FOSTER RAIL

Future of Surface Transport Research Rail

Coordination and Support Action

Grant Agreement No 605734

Date of Annex I against which the assessment will be made: 23-05-2013

Deliverable D2.2 – FINAL – 09-04-2014

Report on Major Factors and Criteria for Rail Business Scenarios

WP	2	Rail Business Scenarios
Task	2.3	Identification of major factors and criteria to be used for setting up rail business Scenarios

Dissemination level[1]	PU
Nature[2]	R

Due delivery date	M6
Actual delivery date	M10

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Document Version	Date	Author(s)
0.1	15/10/2013	Wolfgang H. Steinicke, Claus Seibt, Lennart Senger
0.2	8/11/2013	Chris Nash, Mark Wardman
0.3	27/01/2014	Wolfgang H. Steinicke, Lennart Senger
0.4	28/01/2014	Claus Seibt
0.5	12/03/2014	Claus Seibt
0.6	12/03/2014	Chris Nash
0.7	12/03/2014	Manuel Pereira
0.8	18/03/2014	Lennart Senger, Wolfgang H. Steinicke

[1] Dissemination level: **PU** = Public, **PP** = Restricted to other programme participants (including the JU), **RE** = Restricted to a group specified by the consortium (including the JU), **CO** = Confidential, only for members of the consortium (including the JU)

[2] Nature of the deliverable: **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

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1. Executive Summary

This deliverable puts its focus on major factors and criteria which are important for setting up Rail Business Scenarios. Transport demand growth prognoses at least as potential medium-horizon market trends up to 2025 or 2030. Forecasts of transport demand trends related to expected economic trends and policy options shaping the transport sector in the years up to 2030 and beyond. Trend factor estimations deriving from economic and transport demand forecasts are crucial information and data to sketch out one particular route of storylines in the rail business scenarios. However, looking into far horizon futures up to 2050 and beyond potential futures get more contingent and uncertain. Trend curves which are extrapolating correlations observed in the past to the future may break (curves are peaking) or at least being levelled down and not as steeply increasing as anticipated in the past. Nobody did for example expect in 1980 that energy demand will not further steeply increase, but decrease. Trend break or peak was triggered by unexpected energy saving and efficiency technologies. A similar debate is recently pronounced for peak car: a trend of particularly younger persons shifting to public transport, cycling and walking and sharing instead of owning a car. So a second important route to find criteria for drafting storylines for business scenarios is the examination of social and economic trends and the potential of trend beaks as potentials for intensifying trends as major drivers. Potential future shaping capacities of trends and drivers may be already visible or they can first be noticed as weak signals, but worthwhile to examine and discuss. Both the surveyed factors as the criteria will be the basis for Task 2.4 and Deliverable 2.3.

2. List of tables

3. Description of the Deliverable

The aim of this deliverable is to contribute towards developing European rail future business scenarios by exploring existing prognoses and forecasting studies, foresight studies on major trends and drivers, analysing visions and policy strategies and exploiting draft narratives of relevant scenario studies. Based on these sources major factors and criteria to develop 4 alternative rail business scenarios will be identified and discussed. In the past years many forward looking exercises were performed at the European, the member states and regional and local level. This deliverable can not analyse each of these exercises in detail, but proceeds by identifying and framing significant information deriving from relevant forecasting and foresight studies, corporate vision and strategic planning to gain appropriate information for drafting a range of convincing rail future business scenarios.

The main chapter of the deliverable on major factors and criteria for rail business scenarios is structured into 5 sections. A final chapter will draw some conclusions and synthesise the main considerations relevant for drafting the range of the 4 different rail future scenarios. In the first section of the main chapter (2.1) transport prognoses and some relevant forecasting exercises will be reviewed to gain estimate figures and factors regarding trends in transport demand and potential markets based on these figures. Trends in transport demand in transport prognoses are aggregate figures. In forecasting models, past relationships e.g. that between GDP growth and transport demand, are used as assumptions to project transport demand. Furthermore, these models allow us to examine different policy options, for example to calculate CO2 reduction potential with the options.

However, transport demand prognoses and forecasts do not appropriately reflect potential trend breaks and rather unexpected pathways into the future. Thus, in particular under a farhorizon perspective (2050) the forecasting approach is not sufficient and has to be combined with foresight exploring potential trends and drivers as well as trend breaks. Thus, state of the art today in most forward looking exercises is to combine forecasting with foresight, to gain visions and expectations and forward looking trends and drivers and potential trend breaks as major criteria for sketching out alternative future scenarios. This exploration of trends and drivers and trendbreaks will be adressed in section 2.2.

Section 2.3 will deliver considerations regarding the framing potential of transport policies and rail related policies in a European multilevel, multiactor system perspective. The section will look at the governing potential of agenda setting processes at different policy levels starting with the European level. The chapter will comparably, but due to the multiplicity of sources by example, look at the agenda setting at the member states and regional and local policy level. The chapter will further address agenda setting coordination among actor groups in the rail sector sharing cooperate visions and strategies. Section 2.4 will finally give some examples of relevant scenarios discussing

the future narratives (transport and rail related) sketched out by experts in these studies.

4. Major Factors and Criteria

This chapter contributes towards developing European rail future business scenarios extending from a 2030 to a 2050 time horizon by reporting the outcome of a range of relevant prognoses and forecasting studies, discussing trends and drivers and potential trend-breaks and rail policies and longterm investment planning at different policy levels in the European mulltlevel policy system . Addtionally corporate visions and strategies of significant actors and actor groups in the European rail community will be refflected.

However, transport demand prognoses and forecasts do not appropriately reflect potential trend breaks. In transport forecasts performed before 2007 trend breaks, for instance, the unexpected slow-down regarding GDP growth was not foreseen and the projected transport demand heavily overestimated. Under a far-horizon perspective 2050 forecasting approaches referring alone to trend progression, but not exploring potential alternative trends and trend breaks can not be successul, Trends and drivers and potential trend breaks have to be profoundly explored to deliver criteria for alternative futures scenarios. Alternative scenario narratives can be later used to reflect on assumptions taken in forecasting exercises and prognoses. Furthermore polices and corporate visions and strategies which are expected for shaping the future can be tested against the forecasting models and transport demand prognoses.

4.1 Transport demand prognoses and forecasting (factors)

As well at the European as at the member states level transport demand prognoses are a significant instrument for transport policy and infrastructure planning. In each transport ministry at the member states as well as at the European policy level transport demand prognoses and forecasts are performed or commissioned from external contractors. This paragraph will first present a brief overview of recent trends in rail transport demand. Secondly it will look at forecasting studies for alternative long run scenarios at the European level, resting heavily on the Transtools model approach, and in this case referencing to the EU-TRANSVISIONS project.

Table 1 reports trends over the past 40 years in increase of main line rail passenger kilometres (i.e. excluding tram and metros) across the EU27 member states. Table 2 does the same for tram and metro. The figures were obtained from EUROSTAT. The final four columns show the ratio of traffic of 2011 over 1970, 1980 1990 and the year 2000 respectively.

