

TRANSvisions

Contract A2/78-2007: Report on Transport Scenarios with a 20 and 40 Year Horizon

Final Report

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Table of Contents

1	Executive summary	11
1.1	Outline of study	11
1.2	Transport structure and trends	12
1.3	Policy packages	13
1.4	Social impacts of transport	14
1.5	Policy aims and objectives.....	15
1.6	Policy synthesis	16
2	Introduction	19
2.1	Overview	19
2.2	The overall project approach	20
2.3	Scenarios	22
3	Transport drivers	25
3.1	Introduction	25
3.2	External transport drivers.....	26
3.2.1	<i>Population, households and urbanisation</i>	26
3.2.2	<i>Economic development</i>	28
3.2.3	<i>Social change</i>	36
3.2.4	<i>Energy trends</i>	38
3.2.5	<i>Technological trends</i>	45
3.3	Internal transport drivers	48
3.3.1	<i>Development and use of Infrastructure</i>	48
3.3.2	<i>Environmental trends</i>	53
3.4	The results of the DELPHI survey	57
3.5	Policy drivers.....	61
3.5.1	<i>Sustainable Development Strategy</i>	61
3.5.2	<i>EU transport policy</i>	61
3.5.3	<i>Enlargement and cohesion policy</i>	63
3.5.4	<i>Environmental and climate policy</i>	63
3.5.5	<i>EU trade policy</i>	65
3.5.6	<i>Security policy</i>	65
3.5.7	<i>Policies in a long term framework</i>	65
3.6	Summary and conclusions.....	66
4	Definition of scenarios	71
4.1	Introduction	71
4.2	Methodological issues in scenario analysis.....	72
4.2.1	<i>The TRANS-TOOLS model</i>	72
4.2.2	<i>Paradigm for 2030 scenarios</i>	73
4.2.3	<i>Differences between foresight and forecast approaches</i>	74
4.2.4	<i>Interface of scenarios</i>	75
4.3	TRANS-TOOLS scenarios for 2020 and 2030	75
4.3.1	<i>Introduction</i>	75
4.3.2	<i>Overview of scenarios</i>	76
4.3.3	<i>Baseline</i>	77
4.3.4	<i>High Growth Scenario (Sustainable Economic development)</i>	84
4.3.5	<i>The Low Growth Scenario</i>	91
4.4	The four exploratory scenarios for 2050	93
4.4.1	<i>Introduction</i>	93
4.4.2	<i>Global reference scenario</i>	95
4.4.3	<i>“Moving Alone” or Induced mobility scenario</i>	96
4.4.4	<i>“Moving Together” or Decoupled mobility scenario</i>	97
4.4.5	<i>“Moving Less” or Reduced mobility scenario</i>	98
4.4.6	<i>“Stop Moving” or Constrained mobility scenario</i>	99
4.5	The Meta-Models approach.....	101
5	Model predictions and evaluation	109
5.1	Introduction	109
5.2	The TRANSvisions MCA	109
5.2.1	<i>Introduction</i>	109
5.2.2	<i>“Traditional” transport indicators</i>	110

5.3	Quantification of TRANSvisions 2030 scenarios	112
5.3.1	<i>Details about 2030 scenarios</i>	112
5.3.2	<i>“Headline” trends in the exogenous 2030 scenarios</i>	112
5.3.3	<i>Freight Transport</i>	114
5.3.4	<i>Passenger transport</i>	119
5.3.5	<i>TRANS-TOOLS model limitations and possible improvements</i>	123
5.4	Policy tests for 2030 using TRANS-TOOLS	125
5.4.1	<i>Pricing Policy test</i>	125
5.4.2	<i>Test of an Infrastructure Policy Package</i>	127
5.5	Quantification of Meta-Models scenarios	129
5.5.1	<i>TRANS-TOOLS and TRANS-TOOLS Meta-Models</i>	129
5.5.2	<i>Metamodelling formulation</i>	130
5.5.3	<i>Calibration of TT Meta-Models</i>	131
5.5.4	<i>Elasticity of transport by type of trips</i>	138
5.6	CO ₂ emissions from 2005 to 2050.....	140
5.6.1	<i>Assessments of transport CO₂ emissions in exploratory scenarios 2050</i>	140
5.6.2	<i>Impact of economic growth on CO₂</i>	142
5.6.3	<i>Impact of technology on CO₂</i>	145
5.6.4	<i>Impact of speed limits and car technology (EURO V directive) on CO₂</i>	146
5.7	Policy backcast analysis 2050-2005.....	148
5.7.1	<i>Policy backcast exercises</i>	148
5.7.2	<i>How to achieve CO₂ targets in the Decoupled (Moving Together) scenario? ...</i> 148	
5.7.3	<i>How to achieve CO₂ targets in the Induced Mobility (Moving Alone) scenario?</i> 151	
5.7.4	<i>Summary of backcast results</i>	153
5.8	Policy packages for 2020, 2030 and 2050	155
6	Further issues concerned with trends and challenges	161
6.1	Introduction	161
6.2	Social sustainability	161
6.3	Social aspects of passenger transport	164
6.3.1	<i>Passenger transport: Urbanisation and transport</i>	164
6.3.2	<i>Passenger transport: Holiday/leisure travel</i>	165
6.3.3	<i>Mobility of the elderly</i>	166
6.4	Challenges identified by a broad scenario analysis.....	168
6.4.1	<i>Comparison of TRANSvisions exploratory scenarios with other foresight scenarios</i>	168
6.4.2	<i>Challenges</i>	172
6.5	Highly disruptive events.....	173
6.5.1	<i>Economic disruptions</i>	174
6.5.2	<i>Environmental disruptions</i>	175
6.5.3	<i>Social/political disruptions</i>	176
6.5.4	<i>Other types of disruption</i>	177
6.6	Summary and Conclusions.....	177
7	Long-term aims and objectives for European Transport Policy	179
7.1	Introduction	179
7.2	Sustainable Development Strategy (SDS)	179
7.2.1	<i>Overall aims</i>	179
7.2.2	<i>Transport aims and objectives of the SDS</i>	180
7.2.3	<i>Transport instruments in the SDS</i>	183
7.2.4	<i>Comparison with transport elements of EU treaties</i>	184
7.3	2001 White Paper	185
7.3.1	<i>Introduction</i>	185
7.3.2	<i>Aims and objectives in the 2001 White Paper</i>	185
7.3.3	<i>Policy instruments in the White Paper</i>	187
7.4	Mid-Term Review of 2001 White Paper: Keep Europe Moving.....	187
7.4.1	<i>Introduction</i>	187
7.4.2	<i>Aims and objectives</i>	188
7.5	Discussion of EU Transport Policy aims and objectives in the light of trends and challenges	189
7.5.1	<i>Decoupling: political issues</i>	189
7.5.2	<i>Decoupling: methodological issues</i>	189

7.5.3	<i>Demand management</i>	190
7.5.4	<i>Technological optimism</i>	190
7.5.5	<i>Optimism concerning continuity</i>	191
7.6	Suggested aims and objectives for European Transport Policy.....	191
7.6.1	<i>Aims of European Transport Policy</i>	191
7.6.2	<i>Objectives</i>	191
7.6.3	<i>Quantitative targets</i>	193
8	Policy Instruments to Meet Long Term Aims and Objectives	195
8.1	Introduction: classification of instruments and packaging of instruments.....	195
8.1.1	<i>Overview</i>	195
8.1.2	<i>Classification of policy instruments</i>	195
8.1.3	<i>Packaging of instruments</i>	196
8.1.4	<i>TRANSvisions case studies</i>	197
8.2	Participatory instruments.....	200
8.2.1	<i>Consultations on a European level</i>	201
8.2.2	<i>Consultations at a lower level of governance</i>	201
8.3	<i>A priori</i> set of policy instruments.....	207
8.3.1	<i>Description of instruments</i>	207
8.3.2	<i>Relationship of a priori instruments to objectives in Chapter 7</i>	211
8.3.3	<i>Current Commission actions with respect to social sustainability</i>	215
8.4	Division of labour between political jurisdictions.....	216
8.5	Summary and Conclusions.....	217
	References	221
Annex 1	Foresight scenarios from other studies	223
Annex 2	Pathways to 2050	227
Annex 3	Information relevant to generic challenges	230
Annex 4	ACTION PROGRAMME of the 2001 White Paper	232
Annex 5	Backcast Scenarios to Achieve CO₂ Targets 2005-2050	236
Annex 6	Policy assumptions in the exploratory scenarios	240
Annex 7	2005-2050 Meta-Models results	241

List of tables

Table 2.1 Correspondence between scenarios	24
Table 4.1 Overview of assumptions in the TRANSvisions' TRANS-TOOLS scenarios ..	77
Table 4.2 - Description of global reference scenario and four exploratory scenarios	103
Table 5.1: Headline values of indicators for 2005, the 2020 and 2030 Baseline Scenarios, and the 2030 High Growth and Low Growth Scenarios, as calculated by TRANS-TOOLS (using REMOVE indicators to calculate CO ₂ emissions)	113
Table 5.2: Freight transport by road and rail in EU in 2005 and 2030, in billion tonnes-kms, disaggregated by distance class	114
Table 5.3: Road pricing charges applied in Pricing Policy Test	125
Table 5.4: Values of headline indicators for the Pricing Policy test.....	126
Table 5.5: Values of headline indicators for the TEN test	128
Table 5.6 Comparison of Pocketbook and TRANSvisions CO ₂ emissions	137
Table 5.7 CO ₂ emission reduction for different policies.....	148
Table 5.8: Parameter variation on the Decoupled Mobility backcast scenario.....	149
Table 5.9: Parameter variation on the Induced Mobility Backcast scenario.....	151
Table 5.10: CO ₂ emissions reduction within EU27	154
Table 5.11: Values of indicators defined in the policy packages.....	156
Table 8.1: Classification of policy instruments.....	196
Table 8.2: Formal requirements for consultation in a selection of EU countries	202
Table 8.3: Mapping of <i>a priori</i> policy instruments with objectives for an economic sustainability aim.....	212
Table 8.4: Mapping of <i>a priori</i> policy instruments with objectives for an environmental sustainability aim.....	212
Table 8.5: Mapping of <i>a priori</i> policy instruments with objectives for a social sustainability aim	213

List of figures

Figure 2.1: Overall structure of TRANSvisions project	21
Figure 3.1: Constant Travel Time Budget.....	28
Figure 3.2: GDP growth rate by European country	30
Figure 3.3. World Trade as % of GDP + Shares of World Exports (1870 – 1998), China/India, OECD and Rest of World	31
Figure 3.4 World Trend Labour Productivity Growth Rates: 1991-2003	32
Figure 3.5 Growth in the volume of world merchandise trade and GDP, 1997-2007 Annual % change	33
Figure 3.6 Evolution of transport demand and GDP EU-25 (1995=100).....	35
Figure 3.7: Transport activity growth in EU, 1990-2030	36
Figure 3.8 Use of oil by sector, 2005.....	38
Figure 3.9 Development of energy demand by main sector 1990 - 2030	41
Figure 3.10 Energy Efficiency Indicators for Road Transport.....	42
Figure 3.11 World Exports as a Share of Global GDP: Highly Sensitive to Oil Prices.....	44
Figure 3.12: Average costs of passenger travel (in 1990 euro per km)	50
Figure 3.13 Transport vehicle CO ₂ emissions by regions	55
Figure 4.1. Population growth 2030 against 2005 in EU27, Baseline	78
Figure 4.2. Population development by age group 2005 – 2030, Baseline.....	79
Figure 4.3. Development in GDP per capita in constant prices, 2005 – 2030, Baseline..	79
Figure 4.4. Development in passenger cars per 1000 inhabitants, 2005 – 2030, Baseline	80
Figure 4.5. Oil price development 2005 - 2030	80
Figure 4.6. Road infrastructure development in Baseline, 2030	84
Figure 4.7. Rail infrastructure development in Baseline, 2030.....	84
Figure 4.8. Population 2030 High Growth compared to baseline.....	85
Figure 4.9. Population by age group 2030:High Growth compared to Baseline	86
Figure 4.10. Car ownership (passenger cars per 1000 inhabitants) 2030; Baseline, High Growth and Low Growth	87

Figure 4.11. Road infrastructure development in the High Growth Scenario compared to baseline, 2030.....	89
Figure 4.12. Rail infrastructure development in the High Growth Scenario compared with Baseline, 2030	89
Figure 4.13. Road infrastructure development in High Growth Scenario Alternative compared to High Growth Scenario, 2030	90
Figure 4.14. Rail infrastructure development in High Growth Scenario Alternative compared to High Growth Scenario, 2030	90
Figure 4.15. Population by age group 2030: Low Growth compared to Baseline	91
Figure 4.16 Consolidation of four exploratory scenarios of future transport in Europe	94
Figure 5.1. Effect on growth in trade volumes based on a 10 % growth in GDP	116
Figure 5.2: Breakdown of short distance freight transport in south, north-centre and eastern zones by distance class (absolute levels) 2005 and 2030	117
Figure 5.3: Breakdown of passenger trips 2005 and 2030 by distance class	119
Figure 5.4: Geographical zones of passenger-kms for shorter distance classes (2030)	120
Figure 5.5 Growth in passenger-km by mode and distance	121
Figure 5.6: Long distance trips (>100km) and change in GDP	121
Figure 5.7 Population within EU-27 (permanent residents).....	131
Figure 5.8 Gross Domestic Product EU-27	132
Figure 5.9 Yearly Passenger-km for all motorised transport modes inside EU-27 (inland and air space)	133
Figure 5.10 Freight tonnes-km all modes inside EU-27.....	134
Figure 5.11 Rail passenger share (over long distance inland traffic) (passenger-km) ...	135
Figure 5.12 Rail freight share (over long distance inland traffic) (tonnes-km).....	136
Figure 5.13 % Direct CO ₂ emission reduction with TS1 and TS2 2005-2030	138
Figure 5.14 Passenger-km annual growth 2005-2030 comparison.....	139
Figure 5.15 Tonnes-km annual growth 2005-2030 comparison	140
Figure 5.16 Share of non-fossil fuelled vehicles (cars and trucks).....	141
Figure 5.17: CO ₂ relative reduction (g CO ₂ /km) on fossil fuel road vehicles	141
Figure 5.18: Annual total transport CO ₂ emissions (EU-27 inland, air and SSS).....	142
Figure 5.19 % Annual Gross Domestic Product growth in EU-27 according to prospective scenarios.....	143
Figure 5.20 % Annual Gross Domestic Product growth in EU-27 Different path starting with a recession period and having a fast recovery in 2020.....	144
Figure 5.21 Comparison between CO ₂ paths of Baseline scenario, depending on evolution of GDP	144
Figure 5.22 Direct CO ₂ emission reduction in 2020 within EU27 for two different sets of technology implementation paths	146
Figure 5.23 Average fuel consumption curve for the European car park at present and assuming a full implementation of the EURO V directive	147
Figure 5.24 Aggregated distribution of car-km by speed range in 2005 TRANS-TOOLS results	147
Figure 5.25: Reduction of CO ₂ emission rates on fossil fuel road vehicles for the Backcast Decoupled Mobility scenario.....	149
Figure 5.26: Share of non-fossil fuel road vehicles for the Backcast Decoupled Mobility scenario	150
Figure 5.27: Rail freight share over long distance inland traffic for Decoupled Mobility Backcast scenario.....	150
Figure 5.28: Direct CO ₂ emissions for the Decoupled Mobility Backcast scenario	151
Figure 5.29: Reduction of CO ₂ emission rates on fossil fuel road vehicles for the Induced Mobility Backcast scenario	152
Figure 5.30: Share of non-fossil fuel road vehicles for the Induced Mobility Backcast scenario	152
Figure 5.31: Direct CO ₂ emissions for the Induced Mobility Backcast scenario.....	153
Figure 5.32: Direct CO ₂ emissions in the Backcast scenarios	153
Figure 5.33: Indirect CO ₂ emissions in the Backcast scenarios	154
Figure 5.34 Policy impacts on CO ₂ reduction in relation to Baseline emissions	157
Figure 5.35 Accumulated policy impacts on CO ₂ reduction in relation to Baseline emissions	157

Figure 5.36 Accumulated policy impacts on CO ₂ reduction in relation to 2005 emissions	158
Figure 5.37 Evolution of direct CO ₂ emissions for different policy packages	158
Figure 5.38 Evolution of direct CO ₂ emissions for the Baseline and all policy packages applied	159
Figure 6.1: Sustainable Livelihoods Framework (from DfID Guidance Notes).....	162
Figure 6.2: Impact pathway of ageing on leisure traffic	167
Figure 6.3: Economic sustainability versus social sustainability	170
Figure 6.4: Economic sustainability versus environmental sustainability	171

Abbreviations

AC	Accident Cost
ATM	Air Traffic Management
CAP	Common Agricultural Policy
CBA	Cost Benefit Analysis
CCA	Contraction and Convergence Agreement
CIEMAT	Center for Energy, Environment and Technological Research
BAU	Business as Usual
DfID	Department for International Development
DG-ECFIN	EC's Directorate for Economy and Finance
DOE	Department of Energy
DOT	Department of Transportation
EBCUs	energy-backed currency units
EC	European Commission
EEA	European Environmental Agency
EET	European Energy and Transport
EPOSS	European Technology Platform on Smart Systems Integration
ERTMS	European Rail Traffic Management System
ERTRAC	road transport research Platform
ETS	EU Emissions Trading System
EU ETS	European Union Emission Trading System
EU12	The Czech Republic, Cyprus, Hungary, Slovakia, Slovenia, Estonia, Latvia, Lithuania, Poland, Malta, Romania, Bulgaria
EU15	Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and United Kingdom, Austria, Finland and Sweden
HST	High-Speed Trains
ICT	Information and Communication Technology
ILO	International Labour Organisation
IPCC	International Panel for Climate Change
ISAS	Intelligent Speed Adaptation Systems
IT	information technology
ITS	Intelligent Transport System
IWW	Inland Water Ways
JRC	European Commission's Joint Research Centre
GDP	Gross Domestic Product
GHG	Greenhouse Gas
LOS	Level of Service
MCA	Multi Criteria Analysis
NCT	Neighbouring Countries in TRANS-TOOLS
NST/R	Standard Goods Classification for Transport Statistics (Nomenclature uniforme des marchandises pour les statistiques des transports)
NUTS	Nomenclature of Territorial Units for Statistics
OECD	Organisation for Economic Co-operation and Development
PB	Pocket Book
PPP	Public-Private Partnership
PSA	Plataforma Solar de Almería
R&D	Research and Development
RTD	Research in Transport Development
SDS	Sustainable Development Strategy
SEI	Global Scenario Group
TEN-T	Trans-European Network for Transport
SESAR	Single European Sky ATM Research
SLF	Sustainable Livelihoods Framework
SSS	short sea shipping
TEU	Treaty on European Union
TFEU	Functioning of the European Union
TFP	Total Factor Productivity

TREND	T owards new R ail freight quality and concepts in the E uropean N etwork in respect to market D emand
TT	TRANS-TOOLS
TS1	The first technological strategy
TS2	Technological Strategy 2
UCEs	Units of Carbon Entitlements
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
VOC	Vehicle Operation Cost
WTO	World Tourism Organisation/World Trade Organisation
WTTC	World Travel and Tourism Council

1 Executive summary

1.1 Outline of study

The **purpose** of the study is to provide technical support to a debate on **transport scenarios with a 20- and 40- year horizon**, *inter alia*, by collecting and analysing information on transport long-term scenario forecasting, by developing long-term transport scenarios including modelling work and case studies, and by suggesting long-term objectives for the European transport policies.

A comprehensive discussion of the drivers related to transport has been carried out in the study, resulting in a subdivision of the drivers in question into: **external drivers**, that is drivers external to the transport sector, where five main categories of drivers were identified (population, economic development, energy, technology development and social change); **internal drivers**, that is drivers internal to the transport sector e.g. infrastructure, vehicles and fuel development and transport impact on environment and society; and finally **policy drivers**, that is broad policy responses which affect the evolution of the transport system, and in particular the governance of the transport sector.

It is assumed that policies now under discussion, and today's emerging technologies, will still be important in 2030. But we don't know how transport will develop towards 2050. Many policies and technologies to be applied in 2050 do not exist today. Hopefully vehicles will be cleaner and more intelligent, and maybe on-line pricing and traffic management will reduce the difference between public and private transport, thus making door-to-door trips equally attractive. So the categories we use today as "transport modes" may not be relevant in forty years time. In order to somehow explore these and many other uncertainties, TRANSvisions carried out an intensive research of "seeds", defined as current developments all over the world that, even if embryonic, may show starting points of changes that may have an huge impact in the future.

A number of different **exploratory scenarios** for 2050 have been formulated based on the identified drivers. The scenarios are formulated as different paths towards a post-carbon society. These scenarios have been named: "Move Alone" (Individualistic transport, technology, supply management and market spontaneous self-organisation); "Move Together" (pricing and modal shift, land planning, emphasis on cohesion); "Move Less" (behavioural policies and regulation, lifestyle changes, priority to local production); and "Stop Moving" (society initially puts a strong emphasis upon technology, but when breakthroughs do not take place it falls back on regulation and banning activities).

Scenarios have also been developed for 2030. These are fitted to the use of EC's transport model TRANS-TOOLS in the sense that the scenarios are established based on the main inputs for the TRANS-TOOLS model. Such inputs include: socio-economic input (population, GDP development, work places); transport policy input (change in vehicle operating costs, fares and transport costs for different transport modes); and network input (links and nodes and data related to these). Three scenarios have been set up: "Baseline", "High Growth" and "Low Growth".

An important aspect of the study has been to analyse different transport policy options to obtain reductions of the transport sector's CO₂ emissions by arbitrarily set targets of 10 % in 2020 and 50 % in 2050, compared to 2005. The main tool to accomplish this analysis has been the use of "Meta-Models", developed by the project for this particular purpose.

Meta-Models comprise sets of interdependencies between exogenous input and resulting output, mainly in the form of elasticities between two or more variables. The Meta-Model specification makes it possible to address the particular problems under investigation and it is possible to establish a model which enables analysis of the effect of different policy options on specific transport and environmental indicators. The Meta-Models applied in this study have been calibrated against TRANS-TOOLS results for 2005 and 2030.

It is emphasised that while TRANS-TOOLS is a forecast model based on a detailed description of the present (2005) situation, the Meta-Models are less accurate and their main application is in foresight studies e.g. providing transport indicators for the exploratory scenarios mentioned above.

Different policy options have been analysed with the TRANS-TOOLS model for 2030 and with the Meta-Models in 2020, 2030 and 2050.

Based on the results of the quantitative analysis and a thorough investigation of policy documents issued by the EC, a number of conclusions of the study were made, which are now presented.

1.2 Transport structure and trends

The policy analysis included the specification of policy packages aimed at reducing Greenhouse Gas emissions in Europe, with particular emphasis on CO₂. In order to do this a detailed analysis of the development of the structure of transport in the EU was carried out based on statistics and TRANS-TOOLS results. The following overall conclusions can be drawn:

Total passenger motorised transport with origin and/or with destination in EU27 (measured in passenger-km) will keep growing along existing patterns. A basic constraint which is expected to continue to prevail in the future for all scenarios is that the average time spent on transport per day per person is about one hour and that approximately 15% of personal available income is allocated, on average, to personal transport. Depending on GDP per capita and the evolution of transport costs, passengers will travel more or less (in passenger-km). This reflects the fact that personal mobility is not only driven by economic considerations. While daily commuting trips may remain stable, business, personal visits or leisure trips abroad will show more variation.

Road traffic is still expected to remain the dominant transport mode in passenger transport although it will lose some market share to the benefit of railways.

The relationship between passenger transport (passenger-km) and GDP depends very much on the type of trips made. When considering trips made by EU27 citizens inside the EU27 territory the expected growth in transport is less than the growth in GDP. The same result is valid if non-EU citizens' transport inside the EU is added to the transport carried out in the EU territory. However, when EU27 citizens' travel outside the borders of EU is added, the expected transport growth (passenger-km) is faster than the EU GDP growth. And the population of the transition countries (e.g. China, India, Russia) is expected to bring about further long-distance travel to and from the EU.

Total freight motorised transport with origin and/or with destination in EU27 (measured in tonnes-km) will keep growing following previous patterns, following the overall growth of the economy for all scenarios, but the elasticity to GDP growth will depend on the scenarios.

The freight transport elasticity towards GDP depends very much on the types of movement considered. National transport has a low elasticity, while export and import in tonnes-km inside EU show growth rates more in line with GDP growth. The development of freight transport is even faster if neighbouring countries are included, in particular because the import of crude oil and oil derivatives from Norway and Russia are linked to economic development. When overseas trade is included, the growth rates of tonnes-km are increasing considerably more than the EU GDP.

In relation to freight, road transport may also be losing shares, but just marginally.

It is expected that Short Sea Shipping will continue to grow in Europe in line with over-seas traffic. Therefore transshipments hubs and secondary ports in Europe may become more important in their regional hinterlands.

The footprint of Europe in the rest of the world measured in terms of CO₂ direct emissions due to freight and passenger transport activities is already high, just a bit smaller than emissions generated inside the EU. Therefore, it is absolutely necessary to think more of European transport as an activity that European citizens and companies do at world level, and not only within Europe.

1.3 Policy packages

Five different groups of policy instrument were defined. The groups were:

- **Infrastructure**; development of new infrastructure in order to improve cohesion, accessibility and reduce congestion. However, it should be acknowledged that a majority of large infrastructure is in place today. If a new type of vehicle is invented, new infrastructure can be established relatively fast, as was demonstrated with the European High Speed Train system. EU has the possibility to influence infrastructure development.
- **Technology**; development of new or improved technology in the transport field. This includes development and improvement of vehicles using other types of fuel than fossils, but it also includes development of automotive technology, less fuel consuming technology, and integration and application of IT. EU has got limited possibilities for influencing this policy area (such as support to Research and Development, and framework conditions for introduction and use of new technology).
- **Economic**; this is an area where a number of transport policy initiatives are being carried out, including infrastructure charging and internalising external costs.
- **Regulatory**; development of legislation and regulations monitoring traffic, vehicle performance, working hours, and land use and planning regulations
- **Participatory**; instruments concerned with citizen involvement, for example in the planning of new infrastructure

Analyses were carried out, using the TRANS-TOOLS model, of two policy measures: Pricing of passenger cars on interurban roads and development of infrastructure networks. For the 2030 time horizon, the pricing measure led to a predicted reduction in CO₂ emissions, whilst the infrastructure measure led to a predicted increase of CO₂ emissions. In general though, the impacts of these policy measures (for 2030) on transport levels and CO₂ emissions was very limited in comparison to the impacts resulting from socio-economic changes, such as population development and economic development. The infrastructure improvements were mainly related to interurban road and rail development, and it is likely another result would have been reached if the improvements had been directed towards urban areas.

Analyses were also carried out with the Meta-Models testing four policy packages involving combinations of instruments from each of the first four of the policy instrument groups above. The aim of these tests was to examine the potential of the packages for reducing CO₂ emissions, and in particular for meeting two arbitrarily set targets involving the reduction of transport-related CO₂ emissions reductions by 10% in 2020 and by 50% in 2050. (The first of these targets was inspired by the existing targets for non-ETS sectors as a whole, since no specific targets exist for transport.)

The analysis shows that by combining different policies it is possible to meet these targets.

The policy packages involve:

- Technology: Vehicle technologies, reducing CO₂ emission limits for new vehicles and the introduction of non-fossil fuelled vehicles
- Regulatory: A reduction of vehicle speeds in roads and motorways and increase in rail urban transport
- Economic: Use of pricing mechanisms to increase occupancy rates and load factors
- Infrastructure: Selective road investments in congested road links.

All of these measures were tested against a baseline that includes measures already "in the pipeline" such as: ETS for aviation; CO₂ emission limits for cars; and the internalisation of external costs for lorries.

According to the analysis the most effective measures concern vehicle technologies and pricing to increase occupancy rates. The measure concerning reduction in vehicle speeds and improvement of public transport is moderately effective. The construction of new roads is the least effective, but still it may bring CO₂ reductions due to the reduction in congestion.

The conclusion of these tests is that with the application of a combination of these policy instruments it is possible to meet these targets in all the analysed exploratory scenarios. The analysis shows that, in the long term, technology and/or changed behaviour will have an important effect on reducing CO₂ emissions, whereas more traditional transport policy measures are necessary in order to fulfil the 2020 target.

1.4 Social impacts of transport

It has previously been agreed at a high level that transport policy making in the EU should take into consideration the following sustainability impacts: economic, environmental and social. The first two such sustainability impacts are relatively straightforward to quantify and are thus generally included in practical policy evaluation. However, the third type of sustainability impact is often "forgotten". It is therefore suggested that more emphasis in transport policy-making should be put on the **social sustainability impacts** of transport. In doing so, the concept of **social capital** is useful, providing an indication of "social strengths that need to be sustained". Social capital can be understood as having two main components: **social cohesiveness** and **political capital**, which are described as follows:

Social cohesiveness considers the cohesiveness of communities on both local and EU-wide levels. It is understood that such cohesiveness includes both a "collective dimension" concerning how well the community "binds together", as well as providing the basis for the "self-realisation" of individuals within the community (thus removing obstacles to individual and community self-empowerment). Social cohesiveness can be understood in the sense of "capacity to withstand threats". With respect to the transport sector, such threats arise from:

- (i) Differences in mobility opportunities between different social groups and between different regions of the EU, leading to problems of social exclusion. "Mobility" here can be understood in both the sociological sense of the "possibility for change in lifestyle and/or employment" as well as in the transport sense of "the physical means of movement by which such change might be facilitated".
- (ii) Differences in accessing "local facilities" (jobs, education, healthcare), where those individuals with difficulties in this respect being required either to travel more than they would desire or be forced (against their wishes) to migrate to another location. This type of mobility will be classified as "coerced mobility".

- (iii) A range of transport-related "security" problems resulting from tensions in society, including phenomena such as fear of walking alone or the threat from terrorist attacks on transport targets (planes, airports, trains, buses etc).

Apart from such threats, social cohesiveness also comprises an element concerning the "likelihood of citizens to treat each other with respect". In terms of the transport system, such respect leads to "polite behaviour", examples of which are: drivers voluntarily giving way to other drivers at road junctions (in accordance with local norms and rules); and drivers stopping their vehicles to allow pedestrians to cross the road.

In general, it is useful to distinguish between social cohesiveness impacts of transport that are **internal** or **external** to the transport system, with these terms being explained as follows:

- Internal social impacts of transport are those that affect individuals as "participants" in the transport system, as passengers or as transport workers. Policies which improve the experience of such participants, such as the enhancing of passenger rights or the raising of minimum working conditions for transport workers, have an impact on the overall social cohesiveness of society.
- External social impacts of transport are those that are experienced "outside" the transport system. For example, the impact of the transport system in terms of the possibility of accessing facilities (as mentioned above) would be an external social impact.

The concept of **political capital** is closely tied with the concept of social cohesiveness. Political capital emphasises the capacity of the community, and individuals within the community, to take control (in a political sense) over their everyday lives and futures. In particular, with respect to the transport system, two "levels" of political capital can be considered:

- (i) At the local level, political capital involves the amount of public participation in (and hence democratic control over) transport policy-making. With regard to such participation, political capital also involves the freedom of individuals to be able to express diverse points of view.
- (ii) At an EU level, political capital concerns the political strength of the EU as a transnational community and the resulting benefits for EU citizens when interacting with the rest of the world.

1.5 Policy aims and objectives

Various EU policy documents have been examined with respect to their stated aims and objectives. As a result of this review, the following **aims** are suggested by TRANSvisions:

- (1) To ensure that our transport systems meet society's economic, social and environmental needs whilst minimising their undesirable impacts on the economy, society and the environment.
- (2) To ensure that our transport systems are sufficiently resilient to be able to meet the future challenges presented by an uncertain world.

Furthermore, the following **objectives** are suggested, corresponding to the three axes of sustainable development (economic, environmental and social):

Economic sustainability

- Two objectives concerning the ability of the transport system to:
 - Contribute to **economic growth**
 - Contribute to **generation of employment**
- A further objective concerned with **reduction and avoidance of congestion**.

Environmental sustainability

- Three objectives concerned with the reduction and avoidance of
 - **climate change** effects by reducing greenhouse gases
 - harmful **local pollutants**
 - **noise** nuisance from transport
- Protection of **environmentally-sensitive areas** from transport encroachment

Social sustainability

- Reduction and avoidance of **fatal and serious accidents**
- Provision of **accessibility** to opportunities/services
- Enhancement of **social cohesion**, including the reduction of social and territorial exclusion
- Enhancement of political capital through the encouragement of a **participatory approach to transport planning**
- Enhancing the **rights of travellers** to good quality transport provision
- Attaining and maintaining **high quality standards of employment** within the transport sector

1.6 Policy synthesis

As described above, two types of modelling test have been carried out: “traditional” modelling of specific instruments using TRANS-TOOLS; and a “lighter” type of modelling of generic instruments using the Meta-Models. The TRANS-TOOLS modelling tests have been restricted to instruments that are implemented at a high (EU) level of governance (instruments concerning EU interurban road pricing and the Trans European Networks). The tests using Meta-Models have involved instruments that can be implemented at various different levels of governance, including urban. Both types of test have concentrated upon predicting the CO₂ impact of policy instruments.

A number of further “non-modelling” analyses of transport policy instruments have been made from a variety of methodological perspectives, putting particular emphasis on the social sustainability dimension of policy-making, as defined above. These analyses have ranged from theorising about participatory instruments to illustrative “real-life” examples of a variety of specific instruments, as given in the TRANSvisions case studies. Furthermore, a set of *a priori* instruments has been presented, which generally represent a “continuity” approach to EU policy instrument formulation.

The main conclusions from the synthesis of both modelling and non-modelling activities are:

- When formulating policy instruments for meeting specific aims, it is useful to think in terms of the creation of policy packages, where such a package is a combination of a number of instruments that are synergetic, or at least complementary, in their overall impact. In particular, packages can help ensure that the negative aspects of particular instruments can be offset by the positive aspects of other instruments in the package. When considering such complementary and compensatory effects, it is useful to think in terms of “instrument-types” (listed above as infrastructure, technology, economic, regulatory and participatory instruments).
- With respect to the reduction of CO₂ emissions, the model results show that options are limited if only those instruments are considered which can be implemented as a high level of governance (such as those in the TRANS-TOOLS tests). Large reductions in CO₂ emissions need to involve instruments that can be implemented at a variety of levels of governance, including urban (such as in the Meta-Models tests). In the specific context of European Transport Policy, this result has important consequences for subsidiarity issues. Furthermore, it is likely that an important contribution to the reduction of CO₂ emissions will come from “emerging technology” instruments (with a large number of such instruments being described in further detail in the TRANSvisions Case Studies). Given that new technology is invented and developed through the combination of a variety of factors, it can be seen that the implementation

of technology instruments is not as straightforward (in a policy formulation sense) as the implementation of certain other types of instruments (such as road pricing or building new infrastructure). However, the EU can take a variety of actions to help the implementation of such instruments, where such actions can be classified under two general headings. Firstly the EU can provide financial support to help research and development of new technology. Secondly, once such technology is available, the EU can help its introduction through a variety of regulatory instruments and demonstration actions.

- Broadening the perspective from one focussing upon CO₂ emissions, it is clear that transport is an extremely complex phenomenon, as shown by the many strands of results and analysis presented in the TRANSvisions study. Given this complexity it inevitably follows that any policy thinking concerning the long term future (over the next 40 years) must be “doubly complex”, given the uncertainties concerning the future. However, as is shown in this report, some aspects of the “long term transport problem” are reasonably well understood (for example some of the issues concerning different types of challenges). Furthermore, it is clear that transport policy needs to meet the overall goals of economic competitiveness and environmental sustainability. It is argued, though, that the “overall problem of transport policy” can be defined as being the fact that many other aspects of the transport system, particularly concerning social aims and issues, are not sufficiently well-understood, thus potentially giving an impression of fragmentation in much transport policy thinking.
- As stated above, it is suggested that transport policy-making puts more emphasis upon social sustainability, particularly concerning the “external social impacts” of transport policy (as opposed to “internal impacts” concerned with passenger rights and the working conditions of transport employees, which are well covered in terms of current EU policy-making). Arguably social sustainability concepts (social capital, social cohesiveness and political capital) can provide the “set of missing links” to overcome to fragmentation remarked upon above. One immediate use of such concepts is to provide a more nuanced understanding of the “restriction on freedom” criticism levelled at attempts to manage demand. Heightening focus upon social sustainability includes a recognition that some travel is unwanted/undesirable from the point of view of the people making the journey (e.g. they would prefer services to be closer to home).
- With respect to policy instrument formulation, packages of policy instruments need to be devised to meet objectives associated with the three dimensions of sustainability. Traditional transport policy instruments have generally not been devised with the purpose of meeting social sustainability aims and future instrument packages need to rectify this omission. Of particular interest here are those instruments that help reduce unwanted travel (by heightening accessibility through planning measures) and those instruments that help public participation in transport policy formulation.
- When devising policy packages, careful consideration needs to be paid to the level of government appropriate for implementing any particular instrument within the package. This in turn raises the issue of subsidiarity. In particular, due to the principles of subsidiarity, the EU has a limited role in urban policy-making. However, careful consideration should be made as to how the EU could expand upon its current role as a “facilitator of good practice”, for example by making clear that it is a champion of public participation in the local transport-planning (without trying to specify *a priori* which conclusions such local planning should reach).

2 Introduction

2.1 Overview

This report presents the final results of the TRANSvisions study. The aim of the study has been to assist the DG TREN in carrying out mid- and long-term analysis of different policy means to enhance the debate on transport policies. The study has analysed existing transport in order to identify drivers and changes in the transport structure, and translated the results into a modelling tool which has assisted in analysing the end-effects of different policy instruments. The study ended up with recommendations concerning transport policy issues to address in the coming years in order to meet aims concerning economic, environmental and social sustainability.

This introduction recapitulates the way the study has been structured, and provides a short reading guidance to this report.

The comprehensive study of drivers affecting the levels and structure of transport is described in **Chapter 3**. Not only are the drivers described, but a number of case studies are referred to in order to indicate future possible development paths. Based on the analysis of the drivers, scenarios have been formulated both for the mid-term (2020 and 2030) and for the long-term (2050). The description of the scenarios are quite different, because the mid-term scenarios have been formulated to fit with the EC transport model TRANS-TOOLS, which requires a limited number of variables (though in great detail), whilst the long-term scenarios have been formulated based on overall development traits, and are much more divergent. The scenarios are described in detail in **Chapter 4**.

The quantitative tests in the study have been carried out using the TRANS-TOOLS model and the newly-developed “Meta-Models”. TRANS-TOOLS has been developed for analysis of new infrastructure and EC transport policies on an European level, and has been used in many different projects. The Meta-Models are developed for the specific purpose of TRANSvisions and the analysis of long-term policy options. Therefore, there are major differences in the way the two model tools are specified. The discussion of the two models is carried out in **Chapter 4** while the presentation of results produced by them is described in **Chapter 5**.

Chapter 6 makes a further analysis (to that made in Chapter 5) of future trends and challenges, focusing upon issues that are not easily captured by the models. Whilst these issues are highly varied in nature, an underlying theme for most of them concerns “social sustainability”, which is described in terms of the concepts *social capital*, *social cohesiveness* and *political capital*. Such aspects of the transport system are typically not included in mid- and long-term assessments because proper methodologies for predicting and assessing social sustainability impacts are not available. Also the chapter touches on issues concerned with highly disruptive events, which also cannot easily be modelled, but which have an important impact on transport in real life, so that they need to be taken into account when formulating transport policy.

Chapter 7 carries out an analysis of currently-specified EU transport policy aims and objectives. As a result of this analysis, and based upon the results concerning trends and challenges in previous chapters, a new set of policy aims and objectives is suggested. Throughout the chapter it is emphasised that policy needs to be organised according to an “aims, objectives and instruments” structure in order to establish a proper framework for future policy development.

Following this structure, **Chapter 8** provides a number of insights into transport policy instruments, using a “multi-methodological” approach”, ranging from theorising about instrument types/packages to illustrative examples of specific instruments, as given in the

TRANSvisions case studies. A set of *a priori* instruments is presented, which generally represent a “traditional” approach to policy instrument formulation and a full description is given of various types of “participatory instrument” to support citizen involvement in policy-making. Finally, the chapter considers appropriate governance levels for the implementation of policy instruments, taking into account issues of subsidiarity.

The TRANSvisions project has been carried out by Tetraplan A/S (Copenhagen), as coordinator, together with ISIS (Rome), Mcrit (Barcelona) and the Institute for Transport Studies (Leeds) as the main partners. The Technical University of Denmark, BMT – Transport Solutions, Systema and Christian Albrecht University have played an important role in discussion of the project results, and provided assistance on specific topics, e.g. TRANS-TOOLS model runs and discussion of data and model short-comings.

The project has during its execution carried out a Delphi survey among experts on foresight studies in order to investigate the credibility of the established foresight scenarios. The Delphi survey was subsequently followed by an external expert seminar where the drivers for transport development and the scenarios were discussed. This workshop provided important material for the continuation of the study.

A number of meetings have been carried out with representatives from DG TREN and other Commission Directorates. These meetings have highlighted important aspects to include in the study, and have also led to important improvements of the specific task reports, and the models applied in the study.

The project has produced following reports:

TRANSvisions, Interim report 1, October 2008

TRANSvisions, Interim report 2, October 2008

TRANSvisions, Qualitative analysis, Task 1 report, February 2009

TRANSvisions, Quantitative analysis, Task 2 report, March 2009

The project has a web-site for transport futures (www.mcrit.com/transvisions). In order to access the website following password should be applied: connecting.

2.2 The overall project approach

The purpose of the study is to provide technical support to a debate on transport scenarios with a 20- and 40- year horizon, *inter alia*, by collecting and analysing information on transport long-term scenario forecasting, by developing long-term transport scenarios including modelling work and case studies and by suggesting long-term objectives for the European transport policies.

An overall illustration of the project is provided in Figure 2.1.

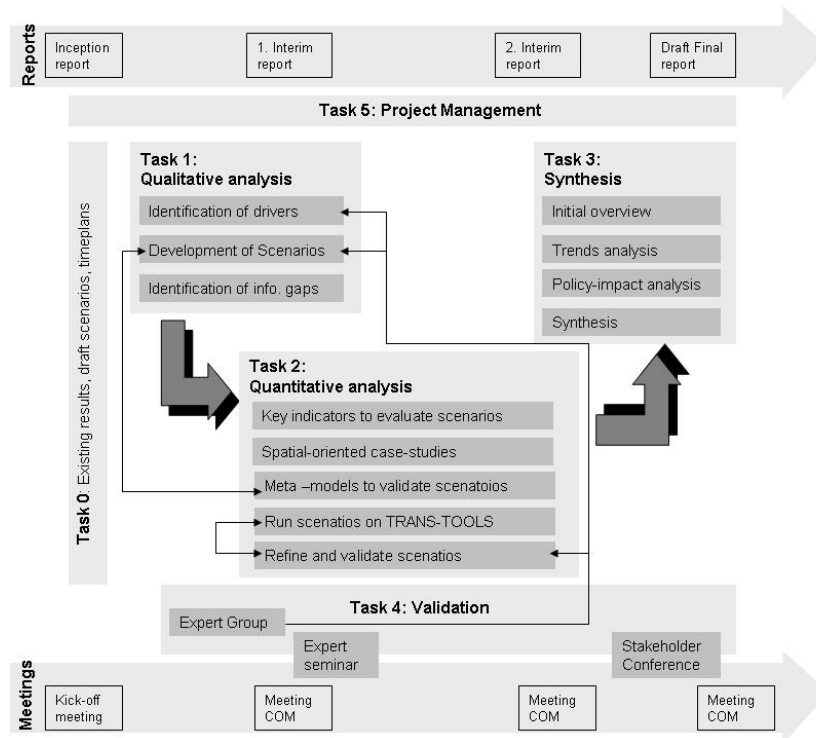


Figure 2.1: Overall structure of TRANSvisions project

A brief account of the different main tasks is provided in the following description.

Task 1 Qualitative analysis

Task 1 provides the scenarios that will form the basis for the analysis of policy recommendations of the project. The scenarios show a wide variety of development prospects for drivers of the transport demand for the EU and neighbouring countries. The scenarios are based on solid analysis of already existing studies and research projects, which has led to determination of main drivers of transport demand and their potential magnitude. To develop the scenarios, synoptic tables have been produced summarizing the description of the determinants and distinguishing the most predictable elements from those more uncertain. The results from Task 1 (both drivers and scenarios) are being utilised and refined through input from Task 2. To support the selection of the drivers and to assess their importance and predictability an External Expert seminar has been convened.

Task 1 also provides a brief overview of the most relevant existing statistical and informational gaps that influence the predictions of the future, and clarifies the assumptions that will have to be made to compensate for these gaps.

The outcome of Task 1 has formed the basis for Chapters 3 and 4 in the present report, where the drivers and the scenarios respectively are summarised.

Task 2 Quantitative analysis

The main outcome of Task 2 is to quantify the scenarios with a number of key indicators to ensure they include the right “mix” of drivers. Estimation is based on existing data, results from previous forecast exercises and educated guesses. The Meta-Models (developed on Microsoft EXCEL and ACCESS based on existing data and forecasts) have been used to validate the consistency of the qualitative scenarios, and to translate the output from the TRANS-TOOLS model into a calibrated foresight system. Meta-Models, different from conventional transport forecast models, do not include complex equilibrium algorithms, and sophisticated statistical calibrations. Meta-Models are mostly based on

elasticity functions adapted to policy-relevant indicators, or to key indicators more closely understandable by experts. Running Meta-Models is much faster than running large models, and therefore allows simulation of many alternatives and different scenarios.

Furthermore, Task 2 has also provided input to the streamlining of the scenarios through a number of detailed case studies, examining in more depth the effect for a number of representative regions, cities and transport modes. The goal of the case studies is not to provide a comprehensive coverage of territories and modes but to highlight the complexity and diversity of situations that cannot be totally included either in the qualitative or quantitative scenarios.

The Task 2 analyses provide the basis for Chapter 5. However, some of the case studies have been included in Chapters 3 and 8 in order to provide insights with respect to possible futures, describing examples of policy-making which are likely to be more common in the future.

Task 3 Policy Synthesis

The main outcome of the policy synthesis is a number of policy recommendations for the European Transport Policy based on the challenges and implications of the possible future transport demand developments. This task, therefore, is focused on “translating” the results of the scenario results into policy recommendations by identifying options that the policy-makers should consider.

A major challenge for formulating long term transport policy is that despite using the best technical modelling tools (as in Task 2) there is an inherent uncertainty about any long term predictions. To cope and measure this uncertainty, the “unforeseen” has been the focus of the analysis. Main structural trends that will affect transport demands have been identified, bearing in mind the obvious uncertainties that exist in predicting the future. The analysis addresses the problem of uncertainty whilst permitting the qualitative consideration of a wide range of possible futures that might deviate highly from central baseline scenarios. Included in the analysis are a number of “unexpected” potential future world developments that could have a severe impact on transport policy, like natural disasters, terrorism, worldwide recession or the invention of any currently unforeseen technology. All are developments that could drastically change the desire to travel or influence purchasing behaviour, so-called disruptive events.

Based on the analysis a number of long-term objectives for the European Transport Policy has been identified, focusing on the “problem” areas for which current policy is not sufficiently flexible to be able to cope with future potential challenges. Special focus is put on trade patterns and tourism, and social sustainability is also an important aspect of this analysis.

The synthesis in Task 3 has provided the basis for Chapters 6, 7 and 8 in the present report.

Task 4 Validation

The results of the Task 1 have been validated through an External Expert Seminar. The External Expert Seminar has been used to create professional consensus of the identified main drivers and determinants and their impact and predictability on the future transport demand. The results have fed into the work of defining the scenarios.

2.3 Scenarios

According to the terms of reference the exploratory scenarios are a tool for a qualitative analysis of possible future trends and developments in the transport sector. As such they

prepare the ground and provide the context for the quantitative analysis carried out through quantitative scenarios, developed in Chapters 4 and 5, which include (central) policy scenarios as well as a quantification of the (sideline) exploratory scenarios. Thus scenarios are an important part of the study.

The quantitative scenarios constructed are the following:

- A Global Reference Scenario (Main existing Commission Baselines)
- Two policy scenarios describing different ways to fulfil the some arbitrarily set Climate Change targets for transport for 2020 and 2050, that is a reduction of CO₂ emissions from transport of 10 % and 50 % respectively (back-casting)
- Two other policy scenarios aimed at investigating how transport demand is affected by different types of transport policies
- The quantitative versions of the four exploratory scenarios outlining the scope of transport development

Therefore there are two sets of scenarios:

- Qualitative Exploratory scenarios → Quantified exploratory scenarios (Meta-Models)
- TRANS-TOOLS baseline → Quantified policy scenarios (Trans-tools and Meta-Models)

The correspondence between these two sets of scenarios is set out in Table 2.1 below:

Terms of reference request	Final Report denomination	Quantitative analysis means
Business as usual	Global reference scenario	Trans-tools Meta-Models
+ Four possible policy scenarios (policy guiding scenarios)		
Backcasting climate change 1 -10% 2020 and - 50% 2050 transport CO ₂	Competitive linking to "Induced mobility" (Technological development)	Meta-Models and TRANS-TOOLS
Backcasting climate change 2 -10% 2020 and - 50% 2050 transport CO ₂	Cohesion linking to "Decoupled mobility" (Mobility reduction based on road pricing)	Meta-Models and TRANS-TOOLS
Policy scenario 1 High Growth, more infrastructure	Sustainable Economic development (High economic growth) linking to "Decoupled mobility"	Trans-tools up to 2030.
Policy scenario 2 Low growth, charges and pricing	Slow economic growth linking to "Reduced mobility"	Trans-tools up to 2030
+ A number of exploratory scenarios		
Exploratory scenario 1 Competitiveness	"Induced mobility" or "Move Alone"	Meta-Models
Exploratory scenario 2 Regulation and behavioural change	"Decoupled mobility" or "Move Together"	Meta-Models
Exploratory scenario 3 Pricing, planning and cohesion	"Reduced mobility" or "Move Less"	Meta-Models
Exploratory scenario 4 Technology failure	"Constrained mobility" or "Stop Moving"	Meta-Models

Table 2.1 Correspondence between scenarios

3 Transport drivers

3.1 Introduction

This chapter examines the main drivers shaping the transport system in a long-term perspective. The analysis will take into account both past trends and likely future developments of these drivers.

The aim of this exercise is twofold:

1. To provide the reader with information about the driving forces behind the different long term scenarios presented in the following chapters.
2. To identify the key variables and parameters which are used as exogenous input or drivers in the quantitative part of the study, involving the application of the TRANS-TOOLS transport model and the Meta-Models.

From the methodological point of view, the drivers which affect transport are classified as follows:

- **External drivers**, i.e. those driving forces which act on the transport system from the outside: energy, economy, demographic change, technological change, and social change.
- **Internal and impact drivers**, i.e. those driving forces which originate in the transport sector or arise as a consequence of the transport impacts on the environment, e.g. climate change.
- **Policy drivers**, taking into account the current global and EU context and possible future evolution of global and EU governance issues.

Concerning the sources of the analysis, these transport drivers have been analysed through a comprehensive literature review on scenarios and drivers both in Europe and abroad. This review has focussed primarily on a “long term perspective” involving the years 2030 and 2050. Furthermore, there has been a focus on the following drivers which influence volume and composition of transport demand:

- demographic trends including ageing, migration, household development and localisation patterns
- economic trends, including economic development, trade and globalisation, logistics and macroeconomic trends
- social change, including change in use of time, leisure and sustainable consumption
- energy trends
- technological trends including the “information society”
- infrastructural development and congestion
- environmental trends, including climate and internalisation of external costs
- policy issues, including EU transport policy, enlargement, climate and security

The reviewed sources are considered to provide the most updated state-of-the-art scenarios for the expected evolution of demographic and urbanisation changes, macro-economic changes, technological foresights, policy outlooks, climate, environmental and energy outlooks and transport outlooks, in many cases up to the year 2050.

Taking a look at the development from the 1890s up to the 1990s it is beyond doubt that the development of a number of important drivers has been extraordinarily fast, as shown in Table 3.1.

Table 3.1: Development of driving forces between the 1890s and the 1990s

Driving Forces	Coefficient of increase
Population	4 fold
Urban population	13 fold
World economy	14 fold
Industrial output	40 fold
Energy use	13 fold

Furthermore, in the 1890s the car had only just been invented and the airplane had not yet lifted from the ground. The UN and EU were a dream of the very few.

This immense development has led to the human change of ecosystems at a scale which has never been seen before. Furthermore, mobility has developed sharply over the period, being particularly influenced by technological achievements and economic development. For transport policy to act on these changes and contribute to sustainable development in the next forty years is a huge challenge.

In the remainder of this chapter, Sections 3.2 and 3.3 describe the external and internal drivers mentioned above and Section 3.4 describes the result of the DELPHI survey on the main transport drivers and scenarios carried out among stakeholders (experts and policy makers). As will be seen, the descriptions of drivers in the current chapter have served as an important input to the definition and description of the scenarios provided in Chapter 4. Section 3.5 describes the policy drivers and 3.6 draws the conclusions from the analysis.

3.2 External transport drivers

3.2.1 Population, households and urbanisation

Increasing population leads inevitably to increasing mobility. Therefore one of the main drivers concerning transport and mobility is the population, particularly concerning where it is located and the way it is organised in households.

Global population is increasing fast. However, the rate of growth is now declining: around 1955 each woman in the world in average gave birth to 5 children, and this figure has declined to 2.65 children in 2005. This decline is significant, especially in East Asia. The present population growth is heavily influenced by economic development (children are no longer necessary as a pension insurance in many parts of the world), rising prosperity and the education of women. It is also influenced by increased medical and human health knowledge, science and technology, as well as the reduction of the impact from epidemics and infant mortality.

Europe has for some time experienced an almost stable population, but life expectancy is increasing, particularly the expected lifetime for someone in a good health condition. Viewed in the long term, the European population is expected to decrease, while the world population is still expected to increase up to about 9 billion people in 2050 according to the United Nations World population prospects (2007), medium variant scenario.

Age structure

Not only is the European population expected to decrease, but the age structure is also under considerable change. According to the United Nations (2005), in 2050 about 30 % of the European population is expected to be older than 64 (medium variant scenario). In 1950 the equivalent figure was about 7%. The productive age group (19 – 64) will diminish considerably, and the age group from 0 – 18 will decrease even more quickly. For business this change has significant consequences as the average age of the workforce is increasing and it will become more difficult to find well-qualified younger staff. In this situation involvement in the job market could be expected to increase until the age of 70. Furthermore, there will be an impact on immigration flows from outside Europe, as described in the next paragraph.

Immigration

As stated above, immigration flows from outside Europe are expected to continue to grow (United Nations, 2005), as they will contribute to fill employment gaps, especially in low-skilled jobs. Such immigration may create social tensions, but at the same time will contribute to lessen the problems that an older European workforce would create for the viability of pension systems. Immigration to the EU25 is expected to amount to about 38 million people for the period 2005 – 2050 (United Nations, 2005), of which the EU15 will receive 95 % of the total (about 36 million people). These immigrants are predicted to arrive particularly in Germany, Italy, Spain and the UK. On the contrary, several EU12 countries, such as Estonia, Lithuania, Latvia and Poland, are expected to have a net emigration. Assuming that in 40 years time economic convergence has been attained in the EU27, this emigration trend may be reversed. However, this reversal has not yet been seen in official population projections.

Households

Household structure is an important driver for the overall mobility of the population. A household is a typical unit owning a car or having access to a car, with the household members sharing the car. The general tendency has been a decrease in household size, and UN projections envisage (United Nations, 2003) a further decrease in EU 27 from 2.4 in 2005 to 2.1 in 2030. These figures indicate that, irrespective of an almost constant total population, there will be an increase in number of households. If the current trends in household car ownership continue, an increase in the car fleet may be estimated.

Urbanisation

Urbanisation is another important driver for transport demand. The global proportion of urban population increased from 29 per cent in 1950 to about 49 per cent in 2005, according to UN World Urbanisation Prospects, and the UN predicts that 60 % of world population will be urbanised in 2030. However, while the majority of the inhabitants of the less developed regions still live in rural areas today, the population in the more developed regions is already highly urbanised. For example, in Europe the proportion of the population residing in urban areas is already 72% (in 2005), and is expected to increase to 78% in 2030. The proportion is higher in the EU15 than in the EU12.

In general, urban populations have a less direct perception of “nature” than rural residents, and typically have higher consumption levels. On the other hand, the urban population may have a greater level of environmental awareness, due to greater access to

education and information. Land use in central urban locations is generally thought to be more efficient, given economies of scale. In addition, urban lifestyles have been associated with a decrease in fertility rates and, therefore, contribute to the slowdown of population growth. Finally, urban centres are the locations of “nodal” interactions that contribute to rapid developments in knowledge, science and technology. Indeed, urban contexts are richer in cognitive dimensions than rural contexts, if only because urban contexts contain more people and a greater range of ideas within a dense setting.

Impacts of population drivers on transport

Given that there is a considerable variation in trip making and trip distances between persons by age, sex, economic position, car availability and income, the level and composition of the population in terms of person types is clearly one of the factors that influences transport demand. This can be seen in a number of travel surveys (e.g. the UK National Travel Survey, the TU trip analysis in Denmark, the Swedish Travel survey – RES). Particular attention is paid to the way trip rates change for each person category, and especially in relation to age and income dependent behaviour.

The time used for transport per person is quite stable. The National Travel Survey from UK has since 1972 carried out analysis of annual hours travelled, and the figure remains quite stable around 360 hours per year, with a deviation of about 4.5 hours. A similar result is obtained from the Danish travel surveys, carried out since 1971.

OECD carried out an analysis in 2002 based on travel surveys over a long span of time and in many different countries. The results showed that there is robust evidence that the daily amount of time spent on travelling has only slightly changed over time. Figure 3.1 shows that the average time budget is around 1.1 hour a day: importantly, this does not depend on income level or historic period.

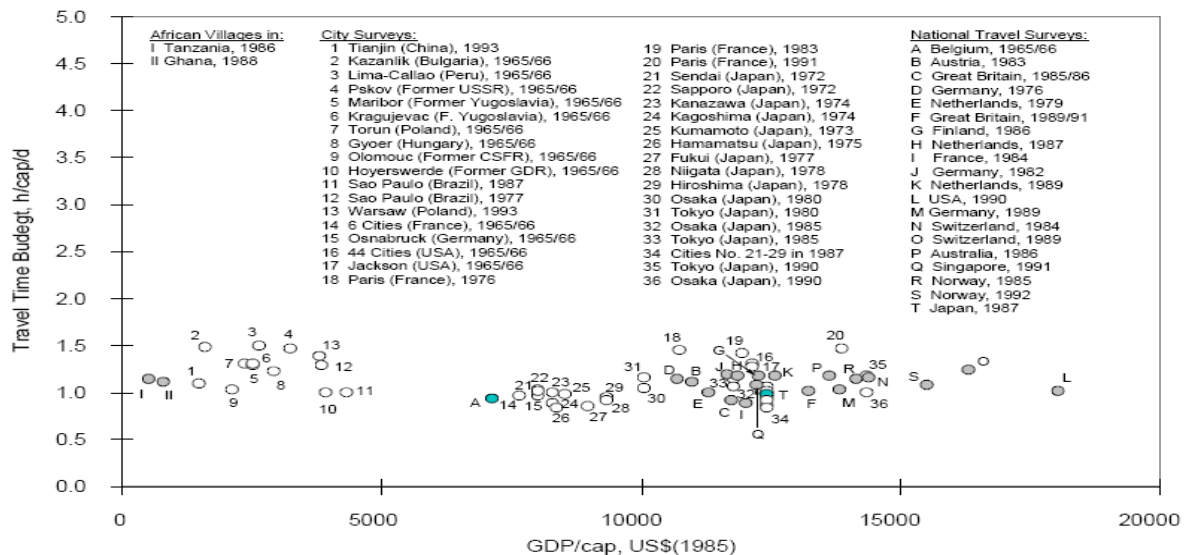


Figure 3.1: Constant Travel Time Budget
 Source: ECMT, 2002

3.2.2 Economic development

Economic development is related to a number of different driving forces, and economic development is in itself a driving force for mobility and transport development. As indicated above, world GDP has increased 14 fold from 1895 to 1995, and since population has only grown 4 fold, it follows that the GDP per capita has increased by a factor of 3.5. The increase in per capita GDP has been distributed rather unevenly across the world. The United States and Europe have been among those countries benefiting the most

from the increase in GDP, whereas a number of the poorest countries in the world have hardly had any progress in GDP development for decades.

There is a well-known feedback between transport improvements and the mobility generated from social relations and economic activities: roads create cities as well as cities create roads. Transport demand can be considered *driven* by social relations and economic activities, as well as by technology, but transport also drives activities and technologies.

The driving force that creates people's mobility is the search for more opportunities for better living. Under certain natural and cultural restraints people across history have travelled as far away as transport technology allowed them.

Also, transport accounts for a certain percentage of each person's disposable income, and this percentage seems to remain rather stable but at different levels in different countries. Since transport is becoming less expensive, relative to most people's revenue, and faster, transport demand is growing in terms of number of trips and total length, even though the natural and cultural thresholds may remain basically stable.

Car ownership is an important determinant of passenger travel behaviour and it is fundamentally interconnected with residential location and decision-making regarding motorized trips. A number of travel surveys have conceded that persons in households located centrally in urban areas have fewer motorised trips than persons located in peri-urban areas. Income is an important factor for car ownership and thus for the level of trip making overall, and for motorised trip making in particular.

It has been argued that transport, both passenger and freight, should be decoupled from economic development. This would mean that mobility and trade should be carried out in a less transport intensive way. Given that mobility as well as trade are some of the fundamentals for development of our society, this debate is complex and controversial. Current discussion is therefore focused on how mobility and trade can be maintained, whilst reducing the adverse effects of transportation: in short, how can economic growth be decoupled from the negative impacts of transport.

GDP development

Economic development is linked to factors such as population development (particularly development of working age population), world trade, labour productivity and capital formation. As already indicated, the working age population in Europe is expected to decrease, whilst immigration is expected to increase in order to substitute the missing work force.

The outlook on the European Economy produced by the *Trends to 2030 - update 2007* indicates an optimistic forecast of growth of the European economy of 2.2 % per annum up to 2030. This is made up of a growth of about 2 % per annum in the EU 15 and about the double this level in the EU12 (4.1 %). Figure 3.2 indicates that a certain convergence towards 2 % per annum can be established from long term time series.

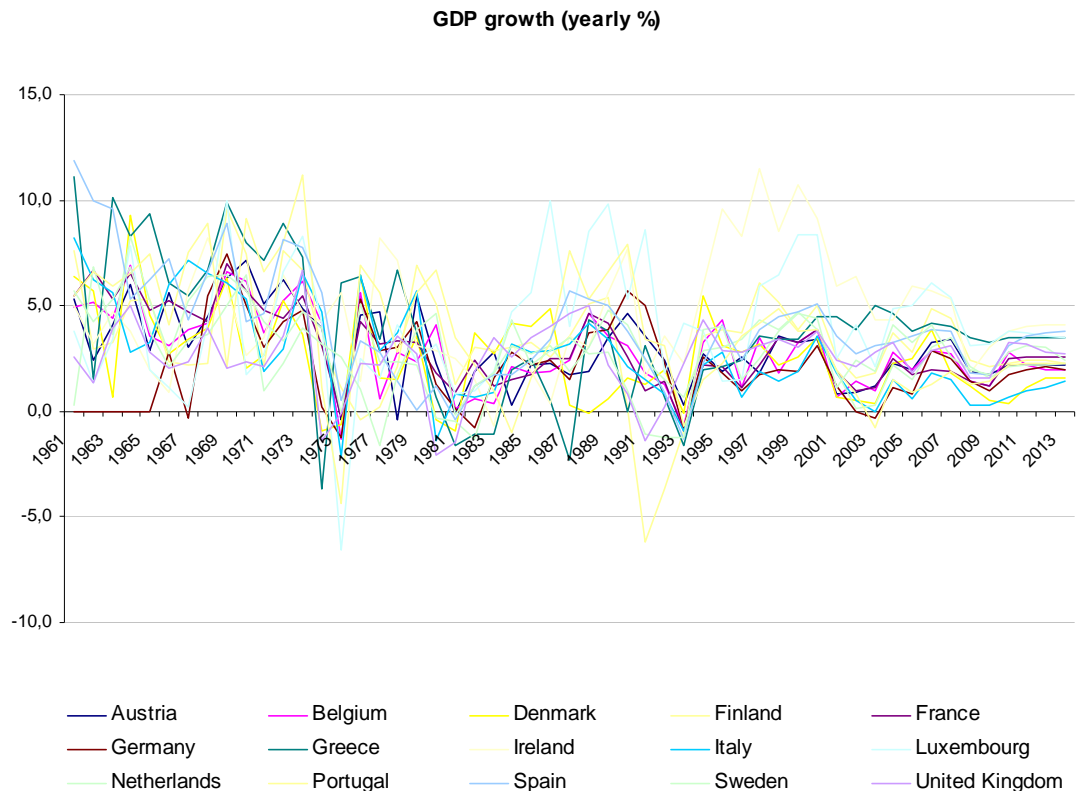


Figure 3.2: GDP growth rate by European country

Source: TRANSvisions elaboration from IMF data

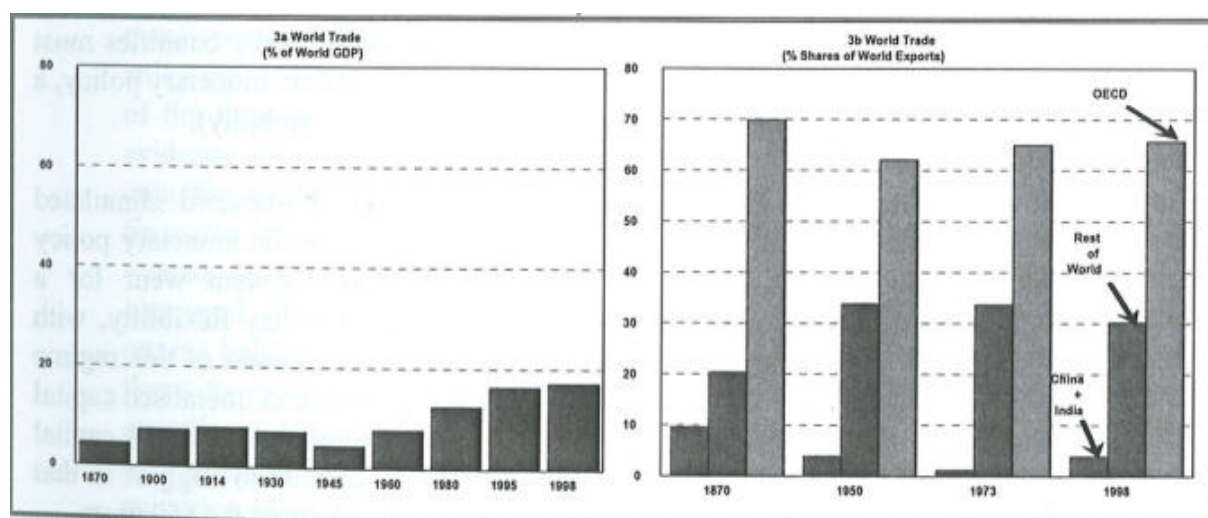
GDP growth rate is related to the development of the productive sectors in Europe. One of its main aspects is the continuous development of the tertiary sector (trade and services) which in 2030 is expected to account for more than 70 % of the total economic activity.

World trade as an indicator for globalisation

World trade is another important aspect of economic growth, and world trade can also be seen as an indicator for globalisation. This can be examined taking three different time-scale perspectives:

- An historical perspective, showing world trade mega-trends over the period 1870-1998.
- A decadal perspective, showing the consequences on trade of the post-1990 acceleration in the global integration process.
- The current perspective, which shows that now (in the years 2007 and 2008) there are signals of a possible reversing of the faster globalisation trends of the last decade

As it concerns the centennial perspective, Figure 3.3 gives an overview of the importance of world trade as a percentage of world GDP over time, and of the respective shares of world trade by the OECD and non-OECD economies.



Source : Crafts (2000), Maddison (2001) and own calculations

Figure 3.3. World Trade as % of GDP + Shares of World Exports (1870 – 1998), China/India, OECD and Rest of World

Source: EC Directorate-General for Economic and Financial Affairs (2006)

The most important points to note at the centennial time scale are as follows:

- Firstly, if one uses world trade flows as a % of GDP as a proxy for the globalisation process as a whole, one can see clearly from the figure that this process is by no means inevitable and is subject to considerable setbacks at the hands of policy makers. While the overall trend since 1870 has been upwards, the interwar years was a timely reminder of the reversibility of the process, with world trade as a % of GDP being cut in half over these years as the tide of protectionism took hold in the major trading powers.
- Secondly, the shift in the post-war WWII period to more open policies ensured that trade integration has been a striking feature of the world economy over recent decades, with the volume of goods presently traded being more than 15 times greater than in 1950 and with its share in GDP tripling.
- Thirdly, the growing integration of national economies into the world's trading system over the post-war period was driven not only by trade liberalisation but also by falling transportation and communication costs, rising income levels, higher productivity growth rates in tradeables compared with non-tradeables, and more recently by an ICT-enabled acceleration in the international division of labour linked with the development of increasingly global production systems. All these developments have led to a sharp increase in overall trade flows, underpinned by an expansion in both intra-industry flows and in a range of internationally tradeable services.
- Finally, in terms of shares of world trade, the figure above highlights the dominance of the OECD countries in the global trading system, with the OECD's world share consistently in the 60-70% range over the whole period 1870 to the late 1990's. While the rest of the world, most notably China, have been making large gains in terms of their world market shares over the most recent years, the graph underlines the extent of the gap to be made up by these countries over the coming decades.

Trade and capital integration

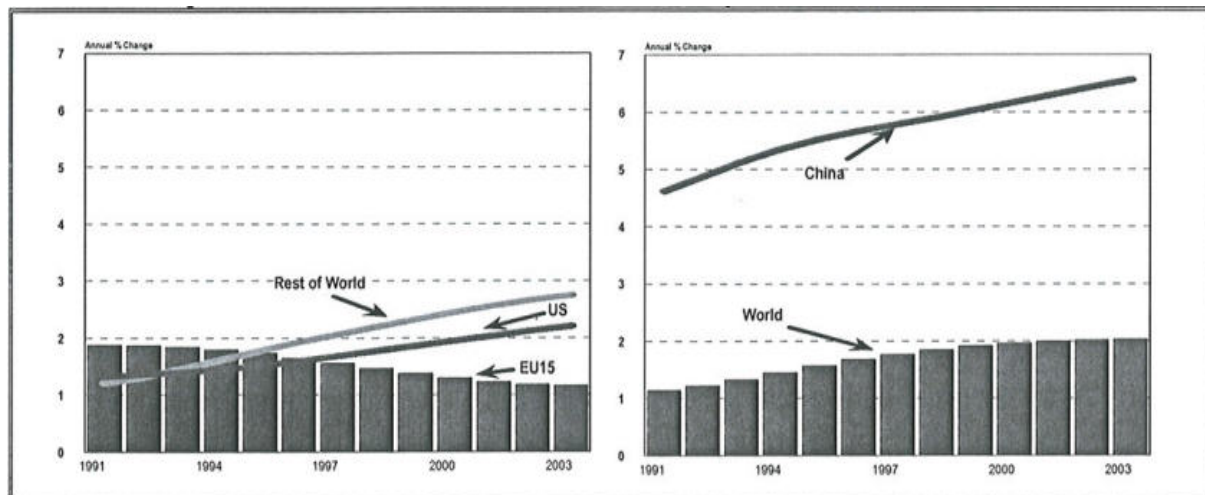
Since 1990 the global integration process has accelerated strongly. Three key features distinguish this phase:

- Firstly, **a further expansion in both trade and capital market integration**: The fall of the iron curtain in Europe and the opening up of China, India and parts of Central

and South America have led to a further increase in international trade and capital flows. However, trade is sensitive to transport costs, and continuously high transport costs may lead to more regionalised trade patterns than observed presently.

- Secondly, **an ICT induced and ICT enabled acceleration in the global relocation of production processes**: The increase in international trade has not been confined to the exchange of finished goods and services since there has also been an expansion in the share of intermediate inputs which are traded internationally. This intermediate trade forms part of a growing trend towards the internationalisation of production including growth in the relocation of labour intensive manufacturing and business-related services to lower cost locations around the globe.
- Thirdly, **a worldwide income and technological convergence process**: Economic globalisation was also driven by the movement of knowledge (technology) across borders, a general increase in education and a better use of available resources. As shown in Figure 3.4, average productivity growth in the rest of the world (world excl. EU15 and US) was about 0.5% point higher than in the EU over the last 10-15 years. The “rest of the world” grouping includes the emerging economies which are having big productivity growth rates. The process of income convergence is likely to continue over the coming decades, underpinned by a persistence of the existing Total Factor Productivity (TFP) growth rate differentials.

As indicated by many growth studies, a country’s level of long run income per capita is strongly related to human capital. Amongst many of the emerging economies in Europe and Asia, human capital is available in relative abundance.



Note : China is also part of "Rest of World" grouping

Source : World Bank (World Development Indicators) and own calculations

Figure 3.4 World Trend Labour Productivity Growth Rates: 1991-2003

Source: EC Directorate-General for Economic and Financial Affairs (2006)

GDP forecasts

Making projections from the post-1990 acceleration phase to the future, the EC Directorate-General for Economic and Financial Affairs (2006) study has provided simulations for alternative global relocation patterns, from the perspective of EU, until 2050. (Another DG ECFIN study has investigated the effect of ageing and globalisation on the economic development in EU25). The forecasts assume a convergence towards a lower growth in GDP than has been experienced for the last 5 decades. The long term forecasts for EU15 indicate a convergence towards a growth in GDP of about 1.3 % per annum in 2050, and of 0.6 % per annum for EU10. This is far below the assumptions applied for 2030 in the 2007 update, but seems realistic taking into account that EU GDP is already at a very high level. The EU10 convergence level, however, seems low. The DG ECFIN analyses indicate that economic growth can be affected by the ageing of population with a variation of about ± 10 % depending on assumptions on how shortages in working age population

are handled. Analyses of globalisation and its effects point out that Europe has not been vulnerable to globalisation hitherto, primarily due to the creation of the internal market and also because, up to now, European production has not been subjected to intensive competition from China and India. However, it is expected that these countries will develop new industrial bases which to a greater extent will compete with the European production industry, though the long term influence of globalisation is expected to affect economic development by not more than -5 % to +8 %.

Finally, as it concerns current trends, growth in world output and trade decelerated in 2007. According to the last World Trade Organisation (WTO) outlook, weaker demand in the developed economies reduced **global economic growth** to 3.4% from 3.7%, the latter figure being roughly the average rate recorded over the last decade. At some 7% growth in the developing regions was nearly three times the rate recorded in the developed regions: the whole of Europe recorded GDP growth of 2.8%, a somewhat better performance than both Japan and the United States. Stimulated by sharply higher export earnings and rising investment, Russia's economic growth of 8% was the strongest annual increase since 2000. The most populous developing countries, China and India, continued to report outstandingly high economic growth. **World trade growth** slid to 5.5% from 8.5% in 2006 and may grow even more slowly in 2008, at about 4.5%, as sharp economic deceleration in key developed countries is only partly offset by continuing strong growth in emerging economies (according to World Trade Organization (WTO) economists). Among the leading traders, China's real merchandise (goods) trade expansion remained outstandingly strong in 2007 as lower export growth to the US and Japanese markets was largely offset by higher export growth to Europe and a boom in shipments to the net-oil-exporting regions.

According to the WTO outlook, the slowdown in economic activity in developed countries was the major factor in the reduced expansion of global trade in 2007. However, as illustrated in Figure 3.5, the real merchandise export growth, estimated at 5.5% in 2007, is still close to the average rate of trade expansion over the last decade (1997-2007), which exceeded global output growth by 2 percentage points.

