment: Time and cost improvement of the railways may gain up to 10 percentage points of market share. The remaining 30% of mode share towards the 50% target need to come from quality and from flanking policy measures. Total transport THG emissions, noise and fatalities would fall by 40% and air pollutants would even decrease by 80% with the Railmap measures and without any other technical measures. Cost estimates (in net present values) arrive at total additional costs of EUR 1345 billion. The most expensive single measures are the completion of the European high speed and freight networks with EUR 416 billion. With a 300% to 500% growth in rail demand customer revenues plus a moderate cross-funding by road and air pricing could easily cover these costs.

Project Context and Objectives:
Within its 7th framework programme for research and technical development the European Commission is co-funding the LivingRAIL research project to explore by which strategic measures transport policy, spatial planning and the rail sector can maximise the market share of electrified rail and thereby contribute to a sustainable Europe 2050 with a high quality of life. In this context LivingRAIL has elaborated visions of the future role of the electrified railways not only within the general framework of mobility of people and goods but also by looking at the broader picture of the evolving demographic and economic structures, environmental challenges, energy issues, social and cultural values, living spaces, technological progress etc. in the long term.

The LivingRAIL project constitutes a joined endeavour of eight European research institutes, SMEs, railway alliances and industry undertakings. The link to current decision-making processes within railway sectors and policies the research team is supported by an Advisory Board composed of representatives from European railways, user organisations, governmental bodies and NGOs. The project is co-ordinated by the Fraunhofer Institute for Systems and Innovation Research (ISI) and runs from December 2012 to May 2015. Project partners are:

• Fraunhofer ISI, Germany (www.isi.fraunhofer.de)
• Allianz pro Schiene, Germany (www.allianz-pro-schiene.de)
• TRT Trasporti e Territorio, Italy (www.trt.it)
• University of Birmingham, United Kingdom (www.birmingham.ac.uk)
• Mcrit, Spain (www.mcrit.com)
• rtca, Austria (www.rtca.at)
• SIEMENS: MOBILITY AND LOGISTICS, Germany (www.siemens.com)
• Savez za Željeznici, Croatia (www.szz.hr)

The overarching goal of the LivingRAIL project is to elaborate a vision of mobility and living cultures in Europe by 2050 and to explore pathways to make this vision work. Focus of the vision is to develop spatial pattern of cities, towns and quarters connected by European and regional rail corridors to enable high accessibility and mobility for all in the long term.

To achieve this objective a number of sub-objectives have to be met. These are partly of technical nature, and partly related to the output envisaged. In line with the terms of reference of the Commission these sub-objectives followed by the LivingRAIL project are:

1. Provide an overview of existing future scenarios and visions on sustainable transport, spatial planning, land use and urban development.
2. Provide an overview of best practices in Europe to make the transport system more sustainable. The role of rail will be particularly
highlighted. The overview shall embrace technical, managerial and policy cases and provide an insight into options, barriers and driving factors by local conditions.

3. Identify relevant mega-trends and other important external factors to be considered when developing the vision 2050. These will include demography, global and regional economic development, climate change, societal evolution etc.

4. Provide an overview of existing best practice in the European rail system, including a vision for 2050 developed by the rail companies (innovations towards energy efficiency, electrification, zero emissions rail, ...) with a focus on how can the railways contribute.

5. Draft a vision of a sustainable transport system and society in 2050 where transport needs are overwhelmingly served by electrified rail. The picture to be drawn shall take into account spatial development, living environments, desirable lifestyles and economic systems across Europe and embed a sustainable, affordable and attractive transport system into this overall vision.

6. Discuss the vision in order to examine how this vision would affect society, the quality of life, economy, competition between modes and transport providers. The following stakeholders will be involved in this dialogue: rail companies, rail supply industry, political decision makers, spatial planning authorities, civil society organisations (CSOs), scientists. The aim of LivingRAIL is to bring these key actors together.

7. Identify options for new transport system design concepts for getting from the existing infrastructure to the positive vision of a sustainable mobility system based on electrified rail. Given the rather long time horizon until 2050 this objective is rather strategic, but shall give advice on how to best proceed from today's situation.

8. Provide a vision 2050 for a sustainable transport system based on electrified rail which better serves the users in passenger and freight sectors, protects the environment and enables the sustainable use of territory.

9. Develop, based on this vision, concrete policy guidelines (roadmap or better: railmap, mid targets and pathways) for local, regional, national and European authorities on how to integrate rail transport development in order to achieve a sustainable spatial and settlement development, urban development with implications on environment and the society. Although strategic in nature, concrete steps for the coming years shall be worked out. They shall support the decision makers in shaping their planning policies.