Table 1 : Railway Passenger Kilometres (Thousand Million Per Annum)

	1970	1980	1990	1995	2000	2005	2010	2011	11/ 70	11/ 80	11/ 90	11/ 00
EU27	**326. 44**	**365. 98**	**400. 71**	**350. 52**	**370. 71**	**377. 15**	**404. 20**	**407. 14**	**1.25**	**1.11**	**1.02**	**1.10**
ALL YEARS	**305. 94**	**347. 98**	**381. 01**	**338. 30**	**360. 54**	**368. 30**	**395. 30**	**397. 99**	**1.24**	**1.14**	**1.04**	**1.10**
BE	8.26	6.96	6.54	6.76	7.73	9.15	10.40	10.40	1.26	1.49	1.59	1.35
BG	6.22	7.06	7.79	4.69	3.47	2.39	2.10	2.07	0.33	0.29	0.27	0.60
CZ			13.31	8.02	7.30	6.67	6.59	6.71			0.50	0.92
DK	3.90	3.80	5.05	4.89	5.54	5.97	6.35	6.61	1.70	1.74	1.31	1.19
DE	62.40	62.50	61.02	70.98	75.40	74.95	83.03	84.98	1.36	1.36	1.39	1.13
EE	1.23	1.55	1.51	0.42	0.26	0.25	0.25	0.24	0.20	0.16	0.16	0.93
IE	0.58	1.03	1.23	1.29	1.39	1.78	1.68	1.64	2.81	1.59	1.34	1.18
EL	1.95	1.46	1.98	1.57	1.89	1.85	1.34	0.96	0.49	0.65	0.48	0.51
ES	14.01	13.53	15.48	16.58	20.14	21.62	22.39	22.80	1.63	1.69	1.47	1.13
FR	40.98	54.50	63.74	55.56	69.87	76.20	85.90	89.00	2.17	1.63	1.40	1.27
IT	32.46	39.59	44.71	46.65	49.57	50.47	47.29	43.34	1.34	1.09	0.97	0.87
LV	3.75	4.69	5.37	1.37	0.72	0.89	0.75	0.74	0.20	0.16	0.14	1.04
LT	2.13	3.26	3.64	1.13	0.61	0.43	0.37	0.39	0.18	0.12	0.11	0.64
LU	0.26	0.25	0.21	0.29	0.33	0.27	0.35	0.35	1.36	1.42	1.68	1.05
HU	16.35	13.54	11.40	8.44	9.69	9.85	7.69	7.81	0.48	0.58	0.68	0.81
NL	8.01	8.91	11.06	16.35	14.67	15.15	15.40	15.75	1.97	1.77	1.42	1.07
AT	6.44	7.59	8.91	10.12	8.74	9.51	10.74	10.88	1.69	1.43	1.22	1.24
PL	36.89	46.32	50.37	26.64	24.09	18.16	17.92	18.18	0.49	0.39	0.36	0.75
PT	3.55	6.08	5.66	4.81	4.03	3.81	4.11	4.14	1.17	0.68	0.73	1.03
RO	17.79	23.22	30.58	18.88	11.63	7.99	5.44	5.07	0.29	0.22	0.17	0.44
SI	1.38	1.44	1.43	0.60	0.71	0.78	0.81	0.77	0.56	0.54	0.54	1.10
SK			6.38	4.20	2.87	2.18	2.31	2.43			0.38	0.85
FI	2.16	3.22	3.33	3.18	3.41	3.48	3.96	3.88	1.80	1.21	1.17	1.14
SE	4.64	7.00	6.60	6.84	8.24	8.94	11.22	11.38	2.45	1.63	1.72	1.38
UK	30.60	30.50	33.40	30.27	38.41	44.42	55.83	56.62	1.85	1.86	1.70	1.47

The table above illustrates how the demand for rail in terms of passenger kilometres has varied in European countries over the past 40 years for each of the 25 EU countries having railway systems operating. The summary EU27 row, provided in the official statistics, sums across countries for each year including those for which was no data available in some years. A more reliable indicator in principle for trends is the 'ALL YEARS' row, which is based only on those countries for which figures were reported in all years. It turns out that the growth rates differ little between the two categories. Over the period 2000-2011, EU27 GDP per capita exhibited no growth. However, we still observe 10% growth in rail passenger kilometres in the table.

Table 2 : Tram and Metro Passenger Kilometres (Thousand Million Per Annum)

		1970	1980	1990	1995	2000	2005	2010	2011	11/70	11/80	11/9011/00	
EU27		**38.91**	**40.67**	**50.64**	**71.37**	**77.88**	**83.35**	**91.67**	**92.98**	**2.39**	**2.29**	**1.84**	**1.19**
ALL YEARS	**38.91**	**40.67**	**48.58**	**48.25**	**54.54**	**59.69**	**65.88**	**67.30**	**1.73**	**1.65**	**1.39**	**1.23**	
BE		0.86	0.77	0.74	0.80	0.87	0.93	1.07	1.13	1.32	1.47	1.53	1.30
BG				0.59	0.28	0.42	0.43	0.91	0.87			1.49	2.08
CZ					7.69	8.07	7.93	9.00	8.72				1.08
DK	-	-		-	-	-	0.16	0.24	0.28				
DE		14.63	13.84	15.10	14.43	14.60	15.49	16.35	16.60	1.13	1.20	1.10	1.14
EE					0.11	0.10	0.08	0.07	0.07				0.63
IE	-	-		-	-	-	0.11	0.13	0.14				
EL		0.63	0.68	0.83	0.74	1.19	1.50	1.69	1.69	2.69	2.49	2.04	1.42
ES		3.67	3.88	4.38	4.25	5.23	6.00	6.25	6.34	1.73	1.63	1.45	1.21
FR		6.50	7.70	10.48	9.33	11.55	13.33	14.70	15.02	2.31	1.95	1.43	1.30
IT		2.21	3.66	4.21	5.15	5.61	6.04	7.12	7.12	3.22	1.94	1.69	1.27
LV				0.73	0.30	0.27	0.27	0.12	0.12			0.17	0.47
HU					2.50	2.57	2.35	2.49	2.50				0.97
NL		1.24	1.35	1.26	1.38	1.43	1.50	1.58	1.58	1.27	1.17	1.25	1.11
AT		1.50	1.65	2.80	3.30	3.58	3.77	4.06	4.06	2.71	2.46	1.45	1.14
PL					5.00	4.70	4.40	4.34	4.40				0.94
PT		0.93	0.74	0.67	0.53	0.53	0.85	1.13	1.15	1.23	1.55	1.71	2.17
RO					6.00	6.00	6.60	7.14	7.14				1.19
SK					0.44	0.35	0.39	0.28	0.31				0.88
FI		0.10	0.13	0.35	0.39	0.50	0.53	0.53	0.52	5.15	3.96	1.47	1.04

Table 2 shows how the usage of tram and metro systems has varied over time. Some increases will be due to investments in new and extended tramway and metrosystems, although the 'ALL YEARS' row removes those countries that did not have data on networks in the early years and hence the implied growth is less. Nonetheless the passenger transport demand growth in urban transport somewhat exceeds that apparent for mainline rail. With increasing urban congestion due to an ongoing urbanisation trends more persons are commuting to work and education by public transport. We might expect different levels of performance across categories of rail transport flows and not just between mainline rail and urban rail (tram and metro). As income increases, longer distance discretionary trips on rail, can be expected to become more attractive and number of trips are increasing. Travelling by rail and not by airplane, at least on medium-distances up to 700 km may become the more convenient mode with investment in high speed rail.

We can also observe large differences in rail passenger transport demand increases across countries, and this is why we provide here Table 3 covering car ownership trends, since this delivers some explanation of differential levels of performance among road and rail. Rail passenger transport demand has grown most in the more mature Western European economies where increases in car ownership levels are slowing down and some

of these markets reaching saturation (peak car). Rail demand has more than doubled since 1980 in France and Sweden, and was not far from doubling in the Netherlands, UK, Finland, Austria Spain, and Denmark. Overall passenger mobility and transport demand has more than tripled with most travelling on road and strongest increase in air traffic on long distance.

