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IMPACT ASSESSMENT

Accompanying document to the

WHITE PAPER

**Roadmap to a Single European Transport Area – Towards a competitive and resource
efficient transport system**

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This report commits only the Commission's services involved in its preparation and does not prejudge the final form of any decision to be taken by the Commission.

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1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

Identification

Lead DG: Directorate General for Mobility and Transport

Agenda Planning: 2010/MOVE/002

1.1. Background in the development of the White Paper on Transport Policy

1. In the last two decades, EU transport policy has been the subject of periodic assessments and of strategic guidance in the form of White Papers, which have provided policy evaluation and alignment with current priorities and general policy orientations.
2. In 1992, the Commission published a White Paper on the common transport policy, which was essentially dedicated to market opening. Almost ten years later, the 2001 White Paper emphasised the need to manage transport growth in a more sustainable way by achieving a more balanced use of all transport modes.
3. The White Paper accompanied by this impact assessment report identifies the challenges that the transport system is likely to face in the future, based on an evaluation of policies and developments in the recent past and on an assessment of current trends. It then defines a long-term strategy that would allow the transport sector to meet its goals with a 2050 horizon.

1.2. Organisation and timing

4. For the preparation of the White Paper on Transport Policy an inter-service group was set up and meetings were organised between November 2009 and June 2010 in order to collect the views of various services¹.
5. This Impact Assessment was elaborated by DG MOVE in collaboration with DG ENER and DG CLIMA. In this context, an Impact Assessment Steering Group (IASG)² was jointly set up and met three times between October 2010 and December

¹ The services involved in this group included the Secretariat-General, DG Agriculture and Rural Development, Bureau of European Policy Advisers, DG Climate Action, DG Competition, DG Economic and Financial Affairs, DG Employment, Social Affairs and Equal Opportunities, DG Energy, DG Enterprise and Industry, DG Environment, Eurostat, DG Health and Consumers, DG Home Affairs, DG Information Society and Media, DG Internal Market and Services, the Joint Research Centre, DG Justice, DG Maritime Affairs and Fisheries, DG Research, DG Regional Policy, and DG Taxation and Customs Union.

² The services involved in this group included the Secretariat-General, DG Agriculture and Rural Development, Bureau of European Policy Advisers, DG Climate Action, DG Competition, DG Development, DG Economic and Financial Affairs, DG Employment, Social Affairs and Equal Opportunities, DG Energy, DG Enterprise and Industry, DG Environment, , DG Information Society and Media, the Joint Research Centre, DG Maritime Affairs and Fisheries, DG Research, DG Regional Policy, DG Trade, and DG Taxation and Customs Union.

2010. The timing of the proposal development and the key aspects of the proposals (including modelling results) were discussed extensively in the context of these inter-service meetings. The last IASG meeting took place on 14 December 2010. A final version incorporating the comments made during this meeting was circulated on 16 December 2010.

1.3. Consultation and expertise

6. With a view to preparing the ground for later policy developments, the Commission has launched a reflection on the future transport system in 2009, comprising a public consultation from 30 January 2009 until 27 March 2009, an evaluation study on the European Transport Policy (ETP); a debate within three ‘Focus Groups’; a study – ‘Transvisions’ – identifying possible low-carbon scenarios for transport and a consultation of stakeholders, notably through a High Level Stakeholders’ Conference on 9-10 March 2009.
7. The Communication on “*A sustainable future for transport: Towards an integrated, technology-led and user friendly system*”³, adopted by the Commission on 17 June 2009, summarises the results of this wide reflection. Through this Communication, the Commission launched an open debate covering the main challenges for EU transport policy, the key objectives for the transport system and the ways how to meet them.
8. In this Communication, the Commission encouraged all interested parties to contribute their views on the future of transport and on possible policy options to address the future challenges of the transport sector. Following the public consultation which has run until 30 September 2009 and had attracted more than 250 respondents, a second High Level Stakeholders’ conference took place on 20 November 2009. It aimed at collecting stakeholders’ views on concrete measures which would need to be considered in the preparation of the new Transport White Paper.
9. The summaries of the stakeholder meetings and the contributions received during the preceding public consultation are available on the Commission website⁴.
10. Input from stakeholders has been taken into account in assessing the different possible actions to improve the sustainability of the transport system in the EU. External expertise was used to assess the various options available, including aspects raised during the public consultation.
11. As shown by the detailed assessment presented in Appendix 1 of this report, it can be concluded that the minimum standards for the consultation have been respected.

³ COM/2009/0279 final

⁴ 1st high level conference of 9 March 2009 (http://ec.europa.eu/transport/strategies/events/2009_03_09_future_of_transport_en.htm; http://ec.europa.eu/transport/strategies/consultations/2009_03_27_future_of_transport_en.htm) and 2nd high level conference of 20 November 2009 (http://ec.europa.eu/transport/strategies/events/2009_11_20_future_of_transport_en.htm; http://ec.europa.eu/transport/strategies/consultations/2009_09_30_future_of_transport_en.htm).

1.4. Results of the consultation of the Impact Assessment Board

12. Following the submission of a draft report to the Impact Assessment Board (IAB) on 20 December 2010 and a hearing with the IAB (which took place on 26 January 2011), the IAB sent its opinion on 28 January 2011, asking DG MOVE to resubmit the draft report. A revised version of the IA report has been sent to IAB on 31 January 2011.
13. In its opinion of 28 January 2011, the IAB made five recommendations that were addressed in the final version of the IA report in the following manner:
 - (1) The IA report should better explain how the IA report builds on evaluation of existing policies to better demonstrate the lessons learnt
14. The main conclusions from the ex post evaluation presented in appendix 2 of the IA report have been introduced in the section on the problem definition. The connection has been reinforced between those conclusions and the baseline projection, the problem drivers, the objectives and the definition of policy options.
 - (2) The IA report should define more clearly the concept of sustainable mobility and how it is reflected in the definition and prioritisation of objectives
15. The concept of sustainable mobility has been clearly defined in the revised version and the specific objectives have been streamlined. A discussion on the prioritisation of the policy objectives and on the possible trade-offs between those objectives and other sustainability goals has been added to the Section 3 of the IA report.
 - (3) The IA report should provide more clarity about the design, content and differences between the options and the features they have in common
16. The revised version of the IA report provides greater clarity on how the seven policy areas and the policy measures were identified. Further explanation about the content of Table 4 has been provided and its presentation improved. The IA report has clarified how the differences between the various policy options have been reflected in modelling results.
 - (4) The IA report should provide much greater clarity about the assumptions underlying the modelling results and give more clarity about cost figures, especially as regards the concept of ‘total transport costs’.
17. The revised IA report has further explained the key assumptions that have been made in the modelling exercise. Subsection 5.6 on sensitivity analysis has been added in the section assessing the possible impacts of the various policy measures. The different concepts of costs used in the IA report have been clarified further. Additional modelling results (in particular on costs) have been provided.
 - (5) The IA report should provide a global assessment of the most affected industrial sectors, social groups and regions, differentiating between short and long term impacts.

18. The revised IA report gives a qualitative assessment about which industrial sectors, social groups, and regions will be most affected by the proposed policies in Section 5 on the assessment of impacts.
19. The revised IA report has also been fine-tuned on the basis of the more technical comments transmitted to DG MOVE.
20. On 2 February 2011, the IAB issued a second opinion on the revised IA report with several recommendations which have been taken into account in the following manner:
 - (1) Clarify certain baseline issues, define sustainable transport in a more operational way, and reconsider subsidiarity with respect to some urban mobility issues
21. This recommendation has been addressed by clarifying in footnote 25 why some policy initiatives are not included in the baseline, by explaining in point 102 the concept of "society's economic, social and environmental needs" and by reconsidering subsidiarity with respect to some urban mobility issues in point 95.
 - (2) Further clarify the content of and differences between policy options.
22. This recommendation has been addressed by:
 - clarifying further the third specific objective linked to congestion in point 103,
 - explaining better the choice of the endogenous variables under each Policy Option in point 136,
 - stating clearly that the IA refers to CO₂ level in excise duty in footnote 101.
 - explaining to what extent the assumptions concerning urban mobility can be the same across options, given that the CO₂ shadow price is an endogenous variable in option 4 in footnote 108.
 - (3) Improve transparency about the assumptions underlying the modelling results
23. This recommendation has been addressed by explaining the assumptions concerning fuel price elasticities in footnote 377, by explaining better the role of the modelling specifications in point 148 and Table 4 and by providing more explanations about the contribution of price signals and sensitivity analysis in section 5.6 and footnotes 83 and 160.
 - (4) Strengthen the presentation of cost categories and clarify remaining inconsistencies
24. This recommendation has been addressed by reinforcing the presentation of cost concept in point 249 and by checking the summary tables.
 - (5) Procedure and presentation
25. A concise version of Table 4 has been added.

2. PROBLEM DEFINITION

2.1. General context

26. On 17 June 2010, the European Council endorsed the Europe 2020 strategy (hereinafter “the EU 2020 strategy”) for smart, sustainable and inclusive growth⁵, setting out a vision of Europe’s new social market economy for the 21st century⁶. The EU 2020 strategy rests on three interlocking and mutually reinforcing priority areas: *Smart growth*, developing an economy based on knowledge and innovation; *Sustainable growth*, promoting a low-carbon, resource-efficient and competitive economy; and *Inclusive growth*, fostering a high-employment economy delivering social and territorial cohesion. In order to meet the agreed EU-level targets, the Commission has proposed a Europe 2020 agenda consisting of seven flagship initiatives to catalyse progress under each priority⁷. Among these, the aim of the resource efficiency flagship⁸ is to support the shift towards a resource-efficient and low-carbon economy that is efficient in the way it uses all resources. The stated aim is to decouple economic growth from resource and energy use, reduce CO₂ emissions, enhance competitiveness and promote greater energy security.
27. The White Paper on Transport Policy accompanied by this impact assessment report falls within the scope of the resource efficiency flagship. In this respect, the assessment of impacts, in particular modelling the effect of various policy options in terms of GHG emissions, was jointly undertaken by the Directorates-General Climate Action, Mobility and Transport and Energy. Therefore the current report is part of a joint impact assessment for the Commission’s initiatives related to the transition to a low-carbon economy by 2050. This ensures consistency not only in the modelling framework, but also in the resulting development of policies. The overall policy goal is to design a path towards a low-carbon, competitive economy that would meet the long-term requirements for limiting climate change to 2 °C.
28. At the same time, the White Paper on Transport Policy addresses also issues related to some other flagships, and notably “Innovation Union”, “An industrial policy for the globalisation era”, “A digital agenda for Europe”, “An agenda for new skills and jobs” and “European platform against poverty” (the territorial cohesion aspect).

⁵ COM (2010) 2020, EUROPE 2020 A strategy for smart, sustainable and inclusive growth.

⁶ European Council 17 June 2010 Conclusions, document EUCO 13/10.

⁷ The seven flagship initiatives are: Innovation union, Youth on the move, A digital agenda for Europe, Resource-efficient Europe, An industrial policy for green growth, An agenda for new skills and jobs, European platform against poverty.

⁸ COM (2011) 21. A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy

2.2. Description and scope of the problem – Mobility of people and businesses today is not sustainable⁹

29. The transport services sector accounted for about 4.6% of total EU gross value added in 2008¹⁰; this figure excludes other related activities, as the manufacturing of transport vehicles and equipment, the construction and maintenance of transport infrastructure, fuel refining, and own account transport¹¹.
30. Modern transport systems have given Europe a high degree of mobility with an ever increasing performance in terms of speed, comfort, safety and convenience. Average mobility per person in the EU, measured in passenger-kilometre per inhabitant, increased by 7% between 2000 and 2008, mainly through higher motorisation levels as well as more high-speed rail and air travel. Freight transport demand continued to grow by more than GDP over the last decade (with the exception of the crisis years 2008 and 2009).
31. However, this enhanced mobility has developed over the last decades in a context of generally cheap oil, expanding infrastructure and loose environmental constraints. Now that those framework conditions have changed, the transport system is no longer able to develop along the same path without serious unintended consequences in the form of environmental, economic and social costs.
32. An in-depth ex post evaluation work undertaken by the Commission¹², has shown that, while several features of the transport system have improved in the last decade - notably its efficiency, safety and security - there has been no structural change in the way the system operates. The inability to modify the current transport paradigm, presently founded on the use of fossil fuels and on the dominance of road transport in moving both freight and passengers, is one of the main causes of unsustainable trends: growing GHG emissions, persistent oil dependency and mounting congestion.
33. The ex post evaluation has revealed that past policies have been ineffective in correcting the market failures that determine the present situation and in triggering the necessary transformation:
- Charges and taxes do not fully reflect the societal costs of transport. The attempts at introducing policies to internalise the transport externalities and to remove present tax distortions have been unsuccessful. The road and aviation sector are the main beneficiaries of such distortions;
 - EU research policies have not been able to address the full cycle of research, innovation and deployment in an integrated way through focusing on the most promising technologies and bringing together all actors involved. As a result the

⁹ The Renewed Sustainable Development Strategy of the European Union adopted by the European Council in June 2006 defines a sustainable transport system as the one that “*meets society’s economic, social and environmental needs whilst minimising its undesirable impacts on the economy, society and the environment*”. Sustainable mobility is transportation undertaken using a sustainable transport system.

¹⁰ Source: Eurostat.

¹¹ Own account transport refers to transport services that firms in all sectors provide for themselves i.e. with their own trucks and other vehicles.

¹² See in this respect Appendix 2 of the present Impact Assessment report.

potential of research and innovation in contributing to EU transport policy objectives has not been exploited to its full extent;

- Investments to modernise the rail network and the transshipment facilities have been insufficient to address the bottlenecks in multimodal transport. Modal networks continue to be poorly integrated. TEN-T policy has lacked financial resources and a true European and multimodal perspective;
- Legislation prescribing market opening in rail freight as of 2007 and in international rail passenger as of 2010 has been implemented slowly and incompletely in the large majority of Member States. Enforcement has been inadequate. National passenger markets, that represent the largest share of the business, are still largely closed. The crossing of national borders continues to cause inefficiencies and additional costs in rail. Also short sea shipping faces higher administrative burden compared to the land-based modes whenever national borders within the EU are crossed. The lack of competition and residual administrative barriers held back the quality and efficiency of the service and partly explain the low appeal of the main alternatives to road transport, particularly on medium and long distances;
- EU policies have not addressed local and urban transport until recently. The concept of helping local government, while respecting subsidiarity, tackle congestion, pollution, and safety problems requires a new and integrated policy approach to urban mobility.

CO₂ emissions from transport are still growing

34. Global warming is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of polar ice caps and glaciers, and rising global average sea levels. The dominant factor in the warming of the climate in the industrial era is the increasing concentration of various greenhouse gases (hereinafter “GHG”) in the atmosphere due to human activities. The GHG contributing most to climate change is CO₂ and its emission has to be significantly reduced in order to limit climate change to 2 °C above pre-industrial levels.
35. Today transport accounts for around one-quarter of EU CO₂ emissions¹³. CO₂ emissions from transport¹⁴ have been growing over the last 20 years. Only in 2008 and in 2009 was there a drop in CO₂ emissions from transport, but this was combined

¹³ The contribution of various modes to the total emissions of the transport sector was as follows in 2008: 71.3% came from road, 15.3% from maritime, 12.8% from aviation, and 0.7% from rail transport. These figures include international aviation and maritime but exclude combustion emissions from pipeline transportation, ground activities in airports and harbours, and off-road activities. The figure for rail only includes emissions from diesel use, but not from electricity use. Looking at final energy consumption by transport mode, electricity represents about 66% of the energy consumed by rail.

¹⁴ In general, the notion of transport-related CO₂ emissions covers vehicle exhaust emissions (i.e. tank-to-wheel emissions). Unless stated otherwise, the references to transport-related CO₂ emissions in this Impact Assessment report relate only to tank-to-wheel emissions. Emissions produced by the energy consumed in the extraction, processing and distribution of fuels, i.e. “well-to-tank” emissions, are not part of the targets assessed. In addition, the present Impact Assessment report does not cover the so-called “embodied energy” CO₂ emissions from the manufacture of vehicles and construction of roads and other components of the transport infrastructure.

with a drop in transport activity¹⁵. New vehicles have become more fuel efficient and hence emit less CO₂ per km than earlier models did in the past, but these gains have been eaten up by rising vehicle numbers, increasing traffic volumes, and in many cases better performance in terms of speed, safety and comfort.

Transport is extremely dependent upon oil

36. The lack of progress in decoupling transport growth from the growth in CO₂ emissions results first and foremost from the fact that transport is one sector of the economy where substitution with other energy carriers has been negligible. Transport continues to rely nearly entirely on oil and oil products: for more than 95% of its needs worldwide and 96% in EU-27¹⁶.
37. Gasoline and diesel consumption makes up for 95% of energy use in road transport. Diesel accounts for almost the entirety of the commercial fleet, and a growing proportion of private cars (a third in 2008). Maritime and aviation continue to rely entirely on fuel oil and kerosene, whereas in rail some further electrification has taken place in the last decade.
38. Since Europe imports 84.1% of its crude oil from abroad¹⁷, this makes transport, and hence the wider economy of Europe, very reliant on the availability of oil and petroleum products on world markets. As "...energy supply security must be geared to ensuring the proper functioning of the economy, the uninterrupted physical availability at a price which is affordable, while respecting environmental concerns"¹⁸, oil security is often equated with improving the security of supply for the transport sector.

Rising levels of congestion prevent the EU transport system from keeping pace with the mobility needs and aspirations of people and businesses

39. Whilst people and businesses value mobility highly, they have also become much more concerned about the adverse impacts of transport on health and quality of life and about their own experience as congestion mounts. In this respect, it is interesting to note that the Consumer Markets Scoreboard of October 2010, identified railways as one of the top four services market where consumers experienced most problems¹⁹.
40. In many places, the current capacity of transport networks is not able to meet the demand that is, or will be, regularly placed on them. In those circumstances, the inevitable result is congestion in urban areas and regions, at the entrance of the main

¹⁵ There is also considerable concern regarding aviation's total climate impact on the global climate which has been estimated by the IPCC as being two to four times higher than the effect of carbon dioxide emissions alone due to releases of nitrogen oxides, water vapour and sulphate and soot particles (excluding cirrus cloud effects). The figures in this impact assessment generally refer to only the carbon dioxide effects.

¹⁶ European Commission, EU Energy and Transport in Figures, 2010
http://ec.europa.eu/transport/publications/statistics/statistics_en.htm.

¹⁷ Source: Eurostat.

¹⁸ COM(2000) 769, Green Paper - Towards a European strategy for the security of energy supply

¹⁹ The others were internet access, real estate services and investments, pensions and securities.
http://ec.europa.eu/consumers/strategy/docs/4th_edition_scoreboard_en.pdf

cities, and on the key transit roads, overcrowding on some public transport links and lengthy queues at some airports. When networks are overused, journey times lengthen and reliability suffers.

41. Changes in commerce and personal travel patterns have increased the importance of a reliable and efficient transport system because of more complex and inter-related supply chains and increasingly complex scheduled activities. In this context, the unreliability and inefficiency of transport has a marked effect on downstream activities. The expectation from these demand trends is increasingly that transport should provide high levels of reliability and of efficiency.
42. The building of new infrastructure to reduce congestion and accommodate higher levels of traffic is less and less a practicable solution. The impact of infrastructure on the environment is a growing concern. In addition, the current economic crisis reasserts the importance of putting budget accounts into a long-term sustainable path. This implies reducing public deficit and debt and improving the quality of public finance. More cost-effective solutions would have to be found to tackle congestion than relying on expanding 'hard' infrastructure.
43. Congestion is not just a problem for the individual user. Congestion that is prevalent in agglomerations and in their access routes is the source of large costs.
44. It has a negative impact on the environment since it results in increased air²⁰ and noise²¹ pollution. Congestion also generates higher fuel consumption²²: vehicle fuel consumption increases approximately 30% under heavy congestion²³. The time wasted in traffic jams prevents the benefits of agglomeration effects to fully

²⁰ In contrast to the evolution of CO₂ emissions, the emissions of some air pollutants from transport vehicles were reduced significantly despite rising traffic volumes: transport-related emissions of particulate matter (PM₁₀) and of acidifying substances have decreased by about one third between 1990 and 2006, those of ozone forming substances have been nearly halved (see EEA, 2010, Towards a resource-efficient transport system — TERM 2009 (EEA Report No. 2/2010). Emission reduction has been more successful in road transport than in other modes of transport. This success is mainly due to the gradually more stringent EURO emission standards for road vehicles. It should be noted, however, that partly due to the discrepancy between real-world and test-cycle emissions of vehicles, road still accounts for the lion's share (more than two thirds) of total pollutant emissions from transport, even if the total amount of pollutants and particulates has been significantly reduced. Moreover, the downward trends have not been observed for all pollutants (e.g. NO_x), and the concentrations of NO_x, ozone and particulate matters in many areas (particularly in cities) are still often beyond what is considered to be healthy. For example, twenty EU Member States have submitted notifications for time extensions for PM₁₀ limits in line with the extension of the compliance year offered by Directive 2008/50/EC.

²¹ About half of the EU-15 citizens are estimated to live in areas which do not ensure acoustical comfort for residents: 40% of the population is exposed to road traffic noise exceeding 55 dB(A) during daytime, and 20% to levels exceeding 65 dB(A). At night, more than 30% are exposed to sound levels that disturb sleep (>55 dB(A)) [See the WHO Night Noise Guidelines for Europe (WHO, 2009)]. Existing studies show that noise exposure increases the risk for high blood pressure and heart attacks. Surveys also show that (environmental) noise is a relevant reason for people moving out of the cities into the suburban area. [See SILENCE project (Integrated Project co-funded by the European Commission under the Sixth Framework Programme for R&D): SILENCE Practitioner Handbook for Local Noise Action Plans, 2008, http://www.silence-ip.org/site/fileadmin/SP_J/E-learning/Planners/SILENCE_Handbook_Local_noise_action_plans.pdf]

²² See in this respect COM/2009/0279 final.

²³ I.D. Greenwood and C.R. Bennett (1996), "The Effects of Traffic Congestion on Fuel Consumption," Road and Transport Research, Vol.5, N°2, June 1996, pp18-31.

materialise. The costs of congestion have a negative impact on productivity, competitiveness of the economy and quality of life.

45. In light of the above, the Commission is of the opinion that today's EU transport system does not sufficiently keep pace with the mobility needs and aspirations of people and businesses. High levels of congestion cause large costs to the society, inconvenience and dissatisfaction to people and companies²⁴. This could ultimately become a brake on economic growth.

Conclusion

In light of the above, it can be concluded that the European Union has not succeeded in containing the growth of the economic, environmental and social costs of mobility while simultaneously ensuring that current and future generations have access to safe, secure, reliable and affordable mobility resources to meet their own needs and aspirations.

The Commission is therefore of the opinion that the EU transport system today is not sustainable enough.

Firstly, it is not sufficiently resource efficient so as to promote sustainable growth in the meaning of the EU 2020 strategy. Transport is extremely dependent upon oil whereas CO₂ emissions from transport-related activities account are still growing.

Secondly, with congestion growing, it does not sufficiently keep pace with the mobility needs and aspirations of people and businesses.

2.3. What if present trends continue?

46. The Commission has carried out an analysis of possible future developments in a scenario at unchanged policies, the so-called baseline scenario or "Reference scenario". The Reference scenario is the same with the one used in the Impact Assessment of the "Low-carbon economy 2050 roadmap" and in the forthcoming 2050 Energy Roadmap. The Reference Scenario to 2050 is presented in more detail in Appendix 3 of the present Impact Assessment Report, whereas the inventory of the policy measures included in this scenario is provided in Appendix 4.
47. The Reference scenario is a projection, not a forecast, of developments in absence of new policies beyond those adopted by March 2010²⁵. It therefore reflects both

²⁴ The costs of transport can be split into private/internal costs (those directly borne by the person engaged in transport activity) and external costs (i.e. those that are imposed on others but not supported by the user). The sum of private and external costs represents costs to the society. The boundary between internal and external costs is defined by the costs the person takes into account when deciding to use a transport service. This means that when engaging in a transport activity, a person will incur private costs linked to the use of a mode of transport (vehicle purchase, tolls or fuel use), but will not be aware of effects imposed on others such as pollution or congestion. His/her decision will not be based on the social costs of his/her activity. In other words, the costs imposed on others— environmental damages, accidents, congestion - generated by transport activities are external costs, more generally referred to as externalities. Most of them have increased over the past years despite technological progress (see in this respect the Impact Assessment on the internalisation of external costs - <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52008SC2208:EN:NOT>)

²⁵ The Reference scenario used for the purpose of this Impact Assessment is the same as the Reference scenario used in the Impact Assessment of the "Low-carbon economy 2050 roadmap". The cut off date

achievements and deficiencies of the policies already in place. This projection provides a benchmark for evaluating new policy measures against developments under current trends and policies. The Reference scenario builds on a modelling framework including PRIMES, TRANSTOOLS, PRIMES-TREMOVE transport model, TREMOVE and GEM-E3 models^{26, 27}.