10. Assess the feasibility of the Vision by contrasting it with the forecast already made by existing transport forecast models at European level (e.g. TRANSTOOLS, TRANSVISIONS metamodels, TT-MSAIC, etc...) in publicly available studies.

11. Assess today's infrastructure investment strategies (e.g. TEN concepts) and provide a critical review of today's infrastructure funding tools at national and European levels in order to give recommendations how to support the future vision 2050 of the transportation system based on electrified rail.

These objectives have been addressed by five scientific work packages:

- WP2 “Concept and Scenarios” provided trends for external variables, gave guidance on target values for internal indicators and detailed the scope and elements of the subsequent scenario processes.
- WP3: “Rail Sector Evolution” explored the technical and organisational options of the rail sector in conjunction with other modes and local policies to achieve the 2050 targets and discussed alternative pathways towards them.
- WP4: “Regional, urban and commercial structures” looked at wider policy options, especially concerning spatial/urban development, and behavioural issues to ensure that rail in an intermodal context can enfold its potential in all appropriate transport market segments.
- WP5: “Vision and Railmap 2050” eventually combined the results of WPs 2 to 4 to a single vision of sustainable, rail based mobility patterns across Europe in 2050 and elaborated policy, technology and research needs in form of a “Railmap” towards 2050.
- WP6: “Communication and Dissemination” finally ensured a high quality and continuous dialogue with stakeholders, politics and the interested public and is thus crucial for the impact of the project.

Project Results:
Background.

The primary goal of forward-looking planning of our social environment shall be to preserve sufficient resources for future generations without compromising the present. These resources include economic strength, environmental quality and social justice, i.e. the three commonly listed pillars of sustainable development. Transport (and other) sectors needs to contribute by efficiently reducing the need to travel, in particular motorised trips and goods movements, as far as possible. However, this panacea needs to be achieved without overly suppressing today’s generation and it is here where collective transport modes need to be developed and used as high quality and low impact alternatives:

Environment. Even with current occupancy rates and fuel mixes, passenger and freight trains have four times less external costs than
cars or trucks. With increasing load rates and further use of renewable energy sources, there is considerable potential for rail to lower air pollution, climate impacts, noise and accidents in the transport sector. Indeed, future strategies within rail and the EU envisage climate neutrality, zero air pollution and noise levels below disturbing thresholds in the coming decades. However, the efficient use of vehicle capacity through a considerable shift of demand from road to rail plays a key role for approaching these goals.

Social issues. Rail and public transport provide travel options for those who have limited or no access to a private car. This not only affects young, elderly, mobility restricted or poor people, but also people living in dense urban areas without parking facilities or simply travellers with heavy luggage, children or acutely immobile citizens. Moreover, collective transport opens the opportunity for sociable group travel, enjoying a glass of wine, working or simply meeting other people on the trip. In urban areas, high capacity rail modes bring about the advantage of freeing up urban space for cultural and leisure activities. No matter how far individual motorised transport closes up in terms of the first two issues, congestion and land use will remain their Achilles' heel even with advanced traffic demand management systems in place.

Economics. The economies of scale described for the environmental benefits of rail also hold for their financial viability. Provided capacity is available on the train, the marginal costs of each additional passenger or unit of cargo is small. Likewise, track infrastructure costs per train kilometre considerably decreases with more traffic on the network. Thus a shift of demand to rail, along with a better use of vehicle and network capacity, e.g. through virtual train control systems, will significantly reduce public sector contributions whilst increasing the rail sector's competitiveness with car and truck. Moreover, less car and truck transport reduces the costs for road expansion and maintenance. Along with a reduction in road space, this cost saving can be considerable.

Other forms of collective transport (i.e. buses) may approach these sustainability targets in a similar way. However, they often lack the high capacity and quality and comfort offered by high frequency rail, especially in dense urban areas. However, both systems will need to integrate and co-operate in a strong environmental alliance to effectively reduce car travel as a preferred mode. As such, the LivingRAIL scenarios rather look at the potential for such a "sustainable mobility alliance" rather than on the isolated role of the railways.

Structure of results.

Fulfilling the LivingRAIL project objectives involves two challenges: First of all these targets are extremely ambitious and require decisive action by the transport sector as well as by the various policy levels. Second the time frame from now to 2050 is considerably long, corresponding to the development from the 1970s to the base year 2010. Developing concepts for such an enormous endeavour over a long period of time requires a vivid picture of what this future could look like, how people actually live with the developments and how technologies, services, cities and lifestyles are linked. Such a picture shall be drawn by our Vision 2050.