Table 3 : Cars Per 1000 Inhabitants

	1970	1980	1990	1995	2000	2005	2010	2011	11/70	11/80	11/90	11/00
ALL	**114**	**202**	**281**	**321**	**375**	**414**	**446**	**456**	**4.00**	**2.26**	**1.62**	**1.22**
BE	213	320	387	421	456	468	482	490	2.29	1.53	1.27	1.07
BG	19	92	152	196	245	329	347	368	19.57	3.98	2.42	1.50
CZ	70	173	234	295	335	386	427	436	6.25	2.52	1.86	1.30
DK	218	271	309	320	347	362	389	394	1.81	1.45	1.27	1.14
DE	194	330	461	495	475	493	517	525	2.71	1.59	1.14	1.10
EE	22	86	154	269	339	367	412	428	19.55	5.00	2.79	1.26
IE	132	215	228	276	348	400	424	417	3.15	1.94	1.83	1.20
EL	26	89	170	207	292	387	461	461	17.88	5.18	2.71	1.58
ES	70	201	309	360	431	463	480	482	6.90	2.40	1.56	1.12
FR	233	354	476	481	503	497	501	502	2.15	1.42	1.05	1.00
IT	189	313	483	533	572	590	606	610	3.23	1.95	1.26	1.07
LV	17	66	106	134	236	324	286	300	17.74	4.54	2.82	1.27
LT	14	72	133	199	336	428	521	570	41.20	7.89	4.28	1.69
LU	212	352	477	556	622	655	659	658	3.11	1.87	1.38	1.06
HU	23	94	187	218	232	287	299	298	12.86	3.16	1.59	1.29
NL	195	320	367	364	409	434	452	470	2.40	1.47	1.28	1.15
AT	160	297	388	452	511	504	528	535	3.34	1.80	1.38	1.05
PL	15	67	138	195	261	323	451	470	32.07	7.06	3.41	1.80
PT	49	129	185	255	336	397	421	447	9.20	3.46	2.41	1.33
RO	2	11	56	97	124	156	202	203	103.3218.84	3.64	1.64	
SI	87	218	294	357	435	479	518	519	5.96	2.38	1.77	1.19
SK	36	110	166	189	237	242	307	324	8.96	2.93	1.95	1.37
FI	155	256	388	371	412	462	535	551	3.56	2.15	1.42	1.34
SE	283	347	419	411	450	459	460	464	1.64	1.34	1.11	1.03
UK	213	277	361	378	425	469	470	466	2.19	1.68	1.29	1.10

In contrast, rail demand has actually fallen in many of the emerging economies of Central and Eastern Europe with extension of the road network in the past two decades. Noticeably, as is apparent in Table 3, the latter countries have experienced very large increases in car ownership whereas further growth in car ownership is slowing or low in other economies. This pattern in Eastern and Central Europe mirrors what happened in Western Europe in the post-war period with the onset of mass motorisation and disseminating culture of individual transport by car. Increased fuel prices, higher levels of road congestion, shrinking prosperity and affordability of car ownership, but as well the impact of ICT and mobile entertainment on the attractiveness of mulitmodal journeys, and

more reliable and comfortable trains will have contributed to a shift to more frequently using rail for travelling.

Table 4 provides corresponding trends for freight transport demand by rail in the past decades.

Table 4 : Rail Tonne Kilometres (Thousand Million per Annum)

	1970	1980	1990	1995	2000	2005	2010	2011	11/70	11/80	11/90	11/00
EU27	**551.1**	**641.4**	**526.34**	**386.14**	**403.68**	**413.19**	**391.21**	**419.96**	**0.76**	**0.65**	**0.80**	**1.04**
ALL YEARS	**495.17**	**575.23**	**466.94**	**349.72**	**374.95**	**388.86**	**369.34**	**397.68**	**0.80**	**0.69**	**0.85**	**1.06**
BE	7.88	8.04	8.37	7.30	7.67	8.13	7.48	7.59	0.96	0.94	0.91	0.99
BG	13.70	17.68	14.13	8.60	5.54	5.16	3.06	3.29	0.24	0.19	0.23	0.59
CZ				22.62	17.50	14.87	13.77	14.32				0.82
DK	1.70	1.62	1.73	1.99	2.03	1.98	2.24	2.62	1.54	1.62	1.51	1.29
DE	113.00	121.30	101.70	70.50	82.68	95.42	107.32	113.32	1.00	0.93	1.11	1.37
EE	5.70	6.50	6.98	3.85	8.10	10.64	6.64	6.27	1.10	0.96	0.90	0.77
IE	0.55	0.64	0.59	0.60	0.49	0.30	0.09	0.11	0.19	0.16	0.18	0.21
EL	0.69	0.81	0.61	0.29	0.43	0.61	0.61	0.35	0.51	0.43	0.58	0.82
ES	9.74	11.28	11.15	10.96	11.61	11.59	9.21	9.75	1.00	0.86	0.87	0.84
FR	67.59	68.82	52.24	48.27	57.73	40.70	29.97	34.20	0.51	0.50	0.65	0.59
IT	18.07	18.38	19.36	21.69	22.82	22.76	18.62	19.79	1.10	1.08	1.02	0.87
LV	15.52	17.59	18.54	9.76	13.31	19.78	17.18	21.41	1.38	1.22	1.15	1.61
LT	13.57	18.24	19.26	7.20	8.92	12.46	13.43	15.09	1.11	0.83	0.78	1.69
LU	0.76	0.67	0.62	0.53	0.63	0.39	0.32	0.29	0.38	0.43	0.47	0.46
HU	19.82	24.40	16.80	8.40	8.80	9.09	8.81	9.12	0.46	0.37	0.54	1.04
NL	3.72	3.47	3.07	3.10	4.52	5.87	5.93	6.38	1.72	1.84	2.08	1.41
AT	9.87	11.00	12.16	13.20	16.60	18.96	19.83	20.35	2.06	1.85	1.67	1.23
PL	98.00	132.40	81.60	68.20	54.00	49.97	48.71	53.75	0.55	0.41	0.66	1.00
PT	0.78	1.00	1.46	2.02	2.18	2.42	2.31	2.32	2.99	2.32	1.59	1.06
RO	43.10	64.80	48.91	17.91	16.35	16.58	12.38	14.72	0.34	0.23	0.30	0.90
SI	3.30	3.80	4.21	3.08	2.86	3.25	3.42	3.75	1.14	0.99	0.89	1.31
SK				13.80	11.23	9.46	8.11	7.96				0.71
FI	6.27	8.34	8.36	9.60	10.11	9.71	9.75	9.40	1.50	1.13	1.12	0.93
SE	17.31	16.65	19.10	19.39	19.48	21.68	23.46	22.86	1.32	1.37	1.20	1.17
UK	24.55	17.82	16.00	13.30	18.10	21.43	18.58	20.97	0.85	1.18	1.31	1.16

The table above presents trends in tonne kilometres by rail freight transport. The ‘ALL YEARS’ row removes the Czech Republic and Slovakia, where information was not provided for all years. Since 1970, rail freight has lost around 20% of its traffic in total in

Europe, mainly due to the collapse of the socialist goverment instructed railfreight sector in Eastern Europe with the end of the communist era. Since 2000 rail freight demand has stabilised, despite recession, with strong growth in some Western European countries and the Baltic states, particularly with combined transport offsetting further decline in Eastern Europe, Italy and Spain, and the decline of the rail freight sector in France. There have also been important changes in commodities carried, with a decline in bulk materials but growth in containers. In general the trend in rail transport demand in tonnes is declining, while on the hand distances freight is forwarded on rail are slightly increasing.

Forecasting of the European transport system

Forecasting studies do not solely rely on extrapolation of trends, but project potential transport demand by modelling and simulation. For these exercises equlibrium transport economic models or system analysis models (e.g. such as the EU Transtools model) are used. At the national and federal state level similar modelling approaches are practiced e.g. the German «Verflechtungsanalye» or the British forward looking exercises. However, each forecasting approach stays distinct regarding its model architecture and the basic assumptions taken for the projections.