2.3.1. *Reference scenario assumptions*

48. The projection is built on a set of assumptions related to population growth, macro-economic projections, developments in oil price and technology improvement.
49. Demographic change is transforming the EU with inevitable consequences also on the transport sector. In the Reference case, the population projections draw on the EUROPOP2008 convergence scenario (EUROpean POPulation Projections, base year 2008) from Eurostat, which is also the basis for the 2009 Ageing Report (European Economy, April 2009)^{28,29}. The key drivers for demographic change are: higher life expectancy, low fertility and inward migration. The EU-27 population is expected to grow by 0.2% per year by 2035 and slightly decline afterwards, remaining fairly stable in number at around 500 million in the next 40 years.
50. Elderly people, aged 65 or more, would account for 24% of the total population by 2020 and 29% by 2050 as opposed to 17% today. Around one in six people in the EU has a disability. Over 20% of elderly people aged over 75 are severely restricted. Ageing and the extended longevity of people can be expected to lead to increasing numbers of elderly people with a severe disability³⁰.
51. In the Reference scenario, the average GDP growth rate for EU-27 is only 1.2% per year for 2000-2010, while the projected rate for 2010-2020 is assumed to recover to 2.2%, similar to the historical average growth rate between 1990 and 2000. In the medium run the higher expected growth rate is due to higher productivity growth assumed in Member States that are catching up. GDP growth rate in the EU-27 is projected to fall to 1.6% during 2020-2050, mainly due to demographic ageing

for the policy measures included in the Reference scenario (March 2010) is common to both initiatives. In other words, the Reference scenario does not incorporate policy measures that were adopted by the Commission after March 2010. In particular, the Reference scenario does not cover the Commission Decision of 14 October 2010 re-launching of the CARS 21 High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union. For the same reason, it does not capture the recent initiatives of car manufacturers as regards electric vehicles (hereinafter “EV”).

²⁶ A brief presentation of the models used is provided in Appendix 5.

²⁷ In addition, the oil price projections are the result of world energy modelling with PROMETHEUS stochastic world energy model, developed by the National Technical University of Athens (E3MLab).

²⁸ European Commission, DG Economic and Financial Affairs: 2009 Ageing Report: Economic and budgetary projections for the EU-27 Member States (2008-2060). EUROPEAN ECONOMY 2|2009, http://ec.europa.eu/economy_finance/publications/publication14992_en.pdf. The “baseline” scenario of this report has been established by the DG Economic and Financial Affairs, the Economic Policy Committee, with the support of Member States experts, and has been endorsed by the ECOFIN Council.

²⁹ Demographic projections in the Reference scenario are common in PRIMES, TRANSTOOLS, PRIMES-TREMOVE transport model, TREMOVE and GEM-E3.

³⁰ European Commission, DG Employment: People with disabilities have equal rights - The European Disability Strategy 2010-2020, <http://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=591&type=2&furtherPubs=no>

which, with a reduction in the working-age population, is expected to act as a drag on growth³¹.

52. The Reference scenario assumes a relatively high oil price environment compared with previous projections, and similar to projections from the International Energy Agency (IEA)³², with oil prices of 59 \$/barrel in 2005 rising to 106 \$/barrel in 2030 and 127 \$/barrel in 2050 (in year 2008-dollars)^{33, 34}. As a result, total fuel costs for the transport sector would be about 300 billion euro higher in 2050 relative to 2010 which represents more than 70% increase over the period under review.
53. In terms of technological developments, battery costs for plug-in hybrids and electric vehicles are assumed to remain high by 2050, at about 560-780 €/kWh³⁵, but further improvements in the efficiency of both spark ignition gasoline and compression ignition diesel are assumed to take place. In addition, the market share of internal combustion engine (ICE) electric hybrids is expected to increase due to their lower fuel consumption compared to conventional ICE vehicles.

2.3.2. *Reference scenario main results*

54. Modelling projections show that, in a no policy change scenario, the unsustainable features of the EU transport system identified in the ex-post evaluation are likely to worsen in a context of growing demand for transport. Total transport activity is expected to continue to grow in line with economic activity even though a decrease is visible for 2008-2009 as a result of the recent economic crisis. The recovery foreseen starting with 2010 is reflected by transport activity returning to its long term trends. Total passenger transport activity would increase by 51% between 2005 and 2050 while freight transport activity would go up by 82%³⁶.
55. Transport accounts today for over 30% of final energy consumption. In a context of growing demand for transport, final energy demand by transport is projected to increase by 5% by 2030 and an additional 1% by 2050 to then 32% of total final energy consumption, driven mainly by aviation and road freight transport. At the same time, however, the energy use of passenger cars would drop by 11% between

³¹ European Commission, DG Economic and Financial Affairs: 2009 Ageing Report: Economic and budgetary projections for the EU-27 Member States (2008-2060). EUROPEAN ECONOMY 2|2009, http://ec.europa.eu/economy_finance/publications/publication14992_en.pdf.

³² The IEA Energy Technology Perspectives 2010 assumes 115 \$/barrel in 2008 prices for 2030 and 120 \$/barrel for 2050.

³³ The oil price projections are the result of world energy modelling with PROMETHEUS stochastic world energy model, developed by the National Technical University of Athens (E3MLab).

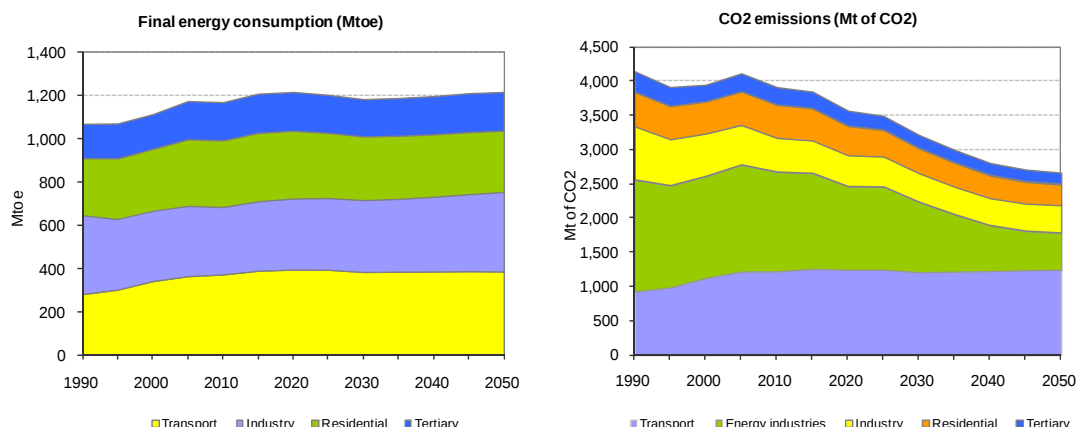
³⁴ This would translate into an oil price of 91 €/barrel in 2030 and 118 €/barrel in 2050.

³⁵ As said above, the Reference scenario does not cover the Commission Decision on re-launching of the CARS 21 High Level Group on the Competitiveness and Sustainable Growth of the Automotive Industry in the European Union and does not capture the recent initiatives of car manufacturers as regards electric vehicles (hereinafter “EV”).

³⁶ Passenger transport activity includes international aviation, while freight transport activity also includes international maritime.

2005 and 2030 due to the implementation of the Regulation setting emission performance standards for new passenger cars³⁷.

56. Renewables would represent 10% of total energy consumption in transport by 2020, reflecting the implementation of the Renewables Directive³⁸. Their share would gradually increase to 13% by 2050³⁹. However, the pace of electrification in the transport sector is projected to remain slow in the Reference scenario: electric propulsion in road transport does not make significant inroads by 2050⁴⁰.



Source: PRIMES and projections based on TRANSTOOLS for maritime

Figure 1: Evolution of total final energy consumption and CO₂ emissions between 1990 and 2050 in the Reference scenario⁴¹

57. As a consequence, the EU transport system would remain extremely dependent on the use of fossil fuels. Oil products would still represent 90% of the EU transport sector needs in 2030 and 89% in 2050 in the Reference scenario.
58. In a no policy change scenario in which pricing mechanisms remain inadequate and in which the way the transport system operates is not improved substantially, people and businesses would not receive sufficient incentives to shift away from road transport. In this context, road would remain the dominant mode in both freight and

³⁷ Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO₂ emissions from light-duty vehicles, OJ L 140, 5.6.2009, p. 1–15.

³⁸ Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L 140, 5.6.2009, p. 16–62.

³⁹ The shares of renewables in transport reported here follow the definition from the Directive 2009/28/EC.

⁴⁰ As said above, the Reference scenario does not cover the European Commission CARS 21 (Competitive Automotive Regulatory System for the 21st century) initiative. This initiative may trigger a higher uptake of electric propulsion vehicles in the Reference scenario, which is currently negligible by 2050. In addition, the Reference scenario was finalised in early 2010 and does not capture the recent initiatives of car manufacturers as regards electric vehicles. As a result, the penetration of EVs might be higher and transport sector oil dependency and CO₂ emissions might be lower in the Reference scenario.

⁴¹ The CO₂ emissions from transport include international maritime and aviation but exclude combustion emissions from pipeline transportation, ground activities in airports and harbours, and off-road activities.

passenger transport. In this context, whereas transport today accounts for about one fourth of total CO₂ emissions⁴², the share of CO₂ emissions from transport would continue increasing, to 38% of total CO₂ emissions by 2030 and almost 50% by 2050, following a relatively lower decline of CO₂ emissions from transport compared to power generation and other sectors. This is due to the higher cost of abating emissions in the transport sector. Overall, CO₂ emissions from transport would still be 31% higher than their 1990 level by 2030 and 35% higher by 2050, mainly owing to the fast rise of transport emissions during the 1990s⁴³. Aviation and maritime would contribute an increasing share of emissions over time. This trend is not compatible with the objective of a low-carbon, competitive economy that would meet the long-term requirements for limiting climate change to 2 °C.

59. External costs of transport would continue increasing. The increase in traffic would lead to a roughly 20 billion € increase of noise-related external costs by 2050 and external cost of accidents would be about 60 billion € higher⁴⁴. The external cost of accidents in urban areas would increase by some 40%. Only the external costs related to air pollutants would decrease by 60% by 2050.
60. In particular, congestion would continue to represent a huge burden on the society. Congestion costs are projected to increase by about 50%, to nearly 200 billion € annually.

2.3.3. *Sensitivity analysis*

61. Considering the high degree of uncertainty surrounding projections over such a long time horizon, especially for such a complex system as transport, a sensitivity analysis has been carried out with respect to developments in oil prices⁴⁵. An evaluation is also provided below for the effects of higher GDP growth on transport activity by 2030.
62. If oil prices in 2050 were almost 70% higher than in the Reference scenario (212 \$/barrel in 2050 in year 2008-dollars, compared to 127 \$/barrel in the Reference scenario), this would have only moderate effects on transport activity: passenger transport activity would be some 5% lower than in the Reference scenario in 2050 and freight transport activity would be almost 8% lower. However, some modal shift would take place in favour of rail, which is expected to be largely electrified by 2050: the modal share of rail in passenger transport would increase by some 3 percentage points while in freight transport rail's share would be more than 1 percentage point higher in 2050 than in the Reference scenario⁴⁶. The high oil price environment triggers the uptake of electric propulsion vehicles on a large scale but conventional ICE cars would still represent about 26% of the total passenger

⁴² The CO₂ emissions include international maritime and aviation but exclude combustion emissions from pipeline transportation, ground activities in airports and harbours, and off-road activities.

⁴³ The CO₂ emissions from transport include international maritime and aviation but exclude combustion emissions from pipeline transportation, ground activities in airports and harbours, and off-road activities.

⁴⁴ The costs are expressed in year 2005 euros.

⁴⁵ The Reference scenario with high oil prices is presented in more detail in the Impact Assessment of the "Low-carbon economy 2050 roadmap".

⁴⁶ Transport activity in this analysis includes international aviation and maritime.

transport activity in 2050. High oil prices would only lead to about 20% lower CO₂ emissions by 2050⁴⁷. CO₂ emissions from maritime transport would decrease by about 20% relative to the Reference scenario in 2050.

63. An estimate of the impact of higher GDP growth on transport activity can be provided by comparing the Reference scenario with a similar scenario from the Impact Assessment of the 2008 Climate and Energy Package, which assumes higher GDP (pre-crisis) projections^{48,49}. In this scenario, GDP in 2030 is some 11% higher than in the Reference scenario. With higher GDP, both passenger and transport demand would be higher relative to the Reference scenario, although the effect is more pronounced for freight transport: passenger transport demand would be some 3% larger by 2030 compared to the Reference scenario, while freight transport would add some 5% over the same time period. Without additional policies in place, CO₂ emissions from transport would be higher in this scenario than in the Reference scenario. The fact that in the Reference scenario the lower GDP growth translates into a less than proportional decrease in transport volumes reflects the view that transport is becoming less responsive to changes in overall economic activity. Indeed, we have already observed the decoupling of passenger traffic from GDP in recent years, possibly due to high congestion levels and the high car ownership in some EU-15 Members States where passenger car activity is close to saturation levels. A similar, though less pronounced development may occur in freight transport owing to the fading out of the effects of the enlargement, to the impact of growing oil prices and to the ever increasing weight of the service sector in the economy, but also due to the restructuring of logistics systems, the realignment of supply chains and the rescheduling of product flows.

Conclusion

It is clear from the above that, factoring in all the indicators, today's unsustainable system of mobility is not likely to become sustainable if present trends continue.

2.4. The root causes of the unsustainability of transport

64. This section analyses why the transport system is not capable to adjust to changing external circumstances – such as climate change, infrastructure constraints and oil scarcity – and take a sustainable path.
65. Transport is a complex system that is based on the interaction of many components all of which need to evolve together: vehicles, infrastructure, behaviour etc. This explains the strong inertia of the system and the need for addressing several problem areas in order to determine a paradigm shift.
66. As indicated in point 33 above, the Commission has identified four main areas in which market and regulatory failures prevent the EU transport system to develop into

⁴⁷ The 20% reduction refers to CO₂ emissions excluding international maritime but including international aviation.

⁴⁸ Impact assessment of the 2008 Climate and Energy Package (SEC(2008) 85/3).

⁴⁹ However, this provides only a rough estimate, because not only GDP but also demographic projections, energy prices and some policy assumptions included in each scenario is different.

a sustainable system. These drivers are relative prices, technology deployment, conditions of supply and planning.

67. At this stage, it is important to note that, whereas the drivers identified below are the root causes explaining why the EU transport system is not sustainable, it is not possible to strictly map a particular driver to a specific problem given the complexity of a system such as transport.

2.4.1. *Cheap for users, expensive to society: prices do not reflect true costs*

68. In transport, like in any other sector, there cannot be economic efficiency unless the prices reflect all costs - internal and external – to the society actually caused by the users. By providing information on the relative scarcity of goods or services, prices convey essential information to users, operators and investors.
69. Today, as highlighted in section 1.1 of the ex post evaluation, most of the external costs of transport are still not internalised⁵⁰. Where existent, internalisation schemes are not co-ordinated between modes and Member States. Many taxes and subsidies directly affecting modal choices have been designed without the internalisation goal in view, rather pursuing traditional fiscal aims: the internalisation part of fuel taxation for instance is not clearly identified against other components of the tax. There are inconsistent taxation rules between transport modes and fuels, between and within Member States. In the worst case, tax systems subsidise environmentally unsustainable choices: for example, the favourable company car taxation rules give incentives for an artificially high car use⁵¹.
70. On the other hand, public support to the transport sector can be justified to the extent that transport brings about positive externalities to society – for example by connecting an isolated region and contributing to its economic growth – or in case of infrastructure that has the characteristics of a public good.
71. As long as the total costs to society induced by transport activities (including the cost of infrastructure provision and maintenance) are not correctly reflected in the costs borne by transport users, the demand for transport stays above its optimal level and the pricing system fails to steer the customers towards most efficient and sustainable mobility choices⁵².

2.4.2. *Research and Innovation: transport technologies do not achieve low carbon mobility*

72. The ex post evaluation undertaken by the Commission has shown that transport research and innovation in Europe today are progressing in supporting the development and deployment of key technologies that are needed to develop the EU

⁵⁰ The Impact Assessment (SEC(2008) 2208) accompanying the Commission Communication ‘Strategy for the internalisation of external costs’ (COM(2008) 435) provided ample evidence that the total costs to society are not correctly reflected in the costs borne by transport users.

⁵¹ See in this respect: http://ec.europa.eu/taxation_customs/resources/documents/taxation/gen_info/economic_analysis/tax_papers/taxation_paper_22_en.pdf

⁵² See COM(2008) 435 final. “ Strategy for the internalisation of external costs”: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0435:FIN:EN:PDF>

transport system into a modern, decarbonised efficient and user-friendly system⁵³. However, bringing the products and services to the market to attain this objective is not fast enough.

73. This situation is due to a wide variety of market and regulatory failures, such as non-appropriability of research, coordination failures, and path dependency⁵⁴. These are manifested as:
- Weak innovation process resulting from the often missing direct link between research and development and deployment;
 - Lack of sufficient coordination of efforts between the EU, Member States, public and private actors related to insufficient data and information and lack of common setting of strategic priorities;
 - Excessive time to bring the technology to market, even though long lifetime of vehicles and infrastructure requires action now to meet our long term policy objectives; and
 - The complexity of technology options, which makes difficult to choose between a ‘broad portfolio’ approach and strategic technology targeting of scarce financial, managerial and scientific resources.
74. The continued oil dependence of transport-related activities is a clear manifestation of the problem⁵⁵.
75. User behaviour plays a determining role in the success or failure of new technologies. Users, apart from ‘early adopters’, are often unwilling to change their customary way of travelling and transporting goods, and accept alternative solutions. Lack of properly presented and reliable⁵⁶ information and uncertainty may also influence decisions, as, for example, in the case of underestimation of fuel savings over the life time of an energy efficient vehicle.

⁵³ The Commission Communication on the Innovation Union (COM(2010) 546) and its Staff Working Document (SEC(2010) 1161) explains in detail the key weaknesses of the EU research and innovation system, such as under-investment, system component-, system linkage- and system governance weaknesses.

⁵⁴ COM(2010) 546. “Europe 2020 Flagship Initiative Innovation Union”.

⁵⁵ The promotion of alternative fuels has been slow and fragmented across Member States. The share of alternative fuels remains below 5% in the EU on average. This situation is due to a series of obstacles such as:

- a lack of high-level coordination and cooperation across relevant policy areas and stakeholders who have not necessarily cooperated before; which results in the absence of EU-wide standards, including on an accepted methodology that enables the comparison of economic, social and environmental impacts of using various fuels and energy carriers based on their production approach.
- consumer myopia and lack of foresight; and
- lack of correct pricing for the externalities of fossil fuel use

⁵⁶ Such as information based on the effective evaluation of real world emissions of vehicles, and a common methodology of calculating carbon footprints.

2.4.3. *Supply of transport services: not sufficiently efficient*

76. Whereas the EU has opened to competition most of its transport markets since the 90's, a number of obstacles to a smooth and efficient functioning of the internal transport market persist. In this respect, a more detailed analysis of this driver, which is based upon the result of the ex post evaluation, is provided in Appendix 6 of the present Impact Assessment report⁵⁷.
77. The level of integration of the EU transport market remains low in comparison to other parts of the economy. A genuine EU-wide internal market exists only in air transport, while other transport modes suffer from different degrees of fragmentation along national borders; this concerns in first place rail and inland waterways, but road and short sea shipping are also affected.
78. Cross-border transport and competition in national markets is hindered by protectionist regulations or attitudes, often defending the interest of incumbents and restricting access to domestic markets by foreign operators and new market entrants. In some liberalised market segments, a complete and correct implementation and enforcement of EU legislation by Member States is still missing. This is particularly the case for rail freight transport, which has been open to competition since January 2007.
79. Besides, transport infrastructure has been historically designed to serve national rather than European goals and cross border links constitute bottlenecks that are likely to become increasingly costly as the EU economy continues integrating.
80. The lack of universally approved standards on, for example, traffic management and data exchange systems, on power supplies, and on educational requirements for transport workers are further obstacles to cross-border traffic and in some cases preclude the reduction of production costs achievable with a larger scale of production.
81. Integration between transport modes is still far from being achieved. Multimodal infrastructure such as multimodal transshipment platforms for freight and integrated rail-air-public transport nodes for passengers is not sufficiently developed. Exchanging data between the modes is difficult because of the co-existence of non-interoperable modal IT systems.
82. In addition, the EU transport system suffers from an uneven level playing field regarding national health, social, safety and security standards, which is particularly felt in some market segments such a road transport.
83. Finally, the human factor is a crucial component in transport to create a higher quality and more reliable transport system with a higher sensitivity to customers' needs. In this respect, the EU transport system has suffered in normal demographic and economic conditions from skill shortages and a tight labour supply, not least given the difficulties inherent to the working conditions of mobile workers (working

⁵⁷ The independent study underlying this section was published on the Europa website in 2009. http://ec.europa.eu/transport/strategies/studies/doc/future_of_transport/20090908_common_transport_policy_final_report.pdf

far from home often at asocial working hours, safety and security risks...)⁵⁸. The sector will be particularly vulnerable as it is ageing more than the economy-wide average and it is a sector where women's participation is much lower than the average. These traits are particularly relevant in railways, inland waterways and short sea shipping which would receive traffic from the more energy intensive modes such as road transport and aviation.

84. All these elements induce suboptimal modal choices, delayed adoption of new technologies, slower renewal of the fleet, and lack of investment in renewable energy sources and in certain types of infrastructure. These inefficiencies translate then into lower resource efficiency, higher transport externalities and higher overall transport costs to the society.

2.4.4. *Transport planning: lack of coordination and insufficient awareness of interactions*

Insufficient transport planning at local level...

85. When taking land-use planning or location decisions, public authorities and companies often do not properly take into account the consequences of their choices on the operation of the transport system as a whole, which typically generates inefficiencies. The problem is particularly acute in urban areas⁵⁹. Urban transport systems are integral elements of the European transport system and therefore are also of concern for the Common Transport Policy. They have a large influence on the achievement of European-wide goals such as those related to GHG emissions, biodiversity, oil-dependency and resource efficiency.
86. Significant changes in urban mobility require comprehensive actions that bring together land-use planning, road use and parking, transport pricing, infrastructure development, public transport policy and much more. Achieving integrated and sustainable urban transport is an increasingly complex task which touches many stakeholders and interests. A greater coordination of all authorities having an influence on the transport system is highly desirable, possibly bringing together the responsibilities for land-use and transport planning, public transport, road use and transport infrastructure. Equally desirable is an extension of the co-ordination of such authorities beyond the strict city borders, so to cover entire metropolitan areas or regional transport systems.

...and at continental scale

87. Weaknesses in transport planning are also present with respect to the Trans-European Transport Network. TEN-T planning and implementation has so far not been driven sufficiently by a coherent European design. National infrastructure planning remains to a large extent disconnected from planning at EU level, and is mainly done at a modal level rather than in an integrated way across countries and modes of transport. The lack of international cooperation and coordination typically produced a number of inefficiencies: lack of joint traffic forecasts leading to differing investment plans; disconnected or even contradictory timelines; lack of joint investment calculation

⁵⁸ See for instance the Commission Freight Transport Logistics Action Plan (COM(2007) 607)

⁵⁹ The Action Plan on Urban Mobility of 2009 (COM(2009) 490) identified as its Theme 1 the need to promote Integrated Policies.

and joint financial structures; incompatible technical characteristics; inadequate joint management of cross-border infrastructure projects.

88. Moreover, national and European infrastructure projects have largely focused on developing individual priority projects rather than on creating a network. Infrastructure planning and assessment of individual projects failed to give an accurate representation of wider effects of infrastructure projects and of how these projects contribute to the overall infrastructure network.

Conclusion

89. The consideration of transport needs and of shifting transport flows is currently not sufficiently integrated in land-use planning decisions, resulting in excessive or sub-optimally distributed transport demand. Consequently, the negative environmental and socio-economic impacts of transport are aggravated.

2.5. Does the Union have the right to act?

90. The right for the EU to act in the field of transport is set out in several articles of the TFEU, especially in Title VI, which makes provisions for the Common Transport Policy and in Title XVI on the trans-European networks. Article 192 TFEU also provides a legal basis for addressing the environmental sustainability of the transport system.
91. Pursuant to Articles 90 and 91 TFEU, the Common Transport Policy should contribute to the broader objectives of the treaties. The goal of the common transport policy is to remove obstacles at the borders between Member States so as to facilitate the free movement of persons and goods. To this end, its prime objectives are to complete the internal market for transport, ensure sustainable development, promote a better territorial cohesion and integrated spatial planning, improve safety and develop international cooperation.
92. All transport and environment policy proposals are decided by qualified majority, except for taxation measures which are decided by unanimity. As regards trans-European networks, the Commission's financing proposals have to be approved by the Member States, who are responsible for the planning and construction of projects. The Union has shared competence in the field of transport safety as set out in Article 4 of the TFEU and only limited competence in the field of urban mobility.
93. In areas which do not fall within EU exclusive competence, EU action has to be justified. In the present case, it is therefore necessary that the subsidiarity principle set out in Article 5 (3) of the Treaty on the European Union is respected. This involves assessing two aspects.
94. Firstly, it is important to be sure that the objectives of the proposed action could not be achieved sufficiently by Member States in the framework of their national constitutional system, the so-called necessity test.
95. Given the fact that the overall concept is to create an EU-wide sustainable and integrated transport system, the Member States per se are not able to meet these challenges individually for the following reasons:

- The issues being addressed by the Transport White Paper, namely CO₂ emissions, oil dependency and overall efficiency of the transport system, have transnational aspects which cannot be dealt with satisfactorily by Member States. These aspects, which concern for instance the cross-border connections between national infrastructure networks, need to be coordinated at EU level. International transport represents a significant and growing share of transport and can not be properly regulated at Member State level⁶⁰.
- The lack of EU action or the individual actions by Member States alone may hinder the development of the single market; give a competitive advantage to some players against the others and therefore negatively impact the free circulation of both goods and people, especially for transnational services. Coordinated action at EU level could overcome these disadvantages.
- The issues identified above have different spatial effects and a strong variability, meaning that impacts across the EU could vary considerably. There is a need to ensure that solidarity is enshrined in the future transport policies. Similarly, it has to be ensured that the ones who are hit hardest by the problems identified will be able to adapt. Cohesion policy can further contribute to address the consequences of new disparities between those regions which suffer most and those that can more easily cope with their impacts.
- Due to its scale, action at EU level can leverage greater results and magnify the efforts in many domains such as capacity building, research, information and data gathering, exchange of best practice, development and cooperation. In particular, only EU action would ensure that all EU citizens benefit from a resource efficient and competitive transport system.
- Because it will be more effective, EU action on transport emissions and oil dependency will produce clear benefits compared with actions at the level of Member States.
- As regards external action, the increased negotiating power of the EU, rather than individual Member States, may confer a leading role to the EU in some sectors. Moreover, since the unsustainable mobility has consequences for the EU economy and the EU supply of energy, there is a need for oversight and responsibility at EU level to complement the actions at national level and to avoid free riding.
- In the field of urban mobility, there are several examples confirming the necessity to take action at EU level. One of the problems related to urban mobility and transport are emissions from road traffic, including emissions that contribute to climate change. This is a problem with a clear transnational dimension, where action by individual Member States, for example to set new limit values, introduce financial incentives or implement their own access restriction rules, could be in violation of EU legislation. Urban congestion affects enterprises from other Member States. No action by the EU in this field, or action by just a few

⁶⁰

30% of total road freight is international and international road freight transport grows twice as fast as domestic road freight transport. Source: Road Freight Transport Vademecum, N°2, March 2009.

individual Member States, could lead to less informed decisions and damage the financial and policy interests of Member States⁶¹.