The full Railmap 2050 links concrete measures elaborated through several workshops and literature review to the story lines of the 2050 Vision to demonstrate more concretely by which suite of interventions the desired future could be addressed. The railmap regards the measures and their timing from different angles, i.e. types of region, actor or transport market. For the railmap measures we provide an impact assessment of both, the vision as it was becoming reality and the proposed measures as all of them involve small or large side effects. Contrasting the vision with the triggering measures and the impact assessment will finally provide the full picture. In particular we identify the more and the less helpful measures and the overall cost coverage and social impact evaluation.

Alternative scenarios. Of course, technological development is not limited to the rail sector. Autonomous cars with emission-free electric or fuel cell propulsion may well compromise the railways' environmental and social advantage. Given the current developments in electric and hydrogen vehicles and the announcement of first commercial roll-outs of self-driving cars makes this development a real threat for public transport. A further threat for the railways is a persistent regime of financial constraints and austerity in Europe. The greatest threat of all, however, is probably the lacking commitment of policy of various levels as well as of the railways themselves to modal shift and customer orientation goals. The LivingRAIL project underlines a positive scenario whilst acknowledging these threats and pitfalls on the way.

Trends and Drivers

Considering trends external to the railway sector is the starting point for the definition of the LivingRAIL visions. Different topics can be identified: environment, economy, energy, society, culture, policy. For each topic we have defined two alternative future scenarios. One scenario is a reference mainstream case, which is depicted according to the current trend and information provided in different
international re-ports, while the alternative scenario depicts a more dynamic and optimistic context. Even the optimistic scenario however does not include fundamental changes of Europe's political, social and economic face in general. Nevertheless, radically alternative behavioural or societal visions may be necessary when it comes to peoples’ and firms’ choice of travel in order to achieve the more than ambitious rail share targets in 2050. We are aware that over the many years until the 2050 radical changes can happen, but the scope of the LivingRAIL is elaborating roadmaps for rail under given framework conditions. Conjectures on very different external conditions would introduce a high degree of complexity which are not able to be addressed in the roadmapping process.

A third scenario describing low or even stagnating economic growth and austerity in Europe might be more likely than the two framework scenario developed in this report. Shrinking labour markets, tighter public budgets, an increasing share of old people and national oriented politics may threaten the evolvement of the European Union and of the rail sector in particular. We did, however, deliberately exclude this case as within such framework conditions the White Paper targets will lose political attention and the huge task of re-vitalising the railways will hardly be possible.

The external trends do not impact only on rail, of course, but on the whole transport domain. A number of transport related foresight studies have been developed in Europe. The aim of these studies varies from one to another, some of them having a dominant prospective dimension aiming at exploring alternative broad possibilities for the development of the transport sector in the future. In these studies narratives have been set up in relation to future transport developments.

Economy and transport demand: We do not consider radical breaks in the economic and social system. Therefore the studies we based our scenarios on still assume GDP growth and assume that one consequence of this is the increase of transport activity. Within the overall trend, public transport is expected to increase its modal share, especially for the contribution of rail. In the year 2050 public transport as a whole is forecasted to represent 17% of total passenger activity (in terms of passengers-km) of the EU+: 10% rail and 7% bus. However assuming more transport activity does not necessarily mean assuming more trips or more tonnes transported. Indeed, already in the recent past, most of the transport freight performance is explained by longer distances travelled rather than by more goods moved. The quantitative indicators we are introducing are just one element of the scenarios, which should be always considered also in terms of their qualitative content. E.g. despite growing urbanisation we assume that local trip frequencies and distances per individual do not increase, while this is the case between Europe's agglomeration centres. Consequently, we see inter-urban travel to grow at a higher pace than urban mobility related to pkm.

Focus areas: European regions are different, and thus there will be no uniform potential for cross-modal demand shifts. So the analysis in LivingRAIL will be developed for stereotypical regional clusters in Europe, the so-called “focus areas”. Given the complexity of articulated roadmapping processes, we must restrict to a maximum of six different regional clusters, covering inter-urban passenger, inter-urban freight and urban passenger transport. Clustering exercises with data from Eurostat's regional and urban audit databases revealed the close inter-relationship between economic strength, population density / city size and rail passenger market share. In Freight transport things look a bit different as in particular in poor and sparsely populated countries the share of rail in freight transport is particularly high.