The most recent comprehensive transport demand forecasts for the European transport system as a whole were produced within the Impact Study of the Commission's most recent transport White Paper (EC, 2011). However, whilst they consider a range of future Euorpean level policy options these are all appraised in the context of a single external socio-economic macro-scenario. The policy options considered in the impact study are relative to a general reference scenario, with existing policies implemented but no new policy measures beyond those in place in 2010, and the following few alternatives:

- Policy option 1: complete implementation of EU policy on internalising externalities and carbon tax set at the European level to ensure the achievement of carbon targets.

- Policy option 2: complete internalisation of externalities only in countries which have or plan to have appropriate kilometre charges for road transport. CO2 price fixed at 20€ per tonne of CO2 post 2020 and emission standards tightened to achieve CO2 targets. High R&D effort is leading to faster technological progress especially regarding batteries.

- Policy option 3: Complete internalisation of externalities except that carbon tax and standards as in option 2, but technological progress (e.g. battery costs) only medium.

Technological developments that are foreseen are continued improvements in energy efficiency in road transport and the growth in the use of hybrid propulsion systems. Vehicle batteries remain expensive in the reference scenario.

The framing socio-economic macro-scenario is one of a return to growth, with population growing to 2035 by 0.2% p.a. in the EU and then staying fairly stable at around 500m, but with age groups over 65s rising to 29% of the population compared with 17% today. GDP growth is assumed to be 1.2% p.a. 2000-2010, rising to 2.2% 2010-2020, and then falling on average to 1.6% p.a. by 2020-2050.

Table 5 : Forecast Rail Market Growth from 2005

	Passenger Policy			Freight Policy		
	1	2	3	1	2	3
2020	33%	22%	32%	38%	30%	36%
2030	65%	39%	63%	87%	44%	60%
2050	124%	75%	111%	148%	62%	87%

Rail transport demand and market growth for each year (by policy option) is projected for all three framing socio-economic scenarios – set out in Table 5. However, growth in rail transport demand for the baseline case is not reported in the same format, but is likely to be close to that for framing policy option 2. Policy option 3 is that seen as most likely by the European Commission, and perhaps could be taken as representing the transport demand forecast for a single European rail market scenario.

Another recent relevant study on alternative long run senarios for European transport system futures was the TRANSvisions study. The aim of this study (Tetraplan, 2009) was to provide technical support to the debate on transport scenarios with a 20 and 40 year horizon during the consultation phase of the White Paper on transport. It adopted a dual concept : long term forecasting with a foresight approach. For 2030, it used what it termed as a 'traditional' forecasting approach based around a conventional four stage transport model with Europe wide coverage based on NUTS III zoning for passengers and NUTS II zoning for freight. The forecasting exercise was based on the already mentioned EC's transport model TRANS-TOOL. For the far-horizon 2050, but also for comparability for 2020 and, endogenous transport related variables, such as travel fares and operating costs for different modes, and network characteristics. The 2030, the forecast was termed a 'lighter' type of forecasting. Essentially an elasticity approach based on a transport economics meta-model was deployed.

The TRANS-TOOLS model uses as input assumptions exogenous socio-economic factors, such as economic activity, income and population meta-model represents relationships between input factors, variables and relevant outputs, typically in the form of elasticities, calibrated to TRANS-TOOLS outputs for 2005 and 2030. This allows more rapid testing of policy options within the range of this type transport economic model. The TRANS-TOOLS model, which is in the centre of all the modelling approaches at the EC level for transport, is based on equilibrium formulations and calibrated to the current transport network situation in Europe. For the 2030 TRANS-TOOLS forecasts, two policy measures were tested which covered the pricing of cars on interurban roads and the forceful development of infrastructure networks.

Table 6 reports the TRANS-TOOLS forecasts for 2020, based on 39% GDP growth over the period, and for 2030 based on a central GDP growth forecast of 61% for Europe as a whole over the period, but with low and high growth variants around this length. The baseline figures for 2030 correspond closely with policy option 2 in Table 5, which is most likely to represent the reference case scenario, although the figures are for all transport modes and not differentiated by mode or in particular by rail.

Table 6 : TRANSTOOLS 2020 and 2030 Demand Growth Forecasts

	Baseline 2020	Baseline 2030	High Growth 2030	Low Growth 2030
GDP Increase	39%	61%	77%	20%
Freight Tonne Km	32%	50%	62%	15%
Passenger Km	22%	38%	55%	9%

Source: Table 5.1 TRANSvisions report

The TRANSvision report states an overall demand growth in passengers on EU territory between 2005 and the 2030 - baseline is expected 1.3% growth per year. This figure is less than the projected GDP growth rate for the Baseline of 1.9% per year". On a modal basis, for trips less than 100km, it was forecast that rail passenger kilometres are expected to fall by 5% by 2030. In contrast, for journeys over 100km and up to 400-500 km, rail is predicted to achieve a 150% demand growth, around three times more than car on this medium long distance and air travel which are similar at around 50% growth. Note though that trips over 100km make up only about 2½% of all trips although around 55% of passenger-km travelled. Regarding demand growth in freight, of course, the Transvisions project did not foresee the financial crisis and recession of 2008, meaning that traffic growth, particularly freight, is still well below the forecasts in TRANSvisions for this period.

In the TRANSvisions forecasting exercise two policy tests were performed for 2030, based on variations of the low growth socio-economic framework scenario. A pricing test involved a 0.06€ per kilometre charge for trucks on motorways in vignette countries and a per kilometre road user charge to internalise external costs. For cars, the internalising charge was 5% of that for trucks plus 0.02€ per kilometre on motorways for cost recovery of motorway construction. The other policy test was one of added road and rail infrastructure, particular in Eastern Europe, and added to the high growth scenario. Results are reported in Table 7. The policy options make generally little difference to transport demand growth.

Table 7 : TRANS-TOOLS 2030 Forecasts with Policy Tests

	Baseline 2030	Low Growth 2030	Pricing Policy Test	High Growth 2030	Infrastructure Test
GDP Increase	61%	20%	20%	77%	77%
Freight Tonne Km	50%	15%	15%	62%	68%
Passenger Km	38%	9%	8%	55%	55%

Sources: Tables 5.4 and 5.5 TRANSvisions report

TRANSvisions also reports on longer term and mode specific forecasts. For the longer term forecasting four scenarios in addition to the baseline scenario were considered based on combinations of high and low GDP growth and human wellbeing. These are:

- **Moving Alone**: High EU Growth and Decreasing Wellbeing - Induced Mobility
- **Moving Together**: High EU Growth and Increasing Wellbeing – Decoupled Mobility
- **Stop Moving**: Low EU Growth and Decreasing Wellbeing – Constrained Mobility
- **Moving Less**: Low EU Growth and Increasing Wellbeing – Reduced Mobility

The Table below of the TRANSvisions report provides a description of factors for the baseline and three more scenarios. Furthermore under broad headings like global governance and policy context, economy, society, energy, technology, environment and transport a list of initial criteria was set up (trend and driver list) which can be found in the annex of the TRANSvisions report. The four scenarios (headings above) were sketched out in detail and combined with the forecasts. Table 8 which reproduces 2050 forecasts in TRANSvisions indicates the variations in the key factors of GDP and population for each scenario. Two of the four scenarios imply very large increases in rail demand.