96. Secondly, it has to be considered whether and how the objectives could be better achieved by action on the part of the EU, the so-called “test of European added value”. The rationale for a European action in the field of transport stems from the trans-national nature of the identified problem. However, it has to take into account that a ‘one size fits all’ approach would not be an adequate response. Therefore, an action at EU level coupled with actions at all administrative levels would yield significant added value.
97. As regards urban mobility, dissemination of information and knowledge, expansion of the knowledge base and exchanges of best practice in the area of urban mobility are best carried out at EU level. This will avoid duplication of work and fragmentation of resources and allow decision-makers to benefit from the broadest, most diverse experience possible. In addition, emission and noise limits are best set at EU level in order to avoid an adoption of different standards in different Member States, which would add to the regulatory burden. Other examples include setting technical standards, e.g. for intelligent travel information and payment systems, including Galileo-based applications. There is also clear added value in action at EU level on information and data collection and monitoring. Based on the above observations, there is a basis to conclude that there is “added value” in EU action in the field of urban mobility and transport⁶².
98. For these reasons, the policy objectives set out in section 3 of the present Impact Assessment report cannot be sufficiently achieved by actions of the Member States alone, but can rather, by reason or scale of the proposed action, be better achieved with high involvement of the EU. A thorough subsidiarity analysis will be performed for the specific policy measures contained in the proposed initiative.

3. OBJECTIVES

99. Section 2 has shown that the EU transport system is not sustainable to the extent of supporting smart, sustainable and inclusive growth in the meaning of the EU 2020 Strategy. More specifically, it has been explained that the efficiency of the EU transport system in the use of natural resources and its ability to respond to the mobility needs and aspirations of people and businesses are not satisfactory.
100. This section defines the general and specific policy objectives of the proposed initiative, discusses possible trade-offs and synergies between sustainability goals and verifies their consistency with other EU horizontal objectives.

⁶¹ See in this respect the Impact Assessment accompanying the Action Plan on Urban Mobility Impact Assessment (COM(2009) 490) {SEC(2009) 1212}.

⁶² See in this respect the Impact Assessment accompanying the Action Plan on Urban Mobility Impact Assessment (COM(2009) 490) {SEC(2009) 1212}.

3.1. Policy objectives

3.1.1. General policy objective

101. A sustainable transport system is a crucial element for achieving smart, inclusive and resource efficient growth in Europe as defined in the EU 2020 strategy. To this end, as indicated under the resource efficiency flagship, the scale of the change that a resource-efficient agenda implies requires a massive technological improvement and a radical change in the transport system.
102. Based on the assessment of the problem and its root causes, the general policy objective of this initiative is to define a long-term strategy that would transform the EU transport system into a sustainable system by 2050. The Renewed Sustainable Development Strategy of the European Union (hereinafter SDS) of the European Union⁶³ defines a sustainable transport system as the one that “*meets society’s economic, social and environmental needs whilst minimising its undesirable impacts on the economy, society and the environment*”. More specifically, the main “*undesirable impacts on the economy, society and the environment*” caused by transport are: congestion, oil dependence, accidents, emissions of GHG and of other pollutants, noise, and land fragmentation caused by infrastructure. The following section formulates specific policy objectives in relation to the main sustainability concerns.

3.1.2. Specific policy objectives

103. The general objective of achieving a sustainable transport system by 2050 can be translated into more specific goals:
- (1) A reduction of GHG emissions that is consistent with the long-term requirements for limiting climate change to 2 °C⁶⁴ and with the overall target for the EU of reducing emissions by 80% by 2050 compared to 1990. Transport-related emissions of CO₂⁶⁵ should be reduced by around 60% by 2050 compared to 1990⁶⁶. This target has been derived from the results of the “Effective and widely accepted technology” scenario from the Impact Assessment on a “Low-carbon economy 2050 roadmap”⁶⁷. It includes aviation, but excludes international maritime⁶⁸.

⁶³ European Council, June 2006

⁶⁴ The “Low-carbon economy 2050 roadmap” identifies a path for the reduction of the EU GHG emissions by 80% by 2050 with respect to 1990. In the “Effective and widely accepted technology” scenario it is foreseen that the transport sector reduces its emissions by around 60%, industry by around 80%, the residential sector and services by around 90%, and power generation by over 90%.

⁶⁵ Unless stated otherwise, the references to transport-related CO₂ emissions in this Impact Assessment report relate only to tank-to-wheel emissions.

⁶⁶ As most GHG emissions from transport are CO₂ emissions, this target can be considered as equivalent to the target of reducing GHG emissions by 60%, as expressed in the Impact Assessment on “Low-carbon economy 2050 roadmap”.

⁶⁷ See also point 27 of the present Impact Assessment report.

⁶⁸ The results for international maritime are presented separately in section 5.

- (2) A drastic decrease in the oil dependency ratio of transport-related activities by 2050 as requested by the EU 2020 Strategy for transport calling for “decarbonised transport”.
- (3) Limit the growth of congestion.
104. The three specific policy objectives could be broadly summarised as the prescription to ‘use less energy, use cleaner energy and better exploit infrastructure’. The first two objectives overlap to a large extent, and should be considered the absolute priority in line with the Resource Efficiency Flagship of the EU 2020 Strategy. There are, however, also significant synergies with the third objective that would typically call for a more extensive use of non-motorised and of public transport, which reduces both the use of space and the use of energy.
105. At the same time, the achievement of the specific policy objectives identified above should not prevent that “current and future generations have access to safe, secure, reliable and affordable mobility resources to meet their own needs and aspirations.”⁶⁹ More specifically, this means, as suggested by the EU Transport Council⁷⁰, that the EU transport system should:
- *in terms of accessibility*: allow the basic access and the development of mobility needs of individuals and companies;
 - *in terms of equity*: promote equity within and between successive generations;
 - *in terms of quality of services*: offer safe, secure and reliable transport services of high quality;
 - *in terms of provision of services*: be affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development; it should promote high quality employment;
 - *in terms of external costs to society*: minimise the external costs of accidents, noise and air pollution, biodiversity loss and increased land use.

⁶⁹ SEC(2010) 1606 final (14 December 2010) Commission Staff Working Document, “A European Strategy for Clean and Energy Efficient Vehicles - Rolling Plan”,

⁷⁰ See in this respect the definition of the concept of a sustainable transport system adopted by the European Union Council of Ministers of Transport (2004), according to which a sustainable transport system:

- Allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations;
- Is affordable, operates fairly and efficiently, offers a choice of transport mode and supports a competitive economy, as well as balanced regional development;
- Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise.

3.2. Trade-offs and synergies between sustainability goals

106. It is generally accepted that sustainable transport implies finding a proper balance between (current and future) environmental, social and economic sustainability goals⁷¹. Two main trade-offs between sustainability goals can be highlighted.
- First of all, there could be a conflict between cheap transport and GHG abatement. Fossil fuels have the great advantage of energy density. This is a valuable characteristic in mobile applications and the reason why fossil fuels are currently the cheapest option for transport. Clearly it will cost more to replace them. The trade-off is solved by setting a goal for emissions (the priority objective) and by devising a cost minimising strategy to achieve it.
 - Secondly, there could be a conflict between improving accessibility and lowering congestion, which could imply additional infrastructure, and land use. This trade-off is more severe in the EU-12, where catching up with EU-15 makes certain infrastructure development a necessity. This trade-off is solved by giving priority to the upgrade of infrastructure over new construction and to ‘green infrastructure’⁷², but each project would have to be assessed individually on its own merits.
107. This being said, there are also substantial synergies between sustainability goals. Policies to reduce GHG emissions can also be expected to reduce local pollutants, noise and energy consumption, thanks to new vehicles and clean fuels. Lower utilisation of road transport would also reduce the number of accidents.

3.3. Consistency with horizontal objectives of the European Union

108. The EU 2020 strategy, the Single Market Act and the Sustainable Development Strategy have set the scene for the transport sector.

3.3.1. EU 2020 Strategy and Single Market Act

109. The objective of the White Paper on Transport Policy clearly contributes to the objectives laid down in the EU 2020 Strategy.
110. The EU 2020 Strategy, under the flagship initiative “Resource efficient Europe”, aims at supporting the shift towards a resource efficient and low carbon economy through the reduction of CO₂ emissions as well as through increased competitiveness and energy security. The specific objectives set out in section 3.1 above are clearly in line with the aim of the above-mentioned flagship. The objectives of the White Paper on Transport Policy are also consistent with other objective defined in priority areas of the EU 2020 strategy such as innovation, high employment, social and territorial cohesion.

⁷¹ See in this respect United Nations General Assembly (March 20, 1987). “Report of the World Commission on Environment and Development: Our Common Future”; Chapter 2: Towards Sustainable Development; Paragraph 35. <http://www.un-documents.net/ocf-02.htm#I>.

⁷² Infrastructure designed in a way to minimise environmental impact.

111. The objectives of the White Paper on Transport Policy are also fully in line with the ambition to create a stronger, deeper and extended Single Market as set out in the Single Market Act⁷³.

3.3.2. *Sustainable Development Strategy*

112. The overall objective of the SDS, regarding sustainable transport 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”. The related operational objective is to achieve sustainable levels of transport energy use and reduce transport’s GHG emissions.
113. The policy objectives of the White Paper on Transport Policy are in line with the renewed SDS by contributing to more sustainable mobility. Making mobility more sustainable would facilitate achieving other sustainable development goals.

4. POLICY OPTIONS

114. As described above, the current transport system is fundamentally unsustainable and major, not just incremental, changes are required to implement next generation transport solutions.
115. In this context, this section will explore alternative policy options aimed at transforming the EU transport into a sustainable system by 2050.

4.1. Preliminary note on methodology

116. As described in the first section of this report, the identification of these policy areas is the result of a long, intense and interactive process of internal and external consultation. The input of this consultation process, together with the findings of two external studies undertaken by the Commission (one on the evaluation of the Common Transport Policy, undertaken by DG Energy and Transport, the other on “EU Transport GHG: Routes to 2050?”, undertaken by DG Environment), has allowed the Commission to identify more precisely the problem to be solved, the four main underlying drivers and the corresponding policy areas and instruments that would be appropriate to address those issues.
117. On that basis, the Commission has identified seven policy areas in which concrete policy measures could have a key role in stimulating the expected shift of the transport system to another paradigm. These policy areas are: pricing, taxation, research and innovation, efficiency standards and flanking measures, internal market, infrastructure and transport planning.
118. The policy areas taken into consideration incorporate a broad range of policy instruments that can be implemented at EU level from softer instruments to more prescriptive ones including communication/awareness raising, research and development (innovation), guidelines, governance and co-ordination, market-based

⁷³ Communication from the Commission: “Towards a Single Market Act – for a highly competitive social market economy”, COM(2010) 608 final/2

instruments, private and EU financing schemes, new regulation and standards. As regards transport planning in urban areas, EU action is limited to soft measures for subsidiarity reasons. EU action on taxation is also limited by the requirement of unanimity among Member States in the decision making process.

119. These policy instruments are not mutually exclusive. In transport, the existence of multiple market failures – as indicated in the analysis of problem drivers – suggests the adoption of a combination of individual instruments that complement each other and create a comprehensive policy mix.
120. The table below gives a mapping between the drivers identified in section 2.4 above and the policy areas. It also provides in the second column an indication of possible policy measures in each of the specified policy areas that would be referred to in the White Paper on Transport Policy as component of the overall strategy. The list of possible policy measures presented below is not exhaustive and will be finalised by the adoption of the White Paper by the Commission.
121. Given the nature of the White Paper as a strategic document, the individual initiatives are broadly defined. The precise specification of the policy measures referred to in the White Paper will be done at a later stage, following a more specific analysis and an individual Impact Assessment⁷⁴. Accordingly, it is outside the scope of the present Impact Assessment report to evaluate each initiative in detail.
122. In this context, the Commission has undertaken a modelling exercise to provide a stylised quantitative assessment of the effectiveness and efficiency of possible initiatives in each policy area, giving illustrative evidence on their relative importance, on the way they interact and on the required intensity of the intervention. The Commission has modelled the impact of the possible policy measures assuming a specification – indicated in the third column and in Table 4 – that does not necessarily correspond to what would actually be proposed at a later stage.

⁷⁴

See section 1.4 of the Commission Impact Assessment Guidelines (SEC(2009)92).

Table 1: Mapping drivers, policy areas, possible policy measures envisaged in the White Paper and modelling hypothesis

Policy Areas	Possible policy measures envisaged in the White Paper	Modelling hypothesis
<i>Driver 1: Cheap for users, expensive to society: prices do not reflect true costs</i>		
Pricing	Strategy for the gradual phasing in of a coherent internalisation system for local externalities in all transport modes on the whole network	Internalisation of local externalities for all modes of transport according to the values specified in the handbook on internalisation ⁷⁵
Taxation	Establish a link between vehicle fuel taxation and the environmental performance and full internalisation of the cost of GHG emissions for all modes of transport in a co-ordinated and stepwise manner	Elimination of distortions in energy taxation by establishing an energy and CO ₂ component in excise duties and abolition of exemptions ^{76,77}
	Establish a link between vehicle taxation and the environmental performance	Introduce a CO ₂ -related element in the registration and annual circulation taxes ⁷⁸
	Assess the possibility of introducing VAT on all international passenger transport services inside the EU	Introduction of VAT on all international passenger transport services inside the EU ⁷⁹
	Promote a revision of company car taxation to eliminate distortions or, as a second best, to provide incentives for clean vehicles.	Elimination of favourable taxation regime for company cars ⁸⁰

⁷⁵ Handbook with estimates of external costs in the transport sector - February 2008 (http://ec.europa.eu/transport/sustainable/2008_external_costs_en.htm)

⁷⁶ COM(2007) 52 final Proposal for a Council Directive amending Directive 2003/96/EC as regards the adjustment of special tax arrangements for gas oil used as motor fuel for commercial purposes and the coordination of taxation of unleaded petrol and gas oil used as motor fuel; and Commission staff working document accompanying the proposal for a Council Directive Amending Directive 2003/96 restructuring the Community framework for the taxation of energy products and electricity (forthcoming)

⁷⁷ Answer given by the Commission to the question of MEP Nick Griffin (NI), <http://www.europarl.europa.eu/sides/getAllAnswers.do?reference=E-2010-4804&language=EN>

⁷⁸ Proposal for a Council Directive on passenger car related taxes SEC(2005) 809; <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52005PC0261:EN:NOT>

⁷⁹ COM(2010) 695 final, Green Paper on the future of VAT, Towards a simpler, more robust and efficient VAT system

⁸⁰ DG TAXUD Taxation Papers, 2010, Copenhagen Economics: Company Car Taxation, Subsidies, Welfare and Environment; http://ec.europa.eu/taxation_customs/resources/documents/taxation/gen_info/economic_analysis/tax_papers/taxation_paper_22_en.pdf

<i>Driver 2: Innovation: transport technologies do not achieve low carbon mobility</i>		
Research and Innovation	Conduct a screening to identify key innovative technologies, with a view to better target existing resources, define a governance structure for organising their development and enhance coordination of European and national (private and public) efforts and funding Bring together all relevant actors within the transport system, to develop research and deployment agendas, to design standards and to build demonstration projects, including bilateral cooperation frameworks in research and innovation with the main transport partners	Improvement of the cost of batteries and of other critical technological components Deployment of supporting infrastructure (charging points, refuelling stations)
Efficiency standards and flanking measures	Use standards for controlling energy efficiency as well as air pollution for all vehicles which have proven to be an effective way of providing the industry with certainty concerning long-term objectives Encourage deployment of clean energy carriers by establishing the necessary supporting infrastructures Improve the effectiveness of fuel efficiency labelling, promote eco-driving and support eco-driving dissemination	Implementation of CO₂ standards for all vehicles (cars, vans, trucks, locomotives, vessels, barges, aircrafts)

Driver 3: Supply of transport services: not sufficiently efficient

Internal market	Railways: develop corridors, strengthen the European Railway Agency and ensure convergence of technical standards, reinforce the network of rail regulators and further pursue the opening of markets (domestic passengers). Aviation: effective implementation of the Single European Sky project - from the designation of a network manager, via the integration of national air traffic control to the deployment of the next generation of air traffic management system (SESAR). Maritime transport: simplification of the formalities for ships travelling between EU ports; a single electronic environment for all port/maritime transport related information exchanges and management; and a review of restrictions on provision of port services. Road transport: phase out of restrictions in the internal market like <i>cabotage</i> and of non-harmonised enforcement of social legislation. Promote quality jobs and uniform working conditions	Increase in the efficiency of all transport modes as a result of the removal of regulatory, administrative and technical barriers Wide deployment of Intelligent Transport Systems
Infrastructure	Propose a core network consisting of nodes and links relying primarily on the efficient use of existing infrastructure via ITS/smart mobility solutions and aiming at bridging missing links, facilitating multimodality and creating links to third countries. Establish a firm long-term infrastructure plan for the completion of the core network together with EU Member States detailing the projects to be completed as well as the modalities.	Increase in the capacity and performance of the network resulting from the elimination of bottlenecks and addition of missing links

<i>Driver 4: Transport planning: not sufficiently integrated from the first to the last mile</i>		
Transport planning	Encourage the establishment of urban mobility plans and implementation of related measures to manage demand in non-collective motorised transport modes	Shadow carbon pricing ⁸¹ as a proxy for locally determined policies (pricing, support to public transport and non-motorised modes, integrated land planning)

⁸¹ The shadow price in this case is the marginal cost of strengthening the constraint on CO₂ emissions.

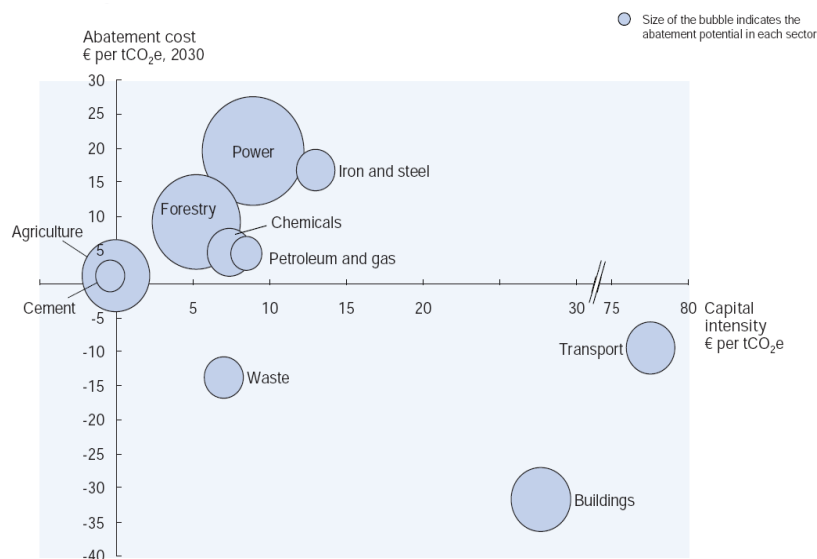
4.2. Rationale behind a comprehensive and strategically coordinated EU action

123. Given the high level of complexity of transport system, the interaction between multiple actors, also at international level, and the global relevance of transport and of its effect on the economy, society and the environment, the Commission considers that – besides the reasons explained in section 2.5 above – EU intervention is fully justified to reach the objectives and complement the action of stakeholders and Member States.
124. To determine appropriate EU policy action, in a first step, the Commission has considered the possible application of an isolated intervention in each of the seven policy areas identified in section 4.1 above. Each of the instruments seems particularly suited for addressing some of the raised issues:
- market-based instruments such as charging and taxation can ensure efficient allocation of resources and efficient modal choices;
 - efficiency standards have produced a significant acceleration in the introduction of more efficient vehicles, by providing clear targets for the industry and avoiding ‘wait and see’ strategies of manufacturers;
 - research and development programs appear necessary to solve other types of market failures in innovation, as for example, the coexistence of multiple technical standards;
 - internal market measures and an effective enforcement of EU competition rules are needed to solve instances of regulatory failure and insufficient competition and to derive benefit from scale economies;
 - infrastructure policy is required to address coordination failures and the existence of network and cross-border externalities;
 - planning policies can take into account the interaction of transport with other policy areas, such as housing.
125. It appears though that none of the categories of instruments alone would be capable of tackling at the same time and in a satisfactory way all the various problem drivers and all the elements of the specific policy objective. A mix of actions would be needed.
126. For example, while pricing and taxation can bring economic efficiency, on their own they are not suited to bring more competition into a market characterised by regulatory failures, or to assist in the definition of technical standards. Market-based instruments are also relatively ineffective in the presence of ‘split incentives’⁸²,

⁸² A common example of split incentives is referred to as the landlord-tenant problem. This problem occurs when the landlord provides energy-using appliances (such as a refrigerator or lighting systems), but the tenant pays the electricity bill. In this situation, there is little incentive for the landlord to choose the most energy-efficient appliance.

where the party paying for the production of externalities does not have control over the investments needed to abate those externalities⁸³.

127. This is particularly the case for many transport modes, as indicated by McKinsey & Company (2009), where it is suggested that transport has negative costs for GHG abatement, but can require relatively high investments. In other words, the graph below shows that implementing GHG abatement measures in the transport sector would demand greater capital intensity than would abatement in any other sector. This may be an indicator that the transport sector requires significant upfront capital investment, and in case of market failures there is a need for complementary public action in addition to the economic instruments.



Source: McKinsey & Company (2009)

Figure 2: Capital intensity and abatement cost⁸⁴

128. A balanced use of several policy instruments can also mitigate the trade-offs and exploit the synergies between sustainability goals. For example, technologies that improve the fuel efficiency of vehicles can lower the cost of transport and generate more travel – inducing thereby a so-called rebound effect⁸⁵ – and more congestion. As shown in the table below, the rebound effect can partially offset the effect of a policy measure aimed at improved fuel efficiency. Similar effects exist for improved

⁸³ Individuals decide on the type of vehicle they purchase, but cannot control investments in, for example, public transport means or in the recharging facilities needed for alternative power trains. As a result, consumers are often restricted in their choices and have low response to prices (inelastic demand).

⁸⁴ Capital intensity of an abatement measure is “defined as the additional upfront investment relative to the BAU technology, divided by the total amount of avoided emissions over the lifetime of the asset. For a more fuel efficient car, for instance, the capital intensity would be calculated as the additional upfront investment compared to the BAU technology, divided by the amount of CO₂ saved through lower fuel consumption during the lifetime of the car. The main difference with abatement cost is the capital intensity calculation does not take financial savings through lower energy consumption into account.” McKinsey & Company (2009). Pathways to a Low-Carbon Economy. Version 2 of the Global Greenhouse Gas Abatement Cost Curve. 2009.

⁸⁵ Rebound effects are indirect, second order effects of policy instruments, which are often unintended and have the potential to undermine the ultimate objective of the primary policy instrument, in this case the delivery of reductions in GHG emissions.

utilisation of infrastructure capacity. While new technologies or innovation will nevertheless provide higher utility for fewer resources, the absolute improvement in resource efficiency can be lower unless appropriate measures are applied to manage demand. Therefore combining action in several policy areas is all the more important.

Table 2: Estimates of the long-run direct rebound effect for consumer energy services in the OECD⁸⁶

<i>End-Use</i>	<i>Range of values in evidence Base</i>	<i>'Best Guess'</i>	<i>No. of studies</i>	<i>Degree of confidence</i>
<i>Personal automotive transport</i>	5-87%	10-30%	17	High
<i>Space heating</i>	1.4-60%	10-30%	9	Medium
<i>Space cooling</i>	1-26%	1-26%	2	Low
<i>Other consumer energy services</i>	0-49%	<20%	3	Low

129. As regards GHG emissions, individual measures or policies that focus exclusively on either the technological or the organisational and regulatory aspects would come short of the target of setting the EU transport sector on a sustainable path and of reducing GHG emissions by close to 60% below 1990 levels by 2050. This conclusion is confirmed by other research work: a recent project funded by the European Commission showed that for the EU, on tank-to-wheel basis, technical options can deliver a 42% reduction in GHG emissions by 2050, compared to 1990. For OECD Europe, IEA (2010) estimates that technical options can deliver about 50% over the same time horizon⁸⁷. The same sources show that the potential of organisational and regulatory measures taken in isolation would be lower than that of technical options.
130. In light of the above, the Commission concludes that a holistic approach that comprises all elements considered so far is therefore needed.