Mode shift targets: The most recent strategies on modal shift have been issued by the European Commission's 2011 transport White Paper, the UIC/CER Sustainable Mobility Strategy and UITP. The EC strategy postulates a shift of road freight to rail and inland navigation of 30% by 2030 and of above 50% by 2050, and the majority of medium distance passengers to go by rail by 2050. The UITP strategy envisages a doubling of urban public transport mode share across all European cities by 2025. The LivingRAIL project simplifies and unifies these objectives by setting a 50% market share target for urban, short- and medium distance passenger trips as well as for long-distance freight movements for electrified rail. Below this general objective we acknowledge that development speeds and potentials are different among regions or cities of different type. Generally we say that the goal to be achieved by regions with currently low rail shares is less than those within a better starting position. But the percent increase market share between now and 2050 will have to be higher in less developed regions or smaller cities. Deliverable 2.3 provided a summary of the achievements of the various activities of WP2. A great care was taken that the deliverable resulted in a readable document with an balanced mix of narrative and data and with an appealing layout in order to reach a wide audience instead of being just a project deliverable used within the consortium and delivered to the Commission. D2.3 was used as part of the input material for the LivingRAIL Brussels workshop held in January 2014 and received good appreciations.

Rail System Evolution

Deliverable 3.2 describes activities which can be performed by players within the railway business to support the sector. The measures summarised in this document have a strong technological and infrastructural element, but also include ‘soft’ pull factors emanating
from within the rail sector designed to make the railways more attractive to passenger and freight customers. The major themes are grouped as ‘stations, services and customer relations’, ‘design and traction’ and infrastructure. Each of the themes is further structured in three to four topics. These describe a narrower field of technology, infrastructure or activity around each theme. The measures identified were collated into groupings that can be used to address the three main markets considered by the LivingRail project. These markets are medium-distance passenger rail, urban commuter rail and rail freight. The discussion formulates narrative descriptions of how the measures may work together in practice. Although the measures and the way they are implemented differ between the markets (and regions) several commonalities are apparent. The main findings of this process are summarised below:

(1) All markets call for an expansion of capacity, but improved track-utilisation through moving block signalling and increase automation is seen as a more pressing development in urban areas rather than in medium to long-distance freight and passenger rail, where an expansion of the network (particularly high speed rail for passenger services) is easier to implement. The measures identified for urban areas also have a much stronger focus on improving the customer experience to remove the psychological barriers to modal shift that road users may have. However, the urban measure package acknowledges that urban mobility is best achieved by working with other existing modes and co-opting new technologies such as automated cars and PRT, hence there is also a focus on measures which enhance intermodality. These include physical developments (linked to spatial planning) including intermodal station design, but also includes more organisational centred measures such as tariff/mobility associations.

(2) The potential combination of capacity-building measures for passenger rail is promising in terms of meeting the 2011 EU White Paper targets for rail modal shift. By carrying out the majority of planned HSR projects throughout Europe and continuing at a similar rate until the end of the road-mapping period (2050), it is estimated that a 400% increase in HSR line length is achievable. It is likely that this capacity increase will be further enhanced through implementation of moving block signalling. It is observed that one major requirement for medium distance passenger rail is the targeting of international links, either through reopening closed lines but more likely through the completion and expansion of the TEN-T rail network. This international aspect will be greatly enhanced by the roll-out of standardised signalling systems. This measure package also acknowledges that overlying change in the remit of EU standards authorities for rolling stock, the shortening of innovation cycles and a much faster authorisation and certification process is essential in the development of innovative new rail systems.

(3) The measure packages are linked in several respects. This is particularly apparent with the separation of passenger and freight services through the creation of dedicated freight lines. Although expensive, this is seen as a key step in improving reliability of passenger services and expanding the rail freight network. Working with other modes is a key aspect of this package, with an acknowledgement that the final leg of journeys will remain best served by road transport. Hence rolling motorways/trucks on trains is seen as a way of conferring many of the benefits of rail transport to the freight sector, whilst retaining flexibility for the final leg.

The final estimate for rail system measures costs is €605 billion. There is a wide range of costs recorded between the different packages, with many of the customer-orientated packages being relatively cheap to implement compared to the more technological and infrastructural packages. The heaviest costs are concentrated around three packages; Infrastructure, with costs of €311 billion, rolling stock with costs of €163 billion, and specific freight infrastructure and stations, with costs of 95 billion. Out of these, the two infrastructure measures are of highest importance for the successful implementation of rail shift strategies.

Spatial Policy Design

The outcomes of discussion in the three stakeholder seminars as well as the analysis of relevant cases developed in Europe constituted the grounds for elaborating a total of 65 policy measure factsheets. Policy measures have been reported in harmonised sets of Measure Reporting Forms (MRF), including General Information, a Numerical Assessment by six focus areas and three time horizons, and Additional Qualifiers.

The measure reporting forms have been implemented in a searchable web database, which is integrated into the LivingRAIL homepage. In its final development stage, the database will carry the roughly 150 Measure Reporting Forms of WP3 and WP4, will allow comments by all users and will have analytical tools to plot comparative results across all measures.