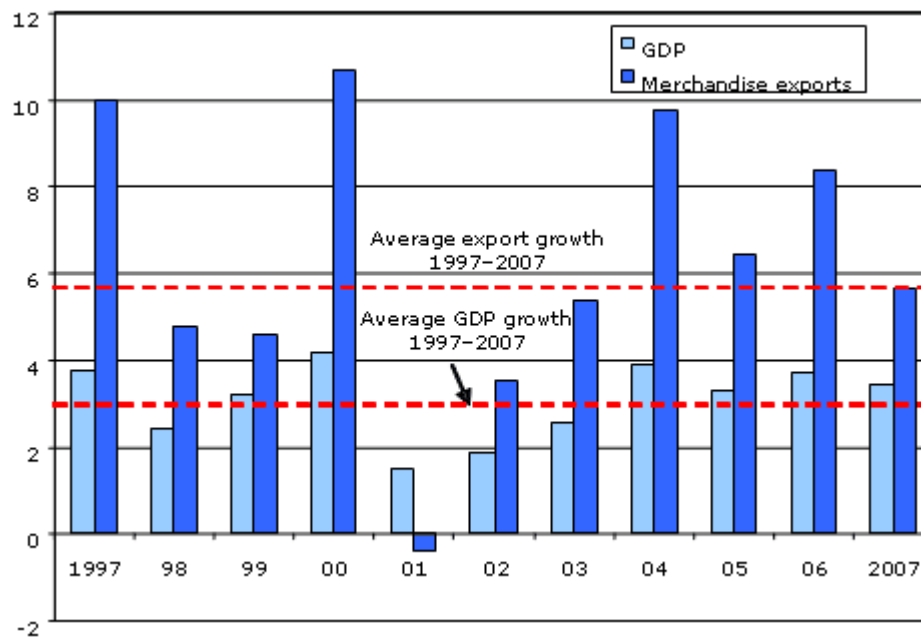


Figure 3.5 Growth in the volume of world merchandise trade and GDP, 1997-2007
Annual % change

Source: WTO Outlook

Europe's real merchandise export and import growth of 3.5% in 2007 continued to lag behind the global rate of trade expansion, as has been the case since 2002. Within Europe, individual countries' trade performances differed widely in 2007.

Globalisation

Globalisation is leading to new ways of organising production and distribution, relying heavily on efficient supply chains and thus the organisation of the logistic process. Increasing returns to scale give industrial companies a strong incentive to concentrate production in fewer factories. Development in transport costs and logistics makes it possible to enlarge the market area served from just one distribution point. In many sectors the focus has moved from nationally based production to single locations producing a particular product for the world market. Concentration of inventory has been another main logistic trend over the last decades. A reduced number of stockholding points can yield a financial benefit much bigger than the additional transport cost they usually cause due to longer trips. This has been facilitated by the decline of international transport costs because carrying capacities have expanded and transport operators could take advantage of larger economies of scale. Other important drivers enabling companies to operate central warehouses are the advances in information technologies and supply chain integration. In some sectors the increase in direct deliveries supported by the diffusion of Internet enables manufacturers to bypass wholesale and retail channels and therefore reduce costs. The wider geographical sourcing of supplies (upstream) and the wider distribution of finished products (downstream) are extending the companies' supply lines upstream and downstream, and this facilitates outsourcing and delocalisation strategies as well, as the companies seek to reduce purchasing and manufacturing or labour costs.

Impacts from economic drivers on transport

Freight and passenger transport growth are developing almost in parallel to economic development. This is not surprising, since economic development is the driver behind many factors in society which also have an impact on transport. Increasing personal income results in increased possibilities for optimising residential location, for purchasing transport and for carrying out longer and more frequent trips. The economy of society is greatly influenced by production and trade which require transport, as indicated above.

The overall consequence of global trade patterns on transport is seen in the close relationship between GDP and freight transport growth. Indeed, the last thirty years of unprecedented growth of world trade, and in particular the post-1990 acceleration, has seen a growing share of long distance trade: more goods were and are still transported over long distances than before. As a result the freight transport volume, as shown in Figure 3.6, grew in recent years faster than GDP.

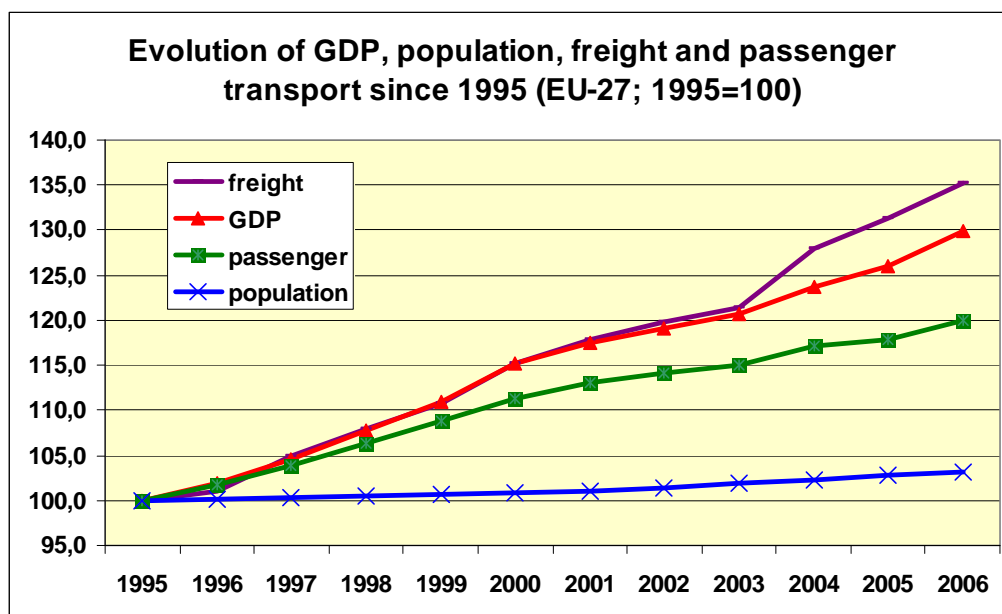


Figure 3.6 Evolution of transport demand and GDP EU-25 (1995=100)

Source: Eurostat

According to the analysis presented in the EC DGTREN Trends to 2030 (Update 2007), in the period 1990 to 2005, the GDP elasticity of transportation activity in the EU was estimated at 0.90 for both passenger and freight transport. This is a remarkably high value indicating great dependence of economic and social activity on transportation. A closer look at the period 2000 to 2005 shows that the GDP elasticity of passenger transport in EU remained constant at a level just below one, but for freight transportation in EU it became as high as 1.45. This reflects the considerable increase in commodity trading following the EU enlargement and the market integration.

The projections for the EC DGTREN Trends to 2030 assume values of the GDP elasticity of transportation activity that remain stable over time as far as passenger transport is concerned and decrease over time for freight transport reflecting saturation and productivity gains. For passenger transport in EU, the GDP elasticity is equal to 0.65 on average for the period 2005 to 2030. For freight transport in EU, the GDP elasticity of activity is projected to decrease gradually, first down to 0.92 in 2005-2010, and then further down to 0.72 between 2010 and 2030. As the values of GDP elasticity of transportation activity are lower than one, the Trend to 2030 displays therefore a gradual decoupling of transportation in EU from GDP growth in EU (see Figure 3.7).

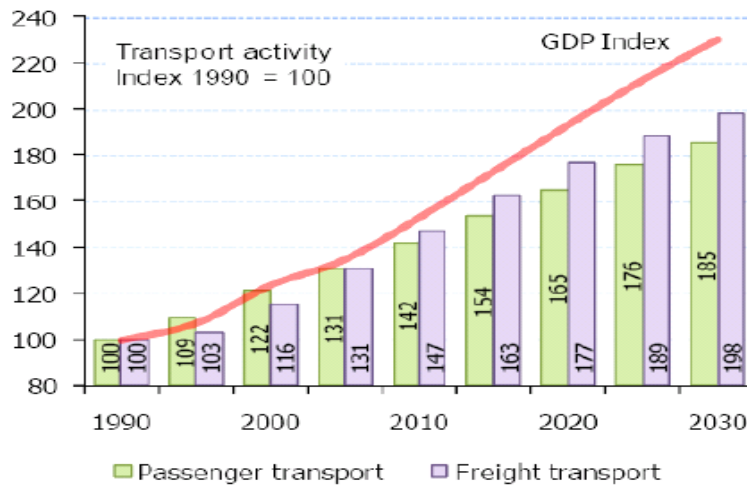


Figure 3.7: Transport activity growth in EU, 1990-2030

Source: Trends to 2030 – Update 2007, EC 2008

The Trends to 2030 – Update 2007 indicates that passenger-km in EU will increase at a rate of 1.4% per year between 2005 and 2030 while the tonnes-km in EU are projected to increase by 1.7% per year during the same period. The figures for freight could be underestimated because they do not include short sea shipping (SSS), which is a mode with a relatively high growth rate. The TRANSvisions calculations for the baseline indicate similar increases of 1.3 % per year for passenger-km in EU and 1.6 % per year for tonnes-km in EU up to 2030.

One of the possible reasons for the decoupling of freight transport could be the dematerialisation of the economy. Decoupling may be greatly facilitated also by growing regional trade patterns, as they could be stimulated by future persisting high energy prices. For passenger transport, decoupling is already taking place due to low demographic growth and congestion.

3.2.3 Social change

Economic development is behind social change. Economic development is the process in which the growing technical efficiency of provision for basic needs allows society to shift its time progressively towards production and consumption activities relating to more sophisticated needs. Cultural change, change in habits and beliefs and values, is an integral part of the process. The developing society does not just engage in new forms of production, but also in new sorts of consumption. Its members can do new things with their time, and different sorts of leisure emerge.

One of the effects of this development has been a growing affluence in the OECD countries. Particularly in the EU, increased economic resources have been applied for establishing welfare societies where working hours are decreasing, and employment in the tertiary sector is increasing far more than in the primary and secondary sectors. Living standards have increased and leisure time has increased.

Today most people take leisure as consisting of a limited (and predictable) set of recreational activities, extending from relatively passive home-based activities such as watching television, via out-of-home spectator or audience activities, to active participation in hobbies and sports.

Since some leisure service consumption takes place outside private homes, the need for appropriate transport possibilities, including public transport services, is increasing. Besides the need for appropriate transport options to serve the everyday travel demand of

an increasing share of leisure consumers in our cities, the most evident consequence of the growing leisure society, and availability of free-time, is the fast growth of tourism.

Impact from social change on transport

The World Tourism Organisation (WTO) estimated there were nearly 900 million international tourist arrivals in 2007, up by about 6% from 2006. International arrivals are expected to reach 1.6 billion by 2020. To appreciate these figures we may consider that international tourist arrivals in 1950 were only 25 million. Domestic tourism (people going on holiday in their own countries) is generally thought to be 4 to 5 times greater than international arrivals. According to the WTO, air transport generated 46% of all international tourist arrivals, followed closely by overland transport. The trend in the last three years has been for air transport to grow at a faster pace than other means of transport. According to the International Air Transport Association, international passenger demand rose 9.3% in the year to November 2007, the fastest growth rate recorded in 18 months.

Globally, tourism accounts for roughly 35% of exports of services and over 8% of exports of goods (WTO). Tourism is said to be the world's largest employer. In 2001, the International Labour Organisation (ILO) estimated that globally over 207 million jobs were directly or indirectly dependent upon tourism. The latest long term forecasts by the industry's World Travel and Tourism Council (WTTC) point to a steady phase of growth for world travel and tourism between 2009 and 2018, with an average growth rate of 4.4% per annum, supporting 297 million jobs and 10.5% of global GDP by 2018.

Europe maintains and consolidates its share of international tourist arrivals. European travellers benefit from a strong EURO. Expansion of low-cost airlines is boosting short-break travel. Extension of the passport-free Schengen area to nine more countries makes trips within Europe easier. However, Europeans are feeling the slowdown of the economy and were affected by the high price of oil in 2008, so that the growth of tourism in the EU was only about 2% in 2008, according to WTTC, compared with worldwide growth of 3-4%.

For faster growth, the industry will have to look to the emerging economies. These are becoming increasingly well established as places to visit and are also starting to provide more visitors too. Consumers' spending power in emerging economies will rise from \$4 trillion in 2006 to more than \$9 trillion, nearly the spending power of Western Europe today, in 2015.

In recent years, domestic and intra-regional tourism, especially in emerging economies such as China, Thailand, India, Korea and Mexico, have grown rapidly and according to WTTC forecasts, Chinese demand for travel and tourism will quadruple in value in the next ten years. At present China ranks a distant second, behind United States, in terms of demand, but by 2018 it will have closed much of the gap.

The forecast for growth in the tourism industry is less reliable than in other industries, partly because tourism is vulnerable to shocks such as natural disasters or terrorist attacks, but also because tourism is in danger of becoming far more expensive if fuel costs increase and full cost accounting is applied to tourism development.

Sustainable consumption

The impact of an emerging "sustainable consumption" culture on transport could be important. Car ownership could be affected most, with a move away from owning a car being seen as a status symbol and the only provider of "mobility freedom", particularly for the younger generation. A new sustainable mobility freedom concept could take off, especially in the urban environment, with a greater attention of people towards active travel (walking and cycling), combined with the use of high quality public transport and information services, as the main way to ensure freedom of movement. On the other side, dis-

tributed energy and information systems could lead to a pattern of distributed human settlements as a superior way of organisation, giving rise to a landscape of scattered new homogeneous motorized neighbourhoods, in which charges would be paid, as needed, to keep down congestion and CO₂ emissions.

3.2.4 Energy trends

Energy trends, particularly with respect to the availability of different types of energy, have a considerable impact, not only on the transport sector but also on society as a whole. Energy is a basic need for production, heating, households and transportation. Energy is created from many different sources, of which wood, water and wind have for millennia been primary sources for households, for agriculture and for small scale industries and workshops. Big scale production of energy for industry and households has relied on coal for centuries. Over the past 100 years, energy systems have undergone a transition from solid fuels to oil and gas, as well as from the distribution of high-quality processed fuels (e.g. liquids, gases and electricity) to dedicated energy infrastructure grids. However, the next 100 years or so are unlikely to unfold as a simple extrapolation of these past trends.

Energy production

Two factors have the potential to bring about fundamental changes in energy production systems in the timescale up to 2050: energy resource scarcity and technological development.

With respect to energy resource scarcity, coal will not become scarce within this timescale, though resources are concentrated in a few countries and will become increasingly complex and distant from markets. In addition, increasing CO₂ emissions constraints will require increased use of clean coal production techniques and carbon sequestration, and increased costs of exploiting and using coal will eventually affect its competitiveness.

The situation, though, is different with respect to oil, which is the main source of energy for the transport sector, with about 65% of world oil production being consumed directly or indirectly (refineries and bitumen) by the transport sector in 2005, as illustrated in Figure 3.8.

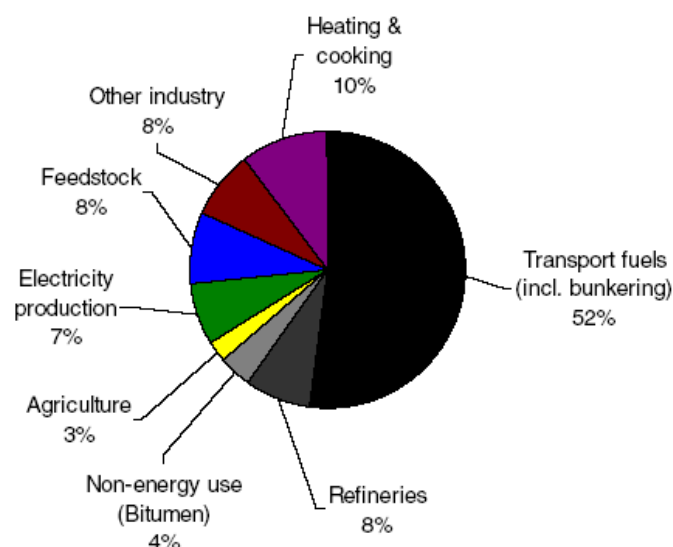


Figure 3.8 Use of oil by sector, 2005

Source: Pierpaolo Cazzola: *Vehicle Fuel Economy improvements*, EIA, October 2007

Oil production has long been expected to peak. Some think that this is now imminent at least within the next 10 years. For others the scarcity of oil supplies, including unconventional sources and natural gas liquids, is very unlikely before 2025. This horizon could be extended to 2040 by adopting known measures to increase vehicle efficiency and focusing oil demand on the transport sector.

With the increasing oil prices witnessed in the first half of 2008, the costs related to exploiting difficult-to-access oil fields were seen as being recoverable, thus leading to the opening up of new fields hitherto unexploited. The high oil price also revealed a pressure for opening up exploitation in environmentally vulnerable areas, e.g. in the Pacific Ocean close to the US coast line. Investigations have also been carried out in Arctic waters, and in the Atlantic Ocean where the water depth is considerable and extraction costs high. Thus, the peaking of oil is to a certain extent dependent on the price of oil. However, ultimately the extraction of oil resources evidently leads to a point where resources are exhausted, and other types of energy must take over.

Gas resource uncertainty is significant. Scarcity could occur as early as 2025, or well after 2050. Gas is considered by many to be scarcer than oil (WETO-H2, 2006), constraining expansion. But the key issue is whether there can be timely development of the infrastructure to transport remote gas economically.

Nuclear energy expansion has reduced its pace in OECD countries, but throughout the world nuclear energy production increased by 85 % in the period 1985 to 2005. In the same period world energy production increased by 50 %. From 2000 to 2005 world energy production increased faster (16 %) than nuclear energy production (7 %), but according to the Nuclear Energy Institute the cost of producing 1 KWh is today (2007) less than producing the same by coal, and considerably cheaper than using gas or liquid fuel. This could lead to another increase in building up nuclear energy capacity both in Europe and the world. However, this is not foreseen in the forecasts from the International Energy Agency up to 2030, for which nuclear energy maintains a constant share of energy production worldwide. Also the Commission's assessment of the energy future in EU notes that nuclear energy is being dismantled in some of the EU countries and presently the expansion plans are stalled in other countries. Therefore, the forecast for nuclear energy up to 2030 in EU is a slight decrease. Further ahead, technology advances could increase nuclear supplies further.

Renewable energy sources may be adequate to meet all potential energy needs, despite competing with food and leisure for land use. However, technological preconditions for a full uptake of renewable energy sources have to be fulfilled. For example, the widespread use of solar, tidal, water and wind energy will require new forms of energy storage, and it is for this reason that renewable energy has made so far few inroads into primary energy supply, even though the costs of wind and photovoltaic sources have fallen dramatically over the past two decades. Also bio-fuels have entered the energy scene, providing petrol and diesel based on food crops such as rapeseed, palm oil and sugar cane. It is however estimated that bio-fuel has a limited scope for replacing oil. The International Energy Agency assesses that first generation bio-fuel may replace 4 to 7 % of oil for road transport in 2030. If bio-fuel is going to have a wider application, technologies need to be developed that make it possible to use cellulose material, such as wood, plant stems and leaves, to produce commercial viable so-called "second generation" bioethanol. In general, technologies are required to enable the use of any type of biomass to produce synthetic fuels. Furthermore, the use of arable land for production of fuel will be considered unsustainable in a world with a growing population, requiring the use of such land for food production. The EU target for 2020 is that 10% of all fuel used in transport will be from renewable sources (biofuels, electricity, hydrogen).

The second driving force for discontinuity in energy patterns is technology. A technology that offers superior or new qualities, even at higher costs, can dramatically change lifestyles and related energy use. Widespread introduction of electricity in the early 20th century prompted fundamental changes in production processes, business organisation and

patterns of life. The internal combustion engine provided vastly superior personal transport, boosting oil consumption. The combined cycle gas turbine has become the technology of choice for power generation, greatly increasing the demand for gas, already the preferred heating fuel.

The new energy technologies are now **solar photovoltaics**, which offer abundant direct and widely distributed energy, and **hydrogen fuel cells**, which offer high performance and clean final energy from a variety of fuels. Both will benefit from manufacturing economies but both presently have fundamental weaknesses. Fuel cells require new fuelling infrastructure, while photovoltaics need new forms of storage as well as significant cost reductions.

Boxes 3.1 and 3.2 show two of the TRANSvisions Case Studies illustrating future opportunities from new energy technologies.

Box 3.1: Hydrosol Project

Source: Plataforma Solar de Almería website.: <http://www.psa.es/webesp/index.html>



The Plataforma Solar de Almería (PSA), a dependency of the [Center for Energy, Environment and Technological Research \(CIEMAT\)](#), is the largest center for research, development and testing of concentrating solar technologies in Europe. PSA activities form an integral part of the CIEMAT Department of Renewable Energies as one of its lines of R&D. The PSA is located in southeastern Spain in the Desert of Tabernas. It receives a direct annual insolation above 1900 kWh/m² and the average annual temperature is around 17°C. The capacity to offer researchers a place with climatic and insolation conditions similar to those in developing solar-belt countries (where the greatest potential for solar energy is found) but with all the advantages of a large scientific installation in the most advanced European countries, makes the PSA a privileged site for evaluation, demonstration and transfer of solar technologies.

Box 3.2: Fuel Cells and hydrogen in the EC Joint Technology Initiatives

Source: http://cordis.europa.eu/fp7/jtis/home_en.html <http://>

In May 2007, the Commission adopted the first proposals for Joint Technology Initiatives. This is the first time that public-private partnerships, involving industry, the research community and public authorities, were proposed at European level to pursue ambitious common research objectives. One of the fields for joint co-operation is Fuel cells and Hydrogen.

With growing concerns about climate change issues, increasing prices of oil and gas and Europe's strong dependence on imports, the development of a policy for a sustainable and secure energy system is a top priority for Europe. Hydrogen, as an energy carrier, and fuel cells, as efficient energy converters, may play an important role in this respect. The Fuel Cells & Hydrogen (FCH) Joint Technology Initiative (JTI) aims to define and implement a target-oriented research and development programme to support the broad market introduction of these technologies. The work will build on the strategic documents produced by the industry-led European Hydrogen and Fuel Cell Technology Platform (HFP), particularly in its Implementation Plan.

The overall objective of the JTI is to speed up the development of hydrogen supply and fuel cell technologies by up to 5 years to the point of commercial take off for e.g. mass market roll-out of transport applications.

Together with the other measures presented in the EU's 'Strategic Energy Technology Plan' (SET-plan), the FCH JTI has the potential to contribute to substantial reduction of greenhouse gas emissions and local air pollutants, to enhanced security of energy supply and to increased employment by creating the conditions for the growth of a strong and competitive industry.

Energy demand

The discussion so far has focused on the energy supply side. On the demand side, it is **final energy demand** that matters most. This is driven by economic activity of non-energy firms as well as the living and working conditions of individuals. The corresponding end-use consumers (such as industry, services, residential and transport) purchase final energy products (such as fuels, electricity and distributed steam or heat), and transform them through appliances and equipment into useful energy forms. The final consumers combine energy and non energy inputs to achieve production or get utility. The mix depends on relative prices, the technical possibilities and the consumer's income. **Energy savings** correspond to various combinations of actions such as: substituting non-energy inputs for energy (e.g. insulation); optimizing the use of energy products in their transformation into energy services (e.g. choosing technological advanced appliances); rationalizing the use of energy services per unit of activity or revenue (e.g. less driving private cars or not letting appliances at stand-by mode). Another important indicator is **energy intensity**. This is defined as the ratio of energy consumption of a consumer or a sector divided by a volume index of the relevant driver, i.e. industrial output, transportation activity, income or GDP. Energy efficiency gain corresponds to a reduction of the energy intensity indicator.

The report *Trends to 2030 – Update 2007* produced by EC provides the following graph (Figure 3.9) indicating the development of energy demand by main sector.

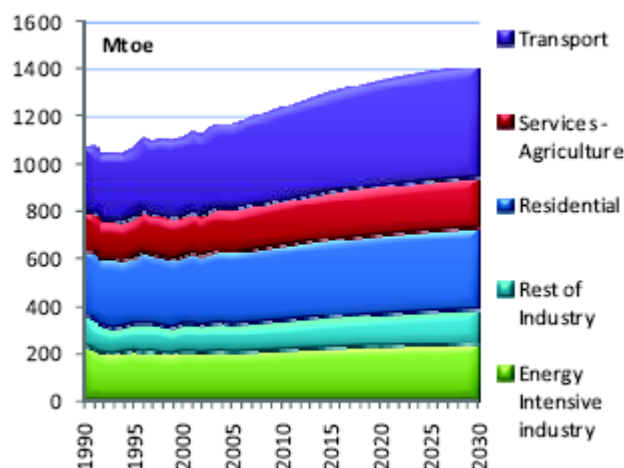


Figure 3.9 Development of energy demand by main sector 1990 - 2030

Source: *Trends to 2030 – Update 2007*, EC 2008

The discussion in the following paragraphs focuses on the transport sector which is the sector with the most increasing energy demand.

Energy and transportation

The analysis of transportation activity by transport mode and the projections for the EC DGTREN Baseline scenario (*Trends to 2030*) focuses on energy consumption in the transport sector, which accounted for 31% of total final energy consumption in 2005, up from 26% in 1990. This increasing share of transport in total energy consumption is projected to persist in the EC DGTREN Baseline scenario, achieving a share of 33% in the year 2030.

Seen in a 2005 world context, road transport accounts for 75 % of the energy demand in transport, rail for 3%, air for 12 % and waterborne transport for 10 %. In the TREND 2030 Baseline scenario the maritime energy usage is not included, which increases the road sector to account for 82 % of the energy demand and air transport accounts for 14 %. The remainder is shared between rail (about 2.5%) and inland waterway (1.5%).

Since road transport is the overwhelmingly most important energy user, it is important to examine the expected development in energy efficiency in this transport segment. The development is illustrated in Figure 3.10.

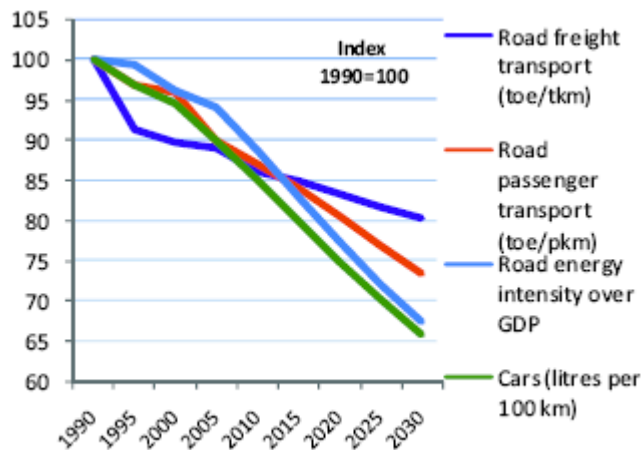


Figure 3.10 Energy Efficiency Indicators for Road Transport

Source: Trends to 2030 – Update 2007, EC 2008

The efficiency of road freight transport increased at a fast rate from 1990 to 1995, as can be seen in the sharp drop in the tonne of oil equivalents (toe) per tonnes-km shown in Figure 3.10. However, efficiency is expected to increase more slowly between now and 2030, with toe/tonnes-km reaching a level of 20 % below the 1990 level. For road passenger transport it is foreseen that efficiency will increase more, with a reduction of about 25 % in toe/passenger-km. Also the efficiency of cars is expected to increase, with litres per 100 km being reduced by 35 % compared to 1990. Although the efficiency increases, it is still expected that the total fuel consumption will increase up to 2030, due to an increase in the overall mobility, which is growing faster than the efficiency gains.

In rail transport the substitution from diesel to electricity will continue. Furthermore, the efficiency of engines, both electric and diesel, is expected to be improved, resulting in an overall decrease in energy consumption in the rail sector (even though the sector is expected to increase its production up to 2030 and most likely beyond).

Energy consumption by aviation has grown by 4.6% per year in the period 1990 to 2000 and by 1.9% per year between 2000 and 2005. Transportation activity handled by aviation, measured in passenger-km, grew faster during the same period. The average energy intensity of flights, measured in toe per passenger-km, decreased 16 % during 1990-2005 due to improved design of engines and aircrafts. The EC DGTREN Baseline scenario projects a continuation of growth of aviation transportation activity at a fast pace in the short and medium term and at a slower pace in the long term. Aviation activity measured in passenger-km is projected to become 4.4 times higher in 2030 than it was in 1990. Energy consumption is projected to increase significantly but less than the activity level, continuing past trends. This is driven by energy efficiency progress of engines and aircrafts which is projected to provide in the period 2005 to 2030 energy intensity gains of 1.2% when measured per year per flight and of 0.84% per year when measured per passenger-km. Energy consumption by aviation grows by 2.2% per year in the period 2005 to

2030, down from 3.7% per year in 1990-2005. Nevertheless, total volume of energy consumed by aviation is projected to triple in 2030 compared to 1990.

Inland navigation is traditionally important in the EU for freight transportation and keeps a small share of the market, showing a slow but steady positive rate of growth of activity (around 0.5% per year). The EC DGTREN Baseline scenario projects a continuation of this trend and also growing energy efficiency. Energy consumption for inland navigation is projected to increase at a slow pace in the medium term and to stabilise in the long term.

The expectations are that crude oil based fuels will continue being the most important source for satisfying the energy demand in the transport sector up to 2030. Railways will continue using a greater share of electricity but for the other modes of transport liquid fuel will be used for at least up to 2030. Alternative fuels like 1st and 2nd generation of biofuels (as described above) are expected to have an impact although this will be limited. The International Panel for Climate Change (IPCC) expects that 2nd generation of biofuels produced from wood and waste will be able to replace 5 to 10% of the fuel required for the road sector. The EU non binding target for introduction of biofuels in petrol and diesel is a share of 5.75 % in 2010. This target is likely to be achieved first in about 2015. A mandatory target for year 2020 has been set as a 10% share of renewables in transport (though this does not only concern biofuels).

Impact of energy on transport

Apart from an early running out of crude oil, which will have an alarming influence on mobility and transport, the main impact from energy on transport is the price of fuel and its consequences.

The **prices for primary energy** carriers traded on the global markets increased in the couple of years up to mid 2008 to a level that was considerably above the values used in energy scenarios and projections in the past. High oil prices affect all economic sectors and determine several macroeconomic impacts. Nevertheless, the transport sector's demand for oil is less price sensitive than any other part of the economy. This is in part because demand for transport services is relatively insensitive to price and in part because substitutes for oil in road transport are currently far from cost-effective. Transport is the one sector of the economy where substitution with other fuels has been negligible.

Consumer responses to changes in fuel prices are often measured through elasticity. The price elasticity of fuel demand is fairly low, meaning that prices have no big impact on demand: a 1% increase of fuel price is estimated to lead to a 0.1% short term decrease in vehicle-km¹. In the long term the decrease is 0.3% per vehicle. However, in the same study the volume of fuel consumed had a short term elasticity of -0.25 and the long term elasticity of -0.6. The results imply that an increase in fuel price will lead to a reduction of driving, but also a change in driving patterns and most likely a change in the long-term of vehicle types, substituting more fuel consuming cars by less fuel consuming cars. Further it was found that the car fleet was reduced with an elasticity of -0.25 in the long term.

The current trends towards a slower growth of world trade are a signal that globalisation is reversible, as higher energy prices are impacting transport costs so much that the cost of moving goods, not the cost of tariffs, is the larger barrier to global trade today: this is at least the thesis supported by a recent study produced by the Canadian Investment Bank².

According to this study, the recent explosion in global transport costs, in tariff-equivalent terms, has effectively offset all the trade liberalisation efforts of the last three decades. Not only does this suggest a major slowdown in the growth of world trade, but also a fun-

¹ Goodwin, Phil, Joyce Dargay and Mark Hanly: *Elasticities of Road Traffic and Fuel Consumption with Respect to Price and Income: A Review*, Transport Reviews vol. 24 no. 3 May 2004

² Jeff Rubin and Benjamin Tal, *Will Soaring Transport Costs Reverse Globalization?*, CIBC World Markets Inc., StrategEcon, May 27 2008

damental realignment in trade patterns. Indeed, recent developments in transportation have led to increased sensitivity to higher energy prices. Most notable of these changes is the massive trend towards containerization that effectively makes shipping costs more vulnerable to swings in fuel costs. Container ships can be unloaded much faster than bulk cargo ships so they spend much more time at sea than in ports. Another factor is speed, as the shift to container ships has increased the importance of ship speed. Over the past two decades, container ships were built to go faster than bulk ships and since container ships were steadily gaining share, the world's fleet speed picked up. But greater speed requires greater energy, as it does in all other modes of transport.

Soaring transport costs suggest trade should be both dampened and diverted as markets seek shorter, and hence less costly supply lines. This is precisely what happened in response to past OPEC oil shocks, as is illustrated by the high sensitivity of the rate of change of world exports as share of global GDP to oil prices, shown in Figure 3.11 below:

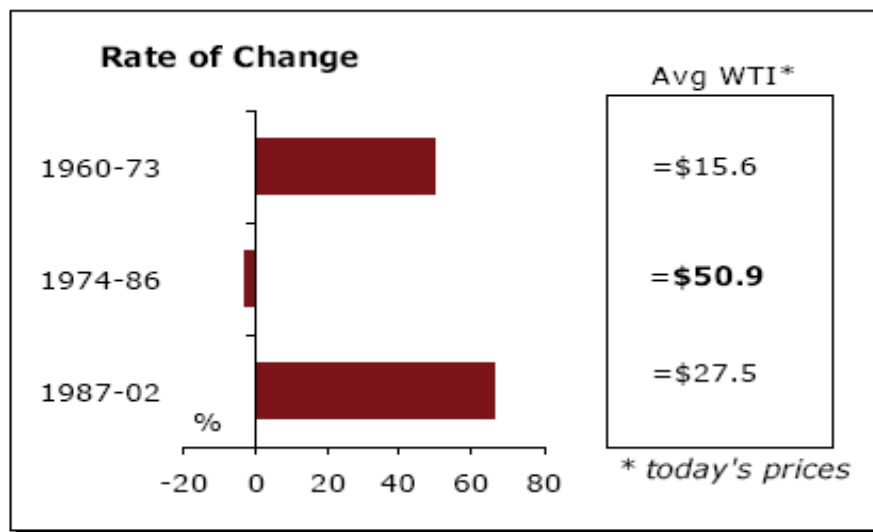


Figure 3.11 World Exports as a Share of Global GDP: Highly Sensitive to Oil Prices

Source: Rubin & Tal (2008)

Between 1960 and 1973, exports as a share of world GDP rose by over 50%, a function of both falling trade barriers and cheap transport costs when oil prices averaged less than \$16 per barrel (in today's prices). Similarly 1987-2002 saw another quantum leap in world trade, spurred not only by a 30% drop in tariffs but by still relatively cheap transport costs based on an average \$27 per barrel oil. In sharp contrast, exports as a share of world GDP slightly decreased between the first OPEC shock and the aftermath of the second, despite a 25% reduction in global tariffs. No doubt the 1974 and 1981/82 recessions dampened trade, but trade should have rebounded strongly on the back of healthy recoveries from those recessions. Annual world GDP growth averaged 3.5%, roughly the same rate as from 1987-2002 which saw world trade to grow again significantly. Trade failed to respond to a pick-up in global growth because transport costs were exploding due to soaring oil prices. Trade not only failed to grow as a share of global GDP but it also diverted along increasingly regional lines.

To what extent the steep increases in transport costs will offset the huge (but shrinking) wage differential between Chinese labour and European labour remains to be seen. Indeed, exactly how much trade, soaring transport costs divert from China (or for that matter anywhere else) depends ultimately on how important those costs are in total costs. Goods that have a high value to freight ratio carry implicitly small transport costs, while goods with low value to freight ratios typically carry significant moving costs. As a matter of fact, a high percentage of Chinese exports fall in the latter category, and there is already some evidence that Chinese exports of freight-intensive goods are beginning to slow under the pressure of rapidly rising transport costs.

In a nutshell, depending on the level of energy prices, world merchandise trade patterns may evolve rather differently. When energy prices are high – in the order of 3-digits per barrel – proximity matters, and regional trade will grow faster than long distance trade, while the contrary will happen when the energy prices are low, provided sufficient demand exists for the goods.

3.2.5 Technological trends

Development of new technology takes place at many different levels combining many different fundamental research and development areas. Among the most important seen from a transport point of view are the development of new engines, new materials, new fuel and new information/communication technologies. Research and development is an ongoing process but the resulting applications often occur in jumps: certain thresholds (legal, financial, technological) need to be overcome before applications are available to the general public.

Development of new technology is a driver for a more sustainable exploitation of the world's resources. And the technology presently being developed is in many cases aimed at facilitating a sustainable development using the latest applications in information and communication technology, in nano-science, and in vehicle and fuel technology. Technological development aims at increasing energy efficiency, increasing utilisation of arable land, de-materialisation and de-carbonisation of economies. Motor cars have become fuel-efficient and the amount of emissions per kilometre driven has dropped significantly. Aircraft have also steadily become more fuel-efficient. In terms of production of energy itself, some forms of renewable energy, such as wind power, are now reliable producers of electricity and have been integrated into national power grids in many areas of the world. Also the management of traffic in urban areas is being streamlined by using network approaches to the flow of vehicles, leading to further gains in fuel efficiency. The planning and implementation of goods transport is being facilitated through the use of ICT, such as optimal route planning, satellite navigation, and load exchanges for minimising empty hauls.

Impact of technology on Transport

In the transport sector, technological development opens up a wide variety of options, in particular for improving car technology in terms of power source and fuel. However, the effective implementation and diffusion of these technologies will require a number of conditions to be fulfilled. This is particularly relevant for the take up of radically new technologies, for which there is a need to overcome introductory barriers such as costs, infrastructure and public acceptance; and to avoid additional side effects elsewhere. The need to earn back investments combined with the extremely long planning cycles in the automotive and aeronautic industries contribute to the risks associated with the introduction of improved and, in particular, radically new technologies.

Another important aspect of technological development in the transport sector is that construction and operation of transportation systems is being transformed by computers, sensors, and communications technology, collectively called information technology (IT). The application of IT to surface transportation is called "Intelligent Transport Systems" (ITS). ITS provides the ability to gather, organize, analyze, use, and share information about transportation systems. In the modern world, this new technological ability is crucial to the effective and economical construction and operation of transportation systems and to their efficient use. As an example ITS is being incorporated by manufacturers in "intelligent equipment" that can be installed as part of the transportation infrastructure to: gather and disseminate traveller information; control traffic signals and variable message signs; electronically collect tolls; and help manage the system. ITS also provides a wide array of in-vehicle technology to improve safety, productivity, and comfort of road travel. The use of ITS in freight transport greatly improves the efficiency of transport chains, both in terms of electronic cargo papers and in route guidance.

Another impact of ICT is improved utilisation of track capacity in the rail sector, allowing higher speeds and shorter intervals between trains due to improved safety distances facilitated by advanced ICT, the so-called ERTMS. Also in the road sector in-vehicle technologies, may improve safety and fuel consumption, providing guidance on optimal driving conditions and foreseeing and avoiding certain types of accidents.

The ability to integrate different ITS systems greatly increases their potential, and also means that they will be inter-operable at European level, a factor of growing importance. Inter-operability includes not only technical, but also operational and organisational aspects. It ensures harmonious and/or complementary functioning of the overall system.

On-road car fuel efficiency development in passenger cars has amounted to about 1 % per year up to mid 1990s and since then about 0.5 % per year. Development in technological progress needs to be improved considerably if mobility in the EU should be kept at the present level per passenger car, whilst at the same time approaching the goals established for reductions of emissions of Carbon Dioxide.

The EU is also driving technological development in terms of the acceptable levels of emissions related to heavy goods vehicles. Presently the norm is EURO 5, which results in considerably less polluting vehicles than the pre-EURO-norm vehicles. In this way the emission of particles, NO_x and HC has been reduced.

Boxes 3.3 to 3.6, taken from the TRANSvisions Case Studies, show examples of current and potential future applications of ICT in transport, and provide examples of the potential attainment of more fuel efficiency.

Box 3.3: Battle hardened, robot-driven cars by 2030

Source: [Dane Muldoon](#), February 2007

<http://www.autobloggreen.com/2007/02/20/battle-hardened-robot-driven-cars-by-2030/>



A scientist speaking at the American Association for the Advancement of Science annual meeting in San Francisco has [predicted robot-driven cars](#) that could drive humans around by the year 2030. Intelligent robot vehicles are likely to be used on battlefields even sooner predicts Sebastian Thrun, an associate professor of computer science and electrical engineering at Stanford University. Thrun is leading the [Stanford team](#) again in this year's 60 mile DARPA Urban Challenge. Computer aided driving systems are already filtering into luxury cars and fully robotic systems are sure to follow. Autonomous Cruise Control is a good example that is already available on a wide range of both luxury and mainstream car brands. The system utilises radar or lasers to monitor the distance between the car and the vehicle in front and will automatically slow the car down or speed up when required. Another example of computer aided driving is Adaptive Braking, a technology found in the new [2008 Mercedes-Benz C-Class](#). Adaptive braking includes hill assistance and panic brake assistance. The hill assistance detects when you are starting on a slope and maintains some brake pressure in the calipers when you move your foot to the accelerator until you actually apply the gas, to keep you from rolling back down the hill. The panic brake assistance detects when you apply the brakes in emergency and helps to apply full pressure.

Box 3.4: Masdar City (Abu Dhabi) To Get Solar-Powered Personal Rapid Transit SystemSource: Michael d'Estries. May 2008: <http://www.groovygreen.com/groove/?p=3034>

One of the more interesting technologies being put into action in Masdar City in Abu Dhabi is the PRT — or Personal Rapid Transit System. Designed to hold six people, these pods, which are solar powered, will travel to more than 1,500 stations distributed throughout the city. Unlike other PRT systems in development, this one will be completely underground. They will basically take you anywhere you want to go. No fixed routes like a Subway.

Box 3.5: The new Insight Concept A small, fuel efficient hybrid car that delivers big style and functionality with a healthy dose of funSource: Honda website. April 2008: <http://corporate.honda.com/press/article.aspx?id=4722>

Honda revealed a concept version of its new small hybrid vehicle, to be named Insight, at the 2008 Paris International Auto Show, October 2nd. The new Insight Concept will provide an early look at the highly-anticipated five-passenger hybrid vehicle. The Insight will advance the affordability and accessibility of hybrid technology to a new generation of buyers. The Insight Concept defines a new stage in the evolution of hybrid technology by utilizing a more cost-efficient motor hybrid technology, resulting in a new level of affordability for hybrid customers worldwide. The Insight Concept is designed with a low center of gravity and a five-passenger cabin. The Insight is expected to have annual global sales of 200,000 units per year - approximately 100,000 in North America. All together, Honda's global sales of hybrids are expected to increase to approximately 500,000 units a year. The original Honda Insight was introduced in December 1999 as America's first fuel-electric hybrid car. Insight was designed from the ground up to demonstrate the ultimate potential for fuel-economy in a two-seater subcompact automobile.

Box 3.6: A Zero Emission Car By Tata Uses Compressed Air To Push The Pistons of MotorSource: George Angus. January 2009. <http://www.examiner.com/x-934-Alaska-Transportation-Examiner~y2009m1d1-Finally-a-zero-emission-car>

Dubbed the MiniCat, this car uses compressed air to push the pistons of the motor instead of a combustible fuel mixture. This means "zero" emissions. The construction is completely different from the standard stamped sheet metal welded to make a unibody frame. It consists of tubular steel and fiberglass married together with industrial adhesive. There could very well be a market for this kind of vehicle in a congested large city where travel distances are short anyway. Tata Motors are indicating a range of about 300 kilometers (186 miles) between fill ups. In India, a fill up should cost less than \$2. The top speed is 65mph. It's anticipated that 6000 of these hit the streets of India in 2008.

3.3 Internal transport drivers

3.3.1 Development and use of Infrastructure

Infrastructure is built for serving the demand for transport, a demand created by the drivers described above. Infrastructure forms homogeneous networks that multiply destination possibilities and offer routing alternatives. Infrastructure creates opportunities for mobility for people and goods. But infrastructure also has the ability to serve as a driver for transport development.

The construction of the Suez and Panama channels changed the main routes of sea borne trade. The development of the Öresund fixed link has created new opportunities for the citizens in Denmark and Sweden, resulting in an integrated housing and employment market. The invention of the air plane opened the possibility for fast travel and, more recently, the introduction of High Speed Trains in France and in other European countries has changed again the nature of long-distance travel. Building of motorways has made it possible to travel fast and safely from one end of a country to another, and between countries. Transport intensive companies prefer to be located near motorways in order to take advantages of the increased accessibility that motorways provide.

Most of the EU's future transport infrastructure is already in place, or is at least in the planning stage. Road networks, rail networks, airports, ports have been constructed over a long period in history, and this infrastructure will also in the future provide the backbone for transport services. However, technological development may lead to new types of vehicles and services being introduced on to this infrastructure. In some cases, though, possible new types of transport systems (vehicle and infrastructure) can be considered for the future, e.g. the magnetic levitated train.

Vehicles and infrastructure already combine together to form integrated transport systems, and this will be more the case in the future due to technological development. The introduction of Intelligent Transport Systems (ITS), as described in 3.2.5, will revolutionize the ways that vehicles and infrastructure interact, creating safer, faster and more efficient transport systems.

The **demand for transport** consists of a multitude of different demands, e.g. passenger and freight, local, regional and international. There is a growing tendency to distinguishing between the passenger and freight transport markets. The two markets use the same infrastructure, although they have very different characteristics. Therefore, there is a tendency to separate them in all modes. Freight transport occupies about 10 % of the vehicle kilometres carried out on the road network (DG TREN (2008)). In the passenger transport market there are demands related to family life and demands related to business. The vast majority of passenger transport in Europe is related to commuting and leisure activities, including holidays.

But infrastructure has inherited weaknesses. Infrastructure can become **congested in** a situation where vehicles compete for scarce capacity, and in such a case some form of rationing is needed. The phenomenon of congestion itself implies time based rationing. Paying for capacity according to social marginal cost pricing will be more efficient and could allow for the financing of extra capacity. Scheduled modes of transport do not experience the same kind of congestion as access to the infrastructure is controlled (apart from buses which access the road infrastructure in competition with other road vehicles). However, overcrowding may take place inside the vehicles of scheduled modes.

Road transport can be carried out in principle over all Europe's borders, though it needs to be taken into account that there are certain limitations on weights and dimensions which are not uniform for all EU countries. However, international movements are generally more complicated in the rail sector since rail infrastructure has for historical reasons

not been integrated across borders. Although the standard gauge is used in the majority of EU member states, there still exist other gauges, which hampers the easy transfer of trains across borders. But gauges are not the only problem. The European railways have for some time worked on improving **interoperability** between the different national networks. Such interoperability relates to safety systems, signalling, ATC, loading gauges, driver's education and electric current systems. The target of European rail policy is to be able to send a train across Europe with the same locomotive, the same driver and without unnecessary stops at borders, thus improving the competitiveness of the rail transport mode. Improving interoperability between the different rail networks is therefore most important. In general, infrastructure is a "scarce resource" and will be even more so in the future as demand for transport increases. It will therefore be very important to utilize the existing infrastructure in the most efficient way possible and to plan for new infrastructure very carefully.

The introduction of containers has revolutionized freight transportation. Use of standardized containers has made it faster, more reliable and efficient to transport goods around the world. It is no longer a problem to transfer goods from one transport mode to another. Swift **transshipment of goods** has become very important and will become even more important in the future. According to UNCTAD, around 30 % of all international sea freight transport is transported in containers.

More generally, it can be said that there is a trend both in freight and passenger transport towards bigger vehicles and vessels, with two main impacts: on infrastructure development and on the level of demand.

1. The impact on infrastructural development involves the pressure put by large ships and planes on port and airport infrastructure, including their access to such infrastructure through the creation of feeder connections. The solutions to such problems will require a large amount of resources.
2. Big vehicles and vessels require sufficient demand. Thus, although there is a move towards bigger vehicles and vessels in order to improve competitiveness by lowering **the price for transport unit** (whether passenger or tonne) and improving the available space per passenger, large vehicles and vessels are only suited to particular types of movement. For example, the A380 airplane is developed only to serve heavily-trafficked long distance routes. Furthermore, the 12,000 TEU containerships, and on a smaller scale double stack trains, are only used on the routes between the main production and consumption sites in the world. The multitude of different transport modes ensures there will be a transport mode available which can almost fulfil every need at the most adequate price. But the price is obviously higher the less the load. The cost of transport is one of the drivers having an impact on both passenger and freight transport.

Reduction in travel costs for the faster modes has promoted their use and a shift to them from other modes.

Figure 3.12 below shows this reduction in costs for the past century. In particular, car driving has experienced a sharp cut in both production and operating costs in the period 1900-1960. This explains partly the success of the car. A similar graph could be made for freight transport where the cost of sea transport has also diminished over time.

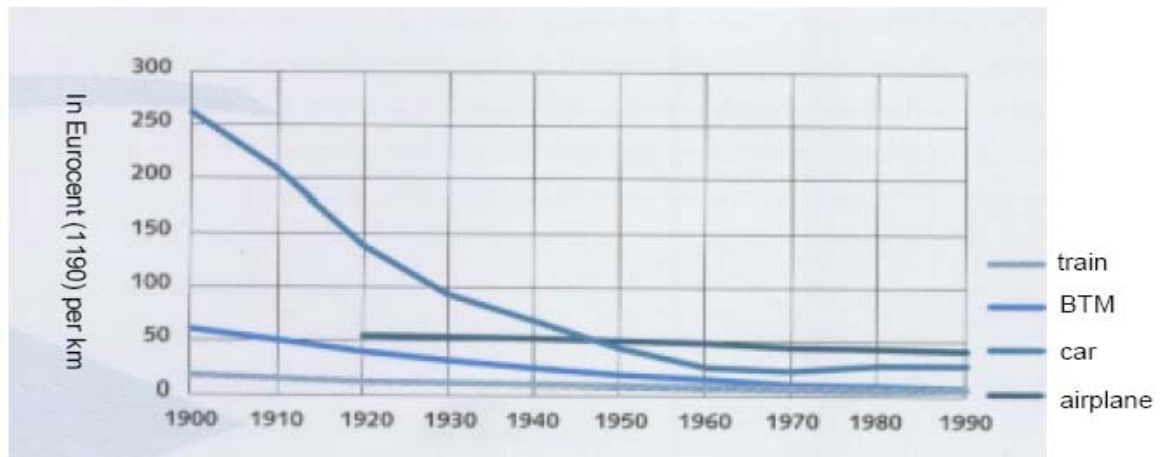


Figure 3.12: Average costs of passenger travel (in 1990 euro per km)

Note: BTM: Bus, Tram, Metro

Source: ECMT, 2002

Transport companies are devoting much energy in developing **optimal supply solutions** for satisfying demand as efficiently as possible. Hub and spoke systems are well known in logistics and freight transport but they are also applied in the air transport sector, in order to ensure that there are sufficient numbers of travellers to fill the major airplanes on the long legs of any trip. Hub and spoke systems have an inherited weakness resulting from the need to change transport vehicle. Travellers need to be content with the system, and therefore transfer time should be kept at a minimum, minimising effort. This point is valid for both freight and passengers. A complicated transfer system in a huge intermodal node is likely to lead to a search for other alternatives, for both the movement of people and goods. Well functioning transfer systems will also maintain an efficient cost regime, which is also of major importance for making transport chains competitive. Problems meeting the demand for swift and comfortable transfer systems could make point-to-point transport popular again. An efficient transport system is a prerequisite for an efficient freight distribution system, where infrastructure, transport modes, vehicles and fuels, warehousing and logistics all together create a system for the efficient handling of goods. Central distribution from one or two warehouses in Europe has become the order of the day, due to the efficiency of the transport system: all transport modes play a vital part in this freight transport system.

Boxes 3.7 to 3.9 show examples, taken from the TRANSvisions Case Studies, of development of new types of infrastructure and vehicles.

Box 3.7: A new generation of more space-efficient airports

Source: Innovations Report website. June 2008

<http://www.innovations-report.com/html/reports/logistics/report-111678.html>

The new JetBlue terminal at New York's JFK Airport will serve twice the number of passengers (20 million) as the recently built international terminal, using just half the space. The new building will cost roughly half a billion US\$. The actual level of air traffic in five, 10 or 20 years and the types of traffic occurring are routinely very far off from original predictions. Leading low-cost airlines with a preference for small, inexpensive airports are now the largest airlines in the United States and Europe, according to an MIT expert on airport design and operations, who said that airport planners in major metropolitan areas need to accept this paradigm shift and build flexibility into airport design. Low-cost airlines require terminals about half the size of those of the legacy airlines, because they use space more intensively. De Neufville recommends flexible design that encourages airport planners to recognize that major airlines may go out of business, air traffic patterns and distribution may change or move to another airport, and incoming airlines may well reject the facility vacated by a previous customer. The solution is to think through the likely possible scenarios, anticipate responses to those, and incorporate maneuverability into design and operations.

Box 3.8: Up to 9,000 TEU containerships in 2010.

Source: Philip Damas. 2006:

http://www.americanshipper.com/paid/MAY01/how_much_bigger.asp

Several shipping lines are close to ordering the first containerships of more than 8,000-TEU capacity, but others in the industry are warning of the associated risks. China Shipping Container Lines is talking to the Korean shipyard Samsung Heavy Industries about orders for a series of 9,000-TEU containerships. When concluded, the orders will be for the world's largest containerships, overtaking Maersk Sealand's "S-class" vessels of about 8,000-TEU effective capacity. Samsung, a shipyard that has led the development of larger post-Panamax containerships in Asia, has designed a 9,000-TEU prototype containership with a length of 330 meters, a draft of 14.5 meters, a width of 45.6 meters and a speed of 26 knots. The width of the ship implies that it will carry 18 containers abreast, one more than the largest containerships afloat today. The vessels would be considerably wider than the 13-container-wide, 32.3-meter Panamax vessel type. The wider vessels will require container terminals to invest in longer cranes that can work 18-container-wide vessels. Meanwhile, Dutch academics are continuing studies about the suitability of introducing, by 2010, a revolutionary vessel type called the Malacca-max. The 18,000-TEU Malacca-max vessels would have the maximum size and draft to transit the Strait of Malacca in Southeast Asia.

Box 3.9: Japan plans world's fastest maglev train: More than 500 km/h by 2025

Source: AFP. December 2007:

<http://afp.google.com/article/ALeqM5jks9rWTSoaNZk6h9wXJpjmhfHg>

Central Japan Railway Co. (JR Central) plans to build a maglev linear-motor train between Tokyo and central Japan at a cost of 5.1 trillion yen (44.7 billion dollars) by the 2025 financial year, a company spokesman said. The Shanghai train, launched in 2002, travels at 430 kph for the 30.5 kilometre run from Pudong airport to the financial district, according to the Shanghai Maglev Transportation Development Co.'s website. JR Central's magnetic-levitated train hit 581 kph in 2003 in a trial run on a test course in Japan's central Yamanashi prefecture, the spokesman said. The maglev train would enter service at a time when Japan looks for a successor to its famed "Shinkansen" bullet trains, which were first rolled out to the world's awe for the 1964 Tokyo Olympics. Japan's fastest train remains the Sanyo Shinkansen run by JR West in western Japan, which travels at 300 kph. The world's fastest train using conventional railway technology is currently France's TGV, which runs at 320 kph. The JR Central board approved the plan and estimated that it would leave the company with a five trillion Yen debt when the train goes into service in the financial year to March 2026. The firm projects the train will bring in five percent additional revenue in the first year, shrinking JR Central's debt to the current level within eight years of operation, a statement said.

Impact of infrastructure demand

In the case of new road infrastructure, mobility can be expected to increase on average by 10 % in the short term and by 20 % in the longer term, although the spread is extremely large since **induced traffic** can vary according to local circumstances and factors of a primarily macroeconomic nature. In the long term, induced traffic can be influenced by higher wages, the cost of using private cars, and the price and attractiveness of other modes. At the local level, the volume of induced traffic will depend upon the size of the new investment in capacity (i.e. the higher speed it allows), existing congestion, local geographical conditions (land use for different activities) and the existence and attractiveness of alternative roads³.

Particularly in congested cases it is doubtful whether an expansion of infrastructure capacity will improve the mobility in the long term. Analyses have shown that expansion of infrastructure capacity in uncongested cases has a limited effect on mobility, whereas expansion of road infrastructure capacity in congested cases leads to a fast development of mobility, and a possible change of land use encouraging urban sprawl along the expanded infrastructure⁴. Whilst, a part of the new demand is latent demand suppressed due to high costs of congestion, another part may be real new demand. There is a tendency to underestimate or even neglect the negative consequences of induced traffic in circumstances where relief of a congested situation, based on infrastructure capacity expansion, is generating a new congested situation at a higher level. Pricing policies, intelligent transport systems to regulate traffic, or improvement of alternative transport modes as an alternative to infrastructure (road) capacity expansion can be considered in any case as a necessary previous step and as a complementary measure to manage the future demand.

³ Infrastructure-induced mobility, Round Table 105, page 293, OECD, November 1996

⁴ Litman, Todd: Generated Traffic and Induced Travel, Implications for Transport Planning, Victoria Transport Policy Institute, 17. Sept. 2007

Box 3.10: London new urban road pricing: Cordon Tolling since April 2003 (30% traffic decline, 60,000 less cars per day, - greater than expected)

Sources: Transport for London: <http://www.tfl.gov.uk/roadusers/congestioncharging/6722.aspx>

International Urban Road Pricing. Final Report. Work Order 05-002: Issues and Options for Increasing the Use of Tolling and Pricing to Finance Transportation Improvements. U.S Department of Transportation. Federal Highway Administration June 2006



London implemented a central area congestion pricing scheme in February 2003 that required the payment of a daily £5 fee to travel within central London between 7:00 am and 6:30 pm, Monday through Friday. The daily rate was increased to £8 per vehicle in July 2005. The fee is enforced through the use of cameras which record the license plate numbers of every vehicle entering the central city and match the license plate numbers to payments made. The technology selected to administer and enforce the congestion charging scheme is a videobased license plate recognition system. This system requires the installation of cameras at entry points and software to accurately read license plate numbers as they enter the zone at speed and link those license plate numbers to a payment. The system charges the same fee regardless of the amount of travel made by a vehicle in the city centre on a given week day. The system is also unable to catch more than 80 percent of the violators due to issues with the cameras or the license plate reading software. The Central London congestion pricing scheme has been particularly successful in reducing congestion within the charging area but less successful in generating revenues for transportation improvements. Car movements have decreased by 60,000 vehicles daily since the congestion pricing scheme was implemented in 2003. After the first year of the initiative, the amount of traffic entering the cordon zone had declined by 18% while the extent of traffic jams (congestion) within the cordon zone declined by 30%. In comparison, there was a 30% rise in taxi use and a 20% increase in bus movements in the zone, both modes being exempt from paying the congestion charge.

When building new infrastructure public authorities can either let the users pay for the investment themselves or can let the taxpayers pay. In order to reduce the burden on taxpayers for raising finance, different types of **Public-private partnership (PPP)** schemes may be devised. PPP schemes describe a government service or private business venture which is funded and operated through a partnership of government and one or more private sector companies. In some types of PPP, the government uses tax revenue to provide capital for investment, with operations run jointly with the private sector or under contract. In other types capital investment is made by the private sector on the strength of a contract with government to provide agreed services. In projects that are aimed at creating public goods like in the infrastructure sector, the government may provide a capital subsidy in the form of a one-time grant, so as to make it more attractive to the private investors. In some other cases, the government may support the project by providing revenue subsidies, including tax breaks or by providing guaranteed annual revenues for a fixed period.

3.3.2 Environmental trends

Environmental issues are having an increasing impact on transportation. This happens both in terms of increasingly tight regulations on emissions, but also in recognition of the impact of population increase and modern life on the environment, landscape, biodiversity, and mankind's own life. In order to maintain the mobility which is one of the basic necessities in modern society it is at the same time important to ensure that the mobility is sustainable, that is does not inflict irreparable damages to the environment. At the same time it is important to take into consideration transportation related aspects like accidents, safety, noise infliction, emissions in order to minimise the effect of these aspects.

Climate

Climate is a key part of natural systems, and a number of important factors for human welfare can all be significantly influenced by fluctuations in climate. Climate varies across a broad continuum of timescales in response to a wide variety of influences.

The global average surface temperature has increased by approximately 0.7° C since systematic measurements began around 1850. More in detail, globally averaged surface air temperature records indicate two periods of strong global-scale warming in the past century: the first took place from 1910-1945; the second began in 1976 and has not yet stopped.

Summarising the findings of current research on the subject, the report of the UN Intergovernmental Panel on Climate Change (IPCC), presented in early 2007, comes to the clear conclusion that a leading factor in the world's climate warming has been anthropogenic emissions of greenhouse gases, particularly CO₂ from the combustion of fossil fuels. This is now at levels never recorded in over half a million years. According to the IPCC an increase of more than two degrees Celsius in the global average surface temperature, which is estimated to correspond to a CO₂ concentration of 550 ppm, has the potential to cause significant damage to the eco-systems on which we are directly dependent.

The principal gases associated with GHGs are carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). Carbon dioxide is the dominant GHG, accounting for about 75% of global emissions in 2005. And the emissions have grown fast in the last 15 years, particularly in major developing countries like Brazil, India and China. Despite this, the per capita GHG emissions in BRIC (Brazil, Russia, India and China) countries were only about one-third of those in OECD countries in 2005 (the equivalent of 5.1 tonnes of CO₂ per person in BRIC countries compared with 15 tonnes of CO₂ per person for OECD countries).

OECD simulations comparing the likely effects of different policies to mitigate climate change suggest two key messages: doing nothing is not an option as the consequence of inaction are high; and achieving ambitious climate stabilisation goals could be affordable, costing roughly a half a per cent of GDP by 2030, but only if we start today and implement the least-cost solutions already available. If nothing is done, global GHG emissions are projected to increase by 52% by 2050 which corresponds to a raise in mean temperature of between 1.7° C and 2.4° C, compared to pre-industrial levels, in 2050.

OECD analysed a policy scenario, where all the major GHG emitters phased-in over several years a tax of USD 25 (escalating at roughly 2% a year) on every tonne of GHG produced. This resulted in global emissions being stabilised at 2000 levels by 2050. Putting in place an immediate tax of USD 25 per tonne of CO₂ – equivalent imposed by all nations today would see global emissions fall to about 21% below 2000 levels by 2050. A more ambitious scenario was also simulated, reflecting a phased-in tax set at the level necessary to limit atmospheric concentrations to 450 ppm of CO₂ – equivalents in the atmosphere in the long term. This would lead to a reduction in global emissions by about 40% in 2050 compared to 2000 levels.

According to the OECD simulations, the global economic costs of limiting climate change are not insignificant, but they are manageable, even for the most ambitious case. Total loss of GDP would be just under 2.5 % in 2050. This can be compared to estimates of damage costs of uncontrolled climate change of about 5 – 20 % of world GDP.

However, the real problem is not the total cost of action, but how it would be distributed around the world, since many developing countries may face far bigger GDP losses than the industrial world if a straightforward global tax policy was used. For example, in the 450 ppm case, the OECD would lose 1.1% of GDP in 2050, but the BRIC countries would lose five times as much – a loss of 5.5% of GDP in 2050. The OECD policy simulations

suggest therefore a need for a mechanism for sharing the burden of the costs of global GHG emissions reduction action (e.g. by enforcing a world-wide emission trading permit system).

CO₂ emissions from the transport sector attract the attention of both transport and climate change policymakers because of their share of overall emissions and their persistently strong growth. Over the past three decades, carbon dioxide emissions from transport have risen faster than those from all other sectors and are projected to rise more rapidly in the future. From 1990 to 2004, the carbon dioxide emissions from the world's transport sector have risen by 36.5%. For the same period, road transport emissions have risen by 29% in industrialised countries and 61% in the other countries (mainly developing countries or countries in transition, IEA 2006). Figure 3.13 below shows the projected increase in transportation CO₂ emissions by world region for 2050.

At present industrialised countries are the main sources of transport emissions. However, the proportion of emissions being produced in developing countries is increasing rapidly, particularly in countries such as China and India. World CO₂ emissions from the transport sector are projected to increase by 140% from 2000 to 2050, with the biggest increase in developing countries.

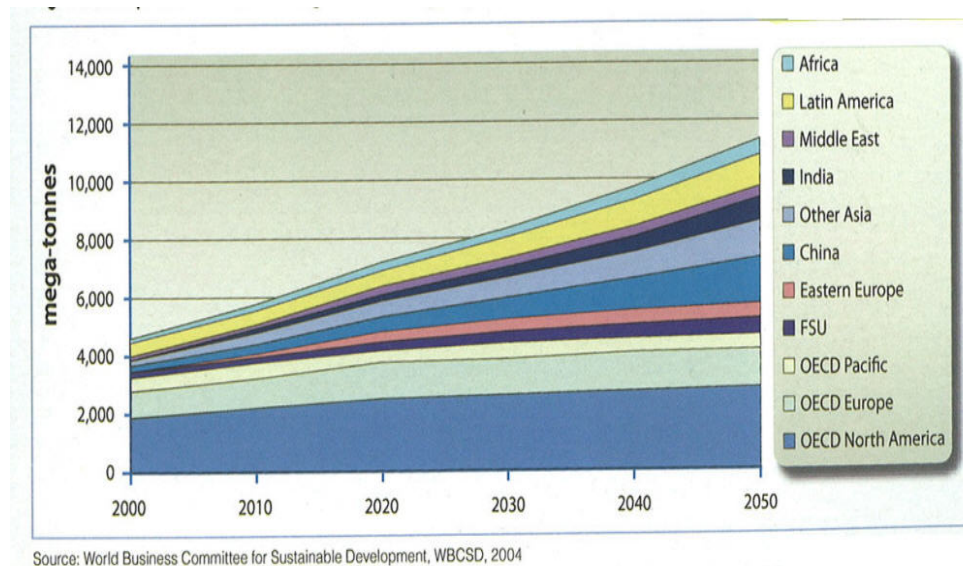


Figure 3.13 Transport vehicle CO₂ emissions by regions

Environmental impacts

Indeed, emissions from transport represent a very high share of overall emissions. Besides CO₂ emissions discussed above, the main components of transport emissions include: Particulate matters (PM); Nitrogen Oxides (NO_x); Sulphur Dioxide (SO₂); Carbon Monoxide (CO); lead (Pb); benzene; and volatile components (CmHn). The contribution of harmful emissions (acidifying substances, particulate matter and ozone precursors), has decreased by 30% to 40% from the 1990 to 2004 with exclusion of maritime transport and aviation contributions. Nevertheless, air quality in the areas immediately adjacent to transport activity, particularly in urban areas, is still a central problem mainly on account of adverse impacts for human health of pollutants such as particulate. And the growing use of diesel cars may contribute further to health problems. However, transport activity causes also environmental impacts due to:

- noise pollution, mostly connected to road traffic and aircraft movements;

- congestion, e.g. inefficient use of transport infrastructure, infrastructure scarcity at certain times of the day, week or year;
- emissions from upstream and downstream processes, namely fuels production, vehicle production and maintenance;
- accidents, which cause loss of human lives, as well as release of hazardous goods and materials during their transport, such as crude oil into the sea;
- provision and utilization of transport infrastructures (roads, rails tracks, dams, bridges, airports, etc.) leading to: landscape fragmentation; loss and disturbance of habitats and species; and the long term influence of partitioning and isolating ecosystems and species population. Additionally, in urban areas, the use of urban space for transport leads to a scarcity of space for other uses.

Internalisation of external costs

A major part of the problem with environmental degradation lies in the fact that many of the costs related to the aspects above are external to the transport system. One way to correct this problem and create the appropriate deceleration of environmental degradation is to “internalize” these external costs. This could be done by taxing environmental degradation (i.e. Pigouvian taxes), establishing cap and trade systems, or estimating the true external costs (including life-cycle impacts) and charging accordingly in all stages.

Because most transport modes fail to fully cover their external costs, users often pay a lower price for their mobility than the real cost to society and the environment, keeping in many cases demand artificially high. Existing excise and vehicle taxes on road transport internalise only partially and inefficiently external costs. Confronting users with these costs by imposing charges on infrastructure use could ensure a more efficient usage of transport, while addressing some of its negative consequences and, at the same time, raising funds for investing in new or optimised infrastructure and alternative transport modes including related information technology.

At the EU level, there are two main directives on charging: Directive 2006/38/EC on the charging of heavy freight vehicles for the use of certain infrastructures and Directive 2001/14/EC which includes rules on charging for railways. In both cases, operators may be asked to pay to recover the costs of infrastructure construction and operation. However, the so-called road “Eurovignette Directive” excludes the possibility of adding any mark up on to toll prices for environmental and health costs. The same is true for railways. Conscious of this problem the legislator required in the Eurovignette directive the development of a “common methodology for the calculation and internalisation of external costs that can be applied to all modes of transport” including a strategy for the stepwise implementation of the internalisation model proposed. Following this request, such a strategy has been developed together with a proposal to review the Eurovignette directive so that it allows Member States to internalise external costs.

The idea of establishing a uniform “user-pays” system for all forms of transport is not new, but it has usually been brushed under the carpet due to the complexity of calculating external costs. The question of which costs should be considered as transport-related externalities (whether it should just be congestion, CO₂ emissions, or also factors like the hospital costs of people involved in traffic accidents) is the main bone of contention, including the derived aspect of how to measure these costs. Another issue is what to do with the money raised from internalising these costs: Add them to the general budget; subsidise new infrastructure for the taxed transport mode; or cross-subsidise cleaner transport alternatives?

3.4 The results of the DELPHI survey

In order to consolidate the professional consensus around the short list of identified key drivers, a DELPHI survey was carried out among experts internal and external to the consortium. The survey and the subsequent external expert workshop provided valuable input to the analysis of the drivers, and to the prioritization of the importance of drivers, as described below.

In general, a DELPHI analysis involves a survey of experts' opinions for identifying developments and/or trends, who reach gradually a convergence of opinion without physically getting together. The essence of the technique comprises questionnaires sent out to the same group of experts (often several times, each time adding to the results of the previous rounds). The concept behind the DELPHI method is to facilitate an "expert discussion", in contrast to a simple survey, whilst at the same time allowing for independent and, in principle, anonymous contributions of the participants.

More specifically, the 23 experts involved in the TRANSvisions DELPHI survey (between June 2008 and the TRANSvisions workshop in July 2008) were asked to give their educated guesses about the evolution to 2050 of 39 key indicators, related to five main transport drivers (society, economy, energy, technology and environment).

The experts' responses were compared with a set of "BAU (Business as Usual)" projections for particular indicators, taken from statistics and research projects, when such BAU estimates were available. When BAU estimates were not available, the experts' individual responses were compared with the average guesses given by the experts' group.

The indicators for which BAU estimates were available include: Society (Total Population; Ageing as % > 65; Net immigration; Urbanization %); Economy (GDP growth and Employment rate); Energy (Gross electricity generation, Renewables share, Nuclear share, Coal share, Oil share, and Gas share) and Environment (CO₂ emissions).

The experts' opinion for a short list (21) of the most important indicators are listed in Box 3.11.

Box 3.11: Short list of the most important indicators

Society

1. Total Population
2. Ageing as % > 65
3. Net immigration (thousands people/year)
4. Urbanization %
5. Work-time regimes (tele-working %)
6. Tourism (Num. of tourists)
7. Safety (Number of injured people)

Economy

8. GDP growth
9. Trade
10. Employment %

Energy

11. Energy supply (Gross electricity generation Renewables share)
12. Energy supply (Gross electricity generation Nuclear share)
13. Energy supply (Gross electricity generation Coal share)
14. Energy supply (Gross electricity generation Oil share)
15. Energy supply (Gross electricity generation Gas share)
16. Share of biofuels in total final consumption of petrol/diesel for transport
17. Prices of fuel €/litre

Technology

18. Share of hydrogen fuelled cars
19. Share of electric cars

*Environment*20. CO₂ emissions21. CO₂ emissions from transport

- The experts' evaluations for the Society indicators (basically demographic indicators) indicated that by 2050 the impact of net immigration will exert an upward pressure on the total EU population.
 - In fact, 94% of the answers considered that future net immigration would be at a level more than 20% higher than the BAU trend (which was taken from the Ageing Working Group of the EU Economic Policy Committee).
 - This would imply a higher EU population (61% of the answers considered that the future EU population will be more than 20% higher than the BAU trend) and a younger population than the BAU forecast (72% of the respondents considered that the share of people > 65 years living in Europe in 2050 would be lower (by more than 10%) than the BAU trend).
 - Concerning urbanization trends, the experts' evaluations basically agree with the BAU trend at 2050 (from the UN World Urbanization Prospects). In fact, 90% of the respondents' answers lay in a range of between +10% higher/lower than the BAU trend.
- The experts' evaluations for the Economy indicators reflected the major uncertainties underlying the assessment of the future economic situation, as compared to the more predictable demographic projections.
 - The estimates on GDP growth rates showed both pessimism about the future (35 % of the experts considered it possible that GDP growth would be more than 20% lower than the BAU estimate) and optimism (41% considered that GDP growth would be more than 10% higher than the BAU estimate).
 - However, the pessimistic approach was more dominant with respect to future employment rates, with all the respondents considering possible a reduction between 10% and 20% compared to the BAU estimate.
- The experts' evaluations for the Energy indicators provided the following picture:
 - 80% of the respondents considered that gross electricity generation in 2050 would be supplied by more than 20% less gas and oil than in the BAU estimate (from the World Energy Technology Outlook project).
 - There will be more use of renewables (about 80% of the respondents considered that the share of renewable would be more than 20% higher than the BAU estimate).
 - No clear patterns could be identified for the use of nuclear and solid fuels sources.
 - Optimistic evaluations have been provided for the share of biofuels in transport fuel consumption, more than 20% higher compared to the BAU share (from the IEA Energy Technology Perspectives 2008 – Scenarios at 2050)
- Concerning the Environment indicators, the experts evaluations about the future CO₂ emissions are optimistic.
 - About 64% of the respondents considered that it would be possible to reduce CO₂ emissions in 2050 by a percentage by more than 20% compared with the BAU forecast (from the World Energy Technology Outlook project).
 - However, with reference to the CO₂ emissions from transport, the opinions were more pessimistic (60% of the respondents considered that the share of future CO₂ emissions from transport would be more than 20% higher than the BAU estimate).

Concerning the indicators for which no BAU forecast are available, the experts' estimates were evaluated by comparing the individual responses with the average value for each indicator. A consensus about future evolution could only be found for the following indicators:

- Trade flows as share of GDP, with 80% of the respondents' estimates ranging between -10% and + 10% from the average value.
- Total GDP nominal value, also with 80% of the respondents' estimates ranging between -10% and + 10% from the average value.

The results of the DELPHI survey were discussed during the TRANSvisions workshop on 9th July 2008, focusing on the following drivers and key issues:

- Technology (vehicles, intelligent traffic management, new energy sources...)
- GDP growth trends / personal income evolution
- Infrastructure availability
- Population / employment evolution
- Transport prices (energy prices / other logistic prices / e-commerce)
- Urbanization: distribution of people in the territory // accessibility
- Environmental constraints
- Policy regulation (free market // institutional framework...)

The following observations emerged in the debate with regard to the drivers and trends that had been considered as most important by the participants:

- **Policy making.**
 - Policies and taxation have minor effect on long distance traffic in comparison to large megatrends.
 - The ESPON policy oriented scenarios showed that differences between Cohesive and Competitive Scenarios were very limited⁵.
 - Demography or urbanization trends have small impacts as well, as their effects on transport can only be seen on the very long term.
 - Other factors, such as improvement of technology or changes in infrastructure stock have much more accelerated effects.
 - Some radical policies, however, can change the status quo. 250 years ago, the British Government passed laws on land expropriation in order to enable adequate construction of infrastructure. In the 1900s, the government forbade building in green belts. Nowadays, people need to ask for permission prior to building in a certain place. All these policies were radical when introduced, but are assumed normal nowadays.
 - Could the Commission moderate transport through radical policy making, mainly on city morphology design regulations and integrated transport modes?
- **Energy Prices.**
 - Transport costs are very sensitive to energy prices, especially to oil. However, traffic flows are less sensitive to transport costs.
 - For passengers, the key element in transport is its cost in relation to people's personal income. If personal income rises, rising transport costs are not a substantial problem.
 - For freight, 90% of traffic flows in Europe are less than 100km long. In this interval, there are no alternatives to road traffic (oil fuelled transport), neither there will be in the next 20 years.
 - 80% of traffic is not price sensitive. Transport prices may be internalized in goods' prices, but transport flows are not reduced.
 - Technology is to provide a solution to increasing energy prices.
- **Passenger traffic**
 - Passenger traffic is very much related to both personal income and travel time. People are willing to travel, and are disposed to spend a certain amount of their income (i.e. 10 to 15% of their personal income) and of their time (i.e. 1h per day) for travel.