Table 8 : TRANSVisions 2050 Forecasts (Compared to 2005)

	Baseline	Decoupled Mobility	Reduced Mobility	Induced Mobility	Constrained Mobility
Annual GDP Growth	2.0%	2.4%	1.2%	2.6%	1.3%
Total GDP Growth	2.47	2.95	1.73	3.22	1.81
Annual Population Growth	-0.03%	0.23%	-0.29%	0.23%	-0.02%
Total Population Growth	-1.2%	10.9%	-12.4%	10.9%	-0.8%
Intra NUTS3 Rail Pass Km	1.48	5.41	1.97	1.41	2.77
Inter NUTS3 Rail Pass Km	3.27	5.37	2.78	5.33	4.32
Inter NUTS2 Rail Freight Tonne Km	2.73	3.29	1.56	4.18	1.75
Pass Rail LD Share (2005=9.7%)	21.5%	28.2%	18.9%	19.9%	26.3%

Sources: TRANSvisions report

The TRANSvisions study predicts some large increases in rail demand and it is essential to place this in some context. Table 9 below provides forecasts using elasticity based approaches as a ‘sense-check’. A GDP elasticity of 0.9 for both passenger and freight demand is used with respect to GDP, as referred to in section 1.2 above which stemmed from the TRANSvisions study. This 0.9 elasticity value alongside the GDP growth assumptions was used to arrive at some forecasts of demand growth by 2030 and 2050.

In table 2 and table 4 of this chapter passenger and freight transport demand growth trends were extrapolated respectively shown for the past 20 and 40 years to compare past developments and project into the future. It can be noted that it is currently about 40 years since 1970 till today and about 40 years into the future until 2050. Whilst it is commonly stated that, in a long run, farhorizon perspective, elasticity estimates and other transport demand factors might not be reliable, it schould in our opinion be noted:

- The demand factors we are currently using in forecasting, if based on time series data, do have a strong background in the past, and often far in the past, so we are implicitly imputing the same demand responsiveness in the future as to in the past.

• Studies that have explicitly tested for price and cost elasticity variation over time tend not to come up with convincing evidence to support such variation patterns.

• Are we so convinced that the elasticities and demand factors and parameters we now use 40 years on from the 1970s are so much different to the factors used in future? Do we expect that people will really respond so much differently to income variations now and in the upcoming years than they did 40 years ago and they will do in 40 years time? The onus might be said to be on those, who believe demand factors and parameters do vary strongly over time. However, it should be born in mind that trends may change, as has happened in car travel, where demand growth seems to have taperde off in a number of countries.

Table 9 : Elasticity Based Forecasts to 2030 and 2050

	Baseline	Decoupled Mobility	Reduced Mobility	Induced Mobility	Constrained Mobility
Annual GDP Growth	2.0%	2.4%	1.2%	2.6%	1.3%
Total GDP Growth	2.47	2.95	1.73	3.22	1.81
Annual Population Growth	-0.03%	0.23%	-0.29%	0.23%	-0.02%
Total Population Growth	-1.2%	10.9%	-12.4%	10.9%	-0.8%
Intra NUTS3 Rail Pass Km	1.48	5.41	1.97	1.41	2.77
Inter NUTS3 Rail Pass Km	3.27	5.37	2.78	5.33	4.32
Inter NUTS2 Rail Freight Tonne Km	2.73	3.29	1.56	4.18	1.75
Pass Rail LD Share (2005=9.7%)	21.5%	28.2%	18.9%	19.9%	26.3%

Sources: TRANSvisions report

Note: Elasticity of 0.9 used for passenger and rail. 1 Intra and Inter NUTS3 rail demand respectively. TV denotes TRANSvisions forecasts.

We observe a close correspondence for 2030 between the TRANSvisions, elasticity and 1990-2010 trend extrapolation for passenger, but we note that the TRANSvisions forecasts are for all modes and do not differentiate. For freight, the TRANSvisions and elasticity forecasts are very similar but in stark contrast to the trend. Given the latter reflects structural changes, it is a less reliable indicator than for passenger travel.

Turning to 2050 and rail passenger transport demand, there is a reasonable degree of consistency between the TRANSvisions study results and elasticity forecasts for the baseline scenarions ; and indeed the 1990-2010 trend extrapolation fits well. However, there is less correspondence for the low and high growth scenarios, particularly the latter. For freight, the TRANSvision forecasts for the baseline and high growth scenarios somewhat exceed the elasticity figures. Although we have not here captured all effects at operation, since the elasticity approach is based solely on GDP, there is in our opinion still some evidence that longer terms forecasts are delivering credible outcome.

4.2 Social and Economic Trends and Drivers

Economic growth generates prosperity and wealth, with individual, particularly middle class customers investing heavily in consumption inter alia in car travelling, air flights and travelling by rail, in Europe and worldwide. Economic prosperity and growth provides rising public budgets by tax revenues and allows improvements by public investments into transport infrastructure. The private sector is interested to invest in transport infrastructure, when revenues are guaranteed, e.g. by growing number of users to be charged for using the infrastructure or by the public sector guaranteeing revenues by public service contracts. Investments in infrastructure allow new opportunities for mobility and transport of people and goods and therefore strengthen economic growth and individual prospects to better access employment, education and health services. It is evident that economic growth has an effect on transport demand growth. However, explicit trend projections for transport demand growth may be contested with trendbreaks and structural change.

Rail transport is expected to be the backbone of the European public transport system, at least regarding mass transit in and between metropolitan and urban areas. There is empiric evidence that a relation exists between growth in economic activity and transport demand development. A recent analysis of the German Transport Ministry pointed out that with every increase of 1% of GDP an increase of 1.6 % of freight transport demand can be projected from today's perspective. Transportation demand regarding all transport modes is changing due to societal change, socio-economic and institutional transitions and technology progress. Society and economy may be expected to gradually or even radically change as technologies may shift with technological progress. As a consequence even the few assumptions given as notions above can be seen as speculative: for example further rise of global trade may not take place as projected and re-regionalisation and protectionism may be revisited. Such trend breaks can make for gradually lowering growth or even breaking transport demand trends.

In the upcoming paragraphs trends and drivers from today's perspective pointing at societal change, socio-economic and institutional transitions and shifts in technology by technological progress will be explored. A distinction is made between the term societal change (social and economic transformation) and socioeconomic and institutional transition. While the term transformation is pointing at societal and economic systems change, the term socio-economic transition is pointing at gradual changes of today's social and economic system. What this implies will be framed out in the considerations below. Potential trends, drivers and trend breaks will be considered and consequences for future of rail system and rail markets will be discussed to diversify criteria for the scenario design.

The exploration of trends and drivers and potential trend breaks in this paragraph is based on various sources mainly European forward looking, foresight and horizon scanning activities of the past years. The European Foresight Platform (EFP) and other prospective studies platforms and archives allow an overview on actual forward looking activities, http://www.foresight-platform.eu. Policy briefs of a wide range of forward looking studies are provided originating from foresight activities at the European, the national and regional, level. Even policy briefs on foresight studies in other regions of the world are provided. To gain more detailed information each of these studies is linked to the respective project webpage. Furthermore some very recent foresight exercises, in this case particularly

related to rail and transport technology and innovation will be taken into account, e.g. the EU-funded projects LivingRail, http://www.livingrail.eu, Spiderplus, http://www.spiderplus-project.eu and Capacitiy4rail, as well as the RACE 2050 and the FUTRE EU projects. Both are transport technology and innovation foresight projects.