⁸⁶ UKERC, 2007, The Rebound Effect: an assessment of the evidence for economy-wide energy savings from improved energy efficiency.

⁸⁷ Sources: Directorate General Environment ("EU Transport GHG: Routes to 2050?"); IEA, 2010 Energy Technology Perspectives.

Conclusion

Only a long-term and overarching strategy established for all identified policy areas has a reasonable chance of achieving the EU objectives. It should combine policy initiatives targeted at enhancing the efficiency of the system through better organisation, infrastructure and pricing with those that are more focused on technology development and deployment. It should also provide a framework for action at all levels of government. This conclusion is in line with the Europe 2020 Strategy which highlights that a resource-efficient agenda implies a massive technological improvement and a radical change in the transport system.

Therefore, taking also into account the fact that the Commission has adopted in June 2009 a Communication on “*A sustainable future for transport: Towards an integrated, technology-led and user friendly system*”, the Commission is of the opinion that a White Paper is the most appropriate *sui generis* document, in terms of simplicity and coherence with the objectives set out in section 3.1 above, to lay down a comprehensive and strategically coordinated EU action.

4.3. Description of policy options

131. In light of the above, the Commission has identified three policy options – besides the baseline scenario – that combine specific EU actions across the seven policy areas described above. The design of policy options build on the achievements and deficiencies of current policies outlined in section 2 and in Appendix 2. All three policy options have been designed to reach the same CO₂ emission reduction target, i.e. 60%⁸⁸ over 1990 levels.
132. All three options envisage action in all seven policy areas and have in common a certain number of initiatives. What distinguishes them is the intensity of intervention that, depending on the option, is higher in some specific field and lower in others.
133. Policy Option 3 is designed to show the effect of policies that emphasise the rapid deployment of new powertrains, by imposing very stringent CO₂ standards on new vehicles and by accompanying them with appropriate innovation policies putting in place the necessary framework conditions. It is assumed that this approach would be the most effective in reducing the costs and the time of introduction of new technologies.
134. Policy Option 2 is designed to show the effect of policies that rely less on performance standards and on active technological deployment and more on managing mobility and on carbon pricing. It is assumed that the industry will not outperform the less stringent CO₂ standards for road and rail vehicles and that the necessary reduction in emission is achieved – in addition to the full pricing of externalities and to the elimination of tax distortions – by letting the carbon price rise by the necessary amount. This could be taken to represent the effect of high carbon

⁸⁸ Policy Options 2, 3 and 4 include the same energy price environment as the “Effective and widely accepted technology” scenario from the Impact Assessment on “Low-carbon economy 2050 roadmap”. In the “Effective and widely accepted technology” scenario, with global climate action, lower energy demand is assumed to keep energy prices at lower levels relative to the Reference scenario. Oil price is assumed to be 80 \$/barrel in 2030 and 70 \$/barrel in 2050 (in year 2008-dollars).

taxation or of the introduction of a transport specific cap and trade system. In case of a very high carbon price, the effect would be equivalent to restrictions in “fossil fuel” mobility and forced modal shift to clean modes.

135. Policy Option 4 represents an intermediate approach. It has values for CO₂ standards and technology deployment in between those of Option 2 and 3. It has full pricing of externalities and elimination of tax distortions as in Option 2, but the additional carbon price element is only applied in the urban context in the form of a shadow price acting as a proxy for a wide-range of possible demand management measures.
136. A detailed description of the content of each policy option is presented in Table 4 below. The policy areas where assumptions are the same are shown in italics. For each policy option, an endogenous variable was identified and derived by the model to ensure that the reduction target of 60% is achieved. These variables are displayed with bold underlined font in Table 4: for Policy Option 2 – the CO₂ tax component of motor fuel excise duties⁸⁹; for Option 3 – the stringency of CO₂ standards for road passenger transport⁹⁰; and for Option 4 – the CO₂ shadow price on urban transport.

Policy Option 1: No additional EU action

137. Policy Option 1, which is presented in detail in Appendix 3 of this Impact Assessment report, represents the future without any additional policy intervention to change current trends.

Policy Option 2

138. Policy Option 2 includes policies with a strong focus on the completion of the internal market, infrastructure development, pricing and taxation. The 60% CO₂ emission reduction target is achieved largely through improved efficiency within each mode, better logistics, modal shift and reduced mobility.
139. With respect to other options, support for R&D and deployment of technologies is more limited. This has been translated into higher cost of batteries and more limited range⁹¹ for passenger cars and trucks. The range limitations act as a barrier to the diffusion of technology. This results in a more modest uptake of new powertrains, despite high price signals. Progress in efficiency is realised with conventional technologies, but up to a limit: although CO₂ standards are put in place for road and rail vehicles with targets in place for 2020, they do not become stricter after 2020. Only autonomous, pricing-driven efficiency improvement follows in the period of 2020-2050. In this scenario, as slower developments in clean transport technologies is assumed, strong pricing signals are required to alter the mobility patterns to an extent sufficient for achieving the required abatement in greenhouse gas emissions.

⁸⁹ For Policy Options 2, the CO₂ tax component of motor fuel excise duties has been chosen as an endogenous variable to reflect the high price signals required in the transport sector with limited technology deployment.

⁹⁰ The stringency of CO₂ standards for road passenger transport is adjusting in Policy Option 3 to illustrate the efforts required in terms of regulatory measures with more limited action on system improvement policy measures.

⁹¹ Range is the distance a vehicle can cover before refuelling/recharging.

140. These strong price signals go beyond the full internalisation of externalities and the elimination of existing distortions in taxation, which are assumed to be an integral part of Policy Option 2 and would be justified by economic theory to improve the economic efficiency in the overall economy. In effect, as technology development is assumed to be limited due to inadequate policies to address the failures identified in Section 2 for research and innovation, the achievement of the 60% CO₂ emission reduction target requires that the CO₂ externality is internalised at a much higher rate than in any other sectors of the economy. This will necessarily affect the cost and transfer payments resulting from this option set-up.
141. The system improvement measures are front loaded in this policy option to allow gradual changes in the transport system.

Policy Option 3

142. Policy Option 3 relies heavily on developing and deploying technologies in particular in the long-term (2030-2040) through the universal introduction of rigorous standards for all vehicles⁹². The crucial element of fuel shift is addressed through the promotion of R&D policies into the development and subsequent deployment of alternative fuel use. This is reflected in the assumption of the lowest battery costs for electric vehicles among all policy options.
143. While transport activities are optimised in the period 2010-2020 to eliminate crucial regulatory and market failures, transport demand in the long-term is satisfied through technological solutions. Internalisation of externalities is not complete over the EU and some distortions in taxation, in particular concerning VAT on international passenger transport and company car taxation, remain beyond 2020. In such an economy where market and regulatory failures are not fully addressed, the achievement of the 60% CO₂ emission reduction target is made possible by very ambitious technological developments triggered by technology improvement measures.

Policy Option 4

144. Policy Option 4 also covers all policy areas identified above (see section 4.1 above), but the intensity of the measures is intermediate with respect to Policy Options 2 and 3, thus envisaging a balanced contribution of system improvement and technology measures to achieve the objectives set out in Section 3. Measures influencing transport activity and modal choice, as well as those improving energy efficiency in a given mode and the carbon intensity of transport fuels are applied throughout the period gradually, reflecting the tightening constraint on CO₂ emissions.
145. Policy Option 4 assumes full internalisation of externalities and elimination of distortions in taxation, in particular concerning VAT on international passenger transport, vehicle taxation and company car taxation. Similarly to Policy Option 2, it also includes policies with a strong focus on the completion of the internal market, infrastructure development. Like Policy Options 2 and 3, this policy option also

⁹² For aviation and maritime transport, setting standards on fuel efficiency needs to be carried out through harmonised EU action in the International Civil Aviation Organisation and International Maritime Organisation.

relies on locally determined policies (pricing, support to public transport and non-motorised modes, integrated land planning) in urban areas. The intensity of the policy measures in urban transport is derived residually to achieve the 60% reduction target.

146. The main difference in the design of this policy option comes from the assumption that vehicles in all modes will be subject to CO₂ standards up until 2050. Battery costs for electric vehicles are assumed to be half way between Policy Options 2 and 4, to reflect an intermediate level of intensity of R&D policies.
147. Policy Option 4 can be described as eliminating distortions through pricing, CO₂ taxation and internalisation measures, but can also be characterised by investment in non-road infrastructure, relatively stringent CO₂ standards for all vehicles and relatively high investment in R&D.
148. As said above, the Commission has undertaken a modelling exercise to provide a stylised quantitative assessment of the effectiveness and efficiency of the identified Policy Options. To this end, the Commission has modelled the impact of the possible policy measures assuming a specification that does not necessarily correspond to what would actually be proposed at a later stage. Indeed, the precise specification of the policy measures referred to in the White Paper will be done at a later stage, following a more specific analysis and an individual Impact Assessment⁹³. Accordingly, it is outside the scope of the present Impact Assessment report to evaluate each initiative in detail. The table 3 displayed below presents an overview of the modelling assumptions whereas table 4 provides a detailed description of the modelling specifications used for each Policy Option.

⁹³ See section 1.4 of the Commission Impact Assessment Guidelines (SEC(2009)92).

Table 3: Overview of the modelling assumptions in Policy Options 2, 3 and 4

<i>Policy measures</i>	<i>Policy Option 2</i>	<i>Policy Option 3</i>	<i>Policy Option 4</i>
System improvement policy measures			
Pricing			
	High	Low	High
	(full internalisation of external costs)	(partial internalisation of external costs)	(same as in Policy Option 2)
Taxation			
<i>Taxation of fuels</i>	High	Low	Medium
	<i>Endogenous variable: CO2 tax component of motor fuel excise duties</i>		
<i>VAT on international passenger transport services</i>	High	Same as in Policy Option 1	High (same as in Policy Option 2)
<i>Vehicle taxation</i>	High	High (same as in Policy Option 2)	High (same as in Policy Option 2)
<i>Company car taxation</i>	High	Same as in Policy Option 1	High (same as in Policy Option 2)
Internal Market			
<i>Opening transport markets and removing regulatory, administrative and technical barriers</i>	High	High (same as in Policy Option 2)	High (same as in Policy Option 2)
<i>Wide deployment of intelligent transport systems</i>	High	High (same as in Policy Option 2)	High (same as in Policy Option 2)

Infrastructure			
<i>Create a core backbone of high performing infrastructure in terms of environmental impact</i>	High	Same as in Policy Option 1	High (same as in Policy Option 2)
Transport Planning			
<i>Better integrate urban mobility in the EU transport policy</i>	Medium (same as in Policy Option 4)	Medium (same as in Policy Option 4)	Medium <i>Endogenous variable: Shadow price on urban transport acting as a proxy for a wide-range of possible demand management measures in urban areas</i>
Technology improvement policy measures			
Research and Innovation			
<i>Battery costs, power density and speed of charge for electric vehicles</i>	Low	High	Medium
Efficiency standards and flanking measures			
<i>CO₂ standards</i>	Low	High <i>Endogenous variable: Level of CO₂ standards for road passenger vehicles</i>	Medium
<i>Standards for controlling air pollution</i>	High	High (same as in Policy Option 2)	High (same as in Policy Option 2)
<i>Deployment of less GHG intense energy carriers</i>	High	High (same as in Policy Option 2)	High (same as in Policy Option 2)
<i>Eco-driving</i>	High	High (same as in Policy Option 2)	High (same as in Policy Option 2)

<i>Fuel efficiency labelling</i>	High	High (same as in Policy Option 2)	High (same as in Policy Option 2)
<i>Internalisation of NOx emissions in aviation</i>	High	High (same as in Policy Option 2)	High (same as in Policy Option 2)

Table 4: Detailed content of Policy Options 2, 3 and 4

The common features between Policy Options are displayed in italic.

<i>Policy measures</i>	<i>Policy Option 2</i>	<i>Policy Option 3</i>	<i>Policy Option 4</i>
System improvement policy measures			
Pricing			
Internalise local externalities for all modes of transport	100% internalisation of all external costs for heavy duty vehicles (HDV), passenger cars, motorcycles, passenger and freight rail, inland navigation and aviation for all Member States by 2050, according to the central value from the Handbook on estimation of external costs in the transport sector ^{94,95} .	100% internalisation of external costs for heavy duty vehicles (congestion, air pollution, noise, infrastructure wear and tear), passenger and freight rail (air pollution and noise) by 2020, for Member States that currently have in place a distance related infrastructure charging system or have officially announced their intention to introduce such a system in the near future, according to the central value from the Handbook on estimation of external costs in the transport sector. After 2020, the coverage of charges remains unchanged.	<i>Same as in Policy Option 2</i>
Taxation			
Taxation of fuels	Phase I (2013-2019) ⁹⁶ : revised structure of the Energy Taxation Directive and of national	Phase I (2013-2019) as in Policy Option 2. After 2020 the taxation level is kept unchanged.	Phase I (2013-2019) same as in Policy Option 2.

⁹⁴ Handbook with estimates of external costs in the transport sector - February 2008 (http://ec.europa.eu/transport/sustainable/2008_external_costs_en.htm).

⁹⁵ The internalisation of external costs means that transport users bear the costs they generate: both private and external. To make transport users pay for these external costs Policy Option 2, 3 and 4 envisage a user charge based on the estimation of these external costs. The central values from the ‘Handbook with estimates of external costs in the transport sector’ have been used for this purpose.

⁹⁶ Commission staff working document accompanying the proposal for a Council Directive Amending Directive 2003/96 restructuring the Community framework for the taxation of energy products and electricity (forthcoming).

taxes and introduction of a CO₂ tax component;

- *diesel rates based on the 2007 commercial diesel proposal⁹⁷, but CO₂ component included;*
- *current exemptions left unchanged;*
- *exemption of compressed natural gas (CNG), liquefied petroleum gas (LPG) and biofuels from the energy component. Taxation of biodiesel increased gradually;*
- *CO₂ tax component: 10 € per tonne of CO₂.*

Phase II (from 2020 onwards):

- *elimination of exemption for diesel use in rail, local public passenger transport;*
- *commercial and non-commercial diesel use is taxed at the same rate;*
- *abolition of exemption of kerosene for aviation and diesel for navigation. For aviation, given that it would be covered by the Emission Trading Scheme starting with 2012, the energy taxation would only consist of the energy component, but not the CO₂ component. The taxation of kerosene for aviation only applies to intra-EU flights, in line the provisions of the Chicago Convention.*
- *energy component for CNG, LPG and biofuels aligned with other fuels.*

Phase II (from 2020 onwards): same as in Policy Option 2 but the CO₂ tax component is equal to 20 € per tonne of CO₂ from 2020 onwards, instead of being endogenously derived as in Policy Option 2.

⁹⁷

COM(2007) 52 final Proposal for a Council Directive amending Directive 2003/96/EC as regards the adjustment of special tax arrangements for gas oil used as motor fuel for commercial purposes and the coordination of taxation of unleaded petrol and gas oil used as motor fuel.

The CO₂ tax component is derived endogenously to achieve the 60% CO₂ emissions reduction by 2050 compared to 1990.

VAT on international passenger transport services

Introduction of a minimum VAT rate of 19% on all intra-EU international passenger transport services⁹⁸

Same as in Policy Option 1 (No additional EU action)

Same as in Policy Option 2

Vehicle taxation

Establish a link in vehicle taxation with the environmental performance by introducing a CO₂-related element in the annual circulation tax and the registration tax^{99,100}. In Member States that did not introduce a CO₂-related element, we assume that at least 25% of the total tax revenue from registration and annual circulation taxes should originate in the CO₂-based element of each of these taxes starting with 2015. From 2017 at least 50% of the total tax revenue from both the annual circulation tax and the registration tax would originate in the CO₂ based element¹⁰¹.

Same as in Policy Option 2

Same as in Policy Option 2

⁹⁸ Currently, the practices applied by Member States differ greatly. While for international passenger transport, sea and air are exempt of VAT in the whole of the EU-27, VAT is payable on inland waterways, rail and road transport in Belgium, Germany, Spain and the Netherlands. France levies VAT on inland waterways, Greece and Austria does so on rail and road transport, while Poland and Slovenia on road transport only. 19% of VAT is applied currently by Germany on international rail transport. Source: European Commission, DG TAXUD. 2010. VAT Rates Applied in the Member States of the European Union; http://ec.europa.eu/taxation_customs/resources/documents/taxation/vat/how_vat_works/rates/vat_rates_en.pdf

⁹⁹ More than half of Member States have introduced a CO₂-related element in their car taxation schemes. Source: ACEA, Overview of CO₂ based motor vehicles taxes in the EU; http://www.acea.be/images/uploads/files/20100420_CO2_tax_overview.pdf

¹⁰⁰ COM(2005) 261 final Proposal for a Council Directive on passenger car related taxes

¹⁰¹ For modelling purposes, it is assumed that only the CO₂ tax component of fuel taxation is endogenously determined.

Company car taxation	<i>Elimination of favourable taxation regime for company cars, reflected through changes in car ownership, vehicle size in the fleet and fuel consumption¹⁰².</i>	Same as in Policy Option 1 (No additional EU action)	<i>Same as in Policy Option 2</i>
Internal Market			
Opening transport markets and removing regulatory, administrative and technical barriers	<i>Increase in the efficiency of all transport modes as a result of the removal of regulatory, administrative and technical barriers, reflected through decreases in the ticket price for passenger rail and operation costs and time costs for freight (10% to 25%, depending on mode)¹⁰³ and higher load factors for road freight.</i>	Same as in Policy Option 2	<i>Same as in Policy Option 2</i>
Wide deployment of intelligent transport systems	<i>Deployment of Intelligent Transport Systems reflected through a reduction in congestion and improvements in energy efficiency, due to more efficient use of infrastructure, vehicle capacity and mode¹⁰⁴.</i>	Same as in Policy Option 2	<i>Same as in Policy Option 2</i>
Infrastructure			
Create a core backbone of high performing infrastructure in terms of environmental impact	<i>Effects of the increase in the capacity and performance of the network resulting from the elimination of bottlenecks and addition of missing links, and increase in the train length (to 1.5 km) and maximum axle load (to 22.5 tonnes), reflected through decreases in</i>	Same as in Policy Option 1 (No additional EU action)	<i>Same as in Policy Option 2</i>

¹⁰² Assumptions based on: DG TAXUD Taxation Papers, 2010, Copenhagen Economics: Company Car Taxation, Subsidies, Welfare and Environment; http://ec.europa.eu/taxation_customs/resources/documents/taxation/gen_info/economic_analysis/tax_papers/taxation_paper_22_en.pdf

¹⁰³ FERRMED (2009), Ferrmed Global Study.

¹⁰⁴ Assumptions based on data from the Verband der Automobilindustrie. Source: International Road Transport Union.

operation costs and time costs (6% to 20%, depending on mode) and higher load factors for freight^{105,106,107}.

Transport Planning

Better integrate urban mobility in the EU transport policy

Same as in Policy Option 4¹⁰⁸

Same as in Policy Option 4

Effects of shadow carbon pricing as a proxy for locally determined policies (pricing, support to public transport and non-motorised modes, land planning)

The value of the CO₂ shadow price is derived endogenously to achieve the 60% CO₂ emissions reduction by 2050 compared to 1990 in this Policy Option.

Technology improvement policy measures

Research and Innovation

Battery costs, power density and speed of charge for electric vehicles

Assumed specific battery costs per unit kWh¹⁰⁹ in the long run: 595-640 €/kWh for plug-in hybrids and 415-530 €/kWh for electric vehicles, depending on range and size¹¹⁰, and range limitations for passenger cars and trucks.

Optimistic assumptions on specific battery costs per unit kWh in the long run: 240-260 €/kWh for plug-in hybrids and 160-210 €/kWh for electric vehicles, depending on range and size, and other critical technological components^{111, 112}.

Assumed specific battery costs per unit kWh in the long run: 390-420 €/kWh for plug-in hybrids and 315-370 €/kWh for electric vehicles, depending on range and size, and other assumptions on critical technological components¹¹³.

¹⁰⁵ Zimmer, W., Schmied, M. (2008), Potentials for a modal shift from road to rail and ship - A methodological approach, ETC/ACC Technical Paper 2008/18. European Topic Centre on Air and Climate Change.

¹⁰⁶ Wiegmans, B.W., Konings, R. (2007), Strategies and innovations to improve the performance of barge transport, EJTIR 7, no. 2 (2007) pp. 145-162.

¹⁰⁷ FERRMED (2009), Ferrmed Global Study.

¹⁰⁸ The CO₂ shadow price has been first derived in the Policy Option 4. Subsequently, the value of the CO₂ shadow price in Policy Option 4 has been used as input (exogenous variable) in Policy Options 2 and 3. The presentation in the table above does not reflect the order in which the Policy Options had been modelled.

¹⁰⁹ kWh stands for kilowatt hour.

¹¹⁰ International Energy Agency (2009), Transport, Energy and CO₂: Moving Towards Sustainability, 2009

Efficiency standards and flanking measures

CO₂ standards	Implementation of CO ₂ standards for passenger cars (95 g CO ₂ /km), light commercial vehicles (135 g CO ₂ /km), heavy duty vehicles (15% compared to 2005), powered two-wheelers (70 g CO ₂ /km) and trains (20% compared to 2005) by 2020. Starting with 2020 assume autonomous efficiency improvements as in Policy Option 1 (No additional EU action).	<u>Derived endogenously to achieve the 60% CO₂ emissions reduction by 2050 compared to 1990, by triggering the large scale uptake of electric propulsion vehicles.</u>	Implementation of CO ₂ standards for all vehicles (cars, vans, trucks, locomotives, vessels, barges, aircrafts). CO ₂ standards by 2020 are the same as in Policy Option 2. In addition, for cars they go down from 95g CO ₂ /km in 2020 to 20 g CO ₂ /km in 2050 [for light duty vehicles: 135g CO ₂ /km in 2020 to 55 g CO ₂ /km in 2050; for heavy duty vehicles, trains, ships and aircrafts 40% , 40%, 45% and 60% improvement in energy efficiency, respectively, by 2050].
Standards for controlling air pollution	<i>Starting with 2030 implement standards for controlling air pollution. For passenger cars: 0.025 g/km for CO; 0.03 g/km for NOx and 0.0025 g/km for particulate matter¹¹⁴. For heavy duty vehicles: assumed halving of the EURO VI limit values.</i>	<i>Same as in Policy Option 2</i>	<i>Same as in Policy Option 2</i>
Deployment of less GHG intense energy carriers	<i>Share of blending of biofuels and carbon intensity for electricity in line with the Effective and widely accepted technology scenario from the Impact Assessment on “Low-carbon economy 2050 roadmap”.</i>	<i>Same as in Policy Option 2</i>	<i>Same as in Policy Option 2</i>

- ¹¹¹ Nemry F., Leduc G., and Munoz A. (2009). Plug-in hybrid and battery-electric vehicles: State of the research and development and comparative analysis of energy and cost efficiency. Technical report, Joint Research Centre: Institute for Prospective Technological Studies, Joint Research Centre Institute for Prospective Technological Studies.
- ¹¹² Martin Eberhard, Co-founder of Tesla, since early 2009 electric vehicle engineering director at Volkswagen’s Electronics Research Laboratory (ERL) in Palo Alto, California. <http://electric-vehicles-cars-bikes.blogspot.com/2010/08/eberhard-500-mile-evs-by-2020.html> (last accessed 15.11.2010); USABC, <http://www.uscar.org/guest/teams/11/Electrochemical-Energy-Storage-Tech-Team> (last accessed 15.11.2010).
- ¹¹³ International Energy Agency (2009), Transport, Energy and CO₂: Moving Towards Sustainability, 2009
- ¹¹⁴ CO stands for carbon monoxide and NOx for nitrogen oxides.

Eco-driving	<i>Assumptions on reduction in vehicle energy consumption (MJ/km) by 2050, relative to Policy Option 1: 1.6% for cars and motorcycles; 2.1% for buses; 3.2% for vans; 1.9% for medium and heavy trucks; 2.2% for passenger rail and 1.3% for freight rail¹¹⁵. For road and rail, virtually all drivers are assumed to be trained by 2050.</i>	<i>Same as in Policy Option 2</i>	<i>Same as in Policy Option 2</i>
Fuel efficiency labelling	<i>Fuel efficiency labelling would have limited effect with mandatory CO₂ standards enforced, but it would still play a role in raising awareness and ensuring independent and comparable information for consumers¹¹⁶.</i>	<i>Same as in Policy Option 2</i>	<i>Same as in Policy Option 2</i>
Internalisation of NOx emissions in aviation	<i>Inclusion of NOx emissions from aviation in the EU Emissions Trading Scheme¹¹⁷ starting with 2020 and apply a 2x emissions multiplier to account for the impact of NOx (1 tonne NOx= 2 tonne CO₂).</i>	<i>Same as in Policy Option 2</i>	<i>Same as in Policy Option 2</i>

¹¹⁵ “EU Transport GHG: Routes to 2050?” project, funded by the European Commission, Directorate General Environment.

¹¹⁶ “EU Transport GHG: Routes to 2050?” project, funded by the European Commission, Directorate General Environment.

¹¹⁷ The current EU Emissions Trading Scheme only covers CO₂ emissions from aviation, but aviation has larger climate impacts due to other emissions such as stratospheric NOx, particulates, contrails and formation of cirrus cloud.