⁵ ESPON 3.2: Spatial scenarios in relation to the ESDP and EU Cohesion Policy

- Passenger mobility will thus react to growth of GDP per capita and to transport speed changes. As transport modes have become faster in cities, people have moved farther away from downtown locations (e.g. TGV commuters)
- The success of low-cost air companies has led to a boom in air traffic flows, and has allowed new types of trip that didn't take place in the past, mainly in tourism.
- **Evolution of logistics.**
 - Current goods' costs are much more influenced by production costs rather than distribution costs. That is why producing in China and then shipping to the EU is nowadays cheaper than producing directly in Europe.
 - However, should distribution costs rise in a dramatic way (i.e. a rise of transport prices), or EU production costs diminish substantially (EU productivity increasing strongly, protectionist policies), the balance between production costs and distribution costs could be altered significantly.
 - Delocalization of production towards Asia could diminish, as production could become located closer to the EU, such as in the Maghreb countries, or could even return to Europe.
 - Japan has actually succeeded in keeping a quite important share of industrial production due to high productivity indexes.
- **Migration.**
 - Europe's population is predicted to reduce in about 20 to 30 years, according to current forecasts, with more than 40% of people being 65 or more.
 - No society can afford such an elderly population: new immigrants will be needed to come to the EU to take up jobs that are not being taken by local population.
 - By 2030, it is estimated that some 200 million immigrants will be needed to fulfil the needs of the economic system, or else Europe's economy will not survive.
 - There is the possibility that jobs will be filled by "invited workers", who come to Europe to work for a period of time and then return to their origin countries. The dynamics of this phenomenon are related on border permeability policies, as weak borders allow people to enter and leave easily, whilst strong borders encourage people to stay due to the difficulty in re-entering later on.
- **Tourism**
 - Tourism is predicted to grow steadily.
 - As millions of people are to become "middle-class" in Asia in the next 20 years, Europe will become a theme park for extra-EU visitors: between 300 and 600 million Asian tourists will be travelling yearly to Europe. This estimate implies a large growth of transcontinental flights, especially towards consolidated tourist areas such as Paris and London, but also towards Italy, Barcelona and Berlin.
 - Internal EU air traffic is predicted to grow as well, as new tourists move according to itineraries between major destinations, and new tourist transport routes are to appear such as long distance high speed rail services targeted on tourism.
 - North to South EU tourism is predicted to grow steadily as well. As air travel is cheap and weather conditions in the South are milder than in Northern countries, thousands of northerners are predicted to travel southwards for leisure, medical and shopping purposes.
 - Population ageing and the increasing well-being of the aged will increase flows even more. Residential tourism in Spain, Italy, Croatia is already booming, as Northern Europeans are purchasing second residences there: either retired people spending winters in the south, or liberal professionals spending 3 or 4 days per week thanks to their work flexibility.

- **Integration and/or more segregation?**
 - These two driving forces interrelate to generate different transport trends, not always in the same directions.
 - The tendency to homogeneity (GDP per capita equity, regional GDP equity) is to prioritize many-to-many transport fluxes (intercity, and interregional), with increased mobility for everybody
 - The tendency to heterogeneity (a few are rich and many are poor; regional disparity) leads to the prioritization of a few nodes over all the others. Few people are able to travel, and there is the development of exclusive transport services, with more segregated networks.
 - Gregariousness together with increased mobility fluxes may bring transport segregation according to travel purpose (tourist trains versus business trains, charter flights versus private jets), while individualism may increase car use.
- **Tele-working**
 - It is difficult to make future estimates about tele-working. In 2050 it is likely that it will be difficult to distinguish “tele-workers” from “non-teleworkers”, since most people will be “part-time tele-workers”.
 - People will work at home, in the office, or in their weekend apartments as it suits them.
 - People will tele-work some days of the week, and they will tele-work as they travel
 - But they will still do some face-to-face work due to human relationship needs, which are fundamental in business.
 - Tele-work indicators should be based on “full equivalent tele-workers”.

3.5 Policy drivers

3.5.1 Sustainable Development Strategy

Policy is an important factor affecting transport, and policy has the possibility to change the factors described above as drivers of transport. This section outlines some of the key policy drivers, concentrating mainly on world and EU governance.

As an introduction to policy drivers the sustainability perspective should be stressed. There are three primary “axes” of sustainable development, comprising economic, environmental and social dimensions. This is made explicit in the overall objective for sustainable transport within the Sustainable Development Strategy (the Gothenburg Agenda), which is to “ensure that our transport systems meet society’s economic, social and environmental needs whilst minimising their undesirable impacts on the economy, society and the environment”.

3.5.2 EU transport policy

EU transport policy in its present form, or rather the view that the European Commission has about it, was developed in the following documents:

- the 2001 White Paper: Time to Decide;
- the Mid-Term Review: Keep Europe Moving; and
- the 2007 Green Paper: Towards a New Culture of Urban Mobility.

The 2001 White Paper is a comprehensive document covering a large amount of transport topics, structured according to the following policy issues:

1. Shifting the Balance Between Modes of Transport (subdivided between “Regulated Competition” and “Linking up the Modes of Transport”)

2. Eliminating Bottlenecks (subdivided between “Unblocking the Major Routes” and “the Headache of Funding”)
3. Placing Users at the Heart of Transport Policy (subdivided between “Unsafe Roads”, “The Facts Behind the Cost to the User”, “Transport with a Human Face” and “Rationalising Urban Transport”)
4. Managing the Globalisation of Transport (subdivided between “Enlargement Changes the Name of the Game” and “The Enlarged Europe Must be More Assertive on the World Stage”).

As a very simple summary, the White Paper covers, in (1) and (2), transport policy-making in traditional terms as an economic activity (putting emphasis upon congestion and bottleneck problems), albeit with a heightened emphasis upon the negative environmental impacts of transport (and thus stressing the need for switching to more environmentally-friendly modes). On the other hand, “new” directions (or at least less prominent directions within traditional transport thinking) are opened up in (3) and (4), which cover the human dimension of transport and the EU’s place in the world respectively. In fact, it could be argued that the policy-thinking in (1) and (2) represent the state-of-the-art for a well-established “economic plus environmental” way of thinking about transport, whilst future innovative policy development will come with increased thinking along the lines suggested by (3) and (4) (though building of course upon the principles embedded in (1) and (2)).

In 2006, the EC published its Mid-Term Review of the 2001 White Paper. This publication was preceded by an impact assessment of the White Paper and a number of consultation exercises. Drawing from a conference in the consultation process of Mr Jacques Barrot (at the time Vice-President of the Commission in charge of transport) the main approach taken can be summarized as it follows:

- Mobility cannot be restrained; even if one wanted to, economic growth implies a growth of transport. The road traffic of goods (international) has to double between now and 2020, as well as air traffic. In EU12, the use of cars increases at a rapid pace. Therefore, there is no question of restraining mobility.
- Mobility is a major asset for competitiveness. One must break with the dogma of the decoupling of the growth rate of transport with the growth rate of GDP. The transport strategy is an essential element to achieve the Lisbon objectives.
- The negative effects must however be averted: traffic congestion, the cost of which is estimated at 1% of the GDP of the EU; environmental pollution (about 27% of the CO₂ emissions come from transport); insecurity on European roads (44,000 deaths per year) and the increased risks of air transport related to continuous traffic growth.

The Mid-Term Review introduced the concept of decoupling from the negative effects of transport rather than between transport and GDP. The mid-term review also introduced also the concept of co-modality defined as the efficient use of the different modes on their own and in combination. The prevailing view in the Commission is that transport policy should facilitate mobility rather than manage it: after some years of slow economic growth the emphasis on mobility as a precondition for competitiveness was raised at least to the same level of importance as environmental sustainability. Demand management as such does not feature in the mid-term review, although more work on pricing which is one of the main demand management tools was announced. The mid-term review contended that the focus of transport policy needed to be revised because of a combination of emerging issues and developments such as: the substantial enlargement of the European Union in 2004; recent changes in the transport industry; evolving technologies and new innovations; and energy supply and security issues (raised in importance as a result of the New York, London and Madrid terrorist attacks).

The 2007 Green Paper on urban mobility represents state-of-the-art thinking about the subject. Throughout, the question “What could be the potential role of the EU?” is repeated. One answer to this question could be to strengthen the role of “EU as facilitator”. Furthermore, a Staff Working Document accompanying the Green Paper, discusses pub-

lic participation approaches. With the coming of the internet age, various possibilities are opened up for public participation.

3.5.3 Enlargement and cohesion policy

The 2001 White Paper makes a connection between EU transport policy and EU enlargement policy. In fact it is self-evident that enlargement, accompanied by the removal of barriers to movement and the encouragement of an internal market, has and will have a significant impact on mobility.

The EU Cohesion policy in the transport field is orientated to increase the accessibility of the countries and regions which benefit from that policy. Better accessibility means indeed less transport costs, less "peripherality" and therefore more traffic. European cohesion policy has been quite active in the provision of transport infrastructure.

3.5.4 Environmental and climate policy

Given the well-established environmental impacts of transport (as emphasised in the 2001 White Paper) it is clear that environmental policy is an important "policy driver" for transport. National governments have initiated environmental management strategies that include measures to control air and water pollution. International environmental organisations and regimes have also played major roles including, but not limited to, the United Nations Environment Programme (UNEP), the Montreal Protocol (concerning substances that deplete the ozone layer), the United Nations Framework Convention on Climate Change (UNFCCC), and the Kyoto Protocol (concerning CO₂ emissions). Arguably, the environmental factor that has been of most importance to the long term future of transport has been climate change. The Kyoto protocol contains legally binding commitments. Most OECD countries have agreed to reduce their anthropogenic greenhouse gas emissions (carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride) by at least 5% below 1990 levels in the commitment period 2008 to 2012.

An important contribution by the EU for meeting climate change targets is provided by the European Union Emission Trading System (EU ETS), which is the largest multi-national emission trading scheme in the world, and is a major pillar of EU climate policy. The ETS currently covers more than 10,000 installations in the energy and industrial sectors which are collectively responsible for close to half of the EU's emissions of CO₂ and 40% of its total greenhouse gas emissions. Under the EU ETS, large emitters of GHG emissions within the EU must monitor and annually report their GHG emissions, and they are obliged every year to return an amount of emission allowances to the government that is equivalent to their GHG emissions in that year.

In the framework of the Climate and Energy Package the European institutions have set up legally binding targets, by 2020, to cut greenhouse gas emissions by 20%, to establish a 20% share for renewable energy, and to improve energy efficiency by 20%. The GHG objective could be revised upwards to 30% if a satisfactory international agreement is reached. Moreover the European Council has expressed its wish to aim at a global reduction of 80% by 2050 compared to 1990. The total effort for GHG reduction is divided between the EU Emissions Trading System (ETS) and non-ETS sectors under the Effort Sharing Decision⁶. Most of the transport sector, together with housing, agriculture and waste sectors is among the latter. The ETS sectors will reduce emissions by 21% compared to 2005 by 2020, the non-ETS taken as a whole will reduce their GHG emissions by 10% within the same period; together they will reduce GHG by 20% compared with 1990. Electric railways are already covered by the ETS system through their power purchases. Aviation will be subject to ETS from 2012 for its CO₂ emissions⁷.

⁶ http://www.europarl.europa.eu/news/expert/background_page/064-44005-343-12-50-911-20081208BKG44004-08-12-2008-2008-false/default_p001c002_en.htm

⁷ EU ETS is about GHG, aviation is included for CO₂ only.

Road transport, navigation and the private car are not subject to ETS. For them as for the other non-ETS sectors it will be left to individual Member States to define the GHG reduction objectives to be reached by each of the individual non-ETS sectors and to implement their own measures. Figure 3.14 shows the non-ETS targets for EU Member States

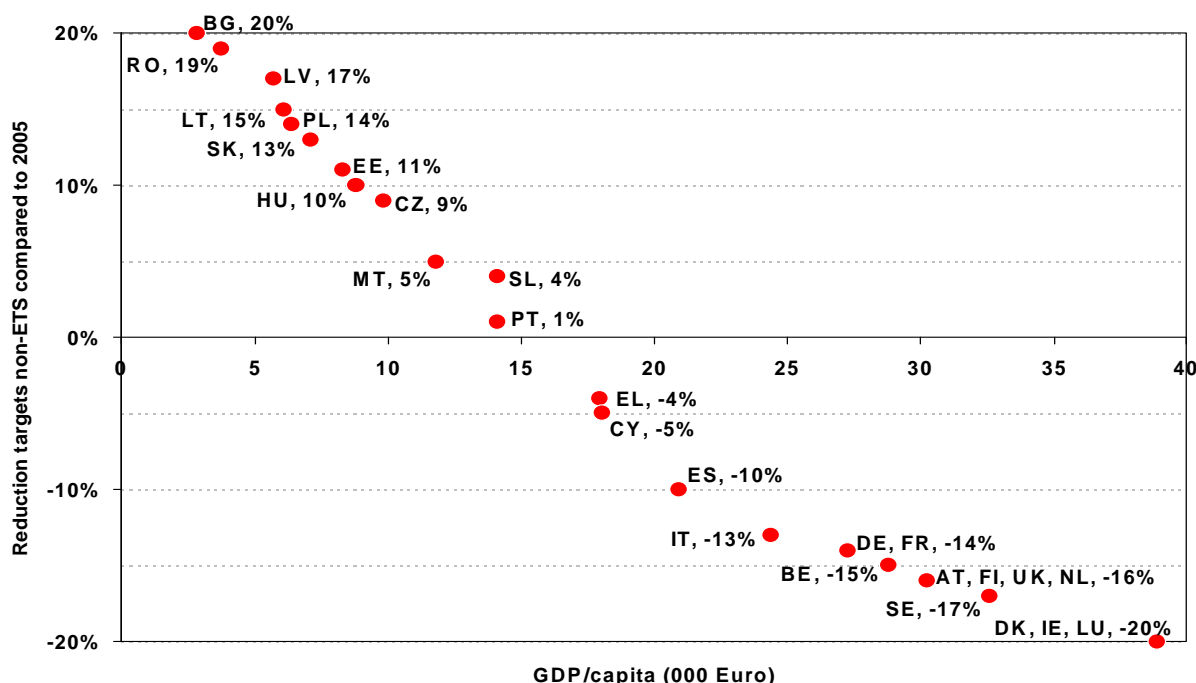


Figure 3.14: GHG reduction targets (non-ETS) for individual EU member states

Three additional climate change policies have been recently adopted, all of them with very high relevance to transport:

- A new regulation will set emission performance standards for new passenger cars registered in the EU. The regulation sets an average target of 130g CO₂/km for new passenger cars to be reached by improvements in vehicle motor technology and introduces a long term target for 2020 for the new car fleet of average emissions of 95 g CO₂/km according to modalities to be defined by the Commission in 2013.
- The revised fuel quality directive requires fuel suppliers to reduce greenhouse gas emissions caused by extraction or cultivation, including land-use changes, transport and distribution, processing and combustion of transport fuels (i.e. fossil fuels like petrol, diesel and gas-oil and also biofuels, blends, electricity and hydrogen) of up to 10% by 2020.
- A new directive will lay down mandatory national targets to be achieved by the Member States through promoting the use of renewable energy in the electricity, heating and cooling, and transport sectors in order to ensure that by 2020 renewable energy makes up at least 20% of the EU's total energy consumption. The agreement foresees that by 2020 renewable energy - biofuels, electricity and hydrogen produced from renewable sources - account for at least 10% of the EU's total fuel consumption in all forms of transport⁸.

⁸ http://www.europarl.europa.eu/news/expert/infopress_page/064-44858-350-12-51-911-20081216IPR44857-15-12-2008-2008-false/default_en.htm

3.5.5 EU trade policy

International trade is clearly linked to transport, and so world and EU trade policy will both act as policy drivers for transport. The issue of trade and the EU is a well-researched subject, and operational characteristics of recent trade negotiations carried out by the EU have been surveyed in detail.

External trade falls entirely into the Union's area of competence. The Union needs to keep open markets for what it sells and for what it imports. A report from DG Trade ("EU performance in the global economy") makes it clear that as the principal exporter and the second largest importer of goods, the main trading power in services, and the major source and host of world direct investments, the EU has a crucial responsibility in maintaining and strengthening a set of transparent and balanced rules for global trade. The EU's commitment to the WTO and the Doha Round is therefore central to EU's trade policy.

The same report makes clear that the EU as a whole relies heavily on global sources for inputs incorporated in its production process as they represent two thirds of extra-EU25 imports excluding energy products. This points very clearly to the need to remain open to imports. Combined with this necessity, it follows from the EU's major position on world markets that EU trade interests are first and foremost outward-looking in nature.

3.5.6 Security policy

Security has become a high profile policy issue since 2001. Given that many of the targets of terrorist attacks are transport-related, security policy has obvious overlaps with transport policy. Furthermore, there is a connection since operational measures to enhance security are likely to put barriers in the way of mobility, either by actually stopping certain flows of people or goods, or at least by adding time to journeys (as can be currently seen with the extra time need for air travel due to airport security measures). In the Mid-Term Review the following statement is made:

"The sustained terrorist threat keeps us aware that transport is both a target and an instrument of terrorism. Following the events of 11 September 2001, the EU reacted swiftly with legislation and quality control inspection regimes to enhance security in aviation and maritime transport. This *acquis* will be refined on the basis of experience. A level playing field needs to be stimulated where the cost of security measures is likely to distort competition. Security rules may need to be extended to land transport, including urban transport and train stations and the intermodal logistics chain. ... Careful consideration needs to be given to international cooperation in order to improve worldwide standards and avoid unnecessary and costly duplication of controls."

For understandable reasons, much of the emphasis of security policy since 2001 has been upon short-term measures to resolve immediate threats, and there has arguably been less focus upon long term strategic security issues (of the type that are consistent with the long term future thinking of TRANSvisions).

3.5.7 Policies in a long term framework

This subsection has up to now been mainly concerned with a description of the role of policy drivers in the present day, although at times mention has been made of potential future developments. If one specific message comes out from this discussion, it is that, from the point of view of the transport sector, policy-making needs to be integrated with policy-making for other sectors of relevance to transport, such as the environment, enlargement, territorial cohesion, trade and security. This confirms the spirit of the statement about the need for integrated policy contained in the 2001 White Paper.

The remainder of the subsection takes up these policy issues in a long-term framework. The approach taken is to consider basic alternative trends in governance, since governance is the determining factor underlying much policy-making. A number of important

issues arise when considering governance in the future: these issues can be distinguished by geographical scale (world, EU and local), although of course an issue on one geographical level will have impacts on the other levels.

With respect to the world scale, the IPCC Scenarios distinguish between two scenarios (A1 and B1) in which there is a convergent world, so that the issue of world governance becomes increasingly central. On the other hand, in Scenarios A2 and B2, the world becomes more heterogeneous and divergent than at present.

On the European level, a basic question can be asked “what will be the EU in the future?”. Two initial stereotypical scenarios can be identified: a “Cohesive Europe” and a “Competitive Europe”. In a Cohesive Europe, there will be no great degree of enlargement from the current 27 member states: development of the EU will be concerned with integrating the populations of these member states to form a cultural and social homogeneity which emphasises (within the overall EU boundary) concepts of equality and justice. On the other hand, a Competitive Europe will grow to take in neighbouring countries such as Turkey, Ukraine and perhaps Russia and parts of North Africa. The intention of such enlargement would be to attain high economic growth, emphasising very much the “market aspect” of the European Union, without a strong attempt at social cohesion. Both scenarios have obvious problems in the social dimension. Whilst a Cohesive Europe might reach levels of equality and justice within Europe, the question arises as to what is the relationship between the EU population and those outside the EU, particularly those from poorer countries. On the other hand, a Competitive Europe would, by its nature, have less watertight boundaries. Whilst at first sight this might reduce the “us and them” distinction between Europeans and non-Europeans, the existence of inequality between citizens within the boundaries of the EU could lead to social conflict between the European rich and poor, and a tendency to “blame outsiders” for such conflict (as can be currently observed with the popularity of a number of far right movements in Europe). In the consideration of all these issues, transport is obviously an important factor. Firstly, transport is the mechanism by which people cross borders, and the issue of ease or difficulty in making such crossings is a fundamental transport issue. Secondly, an inequitable distribution of mobility possibilities between citizens of Europe is one of the potential sources of conflict in an unequal Europe.

Probably the most interesting governance issue on the local level with respect to transport policy-making concerns city governance, and the possibilities of citizen control of transport decision-making. Mechanisms need to be developed for providing opportunities for people to resolve (or at least explicitly recognise) fundamental conflicting interests in transport planning and that, arguably, the EU can take a lead in helping to develop such mechanisms. Part of this development will need to include research on conceptualising such conflicts, and it can be further argued that an important step in such conceptualisation is to make explicit theoretical recognition of the “social dimension” of transport, focussing upon social, cultural and political dimensions of transport and mobility.

3.6 Summary and conclusions

This chapter has described the preconditions for deriving the TRANSvisions exploratory scenarios or “visions” of transport in Europe up to 2050, which will be described in the next chapter. In order to produce such visions, the chapter has analysed the relationship between the main drivers and transport, separately for passenger and freight transport.

In fact, the identified drivers, which have been described in the Sections 3.2 to 3.4, impact passenger and freight transport differently. Some drivers are only impacting passenger transport while others are only relevant for freight transport. However, many of the identified drivers are relevant for both passenger and freight transport.

Table 3.2 identifies the main areas of impact for the different drivers. In the table only those drivers are mentioned which have a direct impact on transport (so that the impact of transport on other sectors mentioned is not dealt with in the table).

Driver	Sub driver	Impacting passenger transport	Impacting goods transport
Population	Size	Transport level	Level of transport by sector
	Age distribution	Trip frequency, trip purposes, mode choice	
	Household type and size	Car ownership, trip frequency, mode choice, trip purposes	
	Localisation	Trip frequency, car ownership, mode choice	
Economy	Macro economic development	Level of transport	Level of transport
	Disposable income	Car ownership, trip distance	
	Productivity by sector		Level of transport by sector, mode choice
	Logistics		Mode choice, trip distance
	Trade		Level of transport by sector, distribution by country, mode choice
	Globalisation	Mode choice, Trip distance	Level of transport by sector, mode choice, trip distance
Social change	Time use	Trip purpose	
	Leisure	Trip frequency, trip distance, mode choice	
	Sustainable consumption	Change in car ownership	Change in transport by sector
Energy	Energy price	Trip frequency, mode choice, trip distance, change in car ownership	Level of transport, mode choice, trip distance
	Availability of fuel	Level of transport	Level of transport
Technology	New and improved transport modes	Level of transport, mode choice, trip distance	Mode choice
	ICT	Level of transport, trip distance	Trip distance
Infrastructure	Improved accessibility	Trip frequency, mode choice, trip distance	Mode choice, transport distance
	Congestion	Mode choice, trip distance, route choice	Mode choice, route choice, transport distance

Driver	Sub driver	Impacting passenger transport	Impacting goods transport
	Interoperability	Mode choice, route choice	Mode choice, route choice
Environment	Internalisation of external costs	Car ownership, trip frequency, mode choice, trip distance, route choice	Mode choice, route choice, transport distance, change to more clean transport modes
Policy	Enlargement	Level of transport, trip frequency, trip distance, mode choice	Level of transport, trip frequency, transport distance, mode choice
	Security	Trip frequency, Mode choice	Mode choice

Table 3.2: The main areas of impact for different drivers

The areas impacted have been grouped in a small number of categories in order to provide a better overview. The impact categories are briefly described in the Table 3.3.

Impact category	Passenger transport	Freight transport
Level of transport (by sector)	Indicates that the total transport level in trips in EU is expected to increase if there is an increase in the driver. The transport level is expected to drop if there is a decrease in the driver.	Indicates that the total transport level or the transport level by economic sector (agriculture, industry, trading) in tons in EU is expected to increase if there is an increase in the driver. The transport level is expected to drop if there is a decrease in the driver.
Trip frequency	Indicates that the number of trips per person, per car or per household is affected by the driver.	Indicates that the number of tons carried is affected by the driver.
Trip purpose	Indicates that the distribution of trips by purpose (commuting, business, private) is affected by the driver	Indicates that the distribution of tons by economic sector (agriculture, industry, trading) is affected by the driver
Mode choice	Indicates that the choice of transport mode per trip is affected by the driver	Indicates that the choice of transport mode per transport is affected by the driver
Route choice	Indicates that the choice of route is affected by the driver. This is valid only for transport modes where a choice of route exists (Road transport)	Indicates that the choice of route is affected by the driver. This is valid only for transport modes where a choice of route exists (Road transport)
Trip/transport distance	Indicates that the trip distance is affected by the driver	Indicates that the transport distance is affected by the driver
Car ownership	Indicates that the car ownership is affected by the driver. The effect could be of second order, e.g. disposable income facilitates the movement to peri-urban areas, where living requires a car. Therefore car ownership is influenced by the localisation.	

Table 3.3 Impact categories used for the driver summary.

The purpose of the identification of drivers has been to identify the drivers with the biggest impact on transport. The impact of each driver, however, depends on the setting in which it operates. Therefore it is often difficult to identify if the impact is big or small without going into a detailed analysis of the setting. The driver analysis should lead to a scenario analysis, and although the present driver analysis is qualitative the following chapter provides quantitative indications of the impact of each driver in different scenario settings. The quantitative analysis leads to further understanding of drivers and their impacts.

4 Definition of scenarios

4.1 Introduction

The scenario method has become rather widespread over the last few decades. Common elements are:

- Scenarios are a tool for better strategic decision making
- The scenario method emphasizes the construction of alternative plausible futures
- For this purpose, existing mental models should be challenged, and qualitative (“storytelling”, narrative) as well as quantitative (“modelling”) approaches are to be used.⁹
- It is important to know for whom scenarios are made and for which purpose. Credibility, legitimacy, and creativity are important aspects, then, of process and product.
- Scenario construction provides a training method for finding key trends, recognising prevalent myths, and imagining attitudes of key players.

The identification of driving forces (as described in Chapter 3), of predetermined elements (in particular slow changing variables), and of critical uncertainties provide the structure or logic of scenarios (Schwartz 1991). It has been argued that one should not create more than three or four scenarios because people cannot handle more due to cognitive limitation. Whilst, the use of a larger number of scenarios (as in this study) allows the coverage of a larger range of uncertainties, the problem of cognitive limitation requires that the scenarios are presented in a stylised and structured way, as described in this chapter.

The TRANSvisions project makes heavy use of a number of different future scenarios. Methodologically, the approach taken by TRANSvisions is highly innovative in that it seeks to use two different types of scenario (two “scenario paradigms”), each of which are based upon different philosophical approaches to the future. In general, research projects in transport restrict themselves to only one of the two scenario paradigms. The advantage of sticking within one paradigm is that it enables methodological consistency. The disadvantage though of sticking within one paradigm is that any paradigm “loses” a large amount of information (that is typically not considered to be of central interest to the paradigm). It follows that the advantage of mixing paradigms is that “as much as possible” information about the future is used. The disadvantage of mixing paradigms results from the difficulties of combining different philosophical frameworks.

Arguably in a study focusing upon a particular aspect of the transport system, it is likely that the “one paradigm” approach is more pragmatic. However, in a study such as TRANSvisions, which has ambitions to take an all-encompassing view of the future of European transport, the “information gain” argument outweighs the “methodological difficulty” argument, and it is therefore worthwhile mixing paradigms. However, it should be remembered at all times that this approach has pitfalls. To aid the reader identify these pitfalls, they will be highlighted whenever they occur throughout the rest of this Final Report.

The two different scenario paradigms in this study are backed up by the following analytical tools:

- 1) The use of a traditional transport model (TRANS-TOOLS) for assessing the effect on traffic of different scenarios, with a mid-term view (until 2030), and

⁹ In TRANSvisions Task 1 the qualitative storytelling approach was followed. The quantitative approach was considered in Task 2, as described further in Chapter 5.

2) A foresight approach, backed up by “Meta-Models” (to be described further in 4.4.7), for a long-term view

Issues concerning the combination of results from these two very different methodologies are outlined in Section 4.2.

Section 4.3 describes the scenario specifications for the TRANS-TOOLS scenarios. The TRANS-TOOLS model has primarily been run for 2030 and three different scenarios have been specified: 1) Baseline; 2) A High Growth (Sustainable Economic Development) Scenario; and 3) A Low Growth Scenario. For the High Growth and the Low Growth scenarios policy scenarios have been specified. These are also described in Section 4.3.

Section 4.4 provides details about four exploratory scenarios that were developed for 2050 with a foresight approach. These scenarios were the outcome of a process in which four more radical scenarios were specified and discussed with external experts. This process also included the consultation of other foresight studies in order to produce the initial scenario specification. Particular emphasis was put upon two studies: the UK “Intelligent Infrastructure Futures, The Scenarios – towards 2055”; and the Dutch “Four Futures for Europe”. At the end of Section 4.4 an introduction is provided to the “TRANSVISIONS Meta-Models” (which will be described more fully in Chapter 5).

4.2 Methodological issues in scenario analysis

This section discusses various methodological issues concerning the two scenario paradigms mentioned in 4.1. Since the TRANS-TOOLS model will be frequently mentioned in this discussion, the section opens (in 4.2.1) with a description of this model.

4.2.1 The TRANS-TOOLS model

TRANS-TOOLS is the most recent state-of-the-practice transport-oriented 4-steps forecast model available at EU level, that includes specific socioeconomic modules based on complementary modelling paradigms.

The modelling capabilities of TRANS-TOOLS are related directly to input variables describing the infrastructure networks and aspects related to the networks as e.g. transport costs or transport times, as well as flows between zones identified based on NUTS III (passengers) and NUTS II (freight). Therefore, the TRANS-TOOLS model is also able to offer answers on policy questions indirectly affecting transport costs and transport times, as well as demand evolution.

TRANS-TOOLS produces results which can be applied in analysis of different types of transport policies, including variables like:

- *Transport performance* (passenger-km, tonnes-km, vehicle-km, etc.); (at EU, national and NUTS II level, on annual basis or more detailed)
- *Modal split* (share of demand using road modes, rail, air, etc.) both with reference to passengers and tonnes and to passenger-km and tonnes-km, thus also *average distance* of transport can be assessed
- *Load on corridors* (passengers and freight vehicles) and, therefore, levels of congestion on road infrastructure (TEN-T and main national links), and also, annual averages, and if available, daily peaks.

The results of TRANS-TOOLS can be transferred to other models like TREMOVE, POLES or ASTRA and thus produce

- *Fuel consumption*

- *Emission levels for CO₂*
- *Change of Gross Domestic Product of regions;*
- *Change of employment levels of regions.*

All indicators are available both at the aggregate level and by country or, where significant, at more detailed geographical level.

Scenario specification in TRANS-TOOLS includes assessing zonal data for about 1440 different transport zones in Europe and data for about 35,000 road links and 5,000 rail links. Further cost specifications related to transport modes and specific network links and nodes are part of the scenario specification of the model. The TRANS-TOOLS model has been designed mainly for analysis of infrastructure development. However, it can be used also for analysis of more general time and cost specifications covering EU27.

4.2.2 Paradigm for 2030 scenarios

TRANSvisions has created a set of scenarios for 2030. The main functional purpose of these scenarios is to provide quantitative estimates for input parameters for the TRANS-TOOLS. The philosophy associated with this procedure is termed *instrumental rationality*, and constitutes the mainstream paradigm within transport modeling since its inception in mainstream planning exercises in the 1950s (the Detroit Metropolitan Area Traffic Study, 1953-1955, is traditionally viewed as being the first such study). This inception corresponds closely with the development of computer technology, and one way of viewing models within an instrumental rationality paradigm is as highly sophisticated computer-based calculating methods. Such models are typically referred to as *forecasting models*. At the heart of the philosophy underlying forecasting models is the belief that accurate predictions can be made about the future by extrapolating observed (past and current) trends. The methodologies used are typically based upon predictive approaches in the natural sciences (especially physics) and the advocates of instrumental rationality frequently emphasise the “scientific nature” of its models. With respect to TRANSvisions, there are both advantages and disadvantages about using such an approach.

Advantages

The methodology restricts as much as possible the role of subjectivity in the modelling process. Once it has been decided which input data should be used for a modelling exercise, the (transparent) assumptions and algorithms within the model should (in theory at least) provide the same results, *independently of whoever is running the model*. If the input data that is used for running the model comes from well-established sources with a certain degree of consensus about data validity (e.g. EUROSTAT), it follows that the model results should obtain a similar level of consensus from all those that subscribe to the assumptions made by the model.

If the model used in a particular study is well-established in terms of its representation of the four steps in the traditional “four stage transportation model” (trip generation, trip distribution, mode choice and assignment), then (in theory at least) there should be a consensus that the model results are accurate, given the accuracy of the input data. A number of qualifications need to be made here though.

Since a forecasting model relies upon trend extrapolation it cannot, by its nature, take account of trend-breaks unless these are fully specified in advance. “Normal use” of models such as TRANS-TOOLS implicitly assumes that there are no trend-breaks in the future (though, as described below, different assumptions can be made as to what trends are actually represented by the model).

A forecasting model is inevitably “reductive” in the sense that it only considers certain driving forces with respect to future change (the most common being GDP growth and demographic change such as population growth). Use of a forecasting model implicitly assumes that driving forces not represented in the model have no substantial effect upon the evolution of the future.

Whilst the underlying mathematical approaches in a model such as TRANS-TOOLS might be well-established, any such model will inevitably be going through constant development in terms of expanding its range of representation (in terms of zones, trip purposes etc) and this is in fact the case with TRANS-TOOLS. It follows that the output of TRANS-TOOLS must be constantly changing.

Disadvantages

The disadvantages of forecasting models such as TRANS-TOOLS strongly parallel two of the qualifications given above. In particular:

The reliance upon trend extrapolation has a number of weaknesses. Most obviously, it can be observed in the real world that trend-breaks actually do occur (with many examples of these being given in the Task 1 Report). A further disadvantage is that the trend-extrapolation assumption underplays the potential role of policy-makers in changing trends. Whilst a typical (forecasting) modelling process can represent the effects of policy decisions made in “Year 0” (as will be shown below for TRANS-TOOLS model runs), there is little possibility of representing future decisions of policy-makers in response to future-predicted situations.

Typically, future scenarios in a forecasting framework do not give full descriptions of the scenario but, rather, only provide a small number of quantitative parameters that are required for input to the forecasting model. It has already been pointed out that this reductive approach has scientific weaknesses. However, there are further weaknesses if the scenario is being used for a type of comprehensive assessment which requires more information about a scenario than can be gained from the input and data of a forecasting model (as is the case in TRANSvisions which is carrying out a social capital assessment, as described above). In fact the lack of description about the scenario leaves it seriously undetermined in some respects (even though it is precisely determined in other respects).

It has already been stated that the approach taken by TRANSvisions is a mixed-paradigm approach. Specifically it is using TRANS-TOOLS as a forecasting tool to provide predictions of traffic and its impacts for 2030, whilst it is using a “foresight paradigm” to produce scenarios for 2050. A number of factors support this approach:

- Due to the limitations of the forecasting paradigm described above, it is not considered that predictions beyond 2030 made by TRANS-TOOLS are useful;
- On the other hand, given that TRANS-TOOLS is the model employed in a number of EC-funded projects, using TRANS-TOOLS for 2030 predictions enables comparison across projects;
- In recent years the foresight paradigm has grown strongly, so that there are now a relatively large number of foresight-based studies which can provide a basis for the TRANSvisions scenarios for 2050.

4.2.3 Differences between foresight and forecast approaches

In summary, the difference between foresight and forecast approaches can be stated as follows:

- A forecast approach aims to provide a “scientific” prediction of the future. Due to its scientific ambitions, it is possible to argue whether a particular forecast prediction is correct or incorrect, depending upon whether the science has been applied correctly or not.
- A foresight approach provides a set of images of the future for the purposes of discussion. Although it is possible to be critical of a particular foresight scenario on the grounds of internal inconsistency, the aim of a foresight scenario is not to be “correct”. Rather its value depends upon its usefulness as an aid to encouraging discussion.

4.2.4 Interface of scenarios

It is clearly desirable for purposes of overall analysis that the two scenario sets (for 2030 and 2050) should be mutually consistent. To provide such consistency is a major methodological challenge, given (as explained above) the differences in underlying philosophy for the two modelling approaches used. However, attempts have been made to provide such consistency ensuring comparable data items are similar in 2030 for both TRANS-TOOLS and the Meta-Models (to be described in 4.4.7 and Chapter 5). The main consistency checks have been carried out on input data such as GDP, population and “Level of Service (LOS) data”, depicting distances, travel times and travel costs for different transport modes. A similar consistency check has been carried out on the resulting passenger-km and tonnes-km for comparable transport modes. It needs to be stated though that even if there is a high consistency between the results produced by the two models in 2005 and for three different alternatives in 2030, comparable results for intermediate years may deviate considerably.

4.3 TRANS-TOOLS scenarios for 2020 and 2030

4.3.1 Introduction

The European transport scene is characterised by a very dense network of road, rail and inland waterway links in the centre of the Union, gradually being less dense as the periphery is approached and population densities become less.

Mobility is an important factor for development of welfare for the citizens of Europe. However, the freedom to move has to be facilitated at the least cost for the environment and decoupling should take place with respect to the negative effects of transport. Thus, the scenarios should include policies on internalisation of the external costs, and this should be viewed in the light of increasing awareness of the climate changes and a possible major change in oil supply, addressing the issue of vehicle operating costs.

There are imbalances of transport modes in Europe. The dominance of road transport, particularly in passenger transport, reflects the encompassing mobility supported by the passenger car. But the ownership and use of cars creates congestion and bottlenecks, threatens competitiveness and welfare of the citizens and increases the pressure on environment. Missing interoperability for some transport modes adds to the congestion. Scenarios addressing this topic particularly in Central Europe and in urbanised areas should be envisaged in terms of congestion charging. In this respect, however, it should be stressed that the TRANS-TOOLS model is addressing the issue of interregional transport, and that local transport is not included in the model except as a preload on the network links in the road network. Local rail transport in terms of Metro, Underground and City-rail is also not included in the TRANS-TOOLS model.

The growing importance of the East-West transport flows has been recognised for some time, and therefore the scenarios need to facilitate this flow in terms of improved connections to the East of Europe. But also an increasing trade with the Mediterranean countries

point to a growing need for connections towards Turkey and towards Morocco. But the ports have also an important role to play in serving the east-west transports.

The focus in the scenario analysis is not only on heavily loaded infrastructure, but also on infrastructure which - if improved - could boost the Single Market, Cohesion and connections to Neighbouring countries.

The following subsections provide the assumptions necessary to carry out a TRANS-TOOLS forecast for 2020/2030.

4.3.2 Overview of scenarios

Three TRANS-TOOLS scenario were drafted for 2030, namely a Baseline (Business as Usual) Scenario, a High Growth Scenario and a Low Growth Scenario. The scenario descriptions are based as far as possible on assumptions taken from official forecasts, whilst using other assumptions, based on previous developments or assessments, where necessary.

The table below provides an overview of the TRANS-TOOLS scenarios considered in the study.

Table 4.1 Overview of assumptions in the TRANSvisions' TRANS-TOOLS scenarios

Scenario	Baseline	Baseline	Sustainable	High	Low growth	Low growth
Year	2020	2030	/high	growth var	2030	2030
App	Basis2020	Basis2030	SU2030	HG2030Ma	LG2030	LG2030
Zonal data relative to 2005:						
- Population (EU27)	1.2%	0.8%	8.5%	8.5%	-5.5%	-5.5%
- Population (Rest of Europe)	-1.3%	-3.4%	-3.4%	-3.4%	-3.4%	-3.4%
- Employment (EU27)	0.0%	-1.1%	6.2%	6.2%	-7.2%	-7.2%
- GDP, EU27	38.6%	61.4%	77.4%	77.4%	20.1%	20.1%
- GDP, Rest of Europe	75%	159.0%	159.0%	159.0%	159.0%	159.0%
- GDP, Overseas	55.8%	129.0%	129.0%	129.0%	129.0%	129.0%
- Carownership EU27	16.1%	25.7%	27.4%	27.4%	11.9%	11.9%
- Hotel capacity ¹⁾	0%	0%	0%	0%	0%	0%
Transport cost relative to 2005:						
- Rail and bus fare	50% GDP (max. 30%)	50% GDP (max. 30%)	50% GDP (max. 30%)	50% GDP (max. 30%)	50% GDP (max. 30%)	50% GDP (max. 30%)
- Passenger car fuel cost	7%	7%	0%	0%	35%	35%
- Air fare	0%	0%	20%	20%	30%	30%
- Truck driving cost	4%	4%	0%	0%	20%	20%
- Rail freight cost	-10%	-10%	0%	0%	10%	10%
- IWW freight cost	0%	0%	0%	0%	0%	0%
- Maritime transport cost	4%	4%	15%	15%	20%	20%
Network:						
- Road	Baseline 2030	Baseline 2030	High Growth 2030	High growth var 2030	Baseline 2030	Baseline 2030
Passenger-km cost	as in 2005	as in 2005	As in 2005	as in 2005	as in 2005	as in 2005
Passenger-km internalisation	0	0	5 % of truck Noise and air poll. + congestion + 0.01 EUR	5 % of truck Noise and air poll. + congestion + 0.01 EUR	0	5 % of truck Noise and air poll. + congestion
Passenger-km cost recovery vignette countries	0	0	0	0	0	0.02 EUR on motorways
Truck km cost	as in 2005	as in 2005	As in 2005	as in 2005	as in 2005	as in 2005
Truck km internalisation	Noise, air poll + congestion	Noise, air poll + congestion	Noise, air poll + congestion + 0.04 EUR	Noise, air poll + congestion + 0.04 EUR	Noise, air poll + congestion	Noise, air poll + congestion
Truck km cost recovery vignette countries	0	0	0.06 EUR on Motorways	0.06 EUR on Motorways	0.06 EUR on Motorways	0.06 EUR on Motorways
- Rail passenger	Baseline 2030	Baseline 2030	Sustainable 2030	High growth var 2030	Baseline 2030	Baseline 2030
- Rail freight	Baseline 2030	Baseline 2030	Sustainable 2030	High growth var 2030	Baseline 2030	Baseline 2030
- Air	2005	2005	Extra low cost lines	Extra low cost lines	Extra low cost lines	Extra low cost lines
- IWW	2005	2005	2005	2005	2005	2005

1) Hotel capacity is a measure of attraction applied to tourism trips. Capacity is only used for distributing the trip ends and the same distribution as in 2005 has been assumed.

4.3.3 Baseline

A baseline for 2020 and 2030 has been established. The baseline is basically a prolongation of existing trends.

The assumptions can be subdivided in socio-economic trends, transport cost assumptions and network assumptions. The socio economic trends depict the expected development in a number of basic parameters like population, employment, income growth, etc. These are based as far as possible on available sources like EUROSTAT population projections, economic development data from DG ECFIN, etc. The transport cost assumptions cover both on-going policy initiatives as well as possible development paths for variables in the TRANS-TOOLS model reflecting the scenario assumptions. The network assumptions address the infrastructural development.

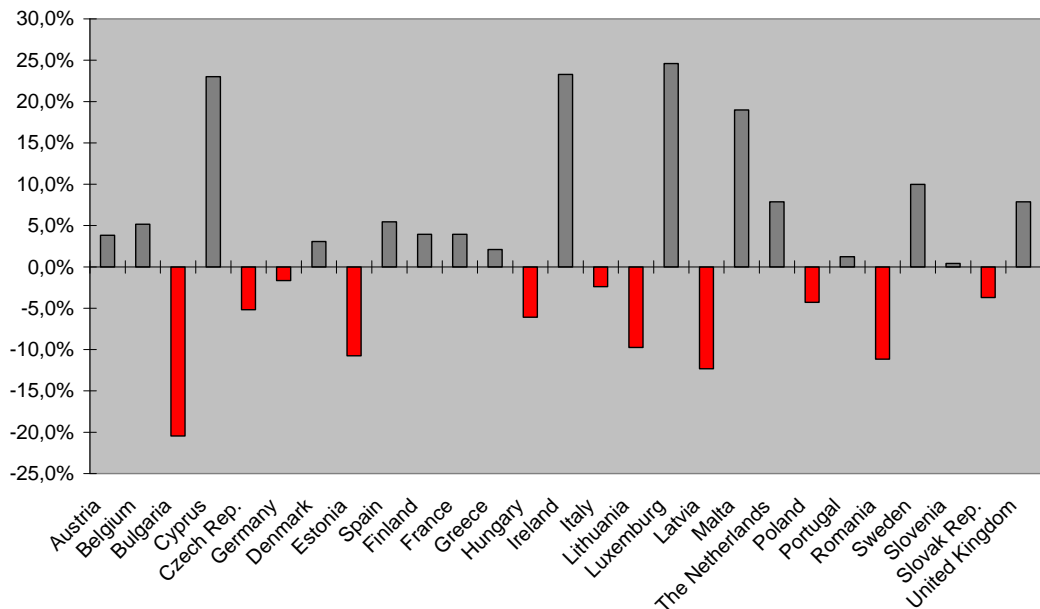
Socio-economic development

The baseline assumes a population growth in EU27 as indicated in the official population TREND-forecast 2004 from EUROSTAT on NUTS2 level. This forecast is unfortunately rather old, even the basic 2005 figures are changed according to the population censuses already available. The forecasts are also old compared to the UN 2006 forecasts, which are applied outside EU. The forecasts however are available at NUTS2 level which implies taking account of a more diversified development within the countries where NUTS2 forecasts are available. Unfortunately population forecasts for UK and France are not subdivided at NUTS2 level.

In 2005 the total EU population was about 491 m. people (census). In 2020 this is expected to be almost 496 m. and the population remains almost constant up to 2030 (495 m.). All in all the EU population remains nearly constant. Population in the EU 15 will be growing slightly, from 387 m. to 399 m., whereas a fall in population is expected in EU12 (from 104 m in 2005 to 96 m. in 2030). The highest population growth is foreseen in Ireland, Luxembourg and Cyprus. Outside the EU the forecasts are based on the World Population prospects 2006 revision from the UN population division. Here Turkey has the highest population increase and the population in Russia is decreasing the most.

An overview of the population development per EU country is presented in Figure 4.1.

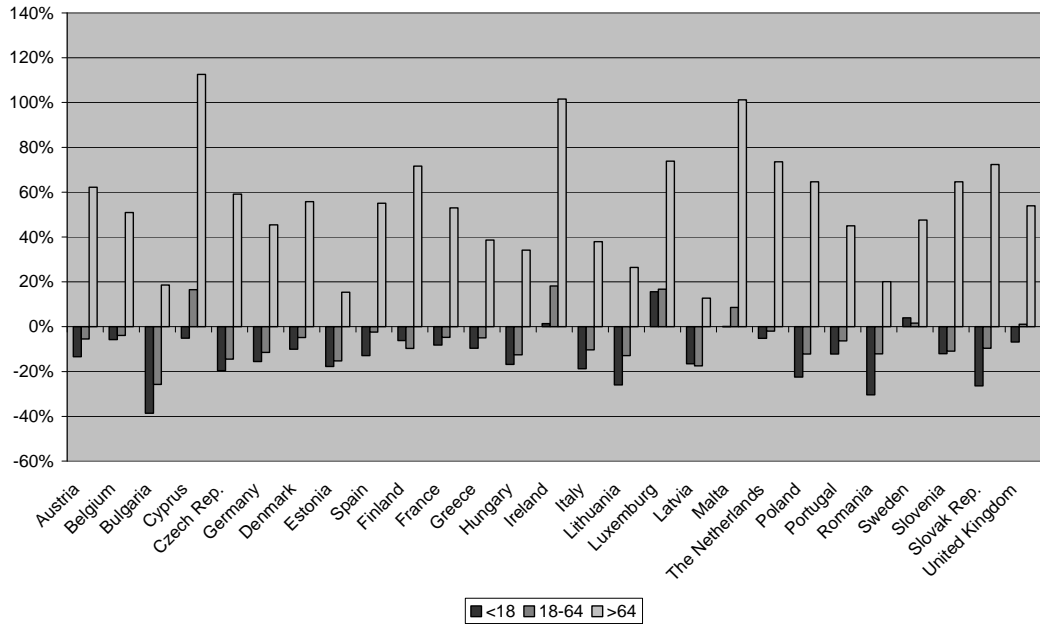
Figure 4.1. Population growth 2030 against 2005 in EU27, Baseline



The population of Europe grows older and the old age group is making up a greater part of the total population. This has the effect that a productive population which decreases has to feed a fast increasing non-productive population. In EU27 the age group above 64 increases with almost 50 % up to 2030, while the age group below 18 decreases with 14

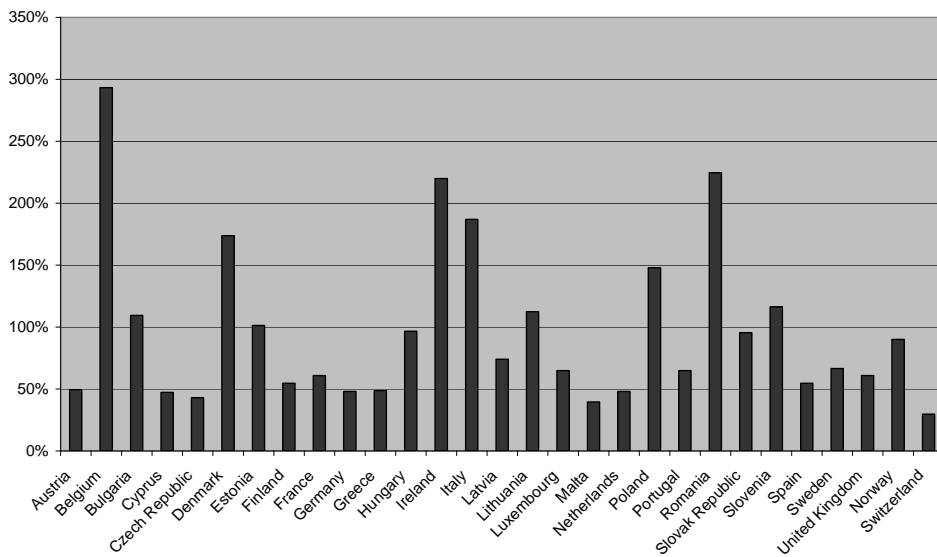
%, and the productive age group decreases with 7 %. There are major differences among the countries. The development is indicated in Figure 4.2.

Figure 4.2. Population development by age group 2005 – 2030, Baseline



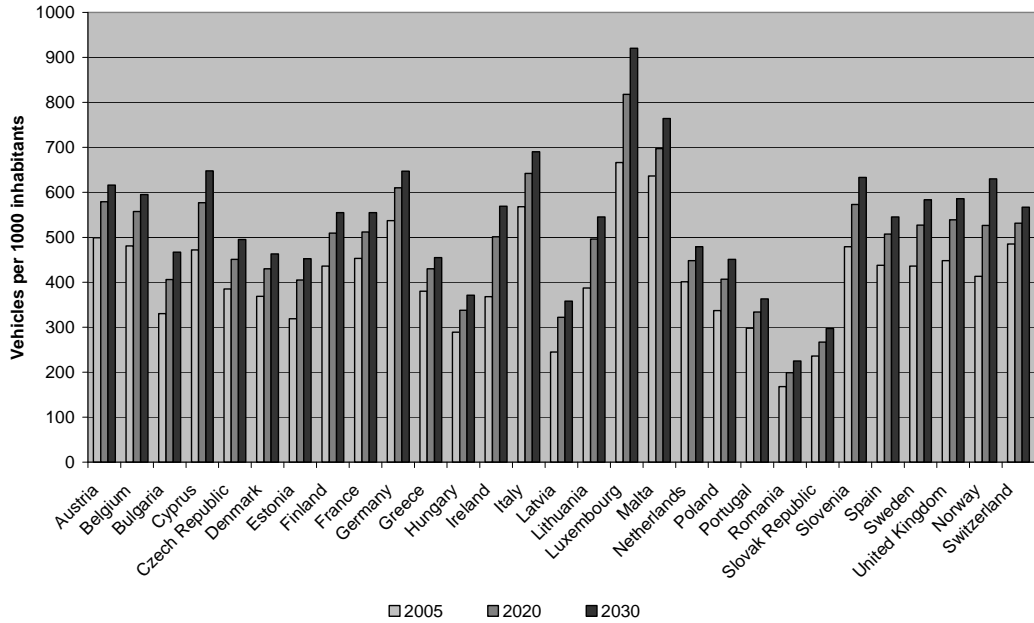
The economic development up to 2030 is based on the DG-ECFIN Note 253 of June 2006. The economic development in GDP per capita is fastest in the eastern part of Europe and less in the western part. This is also in line with the development experienced in the last 10 years. GDP per capita in EU15 in 2005 was about 24,000 EUR in constant 2000 prices, expected to increase to about 37,000 EUR in 2030. In EU12 the GDP per capita was about 5,000 EUR in 2005. This is expected to increase to about 13,000 EUR in 2030. The ratio between GDP per capita in EU15 and in EU12 decreases from 4.7 to 2.9.

Figure 4.3. Development in GDP per capita in constant prices, 2005 – 2030, Baseline



The car ownership increases continuously, however with a slightly decreasing growth rate. In EU15 the level grows from 483 in 2005 to 553 in 2020 and 594 in 2030. In EU12 the number of passenger cars per 1000 inhabitants increase from 337 in 2005 to 402 in 2020 and 447 in 2030. Car ownership in terms of passenger cars per 1000 inhabitants is estimated based on a car ownership model developed from statistical analysis of GDP growth in different countries and car ownership development in the same countries. The model has been established in a current DG TREN study on Trans-European Networks (the TENconnect project) and provides a uniform basis for estimating the car ownership in future years.

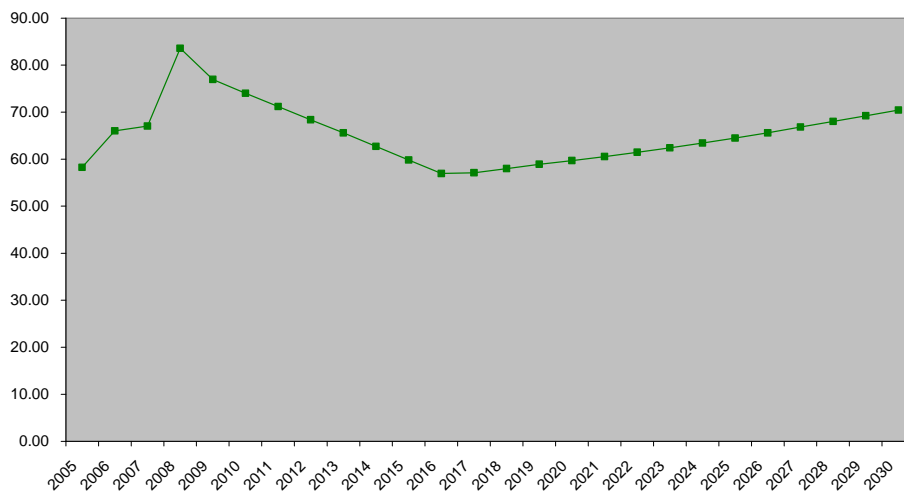
Figure 4.4. Development in passenger cars per 1000 inhabitants, 2005 – 2030, Baseline



It is expected that the world oil price will follow the development indicated by the US Energy Information Administration in their forecast from spring 2008. The price per barrel of oil is expressed in 2006 US\$ per barrel. The development is indicated below.

Figure 4.5. Oil price development 2005 - 2030

Oil price in 2006 US\$, Reference forecast 2008



Note: Low sulphur Light crude oil according to EIA forecast 2008

Compared to 2005, the low sulphur light crude oil price in 2020 is 2 % and in 2030 is 20 % above the 2005 level. The development trend seems contradicting the actual development, where the price of oil passed 147 US\$ per barrel (July 2008). However, in December 2008 the price per barrel had dropped to 43 US\$ in current 2008 prices. Therefore, the assumption of an increase of 20 % of the oil price in 2030 measured in fixed prices is maintained.

Transport costs

All transport costs are in 2005 prices.

For road transport following cost items are estimated:

- Vehicle operating costs which is approximated with fuel costs
- Distance based costs related to the use of infrastructure
- Distance based costs related to internalisation of external costs.

Further travel time is estimated as part of the Level of Service calculation.

For passenger transport the value of transport time is endogenously forecasted with the level of GDP increase in each country.

For goods transport value of time is included in the distance costs referred below.

As indicated it is assumed that the oil price in 2030 is about 20 % higher than in 2005 measured in real prices. A modest improvement of the efficiency is assumed of about 0.5 % per year. These two aspects leads to an expected increase in vehicle operating costs for passenger cars of 7 % measured in 2005 prices.

It is assumed that emission free vehicles will constitute only small proportions of the vehicle fleets, mostly in the major urban areas in EU15. It is also assumed that the fuel costs for the emission free vehicles will follow the cost development for the emitting vehicles.

The use of ITS will be widespread, and the applications will help ensuring an increase in safety and a better utilisation of the congested road systems.

Vehicle operating costs for heavy goods vehicles are combined of a many different cost items like fuel and lubricants costs, maintenance, driver's salary, insurance and administrative costs. Time related costs make up about 2/3 of the costs and the remainder is distance related. The time related costs are linked to the time level of service data. Fuel costs make up about 1/3 to 1/2 of the distance based costs. Technological development, improved efficiency both in terms of better utilisation of the trucks and more efficient load planning, and finally competition are all reasons for the assumption that distance costs for trucks increase with 4 % up to 2030 measured in fixed prices.

On top of the time and distance costs different charges and fees are applicable to truck transport, including internalisation fees and motorway charges. The digital tachograph and more efficient enforcement of driving and resting time regulations have lead to more equal competition between transport modes.

It is stressed that the TRANS-TOOLS model applies only two types of road vehicles, passenger cars and trucks. Therefore, cost items related particularly to trucks need to be evaluated taking into account that it is quite different composition of truck fleets which exists in the different European countries. Charges e.g. the German Maut, also depends

on the type of truck. EURO V trucks have a lower km charge than the EURO I trucks. There are also different weight limits applicable. In Germany trucks above 12 tonnes are subject to the Maut, but in Austria the weight limit is 3.5 tonnes. The TRANS-TOOLS model is a European model and the results should not be applied on country, regional and local level.

In the baseline forecast infrastructure charging in terms of a cost per kilometre in the road network is limited to the motorway system plus additional major pieces of infrastructure (bridges and tunnels). For passenger cars the 2005 charging regime is assumed to be valid also in 2030, that is, the use of the motorway system is generally not charged in Finland, Sweden, Denmark, Germany, Benelux, UK and the Baltic States, whereas charges are applied for using the motorway system in the remaining countries either in terms of vignettes or by direct payment. For road freight, it is assumed that internalisation of external costs is applied throughout Europe in 2030, and motorway charges are applied as a distance cost in most countries. In the Vignette countries charges for using the motorway system is paid in terms of a Vignette. The Vignette countries are the countries mentioned above excluding Germany, which uses a km-charge.

The internalised costs are applied to all links in the road network. In the baseline the internalised costs are only applicable to trucks. It is assumed that the external costs of heavy goods transport is being internalised taking into account noise, air pollution and congestion. The applied costs were originally developed in the IMPACT project, and made operational by Joint Research Center (JRC) in the Vignette impact study carried out in 2008. The costs applied by JRC has been updated to 2005, and applied in the baseline scenario.

Consumer prices for rail transport in EU25 have been increasing with 9 % in real prices between 1999 and 2006, and consumer prices for bus transport have been increasing with 17 % in the same period. GDP in constant prices rose with 17 % in the same period. Since the TRANS-TOOLS is dealing with rail transport as the public transport mode it is assumed that rail prices in real terms will increase with 50 % of the growth in GDP. The fares however, are not assumed to grow with more than 50 %. In border crossing traffic the average growth of the two neighbouring countries is taken as the basis for the fare assessment.

Transport costs for rail freight depends heavily on the capacity costs, i.e. cost of administration, cost of networks, costs of interoperability. For competitive reasons the development in rail transport costs has followed the development in truck transport costs. In the baseline scenario it is anticipated that in the time to come improvement in interoperability of safety systems, internationalisation of drivers' education, improvement of terminal operations and improved utilisation of tracks altogether will lead to a decrease in freight transport costs by rail of 10 %.

Air transport has been the mode with the most modest price increases in the last 7 years. In the baseline, where oil prices are expected to increase only slightly it is expected that efficiency improvements, consolidation of the air transport business, and introduction of less fuel consuming aircrafts also as a result of the introduction of the Emission Trading Scheme for air transport by 2012 will result in the same air fares in 2030 as in 2005 measured in real prices.

Inland Waterway operating costs are assumed to remain constant in fixed prices as are the charges related to use of locks and channels, and also the costs of using rail terminals is assumed to remain constant in fixed prices.

For maritime transport the transport costs depends on the development in eg. ship acquisition, maintenance, operation, fuel and lubricants. These different cost items have considerable different weight depending on the dimensions and types of the ships. Since the TRANS-TOOLS operate with only maritime as one mode irrespective of kind of ship, it

has been assumed that cost development in the baseline scenario will follow the development of truck costs, that is an increase of 4 % compared to 2005 in real prices.

Networks

In order for the TRANS-TOOLS model to function properly improvement of links of both national and international importance needs to be integrated in the TRANS-TOOLS network. The links include extensions and changes to the existing 2005 road and rail network.

The transport networks include the links and nodes to which the traffic of the different transport modes is assigned. The networks are also used for calculating the travel/transport time and transport distances between all zones in the TRANS-TOOLS transport model for the different transport modes. An improvement of a link in one of the networks will therefore lead to an improvement in time and/or distance for the transport mode under consideration.

In the baseline scenario links which have been constructed between 2005 and 2008 and links, which are currently under construction or already planned for construction are added. A number of member states have provided input to the maps. In case no direct communication with member states has existed, the national plans have been used as the basis for appointing the projects. It has however been quite difficult to assess if a project had reached a status of no return. Therefore, the baseline is a conservative estimate of what could be accomplished. The many projects considered in the priority projects, pan European Corridors etc, but not yet finalised have been included in the high growth scenarios.

The roads indicated on the map in Figure 4.6 are road projects improving the main road network. Two different types of road works are foreseen, new construction and changes of existing infrastructure. All changes assumed are depicted. Most of the changes are related to roads changing class or speed. A class change changes the attributes on a road link, e.g. moving from ordinary two-lane road to expressway or motorway standard, or moving from a 4 lane motorway to a motorway with 6 or more lanes. Although it is obvious that a motorway is not constructed in exactly the same alignment as an existing two lane road, it is assumed that the change in length is negligible. If roads are constructed in completely new alignments this is termed "New roads".

The same terminology applies to the rail links in Figure 4.7. Either it is a change of attributes to existing links, e.g. speed improvement, or it is new construction.

The road and rail networks assumed in the baseline scenario are indicated in the following maps.

Figure 4.6. Road infrastructure development in Baseline, 2030

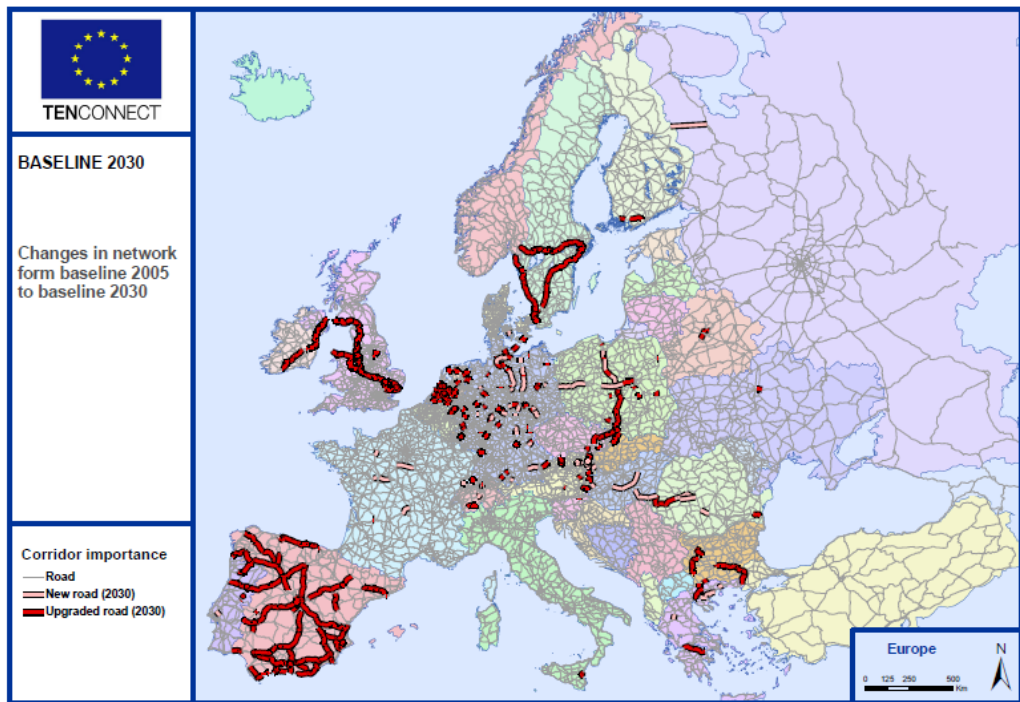
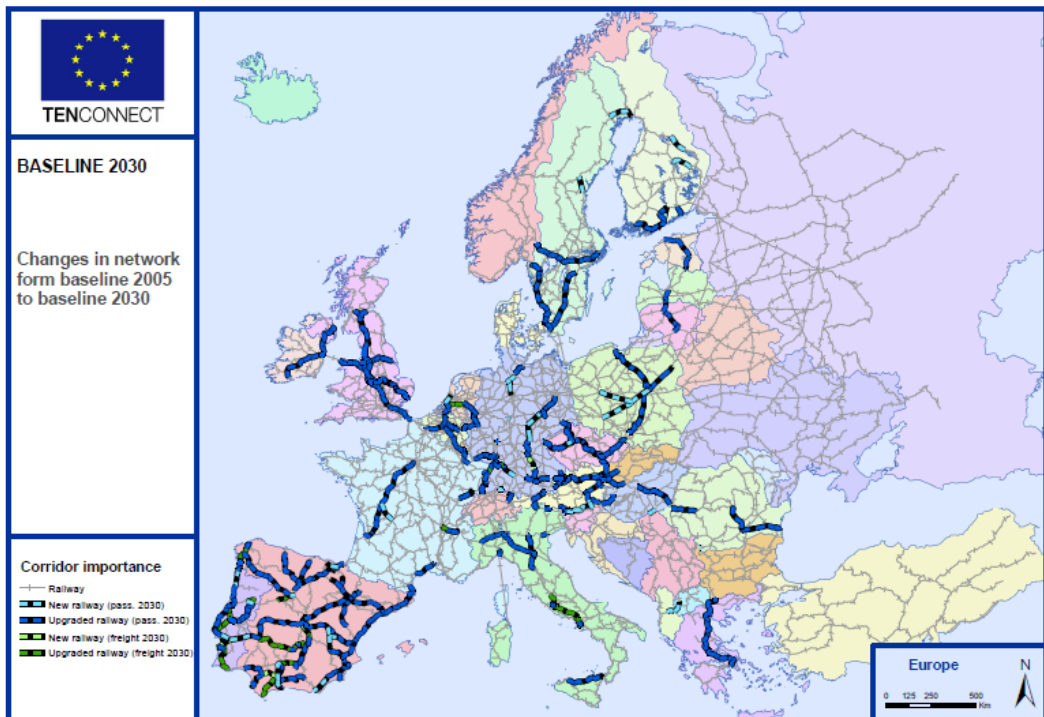


Figure 4.7. Rail infrastructure development in Baseline, 2030



4.3.4 High Growth Scenario (Sustainable Economic development)

Socio-economic development

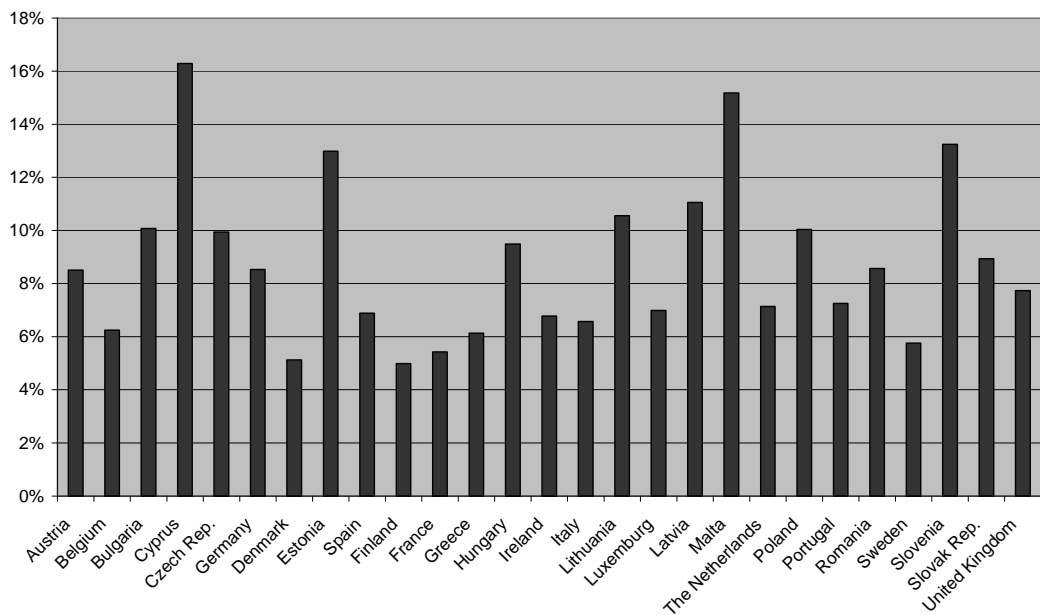
The High Growth Scenario is based on elements giving priority to cohesion (higher economic growth, and improvement of infrastructure particularly in EU12) and elements based on competition (each mode of transport paying its own costs). The scenario, thus,

is a combination of local and global interests which work together with environmental and social interests to create a sustainable Europe.

The European policy is directed towards being a main player on the global scene and at the same time ensuring development to all parts of Europe. The economic growth is supported by a growth in fertility in the EU. The development of the global scene does at the same time put more pressure on the intercontinental ports of northern Europe and the feeder lines into the hinterland.

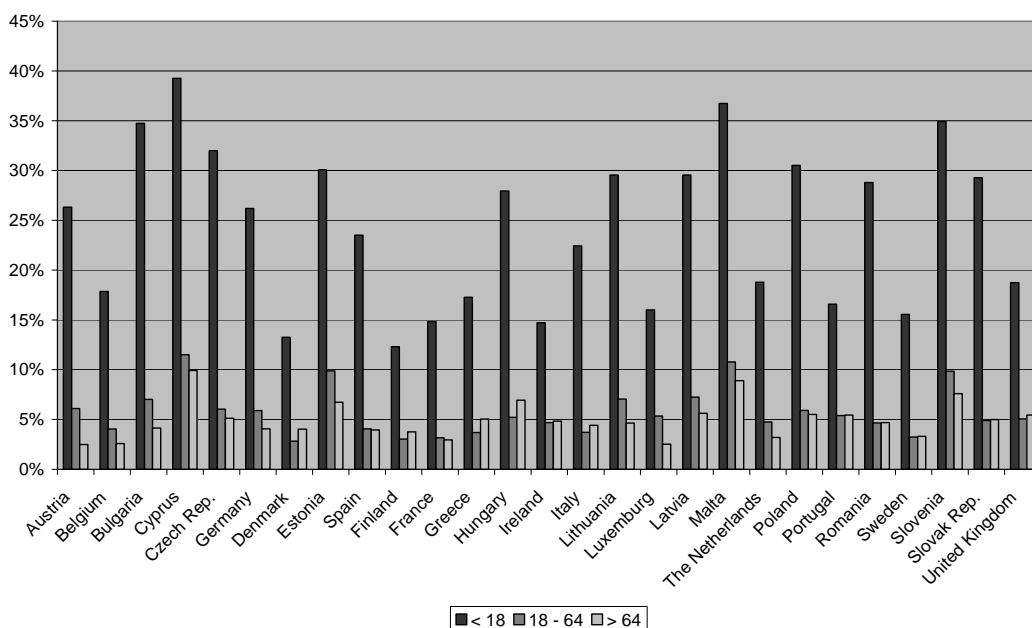
It is assumed that the population development will follow the 2004 EUROSTAT forecast on NUTS2 level with high population growth. This means that the population of Europe will grow with approximately 5 % above the baseline up to 2030 (523 m. In EU27).

Figure 4.8. Population 2030 High Growth compared to baseline



The distribution by age group is quite different from the baseline. Particularly the segment “below 18” is increasing compared to the baseline 2030.

Figure 4.9. Population by age group 2030:High Growth compared to Baseline

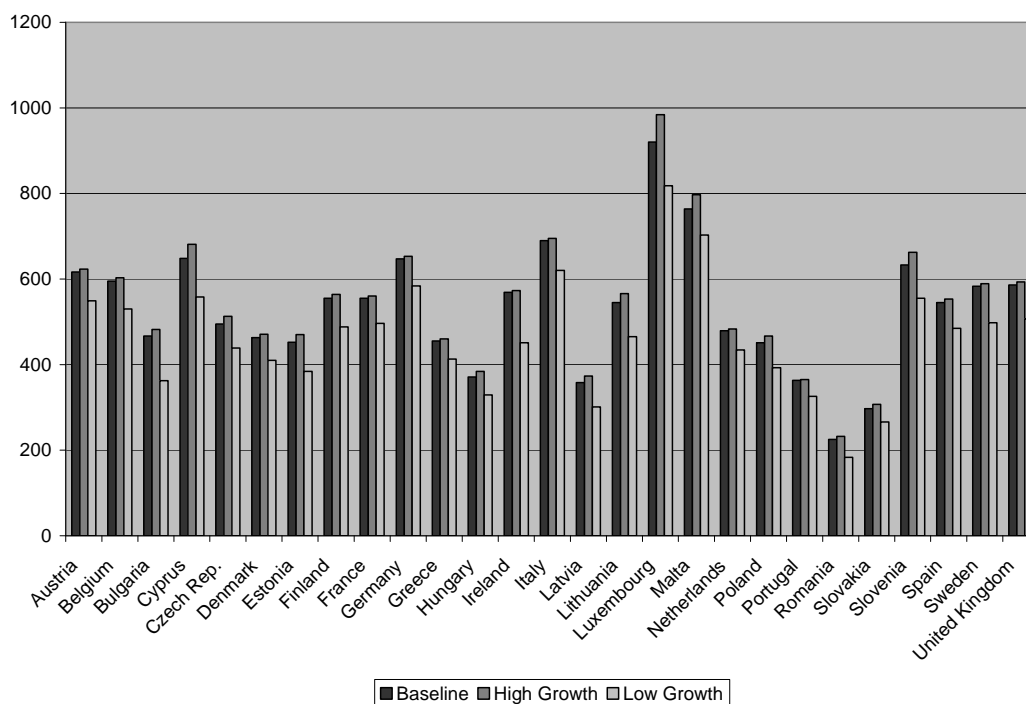


The economic development will be supported both by cohesive measures which will ensure a faster economic development in the cohesion countries, as well as the global development which will provide for an increased economic growth in the centrally located member states. Therefore the economic development measured in GDP per capita will grow to about 33,000 EUR and about 38,000 EUR in EU15 in 2020 and 2030 respectively. In EU12 the development will result in a GDP per capita of 10,000 EUR and 14,000 EUR in 2020 and 2030 respectively.

Climate considerations are important in this scenario, increasing the costs of transport use. Therefore, specific means for supporting the peripheral regions and cohesion countries are necessary.

Due to the increase in population and the increase in GDP the car ownership is expected to grow from 483 passenger cars per 1000 inhabitants in EU15 to 556 in 2020 and 601 in 2030. In EU12 the growth is faster going from 337 in 2005 to 405 in 2020 and 458 in 2030. The car ownership per country is indicated in Figure 4.10 compared to the baseline 2030.

Figure 4.10. Car ownership (passenger cars per 1000 inhabitants) 2030; Baseline, High Growth and Low Growth



The oil price is expected to remain at the high level observed in 2008. This would indicate an increase of almost 45 % from 2005 to 2020, and no increase from 2020 to 2030. At the same time, however, the charging regime related to the environmental and social dimension in the EU is expected to be implemented, and this is extended with a climate change related charge on CO₂ emissions.

Transport costs

In the High Growth Scenario fuel efficiency for passenger cars is actively being improved through a research and development strategy, which increases fuel efficiency with about 40 %. In the high growth alternative the oil price is expected to be higher than in the baseline because higher economic growth puts more strains on the resources. It is assumed that the overall effect is a fuel cost for passenger cars which remains at the level of 2005.