Many other EU funded prospective studies and platforms are just as important and inspiring sources for reflecting societal trends and drivers relevant for the railway sector: Futurium, the European Commissions future poll regarding the digtial agenda, http://ec.europa.eu/digital-agenda/futurium/en/content/themes; the joint research centres on prospective research in Seville (JRC-IPTS) prospective economic analyses, http://ipts.jrc.ec.europa.eu/activities/; recent EU-funded socio-economic forward looking projects, the PASHMINA http://www.pashmina-project.eu, the GLOBAL Europe 2050 expert group foresight, http://ec.europa.eu/research/social-sciences/events-191_en.html or the wwwforEurope EU-funded project initiative, http://www.foreurope.eu. Regarding the future of the European Research and innovation area, recent EU-funded projects like Research and Innovation Futures (RIF), http://www.rif2030.eu, Visions of the European Research Area (VERA), http://www.eravisions.eu or the innovation futures project, www.infu.eu have to be looked at. Many other forward looking and foresight studies at the European level, e.g. the range of studies and activities on knowledge based bio-economy (KBBE) may as well gain prospective ground for the rail sector, implying for example growing demand and changing trends for bulk and single wagon transport. Another type of recent forward looking exercise looking not alone on societal trends but on threats for societies and economies, funded under the security theme, are projects like FORESEC and ETTIS, www.foresec.eu and www.ettis-project.eu. A further overview on general forward looking activities at the Euopean level is given with the following brochure, ftp://ftp.cordis.europa.eu/pub/fp7/ssh/docs/fla_en.pdf.

In the following sub-paragraphs trends and drivers and trendbreaks pointing at more radical shifts will be explored and discussed. They are structured under particular headings, which are in line with the societal trend and driver list in the Strategic Rail Research and Innovation Agenda (SRRIA). Reporting on societal trends and drivers implies to picture more closely on expert debates and the public discourse regarding these trends and drivers. At a later stage, for the strategic research and innovation agenda (SRRIA), most important trends can be singled out and presented as more illustrative propositions. But it has always to be respected that quantitative as qualitative forward looking is rarely based on facts, but expert estimation and opinion.

Actors and actor groups may consent on trends and drivers and trend breaks they jointly see most conclusive. This approach will be taken up in the future dialogue forum planned in the FosterRail projects. Actors may agree on a corporate vision for shaping a potential future, they do not expect, but they want to expect as preferred future. In a complex socio-economic and political framework this is creating a powerful policy stake. On the other hand it can be easily exposed as non reliable lobbyism and far from any realism and pragmatism, if this vision is to simplistic and not based on consideration of multiple factors and criteria guiding an informed consent opting among a range of alternative futures. Futures are not predictable, but we can reason and consent about contingent futures.

4.3 Globalisation and Growth

Globalisation and economic growth are continuing with global population increasing and hence a need for growth in all important areas of provision: food, housing, energy and mobility and transport of people and goods. Energy and transport demand are growing with worldwide increasing production and consumption. However, economic growth trends are not equally spread across regions and districts. Growing and shrinking territories can be observed. Regional and local pockets of wealth and pockets of poverty are emerging.

Globalisation is driven by internationalisation of innovation and production networks with companies not solely trading but manufacturing and innovating globally. International trade is increasing and the skilled labour force is moving across countries and world regions. However, with growing energy costs and increasing prices for transport reshoring and nearshoring trends in production are expected. Small-sized standard components are traded to be assembled in local production. Knowledge society and preceding business areas to production, including digital manufacturing, are becoming increasingly important.

Rail transport demand is increasing up to 2050. However, forecasts regarding this demand increase are difficult to take. Recent trends are showing an increase in rail freight transport on distance above 1000 km. While tonnes in freight transport are decreasing, transport distance is increasing. Rail freight transport demand growth is driven by globalisation, but even more by the integration of the internal market and a European wide shift to rail freight strategy emphasizing on long distance intermodal freight transport with major share on rail.

Rail passenger transport demand is strongly driven by demand growth in urban areas. The number of passengers using public transport services and rail bound public transit is constantly growing up to 2050. Increasing car access and parking restrictions in densifying urban areas are expected strongly driving this shift to rail trend. The demand for long distance cross-national journey by rail is expected to overrun long distance travel by car.

4.4 Demographic changes and changing lifestyles

Population is ageing in Europe and industrialized countries worldwide. This has significant consequences for production and consumption. Age group 80+ is the most fast growing age group up to 2050. Beyond 2050 Europe is expected to be less densly populated unless large migrant numbers are substituting for shrinking native populations. Today nearly as many people are entering European member states as leaving Europe to other destinations. Continuous moving to Europe is a requisite to sustained economic growth and facilitates pension systems.

Populations of the elderly have to be consequently distinguished. Age group 65 to 70 are expected to be still in the workforce with more flexible and part time job arrangements. Work careers will be extended for a large share of the ageing population; telepresence and ambient technologies are expected to support this trend. Age group 70+ will be predominantly in pension and retirement. This age group is foreseen to be very active and in good health and expected to do a lot of travelling on long and medium distances by rail, bus and air. With progressing age in this age group the activity radius is shrinking with

most journeys focusing on short trips for weekly and daily routines. Demand regarding accessibility and special need for comfort, quality and safety in in public transport and rail is rising.

Societies will further differentiate. Societal and economic diversity and disparity is growing. Comprehensive cohesion policies like in the past are not foreseen for the upcoming years. However, social welfare and poverty abatement is expected to stay a major value in Europe compared to other regions in the world. Europe is getting transnational with a multiplicity of persons of different cultural and religious backgrounds shaping societies. Social fabric and culture may come under stress with growing disparities. Inequality regarding employment and income is further increasing. Security and civil protection constraints are arising with organized crime, terrorism and other threats. Regarding international trade the transport sector is threatened by piracy and organized crime, terrorism and regional war. Cyberfraud and cybersecurity constraints, e.g. with vulnerable satellite navigation and data espionage are significantly increasing. Rail transport systems are as large technical infrastructures vulnerable and difficult regarding surveillance and protection.

Lifestyles are changing and therefore travel behaviour does. People in industrialized countries and knowledge societies are facing increasing time intensity. Social disorders like depression, fatigue, diabetes and obesity are spreading with increasing velocity of time. Public health schemes are anticipated to decelerate urban lifestyles encouraging for example people cycling and walking in daily travelling routines. This trend is already obvious for urban areas and it is expected beneficial for public transport and rail mass transit (easing) in peak hours with people moving multimodal and cycling and walking.

Reliability is expected everywhere. Mobility and transport are expected to be exactly as scheduled and seamless, with increasing unrest and aggression of users in case of delay and disruptions. The digital age nomad is fully equipped with devices like handheld, tablet or notebook and an increasing number of other virtual gadgets. It is expected to be fully telepresent 24 hours a day. Public transport and in particular rail gives better opportunity to digitally communicate and social network during travelling time. In knowledge societies an increasing number of persons are using journey time as working hours, in particular in rail.

Individual cars are crucial commodity items in modern societies. However, in particular with young people moving to urban areas cars as commodity items are losing preference. Trends regarding car ownership are peaking in many European countries. Travelling multimodal by public transport, cycling and walking is in many urbanized areas meanwhile a sounder choice for mobility than going by car. With car ownership and car use further getting more costly and projected to be increasingly restricted in urban areas multimodal travelling behaviour and lifestyles are further expected to expand. However, travelling choice and ownership versus sharing transportation means and using public transport is still dependent on availability and flexibility of public transport and carsharing and bike sharing services. Most people in urban areas still own a car for occasion: for leisure times, weekend trips and shopping routines at the malls at cities periphery.

Tourism is increasing with European travelling to other world regions and continuously growing numbers of tourists from other regions of the world visiting Europe. Distances for leisure and holiday trips are increasing with the spread of air services at comparativly low cost. It is expected that in particular airports with direct and high speed rail links will be

dominant airport hubs for travelling in Europe and abroad in the future. Due to growing "intensity of time" as well in holiday travelling, journeys have to be precisely scheduled and seamless to allow as many attractions as possible in short time. In less densely populated, non-urbanized tourist areas, individual transport will play as most flexible mode still a major role. However, public and shared transport modes will increase; particular rail services are in many cases tourist attractions as such. Switzerland is for example the most preferred alpine destination for Asian tourists with seamless public transport allowing to avoid car travelling on an unfamiliar road network.