As concerns the achievement of the LivingRAIL targets, i.e. 50% market share of medium distance urban and regional travel by public transport, of long distance passenger travel below 800 km by rail and of medium and long distance freight, the following results are found:
1. There is not a single measure dominating all others. The achievement of the mode share targets defined by the LivingRAIL framework scenarios needs to take into account a multitude of push and pull actions to provide good services with high accessibility and to stimulate peoples’ mode choice behaviour.

2. Mobility management and information in urban as well as in long-distance travel plays a key role in altering daily routines and informing people on the services offered by rail and public transport. However, this will only work if tailored to people’s actual needs and if rail and PT services are multi-modal, accessible and of sufficiently high quality. The same finding holds for intermodal logistics information systems.

3. Urban and regional mobility behaviour plays a decisive role for mode choice in inter-urban mode choice. Public transport use is determined by the cities’ sustainability concepts.

4. Pricing of competitors to rail and public transport, namely trucks and cars, have the potential to directly impact mode choice behaviour. However, pricing measures may impose considerable social impacts. We thus consider soft forms, such as parking management in cities and the regulation of social standards to be applied to their full extent first.

5. Reforming the market orientation of the railway sector and the decisiveness of transport policy is found to be of ultimate importance for the achievability of the White Paper targets.

In relation to mode share impacts:

1. The targets seem to be most easy to reach in large agglomerations. As these start with an average mode share of public transport of 30% here the ground for a further change in mobility behaviour is paved. The currently high number of mobility solutions tested in big cities, and data on some agglomerations with mode share close to 50% and more support this assumption.

2. In Inter-urban passenger travel the LivingRAIL targets are met to 25% in low density regions and 50% in high density regions by spatial planning and the regulation of road and air modes. Here, consistent and co-ordinated sustainability-oriented transport planning seems to be one of the major keys to realise the 2050 targets.

3. In long distance freight around 40% of overall demand goals can be reached with policy measures. Here, logistics centres around big agglomerations to bundle traffic and the pricing and regulation of road haulage are of utmost importance.

4. There are a number of indirect measures, which do not directly change the rail system of user behaviour, but are essential for changes to happen. These are in first instance financing, planning and research strategies. Some measures, such as transport pricing, can take both roles: generating direct impacts and generating financial resources.

In relation to life cycle costs and revenues:

1. A look at the life cycle costs of the policy packages uncovers rather considerable implementation and operation costs. Discounting these to 2015 leads to €742 billion across all regions and transport sectors. This quantity implies still doubling current investment levels.

2. Most relevant source of funding appears to be road pricing, in different intensities.

3. If we compare the costs of policy measures and their impact in terms of mode shift (% of increased of rail and PT mode share related to total demand), we can see that for five out of six area and market segment categories, the cost per mode shift percentage point lies within a rather narrow corridor between €21 bn. and €39 bn. Only for inter-urban travel in low density areas we see this ratio magnified by a factor 10 (€433 bn./percentage point), meaning that mode shares in peripheral, sparcely populated and poorer regions are pretty rigid against policy interventions.

The 2050 Vision

The 2050 vision developed by the LivingRAIL team with the help of external experts from the transport sectors, from academia and public administration expresses a wishful future rather than an expected trend scenario. The Vision 2050 sets the changes which we believe need to take place in order to give the realisation of the White Paper mode shift targets set out by the Commission in 2011 a chance to become true.

As the targets are radical by demanding for a three to five fold increase of passenger and freight volumes by rail across the EU and even beyond an eightfold increase peripheral regions, the necessary changes in railway supply, policy, spatial structures and user preferences are alike. Accordingly, we do in no way believe the situation described in our 2050 Vision and on the way to then will happen automatically. Strong drivers and action on a variety of activity fields is needed; these measures will be described in later stages of the LivingRAIL project.

In this document we elaborate the main vision statements and the underlying storylines by four themes and 13 sub-themes from the 2050 perspective. While the detailed roll-out of the vision in this document goes from the prevailing situation in 2015 over short- and
medium-term developments, this summary concentrates on the 2050 vision statements. From the 2050 perspective the LivingRAIL Vision reads as follows:

Today, 2050, the majority of regional and long-distance passenger trips and medium to long distance freight movements are done by rail on mainly electrified networks. For high density areas the share of rail travel approaches 60% and even more in large agglomerations, while low density and peripheral regions with still more car dependence have achieved a 40% market share for the railways.

Passengers and industry put much value on sustainable lifestyles and enjoy seamless and high quality Europe-wide rail services. For that purpose, planning standards have been reformed and the railways themselves have undergone a major re-definition, putting customer and market needs way above internal management issues. Thanks to the boost in demand, innovation cycles in the rail industry have shortened and cost efficiency and availability have increased such that the sector’s attractiveness and competitiveness against air and road travel is considerable.