The technological development makes also the trucks more efficient. And in the present scenario thus has a considerable impact on the fuel consumption. However, the cost of freight transport depends on other cost items too, but increasing driver costs and running costs are counteracted through efficiency gains mainly due to intelligent transport systems and application of systems which increase the utilisation of the vehicles. In some countries the 60 tonnes modular haulage truck is introduced which also produces efficiency gains. For trucks the VOC is assumed to be at the same level as in 2005, measured in constant prices.

In the High Growth Scenario it is assumed that the tolls and charges applicable to road traffic in 2005 are still applicable in 2030. Infrastructure charging based on cost recovery is assumed to having been introduced in the Vignette countries for heavy trucks. The level of charges is 50 % of the German Maut corresponding to 0.06 Euro per km on motorways. The Vignette countries are UK, the Netherlands, Belgium, Luxembourg, Denmark, Sweden, Finland, Estonia, Latvia and Lithuania.

Internalisation of external costs is also assumed in the High Growth Scenario. Internalisation is assumed for both trucks and passenger cars. The internalisation for passenger cars is introduced because the high economic growth produces more mobility and thus also more adverse effects on climate, urban environment, safety, etc, and therefore the passenger cars will have to contribute to the costing of this.

Internalisation is based on internalising noise, air pollution, congestion and CO₂. A uniform rate of 0.04 Euro per km is applied for heavy goods vehicles for the CO₂ internalisation. For passenger cars internalisation is assumed to be 5 % of the noise and air pollution heavy goods vehicles external costs, and on top of that the external costs for passenger cars related to congestion are internalised. For CO₂ a contribution of 0.01 Euro per km is applied. The 5 % passenger car internalisation for noise and air pollution is about the same that can be found in the IMPACT study Handbook.

Also it is assumed that more than 10 % of the European car fleet is emission-free or use bio-fuels in 2030.

For rail passenger fares the assumptions made in the baseline scenario are also valid for the present scenario.

For rail freight transport the costs will be influenced by a higher cost recovery charge. This is assumed to make the rail freight transport cost equal to the cost in 2005 measured in fixed 2005 prices.

In the High Growth Scenario, fuel prices are higher than in the baseline, and economic activity is also higher. The air transport industry is fuelled by a considerable growth in tourism both from EU and abroad, but particularly from the countries of emerging economies into Europe. In spite of a high level of research and development the economic conditions and demand for air transport favour a higher price, and this is reflected in a 20 % increase of the air fares in real prices compared to 2005.

For maritime transport it is assumed that transport costs will increase with 15 %.

For Inland Waterways no changes in transport costs are foreseen.

Networks

In the High Growth Scenario a more comprehensive infrastructure development than foreseen in the baseline is assumed. The 30 priority projects are assumed finished as are a number of other projects of importance for the coherence of Europe.

The road and rail networks assumed in the High Growth Scenario are shown in the following Figure 4.11 and Figure 4.12.

Figure 4.11. Road infrastructure development in the High Growth Scenario compared to baseline, 2030

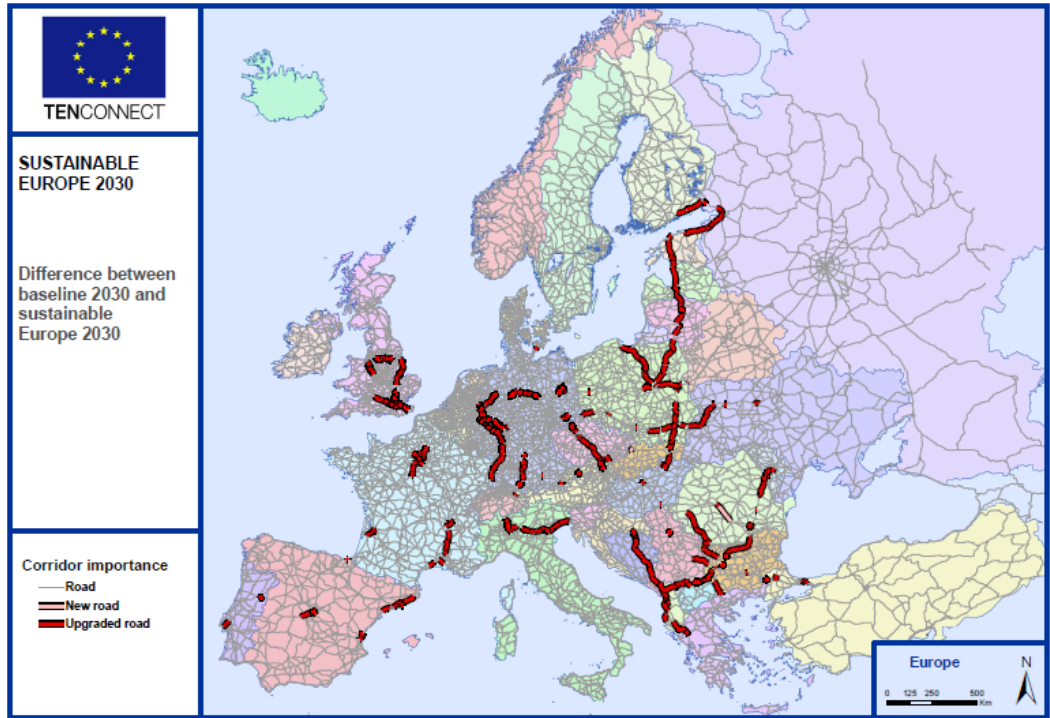
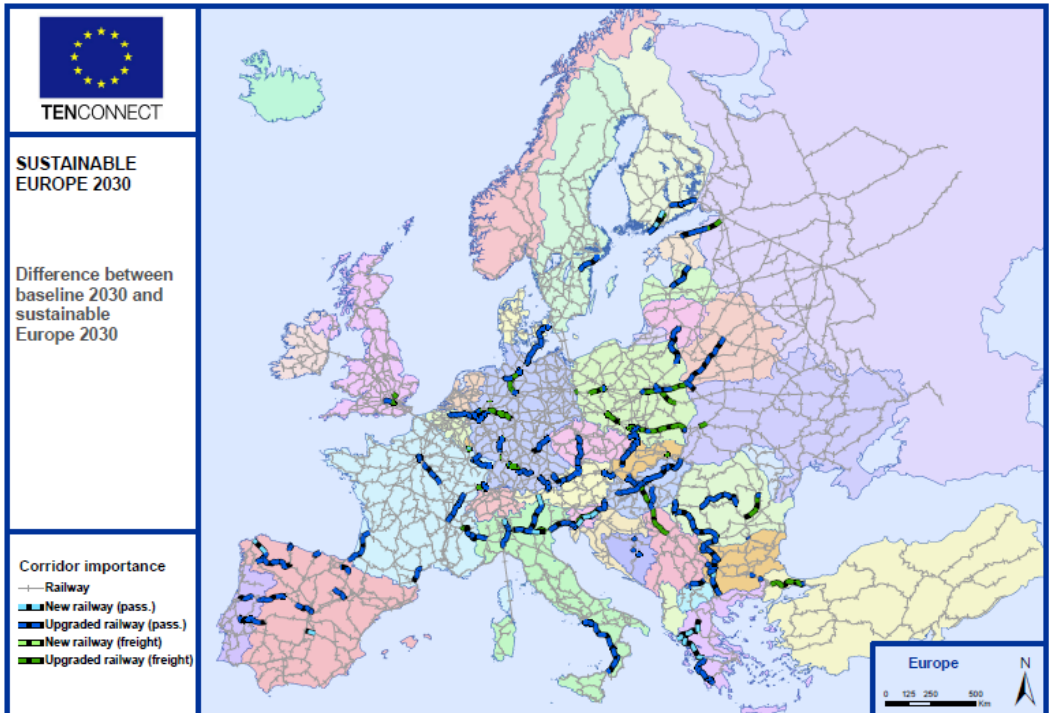


Figure 4.12. Rail infrastructure development in the High Growth Scenario compared with Baseline, 2030



A policy scenario with more infrastructure development

The policy scenario based on the High Growth Scenario assumes a further development of the infrastructure in the EU and neighbouring countries. This goes for both roads and railways. All other assumptions made for the High Growth Scenario are unaltered.

The development of the road and rail networks in this maximum infrastructure scenario is shown in the following maps.

Figure 4.13. Road infrastructure development in High Growth Scenario Alternative compared to High Growth Scenario, 2030

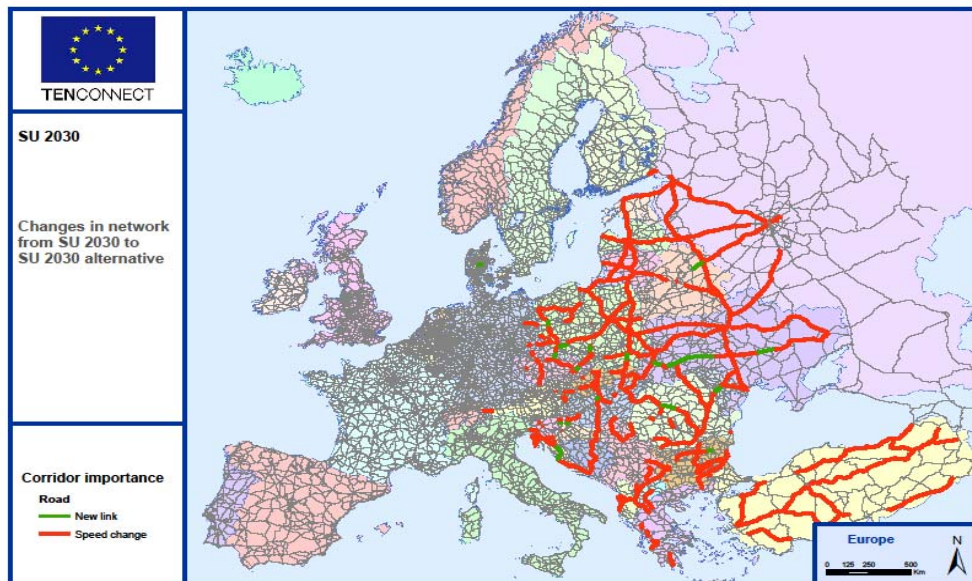
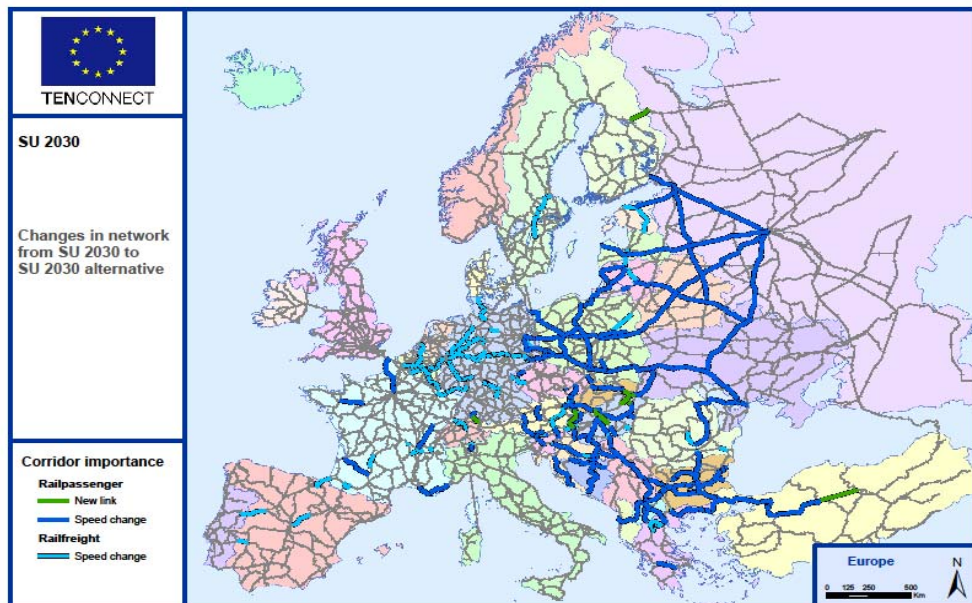


Figure 4.14. Rail infrastructure development in High Growth Scenario Alternative compared to High Growth Scenario, 2030



4.3.5 The Low Growth Scenario

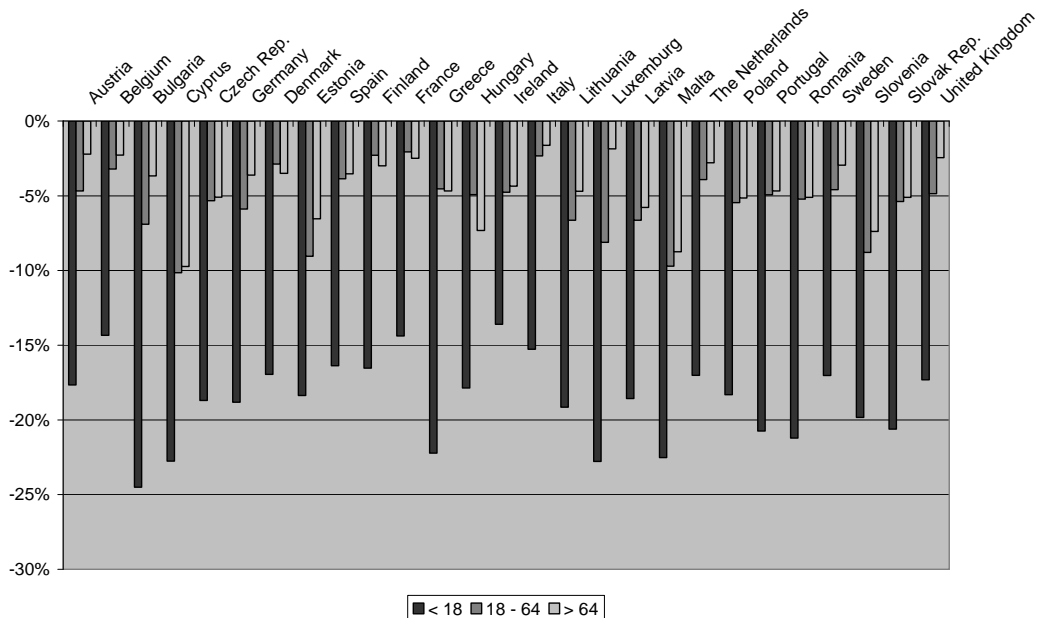
Socio-economic assumptions

The Low Growth Scenario is characterised by a low economic development further emphasized by a negative population development. Low growth happens due to increasing costs of energy, particularly oil. Europe’s answer to the increasing energy costs is mobility reduction in terms of higher operating costs which reflects the high energy prices.

It is assumed that the population development will follow the 2004 EUROSTAT forecast on NUTS2 level with low population growth. This means that the population of Europe will decrease with approximately 6 % in relation to baseline up to 2030 (464 m. in EU27).

The age group development by EU country compared to the Baseline Scenario is indicated in the following graph. Population in all age groups in all Member States declines but the biggest decline is seen in the age group up to 18, where there is a total decline of 17 % in EU27. The productive age group declines with 4 % and the old age group with 3 %.

Figure 4.15. Population by age group 2030: Low Growth compared to Baseline



The economic development per capita is assumed to reach 40% of the high growth level. And with declining population this means a total increase in GDP of EU27 of 20 % in real prices up to 2030. For comparison the increase in the Baseline was 61 % and in the High Growth scenario 77 %.

As a consequence the car ownership is also considerable less in the Low growth Scenario. In EU27 the level is assumed to be 490 compared to the 552 in the baseline scenario.

The price of oil in fixed terms is assumed to increase to a high level. This has an impact both on the general economy but particularly on the transport sector.

Transport costs

In the Low Growth Scenario research and development initiatives are in line with the baseline, but fuel cost for passenger cars is expected to be at a level 35 % higher than in

2005, in constant 2005 prices. Also it is assumed that distance based transport costs for heavy goods vehicles increase with 20 % in constant 2005 prices.

In the Low Growth Scenario it is assumed that the network is the same as in the baseline scenario. However, cost recovery for heavy goods vehicles is being anticipated in the Vignette countries, at the same level as indicated in the High Growth Scenario. In the Low Growth Scenario the introduction of the cost recovery is assumed a necessity in order to carry out necessary maintenance and reconstruction of the network under low growth conditions.

Internalisation is also anticipated in the Low Growth Scenario at the same level as in the Baseline scenario. Therefore the Low Growth Scenario assumes internalisation of noise, air pollution and congestion with the same values per km as indicated in the Baseline scenario.

Passenger rail fares are expected to be the same as in the Baseline scenario. For rail freight the rail transport costs are assumed to increase mainly because the improvements in rail technology and cross border operations are not advancing as fast as in the Baseline scenario. An increase of rail transport costs of 10 % has been assumed.

In the low growth alternative the air transport industry is under strain because of high oil prices and a slow economic development. In order to ensure profitability of the business the 2005 air fares are assumed to be increased with 30 % measured in real terms.

For freight transport by inland waterways the transport costs are unchanged compared to the Baseline scenario.

For the Low Growth Scenario it has also been assumed that maritime transport will develop along the same path as truck transport, which means that maritime transport costs is assumed to increase with 20 % in real terms.

Networks

As indicated above the networks considered in this scenario are the same as in the Baseline Scenario.

A low Growth Policy Scenario

The low growth policy scenario assumes that passenger cars are also contributing to the cost recovery on motorways. The cost recovery is 0.02 Euro per km, and it is only applicable in the vignette countries and Germany. Internalisation of external costs is also introduced for passenger cars, at a level of 5 % of noise and air pollution costs for heavy goods vehicles plus congestion costs for passenger cars.

4.4 The four exploratory scenarios for 2050

4.4.1 Introduction

The approach to the task of visioning the future of transport in Europe for the 2050 horizon was firstly based on building compelling **exploratory** scenarios.

Exploratory scenario studies differ from other assessment studies. As the directions of developments in the future are unknown, we are confronted by a profound lack of information. Different future developments are all possible, even though they may be contradictory. A scenario thus cannot be judged as right or wrong. Scenarios often deal with so many uncertainties that they can never be true in the strict classical scientific sense as there is no factual evidence to refer to. Consequently, the requirements for sound and successful scenarios are rather different from those of other policy studies. Nevertheless we can say that good scenarios should:

- fulfil the objectives of the scenario exercise;
- be plausible and internally consistent;
- tell an appealing story that is not easily dismissed by experts and policy makers;
- refer to sound data and provide a convincing comparative analysis.

Involving different stakeholders and experts helps meeting these criteria. Participatory scenario development helps indeed to:

- give access to practical knowledge and experience about new problem perceptions and identify new challenging questions, i.e. avoid narrow thinking.
- bridge gaps between the scientific communities and governments, business, interest groups or citizens, and thus provide a reality check for research assumptions and methodology;
- improve communication between scientists and stakeholders and facilitate collaboration and consensus-building on problem-solving strategies
- increase the salience and legitimacy of the scenario and thus the acceptance among end users.

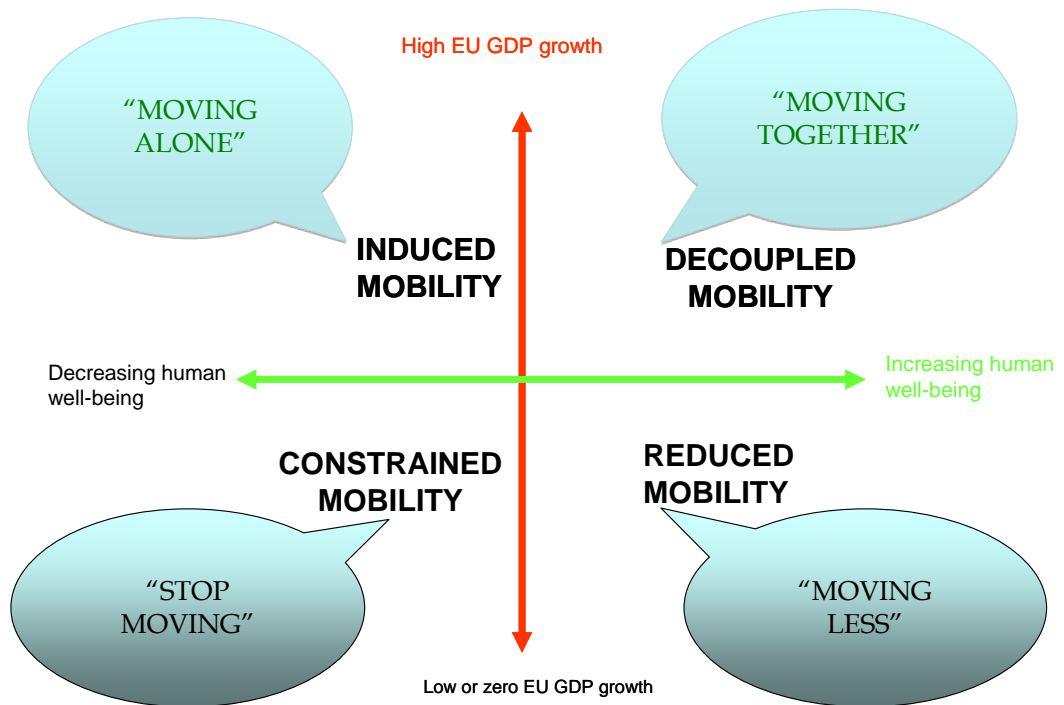
This section (4.4) presents four **exploratory scenarios** of future transport in Europe which have been produced with a participatory approach, involving a number of stakeholders in a DELPHI exercise¹⁰ and in a workshop. The scenarios are all developed:

- as alternative paths with reference to the same **global reference scenario**, which is derived as mere continuation of the tendencies (described in qualitative terms) in place when we entered the third millennium;
- keeping as predetermined element common to all the scenarios the priority given by the European Union to the fight against **climate change** and to improve the **security of energy supply**, and to the importance of making these two objectives complementary with the EU Lisbon competitiveness goals;
- differentiating the scenarios mainly in relation to two “**axes of uncertainty**” as indicated in Figure 4.16.

¹⁰ The TRANSvisions DELPHI survey is described in the box at the end of Section 3.6. This survey was used to elicit experts’ judgement on key drivers and their impacts, as well as on a first draft of more radical scenarios for the 2050 horizon.

Figure 4.16 Consolidation of four exploratory scenarios of future transport in Europe

Consolidation of four exploratory scenarios of future transport in Europe



- the “economy/technology/market” dimension (red vertical axis) spans from an high growth of EU GDP to low or zero growth.
- the “society/environment” dimension (green horizontal axis) refers to the change of human well-being – that we assume measurable with a composite index of population health and quality of life - as it has been demonstrated that over a given income threshold this change starts to be decoupled from GDP growth.

The above 2x2 scenario matrix formed by the two axes of uncertainty shows four alternative scenarios of economic growth and welfare (well-being) changes for the whole Europe, and the consequences in terms of mobility. These exploratory scenarios are described in a nutshell below:

- **“Moving alone” or Induced mobility** (or Always-on, Emerging Technologies markets, Triumphant markets). High growth and a small increase of population due to migration from 2005 to 2050. Combines strong economic growth with risks on social sustainability. Emphasis on technology, supply-management and market spontaneous self-organisation. GDP growth allow for a higher investment on research and development, as well as in more productive infrastructure, leading to a reduction of CO₂ when new more efficient technologies are implemented in the market place. CO₂ still grows fast during the first’s years.
- **“Moving together” or Decoupled mobility** (or Good governance, New social contract, Balanced planning) It is the continuation of 2030 scenario "Moderate growth and stable population", combining moderate economic growth with strong social sustainability. Balanced policies are applied, with emphasis on pricing and modal shift and Public-Private Partnerships. There is an overall optimism in the capacity of public institutions to implement cost-effective policies, and adapt themselves according to the subsidiarity principle. There is a gradual, cost-effective process to reduce CO₂.

- **“Moving less” or Reduced mobility** (or New communities, Alternative life styles, People trusting, Committed communities, Shared values). It is the continuation of 2030 scenario "Low growth and declining population", combining weak economic growth with strong social and environmental sustainability. Behavioural policies reducing demand for motorised transport are applied, as well as speed limits of roads, and land-use regulations, leading towards an increase on Public Transport. Long-distance traffics are reduced. There is a fast process to reduce CO₂, since early stages, not cost-effective, and a reduction on GDP growth.
- **“Stop moving” or Constrained mobility** (or bottlenecks ahead, or Carbon emergency). Very high growth in the short-term and an increase of population due to migration until 2030, until a "bottleneck" is reached because structural reasons (e.g. lack of public investment on infrastructure or failure on implementation of new technologies, leading to a dramatic reduction of private profitability, and a hard economic decline). It is attached to a pessimistic vision concerning the capacity of Europeans to carry on structural reforms. From 2030 to 2050, the scenario combines weak economic growth with weak social sustainability. The economy is depressed, transport prices and taxes are not raised. Regulations and bans are applied to constrain mobility, in order to release congestion and reduce emissions, such as strict Emission Trade Markets. This scenario can be understood as a failing "Moving alone" (or induced mobility) scenario.

The global reference scenario and the four exploratory scenarios are described more in detail in the following subsections. The following sections contain a detailed description of key events/features in the global reference scenario and the four exogenous scenarios at the year 2050.

4.4.2 Global reference scenario

At the turn-around of the 2nd millennium, a wide group of experts has been involved in the FORESIGHT for TRANSPORT project, producing with the help of a DELPHI Survey and a number of workshops a global reference scenario¹¹ based on the projection in the third millennium of the trends in place at the year 2000. This scenario still provides a useful reference against which to contrast the alternative exploratory scenarios developed in TRANSvisions. According to the Foresight for Transport group of experts, **in 2000** you might have seen the world as characterised by (ICCR, 2004):

- **Demographically**, an ageing society with a comparatively high regional variation at the global level (less so within the European space). The total population of the EU is growing very slowly, thanks to immigration flows from outside Europe which compensate for the natural loss of native Europeans.
- **People lifestyle and behaviour** which tends towards individualism with an emphasis on consumerism, self-interest and a positive view of technology. With regard to mobility preferences, European citizens prioritise high-speed and subsequently high-speed travel. This is evidenced, among others, by car manufacturing. Another indicator of preference for speed is the success of high-speed trains (HST).
- Trends with regard to the **social agenda** which point towards a predominance of the laissez-faire approach with increasingly flexible labour markets, decreasing welfare expenditures and higher levels of inequality. The increase of the flexibility of labour markets is reflected in the increase of part-time work.
- **Institutionally** an EU which finds itself at a key turning point, with enlargement and institutional reforms underway. The success and impacts of the latter remain unclear.

¹¹ The same group of experts produced alternative scenarios, which have been considered together with those elaborated in other studies to build the TRANSvisions policy scenarios illustrated in the subsequent sections.

The gradual emergence of the European supra-national policy means that more than 50 per cent of national legislation follows European directives. However, key areas for statehood like fiscal policy, social expenditures, justice and security as well as cultural affairs, continue to be national competencies.

- A continued **technological progress** and incremental changes and improvements. The problem appears to lie more with the diffusion and uptake of new technologies rather than with innovation, whereby the low expenditures in RTD, both from government and business, are in part to blame for this.
- Improvements with regard to the **environment** which are sought through both economy and technological instruments. However, the low uptake of new technologies on the one hand, and the low economic growth on the other, make the introduction of strong ecological policy measures difficult.
- In terms of the **economy**, a tendency to a low level of EU GDP growth with stagnation in terms of international trade and the economic structures.
- An unclear situation at the **political** front. At the crossroads of the European project of integration it remains unclear whether we are moving towards the consolidation of an open democratic system where politics are the arena for active citizenship or whether we are more likely to witness the beginning of an era of political polarisation, elite closure and technocracy.
- Against this background, the **transport** situation was characterised by high transport demand with the trend pointing towards: further growth; high levels of congestion and external negative effects; an increasing trend towards motorisation and, associated with this, a high level of injuries and fatalities.

4.4.3 “Moving Alone” or Induced mobility scenario

This scenario envisions a market-led development where EU is gradually further extended towards the east. Global trade is encouraged and EU is one of the major trade blocks in the world. The growth in economy is fast but the ageing of the population hampers the economic development in the long-term. However seen over the period 2005 to 2050 an economic growth above the previous level is foreseen. Since the vision is market-led, governments engage less in income redistribution and public insurance leading to more disparity among the inhabitants in Europe. Population is expected to increase, both due to high fertility but also because of high migration towards EU.

Societies have a strong preference for flexibility and diversity, which is best provided by the market. This applies in particular to private goods that are currently publicly provided as “merit goods” due to the positive externalities they provide, e.g. health care and higher education. Moreover, government regulations to ensure uniformity in supply (e.g. in pensions and housing), are relaxed so as to meet more diversity in lifestyles. Regulation is lessened allowing people to settle in areas hitherto preserved as green belts and nature conservation areas. Governments remain responsible for the production of pure public goods (basic education, defence, police, justice), but also use their regulatory powers to ensure effective competition on markets.

The Common Agricultural Policy is abandoned leading to market based competition also on agricultural products. The European cohesion policy and the structural funds are reformed so as to concentrate on the Trans-national axes connecting neighbouring countries, ports and airports, with the most populated areas in EU.

The scenario envisions an “always-on” lifestyle for considerable groups of particularly urban population. These are groups being employed in tourism, ICT, services and finance, and their lifestyle reduces their life expectancy. Use of some specific drugs, by

that time legal and free of secondary effects, to enhance intellectual performance of an ageing population is increasing.

The vision is optimistic in terms of technologic improvements and market self-organisation capabilities. Public policies aim to support research and development, use the most cost-effective technologies to reduce emissions, and liberalise and regulate markets allowing healthy competition. Therefore, the scenario envisions improving the efficiency of existing car engines, make use of biofuels and a variety of alternative fuel options, including hydrogen batteries, and then move to a second generation of biofuels and electricity. Intelligent traffic management systems have a significant importance relieving congestion and increasing speed. Energy supply is maintained by increasing use of nuclear power and an increasing use of other non-fossil energy (wind, sun, etc)

Toward the year 2050, intelligent positioning systems, encryption technology, real-time tele-presencing and a shift towards a low-carbon economy have boosted economy and accelerated consumerism that shows few signs of abating. If energy issues have been addressed, other sustainability problems have not. Europe's waste footprint is still far larger than Europe is. As a society, Europe is richer than ever, more than four times as affluent as in 2005, and one consequence is that it is increasingly hard to fill jobs that involve working anti-social hours. With fewer people needing the pay from such jobs, and a growing realisation of the social costs of such work on family life and social relationships, many service deliverers have been forced to put in place sophisticated auto-delivery systems in order to continue to provide the levels of service and frequency of delivery their customers have come to expect. However, other personal services (e.g. home elderly care) continue to be increasingly provided in the richer EU countries by low-skilled immigrants from less well-off European countries or poorer countries outside Europe.

4.4.4 “Moving Together” or Decoupled mobility scenario

The decoupled mobility scenario aims at reducing the environmental footprint to a minimum but also maintain a functioning society where economic development, trade and mobility is producing benefits for the citizens of Europe. However, although technological changes are foreseen, the major shift in environmental footprint is related to cost effectiveness of preserving the physical framework for human activities, and the main issue is a change in tax system from income and VAT to tax on resource use.

Cohesion of Europe is a driving force in this vision. Europe becomes a super-power and is enlarged to including West Balkan and Turkey, and establishes strong trade relations with Ukraine, Russia, other east-European states and Mediterranean countries. European integration intensifies on the basis of reinforced cooperation. EU decision making is eventually reformed and acquires improved legitimacy through increased direct democratic mechanisms of participation, good governance and transparency. Direct democracy and centralised power could reduce transaction costs and improve enforcement of transport legislation, carrying in some cases the deadweight of “one size fits all” policies.

Europe centralises its policies in Foreign and Security Policy. National sovereignty thus diminishes. Decentralised responsibilities remain in other fields. Enlargement increases heterogeneity in the EU which calls for diversity in institutions, e.g. in social security and taxation. The EU develops a framework in which policy competition between member states can take place. Social cohesion is maintained in EU through various collective arrangements. These limit income disparities (e.g. between skilled and unskilled and between those inside and outside the labour force).

The outward orientation of Europe and the deepening of the internal market contribute to productivity growth in the EU. Although ageing is still progressing high fertility and high life expectancy combined with a high migration brings the European population on a growth trail. By 2050 there is a sound mix of children, productive population and elderly. And pension reforms have changed the age of retirement which also stimulates the economic growth.

The integration of goods and services markets leads to trade volumes larger than in the global reference scenario and changing trade patterns. The cohesive Europe trade more with itself but the combination of lower trade barriers and high growth in Asia makes Asia capture a higher proportion of the non-EU trade. The shift from agriculture and manufacturing towards services, especially in Asia, tends to moderate the growth in volumes traded.

Europe combines social cohesion with a fairly competitive and strong economy. It succeeds in deepening the internal market in many fields which intensifies competition and stimulate productivity growth. Also labour mobility is encouraged by the removal of institutional barriers to migration. Accelerating economic growth is reinforced by the completion of a successful European innovation strategy, which includes a European patent and joint policies to stimulate R&D. The budget for the Common Agriculture Policy and Cohesion Policy are maintained, but these policies become less distorting, as they are reformed and become effective instruments to benefit peripheral and rural regions in the European Union – especially in EU12 and the enlargement countries.

A major effort to reduce the environmental footprint is envisioned. This affects the enlarged EU in many ways. Recirculation of all used materials has been systematised. Therefore, erection of new buildings makes use of what is left over from previous buildings. A major recycling industry has developed able to respond to almost all recycling needs, also cleaning of leftovers from the 20th century. Also the tax system has been fundamentally redesigned so that people are taxed principally on the resources they use up, rather on the money they earn or what they spend.

Emissions from industries, power plants and transport modes are being reduced by application of filters, carbon sequestration and change of technology. Illegal emissions are being heavily fined.

Mobility needs are reduced using intensive planning at national, regional and local levels combined with nationwide road pricing and other specific fees and taxes. A significant decrease of transport demand can be observed and both for international and national transport as well as for passenger and freight transport, with technology partially substituting for mobility (through e-commerce and e-work). Public transport is revived, both because urban areas are remodelled in a denser way, keeping motorised individual transport to a minimum. As it concerns the development of specific transport infrastructure and technologies, the leading factor is the renewable of urban transport infrastructure and technologies. Nationwide road pricing was introduced in the great majority of EU countries in 2025 supported by the Galileo system.

4.4.5 “Moving Less” or Reduced mobility scenario

This scenario envisions a Europe with deep divergences moving in different directions. The vision is that in some member states concerns concerning the climate change have a prominent stand among the countries whereas this is not the case in the remaining Member States. Divergences in technological progress do also lead to major differences in mobility and mobility's impact in the two different groups of member states.

The climate concerned Member States emerge as a trade block and co-operation through the EU institutions with the other member states has become increasingly difficult. The climate concerned member states make its own arrangements concerning spending of Cohesion Budget and Common Agricultural Policy, leaving only marginal transfers to the other member states. Therefore, convergence is remote, EU enlargement is not on the agenda, and the group of other member states turn towards other countries in order to expand its trade and income. The US agrees upon a free trade area with other Americas. Europe suffers from this, due to trade diversion.

In light of the barriers to international trade and the lack of competitive forces, which feature this scenario, labour productivity grows only mildly at a rate of 1% per year. In combination with the ageing of the population, which reduces the employment rate, this im-

plies that GDP has a very limited growth. European countries rely on collective arrangements to maintain an equitable distribution of welfare. This scenario is unsuccessful in modernising welfare-state arrangements. Governments largely maintain the welfare state in its original form.

The climate concerned Member States protect their industries and agriculture through trade barriers. Governments in these member states minimise the scope for policy competition through the harmonisation of social policies, such as employment protection legislation, minimum standards for social assistance, and disability insurance. The corporate tax system is harmonised, with a common base and a common rate. The other member states are unable to follow this trail due to lacking support. The Schengen 2 agreement is made between the Climate concerned member states establishing a new border between these states and the other member states in order to avoid illegal immigrants into the climate concerned member states. EU breaks down to a customs union between the climate concerned member states and the other member states.

It is envisioned that people consume less carbon-intensive products and services primarily because of the introduction of carbon tax systems, in particular in North America and in the climate concerned member states. Carbon taxes are based on fossil fuel carbon content and therefore tax carbon dioxide emissions. Carbon taxes are applied by all Climate concerned member states, in a revenue neutral fashion, as the taxes on labour and investments have been reduced. In this way people perceived clearly that what is taxed is “what you burn, not what you earn”, and this perception led to a shift to more energy saving behaviours in all their activities, including mobility. Carbon taxes are efficient and flexible because they support many energy conservation and emission reduction strategies, allowing households and business to choose the combination that works best for them, including more fuel efficient vehicles, more accessible locations and destinations, more efficient modes (and more active travel), more resource-efficient goods (such as recycled products), shifts to alternative fuels etc.

People’s lifestyle is the major area of change in this scenario. Individualistic consumerist attitudes are unaffordable for an increasing share of people. Local food production and services have increased. The full external costs of conventional agriculture (water pollution from overuse of chemical fertilisers, pesticides, soil erosion etc.) have been internalised and incorporated into the price, making conventionally grown food much more expensive.

The world is more local than it was. Less availability and high price of energy means people travel more slowly; they don’t travel so far. Work is closer to the home; in some places home and workplace are the same. More appropriate building design has reduced energy needs.

Economic production and development as well as transport are re-organised according to ecological principles supporting strong sustainability – in general and with regard to transport – and new forms of social organisation with less work, more leisure, strong voluntary sector and “togetherness” in consumption (e.g. co-housing, car-sharing, etc.) emerge. This contributes to reduce the overall impact of human activities on the environment.

4.4.6 “Stop Moving” or Constrained mobility scenario

The constrained mobility scenario is based on a dispersed world where Europe and America forms an axis of trade and wealth, which supports each other. It is envisioned that transport, both passenger and freight, is closely monitored in order to ensure that the Units of Carbon Entitlements provided to individuals and companies are not exceeded. Short sea shipping and railways are increasingly used, as well as public transport in cities.

EU is primarily seen as an economic union with a focus on the internal market. A setback in international trade agreements has been experienced.

The rich transatlantic economic block contrasts sharply with the poorest parts of the world. Less developed countries even suffer from trade diversion as a result of the Atlantic free-trade agreement. There is little interest in Europe and the United States to actively fighting poverty in developing countries.

Also within EU major disparities are envisioned. Not all EU countries are able to obtain the expected outcome in terms of increasing trade from the Atlantic free market. Entry into the Euro zone is slower than original anticipated. West Balkan accedes to the European Union, but Turkey does not. Turkey therefore shifts her attention more eastwards. China and Russia become more isolated, both politically and economically. Because of poor border controls, EU member states suffer from an inflow of illegal immigrants.

Growth in EU is concentrated in ICT-producing sectors, and in ICT-using service sectors such as the financial sector, business services and the public sector. The broad dissemination of ICT boosts labour productivity. However, as the result of declining employment due to ageing GDP growth recedes. The common agricultural policy is abandoned increasing import of agricultural products to Europe from America. The cohesion funds are applied mainly to boost the infrastructure related to the main ports and airports linking Europe and America.

It is envisioned that persistent trade barriers and relatively low economic growth outside the club of rich countries hamper world trade. World exports grow moderately. A large share of the EU Member states exports is intra-EU trade. The United States is an important destination for the exports to other regions because of the European-American internal market.

The scenario foresees that in the internal European – American market the role of the state is diminished. This boosts technology-driven growth and at the same time increases inequality. However, the heritage of a large public sector in EU is not easily dissolved. New markets – e.g. for education and social insurance – lack transparency and competition, which bring new social and economic problems. The elderly dominate political markets.

It is foreseen that publicly provided welfare provisions are limited to social assistance. The EU27 labour market becomes more flexible as employment protection legislation is relaxed, particularly in some of the major EU countries, minimum wages are reduced, and the tax systems are completely reshaped, based on the use of resources. These reforms stimulate participation in the formal labour market and induce people to work longer hours. Europe looks more like the US. Also income disparities are increasing, both between those inside and outside the labour market, and those with high skills and lower skills. However, the introduction of UCEs (Units of Carbon Entitlements) shows that the social impacts of the Contraction and Convergence Agreement (CCA) signed by the G10 and EU27 countries in 2020, are more dramatic than anyone had predicted. Notably, the gap between the poorest 10% of the population and the rest has narrowed significantly as individuals who use little carbon successfully trade their entitlement for cash. Carbon entitlements have affected middle-income families too, forcing many to change their lifestyles in order to make best use of their UCEs.

As it concerns the development of specific IT and transport technologies, those connected to the boosting ICT sectors are obviously facilitated, including the extensive use of ITS in the transport sector, for both passenger and freight applications. By 2030 intelligent speed control is largely implemented in the European conurbations. London and Paris have led the way for further reducing speed limits in cities and car manufacturers are installing Intelligent Speed Adaptation Systems (ISAS) into all models. However, tough national surveillance systems monitoring the use of UCEs means that people only travel if they have sufficient carbon quotas – and these are increasingly tightly rationed. Traffic volumes have shrunk hugely, and will fall further as the carbon ration continues to be reduced.

It is also increasingly important the impact of ICT on transport, in terms of substitution and/or change of daily mobility patterns in the urban environment - as well as of substitution of trips in the long distance transport segment with virtual meetings and/or induction of new business and tourism travel. The renaissance of home-working has created demand for better local infrastructure and services, especially in the urban areas.

The change of EU's transport infrastructure has been limited up to 2030. Apart from the projects linking ports and airports in order to facilitate the Atlantic internal market few long-term infrastructure projects have had the political commitment or investment required to become a reality. In 2030 the ageing infrastructure is becoming an increasing financial burden on the state and business has become concerned about the impact on the EU's long-term economic competitiveness. However, the drastic reduction in transport as a consequence of the introduction of UCEs makes a further delay in infrastructure projects acceptable.

It is envisioned that energy production is based mostly on fossil fuels. There has been little development of infrastructure to distribute alternative fuels such as hydrogen in the road sector, nor incentives for fast adoption of fuel efficient technologies. Therefore, it was hardly surprising that the G10 and the EU27 were forced into a tight multilateral cooperation on climate change mitigating measures, resulting in the above mentioned CCA in 2020.

The vision foresees that in 2050 the economic, environmental and social consequences of signing up to the CCA are clear. The economy has continued to grow, despite a significant reduction in the amount of travel being undertaken. Under the terms of the CCA, individuals each received a carbon entitlement, which had been negotiated and agreed between the regions of the world. The entitlements, in the form of international energy-backed currency units (EBCUs), operate as a parallel currency. The G10 nations have all successfully met the CCA targets on carbon emissions and some of the most pessimistic outcomes of climate change have been avoided.

The key features of the global reference and the four exploratory scenarios are outlined in the summary table 4.2 on page 103. The different scenario features have been identified on the base of the narratives and features of a number of similar scenarios investigated in the literature, and also based on comments collected through the DELPHI process. The table has to be interpreted only as a comparative briefing of the main characteristics of the different qualitative scenarios developed in Task 1.

4.5 The Meta-Models approach

As described above, TRANSvisions uses a foresight exercise that includes a qualitative analytic process based on expert judgment (based on literature review, and DELPHI surveys) leading to the definition of meaningful qualitative scenarios.

It is useful to employ a modelling tool in order to refine and validate these qualitative visions. However, it has already been explained how the TRANS-TOOLS forecast model (based on equilibrium formulations and calibrated for the current situation) is not suitable for such long-term horizons (up to 2050).

In order to deal with this situation, TRANSvisions has adopted a methodological approach, "Meta-Models", based on developing a new forecast and backcasting set of models (multisectoral, focused on the long-term, and interactive) specially programmed for the TRANSvisions exercise.

The purposes of TRANSvisions Meta-Models are as follows:

- Firstly, to validate the consistency of qualitative scenarios, as well as the educated guesses made by participants in the Delphi process in relation to the tendencies of key indicators.
- Secondly, to provide quantitative predictions of scenarios far away from the current situation (from 2030 to 2050), both forecast and backcast. Therefore, the goal of the Meta-Models is to provide a bridge between qualitative and quantitative approaches. It is worth mentioning that the 2005-2050 scenarios defined in TRANSvisions contain complete story-lines. These can be used as a reference to define consistently all independent variables and parameters included in the Meta-Models formulation, and to check the results (in some cases, particularly for the Constrained scenario, story-lines were then adjusted to be consistent).

More information about the Meta-Models is given in Chapter 5.

Table 4.2 - Description of global reference scenario and four exploratory scenarios

Key drivers:	KEY EVENTS/FEATURES OF THE SCENARIOS FOR THE 2050 HORIZON				
	Global reference scenario	Induced Mobility	Decoupled Mobility	Reduced Mobility	Constrained mobility
GLOBAL GOVERNANCE AND POLICY CONTEXT					
- Global Co-operation	Customs Union with West Balkan and Turkey	Co-operation on economic issues. Co-operation in non-trade issues fails. Increasing risk for conflicts US not signing the Kyoto protocol	Europe a super-power. Global climate change mitigation policy	Limited interest in multi-lateral co-operation. North America and EU15 applies common Carbon tax system	Limited interest in multi-lateral co-operation G10 signs CC-agreement
- Global trade governance	Continuation of existing policies within WTO	WTO focuses on free trade.	Lower trade barriers	A number of different trade blocks. North America, Russia/China...	Global trade agreement fails Single market between EU, North America and South America Less developed trade relations on EU East border
- EU enlargement	No	Yes, Turkey, West Balkan, Ukraine, Moldova become members	Yes, Turkey and West Balkan become members. New co-operation agreements with Russia, Ukraine and the Mediterranean countries	Two-speed Europe (Euro and non-Euro areas) ends up in a permanent two-tiers Europe	No EU15 forms its own co-operation unit. NMS12 co-operates more strongly with Russia, Ukraine and China
- EU cohesion	Cohesion policies continue as present	No European cohesion policy is abolished.	Cohesion policies aiming at limiting income disparities	No A two-tier Europe has developed	Cohesion support is ineffective and the new member states have difficulty in adjusting to the market
- EU integration (Single Market vs Political Union)	A mixture of single market and political union	Prevalence of the "Competitive Europe" model. Europe converges towards high economic growth.	Strong European Union EU decision making reformed Uniform Foreign and Security policy Single market is deepened	EU15 forms a political union, with EURO membership for all.	EU seen as an economic Union with focus on internal market Strong cooperation concerning Carbon Contraction Agreement

Key drivers:	KEY EVENTS/FEATURES OF THE SCENARIOS FOR THE 2050 HORIZON														
	Global reference scenario			Induced Mobility			Decoupled Mobility			Reduced Mobility			Constrained mobility		
							Intensified competition								
- EU Taxation policy	No overall coherent tax reform. Continuation of income tax and VAT			Cut in taxes, but still tax on earnings and VAT			Minimum corporate taxation Tax system based on resource use			Tax system based on Carbon use. Tax system revenue neutral. Reduced tax revenues from work and VAT			National tax systems based on RUT (Resource use tax) Introduction of Carbon Entitlements		
- EU distribution policy	A mixture of market led reforms and preservation of welfare institutions			Reformed CAP Structural funds abolished			Privatisation European innovation strategy Reform of CAP and structural funds			Modernisation of welfare state fails			Structural funds are mainly used in EU15 CAP funds are mainly applied in EU15		
ECONOMY															
- GDP Growth	Convergent economic growth in the order of 2% per annum			Convergent economic growth, with GDP growth in the order of 3% per annum			EU GDP growth 1.5 % per annum			EU GDP growth 0.2% per annum			EU GDP growth 1.0 % per annum		
- Labour productivity	1.5 %			2.0 %			1.5 %			1.1 %			1.8 %		
- Interest rates	3 %			5 %			2 %			3 %			1 %		
- Trade growth in volume	2.8 %			5.6 %			4.5 %			2.4 %			3.7 %		
- Trade ex EU25 in volume	40 %			60 %			60 %			35 %			50 %		
- Trade Value distribution		2005	2050		2005	2050		2005	2050		2005	2050		2005	2050
	EU27	66 %	60 %	EU27	66 %	40 %	EU27	66 %	40 %	EU27	66 %	65 %	EU27	66 %	50 %
	OECD	16 %	18 %	OECD	16 %	16 %	OECD	16 %	15 %	OECD	16 %	12 %	OECD	16 %	30 %
	Non-OECD	18 %	22 %	Non-OECD	18 %	44 %	Non-OECD	18 %	45 %	Non-OECD	18 %	23 %	Non-OECD	18 %	20 %
- Employment	Unemployment rate is 9 %			Labour market reform ensures elderly's participation in work force. More immigrants. Unemployment 5 %			EU unemployment rate is about 6 % in 2050. EU employment rate will be reduced slightly.			Labour force participation rate: 40% in 2050. Unemployment will increase (10 %)			Labour force participation rate: 45 % in 2050. Unemployment rate 7%		
- Income	Income disparities grow			Income inequality grows			Limited disparities in income			Growing income disparities between EU15 and EU12.			Income disparities between skilled and unskilled workers, downsizing unemployment compensation. EBCUs change the income distri-		

Key drivers:	KEY EVENTS/FEATURES OF THE SCENARIOS FOR THE 2050 HORIZON				
	Global reference scenario	Induced Mobility	Decoupled Mobility	Reduced Mobility	Constrained mobility
- Public budget constraints	Public sector share of GDP remains constant	Decrease in public sector share of GDP.	Moderate increase in public sector share of GDP Increasing efficiency of public sector Pressure of ageing but outsourcing of tasks.	Government finances overburdened Strong increase in public sector share of GDP.	Welfare states are downsized. Pressure on public expenditures. High pension costs and high health care costs.
SOCIETY					
- Population growth	Slight increase of EU27 population from 495m in 2005 to 515m in 2050.	Growing EU27 population. 2050: 544 m.	Increase in EU27 population 2050: 557 m.	Reduction of EU27 population 2050: 494 m.	Reduction of EU27 population 2050: 509 m.
- Population ageing	Proportion of over 65 increased from 17% to 29%	Proportion of over 65 increased from 17% to 25%	Proportion of over 65 increased from 17% to 28%	Proportion of over 65 increased from 17% to 35%	Proportion of over 65 increased from 17% to 32%
- Migration	Net immigration from outside Europe is at base level: about 0.4 m. per year	Net migration about 1.3 m per year Fixed number of legal immigrants (Green card) Low skilled immigrants from poor countries outside Europe (illegal)	Net migration about 0.7 m per year	Net immigration from outside Europe is about 0.1 m per year	Net immigration from outside Europe is about 0.2 m per year
- Urbanisation	Continued urbanisation	Planning at a bare minimum Urban sprawl	Planned urban and regional development Compact urbanisation Rural areas suffer from poor communication	De-urbanisation: smaller communities Local planning	Sector planning Compact urbanisation
- Work-time regimes; tele-working	Diffusion of telework	Telepresencing is almost a "lifestyle"	Diffusion of telework and flex-work regimes	Use of short-hop wireless systems	Diffusion of telework
- Tourism and leisure	Growth in world tourism (3 % p.a.)	Continuous growth of world tourism (4 % p.a.)	Growth in world tourism 3.5 % p.a.	Change of tourism towards near located places. Low growth (1 % p.a.)	Reduced growth of world tourism: 1.5 % p.a.
- Lifestyles	Continuation of individualistic consumerism	Rising life stress Rampant consumerism. Fall in life expectancy	Increasing sustainable consumption and lifestyle. Less intensive travel and	Local lifestyle Change in consumption patterns	Strong social impact of carbon entitlements. Increasingly diversified

Key drivers:	KEY EVENTS/FEATURES OF THE SCENARIOS FOR THE 2050 HORIZON				
	Global reference scenario	Induced Mobility	Decoupled Mobility	Reduced Mobility	Constrained mobility
		Increasingly automated delivery of services (self-service)	modal shift Zero waste society	Changed tax system	society with increasing disparities.
- Safety		Reduction of EU road fatalities of about 50% as compared to 2006 level (to 20.000 death per year) thanks to driver assistance	Reduction of road fatalities of about 20% thanks to the increased use of sustainable modes	Reduction of road fatalities of about 30% due to the reduction of traffic	Reduction of road fatalities of about 80% thanks to the reduction of traffic and the diffusion of intelligent speed control
- Security		Private security on the rise. Market-led security provision (including part of defence tasks). Security offered by private cars much valued and improved.	Security enhanced through: i) private-public cooperation with the public sector maintaining oversight and private sector sub-contracting; ii) positive and negative incentives for public to cooperate.	Change of lifestyles towards more local activities and social networking increases security	Focus on enforcement, control and corrective action
ENERGY					
- Energy supply	Continuous use of fossil fuels for energy supply supplemented with nuclear energy and other non-fossil fuels.	Nuclear energy increase Non-fossil energy sources (excl. Nuclear) 35 %.	Distributed energy power (microgrids) Carbon sequestration Development of non-fossil fuel Nuclear energy is not developed further	Non-fossil fuels and other clean energy sources	Nuclear energy is not developed further. The main energy is produced based on fossil fuels. Carbon sequestration is widely applied
- Energy demand	Increasing efficiency and savings in energy demand	Higher efficiency but also high rebound effects of increased mobility.	Sustainable buildings Reduced mobility lifestyle by encouragement and road pricing	Sharply reduced due to Carbon taxes. Self-help communities	High fuel efficiency and heavily constrained demand by means of carbon entitlements
- Energy prices	Energy prices around 150 2005 - US\$ per barrel oil.	Successful transition to non-fossil fuels, thanks to diversified energy sources, greater energy efficiency, and the diffusion of hydrogen towards 2050. Moderate energy	High energy prices (e.g. triple-digit oil prices)	Low energy prices as a consequence of falling demand and Carbon taxes	High energy prices (e.g. triple-digit oil prices)

Key drivers:	KEY EVENTS/FEATURES OF THE SCENARIOS FOR THE 2050 HORIZON				
	Global reference scenario	Induced Mobility	Decoupled Mobility	Reduced Mobility	Constrained mobility
		prices increase, due to Arctic oil fields			
TECHNOLOGY					
- New energy infrastructure	Continued use of existing energy network	Full exploitation of nuclear energy.	Full exploitation of distributed micro-generation from natural gas and renewable sources. Small energy community networks (microgrids).	Better local infrastructure and services	Energy infrastructure in two steps, EU15 develops the infrastructure timely, while it is decaying in EU12.
- New transport infrastructure	Limited change of the transport infrastructure	Full development of intelligent transport infrastructure, hydrogen distribution infrastructure. Market-led ITS.	Development of urban transport infrastructure and innovation. Government-steered ITS	Decaying transport infrastructure in EU12.	Limited change of the transport infrastructure, but decay is showing. Intelligent speed control.
- New fuels and vehicles	Fuel efficiency	Drivers assistance Hydrogen cell application Increased fuel efficiency Biofuel buses and cars	Drive away from automated public transport Hybrids between buses and taxis	Research on new vehicles is nearly stopped.	Fuel efficiency Biofuel buses and cars
- ICT development	General use of ITS in every day life	Wireless connection ID devices	Use of ITS mainly in the urban environment	Low-powered communications An eroded information infrastructure technology.	Intelligent speed control
ENVIRONMENT					
- Pollution	Increasing pollution	More local pollution	Local pollution below air quality control targets	Reduced pollution due to reduced activity in the transport and other sectors.	Less pollution as a side-effect of strict carbon regulation
- Waste	Increasing waste	Increasing waste footprint	Zero-waste society	Reduction of waste due to the reduction of production and consumption.	Decreased waste footprint
- Greenhouse gases emissions	Increase in GHG emissions	Reduction of global emissions at 2000 levels by	Reduction of global emissions to about 40% below	Contracted carbon emissions (about 90% below	Reduction in global emissions to about 40% below

Key drivers:	KEY EVENTS/FEATURES OF THE SCENARIOS FOR THE 2050 HORIZON				
	Global reference scenario	Induced Mobility	Decoupled Mobility	Reduced Mobility	Constrained mobility
		2050 (corresponding to an atmospheric concentration of about 550 ppm of CO ₂ -eq.)	2000 levels by 2050 (corresponding to an atmospheric concentration of about 450 ppm of CO ₂ -eq.)	2000 levels) corresponding to 350 ppm of CO ₂ .	2000 levels by 2050 (corresponding to an atmospheric concentration of about 450 ppm of CO ₂ -eq.)
- Climate change effects	Rising water levels	At the atmospheric concentration of about 550 ppm of CO ₂ -eq, global average temperature increase is going to stabilise at about 3 C° by 2100 and the global average sea level rise at 1,2 metres	At the atmospheric concentration of about 450 ppm of CO ₂ -eq, global average temperature increase is going to stabilise at about 2,2 C° by 2100 and the global average sea level rise at 0,9 metres	Atmospheric concentration of CO ₂ -eq fall below 400 ppm, the global temperature increase below 2 C° and sea level rise below 0,4 metres	At the atmospheric concentration of about 450 ppm of CO ₂ -eq, global average temperature increase is going to stabilise at about 2,2 C° by 2100 and the global average sea level rise at 0,9 metres
TRANSPORT					
- Interurban transport		Growing air transport High Speed Trains Increasing long-distance travel	Growing share of slow modes in passenger transport. Increasingly priced air transport Increasingly priced rail transport. Less passenger travel need. In freight transport punctuality and reliability are more important than speed. More rational freight transport	Hard travel Slow transport patterns	Dynamic traffic flow management Inescapable carbon regulation and control
- Urban transport		Flexible local public transport Increasing volumes of traffic	Slower passenger and freight transport Road pricing Mobility rights enforced	Slow transport patterns	Dynamic traffic flow management Increasing public transport commuting Drastically reduced volumes of traffic Inescapable carbon regulation and control.

5 Model predictions and evaluation

5.1 Introduction

This chapter provides and evaluates results from running TRANS-TOOLS and the Meta-Models. Before providing these results, though, an overview of the evaluation methodology (termed the “TRANSvisions MCA”) is described in Section 5.2.

As described in Chapter 4, TRANS-TOOLS has been run for the base year (2005) and five scenarios for 2030: three of these scenarios are “exogenous” (identifying alternative “main structural trends” until 2030) and two are concerned with policy tests. The output from TRANS-TOOLS for the three exogenous scenarios (the “Baseline Scenario”, the High Growth (Sustainable Economic Development) Scenario, and the Low Growth Scenario) will be described in Section 5.3 accompanied by a discussion of the importance of definitions of freight and passenger transport when considering decoupling.

In Section 5.5 a description is provided of the TRANSvisions analysis tools based on Meta-Modelling. The calibration of the Meta-Models to fit the general socio-economic development as well as the TRANS-TOOLS results is described, as is the calibration with respect to CO₂ emissions. With this tool an analysis is carried out (in Section 5.6) of the four exploratory scenarios described in Chapter 4, whilst two backcasting policy scenarios, where different policy measures are applied for attaining goals on CO₂ reduction in 2020 and 2050, are examined in Section 5.7.

5.2 The TRANSvisions MCA

5.2.1 Introduction

The aim of the TRANSvisions Multi Criteria Analysis (MCA) is to provide a coherent framework for assessment in the TRANSvisions study. In particular it aims to ensure that trends, challenges, policy objectives and policy instruments are all treated in a recognisably consistent fashion. This consistency in assessment approach is particularly important given that the TRANSvisions project is using two different paradigms for future-thinking, as described above in Chapter 4.

In general, two types of indicator will be used in this report:

1. Normative indicators which are used primarily to assess whether a future scenario is desirable or not, and are thus fundamental to the MCA.
2. Indicators which are mentioned mainly for descriptive purposes, and generally have no normative orientation in themselves, though they might in some cases act as proxies to the normative indicators in (1).

Indicators of type (1) are organised according to the three “axes of sustainability” at the heart of EU transport policy objectives: economic, environmental and social. These will be described further in detail below. In general, though, these indicators can be put in two further categories:

- I. Indicators used in “traditional transport studies”.

- II. Indicators based upon concepts of “social capital” (which is explained further in Chapter 6) which try to capture those (social) impacts of transport that are traditionally difficult to model or quantify (and which are typically ignored in mainstream transport assessment).

Since the aim of the study is to provide support for policy-makers to make decisions (as opposed to “making decisions for them”), no attempt is made to provide an *a priori* numerical weighting of the importance of these indicators (as would be found in a traditional Cost Benefit Analysis or in some versions of Multi Criteria Analysis).

The main indicators of type (I) are transport usage, distinguished by freight and passenger traffic.

In general, analyses in this report will:

- show values (quantitative and qualitative) of indicators for given time horizons (2030, 2050 etc)
- describe how indicator values vary over time. In general, the base year for most indicators is 2005.
- disaggregate indicators according to a number of criteria, such as geographical and modal
- show composite indicators combining two or more single indicators, such as decoupling indicators

Section 5.2.2 describes all indicators further, with the exception of the social capital indicators which are described in Chapter 6.

5.2.2 “Traditional” transport indicators

In general for all indicators in this section, the units used (and the number of significant figures) are consistent with data shown in tables in “EU Energy and Transport in Figures: Pocketbook 2007/2008”.

Indicators showing level of transport

The two headline indicators of transport usage will be:

- Freight tonnes-kms (billions) per year
- Passenger-kms (billions) per year

Economic indicators

It is assumed throughout this report that the most important “headline” economic indicator is increase in GDP (usually referred to in terms of % annual increase or % increase over a longer period). In other words, when a policy is being assessed, it is considered that the effect on GDP provides the main measure for assessment of the economic sustainability of the policy. It should be noted that GDP is an input to the TRANS-TOOLS model.

Employment and congestion effects will be mentioned where appropriate. The effect on GDP of these two variables is not calculated by TRANS-TOOLS.

Environmental indicators

The headline indicator to be used in analysis will be CO₂ emissions measured in million tonnes per year.)

“Traditional” (transport) social indicators

Road accident fatalities (measured in number of deaths per year) will be the headline “traditional” social indicator.

Decoupling indicators

A number of composite indicators are used to measure decoupling. These indicators, expressed as %s, are defined as follows:

- Freight decoupling index = (% Increase in tonnes-kms) / (% GDP increase)
- Passenger decoupling index = (% Increase in passenger-kms) / (% GDP increase)
- CO₂ decoupling index = (% Increase in CO₂) / (% GDP increase)
- Fatalities decoupling index = (% Increase in road transport fatalities) / (% GDP increase)

A value of 100% would show “complete coupling”, with decoupling increasing as the % lowers. In cases where the indicators are moving in different directions (showing an absence of coupling) it will simply be reported that the value is “negative”.

Geographical disaggregation of indicators

In presenting some of the TRANS-TOOLS results, the following geographical disaggregation of the EU27 into three large zones will frequently be used:

- South (covering Portugal, Spain, Italy and Greece),
- North-Centre (rest of EU15),
- East (12 New Member States),

Disaggregation by distance-class

Some TRANS-TOOLS results are disaggregated by distance-class into five mutually exclusive groups of travel on the territory of the EU27:

- Regional: trips inside a NUTS2 zone (for freight) or a NUTS3 zone (for passenger)
- Domestic: trips inside the same country, but excluding regional transport
- intraZone: trips inside the same EU geographic zone (North-Center, South, East), but excluding regional and domestic transport (so that intraZonal trips are international trips)

- extraZone: trips between EU geographic zones
- extraEU: trips with origin or destination outside the EU27 (with transport statistics relating to the part of the trip on EU territory)

5.3 Quantification of TRANSvisions 2030 scenarios

5.3.1 Details about 2030 scenarios

As described in Chapter 4, five scenarios have been created for 2030, to be used in TRANS-TOOLS model runs. These scenarios are made up of:

Three “exogenous” scenarios, representing developments within EU and the world that are largely out of the control of EU transport decision-makers (although each scenario has built-in transport policy assumptions):

- A “Baseline” scenario, representing mainstream trends until 2030
- A High Growth (“Sustainable Economic Development”) scenario involving higher levels of GDP growth than the Baseline.
- A “Low Growth” scenario representing lower levels of GDP growth than the Baseline.

Furthermore, two “policy” scenarios have been created which involve variations in transport policy with respect to the Sustainable Economic Development and Low Growth scenarios

The assumptions made in each of these scenarios have been described in Chapter 4.

The forecasting approach is relatively undetermined about any parameters of future scenarios that are not covered in the forecasting model (and is thus less holistic than the foresight approach). It follows that it is difficult to make many conclusions about social capital from TRANS-TOOLS results (the predictions from TRANS-TOOLS are typically consistent with either higher or lower levels of social capital) and so will not be discussed in this chapter.

5.3.2 “Headline” trends in the exogenous 2030 scenarios

Overview of trends

Table 5.1 shows the headline values of indicators (described above) for the Baseline Scenario. As mentioned, units used (and number of significant figures) are consistent with tables in “EU Energy and Transport in Figures: Pocketbook 2007/2008”.

All numbers refer to EU27	2005	Baseline 2020	Baseline 2030	High Growth 2030	Low Growth 2030
GDP increase* p.a. from 2005	—	2.2%	1.9%	2.3%	0.7%
GDP increase* (%) 2005-2020/2030	—	38.6%	61.4%	77.4%	20.1%
Freight Tonnes-kms (inside EU27) in billion tonnes-km, excluding maritime but including IWW	2288	3020	3429	3709	2642
Annual % increase in tonnes-kms, excluding maritime	—	1.9	1.6%	1.95%	0.6%
Increase (%) in tonnes-kms, 2005-2020/2030, excluding maritime	—	32%	50%	62%	15%
Freight decoupling index, excluding maritime	—	83%	81%	80%	77%
Passenger-kms (inside EU27) in billion pkm for car and rail (intercity)	4889	5956	6746	7565	5344
Annual % increase in passenger-kms	—	1.3%	1.3%	1.8%	0.35%
Increase (%) in passenger-kms, 2005-2020/2030	—	22%	38%	55%	9%
Passenger decoupling index	—	57%	62%	71%	50%
CO ₂ from land transport, in million tonnes, based on TT (EU27) ¹	560	634	705	774	534
Increase (%) in CO ₂ from land transport, 2005-2020/2030	—	13%	26%	38%	-5%
CO ₂ decoupling index	—	34%	42%	48%	Negative
Road accident fatalities, based on TT (EU27)	41,579	29,383	12,700	13,700	10,560
Decrease (%) in road accident fatalities, 2005-2020/2030	—	29%	69%	67%	75%
Fatalities decoupling index	—	Negative	Negative	Negative	Negative

*Input to TRANS-TOOLS

Table 5.1: Headline values of indicators for 2005, the 2020 and 2030 Baseline Scenarios, and the 2030 High Growth and Low Growth Scenarios, as calculated by TRANS-TOOLS (using TREMOVE indicators to calculate CO₂ emissions)

The CO₂ emissions are calculated based on the following assumptions:

- The 2005 values refer to a EURO 3 technology
- The 2030 values refer to a EURO 5 technology, diesel and petrol, medium size car for passenger and HGV diesel for freight. For HGV travelling in motorways, we have considered a representative vehicle > 18 ton, for HGV travelling across urban areas, a HGV < 18 ton has been considered
- Emissions coefficients have been taken from the TREMOVE database v. 2.7

A number of summary comments can be made about Table 5.1:

- In 2005, the level of freight transport by road, rail and inland waterway within the EU27 was 2288 billion tonnes-kms. TRANS-TOOLS is not providing any tonnes-km by maritime transport because the goods is not allocated to a network. Maritime transport is however included in the modal split, and the maritime goods is distributed

in a matrix providing zone to zone flows of maritime transport. Estimates of the tonnes-km by maritime transport are made in the Meta-Models.

- In Baseline the projected GDP increase from 2005 to 2030 is about 61% in EU27 and 76 % in the TRANS-TOOLS models coverage area. Given that freight transport by land transport modes and IWW in EU27 is projected to increase by 50%, there is a certain degree of decoupling between economic growth and freight transport (decoupling index = 81%). Decoupling remains at the same level irrespective of the scenario considered (80% in the High Growth Scenario and 77% in the Low Growth Scenario)
- Decoupling is stronger in the case of passenger transport by road and rail which is projected to increase by only 38% (decoupling index = 62%) in the Baseline. For passenger transport is the decoupling index quite different in the three scenarios (71% in High Growth and 50% in Low Growth). However, it should be noted that the level of decoupling is highly dependent upon what movements are included in the definitions of freight and passenger transport. If, as an example the Passkm in the North and Central zone is looked at, the decoupling index is calculated to 66%, whereas it is calculated to 47% in the East zone.
- The decoupling is mainly related to the passenger car transport. The decoupling index in the North zone is 61% for passenger cars and there is no decoupling with rail (decoupling index 103%). In the East zone decoupling for passenger transport by road is 37%, whereas the decoupling index for rail is 153%.
- CO₂ emissions are projected to increase by 26%, with a decoupling index of 42%. In the High Growth scenario the decoupling index is 48%, while the CO₂ emission is reduced with 5% in the Low Growth scenario.
- Given that road accident fatalities decrease by 69%, 67% and 75% in the three scenarios there is clearly a strong degree of decoupling between transport and the negative safety effects of transport.

5.3.3 Freight Transport

This section presents further results about freight transport for the 2030 Baseline Scenario (in comparison with 2005). All statistics given exclude maritime and inland waterway transport transport.

Main results

Baseline

FREIGHT	Regional	domestic	intra-Zone	extra-Zone	Total intra EU	extra EU	Total
2005	179	605	411	445	1,640	518	2,158
Annual increase	0.4%	-0.3%	1.5%	2.0%	0.9%	3.3%	1.6%
2030	196	558	593	726	2,072	1,166	3,238

Table 5.2: Freight transport by road and rail in EU in 2005 and 2030, in billion tonnes-kms, disaggregated by distance class

Table 5.2 shows a breakdown by distance class of freight transport by road and rail in 2030 (with 2005 figures for comparison). The distance classes are defined in Section 5.2.2.

It can be seen from Table 5.2 that, in 2005, the level of extraEU freight transport in EU by road and rail is approximately one third that of intraEU freight transport, and hence approximately a quarter of total transport within the EU. However, as indicated, the level of extraEU freight transport, with an annual growth rate of 3.3% per annum, is predicted to rise to about One third of total freight transport by road and rail within the EU by 2030.

In terms of decoupling, it can be seen that the predicted increase in extraEU freight transport is significantly higher than the increase in EU GDP which, as shown in Table 5.1, is predicted to increase for the Baseline Scenario by 1.9% per annum until 2030. The longer distance intraEU freight transport (“intraZone” and “ExtraZone”) is predicted to increase by 1.5% and 2.0% per annum respectively until 2030. It follows that the only types of freight movement that are decoupled from economic growth are the shorter distance classes of regional and domestic and to a certain extent the intraZone. In fact domestic freight transport is predicted to decrease (by 0.3% per annum).

Of particular interest in an EU context is international freight transport within the EU. Such transport is associated with two distance classes: intraZone (freight that is international but which stays within one of the three geographic zones defined above) and interZone (freight which moves between these geographical zones). The proportion of freight transport associated with such distance classes does not reduce between 2005 and 2030. In fact, it can be seen from Table 5.2 that the increase in transport associated with these distance classes grows at slightly higher level (1.75% pa) than the overall growth in freight (1.6% pa).

Analysis of extraEU freight

Given the importance of extraEU freight, questions arise as to its nature.

ExtraEU freight in table 5.2 is the tonnes-km by road and rail carried out in the EU of goods exchanged between the EU27 and the other countries in the TRANS-TOOLS model's coverage area. Apart from Switzerland, Norway and Iceland the ExtraEU trade is dominated by Russia. Therefore it is not surprising to find “Oil derivatives” and “Crude oil” making up the largest percentages of tonnes-km in all major zones (South, North-Central and East) in 2005 and 2030. However in the South zone “Solid mineral fuels” comprises the second largest percentage in 2030.

“Solid mineral fuels” and “Ores and metal waste” are also making up major percentages of the tonnes-km in ExtraEU trade in both 2005 and 2030.

In 2030 “Machinery and other manufacturing” accounts for the third largest percentage of the ExtraEU trade related to the North-central and East zones.

A sensitivity analysis has been performed on the effect of a change in GDP on the overall model results from TRANS-TOOLS.

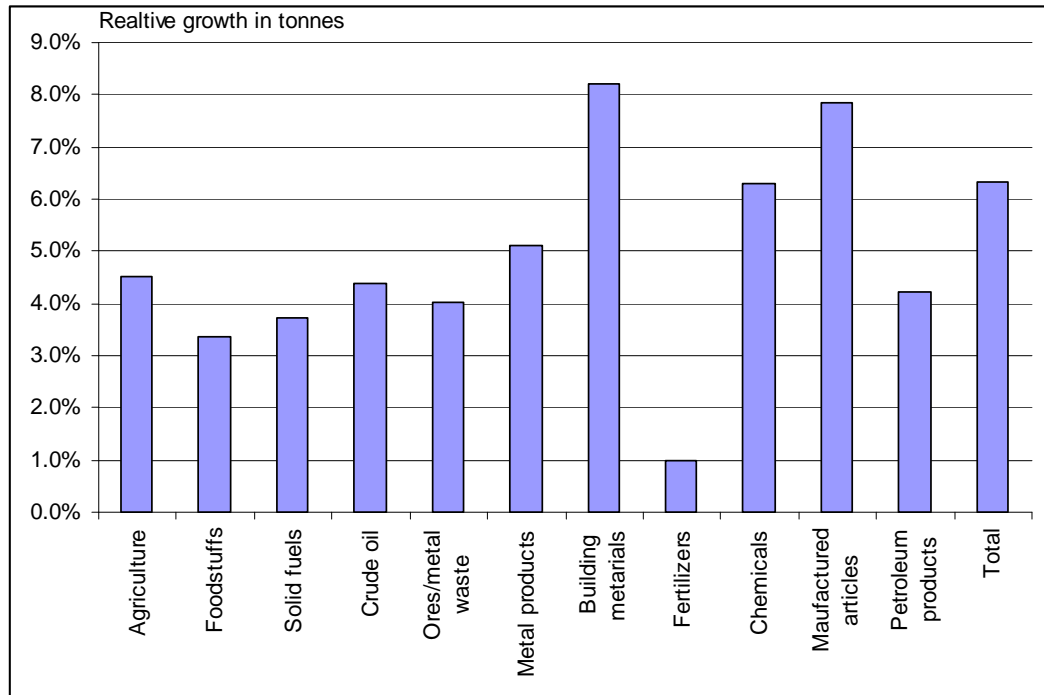


Figure 5.1. Effect on growth in trade volumes based on a 10 % growth in GDP

Manufactured products and building materials show growth rates almost comparable to the GDP (the elasticity is about 0.8), whereas most other commodity groups show elasticities between 0.3 and 0.5. Only fertilizer has a very low elasticity towards GDP (0.1).

Geographical analysis of shorter distance classes

Figure 5.2 provide information on how freight transport in the EU for 2005 and 2030 is broken down by geographical zone and distance class, considering only the three “shorter” distance classes defined above (regional, domestic and intrazonal). Of particular importance for analysis will be the changes between 2005 and 2030. Firstly, though, an explanation is given as to the information contained in the figure.

Figure 5.2 provides a comparison of freight movements in 2005 and 2030 for three geographical zones (South, North-Centre and East), broken down by regional, domestic and intrazonal distance classes. It can be seen that the North-Centre zone has far more internal freight traffic than the other two zones combined in 2005. For 2005 it can be seen that the East zone has similar levels of freight transport in all three distance classes, whilst the other two zones have more domestic (national non-regional) than regional or intrazonal freight transport.