4.5 Land-use and Urbanisation

By 2050 more than 80% of the population are expected to live in urban areas. However, these urban areas are rather differentiated regarding spatial arrangements, e.g. with regards to population and housing density, infrastructure and land-use organisation. A multiplicity of land-use classifications are classed as urban areas. And most of them are not as dense populated and spatially organized as the city and town architectures in Europe and worldwide which evolved before mass motorisation are showing. For dense populated areas, where people are living and working mass transit systems are crucial, and the most cost effective mass transit systems for shifting large numbers of people were in the past and are today rail bound transport systems.

The terms urban or the term urbanized are pointing at a particular societal trend. Most population in industrialized countries and worldwide have meanwhile taken up urban lifestyles, that means a particular behaviour in terms of how to live and organize daily and lifetime routines. Most people are commuting e.g. daily from home to work and education, are having short trips for shopping and leisure at weekends or in evening hours during the week. One or several times a year they are travelling for shorter and longer holidays and recreation trips. Modern economies are heavily depending on division of labour and on economies of scale. Patterns of self sufficiency in daily life are continuously dissolving with economic growth driven by co-modification and business up-take. Rural lifestyles with high grades of self sufficiency are disappearing and thus transport demand is growing.

In the past 50 years a major success for economic growth, prosperity and welfare in Europe was a systematic cohesion policy at the national and federal state level and later the European level (regional and structural funds). The European integration process, in particular the integration of the European internal market, was and is still driving cohesion toward regional development and economic growth. However, a trend is a European landscape dividing into growing and shrinking territories. However, it stays difficult to distinctly classify shrinking and growing territories and districts. A district at the periphery may still stay a high income territory with dedicated urban lifestyles, e.g. tourist regions or regions with specific production and manufacturing sites. Last mentioned are mostly situated along main transport corridors. Such regions are not densely populated, but requiring a robust and cost effective public and rail transport system. Although mass transit systems like rail may be questioned for passenger transport and bus services are more cost effective and sufficient in less dense populated territories.

Growing urban and metropolitan regions in Europe have another face than in many other regions of the world. The spatial arrangement is mostly an agglomeration of cities and as a

larger regional district or along a transport corridor. People are commuting among cities, districts and towns in these regions. Some of them are gowing, others are shinking with a growing share of elderly and old people in shrinking districts. In these districts as political entities the mumber of tax payers is decreasing and therefore public budgets declining not allowing adequate investment in public transport servies and infrastructure.

With an increasing household budget share for mobility due to rising energy costs and pricing for infrastructure an increasing number in particular of younger people are moving closer towards the city and into urban areas. Increasing « time intensity » in working and private life is speeding up this trend. There is a trend amongst yound professionals working in cities to live closer to their work, leading to less travel but also favouring public transport as well as walking and cycling in detriment of car ownership.

4.6 Sustainable development and climate adaptation

Sustainable development is a normative concept as to how to adress the grand challenges of today, in particular environmental challenges and challenges along with climate mitigation and adaption. Sustainable development as a novel societal order can be conceptualized in different ways, on one hand as a green economy concept motivating further economic growth, but progressing technologies towards more environmental friendly and climate sound technological systems. On the other hand sustainable development as changing normative order may call for respecting limits to growth, e.g. regarding resource use and recycling and may drive towards behavioural change regarding travel and transport. Cities and city regions worldwide are currently developing mobility policy and climate action plans to achieve CO2 reduction targets. In most of these action plans car travel in urban areas is heavily reduced by foreseen restriction and access charging and people motivated to use public transport, cycling and walking. Urban rail as electrified mass transit system plays a major role in this planning. This trend has high implications and will be a major driver of the future of rail in urban areas. With public budgets not growing, but rather decreasing in most cities cost pressure will increase as a main driver for cost-effective rail infrastructure, operation and services.

Sustainable development as normative order has as well a social dimension. Sustainable development is driven by an emancipatory trend towards more democratic participation and involvement in policy decision making not only by professional stakeholders, but citizens as well. Sustainable development is visioning a green, socially vital, liveable and healthy environment in the present and allowing such a world as well to the upcoming future generations.

With regards to the development of large infrastructure projects this may be conflicting. Major bottlenecks in the rail network are in most cases not far off, but in dense populated areas. With new infrastructure deployment environmental and health concerns are reinforced. Noise and vibration are still experienced as most environmental problems are caused in the transport sector. However, public opposition trends against large technical infrastructure is not alone fed by environmental and health concerns, but by the wider public being disaffected against large public budget shares spent for technical infrastructure like high speed rail, while at the same time not sufficient budget is available

to invest in education, social welfare, jobs and employment opportunities. The opposition trend is gaining intensity, growing more radical and may hinder roll out of capacity for rail.

Another trend which is expected to continuously proceed is the rise of energy prices with transition to new energy systems and getting away from cheap fossil fuel to renewable energies and new technologies for energy efficient use. Similarly natural resources with today's transport system in general, and in particular the rail system, are getting more scarcy and so more costly. The rail sector is for example heavily relying on copper for catenary systems and some rare minerals for ICT and electronics. Renewable energy production may not take off as fast as expected and at expected average costs.

Long distance rail services are expected to be strongly affected by climate change: railway being a vulnerable infrastructure to extreme weather events. More resilient infrastructures including improved emergency and maintenance services for catenaries and track systems are an increasing trend. This includes in particular reliable information for passengers and freight forwarders and shippers, e.g. in case of disruption advising travel and freight transport alternatives to final destination in due time. Transient infrastructure deployment strategies for being more adaptive to increasing frequencies of extreme weather can be followed as a weak signal for an upcoming trend. A trend is following as well the debate on smart grid futures with power grid infrastructure for electrified rail smartly integrated into rail infrastructure to improve energy efficiency and including renewable energy systems. Energy harvesting in rail infrastructure (e.g. large PV sites) are already today an attractive sustainable innovation trend in the rail sector.

4.7 Public sector and private sector financing

Public sector financing for new transport infrastructures is decreasing. Public budgets are exceedingly devoted with ageing infrastructure to renovation and revitalisation. This trend can be monitored across the different policy levels in Europe. A main trend driven by the European policy level is the removal of bottlenecks and renovation of most important track intercepts at the overall European transport corridor network. At the regional level the public budget is failing in shrinking regions. These regions are lucky if they are situated along one of the European corridors. Growing regions and major urban areas may dedicate budget to urban rail and rail mass transit. However, there is a considerable trend pointing in general at a lack of public budget share for transport infrastructure for road as well as for rail. Regarding the fact that the European Union is financing a small budget share of the overall investment in infrastructure, this trend may cause serious barriers for further roll out of rail.

Public private partnerships are seen as attractive ways of financing transport infrastructure investment whilst keeping the debt off the public sector balance sheet. However, the private sector (including pension funds) looks for assured returns, so governments very often have to commit to government grants and to sharing risk as the price of PPPs. Unless the PPP structure brings other advantages by way of cost effective delivery, it may actually raise the call on public funds.

With expected doubling or even 3-fold increase in capacity demand at several European rail interceptions with high efficiency and cost effectiveness and environmental sound

solutions public budget shares for rail transport infrastructure are heavily strained. While on national and European level the EU Council in Tallinn estimated in 2013 a demand of around 500 Billion Euro for the EU 27, in Germany the Bodewig Commission estimated a demand of 46 Billion Euro in the years to come. UNECE TER/ TEM estimated a much higher need for rail transport infrastructure and corridor Investments and at the same time strong demand for rehabilitation of aging rail infrastructure. Much of the infrastructure (key corridors, multimodal hubs, ports) will additionally require improved capacity to handle volumes three times higher than today, thus the expert expectations and estimations.