5. IMPACT ANALYSIS OF POLICY OPTIONS

149. This section provides an assessment of the economic, social and environmental impacts that is proportionate to the nature of the document proposed. The assessment of those impacts is supported by modelling results¹¹⁸ and/or by academic research where possible. Table 12 presented at the end of this section summarises the results of the assessment of impacts¹¹⁹.
150. At this stage, it is important to underline that modelling results are global and tentative, and present the impacts as illustrations rather than as conclusive evidence to support the preferred option.
151. A 40-years outlook is surrounded by a significant degree of uncertainty, especially for such a complex system as transport. Whereas some parameters such as population growth can be projected with a reasonable degree of confidence, the projection of other key factors like economic growth, oil prices or technological developments over a long period of time incorporates a higher amount of uncertainty. This needs to be taken into account for the assessment of impacts presented below. In this respect, in addition to undertaking individual Impact Assessments for each single measure proposed in the future, regular reviews following the evaluation of policies in place are essential to allow for the necessary adjustments and to reduce policy failures.
152. The nature of the present Impact Assessment report, assessing broad policy measures without going into the precise specifications on concrete proposals, the high uncertainty surrounding the long time horizon and the inherent modelling limitations, requires treating the modelling results with caution. For example, the magnitude of transport-related problems differs across Member States and regions, and various income groups will be affected to a differing degree. However, without further specifying the details of policy measures, assessing the impacts is extremely difficult.
153. Each policy option assessed below incorporates a set of possible policy interventions at EU level, which will be the subject of an individual Impact Assessment report when necessary¹²⁰.
154. Policy Option 1, namely no additional EU action, is analysed in-depth in Appendix 3 of the present Impact Assessment report. The impacts of Policy Options 2, 3 and 4 are assessed compared to Policy Option 1 as required by the 2009 Impact Assessment Guidelines.

¹¹⁸ Modelling results build on a modelling framework including PRIMES, TRANSTOOLS, PRIMES-TREMOVE transport model, TREMOVE and GEM-E3 models. A short description of each model is provided in Appendix 5.

¹¹⁹ A cost-effectiveness analysis has been used in the present Impact Assessment report, in line with the Commission Impact Assessment Guidelines (SEC(2009)92), provided the each policy option achieves the 60% CO₂ emission reduction target by 2050 relative to 1990 and the difficulty of valuing all benefits in money terms.

¹²⁰ See section 1.4 of the Commission Impact Assessment Guidelines (SEC(2009)92).

5.1. Main modelling results

155. The tables presented below give an overview of the main modelling results in terms of transport activity, CO₂ emissions and other external costs. More specific tables will be displayed along with the assessment of impacts.

Transport activity

Table 5: Change in passenger and freight transport activity of Policy Options 2, 3 and 4 relative to Policy Option 1

<i>Policy options</i>	<i>Policy Option 2</i>			<i>Policy Option 3</i>			<i>Policy Option 4</i>		
<i>compared to Policy Option 1 (in %)</i>	2020	2030	2050	2020	2030	2050	2020	2030	2050
<i>Passenger transport activity</i>	-3%	-9%	-18%	0%	0%	-2%	-1%	-2%	-7%
Road	-3%	-12%	-23%	-1%	0%	-2%	-1%	-3%	-9%
Rail	9%	19%	35%	0%	0%	5%	8%	17%	27%
Aviation	-12%	-12%	-22%	1%	3%	-8%	-11%	-9%	-17%
<i>Freight transport activity</i>	-1%	0%	1%	0%	2%	5%	0%	2%	5%
Road	-11%	-27%	-42%	-3%	-1%	2%	-5%	-5%	-3%
Rail	9%	34%	58%	2%	3%	3%	7%	15%	18%
IWW	10%	20%	35%	3%	3%	1%	11%	22%	21%
Maritime	1%	3%	5%	1%	3%	6%	1%	3%	6%

Source: PRIMES-TREMOVE transport model

Table 6: Change in passenger and freight transport activity of Policy Options 2, 3 and 4 relative to 2005

<i>Policy options</i>	<i>Policy Option 2</i>			<i>Policy Option 3</i>			<i>Policy Option 4</i>		
<i>compared to 2005 (in %)</i>	2020	2030	2050	2020	2030	2050	2020	2030	2050
<i>Passenger transport activity</i>	17%	22%	24%	21%	34%	49%	19%	32%	41%
Road	14%	13%	7%	17%	27%	37%	17%	24%	27%
Rail	33%	65%	124%	22%	39%	75%	32%	63%	111%
Aviation	36%	75%	105%	56%	105%	142%	37%	82%	119%
<i>Freight transport activity</i>	21%	41%	84%	22%	45%	92%	22%	45%	92%
Road	13%	2%	-8%	23%	39%	61%	21%	33%	53%
Rail	38%	87%	148%	30%	44%	62%	36%	60%	87%
IWW	24%	47%	79%	16%	25%	33%	25%	49%	60%
Maritime	22%	47%	100%	22%	47%	101%	22%	47%	101%

Source: PRIMES-TREMOVE transport model

CO₂ emissions

Table 7: Main projections regarding CO₂ emissions¹²¹

<i>Policy options</i>	<i>Resulting CO₂ emissions</i>		<i>Resulting CO₂ emissions</i>		<i>Resulting CO₂ emissions</i>	
	<i>2020</i>		<i>2030</i>		<i>2050</i>	
<i>compared to</i>	1990 levels	Policy Option 1	1990 levels	Policy Option 1	1990 levels	Policy Option 1
<i>Policy Option 1</i>	30.8%	0.0%	24.2%	0.0%	24.2%	0.0%
<i>Policy Option 2</i>	18.7%	-10.0%	-1.9%	-22.6%	-60.9%	-68.6%
<i>Policy Option 3</i>	24.5%	-5.7%	12.2%	-11.5%	-62.0%	-69.5%
<i>Policy Option 4</i>	20.7%	-8.6%	7.7%	-15.0%	-60.9%	-68.6%

Source: PRIMES-TREMOVE transport model

¹²¹

As explained above, the modelling results for CO₂ emissions reduction do cover aviation, but do not cover international maritime. Therefore, CO₂ emissions for maritime are reported separately. The modelling results reflect the accounting method set out in Commission Decision (2007/589/EC) establishing guidelines for the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council for the use of biofuels. In this Decision, biomass is considered as CO₂ neutral.

External costs of transport

Table 8: Change in external costs of Policy Options 2, 3 and 4 relative to Policy Option 1

<i>Policy options</i>	<i>Policy Option 2</i>			<i>Policy Option 3</i>			<i>Policy Option 4</i>		
<i>compared to Policy Option 1 (in %)</i>	2020	2030	2050	2020	2030	2050	2020	2030	2050
Congestion	-6%	-16%	-26%	0%	1%	-3%	-3%	-4%	-11%
Air pollution	-6%	-23%	-84%	-2%	-15%	-79%	-3%	-18%	-78%
Noise	-6%	-18%	-46%	-1%	-4%	-39%	-2%	-4%	-32%
Accidents	-4%	-14%	-27%	-1%	0%	-2%	-2%	-3%	-9%

Source: PRIMES-TREMOVE transport model

5.2. Economic impact

156. This section analyses in a first step the impact of the various policy options on the transport sector itself, in terms of level of activity, modal shift and production costs. Given the central role transport plays in the economy and in the everyday life of people, this section also assesses in a second step the impact of the transport system's evolution under each Policy Option on a different aspect: economic growth, efficiency of the transport system, congestion, households, transport-related sectors, innovation and research, administrative burden, EU budget and international relations.

5.2.1. Impact on transport as a business

Transport activity

157. Transport activity is expected to continue increasing in all Policy Options, driven by growth in economic activity. Modelling results show that between 2005 and 2050 passenger transport activity would raise by 49% in Policy Option 3, followed by Policy Option 4 with 41% and 24% in Policy Option 2 (see Table 6:).

158. However, the active policies in place for stimulating change in the transport system would put a brake on the expansion of passenger transport activity in all Policy Options in comparison with Policy Option 1 (see Table 5). Policy Option 2 shows the highest effect on passenger transport activity by 2050 (about -18%) relative to Policy Option 1, due to its strong focus on taxation. The large scale uptake of electric propulsion vehicles enables the decarbonisation of passenger transport with only moderate impact on transport activity in Policy Option 3 (-2%) and Policy Option 4 (-7%) by 2050.

159. Freight transport activity is projected to grow at a strong pace between 2005 and 2050 in Policy Options 3 and 4 (about 92%). The high share of maritime in freight transport activity (around 80%) and its similar evolution in Policy Options 3 and 4 is responsible for this outcome (see Table 6). In Policy Option 2, strong price signals

generate a fall in freight road transport demand by 2050 and, hence, a slower growth in freight transports activity (84%) relative to Policy Options 3 and 4.

Modal shift

160. As indicated in Table 10 below, the market share of different modes of transport will remain relatively stable in Policy Option 3 compared to Policy Option 1.
161. Under Policy Option 4, modal shift takes place in a number of segments of the transport activity: high-speed rail gains further shares (it is projected to undertake 72 billion more passenger kilometres in 2050), and around 88% of freight is carried by rail, inland navigation and maritime in 2050. Passenger rail transport activity is projected to grow by 66% in Policy Option 1 and to more than double in Policy Option 4 between 2005 and 2050, while freight rail would increase by 58% in Policy Option 1 and by 87% in Policy Option 4 over the same period (see Table 6).
162. The greatest changes occur however in Policy Option 2 due to very intensive policies with the objective of managing demand and encouraging a shift in modal choices: demand for road passenger transport and aviation drops by over 20% relative to Policy Option 1 by 2050, while demand for rail passenger transport increases by 35%. For freight, rail transport benefits most in terms of increased demand by 2050, followed by inland navigation and maritime (see Table 5).

Unit costs per user

163. The unit costs per passenger transported would increase in all three Policy Options, despite the decline in the fuel costs per km travelled^{122, 123}. Policy Option 2 shows the highest increase, 23% compared to Policy Option 1 by 2050, due to the capital costs related to public transport and pricing. The cost increase in Policy Option 3 is driven to a large extent by the capital costs for the electric propulsion vehicles, while in Policy Option 4 (13% increase relative to Policy Option 1 by 2050) both capital costs for public transport means and those for electric propulsion vehicles play an important role (see Table 9).

¹²² Passenger transport costs include capital costs, fixed operation costs and variable fuel and non-fuel costs (including taxes and charges).

¹²³ Annualised capital costs include the return necessary on private sector investments in the transport sector. No social discount rate is applied which would result in lower costs.

Table 9: Unit costs of transport in Policy Options 2, 3 and 4 relative to Policy Option 1

<i>Unit cost of transport relative to Policy Option 1 (in %)</i>	<i>2020</i>	<i>2030</i>	<i>2050</i>
<i>Unit cost for passenger transport</i>			
Policy Option 2	5%	18%	23%
Policy Option 3	1%	0%	2%
Policy Option 4	2%	3%	13%
<i>Unit cost for freight transport</i>			
Policy Option 2	13%	36%	43%
Policy Option 3	3%	-1%	-4%
Policy Option 4	4%	2%	-1%

Source: PRIMES-TREMOVE transport model

164. The evolution of the unit cost for freight transport shows similar patterns in Policy Option 2, increasing however by 43% compared to Policy Option 1 by 2050¹²⁴. Capital costs for rail play a more significant role for freight transport in Policy Option 2. In Policy Options 3 the drop in the unit fuel cost outweighs the increase in capital costs and the total unit cost for freight transport slightly declines relative to Policy Option 1 by 2050. The decrease in the unit fuel cost for freight is the effect of tighter efficiency standards and of lower fuel prices in Policy Option 2, 3 and 4, relative to Policy Option 1¹²⁵. In addition, fuel costs play a more important role in total costs for freight, relative to passenger transport. In Policy Option 4 unit cost for freight transport is similar to that of Policy Option 1 by 2050 (see Table 9).

¹²⁴ Similarly to passenger transport, freight transport costs include capital costs, fixed operation costs and variable fuel and non-fuel costs.

¹²⁵ As previously explained Policy Options 2, 3 and 4 include a lower price environment. Oil price is assumed to be 80 \$/barrel in 2030 and 70 \$/barrel in 2050 (in year 2008-dollars).

Table 10: Modal shares in Policy Options 1, 2, 3 and 4

<i>Policy options</i>	<i>Policy Option 1</i>			<i>Policy Option 2</i>			<i>Policy Option 3</i>			<i>Policy Option 4</i>		
<i>modal shares (in %)</i>	2020	2030	2050	2020	2030	2050	2020	2030	2050	2020	2030	2050
<i>Passenger transport activity</i>	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Road	81.2%	79.2%	76.7%	81.2%	77.2%	72.0%	81.0%	78.9%	77.0%	81.5%	78.6%	75.1%
Rail	7.5%	7.7%	8.1%	8.4%	10.0%	13.4%	7.5%	7.6%	8.7%	8.2%	9.1%	11.1%
Aviation	10.8%	12.6%	14.7%	9.8%	12.1%	14.0%	10.9%	12.9%	13.7%	9.7%	11.7%	13.1%
Inland navigation	0.6%	0.6%	0.5%	0.6%	0.6%	0.6%	0.6%	0.5%	0.6%	0.6%	0.6%	0.7%
<i>Freight transport activity</i>	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Road	16.1%	15.3%	13.4%	14.5%	11.2%	7.7%	15.6%	14.9%	13.0%	15.3%	14.2%	12.4%
Rail	3.7%	3.5%	3.1%	4.1%	4.7%	4.8%	3.8%	3.5%	3.0%	3.9%	3.9%	3.5%
Inland navigation	2.2%	2.1%	1.7%	2.5%	2.5%	2.3%	2.3%	2.1%	1.7%	2.5%	2.5%	2.0%
Maritime	78.0%	79.1%	81.8%	79.0%	81.6%	85.2%	78.4%	79.5%	82.3%	78.3%	79.4%	82.2%
<i>% of conventional ICE cars in passenger transport activity</i>	65.6%	59.0%	48.4%	54.5%	35.7%	12.4%	54.8%	29.7%	2.9%	55.0%	30.3%	3.0%

Source: PRIMES-TREMOVE transport model

5.2.2. *Impact of transport dynamics on:*

5.2.2.1. Economic growth

165. The current report is part of a joint analysis and projection exercise for the Commission's initiatives related to the transition to a low-carbon economy by 2050. The transport sector has to contribute to the overall policy goal of designing a path towards a low-carbon, competitive economy that meets the long-term requirements for limiting climate change to 2°C.
166. Previous assessment by the Commission shows that the costs by 2020 of putting the EU economy on a path that meets the long-term requirements for limiting climate change to 2°C would be limited compared to Policy Option 1, at around 0.2%-0.5% of GDP¹²⁶, with access to the carbon market. Using the additional revenues from auctioning the CO₂ emissions allowances in all the EU Emissions Trading Scheme (EU ETS) sectors and the tax revenues from the non-ETS sectors to decrease the labour costs would improve overall macroeconomic results leading to 0.4%-0.6% increase in GDP by 2020, relative to Policy Option 1.
167. The Impact Assessment on a "Low-carbon economy 2050 roadmap" shows that a CO₂ emission reduction target for transport of around 60% is consistent with the aim of achieving emission reductions for the whole economy in a way that minimises the impact on growth. It corresponds to emission reductions in other sectors of around 80% for the industry, 90% for the residential sector and services and over 90% for power generation.
168. As regards the differentiated impact of the four policy options on economic growth, the long-term perspective implies that it is very difficult to go beyond a qualitative assessment¹²⁷.
169. Policy Option 1 would spare the economy the costs of replacing fossil fuels in the transport sector with energy sources that, currently, are less cheap and convenient. However, this initial advantage would eventually be eroded by increasing fuel costs. Perhaps more importantly, since the technological race for clean transport is a global one, remaining a frontrunner is essential for the EU manufacturing industry: other regions of the world will face similar constraints while global demand for mobility keeps growing. On the other hand, delayed action and timid introduction of new technologies as in Policy Option 1 can condemn the EU transport industry to irreversible decline.
170. Policy Options 2 and 4 contain a range of measures aimed at further opening the transport markets and at removing regulatory, administrative and physical barriers to the transport system. A more integrated and efficient transport system enabling the free movement of people and goods across the EU is expected to contribute to

¹²⁶ SEC(2010) 650, Commission Staff Working Document accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Analysis of options to move beyond 20% greenhouse gas emission reductions and assessing the risk of carbon leakage: Background information and analysis.

¹²⁷ In addition, modelling limitations do not allow evaluating the macroeconomic effects of measures like i.e. CO₂ standards.

economic growth, as it would allow a more efficient use of resources. In particular, measures aimed at getting the transport prices right should be at the core of the transport strategy, as they contribute to the efficiency and the sustainability of the transport system. In addition, in Policy Option 2 and 4, the EU economy should also benefit from the increase in the capacity and performance of the infrastructure resulting from the elimination of bottlenecks and addition of missing links. Policy Option 4 would have the additional advantage over Policy Option 2 of providing a greater stimulus to technological development and of allowing greater levels of mobility, to the benefit of trade and economic specialisation.

171. Policy Option 3 relies to a greater extent on technological advance and innovation in the EU. It does, however, bring about more limited improvements on the functioning of the markets and it might suffer from higher overall costs of congestion.

5.2.2.2. Efficiency of the transport system – transport as a service

172. In Policy Option 1, transport prices would continue increasing in line with rising oil prices.
173. In Policy Option 2, smart pricing for transport services is expected to steer the customers towards more efficient and sustainable modal choices. Besides, as highlighted above, the achievement of a Single Transport Area supported by an efficient transport network will be a key to increase the efficiency of the transportation system. While the internalisation of external costs and the taxation is expected to increase end-user prices, the greater efficiency of the transportation system will be able to partly offset this increase.
174. Under Policy Option 3, technology is only capable of delivering limited improvements in the functioning of the transport system compared to the Policy Option 1. The policy intervention that improves the fuel efficiency of vehicles leads to less fuel being required to travel the same distance. As the uptake of advanced powertrains is accelerated under this policy option, economies of scale enable lower costs of production. However, total vehicle purchase costs would still increase by about 20% relative to Policy Option 1 by 2050¹²⁸.
175. Under Policy Option 4, the overall efficiency of EU transport system improves through a balanced combination of system improvement and technology improvement measures.

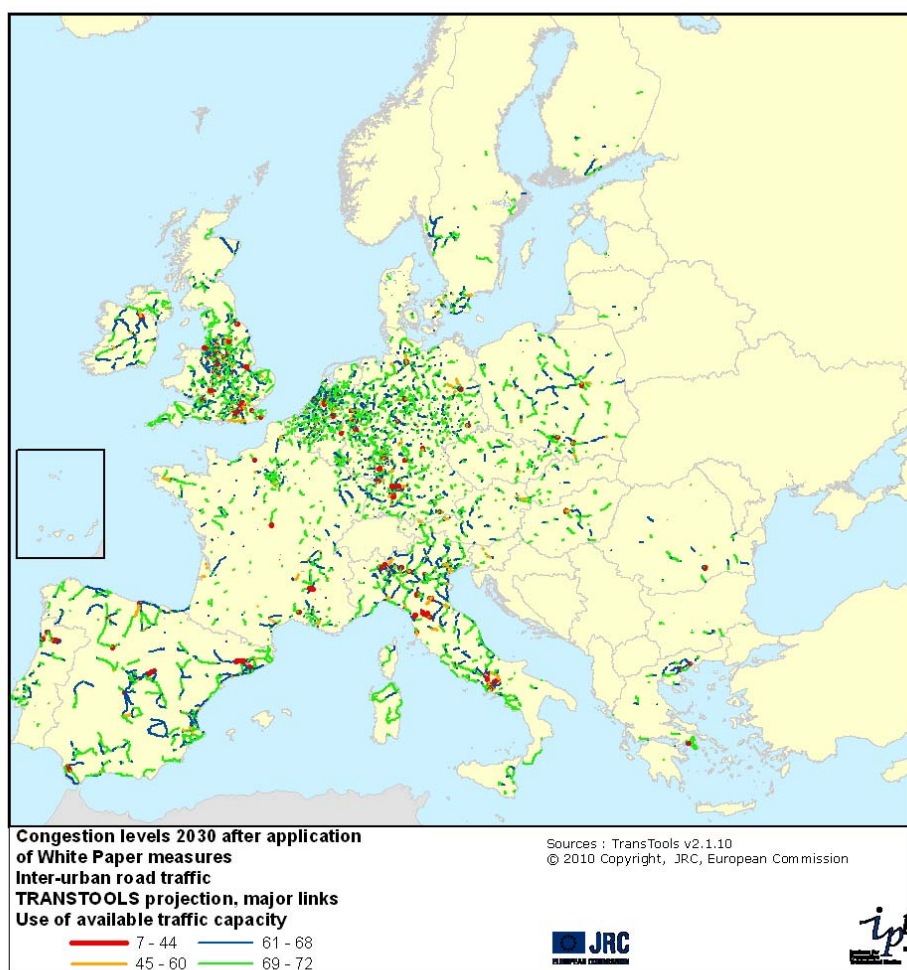
5.2.2.3. Congestion levels

176. In Policy Option 1, congestion is projected to pose a huge burden to the society: congestion costs would increase by about 50% by 2050, to nearly € 200 billion annually.
177. As highlighted in Table 8 above, in Policy Option 2, the modal shift projected from road to rail for passenger transport and from road to rail and inland navigation for freight would have a positive effect on congestion levels and would reduce the bill to

¹²⁸ This statement refers to total vehicle purchase costs and not to unit costs.

the society compared to Policy Option 1. Modelling results indicate that congestion costs in Policy Option 2 would be 26% below those in Policy Option 1 by 2050.

178. In Policy Option 3, the pricing signals are not sufficient to shift traffic away from road. Congestion continues therefore to pose a large burden on the competitiveness of European businesses and on the quality of life, congestion costs being only 3% lower than in Policy Option 1 by 2050.
179. The modal shift in favour of rail induced by Policy Option 4 will have a positive effect on congestion levels compared to Policy Option 1 by 2050, although to a lesser extent. Modelling results indicate that congestion costs would drop by about 11% in Policy Option 4.



Source: TRANSTOOLS

Figure 3: Congestion levels in 2030 in Policy Option 4

5.2.2.4. Household transport costs

180. Prices for private passenger transport would increase in all Policy Options, driven by capital costs increases in Policy Options 3 and 4, and to a large extent by pricing in Policy Option 2. For road freight transport, the decline in fuel costs per km travelled

would outweigh the rise in the capital and operation cost in Policy Options 3 and 4, while user price would increase in Policy Option 2.

181. With respect to transport costs per household, Table 11 shows that the share of passenger transport costs in the income of an average EU household would increase in all Policy Options relative to Policy Option 1. The costs included are the annualised transport equipment costs (i.e. related to vehicle stock), the fuel and electricity costs as well as other fixed and variable non-fuel costs, including taxes and charges.
182. In Policy Option 2, the increase in fixed and variable non-fuel costs, among which mostly taxation and pricing, outweighs the positive effects in terms of fuel costs but also the capital costs. As a result, the share of the transport costs in households income increase by 0.3 percentage points in Policy Option 2 relative to Policy Option 1 by 2050. In Policy Options 3 and 4, capital costs related to the large scale uptake of advanced technologies play a more important role relative to Policy Option 2.
183. The pattern of the additional transport costs as a share of household income is also different between Policy Options 2, 3 and 4. This outcome is due to the different intensity of policy measure included in each policy option and the time profile of the measures. For example, as previously indicated, in Policy Option 2, system improvement measures are front loaded to allow gradual changes in the transport system, which is reflected through higher additional fixed and variable non-fuel costs by 2030. However, all Policy Options show moderate increases in additional passenger transport costs as share of household income by 2050 (see Table 11).

Table 11: Total passenger transport costs in % of households' income in Policy Options 2, 3 and 4 relative to Policy Option 1

<i>Policy options</i>	<i>2005</i>	<i>Policy Option 2</i>			<i>Policy Option 3</i>			<i>Policy Option 4</i>		
<i>compared to Policy Option 1 (in percentage points)</i>	<i>% of households income</i>	<i>2020</i>	<i>2030</i>	<i>2050</i>	<i>2020</i>	<i>2030</i>	<i>2050</i>	<i>2020</i>	<i>2030</i>	<i>2050</i>
Passenger transport total costs	27.8%	0.4%	1.7%	0.3%	0.0%	0.0%	0.3%	0.0%	0.3%	1.3%
<i>of which</i>										
Capital costs	11.7%	-0.1%	-0.7%	-0.3%	0.2%	0.6%	1.2%	0.0%	0.5%	1.6%
Fuel costs	4.2%	0.0%	-0.8%	-1.5%	-0.1%	-1.0%	-1.8%	0.1%	-0.7%	-1.7%
Fixed and variable non-fuel costs	11.8%	0.5%	3.2%	2.1%	0.0%	0.3%	0.9%	-0.1%	0.6%	1.4%

Source: PRIMES-TREMOVE transport model

5.2.2.5. Transport-related sectors

184. European manufacturers are currently amongst the most technologically advanced in the world in all transport modes. Vehicles, trains and aircrafts produced in Europe are highly valued on the non-EU markets. As regards the automotive industry, the Commission's Impact Assessment on CO₂ standards for passenger cars suggested

that efficiency standards would have positive impacts on the competitiveness of European manufacturers¹²⁹. First of all, vehicles that meet strict CO₂ emissions requirements in the EU will be globally competitive and compliant with the climate change policies being implemented in third countries (especially where fuel economy standards exist and are about to be tightened, notably Japan, China, and USA, as well as India which is likely to follow). The reduction of CO₂ emissions is now a global phenomenon and involves all means of transport.