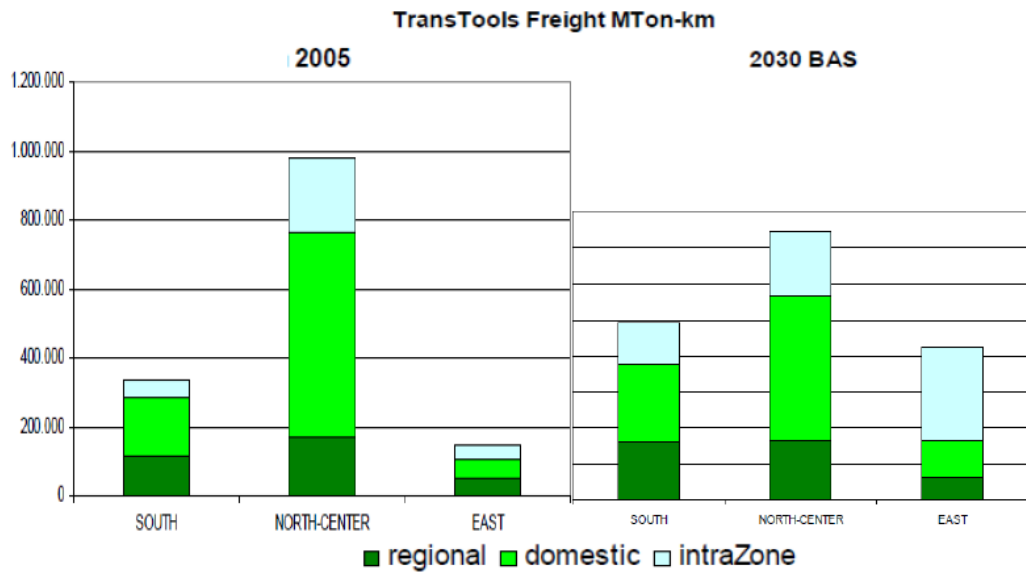


Figure 5.2: Breakdown of short distance freight transport in south, north-centre and eastern zones by distance class (absolute levels) 2005 and 2030

Through comparing the 2030 figures with the 2005 figures, the following comments can be made:

It can be seen that there are large increases (between 2005 and 2030) of freight transport (for the three shorter distance classes) in the South and East zones (approximately 50% and 200% respectively), with a reduction in the North-Central zone (approximately 25%)

In the East zone, the biggest growth is in intrazonal (i.e. international) freight transport. The figure indicates that such traffic will comprise more than 60% of freight traffic (with respect to the shorter distance classes) in the East zone in 2030, compared to approximately 30% in 2005.

It can be seen that in the South zone the biggest increase is in domestic (national non-regional) freight transport. However, the breakdown of traffic by distance class in the South zone remains reasonably stable over time

Also the breakdown of traffic by distance class in the North-centre zone remains reasonably stable over time.

Summary of results

The main points from this section (on freight) can be summarised as follows:

- The overall growth in road and rail freight transport on EU territory between 2005 and the 2030 Baseline is predicted to be 1.6% per year. This figure is less than the projected GDP growth rate for the Baseline of 1.9% per year.
- However, the growth rates of freight transport vary greatly by distance class. National freight transport is projected to have low growth rates: regional (intra NUTS2) freight transport is predicted to rise by 0.4% per year, whilst domestic freight transport (all national movements apart from regional movements) is projected to decrease by 0.3% per year.

- International within-EU (intraZone and extraZone) freight transport is projected to increase by 1.75% per year. The largest growth in freight transport comes from freight movements from/to origins and destinations outside the EU (“extraEU” freight). The parts of such movements are projected to rise by 3.3% per year.
- When considering whether decoupling has been achieved between GDP growth and growth in freight transport, it is crucial to be precise about the definition used for freight transport. Whilst the projected growth in freight transport on EU territory is 1.6% per year, the figure rises to 1.9% per year if the parts of extraEU trips outside the EU are included.
- The extraEU freight-types (according to the NSTR classification) with the highest proportions of tonnes-kms in 2005 are oil derivatives (NSTR 3) and crude oil (NSTR 10), for all three geographical zones considered (South, North/Centre and East). There is generally the same picture in 2030, though an increase in importance of machinery and other manufacturing (NSTR 9) can be detected, particularly in the North/Centre and East zones.
- With respect to the shorter distance classes (regional, domestic and intraZonal), increases in tonnes-kms are forecast between 2005 and 2030 for the South zone (approx. 50%) and the East zone (approx 200%), whilst tonnes-kms in the North/Centre zone will reduce by approximately 25%. Looking at the change in total tonnes-km in these zones the South zone increases with approx 45%, the East zone with 125% and the North-Center zone with 25%. This indicates that the effect of interzonal and ExtraEU transport is by far most important in the North-Center zone.

Discussion in the context of Task 1 Results

The overall picture presented above is that longer distance freight trips are expected to increase faster than shorter distance freight trips. In particular, fastest growth will be associated with freight transport whose origin or destination is outside the EU. This raises the importance of globalisation as a driver of transport. Following other observations can also be made:

- When considering overall levels of freight transport and their growth in the future, it is important to disaggregate between different distance-classes, both for understanding the phenomenon and for formulating future transport policy. As has been seen above, freight for some distance classes is actually projected to decrease. The dominant distance class is increasingly extraEU freight transport.
- The figures on freight given above ignore maritime transport. If maritime transport were included, the dominance of extraEU freight would be even more marked, for both 2005 and 2030.
- When considered as a “transport issue”, energy is typically viewed as problematic in the context of the use of energy by the transport system. However, given that the main freight-types associated with extraEU freight transport are oil derivatives and crude oil, the reverse issue of “use of the transport system for maintaining energy supply” is also highly important.
- The definition of “extraEU freight transport” is clearly highly dependent upon the definition of the EU, which in turn is concerned with future enlargement. If neighbouring countries currently exporting energy to the EU in future become part of the EU, a sizeable amount of extraEU freight transport will become intraEU freight transport. It could be argued that, “on the ground”, such a redefinition would not make any differ-

ence to the actual levels of freight moving around. However, such redefinitions potentially make a large difference to policy analysis. In particular it might be argued (according to a certain way of thinking) that, given the nature of the EU, intraEU freight transport is economically more justifiable than extraEU freight transport.

5.3.4 Passenger transport

This section presents further results about passenger transport for the 2030 Baseline Scenario (in comparison with 2005).

Main results

The total EU27 passenger-km in 2005 and 2030 increase with 38 %. In 2005 passenger-km by passenger car transport amounted to 92 % of all. In 2030 this has decreased to 90 %. Passkm by air transport is not calculated by the TRANS-TOOLS model, thus it is not part of the final result from this model.

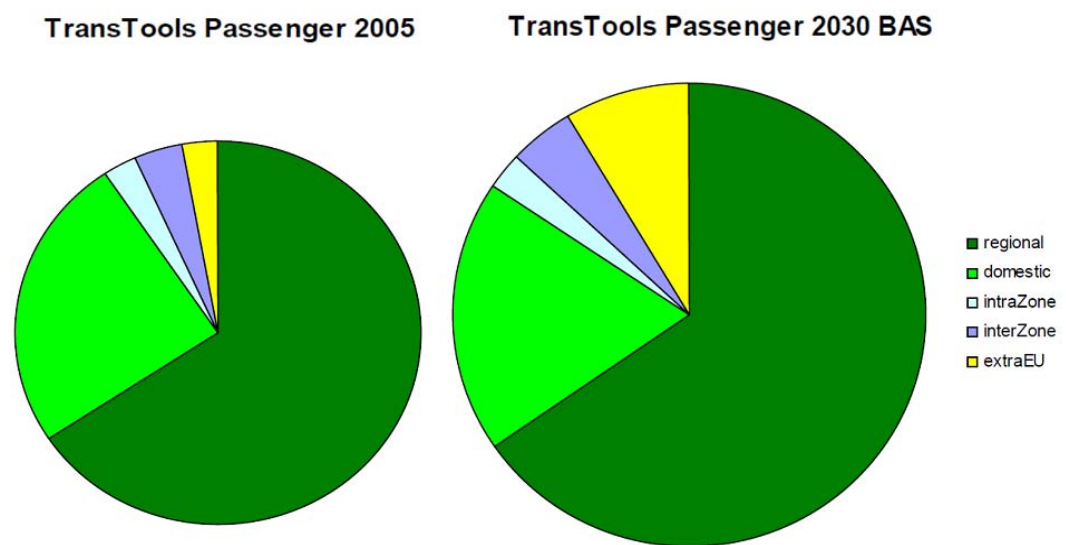


Figure 5.3: Breakdown of passenger trips 2005 and 2030 by distance class

Figure 5.3 shows a breakdown of passenger transport in 2005 and 2030 by distance class, where such classes are defined in Section 5.2.2.

In both 2005 and 2030, the most important type of passenger trip (in terms of total passenger-kms) is regional (i.e. trips within NUTS3 areas).

However, the distance class with the main growth in passenger-kms is extraEU trips

Of particular interest in an EU context is international passenger transport within the EU. Such transport is associated with two distance classes: intraZone (international passenger movements which stay within one of the three geographic zones defined above) and interZone (movements between these geographical zones). It can be seen from Figure 5.3 that the proportion of passenger transport in the intraZonal class stays relatively constant between 2005 and 2030, whilst there is a small increase in the proportion associated with interZonal movements.

Given the importance of regional trips (as a contributor to absolute levels of transport) and extraEU trips (due to their high growth), these two types of movement will be analysed further, with respect to trip purpose. Firstly though, an overview will be made of geographical zones for the shorter passenger distance classes.

Geographical analysis of shorter distance classes

Figure 5.4 shows the absolute level of passenger-kms in 2005 for the three shorter distance-classes (regional, domestic and intrazone) in the three geographical zones (South, North/Centre and East).

The following comments can be made:

From Figure 5.4, it can be seen that, for each zone, the greatest number of passenger-kms is associated with the regional distance class, followed by the domestic distance-class.

In 2005, the level of (shorter distance) passenger transport in the North/Centre zone is slightly less than double that in the South zone (3000 billion passenger-kms compared to 1600 billion passenger-kms) whilst in 2030 the former is slightly more than double the size of the latter (4050 billion passenger-kms compared to 1950 billion passenger-kms). These figures show that trips in the North/Centre zone are projected to increase by 108% whilst those in the South zone will rise by 88%.

The level of (shorter distance) passenger transport in the East zone rises from approximately 650 to 750 billion passenger-kms between 2005 and 2030, a rise of 15%, a figure much lower than the projected rises in the North/Centre zone (108%) and South zone (88%) given above.

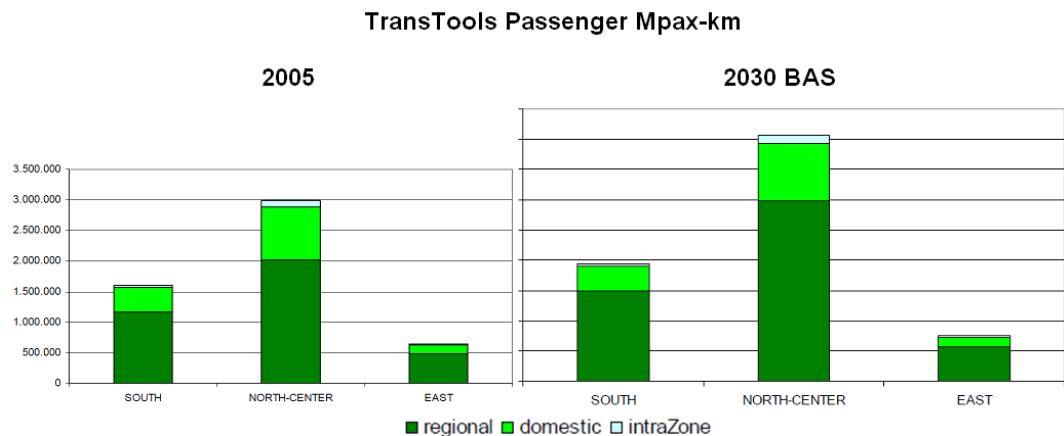
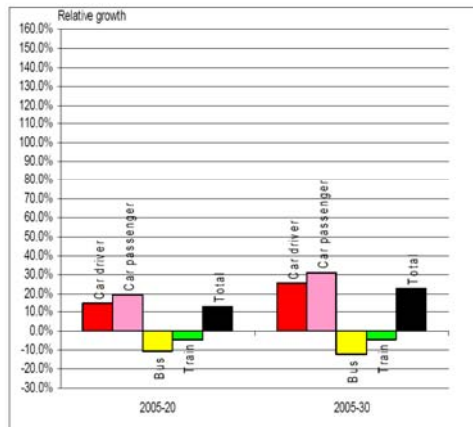


Figure 5.4: Geographical zones of passenger-kms for shorter distance classes (2030)

Analysis of transport modes for passenger trips

Figure 5.5 shows a breakdown by mode for trips shorter and longer than 100 km. In general the long-distance trips grow much faster than the short distance trips. In this comparison it will have to be remembered that the TRANS-TOOLS model does not include air transport leaving the TRANS-TOOLS model coverage area. If these intercontinental trips were included it would be even more obvious that long distance trip was increasing.

Trips ≤ 100 km



Trips >100 km

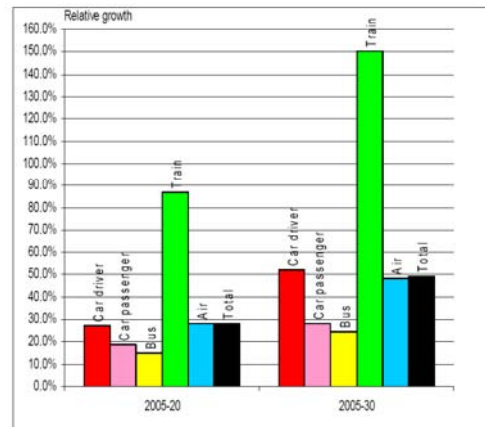


Figure 5.5 Growth in passenger-km by mode and distance

The number of trips of more than 100 km makes up about 2.5 % of all trips in Europe. However they account for about 55 % of the passenger-km.

Figure 5.6 indicates the change in long-distance passenger trips (>100km) resulting from a +10% change in GDP

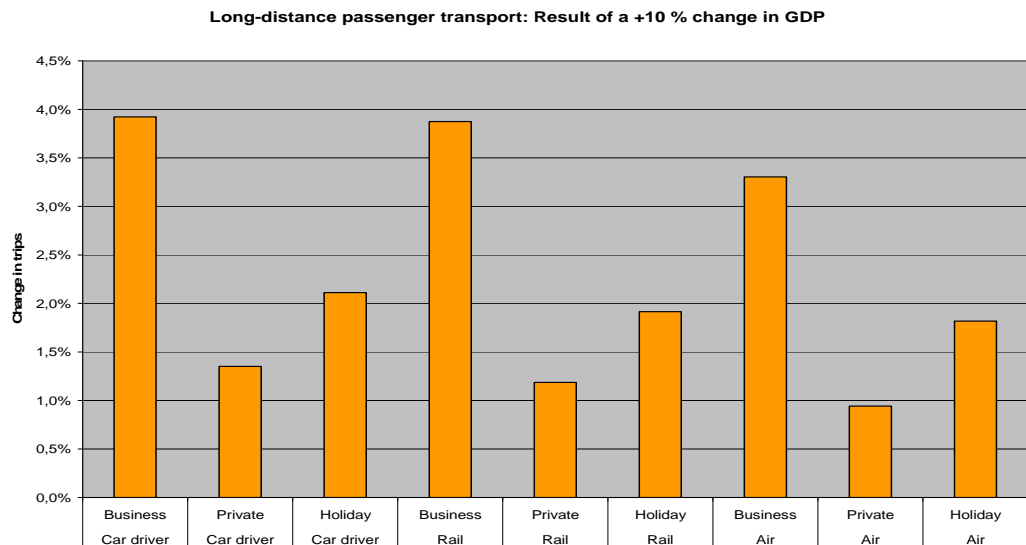


Figure 5.6: Long distance trips (>100km) and change in GDP

Sensitivity for GDP is most pronounced for business trips (elasticity between 0.3 and 0.4), and holiday trips is showing about 50 % of the business sensitivity towards GDP. A recent Danish study concluded that the long-term elasticity for vehicle mileage towards GDP was about 0.4. The above graph indicates that the elasticity for long-distance trips towards GDP is about 0.18 for all modes and trip purposes.

Summary of main points

The main points from this section (on passenger transport) can be summarised as follows:

- The overall growth in passenger transport on EU territory between 2005 and the 2030 Baseline is predicted to be 1.3% per year. This figure is less than the projected GDP growth rate for the Baseline of 1.9% per year.
- In both 2005 and 2030, the most important type of passenger trip (in terms of total passenger-kms) is regional (i.e. trips within NUTS3 areas).
- However, the distance class with the main growth in passenger-kms is trips above 100 km.
- Of particular interest in an EU context is international passenger transport within the EU. Such transport is associated with two distance classes: intraZone (international passenger movements which stay within one of the three geographic zones defined above) and interZone (movements between these geographical zones). The proportion of passenger transport in the intraZonal class stays relatively constant between 2005 and 2030, whilst there is a small increase in the proportion associated with interZonal movements.
- When considering whether decoupling has been achieved between GDP growth and growth in passenger transport, it is crucial to be precise about the definition used for passenger transport. Whilst the projected growth in passenger transport on EU territory is 1.3% per year, the figure rises to 1.35% per year if the parts of extraEU trips outside the EU are included. It should be remembered that air traffic is not included.
- Short distance passenger transport is growing considerably slower than long distance passenger transport.
- In 2005, all three geographical zones (South, North/Centre and East) show a similar pattern with respect to distribution of (regional trip) passenger-kms for different trip purposes: a small amount of business passenger-kms with the remainder of the passenger-kms divided approximately equally between private, holiday and commuting.
- In 2030, all three zones are projected still to have similar patterns (compared to each other) with respect to trip purposes for regional trips. In comparison with 2005, there is: (i) a reduction in the proportion of passenger-kms associated with commuting; (ii) an increase in the proportion of passenger-kms associated with holidays; and (iii) an increase in the proportion of passenger-kms associated with business travel (though in all three zones such travel still accounts for far less passenger-kms than the other trip purposes).

From the results above, two important factors emerge concerning future trends of passenger transport:

- The growth in regional passenger-kms is not as high as the growth of passenger-kms for longer distance trips. However, since such trips account for the largest proportion of passenger-kms, they are clearly of great interest. Of particular importance in this context are trips associated with urbanisation (or suburbanisation) processes.
- The growth in long distance trips is high. A large proportion of such trips are associated with holidays. Furthermore, leisure trips make a significant contribution to shorter passenger-kms.

Both these phenomena (urbanisation and holiday travel) will be described further Chapter 6.

5.3.5 TRANS-TOOLS model limitations and possible improvements

Model limitations

It is evident that some of the more comprehensive analyses of development of passenger-km and tonnes-km cannot be performed by only looking at the results of the TRANS-TOOLS models. It must be acknowledged that the TRANS-TOOLS model has been developed for analysing the EU27 land transport with particular reference to infrastructural development.

In the TRANSvisions project a number of further analyses have been carried out on the results of the TRANS-TOOLS. Some of these have been fairly simple to carry out, e.g. assign a distance to the link between two airports which is described in the model by their flying time and related air fare. Others are more controversial, e.g. assigning a maritime distance to transports between two zones. Taking Rotterdam – Primorsk as an example it is impossible to know if the ship runs between Rotterdam and Primorsk, Sct Petersburg or Ust Luga. It is also impossible to know if the en-route is via the Kiel Canal, via the Great Belt or via Öresund. These uncertainties produce quite uncertain results. This is even more obvious when transports between the Far East and Europe are considered.

TRANS-TOOLS is a traditional sequential state-of-practice transport model, hence, it has all the usual limitations of transport modelling. For instance, uncertainty increases as future scenarios significantly change compared to base year. A long term forecast to e.g. 2050 will be more uncertain than a forecast to 2010. It cannot model major shifts in travel behaviour and trade relations because the model is estimated on basis of actual travel behaviour and trade in base year 2005.

TRANS-TOOLS has a very large geographical coverage area, likely it is the largest transport model in the world with respect to population and square km. It limits the level of detail which can be answered by the model due to complexity and computing time. Only major links in the networks are included in the model and zones are large. The model focuses on long distance travel, and local travel is only included to complete the picture. For instance, the model cannot be used to analyse urban transport plans. Bus passengers are assigned to roads assuming buses operate on every road link in the model, because timetables and line descriptions are not included. Pedestrians and cyclists which plays an important part in urban travel, are not included in the model.

While road congestion is considered, the model treats rail and air modes without capacity limitations with a tendency to over predict future demand. It is common practice in large scale transport models due to the complexity of capacity modelling. Maritime transport is included, but shipments are not assigned to a network. In 2004, in the first phase of development of TRANS-TOOLS model it was decided to include maritime transport at matrix level and not on network level, since a maritime network was not available. As a consequence it is not possible to illustrate and forecast freight volumes at specific ports, if there is more than one port in a traffic zone.

Proposal for TRANS-TOOLS improvements

Current EC studies have contributed to the development of the TRANS-TOOLS model, but the study has also revealed shortcomings and issues of improvement. It is suggested that future developments of the model is divided into two phases. The first phase should elaborate on the existing model framework to improve accuracy and consistency. The second phase should then consider model extensions.

A first phase of model improvements could include:

- Improvement and update of freight model to base year 2005
- Improvement of base year matrices for rail and road
- Reduction of stochastic noise in assignment

In current EC studies, trade and economic models have been updated and improved. It is now possible to calculate GDP-effects of infrastructure projects to feed-back to the model. However, the mode choice and logistics models have not been updated to 2005 which creates an inconsistency in the model system. The mode choice model and logistics model should be spatially resolved to NUTS3 level to match the new trade model and passenger model. Further, there seems to be a need to improve the modal choice model because use has revealed very low sensitivities with respect to cost and time changes. The logistic model is very complex with many user options. Usage shows that an explicit user location of distribution centres would be beneficial.

It has only been possible to collect few data on rail passengers. Therefore it has not been possible to adjust matrices to fit count data, and travel pattern has been built up on matrices from the older version of the model. Forecasts have revealed substantial differences between rail passenger base year matrices and synthetically base year matrices which cause a few odd results. This gap should be reduced by combining the two sources. In UK, the road network has been improved and detailed. However, the density of the road network is still too coarse compared to the zonal structure and travel volume resulting in an overestimation of congestion. This can be reduced by adding more roads to the network in and around London.

CBA analyses conducted in the TEN-CONNECT study has been complicated by the stochastic nature of the assignment models. Several procedures have been implemented to reduce the randomness in calculation of consumer surplus. Few more fundamental changes could be implemented to further reduce the stochastic noise.

The shortcoming and lack of data, has been the major problem in development of the TRANS-TOOLS model. Basically, the performance and accuracy of the model will not improve significantly before quantity and quality of fundamental data have improved. It concerns:

- Networks
- Behavioural data
- Counts

Though networks have been updated in recent studies, a fundamental upgrade of the networks is required because the existing networks build on networks which mainly originate from the 1990s.

The only data sources which were available for estimation of the most recent TRANS-TOOLS passenger model were DATELINE and the Danish Travel Survey. Since almost every country conduct travel surveys, national representatives have been contacted without any success due to data confidentiality. With open access to those national data sources, the foundation of model estimation could be improved significantly.

The lack of reliable rail passenger counts has been stressed as a problem several times and has prevented a proper calibration of the model.

Future improvements of the model could consider extensions of the coverage area, implementation of maritime networks, and capacity modelling. However, it is emphasized that modelling accuracy will never be better than data allows.

5.4 Policy tests for 2030 using TRANS-TOOLS

5.4.1 Pricing Policy test

The Pricing Policy test described in this section is based upon the Low Growth Scenario. It involves charging passenger cars at rates shown in Table 5.3. The per-km internalisation charge for passenger cars at a rate of 5% for trucks + congestion charges has been chosen through making an approximation of the differences between external costs of cars and trucks, based upon data from the IMPACT study.

	Pricing Policy Test	Low Growth Scenario
Freight transport	<ul style="list-style-type: none"> • Same as Low Growth Scenario 	<ul style="list-style-type: none"> • Per-km charge for trucks internalising external costs, as recommended by IMPACT • 0.06 Euros charge per km for trucks on motorways for cost recovery in Vignette countries
Passenger transport	<ul style="list-style-type: none"> • Per-km charge internalising external costs, at a rate of 5% of that for trucks + congestion charging • 0.02 Euros charge per km for cars on motorways for cost recovery in Vignette countries 	No charges

Table 5.3: Road pricing charges applied in Pricing Policy Test

Values of headline indicators for the Policy Pricing test, as calculated by TRANS-TOOLS, are given in Table 5.4, alongside values for the Low Growth Scenario (on which the test is based) and the two other exogenous scenarios (for general comparative purposes).

All figures refers to EU27	Pricing Policy test	Low Growth	Baseline	Sustainable Economic Development
GDP increase p.a. from 2005	0.7%	0.7%	1.9%	2.3%
GDP increase (%) 2005-2030	20.1%	20.1%	61.4%	77.4%
Freight Tonnes-kms (inside EU27) in billion tonnes-km, excluding maritime transport	2640	2642	3429	3709
Impact of policy test on Tonnes-kms (%)	-	-	-	-
Annual % increase in tonnes-kms	0.6%	0.6%	1.6%	1.95%
Increase (%) in tonnes-kms, 2005-2030	15%	15%	50%	62%
Freight decoupling index	77%	77%	81%	80%
Passenger-kms (inside EU27) in billion pkm	5282	5344	6746	7565
Impact of policy test on Pkms (%)	-1.2%	-	-	-
Annual % increase in passenger-kms	0.3%	0.35%	1.3%	1.8%
Increase (%) in passenger-kms, 2005-2030	8%	9%	38%	55%
Passenger decoupling index	40%	50%	62%	71%
CO ₂ from land transport, in million tonnes	526	534	705	774
Increase (%) in CO ₂ from land transport, 2005-2030	-6%	-5%	26%	38%
CO ₂ decoupling index	Negative	Negative	42%	50%
Road accident fatalities	10240	10560	12700	13700
Decrease (%) in road accident fatalities, 2005-2030	75.5%	74.5%	69.5%	67%
Fatalities decoupling indicator	Negative	Negative	Negative	Negative

Table 5.4: Values of headline indicators for the Pricing Policy test

A number of comments can be made about the indicator values presented in Table 5.4 (where the pricing policy test is referred to as the “PP test” and the Low Growth Scenario is referred to as the “LG scenario”).

- The PP test leads to no change in the level of freight transport and a decrease of 1.2% in passenger transport (compared with the LG Scenario)
- Compared to the LG Scenario, the PP test leads to the same level of decoupling between GDP and Freight but more decoupling for passenger transport (a decrease in the decoupling index from 50% to 40%).

- The PP test leads to a higher decrease in (land transport) CO₂ emissions than the LG Scenario, representing a decrease of 6% from 2005 levels (compared to 5% for the LG Scenario)
- The PP test leads to a higher decrease in road transport fatalities than the LG Scenario, representing a decrease of 75.5% from 2005 levels (compared to 74.5% for the LG Scenario)
- For all indicators, the impact of the PP test on the LG scenario is small compared to the differences between (exogenous) scenarios.

5.4.2 Test of an Infrastructure Policy Package

This section describes a test of a package of further TEN infrastructure than that assumed for the High Growth (Sustainable Economic Development) Scenario. The road and rail projects in this package are shown in Figure 4.13 and Figure 4.14. Apart from the extra infrastructure, all aspects of the policy scenario are the same as in High Growth (Sustainable Economic Development).

Values of headline indicators for the “TEN test” are given in Table 5.5, alongside values for the Sustainable Economic Development Scenario (on which the test is based) and the two other exogenous scenarios (for general comparative purposes).

	TEN test	Sustainable Economic Development	Low Growth	Baseline
GDP increase p.a. from 2005	2.3%	2.3%	0.7%	1.9%
GDP increase (%) 2005-2030	77.4%	77.4%	20.1%	61.4%
Freight Tonnes-kms (inside EU27) in billion tonnes-km, excluding maritime transport	3834	3709	2642	3429
Impact of TEN test on tonnes-kms (%)	+3.4%	–	–	–
Annual % increase in tonnes-kms	2.1%	1.95%	0.6%	1.6%
Increase (%) in tonnes-kms, 2005-2030	68%	62%	15%	50%
Freight decoupling index	88%	80%	77%	81%
Passenger-kms (inside EU27) in billion pkm	7560	7565	5344	6746
Impact of TEN test on Pkms (%)	-	–	–	–
Annual % increase in passenger-kms	1.8%	1.8%	0.35%	1.3%
Increase (%) in passenger-kms, 2005-2030	55%	55%	9%	38%
Passenger decoupling index	71%	71%	50%	62%
CO2 from land transport, in million tonnes	782	774	512	678
Increase (%) in CO2 from land transport, 2005-2030	40%	38%	-5%	26%
CO2 decoupling index	52%	50%	Negative	42%
Road accident fatalities	13800	13700	10560	12700
Decrease (%) in road accident fatalities, 2005-2030	67%	67%	74.5%	69.5%
Fatalities decoupling indicator	Negative	Negative	Negative	Negative

Table 5.5: Values of headline indicators for the TEN test

A number of comments can be made about the indicator values presented in Table 5.5 (where the High Growth (Sustainable Economic Development) Scenario is referred to as the “SED scenario”).

- The TEN test leads to an increase of 3.4% in freight transport and no change in passenger transport (compared with the SED Scenario).
- Compared to the SED Scenario, the TEN test leads to less decoupling between GDP and Freight (an increase in the decoupling index from 80% to 88%) and unchanged decoupling for passenger transport (decoupling index 71%).

- The TEN test to leads to a greater increase in (land transport) CO₂ emissions than the SED Scenario: a 40% increase from 2005 levels, compared to a 38% increase for the SED Scenario.
- The TEN test to leads to approximately the same level of road transport fatalities as in the SED Scenario, representing a decrease of 67% from 2005 levels.
- For all indicators, the impact of the TEN test on the SED scenario is small compared to the differences between (exogenous) scenarios.

5.5 Quantification of Meta-Models scenarios

5.5.1 TRANS-TOOLS and TRANS-TOOLS Meta-Models

The procedure for developing Meta-Models based on TRANS-TOOLS followed these steps:

- I. The Baseline, High Growth and Low Growth scenarios were first calculated by TRANS-TOOLS (TT) for 2005 and 2030. Baseline was also calculated for 2020.
- II. The TT Meta-Models, based on 2005 data from TRANS-TOOLS, were then calibrated to be able to reproduce, for key indicators, these scenarios in 2030. The High Growth scenario was linked to the 2030 situation of the exogenous scenario “Moving Together” or “Decoupled Mobility”. The Low Growth scenario was linked to the 2030 situation of the exogenous scenario “Moving Less” or “Reduced Mobility”. Results were calibrated against 2030 TRANS-TOOLS results, 2005 Pocket Book, and 2020 and 2030 results of the Energy Strategic Review, for different scenarios.
- III. The TT Meta-Models were used to validate the consistency of 2030 assumptions for the “Moving Alone” (Induced Mobility) and “Stop Moving” (Constrained Mobility) scenarios, respecting the differences between these two scenarios and the Decoupled and Reduced Mobility scenarios (as given in their qualitative scenario construction).
- IV. The TT Meta-Models were used for checking the consistency in 2050 four exploratory scenarios, producing quantitative values for all variables.
- V. The TT Meta-Models were used for constructing pathways showing how the future evolves between the present and 2050, for each exploratory scenario¹².
- VI. The TT Meta-Models were used to estimate the impact of alternative transport policies in different scenarios, in order to achieve CO₂ targets (e.g. 10% reduction of emissions due to transport activities within EU 27 in 2020, and 50% in 2050).

In conclusion:

- The goal of TT Meta-Models is, first, providing a policy-interface to TRANS-TOOLS, useful to reorganise TRANS-TOOLS results (2 Gb) according to the needs of the policy-analysis to be carried out.

¹² TRANS-TOOLS not being able to produce pathways.

- Then, TT Meta-Models complement TRANS-TOOLS in order to check the consistency of exploratory scenarios, further precise them by providing quantitative estimates, and by doing so “illustrate” the scenarios.
- Finally, the TT Meta-Models are used for a number of policy-oriented analyses.

Meta-Models could be considered as a user-friendly, policy-oriented interface of TRANS-TOOLS developed for the TRANSvision exercise.

Apart from the data related to TRANS-TOOLS results review of existing statistics, analysis reports and studies has been carried out in order to establish a background for the numerous relationships between variables in the Meta-Models.

Long term forecast studies have been reviewed in order to establish a database for testing the consistency of results of the Meta-Models. Among these have been:

- TRIAS Sustainability Impact Assessment of Strategies Integrating Transport, Technology and Energy Scenarios, European Commission – DG Research, ISI, 6th Research Framework Programme (2007)
- Quantifying Four Scenarios for Europe, CPB Netherlands Bureau for Economic Policy Analysis, Arjan Lejour (2003)
- Backcasting approach for sustainable mobility, JRC (2008)
- FORECASTS FOR MOTOR VEHICLE AND OIL DEMAND TO 2030 AND 2050, International Energy Agency (2008)
- ESPON 3.2 SCENARIOS, DGREGIO European Commission (2007)
- Global Future Analysis (Plank, 2008)

5.5.2 Metamodelling formulation

The formulation of the Meta-Models, supported by unsophisticated software applications (Microsoft EXCEL enhanced by Visual Basic, and Microsoft ACCESS), follows a rather simple structure from sociodemographic and macroeconomic indicators aggregated at European level, down to transport demand generation, for passengers and freight. Demand is then demand distributed by: local, regional and long-distance transport; by macrozones, within EU and overseas; by trip purposes; and by mode. Occupancy and load-factors by all modes determine demand in terms of vehicles, trains, planes and vessels. Energy consumption is calculated, based on the available technologies for different types of vehicle. Emission factors by technologies result finally in directly and indirectly generated emissions, according to the energy mix defined in the scenario. This main formulation is complemented by independent modules dealing with passenger and freight, on a regionalised basis. The main objective of the TT Meta-Models is, then, to produce policy indicators, e.g. CO₂ emissions, in the 2050 scenarios, and trace back the path combining trends and policies leading to these “final” emissions.

The more precise and detailed formulation of the Meta-Models is described in the Task 2 report. The model system consists of approximately 300 variables, linked together by growth factors and elasticity functions (based on TRANS-TOOLS as well as other official sources), and by feed-backs and constraints (e.g. for passenger transport demand, a fixed relative budget allocated to transport has been assumed).

The evolution over time of the independent variables or parameters is defined according to the narrative of each scenario. In relation to independent variables, three consistency checks are applied:

1. in relation to the narrative of the scenario
2. in comparison with the assumptions made for other scenarios, and
3. with the results provided by previous studies.

5.5.3 Calibration of TT Meta-Models

In this section the process of calibration and validation of Meta-Models is presented.

Calibration of socioeconomic indicators

For a set of variables to be described below, TRANS-TOOLS provides a “starting” value for year 2005 and predictions for twoints in the future (2020 and 2030) for each scenario: Baseline, Sustainable Economic Development (High growth), and Low Growth. The values of the variables in the Meta-Models are adapted so that their values in the control years (2005 and 2030) coincide with the TRANS-TOOLS values.

The Metamodels baseline scenario 2005-2050 is calibrated with the Baseline from TRANS-TOOLS for all variables (GDP, Population, Passenger traffic, Freight traffic, Modal shares).

The Decoupled Mobility scenario has been adjusted to the results of Sustainable Economic Development, while the Reduced Mobility scenario has been adjusted to the Low Growth Scenario.

There are two other exogenous scenarios, Induced Mobility and Constrained Mobility, independent from the TRANS-TOOLS scenarios.

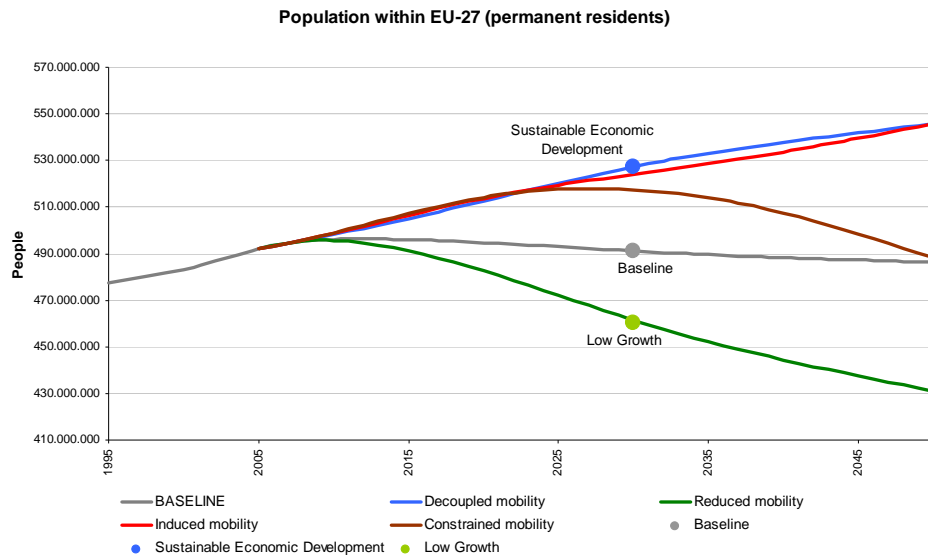


Figure 5.7 Population within EU-27 (permanent residents)
 Note: Evolution 2005-2050 of EU27 population in the exploratory scenarios and values of population for 2030 according to TRANS-TOOLS scenarios. The graphic does not include the population increase due to EU enlargements.

As shown in Figure 5.7, the Decoupled Mobility scenario corresponds to a continuous growth of population until 2050; this is due to a small increase in fertility rates and to a moderate immigration rate. The Reduced Mobility scenario is the opposite with a steady decline of population due to a decrease in fertility rates and, especially, to an end to immigration. The Induced scenario follows the trends of the Decoupled scenario with higher increase of immigration, while the Constrained scenario has a growing trend up to 2025/2030 and then a decrease up to 2050.

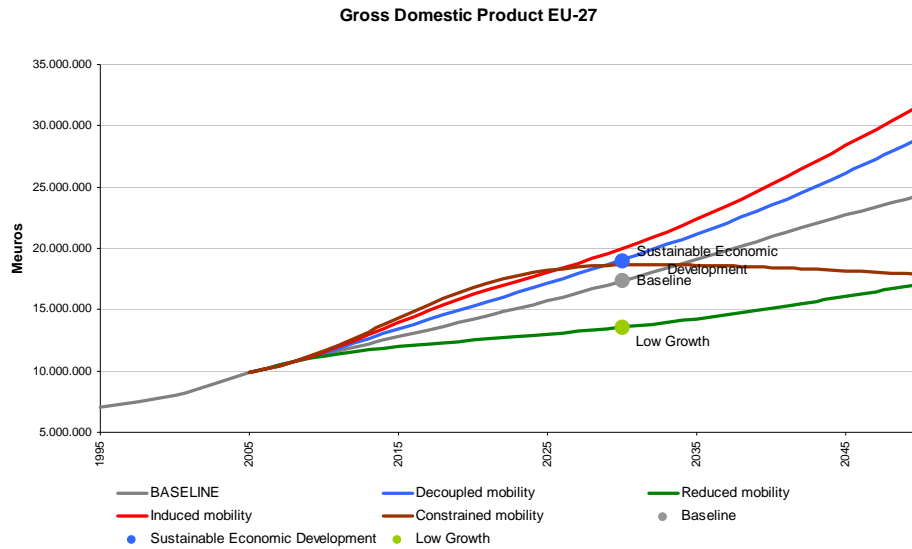


Figure 5.8 Gross Domestic Product EU-27

Note: Evolution 2005-2050 of EU27 Gross Domestic Product in the exploratory scenarios and values of GDP for 2030 according to TRANS-TOOLS scenarios. The GDP trends show a continuous increase in all scenarios but the Constrained one, which grows the most in the first period failing to maintain this trend and declining from 2030 onwards.

Calibration of transport indicators

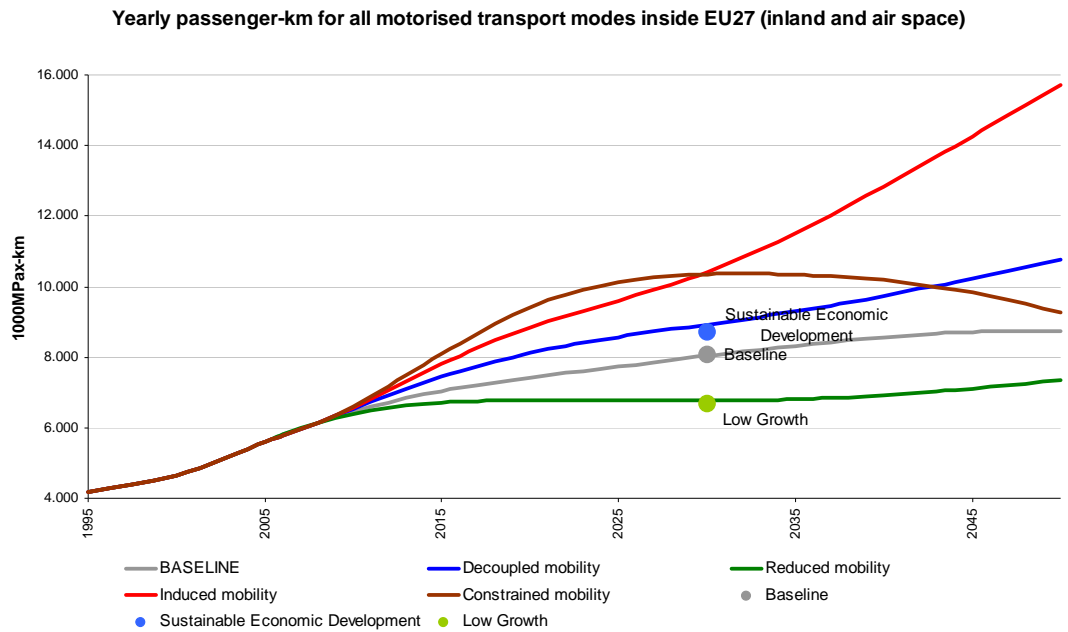


Figure 5.9 Yearly Passenger-km for all motorised transport modes inside EU-27 (inland and air space)

Note: Evolution 2005-2050 of passenger-km in the exploratory scenarios and values for 2030 according to TRANS-TOOLS scenarios. Figures include the passenger-km inside EU27 (inland and air space) for all trips with origin and/or destination in EU27.

The paths in Figure 5.9 show general rising trends in traffic for all scenarios except for the Constrained Mobility scenario. These paths follow to some extent the development of GDP, but changes in elasticity of traffic to GDP make them different. This leads to a Decoupled Mobility scenario with less passenger traffic than one would expect with present elasticity, whilst the Induced scenario ends up with a very high volume of passenger-km. The elasticity for the Reduced scenario is also reduced and thus the passenger traffic even stagnates for a long time. The Constrained scenario has the highest increase of passenger-km in the period up to 2025/2030, due to the high economic development, but afterwards traffic levels decrease when the scenario enters a crisis period.

Freight ton-km all modes inside EU-27
(traffics with origin and/or destination within EU-27 including SSS)

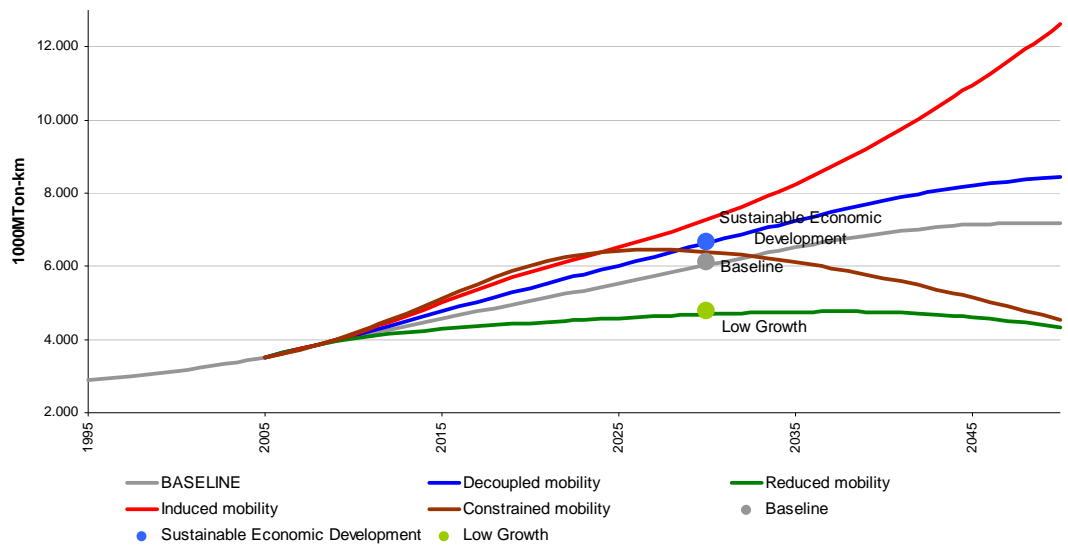


Figure 5.10 Freight tonnes-km all modes inside EU-27

Note: Evolution 2005-2050 of tonnes-km in the exploratory scenarios and values for 2030 according to TRANS-TOOLS scenarios. Figures include the tonnes-km inside EU27 (inland and SSS) for all trips with origin and/or destination in EU27.

As can be seen from Figure 5.10, for freight the stabilisation or reduction of traffic is bigger than for passengers. This could be due to freight being more closely linked to economic activity or is easier influenced by policy as it is more sensitive to external conditions, i.e. has higher cost elasticity. Passenger mobility is not driven purely by economic reasons, as is freight.

As with passenger traffic, most scenarios show a general trend of continuous increase in freight traffic, with the highest levels being reached in the Induced scenario. However, the Reduced scenario has a net decrease of tonnes-km in the last decade of the period being considered (i.e. 2040-2050), reflecting the effective decoupling of trade and economy due to the long term behavioural changes assumed in this scenario.

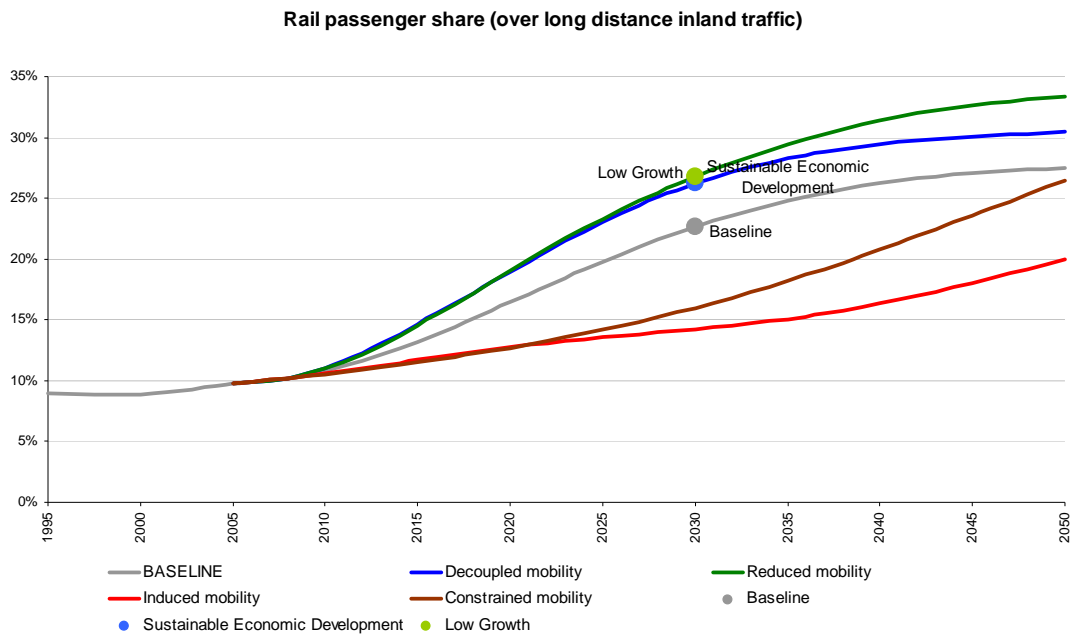


Figure 5.11 Rail passenger share (over long distance inland traffic) (passenger-km)

Note: Evolution 2005-2050 of Rail passenger share (in relation to rail and road long distance traffic) in the exploratory scenarios and values for 2030 according to TRANS-TOOLS scenarios.

Figure 5.11 shows predicted values of rail share, for long distance inland traffic, in each of the exploratory scenarios. "Long distance" is here considered as inter-NUTS3 traffic (it thus covers shorter distances in Germany, where NUTS3 zones are small, than in other countries with larger NUTS3 zones). The figure shows an increase in rail share for long distance trips in all scenarios but the impact varies widely depending on the scenario. The Baseline follows the present trend of developing high speed networks that will effectively substitute a large share of long-distance road and short/mid-distance air trips in favour of rail. Both Decoupled and Reduced scenarios have higher rail shares, due to an important active policy towards rail. The Induced and Constrained scenarios start with a slower growth rate, but nevertheless slightly higher than the trend in past years. The decrease in mobility for the 2030-2050 period in the Constrained scenario translates into an increase of rail share given that road trips (and also air trips) are the most affected by the carbon constraints of the scenario. The Induced scenario supposes that development of new technologies in road and air transport reducing CO₂ levels will make rail less important, and so the share of rail does not increase as much as in the other scenarios.

Figure 5.12 shows the evolution 2005-2050 of the rail freight share (in relation to rail and road long distance traffic) in the exploratory scenarios, providing values for 2030 according to the TRANS-TOOLS scenarios.

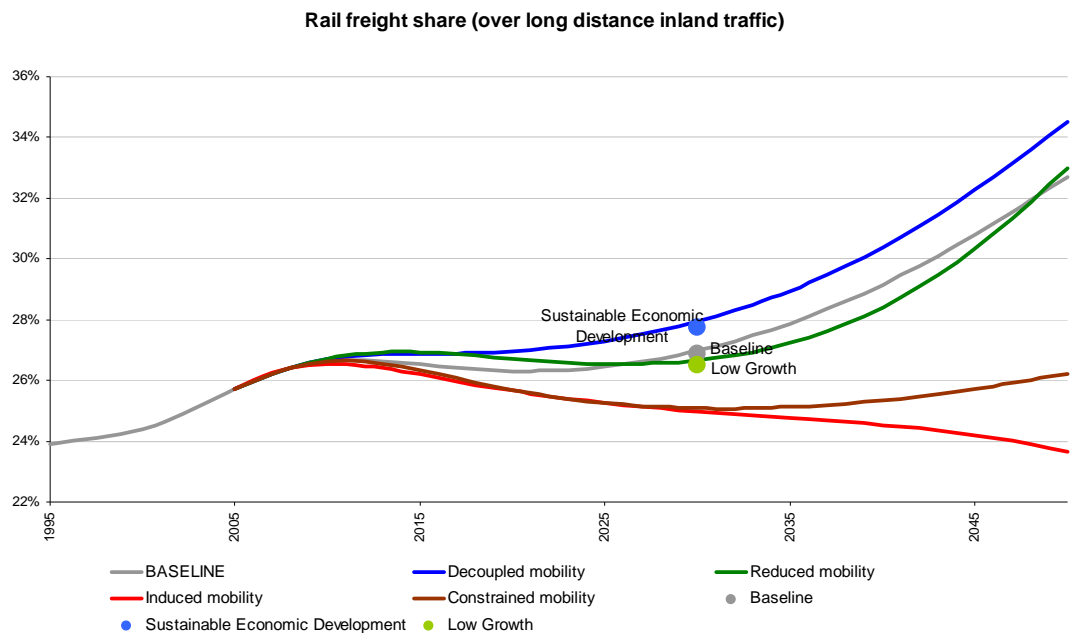


Figure 5.12 Rail freight share (over long distance inland traffic) (tonnes-km)

It can be seen that rail share for freight has a growing tendency in the Baseline, Decoupled and Reduced scenarios. In the Baseline and Decoupled scenarios this is the response to the development of dedicated infrastructure and major improvements in management, whereas the Reduced scenario increases the rail share mainly because of the reduction of road freight traffic. The Induced scenario favours the road mode combined with short-sea shipping (SSS) strategies, and so the rail share remains low. The Constrained scenario follows the path of the Induced scenario but after 2030, when the overall traffic levels decrease, it is road traffic that experiences a serious decline, thus making rail traffic relatively more important.

While the rail passenger mode share grows from 10% in 2005 to between 20% and 35% in 2050 (depending upon the scenario), the growth of the freight mode share is lower in all scenarios: from 27% (in 2005) to a maximum of 33% in 2050. However, it can be seen from Figure 5.12 that most of the curves do not stabilise at the end of the period being considered, and hence that freight seems to have some further growth potential after 2050. In general, up to 2030 passenger rail shares grow more than freight rail shares, whilst after 2030 the opposite seems to happen. In the short-term passenger rail increases, in relative terms, due to HST investments and the increase of long-distance trips (in pass-km). In the long-term, rail freight may grow because of the high growth of goods imported and exported to overseas (rail is expected to be competitive for overseas traffic moving from/to large ports and main consumption centres).

Calibration of CO₂ emissions

TRANS-TOOLS provides the basis for calculating CO₂ figures for non-local traffic (inter-NUTS3) by road, rail and inland waterways. However, further sources of transport emissions need to be added (to the emissions calculated by TRANS-TOOLS) to provide a global vision of the impact of transport regarding GHG. Meta-Models include the "missing" CO₂ emissions from local traffic as well as for the air, sea and local rail modes.

Two different technology strategies have been analysed in relation to the baseline. The first one assumes that no major improvements occur regarding cars, while the second

one applies the current binding rules as well as a slight development of clean technologies:

The first technological strategy (TS1) can be described as follows:

- The 2005 values refer to a EURO 3 technology
- The 2030 values refer to a EURO 5 technology, diesel and petrol, medium size car for passenger and HGV diesel for freight. For HGV travelling in motorways, we have considered a representative vehicle > 18 ton, for HGV travelling across urban areas, a HGV < 18 ton has been considered
- Emissions coefficients and fuel consumption factors have been taken from the TRE-MOVE database v. 2.7

The second technological strategy is:

- The 2005 values refer to a EURO 3 technology
- It is assumed that there is a limit of 95 grCO₂/km for new cars by 2020. This would yield an average emission ratio in 2030 of 152 grCO₂/km in the case of fossil fuel-based cars. In addition, it is assumed that 7% of vehicles are clean (no petrol). For comparison, the average emission ratio of fossil fuel-based cars in 2005 was 196 grCO₂/km, with the TS1 estimate for 2030 being 187 grCO₂/km. Furthermore, it is assumed that 0% of vehicles are clean in 2030 under TS1.

Since it can be argued that TS2 is more line with current trends, it will generally be assumed in this chapter that, unless specified to the contrary, TS2 is being adopted for the baseline predictions.

Table 5.6 compares the Pocket Book data with the Meta-model results on CO₂ emissions, assuming a TS1 technology strategy. It can be seen that the two estimates fit well with a total difference of 1.5%. However, it has to be stressed that figures cannot be directly compared, as they include different scopes regarding EU/extraEU traffic, so some adjustments need to be made to make figures more homogeneous and comparable.

	Pocketbook	TRANSvisions		Absolute differences	Relative differences	Relative differences over total
Total	1099.3	1115.7		16.4	1.5%	1.5%
Road	917.5	925.0	(1)	7.5	0.8%	0.7%
Aviation	151.6	163.9		12.3	8.1%	1.1%
- Civil Aviation	25.6	27.3	(2)	1.7	6.6%	0.2%
- International Bunkers	126.0	130.3	(3)	4.3	3.4%	0.4%
Navigation (domestic)	21.9	19.3	(4)	-2.6	-11.7%	-0.2%
Railways	8.4	7.5	(5)	-0.9	-10.5%	-0.1%

Table 5.6 Comparison of Pocketbook and TRANSvisions CO₂ emissions, 2005

(1) 0.8% difference because traffics are estimated by TRANS-TOOLS

(2) Considering 20% of veh-km are international and 15% to NCT¹³

(3) Adding the veh-km segments over EU27 airspace

(4) Considering 58% of tonnes-km are to NCT (according to TT)

(5) Considering that 30% emissions are due to diesel trains

¹³ Neighbouring Countries in the TRANS-TOOLS model

If the Technological Strategy 2 (TS2) is applied following results will be obtained for 2030.

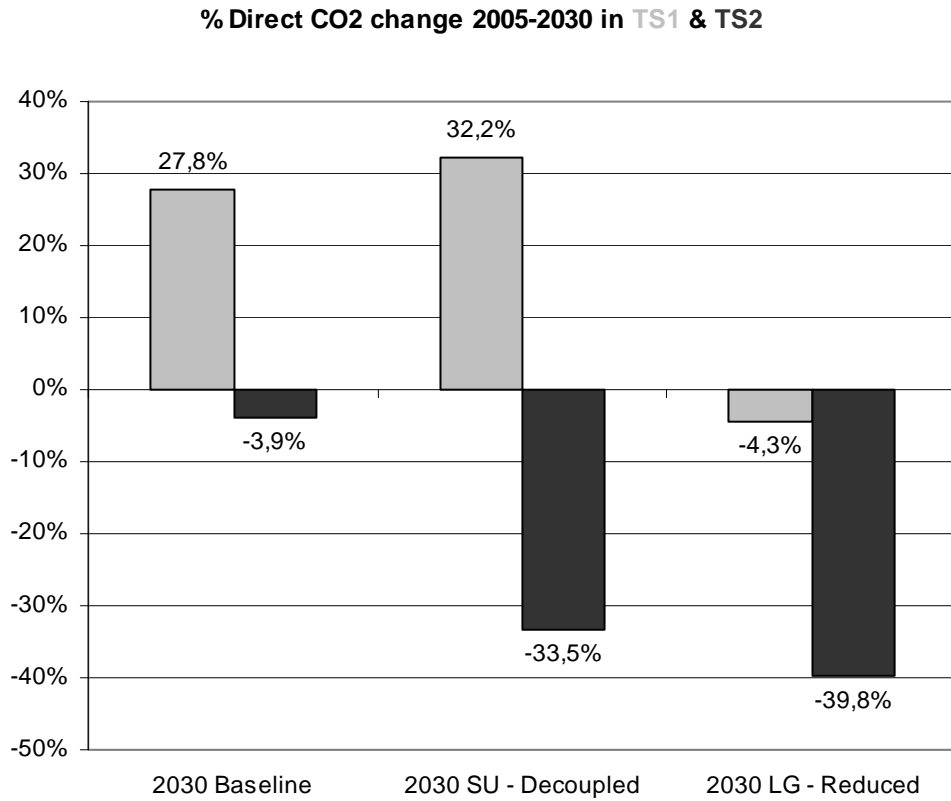


Figure 5.13 % Direct CO₂ emission reduction with TS1 and TS2 2005-2030

The implementation of technology strategy (TS2) leads to a reduction of 4% of direct CO₂ emissions in the 2030 baseline. This reduction is higher for the Decoupled and Reduced scenarios. Using the TS1 strategy for technology gives an increase in CO₂ of 28% in 2030. In 2020, however, the increase in CO₂ is 10%.

5.5.4 Elasticity of transport by type of trips

Figure 5.14 provides a comparison between TRANSvisions results and the *European Energy and Transport 2030 baseline (EET)*, and the 2006 Transport Pocket Book (PB) extrapolation.

Pax-km annual growth 2005-2030

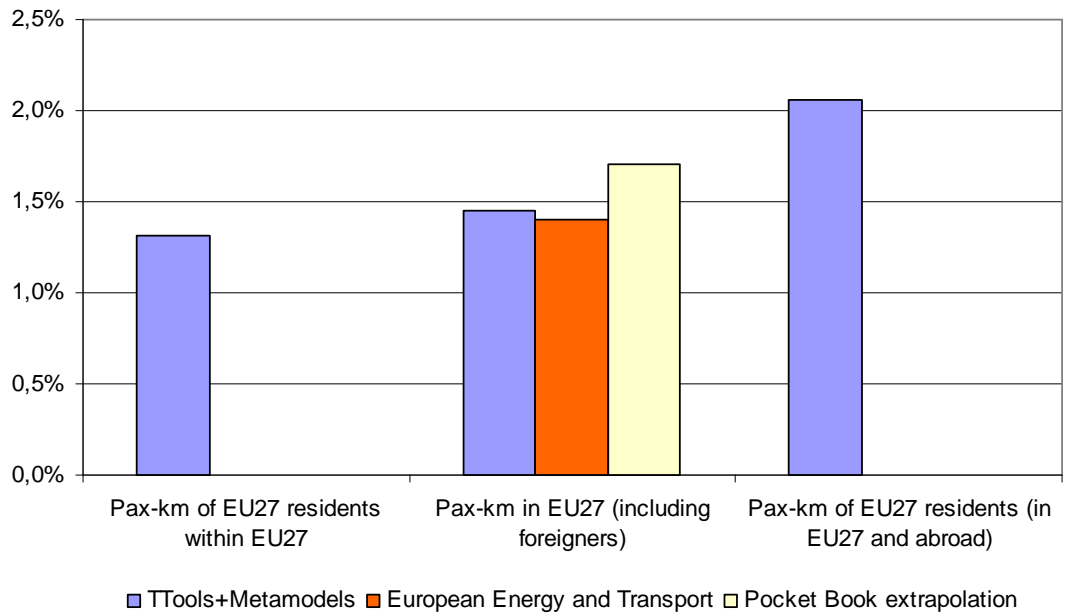


Figure 5.14 Passenger-km annual growth 2005-2030 comparison

When only considering trips made by EU27 residents inside the EU27 territory the growth rate is relatively low, about 1.3% per year. The addition of trips made in EU27 territory by non-residents, i.e. trips with origin or destination outside EU27, increases the growth rate slightly up to 1.45% per year. This figure is very similar to the one provided by EET. The main difference arises when trips made by EU27 residents outside EU territory are included, increasing the annual growth up to 2.1%

Figure 5.15 displays tonnes-km growth rates by different trips segments, comparing TRANSvisions results with the European Energy and Transport 2030 baseline and the 2006 Transport Pocket Book extrapolation.

Ton-km annual growth 2005-2030

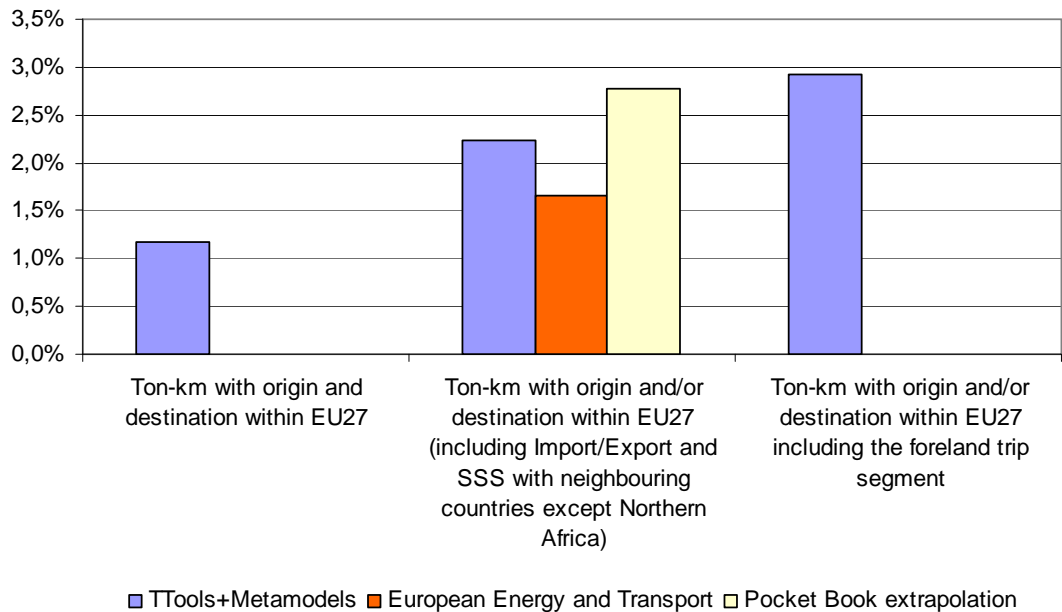


Figure 5.15 Tonnes-km annual growth 2005-2030 comparison

When only considering freight with origin and destination within the EU27 territory the growth rate is low, about 1.2% per year. Addition of freight with origin or destination in EU27 neighbouring countries (except northern Africa) increases the growth rate up to 2.25% per year, mainly due to the great amount of oil, coal and other fuels moved by sea mode coming from Norway and Russia. This number is between the EET and PB values. If the trip segment of freight outside EU27 territory and surrounding waters, i.e. long distance foreland traffic with Asia, America and Africa is added the annual growth increases to about 2.8%

This figure highlights the importance of extraEU traffics and shows how the total freight traffic caused by EU has growth rates equal or even higher than the GDP.

5.6 CO₂ emissions from 2005 to 2050

5.6.1 Assessments of transport CO₂ emissions in exploratory scenarios 2050

The Meta-Models have been used to assess the level of CO₂ emissions in 2050. A comprehensive dataset describing the necessary input data has been established and this dataset forms the backbone in the analysis of the expected CO₂ emissions in the different exploratory scenarios. An overview of the datatable for 2050 is attached as annex 7.

One of the important issues in establishing the CO₂ emissions is the level of technological progress. Figure 5.16 shows development paths for the different scenarios of the share of non-fossil-fuelled vehicles and the subsequent Figure 5.17 shows development paths for emission reduction of fossil-fuelled vehicles.

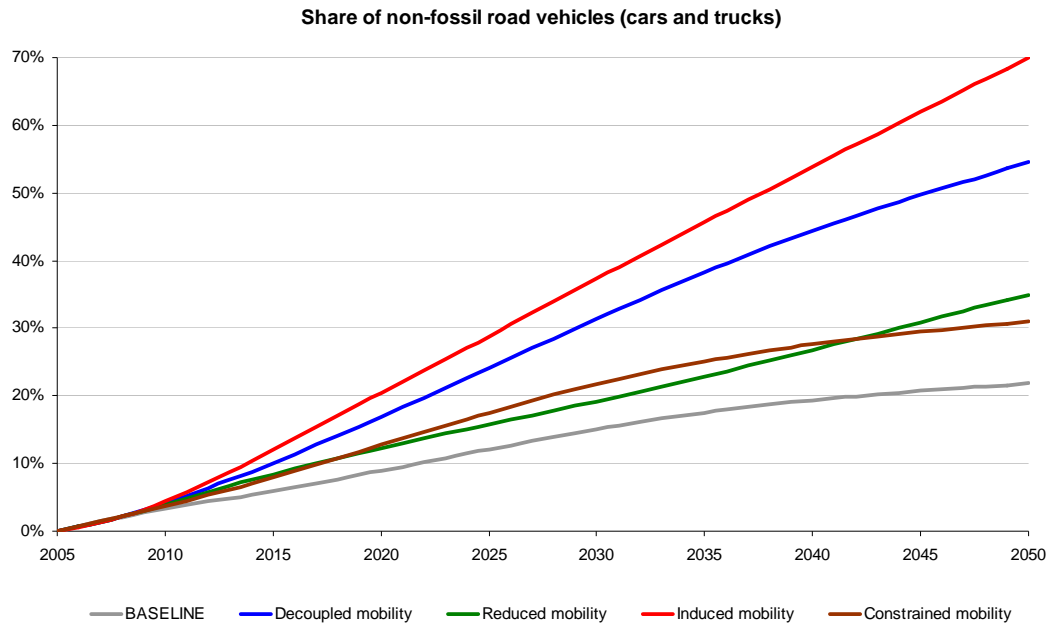


Figure 5.16 Share of non-fossil fuelled vehicles (cars and trucks)

Figure 5.16 shows how the development of clean technologies is most intense and fast in the Induced scenario. The Constrained scenario does not rely much on technology and the crisis period from 2030 onwards stops the development of clean vehicle technology. In all scenarios the share of non-fossil-fuelled vehicles is bigger than in the baseline, which suggests that, in this respect, the baseline is a conservative estimate.

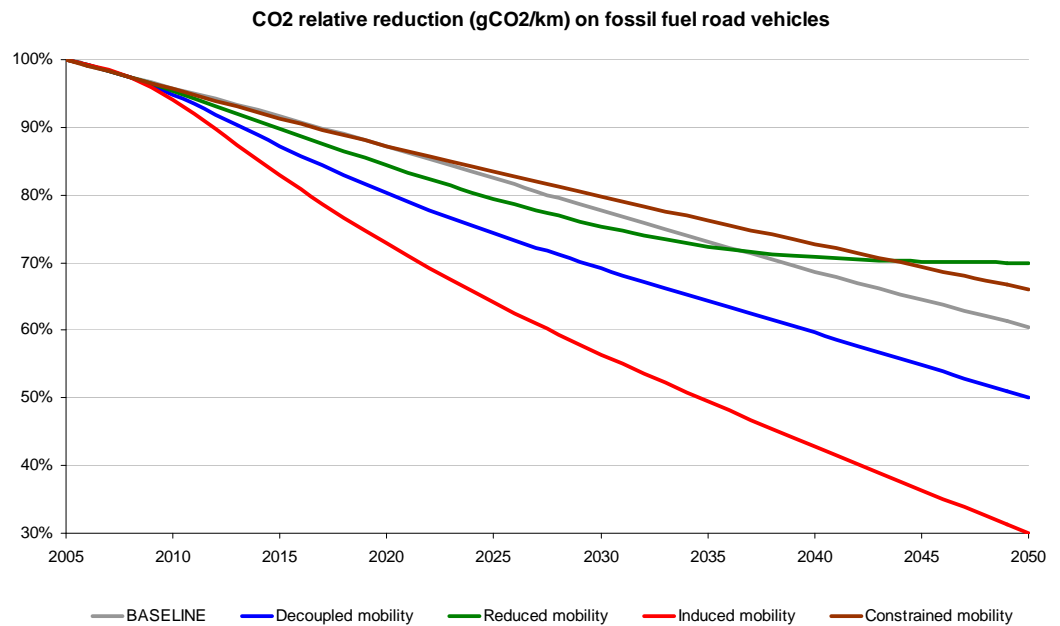


Figure 5.17: CO₂ relative reduction (g CO₂/km) on fossil fuel road vehicles

Evolution 2005-2050 of CO₂ emission ratio reduction for fossil fuelled vehicles in the exploratory scenarios is indicated in Figure 5.17. Again the Induced scenario relies mainly on technology and so it has the highest cut in CO₂ emission ratios.

Both direct CO₂ emissions as well as indirect CO₂ emissions are calculated. The total amount of CO₂ emissions related to transport in 2050, and the path followed to reach this amount, is indicated for each scenario in Figure 5.18.

The Reduced and Decoupled scenarios comply with the reduction of CO₂ emission levels by 10% in 2020 compared to 2005. The Induced, Reduced and Decoupled scenarios comply with the reduction of CO₂ emission levels by 50% in 2050 compared to 2005. The slow development of clean technologies in the Constrained scenario, coupled with the high growth of traffic makes CO₂ emissions increase far more than in the other scenarios during the first half of the period. In the assessment annual CO₂ emissions indirectly related to transport are also included, for example electricity generation for trains and electric vehicles. These emissions are caused by use of fossil fuels in the primary generation of electricity and alternative fuels like hydrogen, and take into account the different source mix for electricity generation in each scenario (fossil, nuclear and renewable). Changes in primary generation, coupled with variation of modal shares cause the paths to fluctuate. It must be noted that the absolute value of these indirect emissions is less than 5% of the total CO₂ emissions from transport.

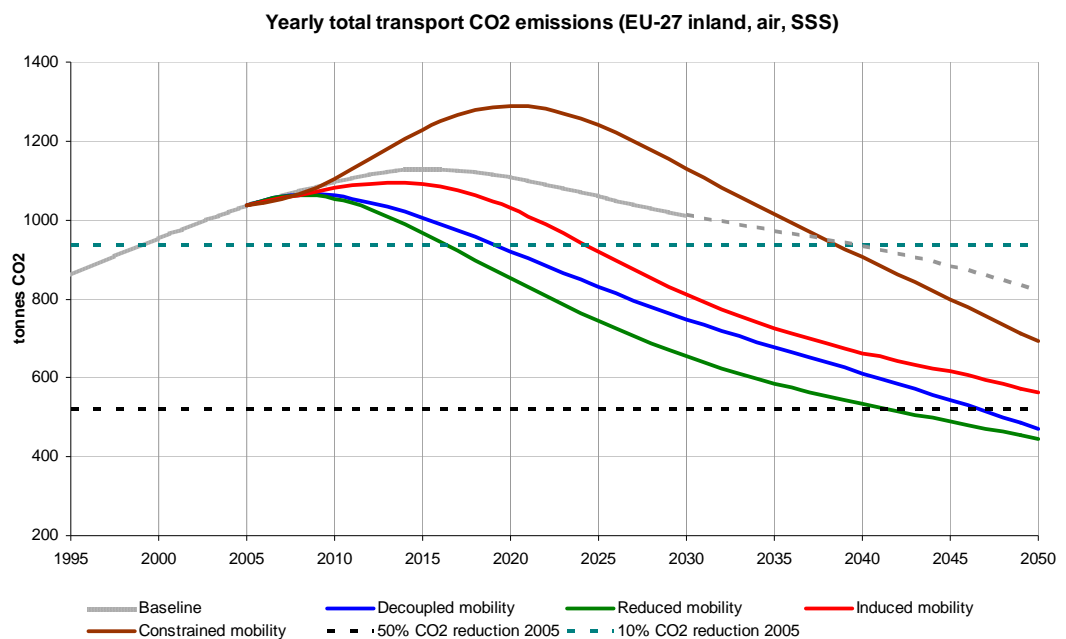


Figure 5.18: Annual total transport CO₂ emissions (EU-27 inland, air and SSS)

5.6.2 Impact of economic growth on CO₂

The objective of the analysis in this section is to analyse the impact that a different path of GDP growth may have in terms of CO₂ emissions for each of the scenarios (assuming that the hypotheses for the rest of variables, particularly for technology development, remain the same). In this analysis, it is assumed that the average annual GDP growth between 2005 and 2050 (and hence the total growth in this period) remains constant: only the evolutionary path between 2005 and 2050 changes.

This assumption is justified if the present economic crisis leads to a strong search for efficiency gains through consolidation of industries and the concentration of firms in their core business.

For a moderate/high rate of growth in the early years of the period, as assumed in the TRANS-TOOLS results and Meta-Models exploratory scenarios, GDP evolution could be as shown in Figure 5.19):

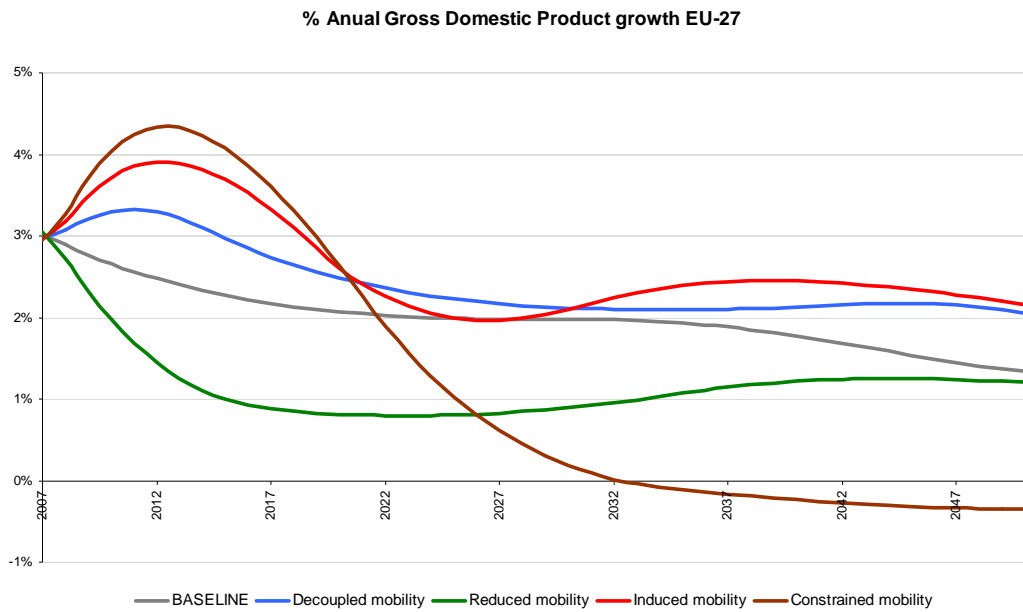


Figure 5.19 % Annual Gross Domestic Product growth in EU-27 according to prospective scenarios

Considering lower growth in the early years, GDP evolution could be as shown in Figure 5.20):

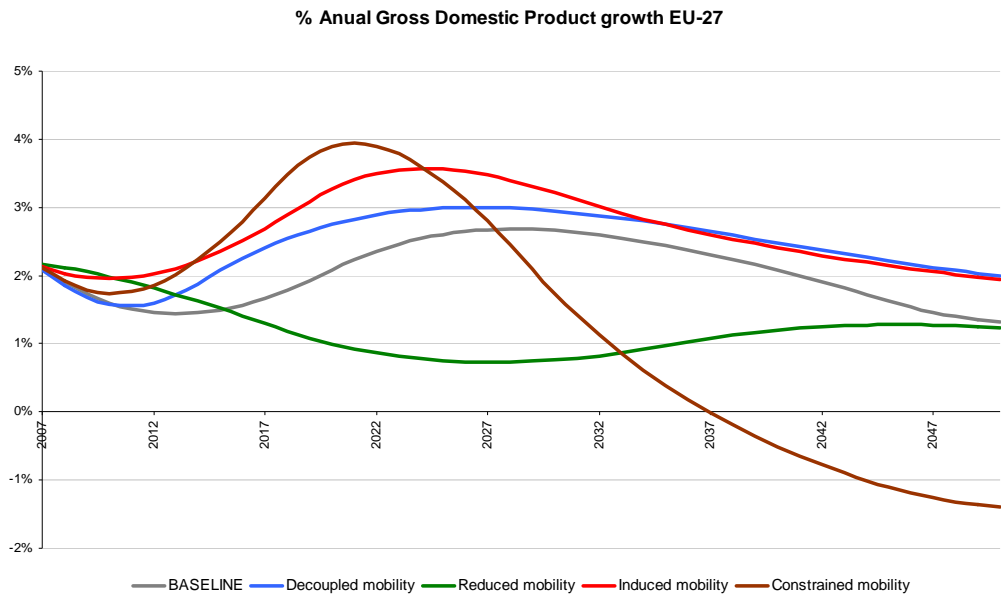


Figure 5.20 % Annual Gross Domestic Product growth in EU-27 Different path starting with a recession period and having a fast recovery in 2020.