To serve the entailed doubling to tripling of freight volumes and the eightfold passenger volumes on Europe's rail networks, all means of capacity utilisation on existing lines, new investments and track upgrades and the use of high volume trains have been exploited to their limit. Information and management systems and automation have been expanded to the extent needed to maximise system reliability, efficiency and user attractiveness.

Although big investments have been indispensable to cater for this new rail based mobility culture, by 2050 completely alternative technology futures and new transport systems are not dominating the transport sector. The transformation of management cultures in railways, planning and financing authorities and the transformation of the 20th century railways – partly using 19th century technologies and concepts – to the 21st century was demanding enough. Moreover, the limits of big data, the all-embracing World Wide Web and the risks associated with mega investment projects became ever more visible. Thus, in line with the change in values of citizens and consumers, policy and economy habits re-focused on the doable and on the clever use of known and reliable concepts.

The 2050 Railmap

The LivingRAIL railmap is composed of 62 single measures, which partly describe larger activities and strategies, and partly refer to more detailed interventions. The measures are not elaborated in full detail as an important part of job if these two groups of players is to regularly reflect on their goals and their options and limitations for action.

Most of the measures need to be started in the short or at least in the medium run. Effectiveness and efficiency considerations clearly points to network extension and upgrading measures to be fostered with most urgency, this is relevant to enable the rail system to cater the three to five fold demand increase expected by 2050. Second, however, come railway and policy reforms, integrated planning and services. Most relevant services are considerably higher train frequencies in all regions, door-to-door offers, guidance and information in passenger and freight, and Europe-wide logistics brokerage platforms. These themes are closely inter-linked as without a clear vision among all parties on where the transport sector shall develop to, and without open, market oriented and self-confident companies and institutions this enormous endeavour is at high risk.

Urban policies and mobility management together are targeted to impact peoples’ and companies’ perception of mobility. The remaining measures stations, rolling stock and regulation full important gaps in the policy and service landscape, but are not alone capable to alter mode shift decisions in passenger and freight transport considerably.

Expensive investments into the rail sector are needed. However, flanking measures making railways and policy capable to act, and providing users with the right incentives to decide for rail, are equally important. International policy and the transport sector (rail and PT companies) play the most relevant role and need to push forward capacity and quality enhancing measures on the European passenger and freight rail networks. Low density countries are considered to have more time to act and erect their networks than high density areas.

Figure X1 summarises the main elements of the Vision 2050 and the top 25 measures identified for its realisation. However, it should be noted that this is only a snapshot. For realising the envisaged mode shift targets the full broadness of all 62 Railmap measures is required.
Impact Assessment & Funding

From the transport market, sustainability and financing assessment we can summarize a number of important key statements:

Demand:
• The overall mode split effect of more fast lines only ranges around two percentage points and less.
• Cheap tickets are found to have a visible impact on mode shares.
• The remaining 30% of mode share need to come from quality and from flanking policy measures.

Sustainability:
• Total transport THG emissions would fall by 40% with the Railmap measures and without any other technical measure.
• Similar reductions are envisaged from noise and – somewhat weaker – for accidents. Even more impacts are envisaged for the reduction of air pollutants.

Economic performance:
• Cost estimates (in net present values) arrive at total additional costs of €1345 bn. The most expensive single measures are the completion of the European high speed and freight networks with €416 bn.
• With a 400% to 500% growth in rail demand, passenger and freight customer revenues are expected to grow by €2522 bn. (NPV) despite a 50% fare reduction.

With road user charges across all Europe and an earmarking of 25% for railway projects, the Railmap could be fully financed. The excess availability of funds provides the freedom to take back some unpopular policy pricing measures. Even if we double costs and half pricing and rail charging incomes the received revenues can easily cover costs.

Final Recommendations

While re-emphasising the basic and necessary ingredients on railway futures advocated since long, the LivingRAIL vision strongly points on business and cultural frameworks. This broad view leads to a number of core policy recommendations in order to achieve the massive mode shift envisaged by the EC White Paper by 2050.

• Be aware of alternative futures. Rail needs to address these by incorporating the new technologies as quickly as possible in its own system and by getting more cost efficient without compromising on customer orientation.
• Place users in the core of decision processes. Without developing the mindset of customers, company managers, policy-makers and at last of railway staff, no substantial increase in rail mode share will happen.
• Immediate action is needed. These actions need to happen quickly and decisively in order to have a sufficiently large effect in the decades ahead.
• Interventions need to be consistent. Stakeholders and decision-makers need to co-operate and that steps taken towards more sustainability in transport need to be consistent in order not to risk achieving given sustainability goals.
• Re-think business and policy cultures. Implementing the radical changes in railway investments, operations and customer care as well as in policy-making, regional and urban planning requires 21st century business and policy-making mentalities.
• Respect the limits of the railways. But the flexibility of the system and its accessibility in sparsely populated areas are limited. Rail providers thus need to co-operate with other modes or integrate these into their core business models.
• Consider Europe's multiple faces. The different economic and cultural conditions in Europe need to be taken seriously, but a strong coordination of national plans is unavoidable.