185. An ambitious EU policy in the environmental field will help maintain the technology lead of the EU automotive industry and thus support its competitiveness. While European automotive firms are market leaders in some transitional drive-train and fuel technologies, they have also been investing heavily in alternative powertrains such as hybrid vehicles, electric vehicles and hydrogen. It is clear that in the medium and long-term the global competition for market leadership in these technologies will intensify. Given the strong position of European manufacturers in the market segment of premium vehicles and its high-quality supplier base, the automotive industry is well-equipped to take a leading role in this global race driven by stricter regulatory standards for environment and safety¹³⁰. In the long term the main areas of growth will come from external markets, as rising income levels improve access to individual mobility. In this context, Policy Options 3 and 4 would allow maintaining to the greatest extent the European manufacturers' competitive position on the external markets. This effect is much less pronounced in Policy Option 2 where policies enable slower technological advance and innovation in the EU.
186. In addition, the wide deployment of ITS technologies foreseen in Policy Options 3 and 4 is likely to have a positive effect on the developers of key enabling transport technologies. This impact is much less prominent in Policy Option 2.

5.2.2.6. Innovation and Research

187. The European automotive industry is a world leader in developing clean and energy efficient technologies based on combustion engines, consequence of substantial investment in the last 15 years in research and development¹³¹. About one third of the R&D investments are directed towards research efforts that reduce the GHG emissions of vehicles, in particular towards the improvement of conventional engine technologies and the development of electric powertrains.

¹²⁹ SEC(2007)1724 "In the global perspective, research and innovation are seen as strengths of the European market and it is not likely that the above trends will have a damaging effect on the competitive position of EU manufacturers. As regards mature non-EU markets where EU manufacturers are already present (e.g. US, Canada) there is a general trend towards the reinforcement of fuel efficiency/greenhouse gas emission standards. Because requirements on these markets are so far less ambitious than those in the EU, the proposed EU legislation will allow European carmakers to provide vehicles that are competitive and meet the reinforced standards to come into force in the coming years." SEC(2009) 1111 final. European Industry in a Changing World. Updated Sectoral Overview 2009.

¹³⁰ A recent research from the Joint Research Centre of the Commission shows indeed that the EU-based automotive industry is the largest private research investor in the EU with a volume of R&D investments of more than 30 bln € in 2008. This high R&D effort, that reaches around 5% of the turnover, indicates that the sector is research-intensive, especially in comparison to the low R&D intensity of companies active in the electricity sector (0.6%) and oil and gas producers (0.2%). See in this respect: JRC.2010. Research of the EU automotive industry into low-carbon vehicles and the role of public intervention http://ftp.jrc.es/EURdoc/JRC58727_TN.pdf

188. In all Policy Options (except Policy Option 1), the decarbonisation of transport relies on technology development towards clean and energy efficient vehicles based on conventional ICE and the deployment of breakthrough technologies in ultra-low-carbon vehicles. This will be achieved mainly through setting long term efficiency targets for vehicles.
189. As said above, past experience has shown that setting long term efficiency targets via specific regulation can steer environmental innovation within the automotive industry in the right direction. Creating appropriate framework conditions for steering the automotive sector's research efforts is therefore of high relevance and impact.
190. As a consequence, all Policy Options are expected to have a favourable impact on research and innovation. However, the magnitude of the effect of each Policy Option on research and innovation will differ. High intensity of policies accelerating the deployment of advanced technologies in Policy Option 3, namely efficiency standards, is expected to bring about the largest investments in innovation, followed by Policy Option 4. Policy Options 2 will also contribute, but to a lesser extent.
191. Sending to the market the right signals can contribute to the creation of a lead-market and bring long-term benefits to EU-based industry. Companies in the lead-market, the so-called first-movers, are better positioned than their competitors when demand for 'their' technology increases and gains world market shares. They are indeed at the forefront of the diffusion of the innovative technology and are the first to experience the benefits of 'technology learning'. As indicated in the Commission Communication on Innovation Union¹³², supporting and facilitating environmental innovation is expected to boost the competitiveness of the European industry, provide new jobs in the automotive industry and in other sectors in the supply chain and support restructuring.

5.2.2.7. Administrative burden

192. Compared to the Policy Option 1, Policy Options 2 and 4 are expected to reduce administrative burden at EU and at national levels given that they both incorporate policy measures that will remove barriers, including administrative obstacles, to a Single Transport Area. A more detailed assessment of the impact of specific proposals on administrative burden will be performed in the context of individual Impact Assessments.
193. Policy Option 3 is not expected to have a significant impact on administrative burden compared to Policy Option 1.

5.2.2.8. EU budget

194. In principle, all Policy Options envisaged in this Impact Assessment report have a direct impact on the EU budget. However, the impact of individual measures on EU budget will be assessed in the context of individual impact assessments.

¹³² EU 2020 Flagship Initiative Innovation Union SEC(2010) 1161

5.2.2.9. International relations

195. Under Policy Options 2, 3 and 4, the EU is foreseen to substantially reduce its GHG emissions. Given the importance of international transport in overall emissions, the international aviation and maritime sector will need to make substantial contributions to the overall abatement effort. As a consequence, modelling analysis shows an 8% to 22% decrease in the overall activity levels of aircrafts by 2050 compared to Policy Option 1, while maritime benefits the most in terms of improvements in energy efficiency and CO₂ intensity. Overall, both modes increase their activity substantially over 2005 levels: 100% to 140% in aviation and about 100% in maritime. The share of biofuels is projected to reach about 40% in energy consumption by aviation and maritime by 2050.
196. Increases in traffic are made feasible in a sustainable way by the technological and operational improvements foreseen to be undertaken in both sectors as a result of additional policies. In particular, achieving a Single European Aviation Area consisting of the neighbouring countries and accommodating the increased trade flows carried on maritime vessels, is accompanied by measures that improve the fuel efficiency of both modes and enable better operations through ITS solutions (SESAR, e-Maritime, speed optimization).
197. All Policy Options demonstrate an increased need for global action that ensures a level playing field internationally. Therefore, depending on what emission reduction policies are adopted in IMO and ICAO, a certain strain on international relations in particular with developing countries can be expected at least in the near and medium-term. In addition, the implementation of taxation policies going beyond the internalisation of external costs for international transport under Policy Option 2 may require substantial diplomatic efforts.

5.3. Social impact

198. As pointed out in the literature¹³³, defining social impacts in transport is not an easy task. Defining social impacts as all impacts on people is a too broad definition, but a limitation to “demographic changes, job issues, financial security and impacts on family life”¹³⁴ would be too narrow. One of the difficulties of assessing social impacts in transport policy is that, often, no clear distinction can be made between social, economic and environmental impacts. For instance, a policy that reduces air pollution induced by transport activities affects primarily the natural environment, but also human health thanks to improved air quality. It has therefore both social and environmental impacts. In this context, the Commission will assess social impacts of the various policy options in the fields which affect primarily people, namely mobility, accessibility and cohesion, equity, employment level and conditions and safety. The impacts of variation of air and noise pollution on human health are assessed in the section analysing environmental factors.

¹³³ See for instance Karts T. Geurs, Wouter Boon, Bert Van Wee (2009): Social Impacts of Transport: Literature Review and the State of the Practice of Transport Appraisal in the Netherlands and the United Kingdom, Transport reviews, 29:1, 69-90.

¹³⁴ IATA (2003): Social Impact Assessment: International principles. Special publication Series N°2

5.3.1. *Impact on the degree of citizens' mobility*¹³⁵

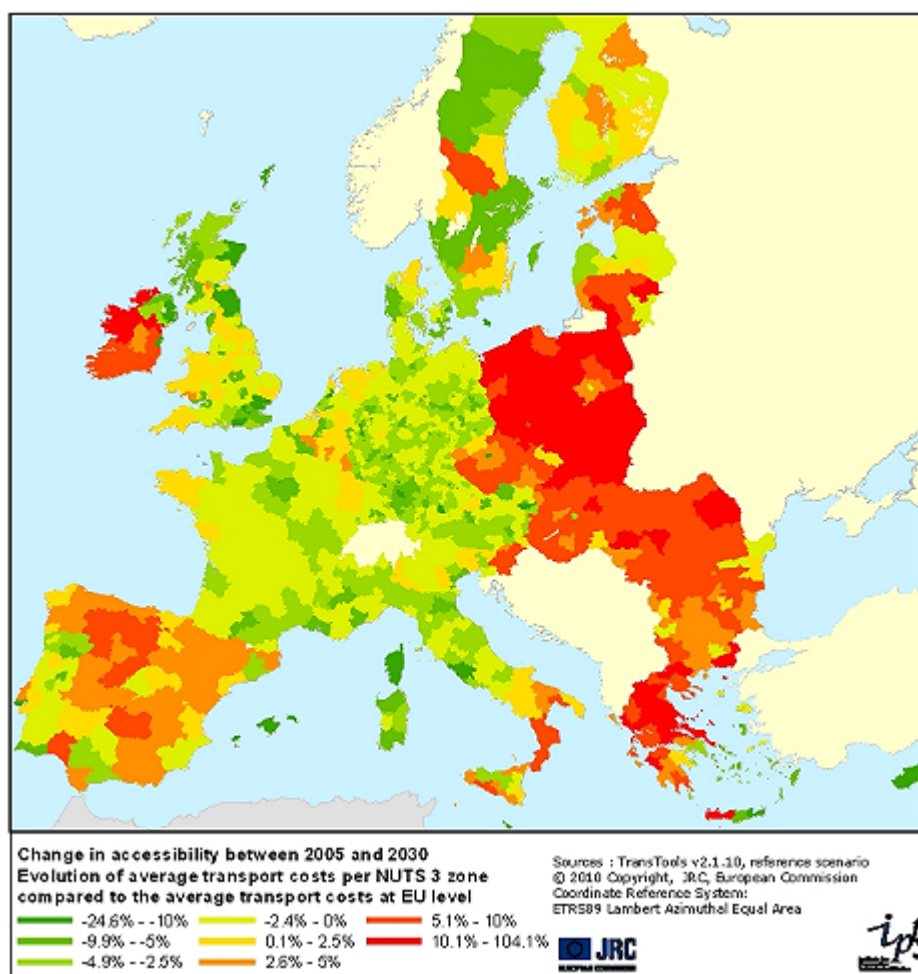
199. In comparison with Policy Option 1, all Policy Options will put a brake on the mobility for the EU citizens by 2050. However, the degree of mobility reached in 2050 with respect to 1990 would still be about 58% higher in Policy Option 2, 90% in Policy Option 3 and 80% in Policy Options 4.
200. The strong focus of Policy Option 2 on pricing policies and taxation implies that mobility of citizens will be substantially constrained relative to Policy Option 1 (-18% by 2050). On the contrary, the large scale uptake of electric propulsion vehicles in Policy Option 3, would enable the EU citizens keeping about the same degree of mobility as in Policy Option 1 by 2050 (-2% by 2050), while also decarbonising the passenger transport.
201. Under Policy Option 4, the combination of demand management measures and technology improvement measures allows to limit the reduction in citizens' mobility to 7% by 2050 compared to Policy Option 1 (see Table 5 above).
202. In terms of choice of transport means, Policy Option 2 and 4 incorporate system improvement measures that render rail more efficient and convenient for citizens. It can therefore be concluded that both Policy Options offer more choice to citizens contrary to Policy Options 1 and 3.

5.3.2. *Impact on accessibility and cohesion*

203. Accessibility in this context is based on the concept of “potential accessibility”, which assumes that the attraction of a destination increases with size, and declines with distance, travel time or cost¹³⁶.
204. In Policy Option 1, the ownership and use of cars would create more bottlenecks and congestion. High congestion levels are expected to seriously affect road transport in several Member States by 2030 in the absence of effective countervailing measures such as road pricing.
205. The expected rise in fuel costs and congestion levels by 2030 would lead to further divergence in accessibility at regional level. Peripheral areas require longer average trips using, in most cases, more expensive modes and networks than the central areas do. As a result, their situation is expected to worsen, with higher average transport cost increases than central areas. With economic activity continuing to demonstrate signs of centralisation at EU level, transport may not support sufficiently economic growth and job creation in the peripheral regions.

¹³⁵ The mobility of citizens is defined in terms of passenger kilometres.

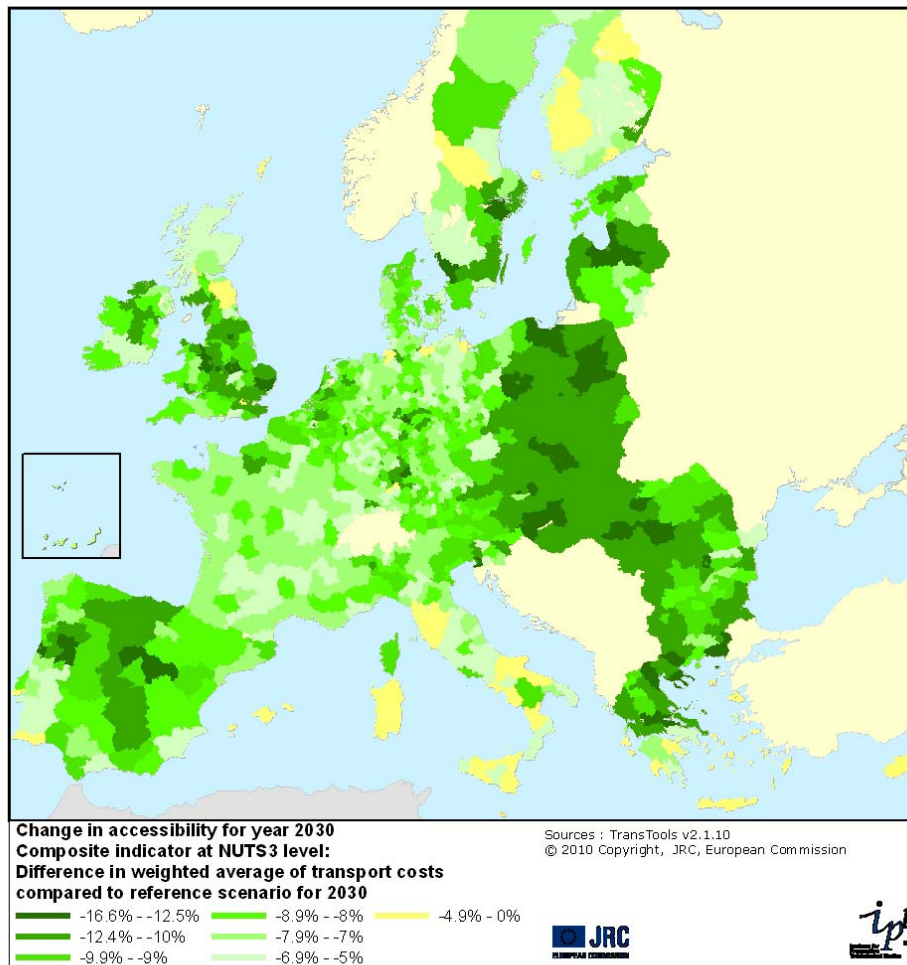
¹³⁶ More specifically, accessibility is defined in terms of generalized transport costs from zone *i* to zone *j* for segment *r* (commodity group or trip purpose) in year *t*, weighed with the traffic volumes.



Source: TRANSTOOLS

Figure 4: Change in accessibility between 2005 and 2030 in Policy Option 1

206. Policy Options 2 and 4 will provide better access for more people than is currently the case. Traffic congestion and time wasted stuck in jams will decrease. Improvements in accessibility under Policy Option 3 are more limited as transport demand remains close to levels under Policy Option 1.



Source: TRANSTOOLS

Figure 5: Change in accessibility in Policy Option 4 relative to Policy Option 1 in 2030

5.3.3. *Distributional impacts*

207. In Policy Option 1, the lack of improvement in the field of quality of service combined with deteriorating accessibility is likely to worsen social equity as the transport system do not adjust to prioritise the needs of those who rely on alternatives to cars. The negative impact of high levels of congestion is relevant in Policy Option 3 as well.
208. In Policy Options 2 and 4, the improved quality of service combined with enhanced accessibility is likely to promote social equity. However the beneficial impact of increased transport efficiency and of the wider availability of alternative, collective modes of transport is partially offset by the higher private cost of transport. This effect is particularly pronounced in Policy Option 2. Data on the share of household expenditure on transport across income groups suggest that highest income group

spends around 5% more on transport than the lowest one¹³⁷. However the distributional impacts will primarily depend on the exact characteristics of any given scheme of internalisation, and in particular the linked method of government revenue recycling. As shown in Section 5.3.2 however, accessibility will improve more in the peripheral regions of the EU-12 as the EU-15 already has a well-developed multi-modal transport network. This will improve EU-wide equity among regions.

5.3.4. *Impact on employment level and conditions (including on gender balance)*

Effect on green jobs

209. The decarbonisation of transport can be expected to have a favorable effect on ‘green jobs’. Numerous studies indeed quantify and describe the trend in green job growth in Europe. A study from Ecorys outlines the manner in which the combination of environmental policy, regulation and public awareness has affected industries such as the automotive and transport sectors¹³⁸. The developments in these sectors have, in turn, been strong drivers for employment in eco-industry sub-sectors, notably the environmental technology, recycling and renewable energy subsectors. Another study pays particular attention to the multiplier effects of environment related activities¹³⁹. The employment multiplier describes the jobs directly and indirectly linked to the eco-industry as a ratio to those directly created in the eco-industry. The study finds multipliers of between 1.3 and 1.9 across the 27 Member States.

Effect on total employment

210. In Policy Option 1, total employment in transport services¹⁴⁰ is projected to roughly maintain its relative share by 2050¹⁴¹, resulting in a lower level of absolute employment by the sector. With growing transport activity demand, the lower employment in transport may negatively affect the workload and working conditions. A scarcity of labour and skills may arise due to ageing, further aggravating the shortage of labour already experienced before the crisis in many segments of the transport sector. In absence of innovative alternatives, this may also result in higher transport costs for the society.
211. In light of the conclusions of various economic studies¹⁴², total employment in transport services is expected to grow under Policy Option 2. Employment effects

¹³⁷ See for instance European Environment Agency. Factsheet TERM 2005 24 – Expenditures on personal mobility; <http://www.eea.europa.eu/data-and-maps/indicators/expenditures-on-personal-mobility-1/term-2005-24-expenditure-on-personal-mobility-final-version.pdf>

¹³⁸ Ecorys (2009), http://ec.europa.eu/enterprise/newsroom/cf/document.cfm?action=display&doc_id=5416&userservice_id=1&request.id=0

¹³⁹ GHK (2007) Links between the environment, economy and jobs; http://ec.europa.eu/environment/enveco/industry_employment/pdf/ghk_study_wider_links_summary.pdf

¹⁴⁰ This figure does not include own account transport. The construction and maintenance of transport infrastructure and of transport means (i.e. road vehicles, ships, trains) is not included either.

¹⁴¹ Result of the GEM-E3 model.

¹⁴² See for instance, “Climate Change and employment – Impact on employment in the European Union-25 of climate change and CO₂ emission reduction measures by 2030”, European Trade Union Confederation (ETUC), Instituto Sindical de Trabajo, Ambiente y Salud (ISTAS), Social Development Agency (SDA), Syndex, Wuppertal Institute (2007).

from modal shift¹⁴³ induced in Policy Option 2 on the various modes of transport depend on the labour intensity of each mode: road transport, public transport and inland waterways are more labour intensive than maritime transport, railways or aviation. Amongst the labour-intensive modes, the largest employer is road freight transport whose job losses due to modal shift may be compensated by new jobs in multimodal transport services, collective modes and in logistics. The use of public transport instead of the private car will moreover have immediate effects on employment as the self-provision of car mobility is not accounted for in statistics even if the negative impact on car servicing businesses may be important. Improvements in transport services in Policy Option 2 will require the creation of numerous jobs that will in particular enable catering for the needs of various users in collective modes. As in the services sector in general, such employment is expected to attract a larger female workforce.

212. Labour shortages in most modes, and particularly in maritime and inland navigation, are likely to be compensated by recourse to extra-EU workers, with the risk of losing EU know-how.
213. In Policy Option 3, it is expected that employment in the transport equipment manufacturing sector will grow. In economic theory, product innovations have a positive impact on employment, since they open the way to the development of either entirely new goods or radical differentiation of mature goods. A study conducted on behalf of the Commission has shown that the large scale uptake of alternative energy carriers should facilitate additional job creation in the renewables sector¹⁴⁴. The reorientation of activities towards new markets and products will generate demand for new skills. The most prominent examples are in the automotive sector and in shipbuilding, responding to low-carbon demands for hybrid vehicles and offshore investment in wind and tidal energy respectively. Generally, skills needs are reflected in demand for additional competences of existing workers. These new environmentally-driven competences relate to new technologies as well as to new management requirements because of the changes in production methods and the adoption of new business models¹⁴⁵.
214. This will happen against the background of an already tight situation in the transport labour market due to the ageing of the labour force and to the little attractiveness of mobile jobs. Hence, labour shortages are likely to appear in the “low carbon marketplace” where existing skills will have to be enhanced and new skills into the European workforce will be needed¹⁴⁶.

¹⁴³ The distribution of jobs within the transport sector, as different from its total volume, depends of changes in the modal split, which will be in part influenced by the policies that will be adopted at European and other levels.

¹⁴⁴ The EmployRES study (2009), funded by the European Commission, showed that achieving a 20% share of renewables in final consumption could provide a net effect of about 410,000 additional jobs by 2020.

¹⁴⁵ CEDEFOP, 2010, Skills for green jobs. European Synthesis report

¹⁴⁶ According to the Commission Staff Working Document “European Industry in a Changing World - Updated Sectoral Overview 2009”, the automotive industry employs directly more than 2.3 million people (about 6% of manufacturing employment). Most of those employed in the automotive industry (60-70%) are engaged in skilled (or semi-skilled) manual work, while 30-40% are trained professionals or technicians.

215. In Policy Option 4, the combination of system improvement measures and technology improvement measures would benefit from the positive impacts of Policy Option 2 on employment in transport services and of Policy Option 3 in the sectors manufacturing equipment for the transport sector. The latter are expected to demand workers with higher skills profile.

5.3.5. *Impact on safety*

216. The projected increase in traffic in Policy Option 1 would induce an increase of accidents: the external cost of accidents would be about 60 bn € higher by 2050 compared to 2010. The external cost of accidents associated to urban transport would increase by some 40% over the same period.
217. In Policy Options 2 and 4, active modal shift policies, which are projected to reduce road transport activity levels, would contribute to improved road safety and to the reduction of death and injury. In Policy Option 2, external cost of accidents would decline by 27% relative to Policy Option 1 by 2050, while in Policy Option 4 by 9% (see Table 8). This improvement in road safety will benefit directly low income groups and ethnic minorities who experience a higher level of death and injury on roads than other groups. The large scale deployment of Intelligent Transport System (ITS) is also expected to have positive effects on safety.
218. The beneficial effects in terms of safety would be more limited in Policy Option 3 because traffic levels would be similar to those in Policy Option 1.

5.4. **Environmental impact**

219. Transport related activities have many impacts on the environment. The most important effects are contribution to climate change, to local air pollution, to noise levels, to biodiversity loss and natural resources depletion.

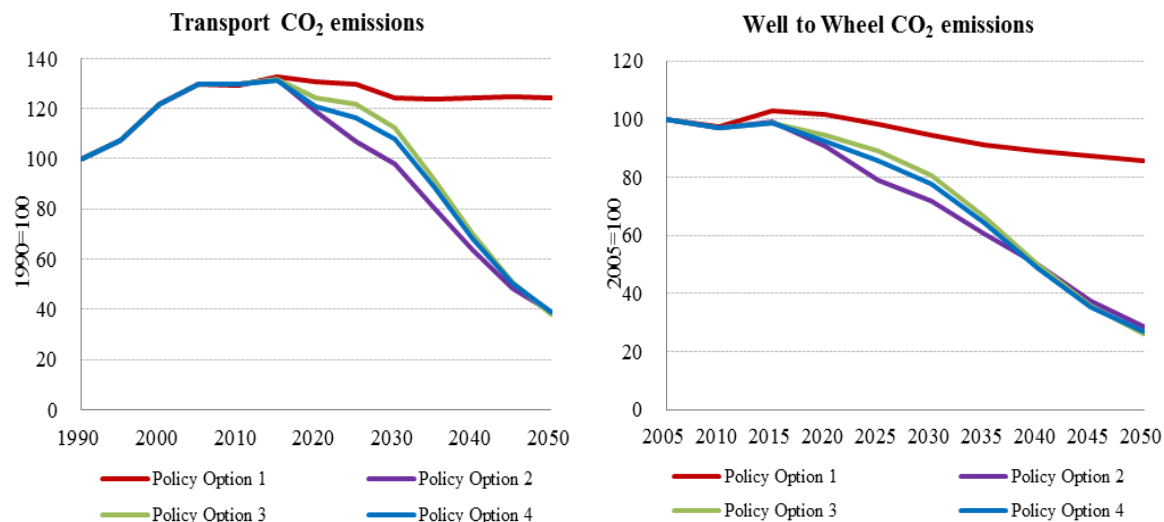
5.4.1. *Impact on climate change*

220. In 2050, CO₂ emissions including international aviation and maritime are projected to be 35% above 1990 levels under Policy Option 1, owing to the fast rise in the transport emissions during the 1990s¹⁴⁷. As indicated in Table 7 above, excluding international maritime this translates into a 24% increase above 1990 levels.
221. As indicated in point 131 of the present Impact Assessment report, the three other Policy Options will be capable of reducing CO₂ emissions by 60% by 2050¹⁴⁸. The approach followed in each of these policy options is however different as shown in the following graph (see Figure 6). CO₂ emissions from international maritime transport would decrease by about 40% between 2005 and 2050 in Policy Options 3 and 4 and by about 50% in Policy Option 2.

¹⁴⁷ The CO₂ emissions from transport include international maritime and aviation but exclude combustion emissions from pipeline transportation, ground activities in airports and harbours, and off-road activities.

¹⁴⁸ The 60% CO₂ emissions reduction target does not cover international maritime.