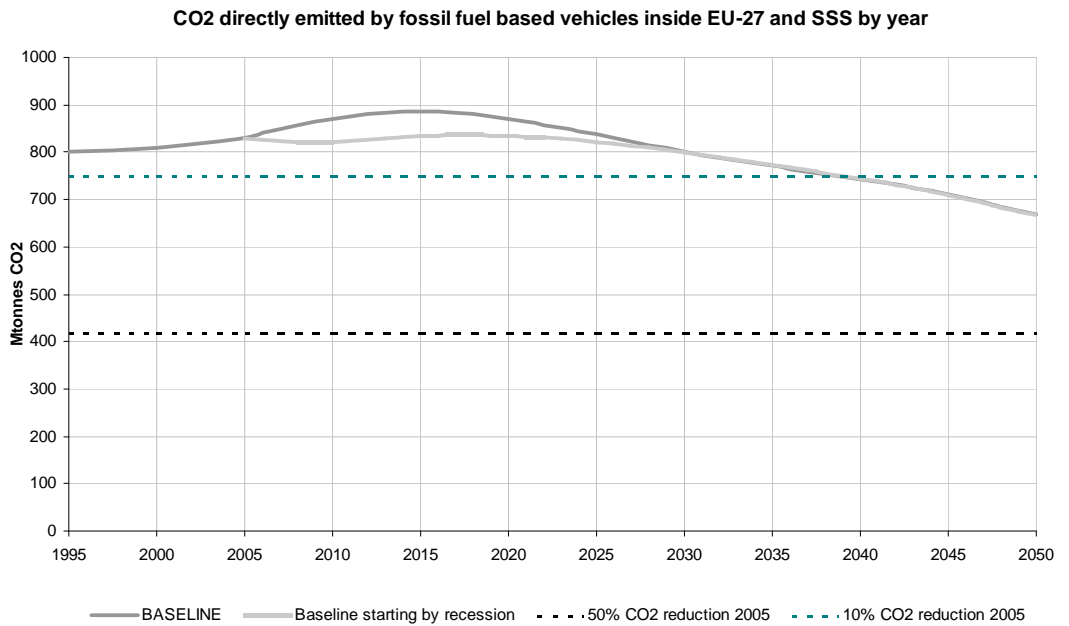


Figure 5.21 Comparison between CO₂ paths of Baseline scenario, depending on evolution of GDP

The results obtained for the Baseline (Figure 5.21) show a net reduction of CO₂ emissions if the GDP starts with a lower rate of growth (even if GDP annual average growth remains the same for the whole period), because major technology innovation is assumed to be implemented later in the period, thus not having a major impact before about 2020.

The conclusion is that if technological development continues undisturbed in the current economic recession, lower economic growth will result in less, but more technological advanced, traffic resulting in a net reduction in CO₂ emissions. However, the current recession might have two consequences:

- 1) Companies and governments might cut down on their RTD investments and take less innovation risks, and
- 2) The renewal of the vehicle fleet might be slowed down significantly.

If either (1) or (2) occur, then when the recession is over and the traffic grows again, CO₂ will grow faster. This issue is examined in more detail in 5.6.3.

5.6.3 Impact of technology on CO₂

The objective of the analysis in this subsection is to determine what impact a slower process of technology implementation might have on CO₂ emissions (assuming a 5-year low growth period as starting point for the economy but maintaining the rest of variables at fixed levels).

It is assumed that technology in year 2050 is the same for both alternatives (i.e. the fast and slow technology implementation paths), so that only the implementation path varies. Given the small improvements of technology in the Baseline scenario, no changes are introduced in the analysis of the Baseline.

Results show a high sensitivity of CO₂ emission to market implementation of technologic innovation in relation to:

- The development of the share of non-fossil fuelled vehicles (car and trucks)
- The development of the emission rates for fossil fuelled vehicles

Figure 5.22 shows that CO₂ reduction targets are not fulfilled in year 2020 by any scenario in the slow technology implementation path. Although the reduction is achieved in some scenarios in the year 2050, the cumulated CO₂ emissions are much higher, particularly in the case of the Induced scenario (Move Alone), being about 7% extra in year 2020 but more than 30% extra in year 2050.

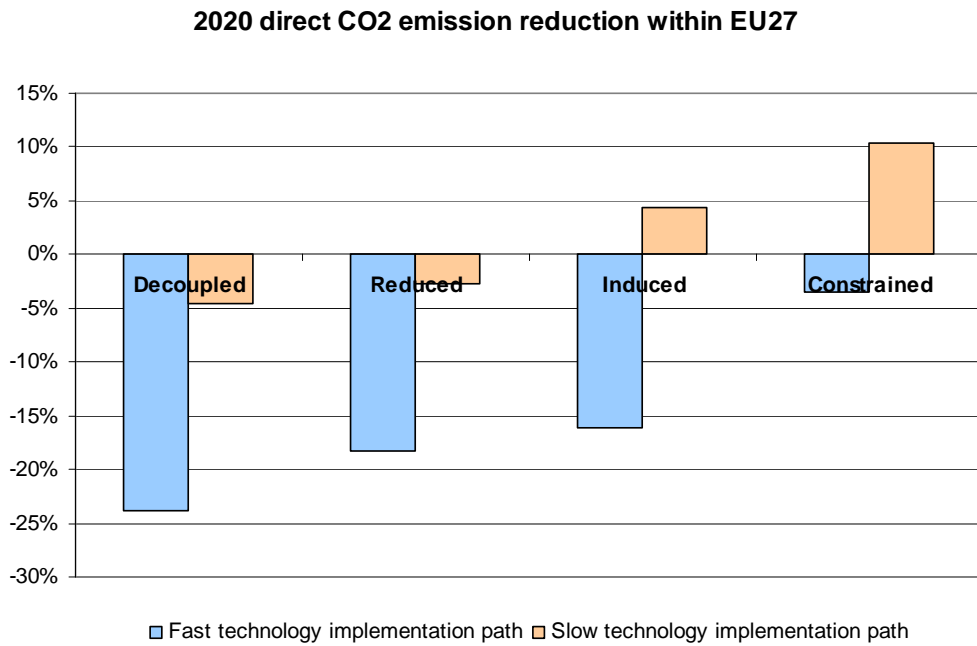


Figure 5.22 Direct CO₂ emission reduction in 2020 within EU27 for two different sets of technology implementation paths

5.6.4 Impact of speed limits and car technology (EURO V directive) on CO₂

As stated above, emissions have been calculated (under different hypotheses) by combining output from TRANS-TOOLS, regarding vehicle-km and speeds, with emission curves from TREMOVE. The TREMOVE curves allow the determination of, among other variables, fuel consumption and CO₂ emissions for different vehicle technologies. Figure 5.23 makes a comparison of fuel consumption, by speed, for two situations: (1) assuming the present vehicle fleet; and (2) assuming that all existing vehicles comply with the EURO V directive.

Average fuel consumption for cars

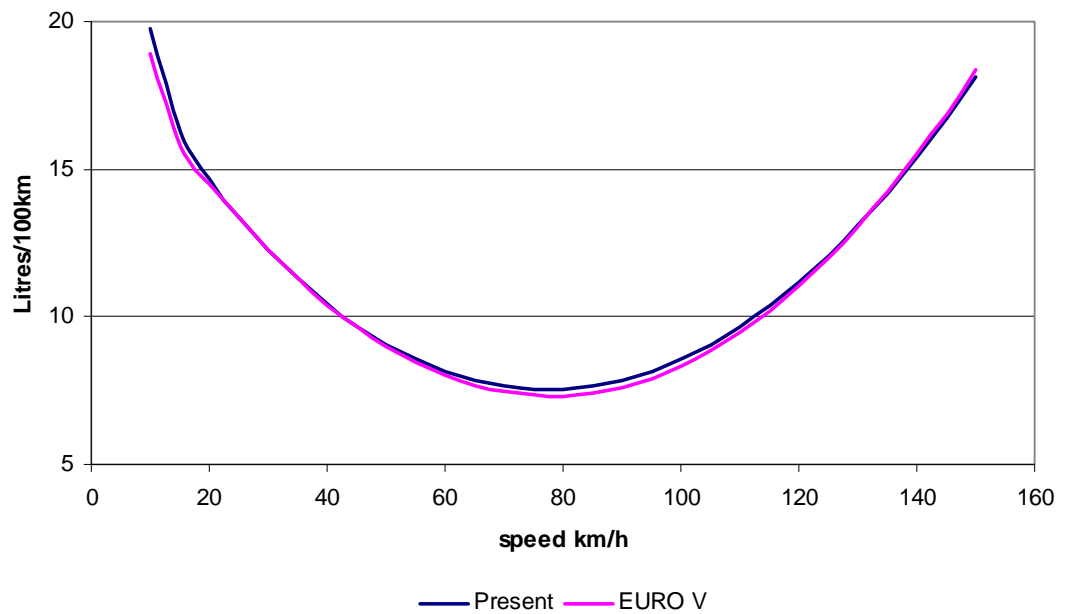


Figure 5.23 Average fuel consumption curve for the European car park at present and assuming a full implementation of the EURO V directive

Aggregated distribution of car-km

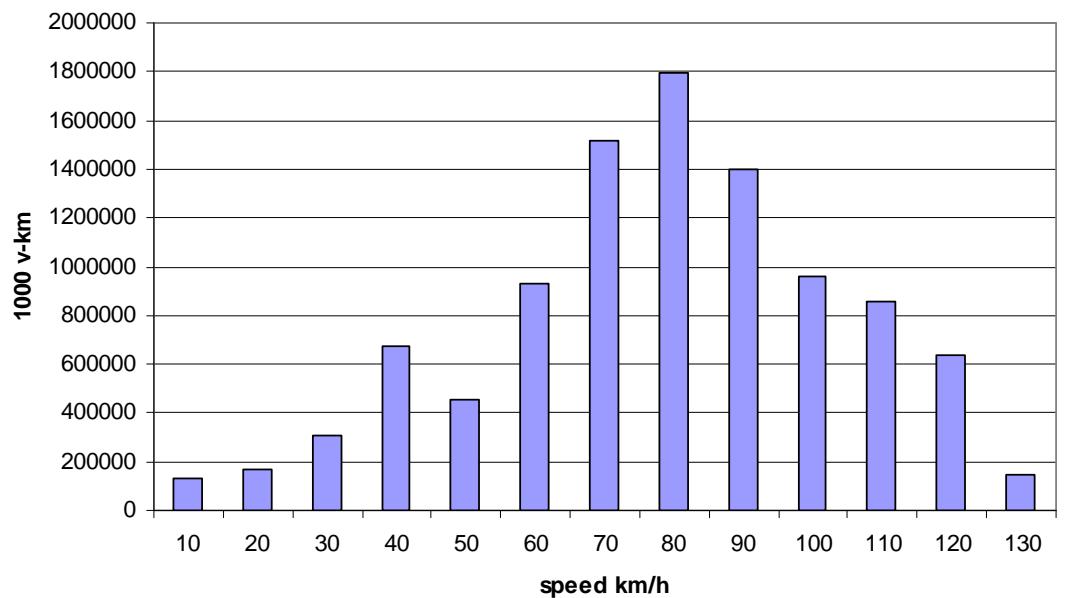


Figure 5.24 Aggregated distribution of car-km by speed range in 2005 TRANS-TOOLS results

A possible measure to reduce CO₂ emissions would be changing maximum speed limits to 100 km/h for motorways and 80 km/h for trunk roads. However, as seen in the Figure 5.24 most driving is carried out with speeds of about 70-90 km/h, which implies that much driving is carried out with optimal speed regarding CO₂ emissions. However, the introduction of speed limits would reduce CO₂ emissions by about 5 % through cutting out very fast traffic. This would also be likely to have a side effect of reducing the number of fatalities.

If the EURO V directive for cars were fully implemented, vehicles with old technology would be replaced by vehicles with EURO V technology. This option would reduce CO₂ emissions by about 2%. Adding the two measures together (speed limits and EURO V technology) would yield a 6.5% reduction.

EURO V	80/100	80/100 + EURO V
1,8%	4,6%	6,5%

Table 5.7 CO₂ emission reduction for different policies

5.7 Policy backcast analysis 2050-2005

5.7.1 Policy backcast exercises

Further to the exploratory scenarios, two “backcast scenarios” have been created with the Meta-Models. Essentially the purpose of such scenarios is to construct images of the future in which certain targets are met; the implication being that these targets are met through policy interventions. Such scenarios are constructed against backgrounds provided by the exploratory scenarios, which provide “exogenous” backgrounds to such scenarios. The two backcast were concreted as follows:

- The first backcast scenario is built with the help of the Decoupled Mobility (Moving Together) scenario (the Decoupled Mobility scenario is used as a framework with the trends on socio-economy and transport but only with the policies implemented on the baseline). Several policies are implemented to fulfil CO₂ emission reduction targets (a 10% CO₂ reduction in 2020, and a 50% reduction in 2050, both from 2005 levels).
- The second backcast scenario is established based on the Induced Mobility (Moving Alone) scenario (the Induced Mobility scenario is used as a framework with the trends on socio-economy and transport but only with the policies implemented on the baseline). Several policies are implemented to fulfil CO₂ emission reduction targets (a 10% CO₂ reduction in 2020, and a 50% reduction in 2050, both from 2005 levels).

In both cases a baseline has been established combining the exploratory scenario with the Baseline policies. These baselines are used for comparisons.

5.7.2 How to achieve CO₂ targets in the Decoupled (Moving Together) scenario?

A main feature of the Moving Together Scenario is a behavioural change, which will increase the utilisation of the vehicles in the transport system, and make the citizen take more responsibility for climate change and environment. Therefore car occupancy will improve as will the use of rail, particularly in long-distance transport. However, there will also be a continuous technological development, though not very fast.

	2005	Decoupled	Decoupled Backcast	Decoupled	Decoupled Backcast
		2020		2050	
%non-fossil fuel vehicles	0%	7.5%	12.2%	21,8%	40,0%
average gCO2/km in cars	196	176	167	119	98
average gCO2/km in trucks	966	869	821	584	483
Rail pax share LD	9.8%	18.9%	19.4%	30.4%	35.2%
Rail pax share SD	6%	6.2%	6.7%	20,0%	20,0%
Rail freight share	28.7%	30%	32.4%	37,5%	44,6%
Direct CO2 reduction	-	-4%	-11.7%		

Table 5.8: Parameter variation on the Decoupled Mobility backcast scenario

Based on these assumptions the direct CO₂ emissions from transport in 2020 can be reduced by 12% compared to the 2005 level of CO₂ emissions.

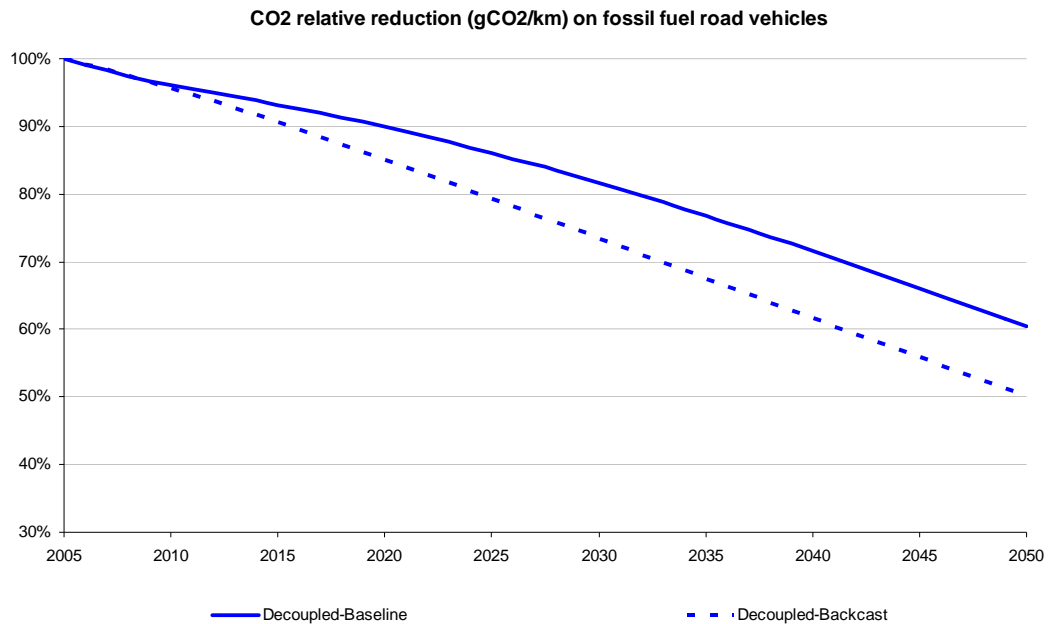


Figure 5.25: Reduction of CO₂ emission rates on fossil fuel road vehicles for the Backcast Decoupled Mobility scenario

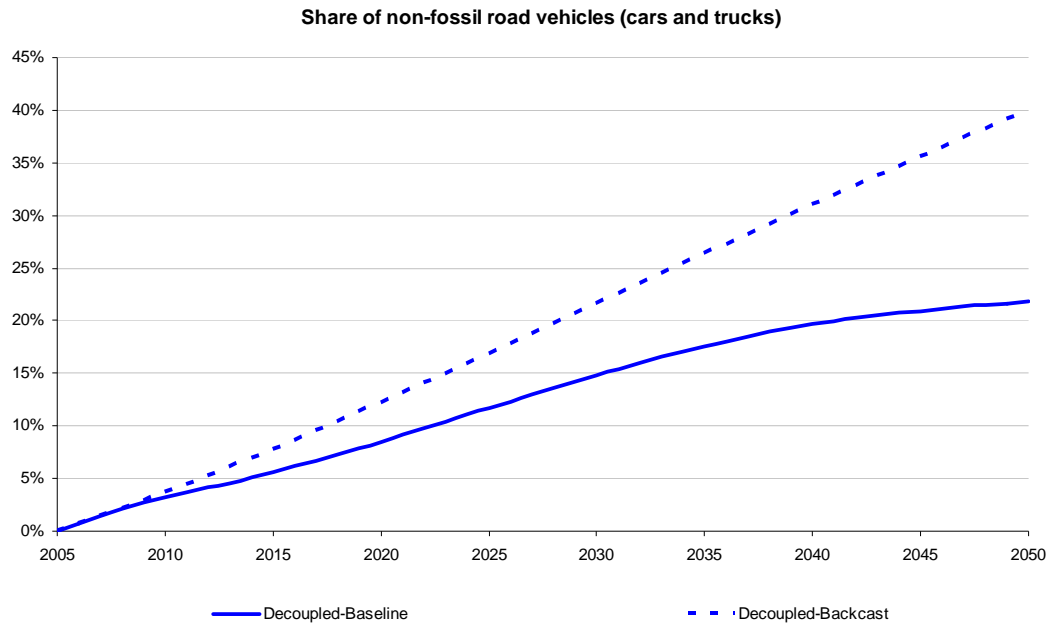


Figure 5.26: Share of non-fossil fuel road vehicles for the Backcast Decoupled Mobility scenario

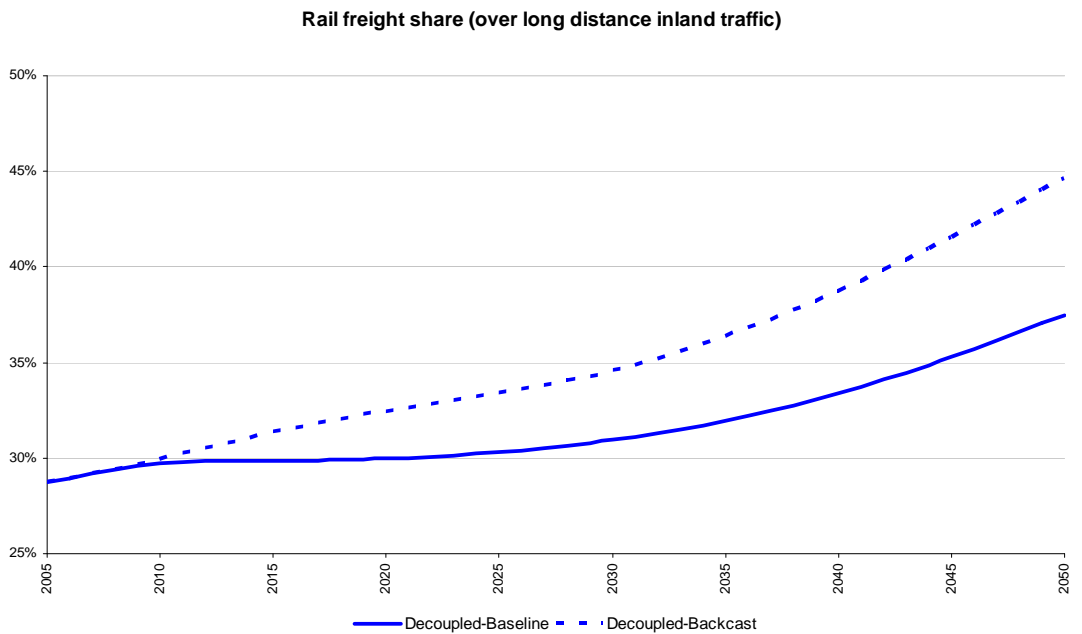


Figure 5.27: Rail freight share over long distance inland traffic for Decoupled Mobility Backcast scenario

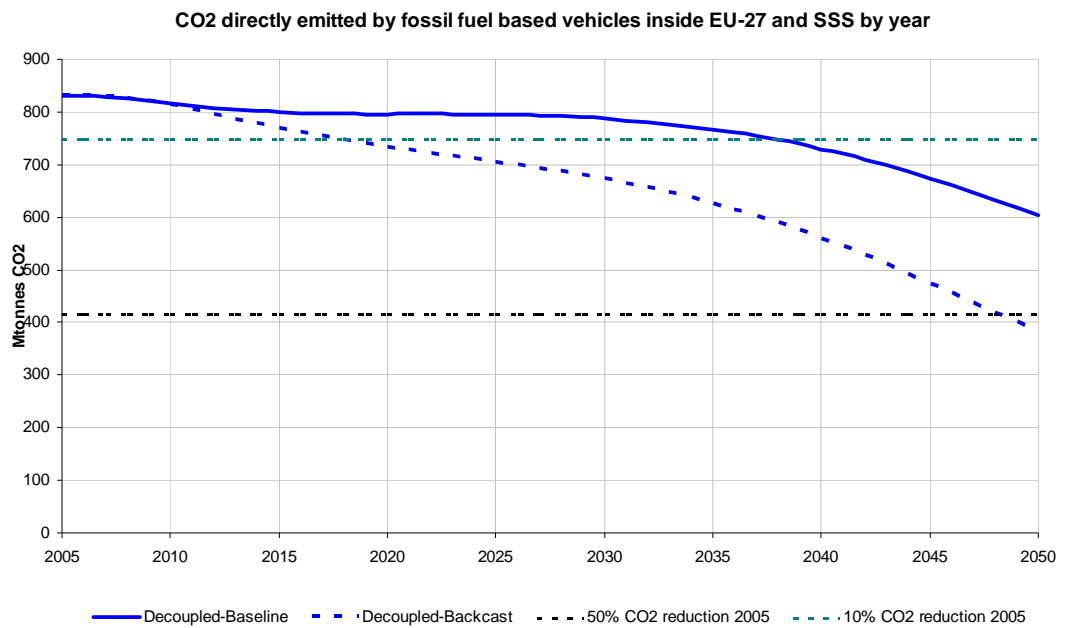


Figure 5.28: Direct CO₂ emissions for the Decoupled Mobility Backcast scenario

5.7.3 How to achieve CO₂ targets in the Induced Mobility (Moving Alone) scenario?

A main feature of the Moving Alone Scenario is a strong relation to market development, however, taking a sustainable economic development into consideration. The market dependence, however, means that a considerable effort is done in the RTD field, leading to a fast technological development. Therefore the main impact on CO₂ emissions relates to development of non-fossil fuel vehicles and better engines in the road vehicles.

		Induced	Induced Backcast	Induced	Induced Backcast
	2005	2020		2050	
%non-fossil fuel vehicles	0%	11,0%	15,1%	21,8%	70,0%
average gCO ₂ /km in cars	196	172	137	119	59
average gCO ₂ /km in trucks	966	846	676	584	290
Direct CO₂ reduction	-	7%	18%	58%	64%

Table 5.9: Parameter variation on the Induced Mobility Backcast scenario

According to different sources, for example “Trends in vehicle and fuel technologies” (JRC-IPTS, 2003), a likely evolution of car technologies could be:

- Hybrid cars constitute 27% of the vehicle fleet, fuel cell cars 10% and electric cars 5% of the vehicle fleet by 2020.
- Fossil fuel-based cars are expected to obtain a 28% reduction of CO₂ emissions by 2020 due to efficiency increases

It is assumed that in the Induced Mobility Backcast scenario a faster implementation of technologies compared to the Induced Mobility Scenario is applied thanks to a policy driven technological development (following the evolution described in the study mentioned above).

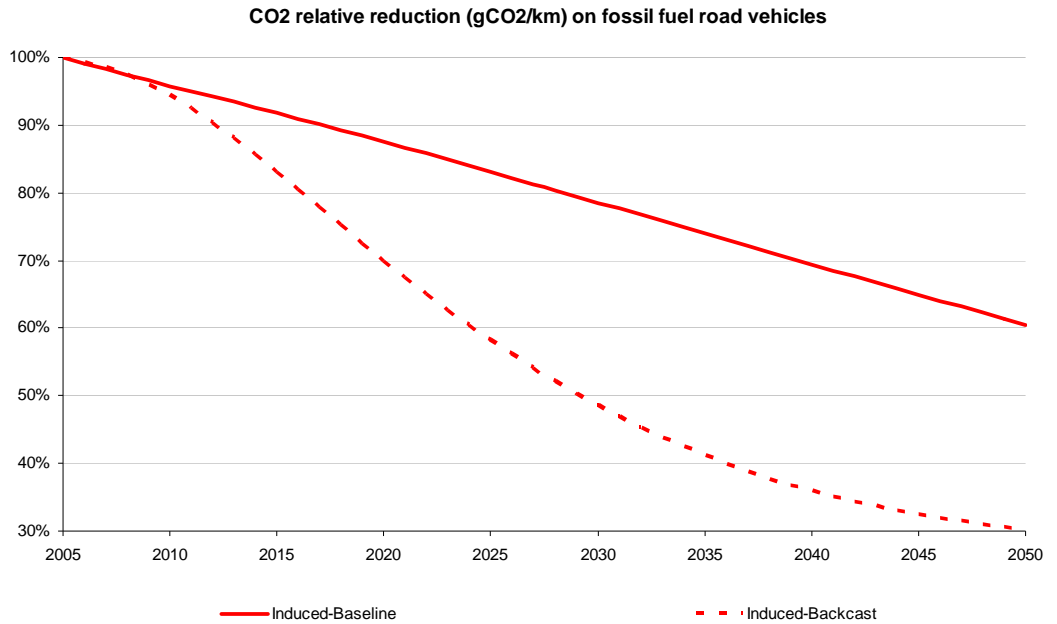


Figure 5.29: Reduction of CO₂ emission rates on fossil fuel road vehicles for the Induced Mobility Backcast scenario

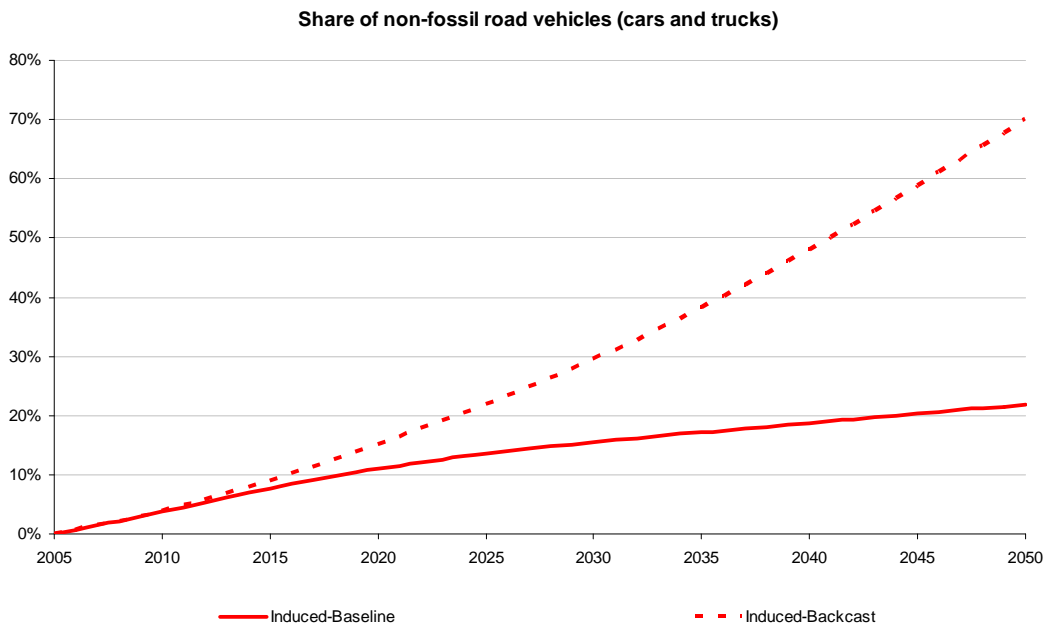


Figure 5.30: Share of non-fossil fuel road vehicles for the Induced Mobility Backcast scenario

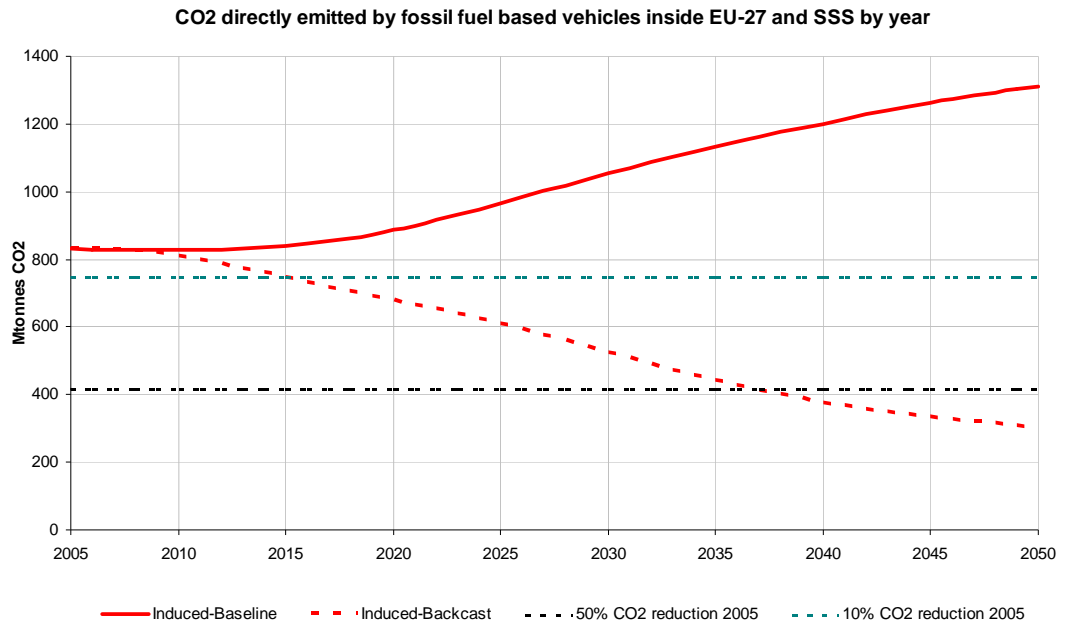


Figure 5.31: Direct CO₂ emissions for the Induced Mobility Backcast scenario

5.7.4 Summary of backcast results

The backcast results for 2020 and 2050 are summarised in Table 5.10 and the development lines are shown in Figure 5.32 and Figure 5.33.

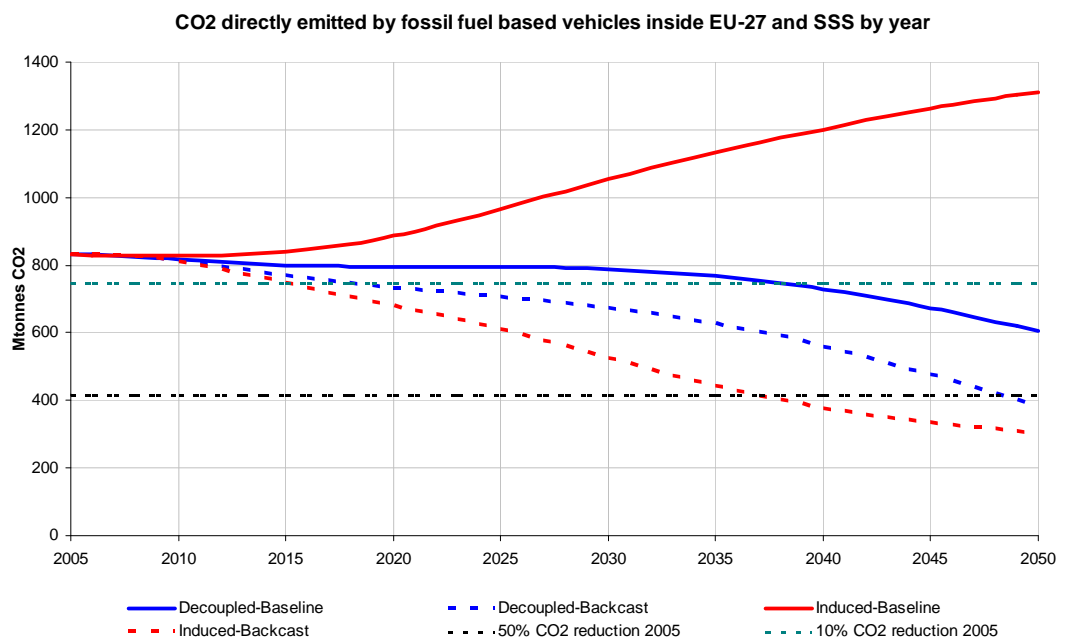


Figure 5.32: Direct CO₂ emissions in the Backcast scenarios

Indirect emissions are related to vehicles that do not use fossil fuels, thus a higher use of rail or an increase in the share of electric vehicles produce an increase in indirect CO₂ emissions.

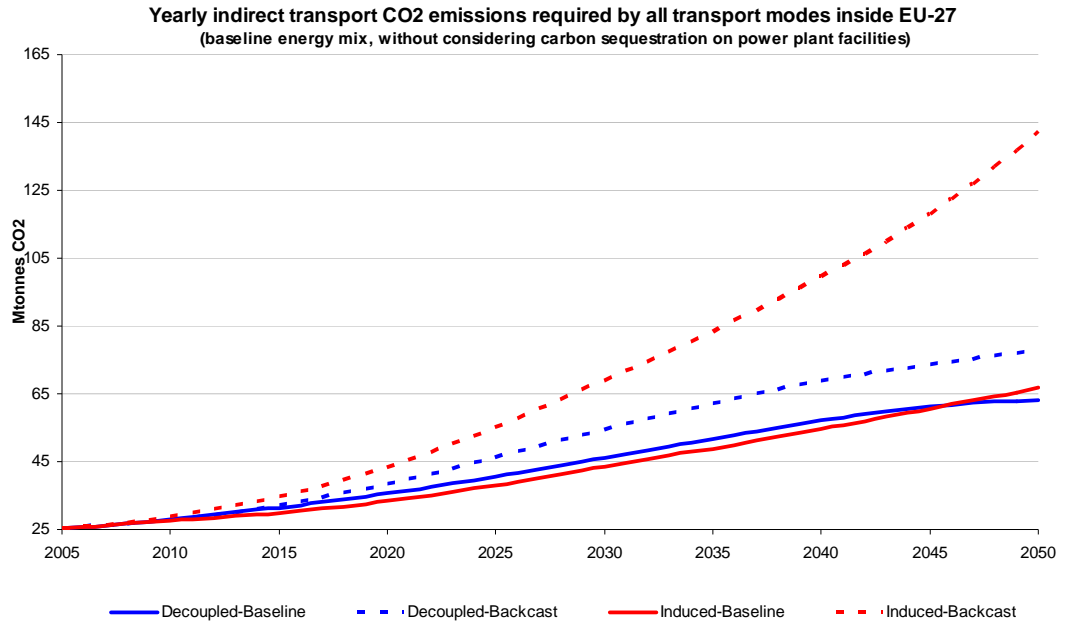


Figure 5.33: Indirect CO₂ emissions in the Backcast scenarios

Trends	Policies	Total CO ₂ reduction within EU27 with respect to 2005 levels	
		2020	2050
Decoupled	Decoupled	-11%	-54%
Decoupled	Baseline	-4.1%	-27.3%
Induced	Induced	-18%	-63%
Induced	Baseline	6.7%	58%

Table 5.10: CO₂ emissions reduction within EU27

From Table 5.10, it can be seen that a major growth in economy, leading to a major increase in traffic (i.e. the Induced scenario) can result in a big increase in CO₂ emissions of more than 50% if current trends regarding transport technologies and modal share are kept (i.e. the Induced scenario with “baseline policies”). However, the implementation of policies to control emission ratios can totally change the path (i.e. the Induced scenario with “Induced Backcast” policies) leading instead to a 63% reduction.

An analogous summary can be made for the Decoupled scenario, which has less economy growth and also a decoupling of transport from GDP. If “baseline policies” are applied in such a scenario there will not be a compliance with the emission reduction targets, even though there is a tendency to reduce emissions. To meet the targets of -10% in 2020 and -50% in 2050, additional policies regarding vehicle technologies and modal share are required (i.e. the Decoupled scenario with “Decoupled Backcast” policies), leading to a 54% reduction in emissions.

5.8 Policy packages for 2020, 2030 and 2050

The Meta-Models have been applied for testing several policy packages consisting of different policy instruments with the specific purpose of reducing CO₂ emissions. The policy packages are applied over the Baseline.

- **The first policy package** consists of technological measures: the reduction of emission ratios for new vehicles and the introduction of non-fossil fuelled vehicles. This implies a renewal of the fleet leading to a reduction of CO₂ emissions for cars from 196 down to 159 g/km in 2020 (plus 15% of the fleet not using fossil fuels). Values for 2050 go down to 98 g/km (plus 40% of the fleet not using fossil fuels). Direct CO₂ for transport within EU-27 is reduced with 4% in 2020 and with 23% in 2050.

This is one of the most efficient packages to reduce CO₂ emissions. However, it implies a major change on the fleet of vehicles, so it is more feasible in the mid and long term, while an early implementation might require strong policy enforcement.

- **The second policy package** consists of regulatory measures: a reduction of maximum speeds in the whole road network (100km/h on motorways and 80km/h on trunk roads) and strict land use planning to avoid urban sprawl encouraging urban public transport. This package, provided that enough urban rail capacity exists or is provided, increases the urban rail share from 6% in 2005 to 10% in 2020 and 28% in 2050 (instead of the baseline values of 7% in 2020 and 8% in 2050). With this measures the direct CO₂ reduces down to -3% in 2020 and -13% in 2050.

Limiting speeds is moderately effective, as it can yield almost a 5% reduction (depending on the speed profile of the existing traffic it might be less), but it is quite difficult to implement from a political point of view. The limitation of speeds might encourage the modal change towards rail, particularly in metropolitan areas, thus complementing the second part of the package.

- **The third policy package** includes pricing mechanisms directed towards increasing the average occupancy of cars, load factor of trucks and long distance rail modal share. This package increases the urban car occupancy up to 50% and the interurban car occupancy up to 30% more than the baseline. Truck loads increase up to 20% instead of the 10% of the baseline. Passenger rail share increases 3% in relation to baseline while freight rail share increases 2%. In this case the CO₂ is reduced -2% in 2020 and -22% in 2050.

This package focuses mainly on mid and long-distance traffic and is the one taking more time to show results, but it has the highest efficiency. The policies towards changing the occupancy of vehicles do not need new infrastructure, so they might be the most cost-effective solutions to reduce CO₂ emissions. On the other hand the modal shift requires investments in rail infrastructure.

- **The fourth policy package** to reduce CO₂ emissions consists of increasing the road investments up to 20% to reduce congestion. This translates in an average reduction of -1% of CO₂.

This package is not very effective and could even have a negative effect, as the reduction of congestion might induce more traffic. However, specific investments on selected bottlenecks can have an important impact at local or regional level.

	Policy	Indicator	Policies				Baseline			Maximum values in exploratory scenarios		
			2005	2020	2030	2050	2020	2030	2050	2020	2030	2050
Vehicles technology	Increase the share of non-fossil fuel based vehicles	% non CO ₂	0%	15%	25%	40%	9%	15%	22%	20%	37%	70%
	Imposing new CO ₂ emission limits for new vehicles and accelerate the retirement of older cars	% reduction CO ₂ emissions	0%	15%	25%	50%	13%	23%	40%	28%	44%	70%
Speed limits, Land Use and Local Public Transport	Limit the maximum speeds to 100km/h in motorways and 80km/h in trunk roads	% reduction CO ₂ emissions	0%	18%	28%	45%	13%	23%	40%	28%	44%	70%
	Reduce urban sprawl changing Land Use, to increase the share of urban rail	Short-distance passenger rail share	6%	10%	15%	28%	7%	7.5%	8%	7%	7.5%	20%
Occupancy, Load Factor and Rail share	Increase the average occupancy rates of cars for urban and interurban traffic	Urban occupancy rate	1.4	1.52	1.71	2.25	1.46	1.48	1.5	1.55	1.7	2.1
		Interurban occupancy rate	2	2.21	2.5	3.25	2.12	2.21	2.5	2.13	2.23	2.5
	Increase in average load on trucks	Average load increase	0%	5%	8.5%	20%	3%	5%	10%	5%	11%	30%
	Increase rail share	Passenger rail share	8%	15%	22%	28%	14%	21%	25%	17%	24%	30%
		Freight rail share	15%	15%	16%	21%	15%	16%	20%	16%	16%	21%
Road Infrastructure	Increase investment in roads to reduce congestion 20% over the Baseline level (from 4.000M€/yr to 5.000M€/y)	% reduction CO ₂ emissions	0%	10%	16%	23%	9%	15%	22%	28%	44%	70%

Table 5.11: Values of indicators defined in the policy packages

If the four packages are applied together, a reduction of 10% of direct CO₂ emissions is obtained by 2020. For year 2050 the reduction is 58%

In conclusion, it seems likely that the 2050 reduction target will be achieved (since different paths are feasible), but it seems relatively difficult to achieve the 2020 target (unless new technologies are implemented faster than expected). On the other hand, the achievement of CO₂ 2020 targets is highly sensitive to the policies to be implemented in the coming years.

Policy impacts on CO2 reduction in relation to Baseline emissions

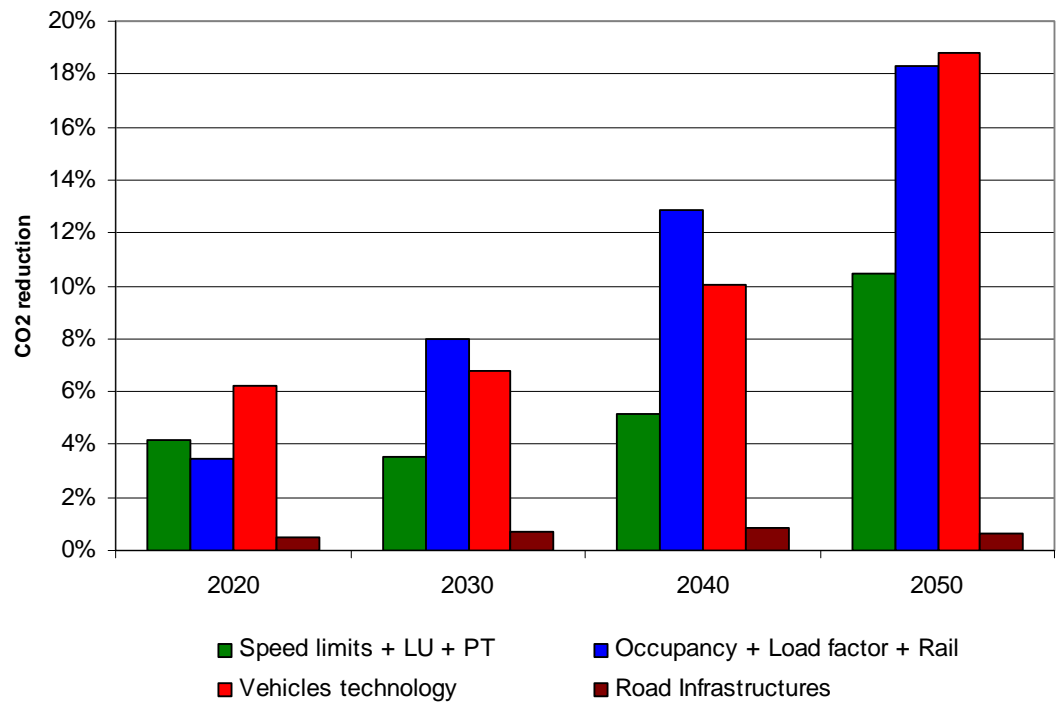


Figure 5.34 Policy impacts on CO₂ reduction in relation to Baseline emissions

Policy impacts on CO2 reduction in relation to Baseline emissions

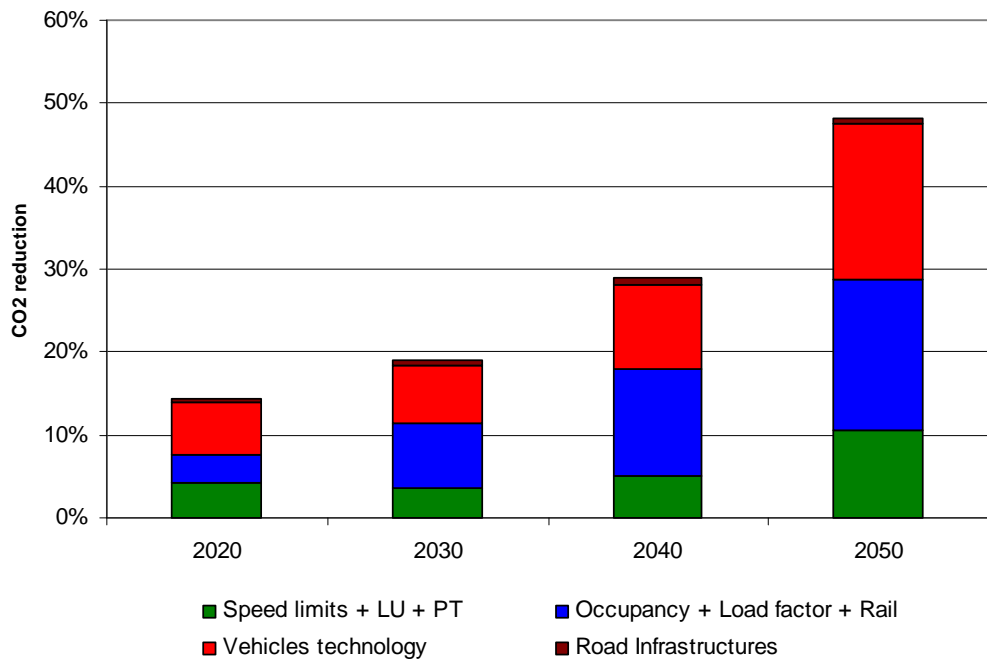


Figure 5.35 Accumulated policy impacts on CO₂ reduction in relation to Baseline emissions

Policy impacts on CO2 reduction in relation to 2005 emissions

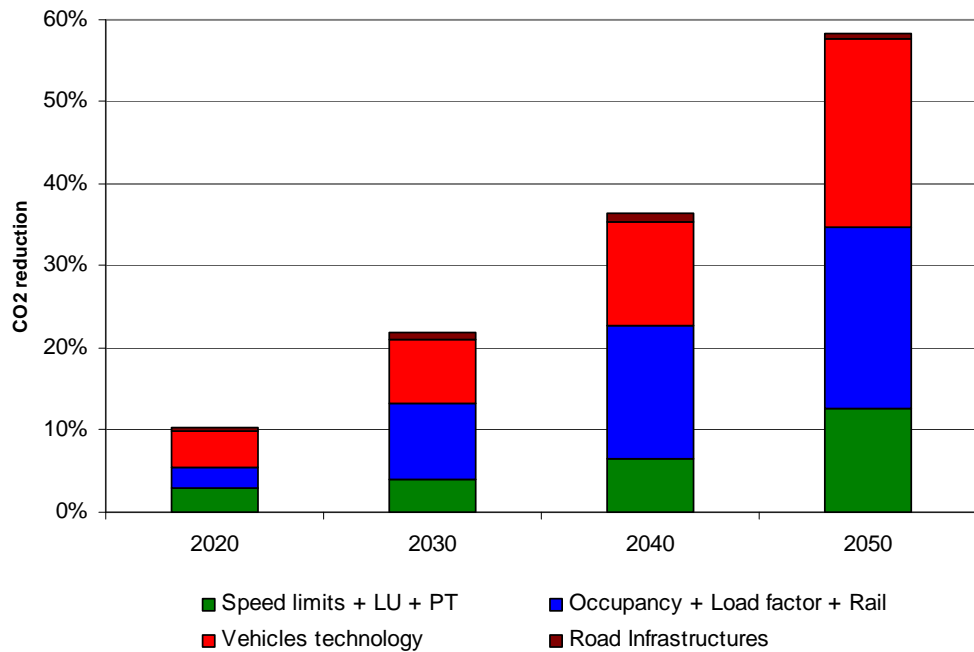


Figure 5.36 Accumulated policy impacts on CO₂ reduction in relation to 2005 emissions

CO₂ directly emitted by fossil fuel based vehicles inside EU-27 and SSS by year

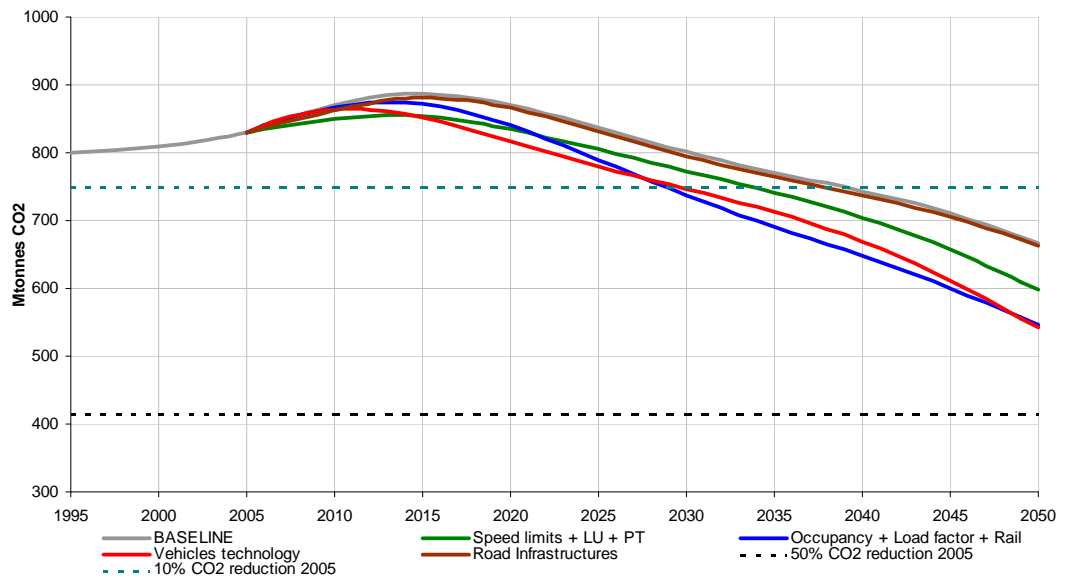


Figure 5.37 Evolution of direct CO₂ emissions for different policy packages

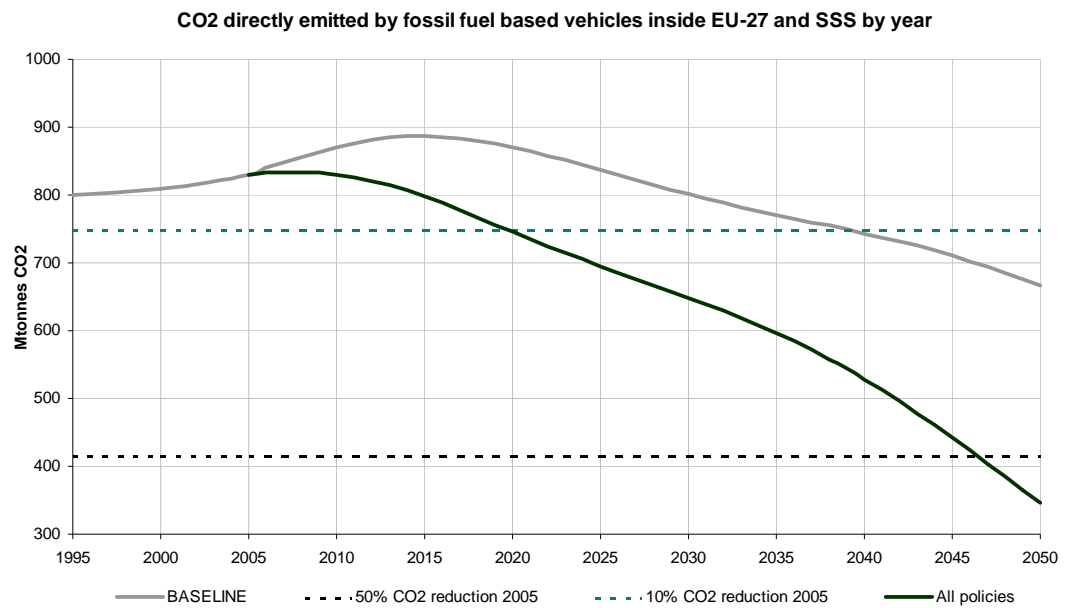


Figure 5.38 Evolution of direct CO₂ emissions for the Baseline and all policy packages applied

As reported above in Section 5.4, the TRANS-TOOLS model was also used for testing policy instruments, but to a much lesser scale than the Meta-Models. Here it is sufficient to mention that the effect of the TRANS-TOOLS analysis indicates a positive effect on CO₂ emission reductions of pricing and a negative effect of infrastructure investments. The latter comprises rail and road investments, and the road investments trigger more traffic which in turn leads to an increase in CO₂ emissions. These results contradict the Meta-Models results mentioned in Table 5.11 above. However, it should be stressed that the investments considered in the Meta-Models are not linked to a specific link, but are general improvements of congested sections, mainly urban, leading to free-flowing traffic. On the other hand, TRANS-TOOLS is a network model and the infrastructure investments are carried out on the interurban network, improving accessibility between regions. Specific investments for relieving bottlenecks can be carried out, but such investments would rather be “small scale” and scattered all over. Thus, if TRANS-TOOLS were used to model such an investment strategy, it is likely that the TRANS-TOOLS results and the results of the Meta-Models would likely be more in line.

While the impact of increasing road infrastructures and reducing road congestion can be analysed by TRANS-TOOLS, a similar analysis for rail infrastructure is not possible. On the other hand, road traffic is responsible for almost 90% of the total CO₂ generated by transport activities, bunkers excluded. It is worth mentioning that reducing road congestion may result in more induced traffic, thus leading to previous congestion levels, unless pricing policies are applied.

6 Further issues concerned with trends and challenges

6.1 Introduction

Chapter 5 has provided much information about future trends and challenges based upon results from TRANS-TOOLS and the Meta-Models. The current chapter discusses these trends and challenges further, covering aspects of transport that are not easily captured by the models and providing synthesis of some of the model results with insights from the Task 1 Report. Although the nature of the chapter is heterogeneous (given that there are a large number of phenomena which cannot be captured by the models), an underlying theme of the whole chapter will be that of social sustainability. This concept will be discussed in general terms in Section 6.2. Subsequent sections cover the following issues:

- Section 6.3 provides a synthesis of some of the main results concerning passenger transport from TRANS-TOOLS and the Meta-Models with insights from the Task 1 report concerning drivers
- Section 6.4 examines future challenges for social sustainability, locating the TRANSvisions exploratory scenarios in the context of various other foresight scenarios
- Section 6.5 examines challenges arising from highly disruptive events

Finally, Section 6.6 provides some conclusions resulting from the chapter which will be of importance in subsequent chapters.

6.2 Social sustainability

Further to the “traditional” social indicator of road accident fatalities used in previous chapters, there is also a need, if assessment is to be sufficiently comprehensive, to capture a number of impacts of transport on what is frequently referred to as “social capital”. Unlike the indicators calculated by TRANS-TOOLS and the Metamodel in previous chapters, these impacts cannot be defined or measured in a precise way and it follows that a qualitative approach for assessment is preferable to an (unrealisable) quantitative approach. One example of the use of social capital as an assessment indicator has been in studies sponsored by the UK Department for International Development (DfID), where it has been used as an element of the Sustainable Livelihoods Framework (SLF). The SLF, which is shown schematically in Figure 6.1, is concerned very much with how societies (and groups within society) can withstand shocks, (challenging) trends, and seasonal difficulties (referred to at the left of the diagram under the heading “Vulnerability Context”). The capacity to withstand such challenges is dependent upon the capital assets of a society (shown under the heading “Livelihood Assets”), such as social capital. These assets are in turn influenced by government policies and institutions (shown in the centre of the diagram).

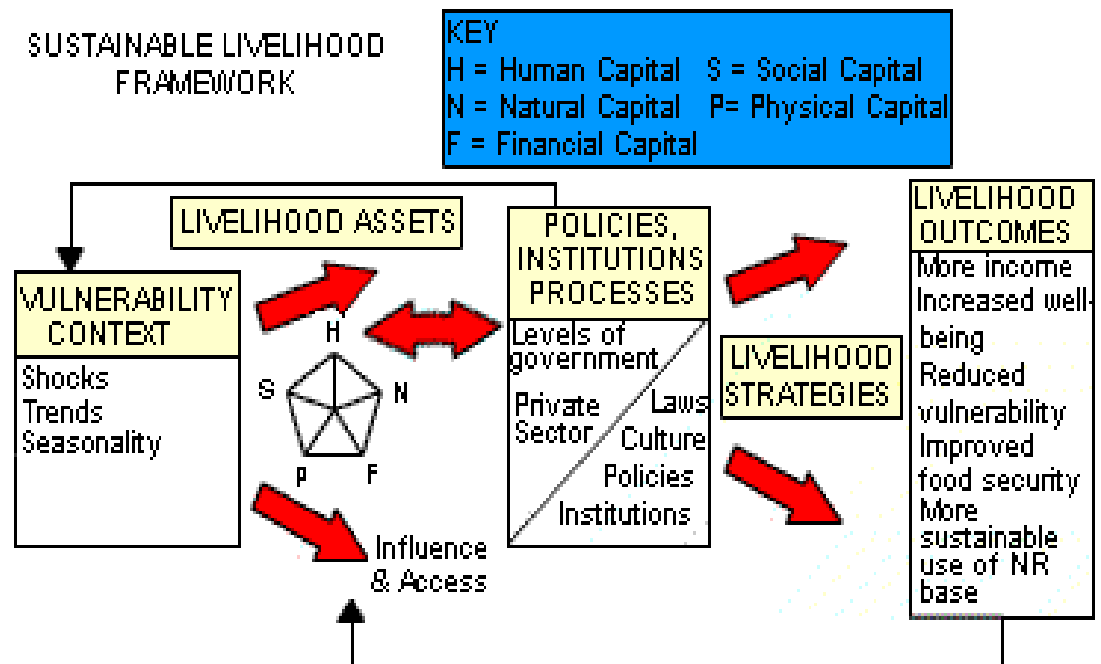


Figure 6.1: Sustainable Livelihoods Framework (from DfID Guidance Notes).

http://www.livelihoods.org/info/info_guidancesheets.html

Whilst the SLF is not being implemented fully in TRANSvisions, the concept of social capital used in the SLF is great use in the project, particularly with respect to challenges and transport policy required to meet such challenges (as described in Chapters 7 and 8). In the context of TRANSvisions, social capital will be considered as having two main elements: social cohesiveness and political capital. These types of capital are further described as follows:

Social cohesiveness considers the cohesiveness of communities on both local and EU-wide levels. It is understood that such cohesiveness includes both a “collective dimension” concerning how well the community “binds together”, as well as providing the basis for the “self-realisation” of individuals within the community (thus removing obstacles to individual and community self-empowerment). Given that social cohesiveness can be a complex concept to define, it is probably more easily further understood in the sense of “capacity to withstand threats” (along the lines suggested in the SLF described above). With respect to the transport sector, such threats arise from:

- (iv) Differences in mobility opportunities between different social groups and between different regions of the EU, leading to problems of social exclusion. “Mobility” here can be understood in both the sociological sense of the “possibility for change in lifestyle and/or employment” as well as in the transport sense of “the physical means of movement by which such change might be facilitated”.
- (v) Differences in accessing “local facilities” (jobs, education, healthcare), where those individuals with difficulties in this respect are required either to travel more than they would desire or are forced (against their wishes) to migrate to another location. This type of phenomenon will be classified as “coerced mobility”.

- (vi) A range of transport-related "security" problems resulting from tensions in society, including phenomena such as fear of walking alone or the threat from terrorist attacks on transport targets (planes, airports, trains, buses etc).

Apart from such threats, social cohesiveness also comprises an element concerning the "likelihood of citizens to treat each other with respect". In terms of the transport system, such respect leads to "polite behaviour", examples of which are: drivers voluntarily giving way to other drivers at road junctions (in accordance with local norms and rules); and drivers stopping their vehicles to allow pedestrians to cross the road.

In general, it is useful to distinguish between social cohesiveness impacts of transport that are *internal* or *external* to the transport system, with these terms being explained as follows:

- Internal social impacts of transport are those that affect individuals as "participants" in the transport system, either as passengers or as transport workers. Policies which improve the experience of such participants, such as the enhancing of passenger rights or the raising of minimum working conditions for transport workers, have an impact on the overall social cohesiveness of society.
- External social impacts of transport are those that are experienced "outside" the transport system. For example, the impact of the transport system in terms of the possibility of accessing facilities (as mentioned above) would be an external social impact.

Various social impacts of transport will have both an external and an internal dimension. For example, road accidents can be seen to have an internal effect on the individuals involved in an accident, but an external effect on their families (if the accident is sufficiently severe).

The concept of **political capital** is closely tied with the concept of social cohesiveness. Political capital emphasises the capacity of the community, and individuals within the community, to take control (in a political sense) over their everyday lives and futures. In particular, with respect to the transport system, two "levels" of political capital can be considered:

- (iii) At the local level, political capital involves the amount of public participation in (and hence democratic control over) transport policy-making. With regard to such participation, political capital also involves the freedom of individuals to be able to express diverse points of view.
- (iv) At an EU level, political capital concerns the political strength of the EU as a transnational community and the resulting benefits for EU citizens when interacting with the rest of the world.

When considering the concepts of social cohesiveness and political capital from an EU perspective, it is important to take into account issues of subsidiarity. In particular, it is necessary to consider to what extent these concepts vary between different countries/regions in the EU. Great care needs to be taken in any discussions of this issue to avoid extremes of universalism or relativism. In this context, a "universalist extreme" can be seen as a point of view supporting "a standardisation of norms concerning social issues dictated from the centre". Apart from any of the ethical problems associated with such an approach, it would need to be rejected on pragmatic grounds, given that it would be likely to lead to a large negative reaction against the "EU project". On the other hand, a "relativist extreme" would involve the idea that all standards on social cohesiveness and political capital can only be decided locally, thus leading to the possibility that EU citizens in one region would be seen as having rights to public participation and access to local facilities, whilst those in other regions would not. Such an approach would undermine any

notion of the EU being a “social entity” and, it could be argued, would undermine the very concept of “European Union”.

6.3 Social aspects of passenger transport

This section provides further reflection on some of the passenger transport results from TRANS-TOOLS and the Meta-Models (from Chapter 5) in the light of insights from the Task 1 Report. The section includes a small number of passages taken from the Task 1 report. In all cases, these passages reflect the views of the report’s authors, i.e. the TRANSvisions consortium. Furthermore, they typically involve longer versions (with more information) of explanations about drivers provided in summary in Chapter 3.

Three subsections are provided, concerning:

- Passenger transport and urbanisation (in 6.3.1)
- Holiday and leisure travel (in 6.3.2)
- Mobility of the elderly (in 6.3.3)

6.3.1 Passenger transport: Urbanisation and transport

With respect to urbanisation and transport, Task 1 provides the following account:

“As a main consequence of urbanisation, per capita urban **land consumption** is increasing, including the land that has been converted from rural to urban use to provide for jobs, recreation and entertainment, shopping, parking, transportation, storage, government services. Transport network and corridors are still the major consumers of space. Land resources in most of Europe are relatively scarce, and achieving a sustainable balance between competing land uses is a key issue for all development policies. Large-scale urban agglomerations and extended peri-urban settlements resulting from the increasing urban sprawl fragment large landscapes and threaten various ecosystem processes through near-complete reliance on importing material goods and unsustainable resource use.

Finally, there is an important relationship between the urbanisation driver and daily **commuting patterns**. Indeed, one of the consequences of urban sprawl is an increasing dependence on the automobile for intra- and inter-metropolitan travel. Urban sprawl entails building extensive transportation systems because houses are increasingly far away from workplaces and commercial centres. This new constructed infrastructure, in return, spurs further urban sprawl – investments made in new motorways or road connections attract new development along the improved transport lines. Growing car ownership and the concentration of work and shopping in out-of-town locations have resulted – and may continue to result - in continuing increases in journey length for all purposes, but particularly for commuting. Trends in trip lengths in some EU 15 countries (e.g. the United Kingdom, Denmark and Belgium) showed a growth in travel during recent decades, with people living further away from work, leisure activities, shopping centres and schools (EEA, Indicator Fact sheet – TERM 2001 14 EU). Increased average trip length and suburb to suburb trips increase fuel consumption and related emissions of air pollutants and greenhouse gases. This low-density living and car dependency creates also another major drawback, i.e. the difficulty maintaining a sense of community in a car-dependent society (Schiller, 2001).”

In spite of this overall trend towards a cycle of urban sprawl and increased transport infrastructure to accommodate such sprawl, there exists a movement in the other direction towards re-urbanisation, as described by Task 1:

“However, it is important to note also the signals of a reverse trend towards **re-urbanisation** and revitalisation of the inner cities, with a number of brownfield development projects creating a mixture of workplaces and residences in downtown areas, increasing the level of residential densities, combined with the realisation of attractive public spaces and the availability of efficient public transport systems. Active urban redevelopment and renewal policies in many urban areas seem to be having some success in reversing the depopulation and decay of urban centres. This reverse trend is facilitated by the decline of household size – single or two-persons households have a higher propensity to locate in the urban centres – and by the growth of the creative knowledge intensive economy, with its strong preference for inner city environments. Urban centres have usually succeeded also in maintaining their position in the retail sector by specialising, offering a wider high-quality products selection.”

These excerpts from the Task 1 report illustrate that issues concerned with urbanisation and transport are very much social in nature, reflecting on questions concerning how we want to live in the future as an EU society. Whilst it is generally accepted that “social factors” play an important role as “transport drivers”, it is frequently not recognised that the reverse is also the case: transport policy can have a significant impact upon social issues (i.e. upon “social capital”). It follows that social issues need to be put at the centre of transport policy-formulation (and not considered simply as exogenous factors for calculating transport demand), being given the same level of importance as economic and environmental issues. A continuing underlying theme of the current report is an attempt to meet this requirement.

6.3.2 Passenger transport: Holiday/leisure travel

The following account was provided by Task 1 concerning leisure travel and tourism:

“Besides the need of more flexible transport options to serve the everyday travel demand of an increasing share of leisure consumers in our cities, the most evident consequence of the growing leisure society and availability of free-time is the fast growth of **tourism**.

Leisure is estimated to account for 75 per cent of all international travel. The World Tourism Organisation (WTO) estimated there were nearly 900 million international tourist arrivals in 2007 from 846 million in 2006, an increase of about 6 per cent. This represents nearly 52 million more arrivals than in 2006 and they are expected to reach 1.6 billion by 2020. To appreciate these figures we may consider that international tourist arrivals in 1950 were only 25 million. Domestic tourism (people going on holiday in their own countries) is generally thought to be 4-5 times greater than international arrivals.

Globally, tourism accounts for roughly 35 per cent of exports of services and over 8 per cent of exports of goods (WTO). Tourism is said to be the world’s largest employer. In 2001, the International Labour Organisation (ILO) estimated that globally over 207 million jobs were directly or indirectly employed in tourism. The latest long term forecasts by the industry’s World Travel and Tourism Council (WTTC) point to a steady phase of growth for world travel and tourism between 2009 and 2018 with an average growth rate of 4.4 per cent per annum, supporting 297 million jobs and 10.5 per cent of global GDP by 2018.

Factors in tourism growth include:

- **Increasing leisure time:** In 1936, the International Labour Organisation convention provided for one week’s leave per year for workers in developed countries. In 1970, this was expanded to three weeks, and in 1999 to four weeks.

- **Increased disposable income:** the strong economic growth of Asian economies such as China, India and Singapore has resulted in greater disposable income resulting in increased demand for foreign travel.

Some stylized facts illustrate the boosting growth of global tourism in the recent decades. In 1950, 97 per cent of international tourists went to Europe or North America (in fact, to just 15 countries). By 2003 this had fallen to 78.8 per cent. In the mid-1970s, 8 per cent of all international tourists were from the North visiting the South. By the mid-1990s, this had risen to 20 per cent. In 1999, more than 70 countries received over a million international tourist arrivals.”

Task 1 describes a further factor of importance to the tourism transport, concerning the ageing of the EU population. This issue will be dealt with in the following subsection (6.3.3).

Tourism raises many complex issues for transport policy. As pointed out in the excerpt above, workers have rights to holidays (i.e. periods when they are not required to work). However, do rights extend to the “right to travel for a holiday”? If so, what sort of travel? Given that, as seen in the predictions for 2030, holiday travel outside Europe is predicted to grow at a faster rate than other types of travel, do citizens of the EU have the “right” to take holidays outside the EU?

It might be objected that the language of “rights” is not appropriate in this context. In a hard legalistic sense, this might well be the case. However, even if citizens of the EU do not have the “right” to take foreign holidays, it is reasonable to consider that such travel would be the “norm” (of the “typical” EU citizen)? This question is of great importance to transport policy-making, since if foreign holidays are understood to be the “norm”, transport policy needs to accommodate this understanding.

As commented above, this type of thinking leads directly to the recognition that transport is a social phenomenon. Furthermore, given the talk about “rights” and “norms”, it leads to a recognition that transport policy needs to be resolved by widespread political consent.

6.3.3 Mobility of the elderly

As stated in the Task 1 Report with respect to the impact of an ageing society upon leisure travel:

“[T]he ageing of society will affect the transport system through its impacts on the structure and patterns of leisure activities. Nowadays older cohorts are more interested in travelling in their leisure time. In view of the current ageing trends, this will result in the future in an increase of demand for collective forms of transport by road and air. However, older people may show more variable habits in terms of mobility than in earlier times, possibly due to higher average income revenues and better health status of the elderly in the more distant future. In addition, even if collective public transport such as rail are not currently preferred by older people, this could change with significant improvements in terms of quality (comfort, accessibility, information) and adapted tariffs. A detailed representation of the impact pathway of ageing on traffic for leisure purpose is provided in Figure 6.2 below:

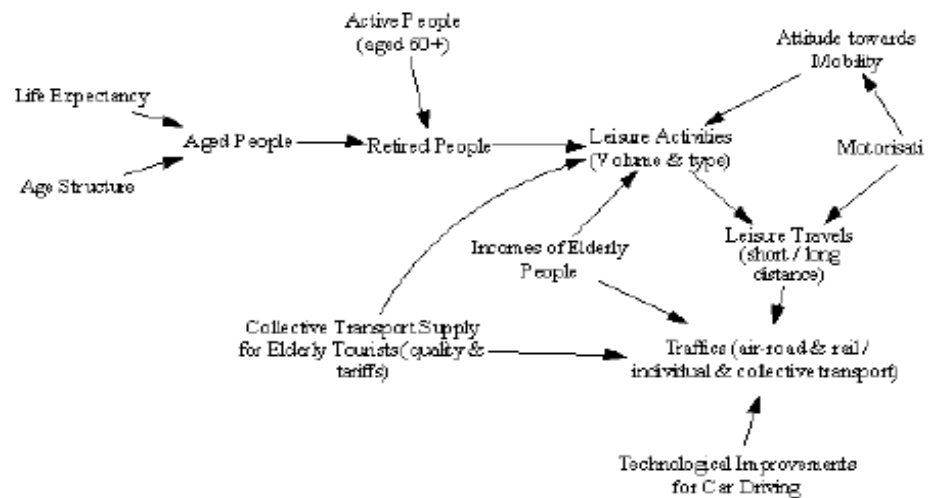


Figure 6.2: Impact pathway of ageing on leisure traffic

Source: ICCR, *Foresight for Transport, Final Report*

In any case, the impact on leisure travel will be ensured by a growing segment of retired people.”

However, the relevance of an ageing society is not limited to leisure travel. In fact many varied transport-oriented challenges arise due to such ageing:

- Ageing results in more difficulties when driving, thus increasing reliance on collective (public) transport, commercial individual transport (taxis and paid drivers) and on technology assisted forms of car driving.
- License holding in old age could face two opposite trends: more people will have driving licences but health controls will be stricter for road safety reasons.
- The ageing of society will also have an impact on the characteristics of the transport solutions that will need to be offered for providing their mobility. Public transport vehicles and infrastructure will need to become more accessible. Pedestrian traffic lights will need to remain on the green stage for longer times to suit the possibilities of people with reduced mobility. This might reduce the capacity of the (urban) infrastructure for road traffic.
- Electric wheelchairs will need to be available at airports and railway stations. Toilets will need to be adapted and made more abundant. Airports, railways and maritime stations will need to have medical services available.
- Mobility is important for the wellbeing of older people and, as stated above, they often depend on public transport. For example, up to 20% of Dutch public transport users feel insecure (subjective perception)¹⁴. However, in objective terms, elderly people (60+) have the smallest chance of becoming a victim of aggression. In case of aggression, though, they are though more vulnerable, which leads to the need to reinforce security services.

¹⁴ Veiligheid in het openbaar vervoer 1997 (Security in public transport 1997), Eysink, Smeets & Etman (copyright) for the Dutch Transport ministry, 1998.

- In general, trips frequently are necessarily intermodal. Given the reduced mobility of old people, integrated ticketing and luggage check-ins will be a necessity for such trips. Trips from door-to-door will need to be carefully planned and booked from home via internet. Transport will need to be more accessible; walking distances to and from stops will need to be kept 'reasonable'.
- Information, ticketing and payment systems need to be easily understood and fare structures need to be fair and simple. Many current applications have been developed with capacities of the young internet generation in mind. There are clear opportunities for innovation and the creation of mobility-related services and products that specifically target the older generation and people with reduced mobility.

6.4 Challenges identified by a broad scenario analysis

6.4.1 Comparison of TRANSvisions exploratory scenarios with other foresight scenarios

Figure 6.3 provides an “impressionistic overview” of the relative strengths and weaknesses of the four exploratory scenarios with respect to their economic sustainability and social sustainability. The exploratory scenarios are located in the context of a large number of scenarios from other foresight studies. The diagram is impressionistic in the sense that it is based upon a qualitative assessment of the scenarios and narratives of other studies, and not upon any quantitative metric. In fact it is not even feasible to identify a formal set of common denominators for all these studies since they are all created from different motivations and consider different aspects of the future.