Potential Impact:
The main objective of Communication and Dissemination activities in the LivingRAIL project (WP6) is to communicate the project aims, progress and results to the relevant target groups. This is considered essential for a deeper impact of LivingRAIL as well as of its sister activities (SPIDER PLUS, Foster Rail, TransForum, Marathon, etc.) as too little communication on objectives and ways forward in the rail sector as well as in related policy fields is considered a major barrier to approaching the White Paper targets for mode shift and THG reduction.

The identification of relevant target groups was therefore the first step in WP6, followed by the composition of an Advisory Board reflecting the various stakeholder views.
To identify the project visually, a recognisable design was created for the communication elements, including a project logo.

Deliverable 6.1 Project Flyer was published in month 6. The flyer communicates the objectives and the concept of the project. The flyer was not only produced as PDF for download, as foreseen in the project work plan, but also in print, as handout for personal contacts.

The public website of the project was launched in month 7. The website is in English, including a general project description in the languages of the project partners (Italian, Croatian, German, Spanish). The navigation of the website is content-driven by reflecting the core topics in the menu bar (vision, railmap, best practices, spatial policy, target groups etc) thereby avoiding the internal sight of work packages and deliverables. The website was constantly updated with all the results in detail, two online databases (best practices and measures), existing studies, the image film, all reports, newsletters and presentations. Finally, the website represents the complexity of the LivingRAIL project by a complex structure and extensive content with up to five levels of subpages and 22 news.

The LivingRAIL image film is 4 minutes long and has an emotional, narrative quality: a young man reflects on a transport system that he wishes for his little daughter when she will be as old as he is now. He imagines a new quality of life in cities offering more space, more green and more quiet, with less cars and more public transport. The film was shown at all LivingRAIL events, like the final conference and the regional conferences, but also at external events, like the General Meeting of Allianz pro Schiene in Berlin on 11th December 2014 and the workshop on transport and environment by Deutsche Bahn on 25th June 2015. The film is available on the LivingRAIL-website in English and German. Both versions are also accessible on YouTube.

Four newsletters had been published, in month 6, 18, 29 and 30, which is one more than foreseen in the project work plan. The first issue informed about LivingRAIL in general, the project's objectives and concept. The second issue informed about the results of work package 2 Framework and Scenarios, and about the results of three stakeholder workshops on Rail System Evolution, on Policy, Spatial Concepts and Urban Design, and on European Experiences on Rail Transport Market Regulation. The third issue informed about the LivingRAIL Vision and the film and invited to the final and regional conferences. The fourth issue informed about the LivingRAIL Roadmap and the final conference. The newsletters have been sent by the project partners to their national and European networks, covering the relevant target groups the consortium agreed on. The distribution lists enfold more than 2500 recipients.

The final conference has been held in Brussels the 23rd April 2015, together with the project SPIDER PLUS. The half day event was promoted by Michael Cramer MEP, Chairman of the Committee for Transport and Tourism, and chaired by Prof. Werner Rothengatter, Karlsruhe Institute of Technology. More than 100 participants registered for the conference in the Solvay Library near the European Parliament. In the joint conference, both projects presented and discussed their findings. The event gave floor to a panel of experts from the railways, policy, environment and social affairs: Michael Cramer MEP, Chairman of the Committee for Transport and Tourism; Dr. Christopher Irwin, European Passengers' Federation; Dr. Libor Lochman, Community of European Railway and Infrastructure Companies; Anna Gigantino, European Railway Agency; Akos Ersek, International Union for Road-Rail combined Transport; Prof. Dr. Marc Ivaldi, Financing & Regulations Expert, Université de Toulouse.

Three regional conferences have been held in Germany, Spain, and Croatia in month 30, to discuss the project results in the national context:

- Berlin, 4th May 2015, organized by Allianz pro Schiene (Pro-Rail Alliance Germany): In Germany, the event entitled "In what kind of transportation system do we want to live and why are we so far away from it" was focussed on the quality of life that can be obtained by more rail and less cars, especially in the cities, according to the LivingRAIL approach. Six experts discussed the car subjection of the Germans and the stagnating German transport policy: Peter Vollmer, Swiss Transport Foundation; Frank Klingenhöfer, Deutsche Bahn AG; Dirk Flege, general manager Allianz pro Schiene; Prof. Hermann Knoflacher, University Vienna; Stefan Heimlich, President Auto Club Europa; and Martin Burkert, chairman of the transport committee in the German parliament. The event was attended by more than 100 participants.