222. As shown in Figure 6 below, the profile of the CO₂ reduction between 2020 and 2040 is projected to be different amongst the Policy Options. Policy Option 2 is indeed projected to reap the benefits of EU action sooner than Policy Options 3 and 4¹⁴⁹.



Source: PRIMES-TREMOVE transport model

Figure 6: Approach followed to reduce transport CO₂ emissions by 60% over 1990 levels¹⁵⁰ and evolution of well to wheel emissions

223. On well-to-wheel basis, the Policy Options deliver over 65% reduction in CO₂ emissions by 2050 compared to the Policy Option 1¹⁵¹ assuming that power generation is decarbonised. Power generation mix plays here an important role: the large scale electrification of transport, not accompanied by the decarbonisation of power generation, would only shift CO₂ emissions from transport to the energy sector¹⁵².

5.4.2. Impact on air and noise pollution

224. As highlighted in Table 8, external costs of transport to the society would continue to increase in Policy Option 1. The increase in traffic would lead to roughly 20 bn € increase of noise related external costs by 2050. NO_x emissions and particulate

¹⁴⁹ Urban planning measures are used as residual component in order to reach the 60% targets in Policy Option 4. Their importance is moderate, as indicated by a CO₂ shadow price of about 200 €/t of CO₂ by 2050. This shadow price is close to the CO₂ price from the “Effective and widely accepted technology” scenario from the Impact Assessment of the “Low-carbon economy 2050 roadmap”. This price signal mimics a combination of measures like: traffic management through congestion charges, integrate planning through urban mobility plans and improvements in public transport and soft modes infrastructure. Policy Options 2 and 3 use the same price signals for urban as Policy Option 4.

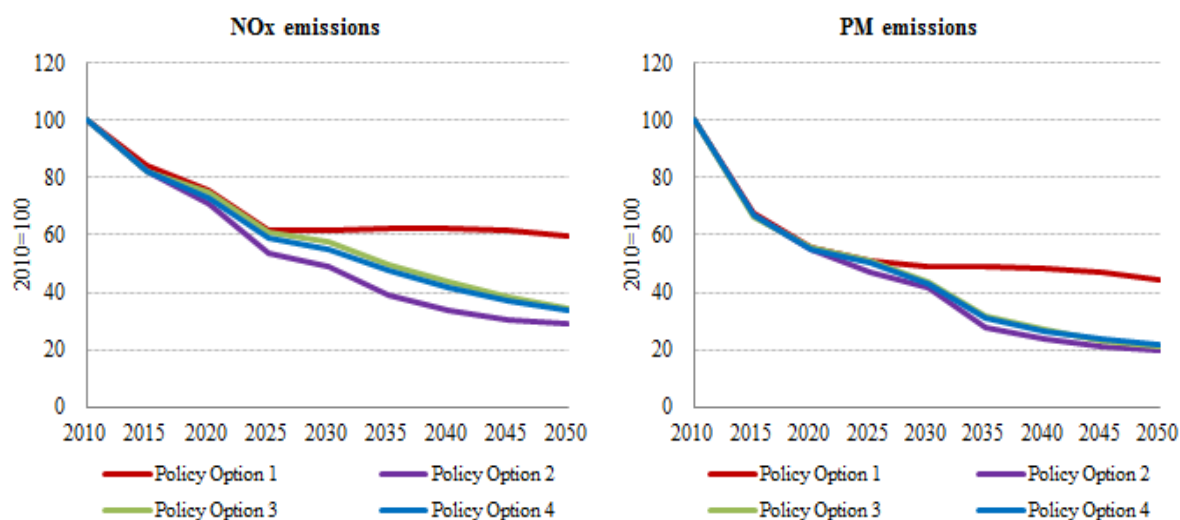
¹⁵⁰ The 60% CO₂ emissions reduction target does not cover international maritime and therefore they are not reported in this figure. The 60% CO₂ emissions reduction target only covers the tank to wheel emissions.

¹⁵¹ The well-to-wheel CO₂ emission factors for biofuels and electricity are identical to those applied in the “Effective and widely accepted technology” scenario from the Impact Assessment of the “Low-carbon economy 2050 Roadmap”.

¹⁵² Such a shift would not result in higher absolute emissions however: the EU Emission Trading Scheme effectively caps emissions from power generation.

matter would drop by about 40% and 50%, respectively, by 2030 and roughly stabilise afterwards (see Figure 7 below). As a result, external costs related to air pollutants would decrease by 60% by 2050.

225. In Policy Option 2, the modal shift induced by a more efficient pricing mechanism and the decline in the passenger transport activity is expected to lead to significant reduction in air pollutants by 2050. Nitrogen oxides emissions would decline by about 50% relative to Policy Option 1, while particulate matter emissions by about 55% (see Figure 7 below). Moreover, there will be a reduction in vehicle related noise pollution due to a decrease in the number of vehicles used and to a limited extent due to the gradual substitution of internal combustion engines for electric vehicles. External costs related to noise would decrease by as much as 46% relative to Policy Option 1 by 2050 (see Table 8 above).



Source: PRIMES-TREMOVE transport model

Figure 7: Evolution of NOx emissions and particulate matter in Policy Options 1, 2, 3 and 4

226. Under Policy Option 3 and 4, large scale electrification in various modes carries significant abatement of pollution. Compared to Policy Option 1, nitrogen oxides would drop by around 40% and particulate matter emissions by about 50% by 2050 in both policy options (see Figure 7 above). Owing to the ‘displacement’ of air pollutants from vehicle tailpipes near streets in mostly urban and densely populated areas to remote power plant sites considerable population exposure benefits are generated¹⁵³. The electric propulsion system is also characterised by considerably lower noise emissions than the conventional ICE powertrain. Therefore, the noise level would be particularly lowered in urban driving situations, whereas interurban driving is mainly dominated by rolling noise and noise from wind resistance. Overall, external costs related to noise would drop by 39% in Policy Option 3 and 32% in Policy Option 4 by 2050, relative to Policy Option 1 (see Table 8 above). The relatively higher decrease in external costs for noise and air pollution in Policy

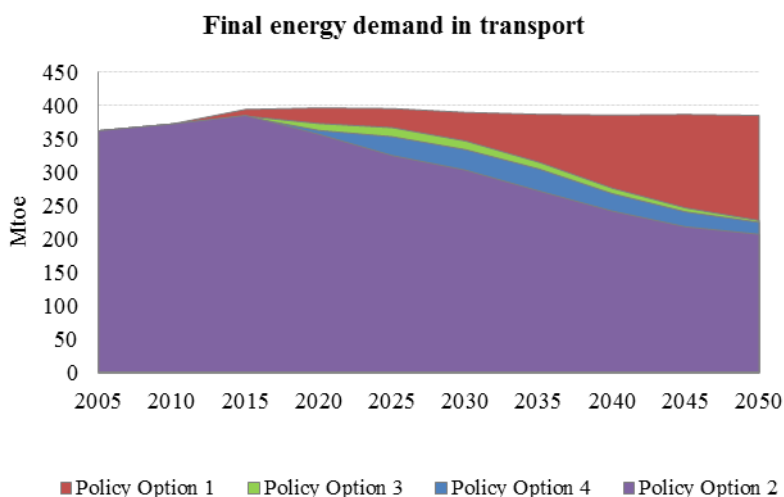
¹⁵³ See for instance “Environmental impacts and impact on the electricity market of a large scale introduction of electric cars in Europe”, ETC/ACC Technical Paper 2009/4, July 2009

Option 3 compared to Policy Option 4 is due to the larger share of electric propulsion vehicles in the vehicle fleet in Policy Option 3.

227. Studies have also shown that co-benefits of policies aiming at mitigating climate change can reduce substantially the number of premature deaths from air pollution, by lowering the chronic exposure to ambient particulate matter, especially in urban areas¹⁵⁴. This is especially true in urban areas.
228. Thanks to the improved quality of air and to the decreased level of noise nuisance under Policy Options 2, 3 and 4, the public health and the quality of life in general will increase.

5.4.3. *Impact on efficient use of energy and renewable energy sources*

229. Energy demand by transport would decline in Policy Options 2, 3 and 4. Policy Option 2 delivers the highest energy savings, in order of 180 Mtoe¹⁵⁵, followed by Policy Options 3 and 4 with about 160 Mtoe¹⁵⁶. Over 60% of these energy savings originate from passengers transport.



Source: PRIMES-TREMOVE transport model

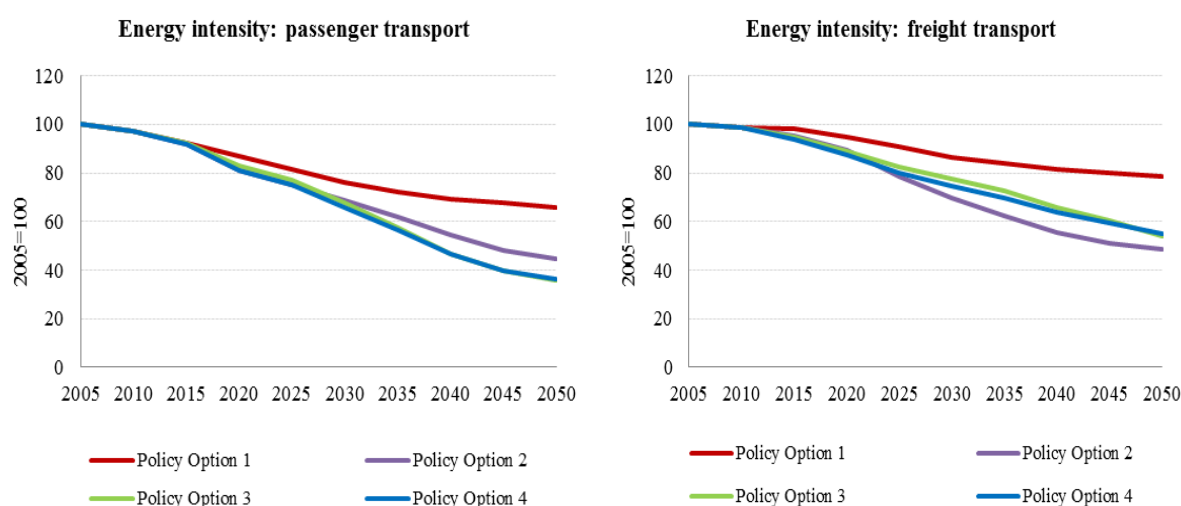
Figure 8: Final energy demand in Policy Options 1, 2, 3 and 4

¹⁵⁴ Bob van der Zwaan, Johannes Bollen, and Sebastiaan Hers, “An Integrated Assessment of Climate Change, Air Pollution, and Energy Security Policy” (December 1, 2009). Fondazione Eni Enrico Mattei Working Papers. Working Paper 366.

¹⁵⁵ Million Tonnes of Oil Equivalent

¹⁵⁶ By 2020, Policy Options 2 and 4 would deliver around 18% reduction in the transport sector energy consumption compared to the PRIMES 2007 baseline (pre-crisis baseline). According to the forthcoming Impact Assessment report on the European Energy Efficiency Plan (until 2020), and based on a study by the Fraunhofer ISI et al. 2009, the cost-effective potential for the transport sector in 2020 is evaluated at 21%. Policy Options 2 and 4 achieve energy savings close to the cost-effective potential. Policy Option 3 also delivers significant energy savings by 2020, although more limited in size compared to the other two options. The reason is that Policy Option 3 relies to a larger extent on technological solutions, which are rather back loaded in terms of effects. In the study conducted by the Fraunhofer ISI the potentials are calculated based on the PRIMES 2007 baseline (pre-crisis baseline). Therefore, the same methodology has been followed here (i.e. comparing the energy consumption of the Policy Options with those of the PRIMES 2007 baseline).

230. In terms of energy intensity, Policy Options 3 and 4 achieve the highest improvements for passenger transport due to the enforcement of CO₂ standards (almost 65% between 2005 and 2050)¹⁵⁷. However, other measures like eco-driving and fuel efficiency labelling also contribute to energy intensity improvements in Policy Options 2, 3 and 4, although to a more limited extent. For freight transport, very intensive policies with the objective of managing demand and encouraging a shift in modal choices deliver around 50% improvement in energy intensity in Policy Option 2 between 2005 and 2050. Overall, Policy Options 2, 3 and 4 achieve an improvement in energy intensity of about 70% by 2050 relative to 2005. Policy Option 2 provides the highest decrease in energy intensity followed by Policy Options 4 and 3^{158, 159}.



Source: PRIMES-TREMOVE transport model

Figure 9: Evolution of energy intensity for passenger and freight transport

231. Transport activity will remain heavily dependent upon oil in Policy Option 1: oil products would still represent 90% of the EU transport sector needs in 2030 and 89% in 2050.
232. Final consumption of oil by transport in Policy Options 2, 3 and 4 is expected to decrease by about 70% by 2050, relative to Policy Option 1. This decline is compensated to a certain extent by the rise in the electricity demand by the road and rail transport and the increased demand for biofuels, especially in aviation, inland navigation and long distance road freight, where electrification is not or less an

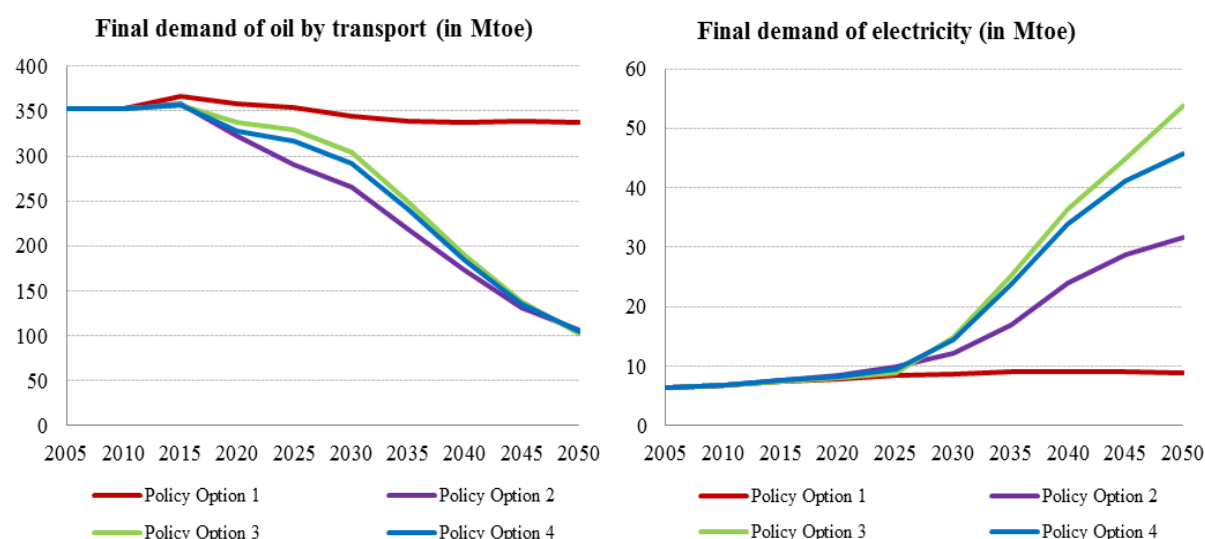
¹⁵⁷ As long as the transport sector is almost completely reliant on fossil fuels, standards on CO₂ emissions of vehicles correspond to *de facto* energy efficiency standards. However in a future where alternative fuels and energy carriers, such as electricity and hydrogen, play a much larger role than today, energy efficiency standards will become more important in encouraging overall resource efficiency in the transport sector by driving lower energy use.

¹⁵⁸ Energy intensity for passenger transport is expressed relative to passenger-km, energy intensity for freight transport is expressed relative to tonne-km, while the energy intensity for total transport is expressed relative to GDP.

¹⁵⁹ The price of electricity is based on the Effective and widely accepted technology scenario from the Impact Assessment on “Low-carbon economy 2050 roadmap”.

option. Biofuels¹⁶⁰ would represent around 40% of energy consumption in aviation and inland navigation and between 37% and 41% in long distance road freight by 2050, depending on the Policy Option. The role of biofuels in energy demand by passenger cars and light duty vehicles would be more limited, ranging between 15% and 25%. The amount of biofuels remains closely in line with the Effective and widely accepted technology scenario from the Impact Assessment on “Low-carbon economy 2050 roadmap. Electricity would provide some 20% of energy demand by passenger cars and light duty vehicles in Policy Option 2 and 60% in Policy Option 3, while in Policy Option 4 would represent about 50%. Electro-mobility would need to be supported by the upgrade of Europe’s networks towards a European supergrid and decarbonisation of electricity sector.

233. As a result of the increased demand for electricity and sustainable biofuels, the share of renewables in transport would increase by 2050, especially in Policy Options 3 and 4. This assumes the decarbonisation of the power generation sector and an important share of electricity based on renewable energy sources by 2050, in line with the Effective and widely accepted technology scenario from the Impact Assessment on “Low-carbon economy 2050 roadmap”^{161 162}.



Source: PRIMES-TREMOVE transport model

Figure 10: Final demand of oil and electricity in Policy Options 1, 2, 3 and 4

5.4.4. Impact on biodiversity and other environmental resources

234. The greatest impact on other environmental resources would be caused by an increase in land use for infrastructure, generating increased pressure on biodiversity and ecosystem services due to direct damage linked to construction, habitat fragmentation and degradation and disturbance. In all scenarios, constraints on the

¹⁶⁰ Ibid Footnotes 121 and 150. The Impact Assessment does not assess the impact of any possible modification in the accounting method set out in Commission Decision (2007/589/EC) for biomass.

¹⁶¹ The pathways for the decarbonisation of power generation would be analysed in the forthcoming Energy Roadmap 2050.

¹⁶² The price of electricity is based on the Effective and widely accepted technology scenario from the Impact Assessment on “Low-carbon economy 2050 roadmap”.

availability of public resources will be a limiting factor for the expansion of infrastructure and new built will probably be significant only in cohesion countries.

235. In a no additional policy scenario, the expansion of infrastructure would remain the standard response to increased congestion levels, so, in principle, this would be the least favourable option in terms of other environmental aspects. Policy Options 2, 3 and 4 tackle differently the pressure on infrastructure. Policy Option 2 relies on better land planning, on traffic reduction and on modal shift; the latter implying an expansion of rail infrastructure. Policy Option 3, would essentially manage high traffic volumes with advanced traffic management systems, but would need relatively more road infrastructure. Policy Option 4 would have intermediate characteristics.
236. It is difficult to rank the three options in terms of fragmentation of the landscape and loss of biodiversity and degradation of eco-system services. A tentative answer would be to consider that the levels of congestion in the three scenarios are representative of the pressure that transport is likely to put on the territory, which, in turn, would suggest that the most favourable scenario is the one described in Policy Option 2 followed by Policy Option 4.

5.5. Conclusions

237. The results of the previous sections give the following picture of the impacts of the various policy options relative to Policy Option 1 by 2050.

Table 12: Summary table of impacts

	<i>Policy Option 2</i>	<i>Policy Option 3</i>	<i>Policy Option 4</i>
<i>Economic impacts</i>			
Transport as a business			
Transport activity	--	=	-
Modal shift	++	=	+
Unit costs per user	---	=	--
Of transport dynamics on:			
Economic growth	++	+	+++
Efficiency of the transport system	++	+	+++
Congestion	++	=	+
Household transport costs	--	-	--
Transport-related sectors	+	+++	+++
Innovation and Research	+	+++	++
Reduction of administrative burden	+	=	+
EU budget	=	=	=
International relations	--	-	-
<i>Social impacts</i>			
Mobility of citizens			
Degree of mobility	---	=	-
Choice	++	=	++
Accessibility	++	=	++
Distributional impacts	=	-	+
Employment level and conditions	++	++	+++
Safety	++	=	+
<i>Environmental impacts</i>			
Climate change	+++	+++	+++
Air pollution	+++	++	++
Noise pollution	+++	++	+
Energy use/energy efficiency	+++	++	+++
Renewable energy use	+	+++	++
Biodiversity	+	-	=

Legend:

= baseline or equivalent to Policy Option 1

+ to +++ low to high improvement compared to Policy Option 1

- to --- low to high worsening compared to Policy Option 1

5.6. Sensitivity analysis of policy options

238. It is clear that the robustness of modelling results is affected by the assumptions underlying the modelling scenarios. As outlined in section 2.3.3, sensitivity analysis has been carried out on these assumptions concerning GDP growth and oil prices, which are used in all policy options¹⁶³.
239. Other assumptions are embedded in the design of specific policy options. A critical hypothesis is that the performance standards imposed on industry (as in Policy Option 3) are more effective than general price instruments (as in Policy Option 2) in lowering the cost of new technologies and in accelerating their deployment. This assumption is certainly questionable, but is in line with the observed acceleration in the introduction of cleaner vehicles following the adoption of CO₂ standards in the EU and with arguments pointing to the existence of market failures in systems' innovation.
240. In any event, the three policy options assume different costs and timing of technology and can therefore be interpreted as 'sensitivity analyses' of the hypotheses on R&D. Whereas the assumptions in one of the policy options would turn out to be unrealistic, the other policy options would represent a more credible alternative. For example, Policy Option 2 highlights a path for decarbonisation where barriers to the electrification of transport still persist (i.e. through range limitations for passenger cars and trucks). On the contrary, Policy Option 3 illustrates achievements under a more favourable technological development.
241. Another important assumption is the neutrality of the transfer of resources collected through pricing and taxes from the transport sector to the public budget. In other words no effect is assumed for the recycling of the revenues. The transfer is particularly high in Policy Option 2 (2.3% of GDP as opposed to around 0.3% in Policy Options 4 and negligible in Policy Option 3).
242. Whereas the full pricing of externalities and the elimination of tax distortion is very likely to improve the efficiency of the entire economic system, it is far more difficult to be conclusive on the impact of very large shifts in the burden of taxation across sectors, going beyond that point. Much would also depend on the exact use of revenues¹⁶⁴. The forthcoming Impact Assessment report on the restructuring of the Community framework for the taxation of energy products and electricity found that the additional revenue from energy taxation would have a positive impact on GDP

¹⁶³ Performing sensitivity analysis on GDP growth or oil prices for Policy Option 2, 3 and 4, while keeping the assumed intensity of the policy measures unchanged, would lead to higher or lower CO₂ emissions reductions relative to the 60% target. For example, higher GDP growth without significant structural change would lead to less than 60% reduction in CO₂ emissions, while higher oil prices would result in more than 60% reduction in CO₂ emissions. As a consequence, the results of these variants would not be comparable with those of Policy Options 2,3 and 4 (which would have different CO₂ emissions), nor with Policy Option 1 – Reference scenario (which would have different macroeconomic assumptions).

¹⁶⁴ An overview of studies by OECD shows that while employment may increase if the extra revenues from environmental market-based instruments are used for reducing taxes on labour and social security contributions, especially when aimed at unskilled labour, the employment effects are uncertain when the extra revenues are used for lump-sum payments to households or for reducing VAT (Source: OECD, 2001. Environmentally related taxes in OECD countries - issues and strategies).

and employment when used to reduce the employers' social security contributions. This is due to lower labour costs which boost employment and decrease domestic price levels thus increasing private consumption. However, the favourable impacts on GDP and employment do not materialize when tax revenues are recycled through lump-sum transfers to households or are used for fiscal consolidation¹⁶⁵. For this reason, together with modelling limitations¹⁶⁶, a neutrality assumption is used in the analysis.

6. COMPARISON OF THE OPTIONS

243. The analysis above has shown that the different levels of ambition in system improvement and technology improvement have clear implications in terms of the related socio-economic and environmental impacts.
- From an economic point of view, Policy Option 4 seems to be overall preferable. In fact, while achieving the CO₂ target at higher costs than Policy Option 3, it has lower congestion costs and the overall benefits of a less distorted pricing system.
 - Also from a social point of view, Policy Option 4 would be the most desirable. Compared to Policy Option 2, it does not affect drastically the present lifestyles and organisation of society and is therefore expected to have lower social costs of adaptation to new circumstances. Compared to Option 3, it would have the benefits of better choice, higher safety and greater accessibility.
 - From an environmental point of view, Policy Option 2 is the most ambitious option since it covers the broadest range of environmental impacts.
244. This section provides for an assessment of how the policy options will contribute to the realization of the policy objectives, as set in Section 3, in light of the following evaluation criteria:
- **effectiveness** – the extent to which options achieve the objectives of the proposal;
 - **efficiency** – the extent to which objectives can be achieved at least cost;
 - **coherence** – the extent to which policy options are likely to limit trade-offs across the economic, social, and environmental domain.

¹⁶⁵ Commission staff working document accompanying the proposal for a Council Directive Amending Directive 2003/96 restructuring the Community framework for the taxation of energy products and electricity (forthcoming).

¹⁶⁶ Modelling limitations do not allow at this stage evaluating the impact of different revenue recycling schemes quantitatively. More specifically, the current Impact Assessment report builds on models with specific focus on the transport and energy sectors. While these models enable the assessment of the detailed policy measures proposed in the policy options, they do not cover the overall economy (i.e. government sector, households) and therefore do not allow an evaluation of various recycling schemes. Other models (i.e. GEM-E3, WorldScan, Quest III) could provide an assessment of the effects of different recycling schemes but they would not be able to reflect all the policy measures considered in the policy options. Even linking the two modelling approaches would prove challenging and would require additional resources for further model development.