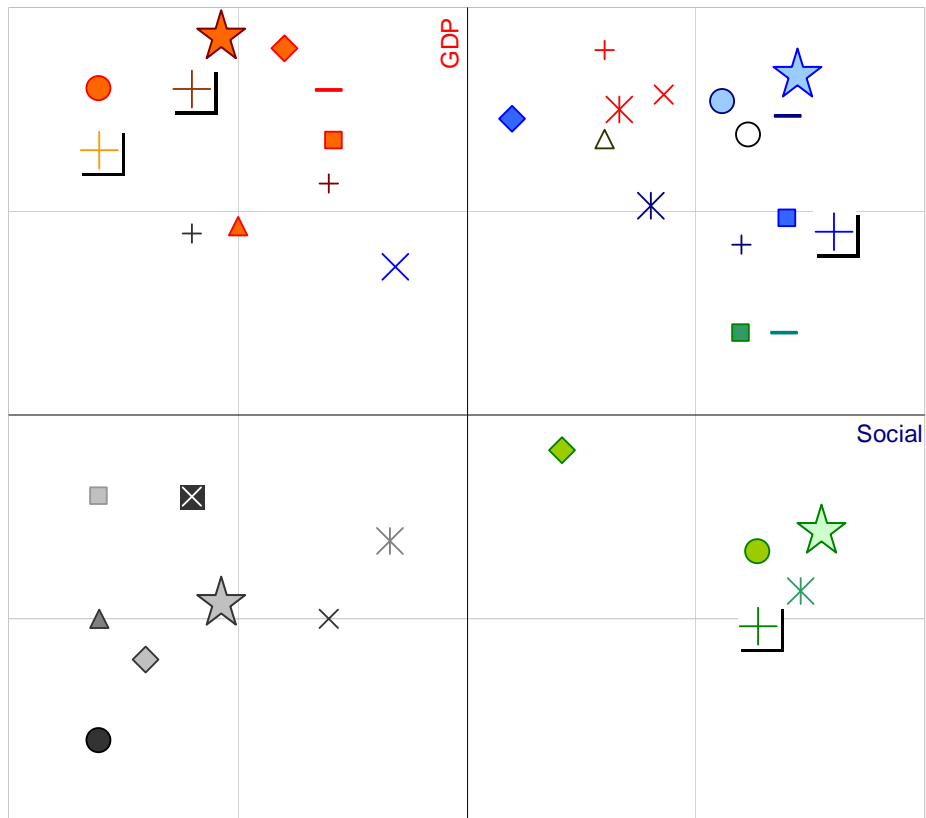
The vertical axis of Figure 6.3 shows the level of economic growth associated with each scenario. The horizontal axis shows levels of social sustainability, interpreted from the scenario descriptions, using an approach analogous to the social capital approach described in Section 6.2 above.

Figure 6.4 provides a similar overview of the relative strengths and weaknesses of the four exploratory scenarios with respect to their economic sustainability and environmental sustainability. Once again, the vertical axis shows the level of economic growth associated with each scenario. The horizontal axis shows levels of environmental sustainability.

There is no need to know the precise details of these other scenarios in order to make a number of points about the four exploratory scenarios, thus providing a basis for the discussion of challenges in 6.4.2:

- None of the TRANSvisions exploratory scenarios are extremely negative in comparison with other scenarios in any of the three dimensions of economic, environmental or social sustainability. The avoidance of extreme negativity, i.e. the avoidance of dystopian (“nightmare”) scenarios, has been a guiding principle in constructing the TRANSvisions scenarios.
- From Figure 6.3 it can be seen that the Induced Mobility Scenario is very strong in terms of economic sustainability but weak in terms of social sustainability. From Figure 6.4 it can be seen that it is almost neutral in terms of environmental sustainability: whilst this scenario does not have a strong social consciousness about environmental issues, this weakness is to a certain extent compensated by the high level of pollution-reducing technology.

- The Constrained Mobility Scenario is weak in all three sustainability dimensions (economic, environmental and social). Whilst it is not a dystopian scenario (for example, the EU remains recognisably the same entity as at present), it represents the nearest that the TRANSvisions scenarios get to a dystopian scenario. From Figure 6.3 and Figure 6.4, it can be seen that "Convulsive Change", "Turbulent Neighbourhoods" and "Tribal Trading" (from other foresight studies) represent such scenarios.
- The Reduced Mobility Scenario is weak in terms of economic sustainability but strong in terms of social and environmental sustainability. However, given that GDP grows steadily between now and 2050 in this scenario, it is not disastrous economically. In fact it could be seen as a scenario of choice for some people who prefer a slower lifestyle.
- The Decoupled Mobility Scenario is strong in all three sustainability dimensions (economic, environmental and social), combining the best aspects of the Induced Mobility and Reduced Mobility scenarios. It could be classed as a "utopian scenario" (though without the connotation of unrealism often associated with this term).



- Triumphant Markets
- Shared Responsibilities
- Turbulent Neighbourhoods
- ◆ Urban Colonies
- ◆ Good Intentions
- Policy First
- Sustainability First
- × The World Wakes Up
- × Backlash
- × I'm in love with my car
- × Moonlight ride in a Diesel
- + The Strong Nation Clubs
- + Compassionate World
- Cohesion-oriented (Danubean Europe)
- △ Knowledge is King
- △ Convulsive Change
- + Transatlantic Market
- + Global Economy
- ☆ Reduced Mobility
- ☆ Constrained Mobility
- ☆ Induced Mobility
- ☆ Decoupled Mo-
- The Hundred Flow ers
- Creative Societies
- ◆ Perpetual Motion
- ◆ Tribal Trading
- Market Forces
- Security First
- × S&T develops a Mind of its Ow n
- ⊠ Please, turn off the Spigot
- × Take the A-Train
- × Riding the rainbow
- + Fortress America
- + Triage
- Pro-active Europe
- Competitiveness-oriented (Rhine-Rhone Europe)
- ▲ Big is beautiful
- + Strong Europe
- + Regional Communities

Figure 6.3: Economic sustainability versus social sustainability

6.4.2 Challenges

With respect to challenges in 2050, the following comments can be made:

- From a perspective of early 2009 (in the midst of a large worldwide financial crisis) the Induced Mobility Scenario might appear to some people as being a projection into the future of a now-discredited approach to the economy which has been dominant for the past 20 years. Clearly views will differ on this issue. However, even the most hawkish believer in “free market dominance” must now, rationally, take into account the possibility of future failure of such an approach (even though they might hope strongly that such failure will not occur). An examination of Figure 6.3 shows that a reduction in economic growth for the Induced Mobility scenario leads to the (undesirable) Constrained Mobility Scenario in terms of social/economic characteristics. In this sense, the Induced Mobility Scenario is one involving “high risk” of devolving to a near-dystopic state if economic growth is not as strong as is hoped.
- The main strength of the Induced Mobility Scenario concerns the high level of economic growth. However, this strength is “balanced” by its weakness with respect to social sustainability, given that it involves a high level of inequality.. A lack of such social sustainability will inevitably have large direct consequences for the social aspects of the transport system. It has already been pointed out in Chapter 5 that the Induced Mobility Scenario (and the Constrained Mobility) will have relatively low rates of rail share. Furthermore, on an urban level, the inequality of wealth between rich and poor will be likely to lead to the need for increased segregation of communities according to wealth (“gated communities” and “ghettoes”). Such segregation will have a direct consequence for the transport system in that provides a “geographical constraint” to a form of “rational” land-use planning which prioritises the reduction of travel (for which jobs and services are located as closely as is feasible to the residences of workers and service users).
- The rates of transport growth in the Induced Mobility Scenario are, as is shown in Chapter 5, higher than in any other scenario after 2030. Such growth will be challenging in terms of infrastructure provision, particularly given that the individualistic nature of the scenario is liable to lead to travel modes that are less space-efficient (e.g. single occupancy cars). Whilst technological development should lead to more efficient use of infrastructure, questions still arise as to the land requirements for such infrastructure, particularly in already-congested areas such as large cities. Presumably, given the wealth inequality (and resulting political inequality) in the Induced Mobility Scenario, there is the threat that (current) residential land used by low-income groups will be used for such construction, thus further weakening social sustainability.
- The “mirror image” of Induced Mobility (in social terms) is the Decoupled Mobility scenario. Both scenarios have high levels of GDP growth but differ both in terms of the social capital built up in each scenario and in terms of their environmental sustainability. It can be seen from Figure 6.3 that if economic growth is less than would be expected for the Decoupled Mobility Scenario, the scenario transforms into the Reduced Mobility Scenario. An important point to note here is that, given that the Reduced Mobility has many benign aspects, the risks to society associated with economic failure are far less drastic than in the case of the Induced Mobility Scenario. In terms of transport, both scenarios emphasise collective transport (e.g. train travel) and integrated land-use / transportation planning. Furthermore, given the relative lack of importance of a “social status factor” associated with “expensive” modes of transport, it is likely that there would be far more

walking and cycling in the Decoupled and Reduced mobility scenarios. This in turn helps with integrated land-use / transportation planning and with meeting both future energy supply challenges and climate change challenges.

As with all foresight scenarios, the exploratory scenarios are tools for debate and inevitably there will be differences amongst people about their precise details. However, their general outlines present recognisable futures. In terms of policy formulation, the following comments can be made:

- Essentially, the challenge highlighted by the four exploratory scenarios is that transport policy needs to be determined to meet the following three criteria:
 - It should enhance the positive aspects of all scenarios
 - It should provide resilience against the negative aspects of all scenarios
 - It should be robust in the sense that it is not over-dependent upon an expectation that one or two particular scenarios will materialise (even if it is hoped that this will be the case)
- The Decoupled Mobility has clearly been constructed up as a near-utopian scenario, and the first reaction of many people might be “why would we not want such a future?”. However, for such a scenario to materialise, society in general needs to make a concerted effort to advance in all three directions of sustainability (economic, environmental and social). Whilst transport policy cannot be (single) responsible for such development, it can certainly make a positive contribution. It follows that transport policy needs to be strong in terms of the three axes of sustainability. It will be argued below that current EU transport policy is weaker in terms of social sustainability than in terms of the other two forms of sustainability, and that future transport policy should aim to rectify this situation.

6.5 Highly disruptive events

The forecasting techniques used by TRANS-TOOLS to predict scenarios for 2030 rely upon the continuance of trends. Even though the pathways created by the Metamodel involve trend-breaks, they are concerned with describing evolutionary images of change over a relatively long period of time (40 years), as opposed to describing particular events within that period, and so are not concerned with modelling the details of the trend-breaks. For much strategic transport policy-making, such a level of representation is sufficient. However, in certain circumstances, the actual trend-breaks themselves (as opposed to their long-term impacts) are of great importance for policy-makers. In this report, such trend-breaks are termed *highly disruptive events*, and are described in this section in terms of the challenges they present.

Before entering into detail about these highly disruptive events, two general comments can be made about them:

- Whilst such events can usually be characterised as to whether they are (initially) economic, environmental or social disruptions, any particular event is liable to lead to a number of complex chain reactions which almost certainly will not be so simple to classify.
- The ability of society to withstand such disruptions will in general depend upon the social capital possessed by society, in the sense described in Section 6.2 concerning the DfID Sustainable Livelihood Approach. It follows that, whilst social capital is a useful concept for assessment within “ordinary periods”, it is particularly powerful when considering disruptive events.

6.5.1 Economic disruptions

Economic collapse

The Task 1 Report was produced during the summer of 2008. Since that date, the world has witnessed a global financial crisis. Somewhat presciently, the Task 1 report included the following passage about globalisation:

“However, this vision of inevitable progress created by market leadership is increasingly becoming controversial. Today, by and large, there is (at least among economists, if not among politicians) an understanding of the limitations of markets. Take for instance the revolutionary explosion in money markets. Most of the foreign exchange movements are about speculation, not investment in wealth creation. The amounts involved are forty or sixty times that of real trade. The 1997 Asia meltdown included \$100 billion abruptly invested from abroad and then abruptly withdrawn within a year. Those countries had long had enough local capital for their own investment needs. Their economies were artificially inflated and then deflated – a classic boom-and-bust cycle, but imposed from the outside.”

A large number of explanations are currently being put forward as to the causes of the current financial crisis and, depending upon the cause or causes put forward, there is a wide divergence as to how long the crisis will last. In particular, there is a divergence as to whether the current crisis is similar to previous crises during the last 40 years or whether it is “on a different scale”. In spite of such uncertainty, though, a number of factors can be identified reasonably uncontroversially:

- There have been two inter-connected elements to the crisis: (i) a financial crisis concerned primarily with the viability of the international banking system; and (ii) a crisis in the “real economy”, which is leading to recession and impacts such as bankruptcies of firms and higher unemployment.
- There is a general acceptance that one of the causes of the crisis has been “overlight” regulation of the financial system by government regulatory bodies.
- The primary government response to these crises has been to abandon a “pure neoliberal” style of economic management in favour of a more “Keynesian” (interventionist) approach. (This is not to say that this approach is uncontroversial. Clearly there exist some political parties and analysts deeply opposed to this change in economic policy. Early indications suggest that a divide is opening up between mainstream political parties over the appropriate level of intervention in the economy, thus breaking a relatively long period of “low-interventionist consensus”).
- The crisis has followed a period of rapid and destabilising increase in prices of raw materials (and oil in particular)

However, the purpose here is not to get involved with a deep analysis of the present crisis. Rather, the aim is to use current experiences to help think about potential future economic crises and, in particular, to consider how transport policy-makers might build resilience into the transport system to meet such crises. Comments about such resilience can be made as follows:

- One aspect of the recent crisis has been a lack/shortage of availability of funds for businesses, since the banks have cut down heavily on lending. This clearly has direct impacts on the transport system, such as on the building of transport

infrastructure which is not financed by national governments and on the viability of companies providing transport services. EU governments have in general taken measures in this situation to help “kick-start” lending. The capability of doing so in future crises is essential for providing resilience to economic crises.

- All economic crises lead to higher levels of unemployment. Two government reactions to such an impact are of particular relevance to the transport system:
 - Governments can reduce the effects of unemployment (and recession in general) by “bringing forward” construction projects, thus generating jobs and enhancing consumer spending power. Many such projects will be of transport nature. It is thus important that a full list of transport infrastructure projects is “ready” for funding when an economic crisis occurs (in the sense that they have already been assessed, through conventional means, of leading to sufficiently high net benefits).
 - In the face of high levels of unemployment, it is essential that unemployed EU workers have the possibility of travel to other parts of the EU (from their home region) for employment reasons. Government policy needs to facilitate such movements, and could, for example, provide funding for such travel where appropriate.
- All economic crises have the potential to lead to widescale social and political disruptions. In order to be resilient in the face of such disruptions attention needs constantly to be addressed to building the social capital of society (in both “good times” and “times of difficulty”).

6.5.2 Environmental disruptions

Disruptions due to climate change

The climate change impacts of transport have been discussed in Chapter 3. Most writing about climate change and transport emphasises the role of greenhouse gas emissions from transport as a contributory factor towards climate change. However, the inverse impact is also significant, since the transport system is liable to be adversely affected by climate change, particularly as a result of extreme weather events such as floods, hurricanes and heat waves. One particular fear associated with such events is that it is not known what their scale will be and exactly what impacts they will have, though it is clear that there exists the potential for huge disruption.

Although attempts are now being made on a worldwide scale to reduce greenhouse gas emissions and hence climate change (such as through the European Emissions Trading Scheme mentioned in Chapter 3), such measures (even if successful) will be too late to avert climate change and its impacts over the next 50 years. It follows that the transport system needs to have resilience built into it in order to deal with these problems, in order to stop relatively minor events turning into major catastrophes. Two aspects of such resilience can be identified:

- A “long term” aspect in the sense that the transport system should be constructed and developed according to principles that recognise the likelihood and impacts of extreme weather events
- Contingency plans need to be formulated well in advance of such events occurring. In particular, such plans should try to ensure network connectivity of the transport system in the face of any disruption. Firstly this will ensure that “normal activities” can be maintained (as far as possible), thus maintaining territorial co-

hesion. Secondly, problems of disconnection are likely to have a direct impact upon the effectiveness of emergency services for dealing with the disruption.

Nuclear accidents

Due to the nature of nuclear power, an accident at (or a planned attack on) a nuclear power station will be highly disruptive. Impacts from such an accident can be viewed on two different time horizons:

- In the short and medium term (though the precise numbers of years is not clear), there is the need to “clean-up” after the accident, resolving both environmental hazards and social disruptions. From a transport perspective, there will inevitably be a major disruption in network connectivity, even if the power station is located in an “outlying region”.
- In the long term, the viability of nuclear power is likely to be called into question, thus leading to a reduction in total energy supply (as discussed in Chapter 3, nuclear power currently contributes 14% of total energy in the EU). Even though the transport sector itself is not a major user of nuclear power, any reduction in overall energy supply will inevitably affect the transport sector.

It is not the purpose here to discuss the pros and cons of nuclear power, which is a highly controversial subject. Rather, the aim is to point out that EU policy should (continue to) develop contingency plans on how to deal with nuclear accidents before they occur, and that the transport aspect should be a core feature of these plans.

6.5.3 Social/political disruptions

This section groups together a wide range of highly disruptive events that can be termed “social/political disruptions”. These include: large-scale terrorist attacks; war between an EU country and a country outside the EU; and the ascent to power of an authoritarian regime within the EU. Clearly all these events are highly specific, and it would be inappropriate in the current context to enter into details about how any such event might come about. Rather the focus of the section, as with the highly disruptive events above, is to consider how resilience might be built into the transport system in order to cope with this type of event. Such resilience has two aspects.

- Firstly, as with other disruptive events, effort needs to be put into forward planning on how to deal with such events before they occur, considering physical impacts such as network disconnection.
- Secondly, efforts need to be made either to avert such disruptions or at least, in advance, to make an attempt to reduce some of their destructive social/political impacts.

With reference to the second point, it is useful to remember the current legal basis of the EU’s common foreign and security policy. As quoted in the Task 1 report, according to the Treaty on European Union, Article 11, (the 1992 Maastricht Treaty),

“ the European Union defines and implements a common foreign and security policy covering all areas of foreign and security policy, the objectives of which are:

- to safeguard the common values, fundamental interests, independence and integrity of the Union in conformity with the principles of the United Nations Charter;
- to strengthen the security of the Union in all ways;

- to preserve peace and strengthen international security, in accordance with the principles of the United Nations Charter, as well as the principles of the Helsinki Final Act and the objectives of the Paris Charter, including those on external borders;
- to promote international cooperation;
- to develop and consolidate democracy and the rule of law, and respect for human rights and fundamental freedoms.”

A benefit of considering these founding aims of EU foreign and security policy is that it reminds the reader that long term security is very much tied up with the existence of a peaceful world, and that a peaceful world is in turn tied up with concepts of justice (as provided in the final bullet point above). This reflects the need for the consistent enhancement of social and political capital. How the transport system can enhance such social and political capital is an ongoing theme of the current report.

6.5.4 Other types of disruption

This subsection mentions further types of disruption that typically comprise a mixture of economic, environmental and political factors:

- Energy supplied from outside the EU might be drastically reduced, or the price drastically increased, for either political or economic reasons (or a combination of both). Preventative approaches of the type described above under “political disruptions” can be taken in order to help ensure that such events do not occur. However, given the possibility of their occurring, it is sensible to make contingency plans to ensure that alternative sources of energy are available in the case of such disruptions. Further, the possibility of sudden energy disruptions, along with the overall problem of energy shortages, provides a strong inducement to encourage lifestyles that are not overly dependent upon energy to fulfil mobility needs. Hence lifestyles that are mainly dependent upon walking and cycling are of obvious benefit to society in this respect (as they are in many other respects, concerning factors such as health, pollution and congestion).
- Contingency plans need to be made in the case of “technical” disruptions such as electricity blackouts (which could be caused intentionally or unintentionally) and computer viruses (which are certainly intentional). Clearly, the more the transport system is dependent upon electricity and ITS, the more susceptible it is to such disruptions.
- A final category of disruptions can be classified as “health hazards”, for example those caused by the spread of natural viruses such as ebola or bird flu. The planning for such events needs to take into account whether they are caused intentionally or unintentionally and the specific nature of the health hazard. In general, though, measures taken in response to such disruptions are likely to have effects on the transport system, for example through the closing of national frontiers.

6.6 Summary and Conclusions

As the title suggests, this chapter has covered a number of “further” issues (to those provided in Chapter 5) concerning trends and challenges for transport policy. Whilst the chapter has inevitably (given its subject matter) been disparate in nature, a common theme of “social sustainability as an impact of transport” has frequently emerged. An attempt has been made (in Section 6.2) to understand the meaning of social sustainability in terms of concepts such as *social capital*, *social cohesiveness* and *political capital*.

These concepts are not frequently employed in transport policy-making, and various explanations can be given as to why this is the case. One such explanation is that these concepts are not “quantifiable” (i.e. measurable in numerical terms). Given that the tools of much transport policy formulation are (by tradition) quantitative (such as most assessment and modelling techniques), there is a tendency to omit factors that do not fit into a quantifiable framework. For example, although models such as TRANS-TOOLS deal with social factors as inputs (for example demographic variables), they are inadequate for providing suitable output on social factors of the type described in 6.2. This creates a huge methodological problem in a situation when omitted factors are central to transport policy formulation, as is the case (based on the results of Sections 6.3 to 6.5) with social impact factors.

Whilst there is no easy answer for dealing with this methodological problem, certain steps can be taken to help reduce its impact. One such step is the use of foresight methodology, which (as has been shown in Section 6.4) is more amenable to social analysis. However, arguably the most important step is simply to recognise the potential exclusion of social sustainability when entering any policy formulation process and to make sure that it is in fact not “forgotten”. This approach will be adopted in Chapters 7 and 8 which, whilst dealing with policy formulation in a general sense, will pay particular attention to its social sustainability dimension.

7 Long-term aims and objectives for European Transport Policy

7.1 Introduction

This chapter examines issues concerned with long-term goals for European transport policy in the light of the trends and challenges described in previous chapters. At the outset it is worthwhile distinguishing between three “arms” of policy-making: aims, objectives and instruments (with aims and objectives being discussed in this chapter, and instruments in Chapter 8).

- An **aim** is a high level goal which guides all policy-making. In general, an aim reflects of the fundamental values of the entity for which policy is being made. An aim is not usually tied to any specific time horizon.
- An **objective** is an operational goal which helps one or more aims to be achieved. Objectives are often associated with particular time horizons, in which case they are frequently in the form of targets.
- A **policy instrument** is an action that can be taken by a political authority to help meet an aim or objective.

In the discussion below, a policy will be said to have an “aims, objectives, instruments” structure if it follows this logical pattern.

This chapter will mainly discuss aims and objectives of EU transport policy-making, as given in three policy documents: the Sustainable Development Strategy; the 2001 White Paper; and its Mid-Term Review. These aims and objectives are presented and commented upon in Sections 7.2, 7.3 and 7.4. They are analysed in the light of the trends and challenges, identified in previous chapters, in Section 7.5, considering economic, environmental and social issues respectively. The final section (7.6) will provide a number of recommendations for future EU policy aim and objectives. Although, as stated above, policy instruments will mainly be discussed in Chapter 8, a mention of them will be made in the current chapter where appropriate for completeness (a full list of the 2001 White Paper policy instruments is given in Annex 4).

7.2 Sustainable Development Strategy (SDS)

7.2.1 Overall aims

Probably at the highest level of aims of EU policy with relevance to transport is the “EU Sustainable Development Strategy (EU SDS)”. As described in the Task 1 Report, the SDS was first adopted by the European Council in Göteborg (2001), with a Renewed Strategy being agreed at the European Council in June, 2006. The text of the Renewed SDS (which can be found at <http://register.consilium.europa.eu/pdf/en/06/st10/st10917.en06.pdf>) includes various definitions of principles relevant to TRANSvisions. Firstly, sustainable development is defined as follows:

“Sustainable development means that the needs of the present generation should be met without compromising the ability of future generations to meet their own needs. It is an

overarching objective of the European Union set out in the Treaty, governing all the Union's policies and activities. It is about safeguarding the earth's capacity to support life in all its diversity and is based on the principles of democracy, gender equality, solidarity, the rule of law and respect for fundamental rights, including freedom and equal opportunities for all. It aims at the continuous improvement of the quality of life and well-being on Earth for present and future generations. To that end it promotes a dynamic economy with full employment and a high level of education, health protection, social and territorial cohesion and environmental protection in a peaceful and secure world, respecting cultural diversity." (p2)

Given this definition, the overall aim of the renewed EU SDS is "to identify and develop actions to enable the EU to achieve continuous improvement of quality of life both for current and for future generations, through the creation of sustainable communities able to manage and use resources efficiently and to tap the ecological and social innovation potential of the economy, ensuring prosperity, environmental protection and social cohesion." (p3).

With reference to the relation between the SDS and the Lisbon Strategy, the text states that "[t]he EU SDS forms the overall framework within which the Lisbon Strategy, with its renewed focus on growth and jobs, provides the motor of a more dynamic economy. These two strategies recognise that economic, social and environmental objectives can reinforce each other and they should therefore advance together.....In this context the EU SDS recognises that investments in human, social and environmental capital as well as technological innovation are the prerequisites for long-term competitiveness and economic prosperity, social cohesion, quality employment and better environmental protection." (p6).

Two points can be made here that have been particularly important in the methodological development of TRANSvisions:

1. It can be seen that, in general, there are three primary "axes" of sustainable development, comprising economic, environmental and social dimensions. This definition is intentionally more encompassing than some alternative uses of the term sustainability, which only consider the environmental dimension of sustainability.
2. The SDS uses the term "social capital" three times within the document, and it can be seen from the above quotes that the TRANSvisions indicators of "social cohesion" and "political capital" are consistent with the SDS.

It is beyond the scope of this report to make a deep analysis of the overall aims of the SDS (as opposed to the transport aspects of it, which are described below in Section 7.2.2). However, The SDS does seem to capture a set of values which could reasonably be seen as embodying a "European ideal". Furthermore, as already pointed out, the concepts of "three axes of sustainable development" and "social capital" play a useful role in helping to organise thinking about the complex world of transport and its impacts, as now described in the remainder of the chapter.

7.2.2 Transport aims and objectives of the SDS

The section on sustainable transport in the SDS makes a classification between "overall objective", "operational objective and targets" and "policy actions". This classification can be seen as being approximately equivalent with the three-way classification of aims, objectives and instruments, given at the start of this chapter, with the following equivalences:

SDS term	TRANSvisions term
overall objective	aim
operational objectives and targets	objectives
actions	instruments

We would argue that the TRANSvisions terms are “neater” than those given in the SDS. In particular:

- Given that the SDS has two different levels of “objective” there is a potential for confusion as to which level is being discussed unless it is always made explicit whether the objective is an overall one or an operational one. However to do so would be cumbersome language-wise and there would always be a temptation on the part of any writer to drop the qualifiers “overall” or “operational” in any (lengthy) discussion and simply use the term “objective”.
- With respect to “action” versus “instrument” the main advantage of the latter is that the term constantly reinforces the fact that what is being done by the relevant political authority is in order to achieve a pre-specified aim or objective, whereas the term “action” does not necessarily have this connotation. Furthermore, there is a difference in meaning. As used in the SDS, an action includes both instruments and more general directions to follow, with an identification of which political governance level is responsible for them. An instrument, as used in TRANSvisions, does not carry this definition of agency.

This section discusses the overall objective and the operational objectives and targets of the SDS. Actions are discussed in Section 7.2.3.

In the SDS, the overall objective of sustainable transport is given as:

- To ensure that our transport systems meet society’s economic, social and environmental needs whilst minimising their undesirable impacts on the economy, society and the environment

This overall objective (“aim” in TRANSvisions terms) is concise, and clearly in line with the general (non-transport-specific) goals of the SDS.

Operational objectives and targets (with numbers added for discussion) are given as:

1. Decoupling economic growth and the demand for transport with the aim of reducing environmental impacts.
2. Achieving sustainable levels of transport energy use and reducing transport greenhouse gas emissions.
3. Reducing pollutant emissions from transport to levels that minimise effects on human health and/or the environment.
4. Achieving a balanced shift towards environment friendly transport modes to bring about a sustainable transport and mobility system.
5. Reducing transport noise both at source and through mitigation measures to ensure overall exposure levels minimise impacts on health.
6. Modernising the EU framework for public passenger transport services to encourage better efficiency and performance by 2010.

7. In line with the EU strategy on CO₂ emissions from light duty vehicles, the average new car fleet should achieve CO₂ emissions of 140g/km (2008/09) and 120g/km (2012).
8. Halving road transport deaths by 2010 compared to 2000.

In order to help with the process of formulation of the TRANSvisions objectives (below), a number of comments can be made about the SDS operational objectives and targets:

- In half the cases (2, 3, 7 and 8) the objectives are linguistically concise, as opposed to the other objectives where there is an objective “to do something further”, i.e. pursuing a higher level aim. With the latter type of objective there is potentially an implication that the objective is the “primary” way of achieving this further aim. In some cases (5 and 6), this implication is uncontroversial and so no more needs to be said. However, in the cases of (1) and (4), the implication needs to be examined further.
- With respect to (1), there is probably little doubt that “decoupling economic growth and the demand for transport” will in fact reduce environmental impacts (of transport) for a given level of economic growth (assuming of course that the decoupling involves a **lower** level of increase of transport demand than would occur if it were coupled with economic growth). The decoupling issue is a controversial one. However, since this issue will be explored further below in the context of the 2001 White Paper and its Mid-Term Review, it will not be discussed further here.
- With respect to (4), if the objective read “Achieving a balanced shift towards environment friendly transport modes to bring about an *environmentally* sustainable transport and mobility system”, it would be uncontroversial. However, as it stands, the objective can be interpreted in two ways.
 - (i) On the one hand, it could reveal a difference in meaning about sustainability between the overall aim (where sustainability is concerned with economic and social issues as well as environmental issues) and the objective (in which sustainability is restricted to the environmental dimension). If so, this is a confusing use of language.
 - (ii) On the other hand, the objective could imply that social and economic sustainability will automatically result from environment friendly transport modes. Whilst this might be an attractive conclusion, it is unlikely that this would actually be the case, as shown in the discussion of scenarios in Chapters 5 and 6.
- In the context of TRANSvisions, the time horizons given in the list of objectives, 2010 and 2012 (in 6, 7 and 8) are all short-term. However, they can be adapted to relevant longer-term objectives.
- None of the objectives listed above is concerned with addressing the social capital aspects of transport given in the aims of the SDS. Given that objectives tend to take centre stage when formulating transport policy instruments, this omission is unfortunate. As a general principle, if certain aims are not reflected in objectives, there is a tendency towards disconnected policy-making.

7.2.3 Transport instruments in the SDS

The SDS states that actions should include:

- The EU and Member States will take measures to improve the economic and environmental performance of all modes of transport and, where appropriate, measures to effect a shift from road to rail, water and public passenger transport including lower transport intensity through production and logistic process reengineering and behavioural change combined with a better connection of the different transport modes.
- The EU and Member States should improve energy efficiency in the transport sector by making use of cost-effective instruments.
- The EU and Member States should focus on possible alternatives to road transport for freight and passengers including the appropriate development of the Trans-European Network and inter-modal links for freight logistics, inter alia by implementing measures envisaged in the Commission action programme for inland waterway transport “NAIADES” and the “Marco Polo II” Programme.
- The Commission will continue to examine the use of infrastructure charging for all modes of transport drawing on new opportunities arising with new satellite, information and communication technologies. In the framework of the Eurovignette-Directive the Commission will present, no later than 2008, a generally applicable, transparent and comprehensible model for the assessment of all external costs to serve as the basis for future calculations of infrastructure charging.
- The Commission and Member States should strive to make progress towards effective global solutions for the reduction of harmful impacts of international maritime and air traffic.
- With a view to halving road transport deaths as well as reducing the number of injured in road traffic, increasing road safety by improving road infrastructure, by making vehicles safer, by promoting common European-wide awareness campaigns with a view to changing road user behaviour as well as by establishing cross-border enforcement.
- In line with the thematic strategy on the urban environment, local authorities should develop and implement urban transport plans and systems taking into account technical guidance provided by the Commission in 2006 and considering closer co-operation between cities and surrounding regions.
- The Commission and Member States will develop a long term and coherent EU fuel strategy.

With the exception of the action concerning road accidents, it can be seen that none of these actions address the social sustainability issues of transport. In particular they do not address issues concerned with social capital that are implicit in the definition of sustainable development in the SDS (given above) and which are mentioned explicitly three times in the SDS document.

7.2.4 Comparison with transport elements of EU treaties

It is instructive to compare the transport elements of the SDS with the transport elements of the Treaty on European Union (2008) and the Treaty on the Functioning of the European Union (2008) (though it should be noted that both of these treaties have yet to be adopted).

The Treaty on European Union (TEU) states in Article 3:

“The Union shall offer its citizens an area of freedom, security and justice without internal frontiers, in which the free movement of persons is ensured in conjunction with appropriate measures with respect to external border controls, asylum, immigration and the prevention and combating of crime.”

The Treaty on the Functioning of the European Union (TFEU) states in Article 26:

“1. The Union shall adopt measures with the aim of establishing or ensuring the functioning of the internal market, in accordance with the relevant provisions of the Treaties.
2. The internal market shall comprise an area without internal frontiers in which the free movement of goods, persons, services and capital is ensured in accordance with the provisions of the Treaties.”

In simple terms, the clause from the TEU could be seen as being concerned with social sustainability with the clause from the TFEU being concerned with economic sustainability. Both clauses though emphasise the “free movement of persons”. It could be claimed that transport objective (1) of the SDS (given above as “decoupling economic growth and the demand for transport with the aim of reducing environmental impacts”) is in conflict with the concept of freedom of movement embedded in the two treaties. This issue will be examined further in Section 7.5 below.

Furthermore, Title VI of the TFEU has a number of articles that provide the legal basis for a common transport policy. In particular, Article 91 states:

“1. For the purpose of implementing Article 90 [i.e. the common transport policy], and taking into account the distinctive features of transport, the European Parliament and the Council shall, acting in accordance with the ordinary legislative procedure and after consulting the Economic and Social Committee and the Committee of the Regions, lay down:
(a) common rules applicable to international transport to or from the territory of a Member State or passing across the territory of one or more Member States;
(b) the conditions under which non-resident carriers may operate transport services within a Member State;
(c) measures to improve transport safety;
(d) any other appropriate provisions.
2. When the measures referred to in paragraph 1 are adopted, account shall be taken of cases where their application might seriously affect the standard of living and level of employment in certain regions, and the operation of transport facilities.”

It can be seen that, as well as having a strong economic dimension, these clauses also have a strong social dimension (arguably stronger than in the SDS, though both consider transport safety), with paragraph 2 being connected to concepts of territorial cohesion.

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7.3 2001 White Paper

7.3.1 Introduction

Chapter 3 provided an overview of the White Paper “EU Transport Policy, a Time to Decide” (CEC, 2001), referred to below as the “White Paper”. Unlike the SDS, the White Paper is not structured according to an “aims, objectives and instruments” format. Although it does not use the term, its objectives (in the TRANSvisions sense) can be readily identified and will be described below in 7.3.2. A list of its policy instruments is given in Annex 4.

One of the key policy thrusts of the White Paper is summed up in the statement “we have to consider the option of gradually breaking the link between economic growth and transport growth, on which the White Paper is based” (referred to as “decoupling” elsewhere in the document). The White Paper then dismisses a “simplistic solution” for accomplishing decoupling “which would be to order a reduction in the mobility of persons and goods and impose a redistribution between modes”, stating this to be against subsidiarity principles and “dirigiste”. Three alternative options are then provided for attaining decoupling, the chosen option comprising:

“a series of measures ranging from pricing to revitalising alternative modes of transport to road and targeted investment in the trans-European network. This integrated approach would allow the market shares of the other modes to return to their 1998 levels and thus make for a shift of balance from 2010 onwards. This approach is far more ambitious than it looks, bearing in mind the historical imbalance in favour of road for the last 50 years. It is also the same as the approach adopted in the Commission's contribution to the Gothenburg European Council which called for a shift of balance between the modes by way of an investment policy in infrastructure geared to the railways, inland waterways, short sea shipping and inter-modal operations..... By implementing the 60-odd measures set out in the White Paper there will be a marked break in the link between transport growth and economic growth, although without there being any need to restrict the mobility of people and goods. There would also be much slower growth in road haulage thanks to better use of the other means of transport (increase of 38% rather than 50% between 1998 and 2010). This trend would be even more marked in passenger transport by car (increase in traffic of 21% against a rise in GDP of 43%)”.

Whilst the White Paper covers a large number of issues concerning the full range of EU transport policy, arguably its core elements concern the decoupling transport growth from economic growth and the switching of traffic to more environmentally-friendly modes.

7.3.2 Aims and objectives in the 2001 White Paper

Although it does not include an explicit statement about high level aims as such (i.e. in the sense that the SDS makes such a statement), such aims can be inferred from the opening two paragraphs of the White Paper:

“Transport is a key factor in modern economies. But there is a permanent contradiction between society, which demands ever more mobility, and public opinion, which is becoming increasingly intolerant of chronic delays and the poor quality of some transport services. As demand for transport keeps increasing, the Community's answer cannot be just to build new infrastructure and open up markets. The transport system needs to be optimised to meet the demands of enlargement and sustainable development, as set out in the conclusions of the Gothenburg Euro-

pean Council. A modern transport system must be sustainable from an economic and social as well as an environmental viewpoint.

Plans for the future of the transport sector must take account of its economic importance. Total expenditure runs to some 1 000 billion euros, which is more than 10% of gross domestic product. The sector employs more than ten million people. It involves infrastructure and technologies whose cost to society is such that there must be no errors of judgment. Indeed, it is because of the scale of investment in transport and its determining role in economic growth that the authors of the Treaty of Rome made provision for a common transport policy with its own specific rules.”

The sentence “a modern transport system must be sustainable from an economic and social as well as an environmental viewpoint” is consistent with the three axes of sustainability described elsewhere in this Final Report. However, whilst the paragraphs above emphasise the economic and environmental dimensions of sustainability (particularly taking into account the environmental orientation of the transport conclusions from the Gothenburg Council), the role of social sustainability is not clear.

As stated in Chapter 3, the White Paper includes four broad policy objectives (although this term is not actually used in the White Paper):

1. Shifting the Balance Between Modes of Transport
2. Eliminating Bottlenecks
3. Placing Users at the Heart of Transport Policy
4. Managing the Globalisation of Transport

In terms of high level aims associated with these objectives, (1) and (2) would appear to be mainly concerned with the economic and environmental dimensions of sustainability, emphasising congestion (a primarily economic problem) and a shift in travel towards environmentally-friendly modes. In order to examine the White Paper in terms of social sustainability, it is best to look more closely at objectives (3) and (4).

The objective “Placing Users at the Heart of Transport Policy” has four sub-objectives:

- (i) Unsafe Roads
- (ii) The Facts Behind the Cost to the User
- (iii) Transport with a Human Face
- (iv) Rationalising Urban Transport

Of these, sub-objective (i), addressing road safety, is clearly concerned with the social impacts of transport. Sub-objectives (ii) and (iii) have a social dimension by providing information to the transport user and improving the quality of the transport experience (through the implementation of user rights and obligations, public service quality, and favouring more technical elements such as integrated ticketing and luggage handling), given that all citizens use the transport system. In the terms given in the social capital discussion in Section 6.2, these are “internal” social benefits to the transport system, and they clearly make a contribution to social sustainability. However, it should be noted that they are not concerned with the wider “external” social impacts of transport. Sub-objective (iv) is concerned mainly with the economic and (particularly) the environmental aspects of urban transport.

The objective “Managing the Globalisation of Transport” has two sub-objectives:

- (i) Enlargement Changes the Name of the Game
- (ii) The Enlarged Europe Must be More Assertive on the World Stage

Whilst these two sub-objectives have some relevance to issues concerned with political capital, they would not be considered as being centrally focused upon tackling social sustainability aims.

7.3.3 Policy instruments in the White Paper

Throughout the text of the White Paper a large number of policy actions are suggested. These specific actions are assembled in an “Action Programme” given as an annex of the White Paper, and reproduced in Annex 4 below. It is clear from inspection of this action programme that a comprehensive set of instruments is included. However, whilst there are instruments concerned with dialogue/consultation between the European Community and various stakeholder groups, no instruments are included which facilitate public participation in transport planning at a lower level of governance than the European level. Such instruments are further described below in Chapter 8.

7.4 Mid-Term Review of 2001 White Paper: Keep Europe Moving

7.4.1 Introduction

As described in Chapter 3, in 2006 the EC published its Mid-Term Review of the 2001 White Paper, “Keep Europe Moving” (CEC, 2006). This publication was preceded by an impact assessment of the White Paper, backed by the ASSESS project, and a number of consultation exercises. A number of commentaries and analyses have been made about the Mid-Term Review, such as that by Stead (2006). Following Stead, it can be said that the Mid-Term Review maintains that the objectives of the Transport White Paper of 2001, and even the objectives of its predecessor, the 1992 Transport White Paper, remain valid. Nevertheless, the Mid-Term Review indicates something of a change in direction and focus in European transport policy largely as a response to the very low economic growth with which the century started, far below the 3% increase of GDP aimed at by the Lisbon strategy. This is quite explicitly recognised in the Mid-Term Review, which for example refers to the ‘need to re-adjust policy measures’ and the need for ‘a broader, more flexible, transport policy toolbox’ (p6) which will lead to more emphasis being paid to efficiency linked issues such as logistics, urban transport, and innovation on ITS and energy technology. The Mid-Term Review asserts that the measures put forward in the 2001 European Transport White Paper ‘will not be sufficient on their own to continue achieving the fundamental objectives of EU policy, in particular to contain the negative environmental and other effects of transport growth whilst facilitating mobility as the quintessential purpose of transport policy’ (p6). The previous sentence introduces the concept of decoupling from the negative effects of transport rather than between transport and GDP.

The Mid-Term Review introduces also the concept of co-modality defined as the efficient use of the different modes on their own and in combination thus stressing the fact that modal balance has to be accompanied by modal performance in all modes, starting with the bigger ones. Clearly, the prevailing view in the Commission is that transport policy should facilitate mobility rather than manage it: after some years of declining economic growth the emphasis on mobility as a precondition for competitiveness is raised at least to the same level as environmental sustainability. Demand management as such does not feature in the Mid-Term Review, although more work on pricing, which is one of the main demand management tools, is announced. The Mid-Term Review contends that the focus of transport policy needs to be revised because of a combination of emerging issues and developments, such as: the substantial enlargement of the European Union in 2002 which increases the heterogeneity of the Union (e.g. in respect of congestion); recent changes in the transport industry; evolving technologies and new innovations; and energy supply and security issues (following the New York, London and Madrid terrorist attacks).

7.4.2 Aims and objectives

The structure of the Mid-Term Review follows more closely an “aims, objectives, instruments” format than the 2001 White Paper. It gives the aim (in TRANSvisions terms) of a European Union (EU) sustainable transport policy as being “that our transport systems meet society’s economic, social and environmental needs. Effective transportation systems are essential to Europe’s prosperity, having significant impacts on economic growth, social development and the environment”. Hence the aim represents a straightforward interpretation of the concept of three axes of sustainability.

It describes how “the **objectives** of EU transport policy, from the transport White Paper of 1992 via the White Paper of 2001 to today’s communication, remain valid: to help provide Europeans with efficient, effective transportation systems that:

- a. offer a high level of **mobility** to people and businesses throughout the Union. The availability of affordable and high-quality transport solutions contributes vitally to achieving the free flow of people, goods and services, to improving social and economic cohesion, and to ensuring the competitiveness of European industry;
- b. **protect** the environment, ensure energy security, promote minimum labour standards for the sector and protect the passenger and the citizen.....
- c. **innovate** in support of the first two aims of mobility and protection by increasing the efficiency and sustainability of the growing transport sector; EU policies develop and bring to market tomorrow’s innovative solutions that are energy efficient or use alternative energy sources or support mature, large intelligent transport projects, such as Galileo
- d. **connect internationally**, projecting the Union’s policies to reinforce sustainable mobility, protection and innovation, by participating in international organisations; the role of the EU as a world leader in sustainable transport solutions, industries, equipment and services must even be better recognised.”

It can be seen that there is a large increase in emphasis on social sustainability in comparison with the 2001 White Paper, in particular with respect to objective (a). In this objective, it would appear that a fundamental aspect of social sustainability is mobility. In a number of respects, this approach is attractive. Firstly, when linked up with the phrase “free flow of people, goods and services”, the objective has connotations of “liberation from restrictions” and undoubtedly many travel opportunities appeal to precisely this sentiment. Secondly, when thinking about issues such as territorial cohesion (and the goal of linking up different regions of the EU) the use of mobility as a social sustainability indicator is highly practical. However, it can be argued that the use of “mobility” as a central indicator of social sustainability is insufficiently theorised. In particular, its use does not take account of the fact that (as described in social capital discussion in Chapter 6) many longer-distance trips are undertaken to access opportunities/services because more local opportunities/services do not exist. In Chapter 6, this phenomenon was described as “coerced mobility”. Such considerations lead to thinking about concepts such as “accessibility”, which lead in turn to consideration of issues such as “rights” that citizens might have in accessing specific opportunities/services. This issues quickly become complex. Whilst it would be uncontroversial to assert that citizens of the EU have rights to easy access of opportunities/services such as basic medical care and primary education, difficult questions arise to whether citizens have the “right” to take foreign holidays (and, if so, how many per year?). It is argued here that these questions can only be thought through satisfactorily within a comprehensive framework of that could be entitled “social

aspects of transport”, and that such conceptual framework should be given greater emphasis in transport policy formulation on the EU level.

7.5 Discussion of EU Transport Policy aims and objectives in the light of trends and challenges

7.5.1 Decoupling: political issues

As described above, two aspects of decoupling are considered in European Transport Policy:

1. “Breaking the link between economic growth and transport growth” (as in the 2001 White Paper and the 2006 Strategic Development Strategy)
2. “Mobility must be disconnected from its negative side-effects” (as in the 2006 Mid-Term Review)

Whatever the merits of (1), it has been strongly criticised on the grounds of being “anti-freedom” in restricting people’s mobility and potentially in conflict with the Treaty on the European Union. This issue will now be discussed.

Arguably, based upon the discussion earlier in this chapter, the main deficiency in the 2001 White Paper concerned its lack of a comprehensive theorisation of social sustainability and the “external” social impacts of transport (particularly with respect to social capital impacts). This made the decoupling aim (1) particularly vulnerable to any economic downturn with its resulting social stresses. From the perspective of the start of 2009 (with Europe facing economic recession and hence greater social stresses), the “social deficiencies” of the White Paper are even more marked. Specifically, if the White Paper had taken a strong grasp on issues of social sustainability and shown how social sustainability is not necessarily in conflict with decoupling version (1), the policy aim of decoupling would have been more robust at the current time. In particular, if the White Paper had shown through social analysis that not all mobility is desirable from the point of view of the individual traveller (i.e. the concept of “coerced mobility”), (1) would have been far less vulnerable to the accusation of “anti-freedom” that has been levelled at it.

Taking into account political realities, it is unlikely that decoupling (1) will be a viable policy aim in the short term (i.e. at the time that the next White Paper is produced). However, it could make a return in the medium term once the current economic crisis, and its after-effects, have been resolved. If it is to make a successful “comeback”, though, it is essential that the social sustainability dimension of decoupling transport growth from economic growth is well theorised.

7.5.2 Decoupling: methodological issues

Separate to the political issues discussed in 7.5.1, various methodological issues arise concerning the decoupling of transport growth and economic growth. As shown in Chapter 5, the measurement of transport growth is highly dependent upon the geographical definitions of levels of transport, both for freight and passenger. A number of such definitions can be made, varying as to what extent they include those trips that have an origin or destination outside the EU. Two extreme definitions can be made:

- If only those trips with both origin and destination within the (current) EU are included, the projected rise (in the 2030 Baseline) is 1.2% per year for freight ton-

nes-kms and 1.3% per year for passenger-kms (EU residents). Given that the Baseline GDP projected growth is 2.28% per year, it can be seen that transport growth is near to half this rate.

- On the other hand, if freight tonnes-kms and passenger-kms include travel outside the EU (concerning trips with origin or destination within the EU), the projected rise in tonnes-kms is 2.8% per year (greater than projected GDP growth) and the rise in passenger-kms is 2.1% per year (near to projected GDP growth).

7.5.3 Demand management

Even if the concept of decoupling transport growth and economic growth is put to one side, European transport policy objectives (and associated instruments) still need to consider concepts of demand management. Various issues arise here;

- The aim of “freedom of movement” for European citizens, as embodied in the Treaty on European Union, would be assumed principally to refer to movements between different parts of the EU. From the results in Chapter 5, these movements are projected to grow at a much lower rate than movements to/from outside the EU. It can thus be argued that the clash between “freedom of movement” and “demand management” is not so strong as might first appear. Rather, the principle movement-type of importance for potential demand management concerns external trips.
- Certain parts of the transport system (for example in many cities) are already overloaded, and any growth in traffic in such locations will lead to problems of “congestion as gridlock” rather than just “congestion as delay”. Problems of gridlock can lead to a serious deterioration in the quality of life of those affected. Given the typical infeasibility of resolving such problems by building new infrastructure, solutions involving demand management objectives and instruments need to be found. In this respect pricing instruments allow the application of “polluter pays” and “user pays” principles, whilst raising the issue that freedom of movement does not necessarily involve movement free of charge.
- On a generic level, a basic problem with demand management objectives and instruments is that they can be viewed as “authoritarian” in the sense that they are imposed “from above” upon “unwilling” citizens. Such a perception reinforces the view that transport policy-making has frequently become alienated from social issues and hence reinforces the need to put social sustainability at the heart of transport policy-making. In particular, if demand management objectives and instruments result from public participation processes, the image of authoritarianism is undermined.

7.5.4 Technological optimism

In general, there is a large risk in taking a policy formulation approach in which it is assumed that only one scenario will occur, with all policy formulation being based upon this assumption. In particular, there is an “optimist” temptation to base all policy formulation on the assumption of strong economic growth and (the resulting) sufficiency of finance for strong technological development to deal with climate change impacts. Given the possibility of lack of such growth, climate change policy needs to include specific objectives and instruments concerned with demand management, as discussed above.

7.5.5 Optimism concerning continuity

As explained in Section 6.5, policy formulation for long-term strategic planning usually reflects assumptions of continuous (smooth) evolution in the world and in the transport system. Disruptive events are typically relegated to area of “operational planning”. However, in certain cases, highly disruptive events have strategic consequences for the transport system. Examples of such events were given in Section 6.5. When considering the aims and objectives of long term European transport policy, it is essential to take the possible materialisation of such events into consideration: ignoring them amounts to an attitude of “over-optimism concerning continuity”.

7.6 Suggested aims and objectives for European Transport Policy

Following the discussion in the sections above, this section makes a number of suggestions for long-term EU transport policy. The first point to make is that it helps clarity to present this policy in the form of an “aims, objectives, instruments” structure. In particular, the policy has a flaw if a specific aim is not “matched” by any objectives or instruments: in short the aim is likely to be forgotten, thus leading to a devaluation of the concept of policy aims. This section will thus deal separately with aims (in 7.6.1) and objectives (in 7.6.2). Section 7.6.3 will address issues concerned with including quantitative targets in objectives.

7.6.1 Aims of European Transport Policy

The concept of “three axes of sustainability” (economic, environmental and social) is sound. Not only does it capture the sense of the “European vision” but it also provides a pragmatic approach for organising the complex diversity of transport policy. The precise phrasing of the overall aim of transport policy can be a matter for debate, though the aim given in the SDS provides a suitable starting point:

“To ensure that our transport systems meet society’s economic, social and environmental needs whilst minimising their undesirable impacts on the economy, society and the environment.”

In the light of the discussion in 7.5 (and throughout this report) about uncertainties of the future, the aim could formally incorporate a reference to resilience. For example, the above single aim could be extended to two aims:

- “(1) To ensure that our transport systems meet society’s economic, social and environmental needs whilst minimising their undesirable impacts on the economy, society and the environment.
- (2) **To ensure that our transport systems are sufficiently resilient to be able to meet the future challenges presented by an uncertain world”.**

7.6.2 Objectives

The aims given above provide an overall structure for the objectives. Given that it leads to a lack of focus if too many objectives are given, it is best to restrict the number to the order of ten.

Following this approach, a small number of objectives could be stated for each of the (three) axes of sustainability. Subjects for objectives could thus be as follows:

Economic sustainability

- Two objectives concerning the ability of the transport system to:
 - Contribute to **economic growth**
 - Contribute to **generation of employment**
- A further objective concerned with **reduction and avoidance of congestion**.

Environmental sustainability

- Three objectives concerned with the reduction and avoidance of
 - **climate change** effects by reducing greenhouse gases
 - harmful **local pollutants**
 - **noise** nuisance from transport
- Protection of **environmentally-sensitive areas** from transport encroachment

Social sustainability

- Reduction and avoidance of **fatal and serious accidents**
- Provision of **accessibility** to opportunities/services
- Enhancement of **social cohesion**, including the reduction of social and territorial exclusion
- Enhancement of political capital through the encouragement of a **participatory approach to transport planning**
- Enhancing the **rights of travellers** to good quality transport provision
- Attaining and maintaining **high quality standards of employment** within the transport sector

The precise formulation of each objective is best left to further (participatory) debate. However, a number of general points should be made:

- Some objectives are phrased in a positive sense (in order to promote a welcome impact) whilst other objectives are phrased in a negative sense (in order to avoid an undesirable impact). In particular, whilst the environmental objectives are all phrased in a negative sense, the economic and social objectives are generally phrased positively (albeit with some exceptions). It could be argued therefore that there is hence an imbalance in the phrasing of these objectives. In answer to this point, it needs to be remembered that the objectives of transport policy are the operational goals which help attain the aims. Whilst the aims of transport policy should reflect both positive and negative senses (as do the aims suggested above in 8.6.1), the objectives should be phrased in the way that is consistent with whether the practical “concrete” concerns of policy-makers are primarily focused upon promoting positive impacts or reducing negative impacts.
- It could be argued that the enhancement of political capital through participation applies to all sectors and not only the transport sector, and thus should not be included as an objective specifically of transport policy. Whilst it is indeed true that participation should be encouraged in all sectors, it can be observed everywhere in the world that the transport sector in particular generates a huge level of public debate and controversy. This debate is reflected in the media and in campaigns for or against specific transport interventions, for example concerning road-

building schemes, city demand restraint measures, road pricing or airport building/extensions. As a result of this interest, it is argued that the transport sector is of particular importance (in comparison with other sectors) with respect to the building of political capital through enhanced public participation (though of course it should not shoulder sole responsibility).

- If any objective is complicated in terms of the number of phenomena it is covering (and many will be so), it can be broken down into sub-objectives (dealing with each phenomenon in turn).
- Sub-objectives can also deal with the means to achieving aims and objectives, where there is a need to express these on a higher level of generality than the policy instruments to be discussed in Chapter 8. For example, if switching modes leads to greater environmental sustainability, this can be reflected in appropriate sub-objectives.
- In the detailed formulation and description of each objective, both present needs and resilience to future challenges (as embodied in the aims) should be reflected.
- There is a question of how many quantitative targets to include in the objectives. This is discussed in the next subsection.

7.6.3 Quantitative targets

In general, it is useful to include quantitative targets within objectives since they help provide a well-defined focus for policy-making.

Various general points can be made about targets:

- (i) Whilst quantitative targets are useful for focus, if policy objectives contain too many targets such focus is blurred
- (ii) A generic risk with targets is that there is always the temptation for policy-makers to “play the game” of meeting targets while ignoring the spirit underlying the targets. This phenomenon is often caused by the fact that targets need to be expressed in terms of indicators which can never infallibly capture the sense of the objective concerned. There is no simple remedy to this phenomenon except to be continually aware of its existence (and to act accordingly).
- (iii) In the case of transport policy targets, two situations can be distinguished:
 - In the case of CO₂ emission reduction targets, there is no essential *a priori* environmental reason for adopting specific transport-related emission-reduction targets. In order to combat climate change, it is not important which sector contributes these reductions, as long as total emissions are reduced. However, whilst it is not possible to argue against the logic of this statement, it is possible to be worried about its potential practical implications. In particular there is the possibility that transport policy-makers might not feel any obligation to reduce transport-related emissions, since other sectors “can make reductions more easily”. This could be seen as an example of the game-playing described in (ii). A pragmatic compromise to this problem is to adopt “indicative” (rather than “binding”) targets for transport-related emission reductions.
 - On the other hand, the above argument does not apply to road fatalities since it is an unacceptable argument to claim that a certain number of accidental deaths per year are tolerable and that it does not matter which sector contributes fatalities.

8 Policy Instruments to Meet Long Term Aims and Objectives

8.1 Introduction: classification of instruments and packaging of instruments

8.1.1 Overview

This chapter provides further information, to that given by the modelling tests reported in Chapter 5, concerning the policy instruments that might be needed to meet the suggested objectives of EU transport policy given in the previous chapter. Given the holistic nature of TRANSvisions, it is not the intention to get involved in detail with the vast range of specific instruments available to EU policy-makers. In fact such an approach would be positively detrimental: focus on the central themes of importance to TRANSvisions would be liable to be lost in a mass of information. Rather, the aim is to give an overview of a wide set of policy instruments that will form the basis for later refinement. A number of factors will be synthesised in order to achieve this aim:

- In order to help manage the complexity associated with the large number of potential policy instruments mentioned above, a small number of instrument-types will be defined in 8.1.2. These instrument-types are generally conventional in terms of transport planning, with one notable exception (concerning public participation) to be described in Section 8.2.
- Task 2 has produced an “*a priori* set” of policy instruments, which is provided in the Task 2 Report and repeated below in Section 8.3. This set of instruments generally reflect “current thinking” on policy instruments.
- Section 8.4 examines issues concerned with the division of labour between different political jurisdictions with respect to the implementation of policy instruments.

Section 8.5 provides a number of conclusions through synthesising the results of the above (non-modelling) analyses with the modelling results from Chapter 5.

The remainder of this introductory section covers three topics. In 8.1.2 a classification of policy instruments is made, whilst in 8.1.3 some issues regarding instrument packaging are discussed. In order to “concretise” the information given in these subsections, a summary is given in 8.1.4 of the “real-life” policy instruments described in the TRANSvisions case studies.

8.1.2 Classification of policy instruments

The analysis carried out below will use, with one exception, a reasonably conventional classification of transport policy instruments, grouping instruments under the following headings:

- Infrastructure
- Technology

- Economic
- Regulatory
- Participatory

Of these groups, the only “non-traditional” instrument-type concerns participatory instruments. These will be described further in Section 8.2.

Table 8.1 provides examples of the instruments in the groups listed above.

Instrument group	Examples of instruments
Infrastructure	<ul style="list-style-type: none"> • The TENS and intermodal platforms • Separated infrastructure networks for passenger and freight traffic
Technology	<ul style="list-style-type: none"> • Intelligent Transport Systems (ITS) • SESAR (Single European Sky) • ERTMS (European Rail Traffic Management System) • Galileo • Vehicle technology
Economic	<ul style="list-style-type: none"> • Pricing for infrastructure use • Fuel taxes • Vehicle taxes
Regulatory	<ul style="list-style-type: none"> • Access to infrastructure by third parties • Interoperability standards • Land-use planning • Speed control • Instruments to protect the rights of passengers • Standards of employment for transport workers
Participatory	<ul style="list-style-type: none"> • Instruments heightening public participation in transport planning (for example Commission Green papers and local participation events). To be described below in Section 8.2

Table 8.1: Classification of policy instruments

8.1.3 Packaging of instruments

Although the focus of this chapter is upon single instruments, it should always be remembered that it is frequently advantageous to implement instruments as part of an integrated package (i.e. a combination of two or more instruments). Two situations can be distinguished:

- In many cases, the introduction of an instrument package is essential to the design of a “primary” instrument. For example, if new infrastructure is built, regulations need to be defined as to who can use it (e.g. pedestrians are prohibited

from using motorways) and how they use it (e.g. speed limits). In general, this type of combination will not be the main focus of this chapter, though if examples of such instrument combinations are important they will be mentioned.

- Of greater importance to this chapter is the situation where the policy-maker has a degree of control of whether particular instruments are combined in a package or not. For example, if new infrastructure is built, a decision needs to be made as to whether to impose charges for using it.

A desirable goal in the packaging of instruments is to attain "synergy", a concept which captures the idea that the aggregate benefits from two instruments combined should be greater than the sum of the instruments applied in isolation. Even if synergy is not attained in this strict sense, it is still desirable that instruments in packages reinforce each other, as for example:

- Given that the introduction of **economic instruments** such as pricing is always liable to be controversial (in the sense of there being some degree of public opposition) careful thought needs to be given to packaging economic instruments with other instruments in order to make them more publicly acceptable. Four particular instrument types are particularly relevant here:
 - If pricing instruments are packaged with infrastructure instruments or instruments to support public transport, under the logic that the former are funding the latter, the pricing instruments are likely to be more publicly acceptable.
 - Regulatory instruments (particularly land-use planning) can ensure that pricing does not stop someone from accessing essential services (i.e. it is made certain that such services are available close to home).
 - Participatory instruments (to be described below) can ensure that an economic instrument results from a process of negotiation (by the "public" who are directly impacted by the instrument).
 - ITS instruments can provide information on charges for using infrastructure in advance of using it, thus helping to reduce any "surprises".
- With regard to **infrastructure** instruments:
 - Clearly one of the greatest problems associated with building new infrastructure concerns how such construction is funded. As indicated above, economic instruments can provide such funding. This combination of instruments not only helps (partially) resolve the funding problem; it also helps make pricing more publicly acceptable by showing that something tangible is gained from it.
 - Even if funding is readily available for infrastructure, there is no guarantee that a particular item of infrastructure will gain widespread public support (given that the funds could have been used to build alternative infrastructure or that the infrastructure is simply unpopular). Participatory instruments can facilitate public involvement in making decisions over infrastructure and thus help ensure its acceptability.

8.1.4 TRANSvisions case studies

For illustrative purposes, information about a number of "real-life" instruments, both current and "futuristic", is given in the TRANSvisions case studies. The titles of these case studies are as follows:

Megaprojects

- Ferrmed
- Tunnel of Gibraltar
- Lyon-Turin rail link: From 6 to 40 million tons per year by 2030
- The Strait of Messina Bridge

Road infrastructure

- Dedicated roadways for trucks: South Boston Bypass Road

Rail

- Barcelona: “New Vueling” dominates but rail taking 25% of Madrid traffic
- Betuweroute, a 160Km double-track freight rail line opened in June 2007
- The Öresund Fixed Link 2000
- Benefits to Airlines From Using High-Speed Train Services

Ports and logistics

- 2.000 ha of expansion in Rotterdam between 2013 and 2033
- The new Tanger Med port
- Annual growth of 7% for Asia Pacific Ports will continue beyond 2010
- Zaragoza PLAZA: the new biggest non maritime logistic area in Europe

Airports

- Heathrow expansion: the busiest airport in Europe
- Boris Johnson airs plan for Heathrow-on-Sea
- Madrid: Europe’s #1 airport by 2016?
- A new generation of more space-efficient airports

Urban Transport

- L9 Barcelona: the largest metro line under construction in Europe
- London new urban road pricing
- Stockholm urban road pricing
- Bicycle rental as emerging public-individual transport in European cities
- New bicycle boulevard
- More bike- bus Lanes
- Bike Boxes
- Pedestrian Scramble
- Masdar City To Get Solar-Powered Personal Rapid Transit System

Emerging car technologies

- Zero VMT vehicle
- Plug-in Hybrids
- The new Insight Concept
- Big 3 U.S. auto giants plug electric cars
- Made in China: A plug-in hybrid for the masses
- Japan taps Better Place for electric car charging
- A visual tour of the GM Volt, electric cars
- The future of the car industry
- Hawaii Plans Electric Vehicle Charging Infrastructure
- Israel launches electric-car program
- Green Fuels, Cars Get Boost from Cow Pie Power, the Queen and New EV Charging Hub
- Honda produces first commercial hydrogen cars
- Toyota to build electric town car, plug-in hybrids
- Yet more rumors of a solar Prius
- Battle hardened, robot-driven cars by 2030

- Aptera EV opts for front-wheel drive
- EnerG2 aims to improve ultracapacitors for electric cars industry
- Electric Cars Are Unlikely to Help Carmakers Cut CO2 Emissions
- A Zero Emission Car By Tata Uses Compressed Air To Push The Pistons of Motor
- Scientists explore putting electric cars on a two-way power street
- Zero-Emission Double Decker Buses Coming to London
- Japan races to build a zero-emission car
- Honda Motor has been conducting research into hydrogen generation from solar power since 2001, but only at an experimental level
- Gordon Murray Design T25 city car: the scoop
- Ford Promises Pure Electric Vehicle for 2011
- Solar electrical systems
- Hybrid cars
- Solar Bug
- Accelerated Composites Aptera
- Solar Trike
- AC Propulsion provided the electric drive systems for the MINI E
- The "It" electric car
- Pedallec Electric Scooter
- BudE
- Volvo premieres world's most powerful truck
- Net-Centric Systems to Guide Trucks

Emerging air technologies

- Boeing flies first ever battery fuel cell plane
- Research on supersonic planes set to revolutionize air travel
- Air New Zealand tests biofuel Boeing
- Terrafugia Transition
- Pal-V: Personal Air and Land vehicle
- Jet packs
- Gryphon Single Man Flying Wing

.....

Emerging train technologies

- Eco-friendly Trains
- Maglev Shinkansen plan
- Japan's hybrid train hailed as the future of rail travel
- Japan plans world's fastest maglev train

Emerging maritime technologies

- Up to 9.000 TEU containerships in 2010
- Chinese Cargo Ships Will Have Solar Sails

New buildings developments

- Green buildings
- 7 Modern Wonders of Green Technology

New urban developments

- Masdar City Project: World's first carbon-neutral city
- Future Cities: Sustainable solutions. Radical Designs
- Reshaping cities for a more sustainable future

Energy

- Hydrosol Project
- Fuel-Cells and Hydrogen Program
- ORNL study shows hybrid effect on power distribution
- Poop-Powered Hydrogen Cars Show Promise
- Gasoline From Trash as a Cheap New Alternative
- Chinese Planning World's Largest Solar Project

Comments that can be made about this list are:

- It can be seen that these instruments mainly concern infrastructure projects (those in the categories of: megaprojects; road infrastructure; rail; ports and logistics; and airports) and technology instruments (emerging transport technologies). However, the instruments listed under “urban transport” and “new urban developments” cover a range of infrastructure, economic (road pricing), technology and regulatory instruments.
- Many of the case studies are location-specific. When considering the possibility of applying such instruments in other locations, care needs to be made in terms of making a transferability analysis, since instruments that “work well” in one place can fail in other locations. Transferability analysis is frequently concerned with the identification of barriers which might impede the successful implementation of an instrument in the “new” location. There are a number of ways of classifying such barriers, though a standard classification of barriers could be made as follows:
 - Various types of **physical** barrier, such as proximity to the sea, lakes or mountains, or other physical restriction, might make the transfer of an infrastructure instrument unfeasible.
 - **Environmental** barriers might arise if the transferred instrument would lead to unacceptable environmental problems in its new location.
 - **Legal/institutional** barriers might arise when an instrument is transferred between locations with different governance cultures (e.g. between different countries)
 - **Political** barriers might arise due to the higher level of controversy associated with an instrument in its new location
 - **Financial** barriers might arise due to the difficulty in finding funding for the instrument in its new location

8.2 Participatory instruments

In general, participatory instruments are those that heighten public participation in transport planning. They can be seen as being particularly appropriate for meeting social sustainability objectives which are concerned with the ideas of social capital highlighted in this report. When discussing such instruments in the context of European transport policy, it is useful to distinguish between two levels of decision-making:

- Decision-making at a European level, to be discussed in 8.2.1
- Decision-making at a lower level (i.e. national, regional or local), to be discussed in 8.2.2

8.2.1 Consultations on a European level

The Commission has a history of development of consultation processes about policy formulation. However, in the context of the 2005 renewed Lisbon Strategy it was clear that more effort had to be made to increase the awareness and ownership of the European population in respect of Community actions, notably those addressing the creation of more growth and jobs and sustainable development at large. This gave rise to a better regulation policy which stressed the need to base policies on extensive consultation and detailed Impact assessment of proposals.. Current guidelines for consultation are given on the website:

http://ec.europa.eu/governance/better_regulation/consultation_en.htm

An overview of these guidelines is given as follows:

“Before making proposals and taking policy initiatives, the Commission must be aware of new situations and issues developing in Europe and it must consider whether EU legislation is the best way to deal with them. Therefore the Commission consults and is in constant touch with external parties when elaborating its policies. These include all those who wish to participate in consultations run by the Commission, be it market operators, NGOs, private persons, representatives of regional and local authorities, civil society organisations, academics and technical experts or interested parties in third countries.

The dialogue between the Commission and interested parties can take many forms, and methods for consultation and dialogue are adapted to different policy fields. The Commission consults through consultation papers (Green and White Papers), communications, advisory committees, expert groups, workshops and forums. Online consultation is commonly used. Moreover, the Commission may organise ad hoc meetings and open hearings. Often, a consultation is a combination of different tools and takes place in several phases during the preparation of a policy proposal.”

It should be noted here that the “ordinary citizen” has the possibility to be involved with the Commission’s consultation processes both as an individual and as represented by a “third organisation” (particularly by a regional or local authority). For the sake of clarity, the representation of the individual by a local authority in EU policy-making should not be confused with the consultation procedures available to the individual for decisions made on a local level (as described in 8.2.2).

8.2.2 Consultations at a lower level of governance

Participatory instruments at a lower level of governance than European level are not typically included formally in EU Transport policy (see Section 7.3 above in the context of the 2001 White Paper), presumably for subsidiarity reasons. However, whilst it would certainly be inappropriate for the EU to be over-prescriptive with respect to such instruments, it can play a useful role in facilitating good practice. A short overview of participation instruments (at a lower level) is provided in this section. Many of the results provided here are in fact taken from EU-funded research projects, thus demonstrating the potential of research to highlight such good practice.

Based upon previous literature, PLUME (2003) identifies five levels of public participation:

- **Information provision:** a one way process to keep those with an interest in the strategy informed.

- **Consultation:** where the views of stakeholders and the general public are sought at particular stages of the study and the results are input back into the study process.
- **Deciding together:** where the stakeholders become decision-makers
- **Acting together:** where the stakeholders also become involved in the implementation of the strategy.
- **Supporting independent stakeholder groups:** where the city enables community interest groups to develop their own strategies.

Country	Before proposals	After publication of authority's proposals	Use of public hearings and enquires
Austria	The public must be informed of intentions to prepare plans and possibility of consultation.	Plan is made available for public inspection and all citizens have a right to make statements on the plan.	-
Belgium	Some plans are subject to pre-draft consultation with public.	Consultation with public on all draft plans for 30 days - citizens have a right to file objections.	-
Denmark	The public are informed of the major issues and are encouraged to submit ideas and proposals. This pre consultation stage must last a minimum of 8 weeks.	Consultation for 8 weeks with the public which have the opportunity to object. Further consultation is undertaken if the plan is modified significantly.	-
Finland	Consultation on the first draft for three weeks with right to object	Further consultation and right to object when plan goes to council for approval.	Hearings after consultation on first draft and second hearing after decision on plan by municipal board
France	-	Consultation for one month on draft after the approval by public bodies and communes. Public have opportunity to object.	Detailed plans are usually subject to public enquiries
Germany	The public are informed and may contribute to setting aims for the plan.	Consultation for 1 month when objections can be made. If the draft of urban land use plan is changed after display, it has to be displayed again and the period can be reduced to 2 weeks.	Public hearings are held for major projects such as motorways
Italy	-	Consultation for 30 days when public can object.	-
Netherlands	The public may be informed but this is not mandatory.	Consultation for 4 weeks on draft plan and opportunity to object.	Objectors may request a hearing to explain their objection in person to the municipality
Portugal	-	Consultation for at least 30 days on draft plan and opportunity to object.	No enquiries held
Spain	The public is involved but this is not mandatory. Initial consultation for 30 days on first draft plan "calling for suggestions" for changes.	Consultation for one month and opportunity to object. A second period of consultation is held if major changes are made.	-
Sweden	Wide public consultation on initial proposals is the norm	Consultation for 3 or 12 weeks depending on the type of the plan.	-
UK	The public may be informed and consulted prior to proposals coming forward. There is a mandatory publicity and consultation stage usually based on the first draft proposals.	Consultation for 6 weeks on the plan and opportunity to object. A further period of 6 weeks for objections if major changes are made after the enquiry.	Enquiry is held unless all objectors agree that it is not necessary.

Source: EU compendium of spatial planning, with updates from TRANSPLUS partners

Table 8.2: Formal requirements for consultation in a selection of EU countries

A distinction can be drawn between *formal requirements for consultation* (which are legally binding) and *informal methods for encouraging participation* (which are typically not legally binding). Table 8.2 shows the statutory planning requirements concerning public participation in a selection of EU countries.

A large number of possibilities of informal active participation in planning processes were identified by the TRANSPLUS project (TRANSPLUS, 2003a). These instruments include:

- Creation of residents' groups and networks invited to participate in planning processes / projects whenever relevant for their area;
- Workshops or forums which try to develop visions for the "city of tomorrow" or which revolve around a concrete project of urban planning;
- Planning cells: random selection of citizens who are encouraged to solve tasks in the field of planning and development through team-work. Planning cells are supported by experts, who give advice, but without influencing the ideas of the citizens.
- Active involvement of target groups with special needs in planning processes, for instance the involvement of inhabitants, children and youth in the design of open spaces, involvement of cyclists in planning cycle-paths and cycle-networks;
- Youth-oriented techniques include Childrens' Parliaments, which promote youth education and learning of how the decision making process concretely works;
- "Planning for Real" techniques whereby members of the public are actively involved in (re)designing their local land uses, sometimes in the form of a three-dimensional model.
- Active involvement of citizens, employees etc. in campaigns and actions which promote environmentally friendly behaviour: for instance the campaign "cycle to work" or the "one week without car usage";
- Action days to promote cycling, public transport and less car usage by several campaigns for instance involvement of schools, citizens organisations. Examples are the Bike to Work Day and Car Free Day in several European cities.

An example of a concrete example of an intensive participation process, concerning the Groningen Local Traffic Plan, is given in box 8.1.

Although these instruments are primarily urban in orientation, in many cases they can be extended to cover interurban planning. One important type of participatory instrument that overcomes the "spatial restriction" associated with the requirement for face-to-face contact concerns those instruments that make use of the internet (thus representing a packaging of participatory instruments with technological instruments in the form of Intelligent Transport Systems). Further information about such instruments is given by Tang and Waters (2005).

Box 8.1: Local Traffic plan developed for Groningen (NL) in the period 1995-1997

Source: PLUME (2003)

Introduction phase:

- **political theatre:** 45 citizens were invited to act as 'advisors' for the city in a debate with city politicians and several interest groups; three concrete projects for immediate implementation, proposed by the interest groups and discussed in this political theatre, were accepted and implemented afterwards.

Phase 1: problem identification

- a **suggestion box** circulated from one public building to another, in which people deposited in writing their ideas, complaints and demands for the traffic situation in their city.
- 660 **telephonic interviews** among a random sample of citizens, conducted by 'professionals': people with responsibility within traffic planning (politicians, officers and representatives of relevant interest groups)
- **traffic survey** and an accompanying invitation to participate in future meetings, in two door-to-door papers: 6000 surveys were returned, 1900 expressions of interest to participate.
- **newspaper** to inform people about the traffic planning process
- 300 of the interested citizens reacted on the invitation to participate in '**round tables**' in which groups (tables) of 16 persons held discussions to select themes
- From the information gathered in the surveys and round tables, 8 different stakeholder groups were distinguished (commuters, scholars, business traffic generators, etcetera). **Workshops** for 12 groups (the 8 stakeholder groups and 4 groups for distinct parts of the city) were organised, discussing 6 different themes. Three series of workshops on these themes took place, focussing first on problems, second on causes, thirdly on possible strategies.
- The participants were offered more information on the subject through a **book** on traffic in Groningen, published specifically for this cause.
- Formulation of the criteria for the future selection of solutions ('denkrichtingen') and the integration of the results from the first phase were compiled in an intermediate document.
- Parallel to the planning process, a **communication channel for individual complaints** ('klachtenbank') on traffic items was installed.