- Barcelona, 19th May 2015, organized by MCRIT: The LivingRAIL conference in Spain was hosted by the Civil Engineers Professional Association (www.camins.cat). The association represents civil engineers in front of public administrations and the society in general. It also regulates the professional activities of civil engineers and provides for services such as conferences and professional training. In Barcelona, the panelists were Jordi Julià, consultant and former director of IFERCAT, the Catalan railway planning agency, and Josep Manau, former director of Renfe Rodalies, the Barcelona commuter rail services.

- Zagreb, 21st May 2015, organized by Savez za željeznice (Pro-Rail Alliance Croatia): In Croatia, Slavko Štečar from the Croatian Pro-Rail Alliance linked and compared the project results presented by LivingRAIL Coordinator Claus Doll, to the Croatian transport strategy (2014) and Operational Programme-Transport. Three Croatian experts - Prof. Tomislav Mlinarić, PhD, Prof. Stjepan Lakušić, PhD, Prof. Mladen Nikšić, PhD – presented the approach for making the Croatian national programme of railway infrastructure
launched in 2015 and discussed it in the context of the LivingRAIL findings. Two press releases have been issued in month 29 and in month 30. The first is focused on the LivingRAIL Vision and the second concentrates on the LivingRAIL Roadmap.

Media coverage:
Several articles have been published in specialized magazines (some articles about the LivingRAIL vision and roadmap will be released after the submission date of this report):

- “Signal”, a German magazine for transport policy, published an article in July 2013 about the LivingRAIL project in general. Another article about the LivingRAIL vision and roadmap will be published in this magazine in August 2015 (see then http://www.gve-verlag.de/signal/signal.php)
- The German railway magazine “Privatbahn Magazin” published an article in July 2013 about the LivingRAIL project in general.
- The CER Monitor, the newsletter of the Community of European Railway and Infrastructure Companies, published an article about the final conference of LivingRAIL and Spider Plus, in its issue 15, April 2015.
- “Der Fahrgast”, the magazine of the German railway passengers association "Pro Bahn" will publish an article about the LivingRAIL vision and roadmap in its edition 143 August/October 2015 (see then http://www.pro-bahn.de/pbz/inhalt.htm)
- “Deine Bahn”, a German magazine for railway professionals, will publish an extensive article (19.500 characters) written by Frauke Jürgens from Allianz pro Schiene in its print edition in August 2015 (see then www.deine-bahn.de).
- Another long article written by Frauke Jürgens from Allianz pro Schiene will be published in the autumn edition of the TRB newsletter of the New York University Transportation Research Center (see then http://ar010.york.cuny.edu/library/newsletter).

Several online media referred to LivingRAIL:
- the Spanish Territorial Monitor of the Catalan Society of Territorial Development posted an article about the LivingRAIL project and disseminated it through their various newsletters / facebook / tweeter accounts
- the Spanish Civil Engineers Association posted an article about LivingRAIL in their corporate blog, referring to the regional conference in Barcelona
  http://blog.camins.cat/2015/05/20/el-projecte-livingrail-el-futur-del-sector-ferroviari-a-europa/
- http://www.civitas.eu posted the invitation to the final conference of LivingRAIL and Spider Plus.
- The final conference of LivingRAIL and SPIDER PLUS was disseminated by the EC Transport Research and Innovation Portal TRIP (www.transport-research.info) and material of the TRIP portal was provided at the event.

LivingRAIL has been presented at external events like the General Meeting of Allianz pro Schiene in Berlin on 11th December 2014 and the workshop Transport and Environment by Deutsche Bahn on 25th June 2015 in Nürnberg.

- The General Meeting of the German Pro-Rail Alliance was attended not only by representatives from the rail sector and from NGOs, but also by representatives of the German federal ministries and of the media, with up to 80 participants. Frauke Jürgens from LivingRAIL showed the film, presented the project and participated in a panel discussion.
- The workshop Transport and Environment by Deutsche Bahn was addressed to representatives from NGOs, with approximately 60 participants. Project coordinator Claus Doll presented the LivingRAIL-results. A panel discussion, entitled “How can a shift to rail contribute to the 2°-target”, was dedicated to LivingRAIL. On the panel: Project coordinator Claus Doll, Fraunhofer ISI; Frauke Jürgens, Allianz pro Schiene; Prof. Andreas Knie, Innovationszentrum Berlin; Sabine Nallinger, Stiftung 2° – Deutsche Unternehmer für Klimaschutz.
- In January 2014 research of the LivingRAIL project was presented at the Transportation Research Board annual meeting in Washington DC. with a paper titled “Success Factors for Public Transport: the Role of Green Communities”.

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