Improved funding & financing arrangements and methodologies or what is in general called financial innovation is called for. There is an ongoing trend to deploy and experiment with new financial and taxation arrangements, at the public side in particular with infrastructure pricing and user charging to gain revenues additional to tax income. This trend is strongly facilitated at the European level by an ongoing debate calling for internalisation of external cost and public awareness campaigning assuring infrastructure users about the benefit of transport infrastructure and its role for economy and welfare.

Alternative sources of funding may be a neighbouring beneficiary of transport infrastructure, e.g, a large shopping mall benefitting as a third party. Private sector and institutional actors like development banks may invest as well in large transport infrastructure like the EU Asia link by rail. However, these trends are often strong related to economic boom cycles and in recent years private as public sector investors got explicitly more cautious about such investments than in the years before the financial and economic crises. If this crisis caused a trend break regarding investment in huge technical infrastructures like in the rail sector can at this point not be conclusively determined.

4.8 Developments in technology

A number of large technological systems are in place shaping the overall rail technology and transport system. Changes in these systems are more than technological innovation, but also a matter of organisational change and institutional reform. There is a strong trend to transfer political authority - that means legal and institutional power for governing at least the technological system - to the European policy level. Expectation and hope with this strategy is to gain better technical integration and interoperability as well market integration. However, such developments are costly, and may actually reduce competition by imposing costs beyond the resources of small companies.

Some of the large technological systems in the rail sector are more developed and already integrated than others, for example the European Rail Traffic Management System (ERTMS). Innovation and improvement in this area is pushed forward through technical harmonization of interfaces and specifications. Despite the relevance and impact of such integrating systems, they are still exceptional so they are still merely used for niche applications. Train control and traffic management as well as information and

communication technologies (ICT) are undoubdtoudly and among others crucial enabling and key technology areas in the rail sector.

Some other innovations in the rail sector (e.g. magnetic levitation; dual rail road vehicles) have not yet seen wide deployment.

The main innovation trends in the rail sector are converging technologies, i.e. analog components converging with the digital world. Rail users are expecting fully functional digital communication and information services travelling by rail. Fast diffusing telepresence technology trends are seen in many foresight studies as weak signals for less travelling in the future, or for reducing travel at peak hours by teleworking and getting more independent of conventional working hours. At the same time these technology trends are an argument for using rail for doing communication and work before reaching the office. Trams and trains are further converging in particular in urbanized areas and with regional rail into tramtrain concepts. This technology trend is complemented by a trend in high speed rail, at least in network oriented HSR systems, converting particularly intercity relations to express trains for long distance commuting either daily or weekly at weekends.

From a technological point of view innovation is expected to bring more energy and resource efficient systems for rolling stock and infrastructure with direct inpact in overall performance and capacity. Integrated services for ticketing, traveler information and guidance including in case of disruption are expected to be implemented throughout Europe by 2050. Quality and safety and security management systems are foreseen to be harmonized across Europe to keep up with the promise of an interoperable European wide rail system, at this time. Due to public budget constraints most cost effective and lean solutions are expected to warrant rail services in the future.

Semi and fully automated and alternatively propelled cars are seen to be a major trend towards 2050 and thus a competitor to electrified rail transit at least on parallel ring routes around city centers. Bus rapid transit systems are also gaining popularity as a cheaper alternative to rail mass transit. However, in the dense and urbanized metropolitan areas of tomorrow it is still expected that rail mass transit will be a major trend; this to prevent congestion and reduce spatial burden caused by moving and parked cars. Increased occupancy in individual cars and cycling and walking are seen adoptions to ease mass transit in peak hours. Sustainable mobility actions with local climate policies driving carbon emission reduction in cities and city regions are routing modal shift towards public transport and rail transport and thus integration in urban mobility policy plans. Park and ride and other commuting facilities are completed to constrain car travel to inner city centers in line with parking and access restriction schemes expected for most urbanized areas. These city development strategies are enhancing as well the long distance rail

demand trend by making car travelling in intercity relations much less comfortable, than years ago.

4.9 European Policy and Governance

The European Union as federal system in 2050 has finally its Constitution. Policy authority regarding rail regulation and standardization is at the European level, while rail infrastructure policy although coordinated by European policy is still authorized at member states and regarding urban rail at the local and the regional level. This is due to the European Union also in 2050 not having major tax revenues and thus staying fully dependent on public budgets allocated to the Union by member states. The European rail area will be built upon a network of rail networks which are thoroughly connected and interoperable. Towards 2050 it is expected that a growing budget share will be earmarked to complete a European rail area driving a powerful European shift to rail policy strategy.

Rail research and innovation policies at the European level are strongly driven by the idea to strengthen European rail industries in competing rail markets. On the other hand rail research and innovation policies are progressing to encourage a European wide shift to rail strategy considering increasing restrictions to road transport and European wide policies towards phasing out conventionally fuelled vehicles in urbanized areas. High rail research and innovation budget shares are still available among member states. This budget is dedicated to solving actual rail and network related problems and is mostly managed under public procurement rules and not research funding regulations.

To coordinate efforts beyond Europe includes having additional international partners involved. It is expected that beyond the focus on a Joint Technology Initiative (JTI) and underpinning Joint Research Initiatives (JRI), Joint Programming Initiatives (JPI) will also be further advanced to strengthen a European rail area. Education in the rail sector will be strongly competing with education and training in other areas. New comprehensive training solutions are a visible trend. Therefore, regarding futures of rail training and education it is expected that with smaller young populations this area has to be internationalized, e.g. via the virtual European University of Railway (EURAIL).

5. Conclusions

Rail transport demand is steadily growing in Europe and the expectation is that under the policies of the 2011 Transport White paper that growth will accelerate. Most transport freigth growth till 2050 shift to rail along intermodal transport chains while rail passenger transport demand strongly grows in urban areas and regional level in, to and between large cities and other urban areas.

The Commission's impact assessment of the White Paper suggests roughly a doubling of passenger and freight demand by 2050 and so does the *Vision for Railways in 2050* (OECD/TIF, 2010) with rail freight 2050 by 180% and rail passenger 2050 by 197% (ref. 2005). Some demand forecasts, suggest that the growth will need to be much higher to reach the target of rail being the main mode for long distance freight and medium distance passenger transport, as total demand is driven upwards by economic growth, continued globalisation and European internal market integration.

Considering the fact that forecasts are not directly comparable because of the precise variations in key input parameters and scenario characteristics, different modal and distance disaggregations and time time periods, we can learn by systematising economical, social, technological, regulatory and political trends and drivers from this Deliverable D2.2.

While corporate visions are reflecting particular strategic intentions, FosterRail could be understood to pave the way ahead and to try to channel the visions and strategies of the European rail stakeholders involved. We should be aware, that this attempt with generic outcome may be too ambitious, since not all relevant actors are involved in the process. Furthermore factors with regard for setting up rail business scenarios, variatons can be taken regarding GDP growth and related transport growth.

Demographic change and changes in lifestyles will be important influences on transport demand. The number of elderly (including especially 80+) people will grow to 2050 with increasing public investment in health and care services. Elderly will use trains more frequently in particular in urban areas and for long distance journeys. On the other hand aging society's behaviour can vary respectively to disparities of household income and quality of life.

Although economic forces will continue to determine how the transport modes compete, it is likely that external costs, especially carbon emissions but also congestion and safety will play a larger role in the future of the sustainable transport system and of the prominent role assigned to the rail system.

While GDP is not the sole driver of demand, policy measures and managerial innovation complementing to technical innovation can lead to nontrivial variations in rail demand growth.

Implementing major factors and criteria as outlined in the current Deliverable D2.2 and identifiyng key influences to the rail business scenarios help to support a clear transport policy and guideline for capacity, efficiency, social and user quality services by

- Enabling economic growth and welfare
- Tackling the grand challenges
- Looking at transport what is does for us and sometimes to us
- With the primary ″game changer″ for railway to be the carbon capture.

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