Phase 2: Strategy formulation

- **Workshops in smaller groups;** 80 participants divided over 4 groups. The participants to these workshops were representatives from political parties, interest groups and one representative from each work group from the previous phase. Each group discussed one of four scenarios developed by project leaders based upon the previous phase.
- The results were brought back to the Groningen population through different channels: two **presentations in the Groningen grand theatre**, where a representative of each group and the project coordinating team presented the results of the discussion, pro's and contra's. The visitors of these 'presentations' (200 people) were invited to vote for one of the proposed scenarios. The results were also **published in an advert in the door-to-door papers**, with the invitation to the citizens to react individually on the scenarios. The project team organised **presentations for organised interest groups**. These interest groups and the political parties were invited to react on the scenarios and even to propose alternative plans, leading to 15 alternative plans.

Phase 3: Policy choice and formal decision-making

- The third phase concentrated on **work within the project team, the city governors, and expert bureaus**. Starting from the common aspects that came from the four discussions on the scenarios and consequent solutions, drafts for discussion on the level of political representatives were prepared by the project team, expert bureaus etcetera.
- One of these **drafts was again taken to the people**, through different means; a new **presentation in the Grand Theatre**, a possibility to send **reactions individually** and a **survey** among the 1900 citizens that expressed their will to participate in the former stages.
- Simultaneously and thus preceding the formal participation procedure, the political parties and the interest groups were invited to react on the draft.
- The remaining points of discussion coming from the survey and the input from the parties and interest groups were debated in two public **forum-discussions**, with participation of the city councillors, alderman and interest groups.

This phase was followed by the usual and formal decision-making process, involving the formal public inquiry, which raised many less reactions that could have been expected without the open planning process.

As reported in PLUME (2003), TRANSPLUS (2003b) emphasises that the following issues should be taken into account considering different types of consultation / participation:

- It would be a mistake to view the processes listed above as if they were part of a relationship between a monolithic single public authority and a homogenous public. In reality, with respect to a particular location, there will be a number of differing public bodies (with differing geographical and technical responsibilities) with responsibility for land use and transport planning. On the other hand, the public that needs to be consulted will comprise a range of different social groups with different needs, ideologies and levels of confidence in putting over their views, and there will be varying types of power relationship existing between such groups which influence any participatory activities.
- A distinction needs to be made between “direct” forms of participation, which involve individuals directly, and “mediated” forms of participation in which a well-established organisation represents the views of a particular social group. Whilst the second option might be easier to organise in practice (especially for a large locality) there is a potential problem in that the organisation might well have aims of its own that are not reflective of the people that it is representing.
- Many experiences have shown that some members of the public are more interested in participating in discussion around local short-term schemes rather than in defining long-term strategies. Whilst the former type of participation should be encouraged, methods need to be developed to encourage both types of participation to take place in synchronisation.

Further to the distinction between *formal* and *informal* instruments described above lies a category of participatory instrument that can be referred to as *semi-formal*: such instruments are discretionary on the part of a local authority but are more binding than informal approaches with respect to the results of the participation process. Two examples of such instruments can be given:

- Local authorities can opt to resolve decisions about specific transport instruments by carrying out referenda. Such referenda are often used for making controversial decisions such as those concerning urban road pricing. In recent years, referenda have been conducted for road pricing schemes in Edinburgh (2005), Stockholm (2006) and Manchester (2008). Of these three referenda, only the referendum in Stockholm led to support for road pricing (more information about the Stockholm scheme, one of the TRANSvisions case studies, is given in Box 8.2). Although the London road pricing scheme (also described in the TRANSvisions case studies) did not include a formal referendum, it can be argued that Mayor Livingstone’s re-election in 2004 gave a certain level of popular approval to the previously-introduced road pricing scheme, given that the scheme was a central theme in the election.
- “Participatory budgeting” instruments have been pioneered in Latin America (particularly in Brazil). Such instruments encourage high levels of public participation in setting and monitoring annual budgets, primarily concerning infrastructure expenditure. Although mainly adopted on an urban level, they have also been implemented on a state level. Such instruments have been the subject of a Network in the Europeaid URB-AL Programme, where they have generated great interest on the part of European cities.

Box 8.2: Stockholm urban road pricing**25% traffic reduction, 40,000 less cars per day**

Source: IBM website. April 2007

http://www.ibm.com/podcasts/howitworks/040207/images/HIW_tr_04022007.pdf

Traffic congestion has been a growing aggravation in Stockholm for years, with over half a million cars travelling into the city every weekday. And it's not going to get any better on its own. The population of Stockholm County is growing at a rate of around 20,000 people a year, which inevitably means more traffic and an even greater burden on city streets.

Simply building more roads isn't the answer. Road building cannot keep pace with the increased demand, and the environment wouldn't be able to sustain the impact. Authorities in cities across the world have encouraged people to make greater use of public transport, but still the bottlenecks get worse.

And so a few years ago, the Swedish National Road Administration and the Stockholm City Council set out to find another way to reduce both the number of traffic jams in Stockholm and its air pollution levels.

The solution they came up with was a hightech traffic charging system that directly charges drivers who use city center roads during peak business hours. The hope was that this pilot project, which launched in January 2006, would encourage more people to leave their cars behind and use public transportation instead. The charge was also intended to bring about an overall improvement in the urban environment in Stockholm, particularly in air quality.

As part of the project, 18 roadside control points located at Stockholm city entrances and exits were set up to identify and charge vehicles depending on the time of day—higher during peak times, lower during off peak hours.

The way it works, drivers can install simple transponder tags that communicate with receivers at the control points and trigger automatic payment of road use fees. Once a vehicle passes a roadside control point during designated congestion hours, it is recognized by the transponder that is read by sensors.

In addition, cars passing through these control points are photographed, and the license plate numbers are used to identify those vehicles without tags and to provide evidence to support the enforcement of non-payers. The information is sent to a computer system that matches the vehicle with its registration data, and a fee is charged to the owner. Drivers can pay their bills at local banks, over the Internet and at area convenience stores, like 7-Eleven. The technologies at work here include RFID tags, which use radio waves to automatically identify objects, and wireless sensors, which are little devices that can detect and measure real-world conditions and convert them into signals that are sent to computers.

Another emerging technology—optical character recognition software—is used to identify license plates from any angle. The road charging system had an immediate impact on congestion and overall quality of life for the citizens of Stockholm. By the end of the trial, traffic was down nearly 25 percent and train and transit passengers increased by 40,000 a day.

What's more, the reduction in traffic led to a drop in emissions from road traffic by eight to 14 percent in the inner city; and greenhouse gasses such as carbon dioxide fell by 40 percent in the city. In the face of local skepticism about the project, the authorities decided to implement road pricing for one year—on a trial basis—and then allow citizens to decide via a referendum whether to make it permanent. That referendum recently passed. The success of the project also signals the coming of age of a whole new generation of technologies—more powerful and accessible than ever before.

8.3 *A priori* set of policy instruments

8.3.1 Description of instruments

As stated above, Task 2 has provided an *a priori* set of policy instruments, which form the basis for the analysis of policy instruments in the remainder of the chapter (though importantly, as will be seen, the instruments considered in the chapter will not be restricted to this *a priori* set). The set is described as follows:

The general objectives of the European Union are sustainability and competitiveness to improve the standards of living of its citizens. These objectives are threatened by the ageing of its population, globalisation, the energy transition and climate change. The transport system should contribute to the attainment of these objectives by increasing its own efficiency in the use of resources, including natural ones, and therefore that of the other sectors of the economy.

Of those developments the energy transition and climate change concern directly the transport sector: transport relies up to 97% on oil and contributes up to 27% to CO₂ emissions. Ageing and globalisation pose the problem of competitiveness.

TRANSvisions results, with their often diverging scenarios illustrate well the deep uncertainty that derives from the fact that the baby boom ageing, the technological revolution and globalisation (China's emergence as a super-power), climate change and the energy transition are extraordinary events each on their own. Put together they represent an extreme challenge to any policy planner.

Thus, to give an answer to this uncertainty while reaching its objectives of sustainability and competitiveness, the transport system must be efficient and well interconnected. But it must also be flexible and resilient to unforeseen events. Therefore transport planning must be sensitive and responsive to what is going on at any moment, with policy-makers preparing contingency plans which will include levels of redundancy in the system (e.g. ferries in case a bridge/tunnel is blocked). The transport system must also be able to work through oil supply disruptions. What happens if there is an embargo, or a terrorist attack blocks the main straits that give oil its access to Europe?

The EU transport policy covers already large areas of action built upon the initial Common Transport Policy of the 1957 Treaty of Rome. The European Union right to act is limited by the Treaties and the derived legislation the "acquis communautaire" and by the general principle of subsidiarity. Member States transport policies are not subject to the same constraints. Transport policy has been reviewed upside down by international organisations in the context of the fight against climate change (e.g. IPCC). There are few surprises to be expected in the field of policies: the latter have been quite comprehensively examined in this study and will be recalled in the next pages. Any novelty may come rather from the organisation of these policies with the emergence and consolidation of new forms of supranational governance and cooperation between States and with an increase of the participation of the population to make societal change possible.

The operation of the EU transport policy levers has to be seen in the context of the 2001 White paper and its 2006 mid-term review. Broadly speaking, the 2001 White Paper indicated that if European institutions and companies invest in railways and put charges on roads the transport system will go in the right direction (CO₂ reduction, less accidents and congestion). This approach was based on the understanding that road transport was not paying for all the costs it produced and took into account that railway networks were the least interconnected modes. The mid-term

2006 review further wanted to improve the efficiency of transport as a whole, including the largest sector, which is road transport. A more efficient road transport sector improves the efficiency of the transport system as a whole, but may also produce unwanted rebound effects. This is a permanent dilemma of the transport sector where desirable reductions in internal costs often result in an increase in external ones. Any future policy statement at EU level has to find a balance between these two desirable but sometimes contradictory objectives

Policies inducing GDP growth and competitiveness by facilitating mobility could be the following ones: opening markets, better use of existing infrastructure, more investment in TENs and nodes (platforms), increase in funds for research and subsidies to the introduction of new technologies (e.g. electric cars, fuel cells). These are "pull" measures which would feature high in the promotion of a situation like that described in the "induced mobility" scenario or in any approach looking for a "technological fix" to future challenges. Some of these measures may just allow the market to provide its own incentives.

Policies that may reduce or constrain economic growth in the short-term but result in a more sustainable and healthy growth in the future could be: pricing, taxation, ETS (although energy savers can make a profit out of it), standards and bans. These are "push" measures that try to steer behaviour in a way that it is both fair with the participants and convenient to society. Policy action trying to promote a situation like the one described in the decoupled or reduced mobility scenario would have recourse to policy packages involving this kind of measures.

Based on these two broad types of policies, the generic transport policies that could be discussed, in the frame of the next Communication, planned for June 2009, could be the following ones:

- **Target setting for environmental purposes has become possibly the most determinant policy instrument for the years to come.** In the framework of the Climate and energy package the European institutions have set up legally binding targets, by 2020, to cut greenhouse gas emissions by 20%, to establish a 20% share for renewable energy, and to improve energy efficiency by 20%. The GHG objective could be revised upwards to 30% if a satisfactory international agreement is reached. Moreover the European Council has expressed its wish to aim at a global reduction of 80% by 2050 compared to 1990. The total effort for GHG reduction will be divided between the EU Emissions Trading System (ETS) and non-ETS sectors. Most of the transport sector, together with housing, agriculture and waste sectors are among the latter. Electric railways are already covered by the ETS system through their power purchases. Aviation will be subject to ETS from 2012. The EU ETS sectors will reduce emissions by 21% compared to 2005 by 2020, the non-ETS taken as a whole will reduce their GHG emissions by 10% within the same period; together they will reduce GHG by 20% compared with 1990. However, it has been left to member States to decide the extent to which they will focus their efforts to reach the non-ETS 10% target on the transport sector, the Commission having mostly a monitoring role. This may give rise to a kind of "distributed" European transport policy.
- **Regulations on the energy efficiency of vehicles:** One of the main forthcoming measures for non-ETS transport modes refers to the setting of binding targets for car efficiency. Passenger cars account for about 12% of the Union's CO₂ emissions, almost half of the 27% due to the transport sector. A new regulation will set emission performance standards for new passenger cars registered in the EU. The regulation sets an average target of 130g CO₂/km for new passenger cars to be reached by improvements in vehicle motor technology and introduces a long term target for 2020 for the new car fleet of average emissions of 95 g

CO₂/km according to modalities to be defined by the Commission in 2013. Vehicle energy efficiency is one of the main levers to steer the transport system towards a reduction of emissions and is a basic element of the "induced mobility" scenario which allows the continuity of an "auto-mobile" society. These measures concern the nominal performance of vehicles and fuels, not the volumes of vehicles operating and fuels consumed which may also increase as a rebound effect of greater efficiency and cheaper mobility. Transport control and management measures therefore have to complement the vehicle and fuel technology side. There come all the measures on modal shift, eco-driving, private-to-public shift, etc.

- **Increase in funds for research and development** in particular towards energy efficiency improvements and breakthrough technologies aimed at achieving step changes in the transport system. This will be implemented in close collaboration with industry including PPPs such as the Fuel cells and hydrogen Joint technology initiative or the Clean Sky JTI. Technological projects to improve the use of capacity such as Galileo, SESAR or ERTMS will be further strengthened. Research activities will also be aimed at improving accessibility for all and reducing congestion.
- **Enhanced support to technological innovation and applied research** is a key policy to facilitate the fastest possible implementation of new technologies, in the short-term in relation to the improvement of existing oil-based cars, later on in relation to a new generation of vehicles and intelligent infrastructures, as well as on-line management systems. The skills of the labour force will have to be upgraded to cope with intelligent highly automated systems. In the long term, the introduction of new technologies such as cell fuels and alternative fuels could more than halve current transport emission levels. The vehicle R&D strategies, such as developed by ERTRAC (road transport research Platform), EPOSS (European Technology Platform on Smart Systems Integration), and the hydrogen fuel cell JTI, foresee large scale market deployment of electric and hydrogen vehicles by 2020. That should considerably reduce the average CO₂ emissions of new vehicles.
- **Market opening and liberalisation to complete the internal market within the respect of social and public service constraints:** To improve productivity by facilitating healthier competition, the current liberalisation policies could be reinforced. The European Parliament has asked Road cabotage liberalisation by 2014. The impacts of such a measure have to be studied, but in theory by allowing new operators and increasing competition this measure will possibly reduce costs and time of road transport. In the medium term a relaxation of the road cabotage rules, could be favoured by low demographic growth, which could produce both a convergence in road driver wages and of their social conditions and a big scarcity of truck drivers. Further market opening for other modes in order to complete the internal market would allow to overcome remaining national barriers (rail, ports and airports) and better integrate Europe in World markets, not least with the USA (ports and aviation e.g. open skies). These measures are efficiency oriented and could be taken over in scenarios such as the induced or decoupled. However, they pose also the problem of public support and highlight the need to take care of the social dimension.
- **Better use of existing Infrastructures:** ICT and on-line supply management technologies have to be applied to make the best possible use of scarce capacity, especially when heterogeneous traffic flows overlap. More segregation between urban/long-distance, passenger/freight services is to be expected in near-congested corridors. Subsidies to intermodality (Marco Polo, State aid), free information provision. ITS, reduction of administrative bottlenecks would continue.

This kind of measures belongs to the field of organisational improvements backed by technology use. They encompass the technological focus of the induced mobility scenario with the social organisation approach taken in the decoupled and reduced mobility scenarios.

- **Infrastructure investments on TENs**, especially in a **freight network of dedicated or priority rail and road corridors** linked to ports and logistic centres will make mobility cheaper and more reliable and increase it, even if the net increase in total mobility is lower than in the mode that happens to benefit from these investments due to modal shift. The enormous growth on freight imports and exports from/to Europe will make this integrated and interoperable network increasingly necessary. Among those projects could be studied a programme of intermodal transshipment platforms, perhaps financed through PPP programmes. It could also be assumed that bottlenecks in rail access to ports are reduced through well targeted low-cost infrastructure works allowing the coexistence of rail passenger and freight, 24 hour service loading/unloading timetables at ports and stations and slot priority to rail freight. These measures go beyond the "predict and provide" approach which would be typical of the induced mobility scenario and may be steered towards some forms of infrastructure (links and nodes) considered more sustainable, which would be typical of the "decoupled" scenario approach.
- In this respect, an **integrated network of passenger transport** assuring efficient connections to large intermodal nodes (with airports and HST) for long-distance travellers will become necessary to overcome capacity bottlenecks. Existing priority projects and TENs would have to be redefined accordingly.
- **Getting prices right is indispensable to assure the user-pays and polluter-pays principles**, so users have the incentive to rationalize their consumption of transport overtime. Given that transport congestion happens just on peak periods, right pricing may increase significantly the productivity of existing infrastructure. Road pricing, starting by the Eurovignette directive and its ongoing revision, will be based on a cost-recovery and internalisation of social and environmental impacts due to road traffic. In some years transport fees will be applied on-line. Other transport modes should follow in the framework of a gradual strategy, including private cars, subsidiarity allowing. This measure is an essential component of a decoupling scenario. To be correctly implemented it needs accompanying measures that provide alternatives to the users and convinces them that the money they pay is put to good use. Therefore, in this case the social dimension is very important as the measure needs public support to be politically feasible and practically successful.
- **Taxation will change in the coming years because of the expected reduction on oil consumption.** Nowadays, oil taxation represents approximately 1.9% of GDP, with taxes on vehicles 0.6%, but the public revenues generated by the transport sector do not compensate overall the budget allocated to infrastructure investments (1%) and the environmental externalities (-1% of GDP), congestion (-1.1%) and road safety (-0.5%) according to the UNITE study. This does not mean that the system is efficient as payments apply the polluter and user pay system in a very blunt way, mixed with the need to collect fiscal resources. The distribution of the resources generated by taxes among territorial scales and transport modes is not in balance, either. The gradual substitution of the actual taxation system for an on-line pricing system would likely increase largely the productivity of the sector. Thus the market efficiency and the overall resource efficiency of road freight would improve, as well as the efficiency of intermodal rail/road or other combinations due to freight logistics improvements.

- **Move to self-financing.** For a maximum assurance, in a public finance context whether other social expenses may have more priority than the transport system, the latter should also be able to finance itself in a close loop if need be. This does not mean giving up the possibility of grants to compensate socio-economic benefits, but is an element of resilience to a scarcity of public funds. Possibly the best way to ensure financing self-sufficiency and responsiveness to demand is congestion pricing combined with PPP financing which adds the long way to it. Pricing should also include internalisation, which is only effective in reducing externalities if there are real alternatives (e.g. really efficient railways and sea motorways).
- As financing instruments will become increasingly expensive and pricing is politically costly other mostly **regulatory measures** such as allowing the introduction of truck gigaliners could be implemented taking again care –e.g. through pricing and regulation - that a reduction in internal cost does not result ("rebound") in an increase in external costs.
- **The establishment of bans** (e.g. to road vehicles with emissions higher to a given threshold, as well as to certain type of infrastructures, like motorways passing-through urbanised or protected areas...) may have a contradictory impact: while in the short-term may reduce to some extent the economic growth, in the longer run may result in more technologic innovation and higher productivity. Another regulatory instrument is the introduction of the same private car speed limit than in the USA (40 – 48 kph in urban areas, 88 – 104 kph on interurban roads and 88 – 120 kph on motorways). The majority of states has speed limits on or below 113 kph on motorways). Road congestion could be fought with regulatory measures such as dynamic speed management, high occupancy vehicle lines or ramp metering. Lower congestion would also favour road freight traffic. In case CO₂ emissions grow too much, partially as a result of rebound effects, CO₂ efficiency standards for trucks and vans as the ones that exist for cars could be introduced.
- An **urban transport dimension** may be found for most of the previous policies and measures. Cities are keys to economic development and their importance in the transport system has been underlined in the different scenarios examined in this study. Almost 85% of the EU's Gross Domestic Product is generated in cities. But at the same time, urban transport is responsible for 40% of CO₂ emissions and 70% of emissions of other pollutants arising from road transport. Though the question of subsidiarity arises, there are certain fields where Europe can play a supporting role. Many cities are looking at ways to address the problems of urban congestion and pollution. For example: Congestion charging schemes, low emission or "Green" zones, the use of clean vehicles and alternative fuels, and improved logistics for freight deliveries, as well as high quality public transport. In 2007 a Commission Green Paper¹⁵ proposed an integrated approach. Different policy issues, such as transport, energy, environment and planning need to be treated in an integrated way. And most importantly, the different policy levels need to work together, from local to EU level.

8.3.2 Relationship of *a priori* instruments to objectives in Chapter 7

The first point to note about the policy description given above in 8.3.1 is that it includes both policy objectives (including targets) and policy instruments. As stressed in Chapter 7, it is important for clear policy thinking to distinguish between objectives and instruments. A first step in synthesising the *a priori* instruments with the "aims, objectives, in-

¹⁵ Commission Green Paper on Urban Mobility. COM (2007) 551

struments” logic at the heart of Chapter 7 is to identify the mapping between these instruments and the aims/objectives given in Chapter 7. Table 8.3 to Table 8.5 provide such a mapping for the aims of economic sustainability, environmental sustainability and social sustainability respectively. When looking at these tables it needs to be borne in mind that any particular policy instrument might contribute to more than one policy objective. However, for the sake of simplicity, the table (in many cases) only provides the “main” policy objective associated with the instrument (though in some cases there might clearly be a debate as to what the “main” objective actually is).

Objective	<i>A priori</i> instruments
Economic growth	<ul style="list-style-type: none"> • Road cabotage liberalisation • Liberalisation in other sectors (e.g. “open skies”) • Replacement of current (transport) taxation system with an on-line pricing system
Generation of employment	
Reduction of congestion	<ul style="list-style-type: none"> • ICT and on-line supply management technologies • Subsidies for intermodality (e.g. Marco Polo) • Infrastructure investment in TENs, especially in a freight network of dedicated or priority rail and road corridors • An integrated network of passenger transport, ensuring efficient connections to large intermodal nodes (including airports and HST) • Road pricing • Dynamic speed management • High occupancy vehicle lanes • Ramp metering

Table 8.3: Mapping of *a priori* policy instruments with objectives for an economic sustainability aim

Reduction of GHGs	<ul style="list-style-type: none"> • Emissions Trading system (ETS), (relevant to air sector) • Support for technological innovation and applied research • Bans of road vehicles with emissions higher than a given threshold • Road pricing
Reduction of local pollution	<ul style="list-style-type: none"> • Support for technological innovation and applied research • Bans on specific roads of road vehicles with emissions higher than a given threshold
Reduction of noise	<ul style="list-style-type: none"> • Support for technological innovation and applied research
Protection of environmentally-sensitive areas	

Table 8.4: Mapping of *a priori* policy instruments with objectives for an environmental sustainability aim

Reduction of accidents	<ul style="list-style-type: none"> Support for technological innovation and applied research Reduction in car speed limit
Provision of accessibility to opportunities/services	
Enhancement of social cohesion	
Enhancement of a participatory approach to transport planning	
Enhancing the rights of travellers to good quality transport provision	
Attaining high quality standards of employment within the transport sector	

Table 8.5: Mapping of *a priori* policy instruments with objectives for a social sustainability aim

It can be seen from Table 8.3 to Table 8.5 that the *a priori* instruments are generally associated with the aims of economic and environmental sustainability, and not with social sustainability (with the exception of the objective for reducing traffic accidents). As has been remarked at a number of places in this report, this imbalance is common. The following types of instrument can be highlighted for helping with social sustainability objectives:

1. Participatory instruments (as described above in Section 8.2)
2. Integrated land-use/transportation planning instruments, for meeting accessibility and social cohesiveness objectives. A “futuristic” vision of such planning, the Masdar City Project, taken from the TRANSvisions Case Studies, is shown in Box 8.3. Land use planning instruments, when applied on an urban level, are greatly helped by instruments that encourage non-motorised forms of transport, i.e. walking and cycling. A number of such instruments are described in the TRANSvisions Case Studies. One of these case studies, concerning bicycle rental schemes, is shown in Box 8.4.
3. Instruments to enhance the rights of travellers, such as those contained in the 2001 White Paper
4. Instruments to attain high quality working conditions for workers in the transport sector, as mentioned in the 2006 Mid-Term Review

The current actions of the Commission with respect to instruments in categories (3) and (4) are described in 8.3.3

Box 8.3: Masdar City Project: World's first carbon-neutral citySource: Abu Dhabi Future Energy Company: <http://www.masdaruae.com/>

Masdar City is the most ambitious sustainable development in the world today - it will be the world's first zero carbon, zero waste city powered entirely by renewable energy sources. Masdar City will be built over seven years at an investment in excess of US\$20 Billion. Its masterplan design meshes the century-old learnings of traditional Arabic urban planning and architecture with leading-edge technologies to create a sustainable, high-quality living environment for all residents. The City will be built in seven carefully designed phases, incorporating the latest technological advances generated in its clean-tech cluster and globally. Strategically located at the heart of Abu Dhabi's transport infrastructure, Masdar City will be linked to surrounding communities, as well as the centre of Abu Dhabi and the international airport, by a network of existing road, and new rail and public transport routes. The City will be car free and pedestrian friendly. With a maximum distance of 200 meters to public transport and amenities, and complemented by an innovative personal rapid transport system, the compact network of streets will encourage pedestrians and community social life. Infrastructure support projects at the City will include landscaping, common areas, leisure areas, access roads, bridges, tunnels and Information & Communication Technology (ICT) services as well as development management. To accomplish its ambitious endeavour, Masdar requires access to leading edge thinkers and companies through mutually beneficial partnerships. Masdar is currently embarking on a global drive to attract industry partners to participate in this historic endeavour. Masdar City will take sustainable development and living to a new level and will lead the world in understanding how all future cities should be built. The development will have multiple phases, each with different requirements and therefore different strategies, objectives, and partnership structures.

Box 8.4: Bicycle rental as emerging public-individual transport in European cities

Source: Sebastian Bühramann; European Conference on Bicycle Transport and Networking –MEETBIKE; Dresden. April 2008



Innovative schemes of rental or free bicycles in urban areas can be used for daily mobility as one-way –use is possible. They are part of the public transport system. Differ from traditional, mostly leisure-oriented bicycle rental services as they provide fast and easy access. Have diversified in organisational layout, the business models and the applied technology towards “smart bikes” (automated rental process via smart card or mobile phone). There are many different applications in European cities: Lyon–“Vélo’v”, Barcelona– “Bicing” (since March 2007); Paris – “Velib’” (since July 2007). Other cities beyond Europe: Buenos Aires, Beijing, San Francisco, Tel Aviv, Brasil, Montreal, etc. Challenges. The challenges of this scheme: it is not easy to get it started, financing is another hurdle to overcome; achieving real long term impact needs continuous development of overall urban transport strategies towards multi-modal travel behaviour.

8.3.3 Current Commission actions with respect to social sustainability

With respect to social sustainability (separate to accident prevention), the current Commission is applying the programme contained in the Mid-Term Review of the 2001 Transport White Paper:

- **Action:** Examine, together with stakeholders, how increased quality of service and assurance of basic **passenger rights can be promoted in all modes of transport**, notably as regards **passengers with limited mobility**.
- **Action:** **Encourage training and take-up of transport professions** by young people; examine in consultation with stakeholders the **rules on working conditions** in road haulage and propose adjustments where needed; encourage **dialogue between social partners** across borders, notably to apply the ILO Convention in the maritime field.

Concerning passenger rights, air transport is the most advanced mode in their protection: Regulation 261/04 on passengers' rights (denied boarding, delays) which have a general impact on all air travellers and regulation 1107/2006 concerning the rights of disabled people. As to rail transport, a Regulation on rail passengers' rights and obligations will start applying from 2009 onwards establishing full non-discrimination in relation to persons with reduced mobility.

- o As to the future, two measures have already been prepared along the same lines for **maritime transport and bus and coach transport** to apply to disabled people in order to ensure their access to these transport modes.

The rights to mobility and accessibility are particularly at stake in the case of **urban mobility**. The Green Paper on urban mobility adopted by the Commission in 2007 covers all urban transport modes and deals with both urban freight and passenger transport. The paper addresses objectives such as better accessibility of (public) urban transport, safe transport and better working conditions.

- As to future actions, DG TREN is now working on an **action plan on urban mobility** which will consider accessibility to urban transport among other issues.

As regards working and social conditions, the Commission has profited from the collaboration of the social partners to develop the European legal framework. In the recent example on labour conditions for seafarers the social partners have played an exemplary role throughout the negotiation process at the ILO **and** for the European social partner agreement thereafter. This agreement has been "taken over" into Community law on 20 May 2008 (it coincided with the first European maritime Day).

The transport sector can also boast of a solid basis of social legislation regarding for example harmonized maximum working hours for road transport. A road social package was presented in 2007 which provides a clearer definition of "cabotage" and strengthens the conditions of access to the carrier profession.

- This proposal has been complemented in 2008 by a **proposal on the working time of independent lorry drivers** in order to better define the notion of false self-employed and to improve enforcement.

8.4 Division of labour between political jurisdictions

As already discussed in Chapter 3, a number of important issues arise when considering governance in the future. These issues can be distinguished by geographical scale (world, EU and local), although of course an issue on one geographical level will have impacts on the other levels.

The exploratory scenarios described in Chapter 4 are primarily concerned with developments within the EU rather than world developments. However, with respect to the world scale, we can distinguish between scenarios in which there is a convergent world, so that the issue of world governance becomes increasingly central, and scenarios in which the world becomes more heterogeneous and divergent than at present. Given the fact that transport is the mechanism by which different parts of the world are physically connected, and due to the global nature of some of the negative impacts of certain forms of transport (for example climate change and the overuse of limited supplies of fuel), there is a clear benefit to transport planning in attaining a system of world governance. This point appears to be consistent with the thinking underlying the scenarios proposed by the Global Scenario Group (SEI) (mentioned in Annex 1), which define the world as currently being in a "Planetary Phase" which could potentially evolve into a utopian future ("Great Transition") in which there is worldwide equality and justice, or could descend into a dystopian world ("Barbarization") involving war and general global breakdown. The utopian future would clearly need a system of world governance, though this would be democratic rather than authoritarian. The Great Transition represents a cohesive and environmentally-friendly world in which security concerns (and hence security policy) do not play a major role. On the other hand, security policy would arguably be the most important policy driver in Barbarization, reducing other policy drivers to minor significance. In the context of world governance, it should be noted here that the 2001 White Paper had a section entitled "The Enlarged Europe Must be More Assertive on the World Stage" which led to the recommended action for "Full membership for the European Community in the main international organisations, in particular the International Civil Aviation Organisation, the International Maritime Organisation, the Rhine Navigation Commission, the Danube Commission and Eurocontrol."

On the European level, policy implementation can be distinguished according to whether the policy concerns transport that is international, national or local (including urban). This distinction raises the principle of subsidiarity on which EU policies are based. According

to this principle collective action should be taken at the level which is as close to the citizen as possible: when collective action needs to be taken at EU level it has to be well targeted and the means employed have to be in proportion to the objectives sought. The application of the subsidiarity principle may also determine that collective action is not needed and that the market can cope. Specific advantages in favour of the division of labour towards higher level jurisdictions such as the EU are: economies of scale for large projects which can only be undertaken at EU level; the existence of cross-border positive externalities between Member States; and the sharing of risks in risky projects. In all cases, however, the costs of implementation at the different levels have to be taken into account.

In general the EU has a clear responsibility for policy instruments associated with international transport (such as the TENs) and support for activities taking place on an international level, such as R&D (including the Framework Programmes). Furthermore, it has an important responsibility for devising contingency plans for dealing with highly disruptive events (described in Section 6.5) on a continental scale (the most disruptive of such events are all likely to be on such a scale). The EU can also play an important coordinating role concerning transport policy instruments enacted at a national level. Examples of the latter concern: infrastructure, implemented at national level, but which needs to link up coherently with the TENs; standardisation of technology; and competition rules.

As mentioned in Chapter 3, many interesting issues concern the role of the EU in local (particularly urban) policy-making. The sum total of all urban transport throughout Europe clearly has a significant impact on Europe as a totality, for example in terms of CO₂ emissions and energy consumption. Furthermore, since the urban population is predicted to rise from 72% of total population in 2005 to 78% in 2030 (as described in the Task 1 Report), the “urban dimension” of policy-making is clearly significant. However, due to the principles of subsidiarity, the EU has a limited role in urban policy-making and it certainly would not be appropriate for the EU to try to adopt a “dirigiste” attitude towards urban transport policy-making (to use the term employed in the 2001 White Paper). Apart from any other reason, given the controversial nature of much urban transport policy-making, an authoritarian approach on the part of the EU could fatally undermine the credibility of the EU and lead to its disintegration. However, there is a middle-way between authoritarianism and “laissez faire” and it would be sensible for the EU to consider further how to pursue fruitfully such a middle way. For example, one important step could be for the EU to pursue more strongly its current role as a “facilitator of good practice” (funding interchanges between city politicians for example). One further aspect of this approach would be for the EU to make clear that it is a champion of public participation in the local transport-planning, without trying to specify *a priori* which conclusions such local planning should reach.

8.5 Summary and Conclusions

As described in Chapter 5, two types of modelling test have been carried out in TRANvisions: “traditional” modelling of specific instruments using TRANS-TOOLS; and a “lighter” type of modelling of generic instruments using the Meta-Models. The TRANS-TOOLS modelling tests have been restricted to instruments that are implemented at a high (EU) level of governance (instruments concerning EU interurban road pricing and the Trans European Networks). The tests using Meta-Models have involved instruments that can be implemented at various different levels of governance, including urban. Both types of test have concentrated upon predicting the CO₂ impact of policy instruments.

The current chapter has included a number of further “non-modelling” analyses of transport policy instruments from a variety of methodological perspectives, putting particular emphasis on the social sustainability dimension of policy-making, as discussed in Chapters 6 and 7. These analyses have ranged from theorising about participatory instruments

to illustrative “real-life” examples of a variety of specific instruments, as given in the TRANSvisions case studies. Furthermore, a set of *a priori* instruments has been presented, which generally represent a “traditional” approach to policy instrument formulation.

The conclusions from the synthesis of both modelling and non-modelling activities include the following:

- When formulating policy instruments for meeting specific aims, it is useful to think in terms of the creation of policy packages, where such a package is a combination of a number of instruments that are synergetic, or at least complementary, in their overall impact. In particular, packages can help ensure that the negative aspects of particular instruments can be offset by the positive aspects of other instruments in the package. When considering such complementary and compensatory effects, it is useful to think in terms of “instrument-types” (listed above as infrastructure, technology, economic, regulatory and participatory instruments).
- With respect to the reduction of CO₂ emissions, the model results show that options are limited if only those instruments are considered which can be implemented as a high level of governance (such as those in the TRANS-TOOLS tests). Large reductions in CO₂ emissions need to involve instruments that can be implemented at a variety of levels of governance, including urban (such as the tests made by the Meta-Models). In the specific context of European Transport Policy, this result has important consequences for subsidiarity issues. Furthermore, it is likely that an important contribution to the reduction of CO₂ emissions will come from “emerging technology” instruments (with a large number of such instruments being described in further detail in the TRANSvisions Case studies). Given that new technology is invented and developed through the combination of a variety of factors, it can be seen that the implementation of technology instruments is not as straightforward (in a policy formulation sense) as the implementation of certain other types of instruments (such as road pricing or building new infrastructure). However, the EU can take a variety of actions to help the implementation of such instruments, where such actions can be classified under two general headings. Firstly the EU can provide financial support to help research and development of new technology. Secondly, once such technology is available, the EU can help its introduction through a variety of regulatory instruments and demonstration actions.
- Broadening the perspective from one focussing upon CO₂ emissions, it is clear that transport is an extremely complex phenomenon, as shown by the many strands of results and analysis presented in the TRANSvisions study. Given this complexity it inevitably follows that any policy thinking concerning the long term future (over the next 40 years) must be “doubly complex”, given the uncertainties concerning the future. However, as is shown in this report, some aspects of the “long term transport problem” are reasonably well understood (for example some of the issues concerning different types of challenges). Furthermore, it is clear that transport policy needs to meet the overall goals of economic competitiveness and environmental sustainability. It is argued, though, that the “overall problem of transport policy” can be defined as being the fact that many other aspects of the transport system, particularly concerning social aims and issues, are not sufficiently well-understood, thus potentially giving an impression of fragmentation in much transport policy thinking.
- As stated above, it is suggested that transport policy-making puts more emphasis upon social sustainability, particularly concerning the “external social impacts” of transport policy (as opposed to “internal impacts” concerned with passenger rights and the working conditions of transport employees, which are well covered in terms of current EU policy-making). Arguably social sustainability concepts

(social capital, social cohesiveness and political capital) can provide the “set of missing links” to overcome to fragmentation remarked upon above. One immediate use of such concepts is to provide a more nuanced understanding of the “restriction on freedom” criticism levelled at attempts to manage demand. Heightening focus upon social sustainability includes a recognition that some travel is unwanted/undesirable from the point of view of the people making the journey (e.g. they would prefer services to be closer to home).

- With respect to policy instrument formulation, packages of policy instruments need to be devised to meet objectives associated with the three dimensions of sustainability. Traditional transport policy instruments have generally not been devised with the purpose of meeting social sustainability aims and future instrument packages need to rectify this omission. Of particular interest here are those instruments that help reduce unwanted travel (by heightening accessibility through planning measures) and those instruments that help public participation in transport policy formulation.
- When devising policy packages, careful consideration needs to be paid to the level of government appropriate for implementing any particular instrument within the package. This in turn raises the issue of subsidiarity. In particular, due to the principles of subsidiarity, the EU has a limited role in urban policy-making. However, careful consideration should be made as to how the EU could expand upon its current role as a “facilitator of good practice”, for example by making clear that it is a champion of public participation in the local transport-planning (without trying to specify *a priori* which conclusions such local planning should reach).

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Annex 1 Foresight scenarios from other studies

Table A1.1 repeats (from Chapter 4) a list of scenarios from other foresight studies. Indications are then given as to which of these scenarios are similar to the TRANSvisions Exploratory Scenarios. This is followed by short summaries of these scenarios (from other studies).

UK OFFICE SCIENCE & TECHNOLOGY	Perpetual Motion
	Urban Colonies
	Tribal Trading
	Good Intentions
FORWARD STUDIES UNIT "Five different futures for Europe"	Triumphant Markets
	The Hundred Flowers
	Shared Responsibilities
	Creative Societies
CPB, "4 FUTURES 4 EUROPE"	Turbulent Neighbourhoods
	Strong Europe
	Transatlantic Market
	Regional Communities
EMCC. "Trends and drivers of Change in the EU transport and logistics sector:scenarios" 2008	Global Economy
	Take the A-Train
	I'm in love with my car
	Riding the rainbow
ESPON 3.2.	Moonlight ride in a Diesel
	Pro-active Europe
	Cohesion-oriented (Danubean Europe)
UN GEO-3	Competitiveness-oriented (Rhine-Rhone Europe)
	The Markets First
	Policy First
	Security First
MEDACTION	Sustainability First
	Knowledge is King
	Big is beautiful
GLOBAL SCENARIO GROUP	Convulsive Change
	Market Forces
	Policy Reform
	Great Transitions
MILLENIUM PROJECT SCENARIOS	Fortress World
	S&T develops a Mind of its Own
	The World Wakes Up
	Please, turn off the Spigot
JAMES MARTIN	Backlash
	Fortress America
	The Strong Nation Clubs
	Triage
GLOBAL FUTURE ANALYSIS	Compassionate World
	Doing nothing
	Extending the past
	Reinventing prosperity

Table A1.1: Foresight scenarios from other studies.

Reduced Mobility*Similar scenarios*

- “The hundred flowers” (Forward Studies Unit)
- “Regional communities” (CPB)
- “Take the train” (EMCC)
- “Sustainability first” (UN GEO-3)

Induced Mobility*Similar scenarios*

- “Perpetual motion” (UK office of Science and Technology)
- “Triumphant markets” (Forward Studies Unit)
- “Global economy” (CPB)
- “Transatlantic market” (CPB)
- “Moonlight ride in a Diesel (EMCC)
- “Rhine-Rhine, competitiveness-oriented” (Espon 3.2)
- “The markets first” (UN GEO-3)
- “Big is beautiful” (MedAction)
- “Market forces” (Global Scenario Group)

Constrained Mobility*Similar scenarios:*

- “Good intentions” (Office of Science and Technology, UK study)
- “Turbulent neighbourhoods” (Forward Studies Unit)
- “I’m in love with my car” (EMCC)
- “Security first” (UN GEO-3)
- “Convulsive Change” (MedAction)
- “Fortress World” (Global Scenario Group)

Decoupled Mobility*Similar Scenarios*

- “Urban colonies” (UK office of Science and Technology)
- “Shared Responsibilities” (Forward Studies Unit)
- “Creative Societies” (Forward Studies Unit)
- “Strong Europe” (CPB)
- “Riding the Rainbow” (EMCC)
- “Danubean-Europe, cohesion-oriented” (Espon 3.2)
- “Knowledge is King” (MedAction)

Summaries of other scenarios

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Trends and drivers of change in the EU transport and logistics sector: SCENARIOS European Foundation for the Improvement of Living and Working Conditions, 2008

This report sets out four different scenarios for the European transport and logistics sector. Scenarios depict plausible hypotheses about the future; thus, they are useful tools for forecasting, analysing and formulating policy, as well as for strategic planning in private companies and among the social partners. In a rapidly changing and complex world – where demand and supply change equally fast – planning for the future cannot rely on simple projections of past trends. Alternative views of the future can help to broaden the understanding of issues that need to be addressed today. Scenario methodology provides such alternative views by embracing the uncertainty inherent in the future. This outline of four scenarios represents realistic, internally consistent, and plausible pictures of alternative futures for the transport and logistics sector.

Scenario 1: Take the A-train
Scenario 2: I'm in love with my car
Scenario 3: Riding the rainbow
Scenario 4: Moonlight ride in a diesel

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Intelligent Infrastructure Futures, The Scenarios – Towards 2055 A.Curry, T.Hodgson, R.Kelnar, A.Wilson

The Foresight Project on Intelligent Infrastructure Systems (IIS) set out to examine the challenges and opportunities for the UK in bringing 'intelligence' to its infrastructure – the physical networks that deliver such services as transport, telecommunications, water and energy. In particular, the project explored how, over the next 50 years, we can apply science and technology to the design and implementation of intelligent infrastructure for robust, sustainable and safe transport, and its alternatives. The technological opportunities and social factors are such that IIS can develop in many different ways. The direction will depend on the direction that society takes. The Foresight project investigated many alternative futures and identified 60 different 'drivers for change'. It is difficult to say how these drivers will change the future. However, to illustrate the possibilities, and guide its thinking and analysis, the project created four scenarios of how the future might look.

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4 futures for Europe. (WorldScan model) A.Lejour, P.Veenendaal, G.Verweij, N.van Leeuwen. CPB Netherlands

WorldScan is a recursively dynamic general equilibrium model for the world economy, developed for the analysis of long-term issues in international economics. The model is used both as a tool to construct long-term scenarios and as an instrument for policy impact assessments, e.g. in the fields of climate change, economic integration and trade. In general, with each application WorldScan is also adapted. This publication brings the model changes together, explains the model's current structure and illustrates the model's usage with some applications.

ESPON 3.2 Spatial Scenarios in relation to the ESDP and EU Cohesion Policy
Espon Project 3.2

The main objective of the project is to develop spatial scenarios which should on the one hand be prospective, capable of prognostics with reference to a laissez-faire scenario on themes of the ESPON and policy orientations of the ESDP. On the other hand the scenarios should as well be proactive testing alternative objectives and provide insight for recommendations on policy adjustments/changes in EU policies that would favour a balanced and polycentric territory and territorial cohesion within an enlarged European Union. The time horizon for the spatial scenarios is set to 2015 (mid term) and 2030 (long term).

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Scenarios for Europe. Five possible futures for Europe.

Forward Studies Unit, EC 1999.

The notion that Europe at the start of the third millennium is facing many challenges has gained widespread credence. The fact that our societies along with their values and traditions are changing rapidly is also commonly accepted. Daily, the threats and opportunities stemming from new technologies are the subject of numerous public debates. Our political leaders incessantly reiterate that we must find new ways to deal with the complexity of our contemporary world. Very seldom, however, are concrete examples presented in order to give people the opportunity to form an idea of how the future of Europe might look. Even more rarely are coherent and contrasted illustrations given of how Europe may evolve in the future depending on the actions and decisions that are taken today.

Great Transition, the promise and lure of the Times Ahead

Global Scenario Group, Tellus Institute.

Each generation understands its historic moment as unique, and its future as rife with novel perils and opportunities. This is as it should be, for history is an unfolding story of change and emergence. Each era is unique—but in unique ways. In our time, the very coordinates through which the historical trajectory moves—time and space—seem transformed. Historical time is accelerating as the pace of technological, environmental and cultural change quickens. Planetary space is shrinking, as the integration of nations and regions into a single Earth system proceeds. Amid the turbulence and uncertainty, many are apprehensive, fearing that humanity will not find a path to a desirable form of global development. But a transition to an inclusive, diverse and ecological planetary society, though it may seem improbable, is still possible.

Annex 2 Pathways to 2050

Reduced Mobility

Story line

- 2010-2020: Continuation of existing trends. Behavioural policies have implementation problems. Diversification of energy sources. Emphasis on land-use and mobility regulation. CO₂ growth at a lower ratio. Decline in GDP.
- 2020-2030: Change of existing trends. Emphasis on pro-active policies to reinforce behavioural policies. Land-use policies start to be effective. Important reduction of CO₂. Emerging of local markets. Increase in renewable technologies. GDP become stabilised.
- 2030-2040: Continuation and intensification of the previous trends. Emergence of new technologies bringing sustainable economic growth. Zero carbon-economy achieved.
- 2040-2050: Stable and sustainable growth is maintained.

Induced Mobility

Story line

- 2010-2020: Continuation of existing trends. Ongoing congestion levels and increase in oil price stimulates the support to researching new energy sources and increasing the infrastructure stock. Intensive market economy allows to keep a high growth of GDP, but survival of this scheme depends on successfully moving from a carbon society to a non-carbon one. There is a continued economic growth, increasing competition, use of intelligent technologies and globalisation, a mix of nuclear energy, clean coal and renewable energy supply, high travel demand, the diffusion of cleaner fuel technologies (e.g. hydrogen fuel cells), 24/7 “always on” society, intensive work.
- 2020-2030: The diversification of energy sources, complemented by an open market policy has allowed a continuous growth of economy and traffic levels. European regions tend to specialise and economic disparities increase. Emergence of new technologies in the transport sector (electric-hydrogen cars, implementation on-line pricing). Renewable resources become more efficient. Huge productivity gains achieved.
- 2030-2040: Continuation and intensification of the previous liberalisation trends, with creation of economic poles. The need of economic growth becomes a lifestyle, meaning that retirement age increases and welfare is reduced mainly due to the stressing way of life. Emergence of new energy sources, such as solar and/or nuclear fusion. Use the most cost-effective technologies to reduce emissions, and liberalise and regulate markets allowing healthy competition. Therefore, the scenario envisions improving the efficiency of existing car engines, make use of biofuels and a variety of alternative fuel options, including hydrogen batteries, and then move to a second generation of biofuels and electricity. Intel-

ligent traffic management systems have a significant importance relieving congestion and increasing speed.

- 2040-2050: The development of IT with virtually infinite capacity and almost free energy boosts up GDP and traffic levels. Zero-carbon economy achieved. Singularity reached. Toward the year 2050, intelligent positioning systems, encryption technology, real-time tele-presencing and a shift towards a low-carbon economy have all played their part in driving the rampant consumerism that shows few signs of abating. If energy issues have been addressed, other sustainability problems have not. Europe's waste footprint is still far larger than Europe is.

Constrained Mobility

Story line

- 2010-2020: Continuation of existing trends. Ongoing congestion levels and increase in oil price poses difficulties for economy to grow, but bypassing CO₂ restrictions allows to overcome this difficulties for a while. However, this worsens the climate change situation
- 2020-2030: Oil production peaks but lack of R+D in new energy sources makes it impossible to avoid dependence on oil, thus energy prices increase dramatically. The carbon entitlement system is developed to mitigate GHG emissions as well as limiting the demand of transport. Economy suffers as transport decreases and GDP goes down. As a mitigation to ongoing climate change, an important effort is done in researching CO₂ sequestration methods, partially used to facilitate drilling deeper oil field.
- 2030-2040: Travelling has become an expensive commodity, but the change has been very abrupt and the lack of long term measures to solve the energetic problem keeps the GDP level decreasing. Carbon titles are now an important currency that has allowed less developed regions to catch up with the richest ones. More effective segregation CO₂ technologies applied.
- 2040-2050: Reduction of economy and transport together with minor policies aiming at energy efficiency result in a high reduction of CO₂ emissions, but the price has been a global cut down on the growing patterns from the 20th century. As a result communities have become more local

Decoupled Mobility

Story line

- 2010-2020: Slow introduction of behavioural policies. Research in energy sources starts the change from carbon fuels to CO₂ free ones. CO₂ keeps growing while the mix of policies are being implemented, but at a slower pace. During this period GDP grows because no radical measure are being considered for reducing global warming
- 2020-2030: Land-use policies have lead to an important reduction of urban sprawl, reducing the needs of travelling by car. Development of distributed energy generation, rise of renewables, vehicle improvements like hybrids and electric cars and shift towards more ecological transport modes triggers a descent of CO₂ emissions. Introduction of on-line road pricing encourages the descent of road transport use

- 2030-2040: Oil production peaks, but the transition to non fossil fuels is almost complete and thus economy does not resent of high oil prices. While global mobility decreases, short distance trips increase because urban areas have become very dynamic with the help of the developed urban transport infrastructures
- 2040-2050: Society inequalities are further reduced, having a positive impact in economy. CO₂ emissions continue to reduce

Annex 3 Information relevant to generic challenges

A3.1 Enlargement

It is self-evident that enlargement, accompanied by the removal of barriers to movement and the encouragement of an internal market, has and will have a significant impact on mobility.

Currently, two categorisations exist for states who are involved in formal processes that could lead to EU membership. Those with a most advanced status in this respect are the “candidate countries”: Croatia, the Former Yugoslav Republic of Macedonia, and Turkey. The Western Balkans states of Albania, Bosnia and Herzegovina, Montenegro and Serbia are not yet recognised as candidate countries but are in the enlargement process and are classified as “potential candidate countries”. Other states with aspirations to join the EU, but without any formal status in this respect, are Armenia, Belarus, Georgia, Moldova and Ukraine.

Some see enlargement as a relatively straightforward process, with a number of states “queuing up” to join the EU and being accepted as long as they meet the following “Copenhagen criteria” established by the European Council in 1993:

- Stability of institutions guaranteeing democracy, the rule of law, human rights and respect for and protection of minorities.
- The existence of a functioning market economy as well as the capacity to cope with competitive pressure and market forces within the Union.
- The ability to take on the obligations of membership including adherence to the aims of political, economic and monetary union.

However, others see the process in much more problematic terms, particularly with reference to the accession of Turkey. Although many points of view exist on these issues, disagreement often is reduced to two alternative visions of the EU: a “competitive” EU versus a “cohesive” EU. Whilst many would claim that the EU should be both competitive and cohesive (and this is in fact the stance of the Lisbon Strategy), the disagreement surfaces if it is considered that, for a specific policy decision, there is a need to choose between the two alternatives. As a general rule, those favouring a competitive EU over a cohesive EU would support greater enlargement, one reason being to be able to exploit the opportunities for cheaper labour that would result. Those favouring a cohesive EU would tend to be less supportive towards further enlargement, in order to concentrate on resolving equity problems that exist in the current EU.

A3.2 Territorial cohesion

Faludi (2007) provides a comprehensive overview of EU cohesion policy, describing the importance of Jacques Delors, European Commission President from 1985 to 1995, in pursuing such a policy. Faludi describes the terms “cohesion policy” and “territorial cohesion policy” as follows:

“[Cohesion] policy is about compensating least favoured regions and member states for disadvantages suffered from the widening and deepening of the EU. Territorial cohesion policy is its latest offshoot. The rationale behind it is to be found in the Third Cohesion Report: “. . . people should not be disadvantaged by wherever they happen to live or work in the Union” (CEC, 2004, p. 27). Accordingly, territorial cohesion is about a just distribution of opportunities in space. However, the idea is that this will also unlock much dormant potential. As Allen (2005, p. 238) puts it: “The logic assumes that economic conver-

gence among countries and among regions will deliver cohesion, which in turn will deliver growth, competitiveness, employment, and sustainable development, and thus the Lisbon and Gothenburg objectives”.

Two points can be made here:

1. Cohesion policy in the transport field is orientated to increase the accessibility of the countries and regions which benefit from that policy. Better accessibility means indeed less transport costs, less "peripherality" and therefore more traffic. European cohesion policy has been quite active in the provision of transport infrastructure, in particular as the Cohesion Fund was obliged to provide grants only for environmental and transport projects.
2. The final sentence in the above quotation stresses that cohesion and competition are not necessarily in conflict, and that there exists the possibility of a “win-win” situation which emphasises both. However, although this might be happy general approach, there will frequently be situations (such as whether a particular state gains accession to the EU, as mentioned above) in which discrete choices need to be made, and such choices will often involve emphasising competitiveness over cohesion or vice –versa.

Annex 4 **ACTION PROGRAMME of the 2001 White Paper**

The measures proposed in the White Paper may be summarised as follows:

1. SHIFTING THE BALANCE BETWEEN MODES OF TRANSPORT

1.1. Improving quality in the road sector

- Harmonise inspections and penalties by the end of 2001 in order to:
 - promote efficient, uniform interpretation, implementation and monitoring of existing road transport legislation;
 - establish the liability of employers for certain offences committed by their drivers;
 - harmonise the conditions for immobilising vehicles;
 - increase the number of checks which Member States are required to carry out (currently on 1% of days actually worked) on compliance with driving times and drivers' rest periods.
- Keep the road transport profession attractive by promoting the necessary skills and ensuring satisfactory working conditions.
- Harmonise the minimum clauses in contracts governing transport activity in order to allow tariffs to be revised should costs increase (e.g. a fuel price rise).

1.2. Revitalising the railways

- Gradually open up the railway market in Europe. By the end of 2001 the Commission will submit a second package of measures for the rail sector with a view to:
 - opening up the national freight markets to cabotage;
 - ensuring a high level safety for the railway network based on rules and regulations established independently and a clear definition of the responsibilities of each player involved;
 - updating the interoperability directives for all components of the high-speed and conventional railway networks;
 - gradual opening-up of international passenger transport;
 - promoting measures to safeguard the quality of rail services and users' rights. In particular, a directive will be proposed to lay down the terms of compensation in the event of delays or failure to meet service obligations. Other measures relating to the development of service quality indicators, terms of contract, transparency of information for passengers and out-of-court dispute resolution mechanisms will also be proposed.
- Step up rail safety by proposing a directive and setting up a Community structure for Railway Interoperability and Safety.
- Support the creation of new infrastructure, and in particular rail freight freeways.
- Enter into dialogue with the rail industries in the context of a voluntary agreement to reduce adverse environmental impact.

1.3. Controlling the growth in air transport

- Propose the introduction by 2004, in the context of the Single Sky, of:
 - a strong regulator with adequate resources independent of the various interests at stake, and capable of setting objectives allowing traffic to grow while guaranteeing safety;
 - a mechanism enabling the military to maintain defence capabilities while using the scope for cooperation to ensure more efficient overall organisation of airspace;
 - social dialogue with the social partners, which could begin with the air traffic controllers, allowing consultation, following the experience in other sectors, on aspects of

the common aviation policy that have a considerable social impact. This dialogue could lead to agreements between the organisations concerned;

- cooperation with Eurocontrol to draw on its expertise and know-how to develop and administer the Community rules;
- a surveillance, inspection and penalties system ensuring effective enforcement of the rules.

- In the framework of the International Civil Aviation Organisation, rethink air transport taxation and negotiate the introduction of a kerosene tax by 2004 and differential *en route* air navigation charges.
- Launch a debate in 2002 on the future of airports in order to:
 - make better use of existing capacity;
 - review the airport charges systems;
 - integrate air transport into a logical system with the other modes of transport;
 - determine what new airport infrastructure is required.
- Present a revision in 2003 of the slot allocation system, in order to improve market access while taking account of the need to reduce environmental impacts at Community airports.
- Negotiate with the United States a Joint Transatlantic Aviation Agreement to replace the current open skies agreements.

1.4. Adapting the maritime and inland waterway transport system

- Develop the infrastructure needed to build veritable “motorways of the seas”.
- Simplify the regulatory framework for maritime and inland waterway transport by encouraging in particular the creation of one-stop offices for administrative and customs formalities and by linking up all the players in the logistics chain.
- Propose a regulatory framework for safety controls for passengers embarking on ships offering European cruises in order to combat the risk of attacks, along the lines of what is done in air transport.
- Tighten up the maritime safety rules in cooperation with the International Maritime Organisation and the International Labour Organisation, in particular:
 - by incorporating the minimum social rules to be observed in ship inspections, and
 - by developing a genuine European maritime traffic management system.
- Encourage the reflagging of the greatest possible number of ships to Community registers, based on the best practices developed in social and fiscal matters, by proposing in 2002 measures on tonnage-based taxation and the revision of the guidelines on State aid to maritime transport.
- Improve the situation of inland waterway transport through:
 - the current standardisation of technical requirements for the entire Community waterway network by 2002;
 - greater harmonisation of boatmasters' certificates throughout the Community's inland waterway network, including the Rhine. The Commission will present a proposal on this subject in 2002;
 - harmonisation of conditions in respect of rest periods, crew members, crew composition and navigation time of inland waterway vessels. The Commission will present a proposal on this subject in 2002.

1.5. Linking up the modes of transport

- Establish by 2003 a new programme to promote alternative solutions to road transport (Marco Polo), which could have a budget of some 30 million euros per year in help launch commercial projects.
- Propose by 2003 a new Community framework for the development of the profession of freight integrator and the standardisation of transport units and freight loading techniques.

2. ELIMINATING BOTTLENECKS

- In 2001 revise the trans-European network guidelines in order to eliminate bottlenecks by encouraging corridors with priority for freight, a rapid passenger network

and traffic management plans for major roads, and adding to the “Essen” list such projects as, by way of illustration:

- a high-capacity railway route through the Pyrenees for freight;
 - East European high-speed train/combined transport Paris-Stuttgart-Vienna;
 - the Fehmarn bridge/tunnel between Germany and Denmark;
 - the Galileo satellite navigation project;
 - improvement of the navigability of the Danube between Straubing and Vilshofen;
 - the Verona-Naples rail link, including the Bologna-Milan branch;
 - the interoperability of the Iberian high-speed rail network.
- In 2001 increase to 20% the maximum funding under the trans-European network budget for the main bottlenecks, including those still remaining on the Union's frontiers with the accession candidate countries, and then introduce conditionality rules.
 - In 2004 present a more extensive revision of the trans-European network aimed in particular at integrating the networks of the accession candidate countries, introducing the concept of “motorways of the seas”, developing airport capacities and improving territorial cohesion on the continental scale.
 - Establish a Community framework for allocating revenue from charges on competing routes to the construction of new infrastructure, especially rail infrastructure.
 - Harmonise minimum safety standards for road and rail tunnels belonging to the trans-European transport network.

3. PLACING USERS AT THE HEART OF TRANSPORT POLICY

3.1. Unsafe roads

- Set a target for the EU of reducing by half the number of people killed on European roads by 2010.
- By 2005 harmonise the rules governing checks and penalties in international commercial transport on the trans-European road network, particularly with regard to speeding and drink-driving.
- Draw up a list of “black spots” on trans-European routes where there are particularly significant hazards and harmonise their sign-posting.
- Require coach manufacturers to fit seat belts on all seats of the vehicles they produce. A directive to this end will be proposed in 2003.
- Tackle dangerous driving and exchange good practices with a view to encouraging responsible driving through training and education schemes aimed in particular at young drivers.
- Continue efforts to combat the scourge of drink-driving and find solutions to the issue of the use of drugs and medicines.
- Develop a methodology at European level to encourage independent technical investigations, e.g. by setting up a committee of independent experts within the Commission.

3.2. The facts behind the costs to the user

- In 2002 propose a framework directive setting out the principles and structure of an infrastructure-charging system and a common methodology for setting charging levels, offset by for the removal of existing taxes, and allowing crossfinancing.
- Make the tax system more consistent by proposing uniform taxation for commercial road transport fuel by 2003 to round off the internal market.
- In 2002 propose a directive guaranteeing the interoperability of means of payment on the trans-European road network.

3.3. Rights and obligations of users

- In 2001 increase air passengers' existing rights through new proposals concerning in particular denied boarding due to overbooking, delays and flight cancellations.
- In 2001 put forward a regulation concerning requirements relating to air transport contracts.

- By 2004, and as far as possible, extend the Community measures protecting passengers' rights to include other modes of transport, and in particular the railways, maritime transport and, as far as possible, urban transport services. This concerns in particular service quality and the development of quality indicators, contract conditions, transparency of information to passengers and extrajudicial dispute settlement mechanisms.
- Propose an adjustment of procedures for notifying State aid, particularly in cases relating to compensation for public service obligations on links to the Community's outlying regions and small islands.
- Clarify the general principles which should govern services of general economic interest in the field of transport in order to provide users with a service of quality, in keeping with the Commission communication on services of general interest in Europe.

4. MANAGING THE EFFECTS OF TRANSPORT GLOBALISATION

- Link the future Member States to the EU's trans-European network by means of infrastructure of quality with a view to maintaining the modal share of rail transport at 35% in the candidate countries in 2010 by mobilising private-sector finance.
- Make provision in the Community's future financial perspective for adequate public funding of infrastructure in the new member countries.
- Develop the administrative capacities of the candidate countries, notably by training inspectors and administrative staff responsible for enforcing transport legislation.
- Full membership for the European Community in the main international organisations, in particular the International Civil Aviation Organisation, the International Maritime Organisation, the Rhine Navigation Commission, the Danube Commission and Euro-control.
- By 2008 develop for the EU a satellite navigation system with global cover, over which it will have control and which will meet its accuracy, reliability and security requirements (Galileo).

Annex 5 Backcast Scenarios to Achieve CO₂ Targets 2005-2050

The two backcast scenarios (Sustainable Mobility and Efficient Mobility) are based on two of the exploratory scenarios (Decoupled Mobility and Induced Mobility), with adjustments to comply with CO₂ targets.

Sustainable Mobility

The Sustainable Mobility Scenario is based on the Decoupled Mobility scenario with policy adjustments to comply with CO₂ reduction targets of -10% in 2020 and -50% in 2050)

Scope

- Environmental concern: CO₂ emissions are reduced quickly, but in harmonious way, hampering the minimum economic development to achieve reduction targets
- Decoupling economic development and traffic is gradually achieved due to transport policies focused on road pricing, using cleaner and more effective technologies as well as by significant changes in consumer values.
- Change in behaviour: policies aiming to modify users and firms mobility decisions are effective

Population dynamics

- Increase of total population mainly due to vegetative growth
- Moderate immigration
- Moderate ageing

Socio-economy and technology dynamics

- In the short-term, GDP increase slower than in the induced and constrained scenarios, but it is more stable.
- Development of new forms of tourism (e.g. business, health, education...)
- Unemployment is reduced thanks to the constant growth of economy and flexible work regime policies
- Support to R+D of renewables and distributed energy production technologies, as well as CO₂ sequestration facilities to cut down global warming.
- Income inequalities are reduced across European regions

Transport, energy and other mobility-related policies

- Reduction of unnecessary trips thanks to technology (internet shopping, teleworking, IT convergence)
- Better management of infrastructures to improve transport efficiency
- Increase in urban infrastructure stock to encourage short distance trips
- Pricing systems and incentive schemes in transport, including higher taxation, to encourage a behavioural change as fast as possible

- Strong land-use policies aiming at reversing the urban sprawl tendency, thus helping to reduce travelling needs
- Enlargement of the EU towards the Balkans and Turkey, and close cooperation with eastern Europe countries

Mobility and energy

- Elasticity of passenger transport decreases because of more strict land-use policies and behavioural attitudes
- Elasticity of freight transport decreases because economy turns to less material commodities and increasing importance of local markets
- Average trip length is reduced
- More intensive use of public transport in urban areas.
- A big share of long distance traffic becomes short distance traffic
- Shift towards slower and more environmentally friendly modes
- Rural regions tend to be relatively less well communicated because transport investments are focused in urban zones
- Transport price increases due to taxation, specially in carbon based energy
- Optimisation of capacity, increasing the size of the vehicles and the occupancy ratios
- Emission factors improve because technology is oriented to achieve this goal

Story line

- 2010-2020: Introduction of behavioural policies. Research in energy sources starts the change from carbon fuels to CO₂ free ones. CO₂ keeps growing while the mix of policies are being implemented, but at a slower pace. During this period GDP grows
- 2020-2030: Land-use policies have lead to an important reduction of urban sprawl, reducing the needs of travelling by car. Development of distributed energy generation, rise of renewables, vehicle improvements like hybrids and electric cars and shift towards more ecological transport modes triggers a descent of CO₂ emissions. Introduction of on-line road pricing encourages the descent of road transport use
- 2030-2040: Oil production peaks, but the transition to non fossil fuels is almost complete and thus economy does not resent much of higher oil prices. While global mobility growth decreases in relation to GDP growth, short distance trips increase because urban areas have become very dynamic with the help of the developed urban transport infrastructures Tourism and leisure trips are also more local
- 2040-2050: Society inequalities are further reduced, having a positive impact in economy. CO₂ emissions continue to reduce

Efficient mobility

The Efficient Mobility Scenario is based on the Induced Mobility scenario with adjustments to comply with CO₂ reduction targets (-10% by 2020, and -50% by 2050)

Scope

- Exponential growth of technology: substitution of oil by more efficient and clean energy sources lead to CO₂ reductions complying with the targets

- Technology reaches a “singularity” in 2045, leading to unlimited information (following the exponential increase in computer processing power) and unlimited and cheap energy (from oil to fusion and solar).
- Focus on economic growth.

Population dynamics

- Moderate increase of total population
- High increase of immigration, specially skilled workers.
- Marked ageing but limited due to immigration
- Immigration from north to southern sunbelt regions.

Socio-economy and technology dynamics

- Technology increases productivity, thus enhancing economy measured as GDP
- Globalisation process continues on with companies tending to delocalise production factors
- Trade grows following the globalisation patterns
- Tourism increases both in volume and length as transport costs reduces
- Unemployment levels are kept at about 10%, lifestyle forces reforms in labour market that delay retirement age
- Economic disparities across regions become more marked as GDP gap increases
- Regional specialisation.
- Enlargement of EU continues on the Balkans and eastern Europe

Transport, energy and other mobility-related Policies

- Transport development follows demand needings
- Increase of infrastructure stock, both road and public transport
- Better management and more intelligent transport systems
- On-line pricing is generalised on all transport modes
- Increase in average trip length due to delocalisation
- Increase in wealth and travelling speeds leading to longer or more frequent trips
- European policies are reformed towards more liberalisation

Mobility and energy

- The elasticity of passenger transport increases as urban sprawl continues and personal wealth grows
- Elasticity of freight transport increases because of globalisation patterns continue as well as regional specialisation
- Support to R+D to develop cheaper and more efficient just-in-time global transport
- Transport prices decrease as new technologies allow abandoning carbon fuels and moving to cheap CO₂-free energy sources
- Support to renewable resources that have high economic efficiency
- New vehicles providing faster, cheaper and specially cleaner transport, drastically reducing CO₂ emissions.
- ICT continuous growth leads toward increasing social and economic relations world-wide, leading to more personal and freight trip demand.
- Vehicle occupation decreases following the individualism of society, mainly because of the need of flexibility and transport price reduction.

Story line

- 2010-2020: Continuation of existing trends. Ongoing congestion levels and increase in oil price stimulates the support to researching new energy sources and increasing the infrastructure stock. Intensive market economy allows to keep a moderate growth of GDP, but survival of this scheme depends on successfully moving from a carbon society to a non-carbon one
- 2020-2030: The diversification of energy sources, complemented by an open market policy has allowed a continuous growth of economy and traffic levels. European regions tend to specialise and economic disparities increase. Emergence of new technologies in the transport sector (electric-hydrogen cars, implementation on-line pricing) have reduced CO₂ emissions noticeably. Renewable resources become more efficient. Important productivity gains achieved.
- 2030-2040: Continuation and intensification of the previous liberalisation trends, with creation of economic poles. The need of economic growth becomes a lifestyle, meaning that retirement age increases and welfare is reduced mainly due to the stressing way of life. Emergence of new energy sources, such as solar and/or nuclear fusion.
- 2040-2050: The development of IT with virtually infinite capacity and almost free energy boosts up GDP and traffic levels. Zero-carbon economy achieved. Singularity reached.

Annex 6
narios

Policy assumptions in the exploratory sce-

	TRANS-TOOLS				
	High growth	Baseline	Low Growth		
Meta-Models	Induced	Decoupled	Baseline	Reduced	Constrained
Economic growth	VERY H. GROWTH	HIGH GROWTH	STABLE GROWTH	LOW GROWTH	VERY L. GROWTH
Population growth	HIGH GROWTH	VERY LOW	LOW DE-CLINE	HARD DE-CLINE	LOW DECLINE
Technologic development	VERY HIGH	HIGH	HIGH	LOW	VERY LOW
Mobility growth	INDUCED	DEC&SHIFTED	DECOUPLED	REDUCED	CONSTRAINED
European enlargement (€-ZONE)	VERY HIGH	HIGH	LOW	LOW	VERY LOW
Policy-aims (*)					
Internal Territorial Cohesion	3	6	7	5	5
External Economic Integration	6	4	4	7	3
Political integration at EU level	5	8	6	4	4
Environmental sustainability	5	6	7	10	8
Economic competitiveness	9	6	6	3	10
Safety/Social and cultural aspects	7	5	5	6	5
Policy instruments					
Opening of markets	9	6	6	4	7
Effective pricing	8	7	6	7	6
Other behavioural incentives	2	5	4	9	3
Better infrastructure management	6	7	5	7	6
Increase stock long-distance roads	6	4	5	2	7
Increase stock ports and logistics	6	6	7	3	6
Increase stock airports	7	6	7	3	6
Increase stock long-distance rail/PT	3	5	9	4	6
Increase stock urban infrastructures (PT)	7	6	6	6	6
Public support to R+D on technology	9	6	6	7	4
Strict land-use regulations	2	6	3	10	6
Taxation	5	6	6	8	8
Strategic evaluation					
Economic development (GDP)	8	6	5	4	4
Social Welfare (Social gaps)	2	6	5	6	3
Technological development (Productivity)	9	6	5	4	3
Environmental sustainability (CO ₂)	5	6	5	9	5
Safety (Accidents)	6	6	5	7	5

Table A6.1: Policy assumptions in the four exploratory scenarios

Annex 7 2005-2050 Meta-Models results

2005-2050 Main results

	2005	Baseline	Decoupled mobility	Reduced mobility	Induced mobility	Constrained mobility
Total population	491.999.371	486.218.917	545.598.557	431.090.794	545.740.798	488.212.797
Annual population growth	-	-0,03%	0,23%	-0,29%	0,23%	-0,02%
Total GDP B€¹⁶	9.853.475	24.359.922	29.051.343	17.091.935	31.717.532	17.868.710
Annual GDP growth	-	2,0%	2,4%	1,2%	2,6%	1,3%
EU27 intra-NUTS3 passenger traffic						
Road passenger 1000Mpassenger-km	3.433	5.048	5.185	3.863	9.888	5.411
Rail passenger 1000Mpassenger-km	215	318	1.164	423	303	596
EU27 inter-NUTS3 traffic						
Road passenger 1000Mpassenger-km	1.491	1.921	2.200	1.921	3.460	1.945
Rail passenger 1000Mpassenger-km	161	526	864	449	858	696
Air passenger 1000Mpassenger-km	320	315	345	295	1.262	633
Extra EU27 passenger traffic						
Air passenger in EU airspace 1000Mpassenger-km	68	151	148	63	170	62
Air passenger outside EU airspace 1000Mpassenger-km	651	1.664	1.777	634	2.207	617
EU27 intra-NUTS2 freight traffic						
Road freight 1000M/tonnes-km	395	465	494	264	872	340
EU27 inter-NUTS2 traffic						
Road freight 1000M/tonnes-km	1.316	2.347	2.599	1.290	5.843	2.189
Rail freight 1000M/tonnes-km	447	1.222	1.471	698	1.868	780
Extra EU27 freight traffic						
Sea freight 1000M/tonnes-km	1.525	2.949	3.476	1.861	4.733	1.485
Sea freight outside EU 1000M/tonnes-km	52.022	129.104	154.835	91.121	168.837	94.520
Annual EU27 intra-NUTS3 passenger traffic variation						
Road passenger	-	0,9%	0,9%	0,3%	2,4%	1,0%
Rail passenger	-	0,9%	3,8%	1,5%	0,8%	2,3%
Annual EU27 inter-NUTS3 traffic variation						
Road passenger	-	0,6%	0,9%	0,6%	1,9%	0,6%
Rail passenger	-	2,7%	3,8%	2,3%	3,8%	3,3%
Air passenger	-	0,0%	0,2%	-0,2%	3,1%	1,5%
Annual Extra EU27 passenger traffic variation						
Extra EU27 air passenger	-	2,1%	2,2%	-0,1%	2,7%	-0,1%
Annual EU27 intra-NUTS2 freight traffic variation						

¹⁶ GDP of the whole area covered by TRANS-TOOLS

2005-2050 Main results

	2005	Baseline	Decoupled mobility	Reduced mobility	Induced mobility	Constrained mobility
Road freight	-	0,4%	0,5%	-0,9%	1,8%	-0,3%
Annual EU27 inter-NUTS2 traffic variation						
Road freight	-	1,3%	1,5%	0,0%	3,4%	1,1%
Rail freight	-	2,3%	2,7%	1,0%	3,2%	1,2%
Annual Extra EU27 freight traffic variation						
Sea freight	-	1,5%	1,8%	0,4%	2,5%	-0,1%
Sea freight outside EU	-	2,0%	2,5%	1,3%	2,7%	1,3%
EU27 traffic						
Passenger 1000Mpassenger-km	5.619	8.129	9.759	6.950	15.771	9.281
Freight 1000M/tonnes-km	3.683	6.983	8.039	4.114	13.316	4.794
Annual EU27 traffic variation						
Passenger	-	0,8%	1,2%	0,5%	2,3%	1,1%
Freight	-	1,4%	1,7%	0,2%	2,9%	0,6%
Passenger Rail share for long distance inland traffic	9,7%	21,5%	28,2%	18,9%	19,9%	26,3%
Freight Rail share for long distance inland traffic	25,3%	34,2%	36,1%	35,1%	24,2%	26,3%
Energy consumed by road oil-based transport inMToe	362	291	130	182	99	246
Average taxes on oil in €/litre	0,61	1,40	1,60	1,80	1,20	2,00
Taxes on oil by transport in M€	184.216	338.933	173.406	273.525	98.612	409.789
% Renewable in primary electricity generation	15	25	40	20	35	40
% Nuclear in primary electricity generation	35	40	35	35	50	40
Car CO2 emission ratio in gCO2/km	196	119	98	137	59	129
Truck CO2 emission ratio in gCO2/km	966	889	483	676	290	638
% non-fossil fuelled vehicles	0%	21,8%	54,5%	35,0%	70,0%	31,0%
Energy consumption reduction per km in rails	-	40%	46%	33%	51%	34%
Energy consumption reduction per km in ships	-	49%	57%	40%	62%	42%
Energy consumption reduction per km in airplanes	-	62%	71%	50%	78%	53%
Car occupancy in urban trips pax/veh	1,40	1,50	1,60	2,10	1,10	1,60
Car occupancy in interurban trips pax/veh	2,0	2,10	2,50	2,50	1,50	2,00
Truck load in ton/veh	7,0	7,78	8,75	10,00	8,24	7,78
Direct CO2 emission variation 2005-2020	-	-23%	-61%	-61%	-56%	-36%
Indirect CO2 emission variation 2005-2020	-	77%	206%	95%	369%	94%
Total CO2 emission variation 2005-2020	-	-21%	-55%	-57%	-46%	-33%
Direct cumulated CO2 emissions 2005-2020	-	44.892	34.213	32.007	36.805	46.677
Indirect cumulated CO2 emissions 2005-2020	-	1.714	2.372	1.893	2.719	2.132
Total cumulated CO2 emissions 2005-2020	-	46.606	36.585	33.900	39.524	48.809