Effectiveness

245. The following table gives a synthetic overview of the policy options' effectiveness with regard to the specific policy objectives defined in section 3. From this table, it appears that Policy Option 2 scores best on effectiveness. It offers indeed the most appropriate pallet of actions to meet the defined objectives.
246. As regards the resource efficiency objective (CO₂ target and oil dependency), since all three Policy Options have been designed to reach the 60% target, they are all effective. However, it must be noted at this stage that Policy Option 3 is highly dependent on the successful uptake on large scale of alternative fuels. Significant challenges remain in the area of electrical energy storage (i.e. in terms of cost, weight, volume, etc.), while alternative vehicles are likely to remain more expensive than the existing conventional ones despite their potential lower operation costs¹⁶⁷. In addition, the potential GHG emissions reduction from the use of biofuels depends on the feedstock and their production methods. The use of biofuels in transport may also be constrained by total limits to land availability and by competing demand for biomass or for land and water from other sectors. Finally, ensuring that biofuels deliver GHG emissions reductions over the lifecycle of the fuel (taking into account the effect of direct and indirect land use changes) remains a challenge.¹⁶⁸
247. Therefore, in case the uptake of new technology on a large scale does not occur as expected and ambitious policies favouring modal shift are not in place, the only way to achieve the 60% target will be to constrain mobility leading to disproportionately high negative social impacts. Policy Option 2 is the option which is the least exposed to technology risk, and hence can be considered more reliable in achieving the GHG emission target.
248. As regards the objective linked to the limitation of the growth of congestion, Policy Option 2 offers the best possibilities thanks to its strong focus on policy measures covering demand management and system improvement. In Policy Option 3, which has a strong technology focus, congestion still represents a high cost to the society whereas Policy option 4 scores better than Policy Option 3.

¹⁶⁷ When assessing the barriers for the electrification of transport in the context of the Strategic Energy Technology Plan, the Joint Research Centre found that low-energy density of available batteries, which limits the range of driving between charges, remains the main challenge. For example, lead-acid batteries are cheap (ca. €100 per kWh) but they are too heavy due to the low energy and power density and they also lack deep cycling capabilities. Other battery technologies can double the vehicle's driving autonomy but they are still too expensive (NiMh or Li-Ion, ca. 500 – 1500 €/kWh). In addition, other social and infrastructural barriers may delay the widespread use of plug-in hybrids and electric vehicles: the lack of standardised electric infrastructures, the high cost of vehicles and their batteries (including warranty), the unrealistically short times (< 5 months) expected by consumers to recover their investment in electric vehicles, the inertia of the current transportation system and the major market players, the perceived high infrastructural investment costs, etc. See in this respect JRC(2009), Technology Descriptions of the 2009 Update of the Technology Map for the SET Plan.

¹⁶⁸ Skinner I, van Essen H, Smokers R and Hill N (2010), Towards the decarbonisation of EU's transport sector by 2050. Final report produced under the contract ENV.C.3/SER/2008/0053 between European Commission Directorate-General Environment and AEA Technology (<http://www.eutransportghg2050.eu>)

Table 13: Effectiveness of envisaged policy options in light of objectives

	<i>Policy option 1</i>	<i>Policy option 2</i>	<i>Policy option 3</i>	<i>Policy option 4</i>
<i>GHG emissions and oil dependency reduction compared to 1990 levels</i>	0	high	high	high
<i>Limit the growth of congestion</i>	0	high	low	medium
<i>Associated technology risk</i>	0	Low reliance on large scale deployment of electric propulsion in transport	Extensive reliance on large scale deployment of electric propulsion in transport	Moderate reliance on the deployment of electric propulsion in transport

Efficiency

249. In terms of efficiency, the model provides an indication of the total costs of transport of each Policy Option. These costs include: capital costs related to transport equipment, infrastructure costs for the charging and refuelling of electric propulsion vehicles¹⁶⁹, fixed operation costs, variable operation costs (including fuel costs), users' disutility¹⁷⁰, and external costs of congestion, air pollution, noise and accidents¹⁷¹. So defined, the concept of total cost covers the costs for the society of each Policy Option and, as such, measures the extent to which objectives can be achieved at least cost for the society.
250. The modelling results indicate that, compared to Policy Option 1, the total costs of transport so defined would be the highest in Policy Option 2, adding an additional 1,193 billion € by 2050. Policy Option 4 follows adding 1,012 billion € and Policy Option 3 about 640 billion €.

¹⁶⁹ The investment required for developing the electric road transport infrastructure is estimated at roughly 140 billion € in Policy Option 3, followed by Policy Option 4 with about 120 billion and Policy Option 2 with about 80 billion. These costs cover the recharging infrastructure for cars, trucks, coaches and the reinforcement of the Low voltage (LV) and Medium voltage (MV) power grid. Some industry studies suggest that the costs of development of a network for refuelling hydrogen fuel cell vehicles would be roughly comparable (Cf. McKinsey (2010), A portfolio of power-trains for Europe: a fact-based analysis; available at: http://www.iphe.net/docs/Resources/Power_trains_for_Europe.pdf). The present value of the electric road transport infrastructure costs is derived using a discount rate of 4%.

¹⁷⁰ The welfare losses due to the limitation in mobility (users' disutility) are reflected through the compensating variation. Compensating variation refers to the amount of additional money an agent would need to reach its initial utility after a change in prices, or a change in product quality.

¹⁷¹ The present value of the additional costs corresponding to each Policy Option has been calculated using a discount rate of 4%, in line with the requirement laid down in the 2009 Impact Assessment Guidelines.

Table 14: Total cost of Policy Options 2, 3 and 4 relative to Policy Option 1

<i>Policy options</i>	<i>Policy Option 2</i>	<i>Policy Option 3</i>	<i>Policy Option 4</i>
<i>Additional total costs relative to Policy Option 1 (in billions €)</i>	1,193	640	1,012
<i>Additional average yearly total costs relative to Policy Option 1 (in % of GDP)</i>	0.4%	0.2%	0.3%

Source: PRIMES-TREMOVE transport model

251. An element which is common to all Policy Options is the considerable amount of savings in fuel costs, which amounts between 300 and 330 bn € in 2050 relative to Policy Option 1.
252. Another way of looking at the net additional costs of Policy Options 2, 3 and 4 with respect to Policy Option 1 is by singling out from the total cost the gains from the reduction in the external costs and expressing the two elements thus obtained in terms of €/ton of CO₂. The two components would therefore represent the “mitigation costs”¹⁷² of achieving the CO₂ target (i.e. the cost of each Policy Option per tonne of CO₂ avoided) and the “co-benefits” (i.e. the benefit of each Policy Option per tonne of CO₂ avoided)¹⁷³. They are summarised in Table 15^{174, 175, 176}.

¹⁷² The overall mitigation costs as presented here are a measure of total cost not directly comparable with the marginal abatement cost as derived in the Impact Assessment of the “Low-carbon economy 2050 roadmap”, which evolves in time. Having said this, the 60% target for the reduction of transport GHG emissions was derived with the PRIMES model based on the constraint of equal marginal abatement costs across sectors. The Policy Options in this impact assessment were developed as alternative ways of meeting this 60%.

¹⁷³ Policies aiming at reducing CO₂ emissions, like taxation, can also bring benefits such as the reduction of congestion.

¹⁷⁴ Co-benefits are defined as the difference between the present value of the external costs in each Policy Option and those in Policy Option 1, divided by the difference in the cumulative well-to-wheel emissions in each Policy Option relative to Policy Option 1. A discount rate of 4% has been used for the calculation of the present value.

¹⁷⁵ Mitigation costs are defined as the difference between the present value of transport costs excluding external costs in each Policy Option and those of Policy Option 1, divided by the difference between the cumulative well-to-wheel emissions in each Policy Option and those in Policy Option 1. The costs also cover the electric road transport infrastructure. A discount rate of 4% has been used for the calculation of the present value.

¹⁷⁶ As already explained, the Reference scenario does not cover the European Commission CARS 21 (Competitive Automotive Regulatory System for the 21st century) initiative and the recent initiatives of car manufacturers as regards electric vehicles. These initiatives may lead to higher penetration of EVs, which is currently negligible in the Reference scenario, and lower oil dependency and CO₂ emissions for the transport sector. As a consequence of lower CO₂ emissions in the Reference scenario, the mitigation costs and net costs may be lower for the Policy Options considered. However, their relative order of importance will remain the same.

Table 15: Mitigation cost and co-benefit of envisaged Policy Options

<i>Policy options</i>	<i>Policy Option 2</i>	<i>Policy Option 3</i>	<i>Policy Option 4</i>
Mitigation cost (€/ton CO₂)	172	76	116
Co-benefit (€/ton CO₂)	83	21	35
Net cost (€/ton CO₂)	89	55	81

Source: PRIMES-TREMOVE transport model

253. The calculation of net total costs – and therefore the comparison between options – does not include research and development costs and infrastructure costs referred to the upgrade and possible extension of the network. Moreover, they exclude transfer payments to the budget (i.e. excise duties, value added taxes, registration taxes and other ownership taxes, charges, payments for CO₂ allowances in aviation under the EU Emission Trading Scheme, etc.), which are additional costs for the user, but a transfer from the point of view of society.
254. The reasons for not taken into account R&D costs and network costs in comparing options in terms of efficiency are the following:
- There is a weak link between investment in research and development and technology outcomes, which does not allow for an easy quantification of total costs associated with the different Policy Options. However this aspect is addressed in discussing the risks associated with relying on more favourable technological developments.
 - The network infrastructure requirements – and thus the related costs – are assumed to be the same in Policy Option 2 and 4 and geared toward a greater use of multimodal solutions. Accordingly, they do not affect the choice between these two options. Infrastructure costs would however be lower in Policy Option 3 if, as assumed, road congestion is not accommodated by significant additional investment in the road network.
255. An estimation of network infrastructure costs will be established by the Commission as part of the revision of the TEN-T guidelines and therefore only a rough estimate can be offered at this stage. Investment in the network designed to serve the transport system up to 2050 would need to be put in place much earlier. The cost of EU infrastructure development to match the demand for transport has been estimated at over € 1.5 trillion for 2010-2030. The completion of the TEN-T network requires about € 550 billion until 2020 out of which some € 215 billion can be referred to the removal of the main bottlenecks¹⁷⁷.

¹⁷⁷ The assessment of the feasibility for each Member State to afford additional infrastructure investment in view of current fiscal constraints is outside the scope of the present Impact Assessment report.

Coherence

256. As highlighted in Table 12 above, Policy Option 4 ensures the achievement of the objectives with lowest trade-offs across the economic, social, and environmental domain.

Conclusion

257. In general terms, the modelling exercise shows that several policy instruments need to be used to put the transport system on a sustainable path, lowering CO₂ emissions, oil dependency and congestion. It also shows that policy action has to be very ambitious to reach the objective.
258. The table below summarizes the results of the comparison of policy options in terms of effectiveness, efficiency and coherence.

Table 16: Comparison of Policy Options

	<i>Effectiveness</i>	<i>Efficiency</i>	<i>Coherence</i>
<i>Policy Option 1</i>	no	no	no
<i>Policy Option 2</i>	high	low	medium
<i>Policy Option3</i>	low	high	low
<i>Policy Option 4</i>	medium	medium	high

259. In light of the above, Policy Option 3 is discarded, despite being the less expensive and most powerful option to reach the 60% target. This is because it incorporates a high degree of uncertainty associated with the technological component. It also contemplates delayed or weak action on pricing, which would compromise the possibility of bringing about the structural change that undistorted price signals can determine. Finally, it is not sufficiently effective in reducing the cost of congestion to the society in comparison with Policy Options 2 and 4.
260. Modelling results do not point to huge differences between Policy Option 2 and Policy Option 4, and indeed the two options have many elements in common, as the elimination of obstacles to the internal market and the investment in a multimodal network. The preference is given to Policy Option 4 since it offers the advantage of greater balance between system improvement and technological development. Policy Option 4 would avoid the creation of a specific carbon price for the transport sector or, else, of a pervasive command and control approach to mobility, but it would not refrain from eliminating price distortions by internalising external cost of transport and by introducing smarter taxation. Factoring in all these elements, Policy Option 4 appears to offer the highest benefits at the lowest cost with moderate technology risk, and more balanced solution to the trade-offs across the economic, social, and environmental domains
261. However, Policy Option 2 is not formally discarded. Indeed, as said above, all Policy Options include a technology component that is low in Policy Option 2, moderate in Policy Option 4 and high in Policy Option 3 (see Table 3). In this respect, if the

technology does not deliver as it is projected in Policy Option 4, an approach closer to that in Policy Option 2 will be necessary in order to achieve the 60% target by 2050.

262. In this context, a proper monitoring and evaluation of the implementation of the White Paper is a key element.

7. MONITORING AND EVALUATION

263. The Commission will properly evaluate and review the White Paper on transport policy 5 years after its adoption by the Commission. The policy design and its implementation will be in any case continuously fine-tuned on the basis of individual impact assessments as mentioned above.
264. In addition, the Commission will constantly monitor a set of core transport indicators which are already available. These indicators will be used to measure to what extent Policy Option 4 under the comprehensive and strategically coordinated EU action is properly implemented and its objectives achieved. This set of core indicators will be updated to trace the development and deployment of new transport technologies.
265. These indicators are:

Table 17: Monitoring indicators

<i>Key indicators</i>	<i>Definition</i>	<i>Relevance</i>
<i>Monitoring the environmental performance of transport</i>		
<i>Share of renewable energy in transport</i>	This indicator is the share of energy from renewable sources in gross final energy consumption for transport	This indicator monitors the progress achieved in reducing oil dependency of transport
<i>GHG emissions from transport</i>	Each greenhouse gas (CO ₂ , methane, and nitrous oxide) is weighted by its global warming potential and aggregated to give total greenhouse gas emissions expressed in terms of CO ₂ equivalents.	This indicator shows trends in the greenhouse gas emissions from transport by mode of transport.
<i>Emissions of particulate matter from transport</i>	This indicator is defined as the aggregated particulate-forming potential of emissions of particulate matter (PM10), nitrogen oxides, sulphur dioxide and ammonia from transport.	This indicator shows trends in emissions of PM10 from transport.
<i>Fragmentation due to transport infrastructure</i>	This indicator is calculated on basis of the mesh size of unfragmented areas, related to the construction of new or improved transport infrastructure	Indicator shows the state of fragmentation of land and ecosystems due to transport infrastructure
<i>Average CO₂ emissions per km from new passenger cars</i>	This indicator is defined as the average emissions of carbon dioxide per kilometre by new passenger cars sold in a given year.	This indicator measures the CO ₂ efficiency of new fleet
<i>R&D intensity in transport</i>	This indicator is defined as business expenditure in R&D in transport (manufacturing) as % of value added in the transport sector	This indicator measures R&D intensity in transport

Monitoring the overall efficiency of EU transport system

Modal split of passenger transport	This indicator is defined as the percentage share of each mode of transport in total inland transport, expressed in passenger-kilometres. It is based on transport by passenger cars, buses and coaches, and trains.	This indicator monitors the achievement of a balanced shift towards environmentally friendly transport modes for passengers
Modal split of freight transport	This indicator is defined as the percentage share of each mode of transport in total inland transport expressed in tonne-kilometres. It includes transport by road, rail and inland waterways.	This indicator monitors the achievement of a balanced shift towards environmentally friendly transport modes for freight
Investment in transport infrastructure to GDP	This indicator is the ratio between total gross investment expenditure and GDP. Infrastructure expenditures cover new construction, extension, reconstruction and major repairs of selected EU-27 Member States for transport infrastructure for road, rail, air transport, sea ports and inland waterways.	Investments are one way in which the objective creating a single transport area can be realised
Road safety	This indicator is defined as the fatalities caused by road accidents include drivers and passengers of motorised vehicles and pedal cycles as well as pedestrians, killed within 30 days from the day of the accident	This indicator monitors the trend in road safety

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9. ANNEXES

Appendix 1: Assessment of the application of the minimum consultation standards

– Clear content of the consultation process

1. The objectives of the White Paper and the principles for its design were clearly described on the public consultation websites. The public hearings and the public consultations have been publicised to relevant stakeholders as well as widely through press releases¹⁷⁸. The Commission services have made clear how comments received would be dealt with and how the process would proceed.

– Consultation of target groups

2. Given that the White Paper will affect a broad range of stakeholders, namely EU Member States, citizens and companies, the consultation has been open to the general public. Representatives of a wide range of stakeholders were invited to both conferences¹⁷⁹.

– Publication

3. The preparation of the White Paper was announced in an earlier Communication. Interested parties were aware that there was to be consultation on the issues to be addressed in line with the better regulation principles. Special websites were created for the public consultations and the public hearings.

– Time limits for participation

4. The Commission provided stakeholders with a month or more notice of the public hearings. It has given 8 and 15 full weeks for the submissions of written comments to the public consultations. Stakeholders have been given adequate time to provide written comments to the public consultations, as well as to make a statement in the public hearings. Overall, the Commission has been in an ongoing dialogue with stakeholders and met with all interested stakeholders requesting to do so. All stakeholders should therefore have been able to express their views on the main challenges for the EU transport policy, the key objectives for the transport system and how to meet them.

– Acknowledgement and feedback

¹⁷⁸ <http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/936>
<http://europa.eu/rapid/pressReleasesAction.do?reference=IP/09/365>

¹⁷⁹ The lists of participants is available at the following websites: http://ec.europa.eu/transport/strategies/events/doc/2009_03_09_future_of_transport/2009_03_09_participants.pdf;
http://ec.europa.eu/transport/strategies/events/doc/2009_11_20_future_of_transport/participants_list.pdf

5. Responses from stakeholders following the public consultations and stakeholder meetings have been acknowledged and the stakeholders' responses are publicly available¹⁸⁰.
 6. According to the privacy statement, no individual's contribution can be posted therein without their consent. The Commission has not responded to the points raised in individual responses given the wide range of issues raised, it was however able to identify the main issues.
- Main results and how these have been taken into account
7. The Commission has analysed the comments made, and the results of the consultation are available on the Commission website¹⁸¹.
 8. Input from stakeholders has been taken into account in assessing the different possible actions to improve the sustainability of the EU transportation system. External expertise was used to assess the various options available, including aspects raised during the public consultation.

¹⁸⁰ http://ec.europa.eu/transport/strategies/consultations/2009_03_27_future_of_transport_en.htm;

¹⁸¹ http://ec.europa.eu/transport/strategies/consultations/2009_09_30_future_of_transport_en.htm
http://ec.europa.eu/transport/strategies/events/doc/2009_11_20_future_of_transport/summary_of_the_contributions.pdf.

Appendix 2: Ex-Post Evaluation of Transport Policy 2001-2010¹⁸²

1. This appendix puts the White Paper into its historical context and assesses to what extent previous political objectives – in particular those of the 2001 White Paper¹⁸³ and its mid-term review of 2006¹⁸⁴ – have been achieved. The assessment looks at the state of the European transport sector at the beginning of the 21st century and compares it with today's situation. It concentrates mainly on the measurable objectives and is partly based on the findings of an external study of 2009 that evaluated the Common Transport Policy between 2000 and 2008¹⁸⁵.

1. MANAGING TRANSPORT GROWTH IN A MORE SUSTAINABLE WAY

2. Transport demand has shown strong growth rates in the 1990s. Rapidly rising traffic volumes resulted in high levels of congestion, noise and air pollution which were considered to be unsustainable. One of the main objectives of the 2001 White Paper was therefore to decouple transport growth from GDP growth and hence to limit the growth in transport demand. As transport growth in the 1990s had been uneven – mainly benefiting road and air, while largely neglecting cleaner and less congested modes of transport such as rail and inland waterways, another main objective in 2001 was rebalancing the modal distribution of transport, away from congested roads and airports towards other, less congested and often also more environmentally friendly modes.

1.1. Decoupling transport growth from GDP growth

3. Decoupling transport growth from growth in GDP, hence reducing the transport intensity of the European economy, was one of the core objectives of the 2001 White Paper. It was also an objective of the Sustainable Development Strategy which the European Council had adopted in June 2001 in Gothenburg.
4. This objective should be seen in the context¹⁸⁶ of the 2001 White Paper: Between 1970 and 1998, the European economy was characterised by increasing transport intensity: both passenger and freight transport had grown faster than GDP. Moreover, following the adoption of the Lisbon Strategy in March 2000, an enhanced GDP growth rate of about 3% was expected for the decade 2000-2010. Even higher GDP growth rates (4-5% per annum) were predicted for the then candidate countries of Central and Eastern Europe. An increase in transport demand that would outpace GDP growth was thought not to be sustainable. Apart from the negative environmental impact, it would have led to even more congestion which could have paralysed the transport system, in particular on roads and in aviation which showed signs of capacity shortages. The overall objective was to break the link between transport growth and GDP growth, which was to be achieved through the implementation of the measures announced in the White Paper, without the need to restrict the mobility of people and goods.

¹⁸² This ex-post evaluation is based on data up to 2008; where available, more recent data have been used.
¹⁸³ COM(2001)370.

¹⁸⁴ COM(2006)314.

¹⁸⁵ The study can be downloaded from the internet under http://ec.europa.eu/transport/strategies/studies/doc/future_of_transport/20090908_common_transport_policy_final_report.pdf

¹⁸⁶ As described, for example, in Section 3 of Chapter II of SEC(2001)502.

5. Essentially, this meant eliminating ‘unnecessary’ transport activities – activities that do not add any economic value or which are the result of regulatory failures. One regulatory failure was seen in the fact that transport users did not pay the full price of the external costs which their activities produce. The full internalisation of the external costs of transport was believed to be an effective instrument to decouple transport growth and GDP growth. As long as external costs were not fully borne by transport users, the demand for transport was bound to be artificially high. Appropriate pricing and infrastructure policies that applied the “user pays” principle and the “polluter pays” principle would largely remove these inefficiencies over time.
6. As part of the greening transport package of 2008, the Commission presented a strategy for the internalisation of external costs¹⁸⁷ for all modes of transport. It proposed a revision of the Eurovignette Directive¹⁸⁸ which was to allow the charging of heavy goods vehicles for external costs of air pollution, noise and congestion, also beyond the amount needed to recover infrastructure costs, which – as a rule – was the limit set by the Directive at the time. The revision of the Directive is still being debated in the Council and the European Parliament. In rail transport, infrastructure charges may be modified to take environmental costs into account. As long as there is no comparable level of charging of environmental costs in competing modes, however, such charging shall be revenue-neutral for the rail infrastructure manager¹⁸⁹. The costs of climate change shall be internalised by identifying a carbon component in fuel taxes and/or by direct or indirect participation in the European emission trading scheme (ETS). Aviation will be included in the ETS from 2012 onwards¹⁹⁰, electrified rail traffic is indirectly included in the ETS through the power generating sector.
7. The policy of internalising all external costs is still far from being fully implemented. Consequently, it has so far not contributed much to the decoupling of transport and GDP growth.
8. Another example of regulatory failures that produce more transport than necessary would be the different fuel taxation levels in the Member States which give rise to the phenomenon of ‘tank tourism’. Attempts to harmonise fuel taxes across the EU have so far failed, however. Traffic generated by a lack of efficient intermodal connections or state-of-the-art transport information and guidance systems (e.g. to help drivers looking for a place to park their vehicles) may also be considered to be ‘unnecessary’. If this kind of traffic could be eliminated, some congestion could be eased.
9. Even if all proposed measures had been fully implemented, it is however questionable whether significant progress in decoupling *freight* transport from economic growth could have been achieved. Freight transport is largely a commercial business in which ‘unnecessary’ transport activities are already limited. Moreover, logistics practices like ‘just-in-time’ delivery and growing specialisation

¹⁸⁷ COM(2008)435.

¹⁸⁸ COM(2008)436.

¹⁸⁹ Cf. Art. 7(5) of Directive 2001/14/EC.

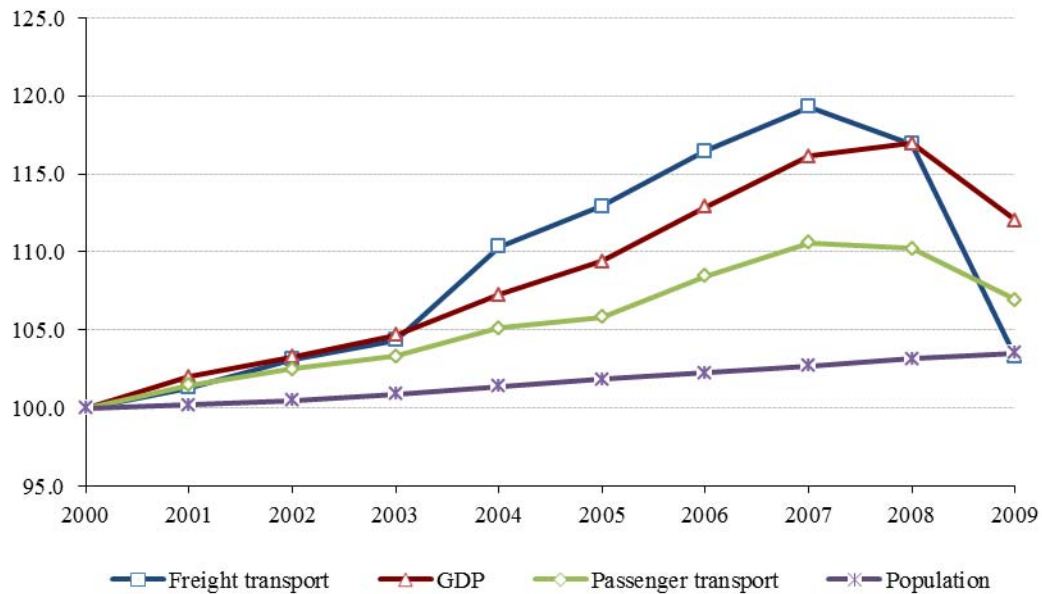
¹⁹⁰ Directive 2008/101/EC.

patterns dominate in modern industries. While improving the efficiency of European industry, they tend to increase the transport intensity of the economy.

10. External trade also has a direct impact on freight transport volumes. While in years of economic growth trade usually grows by more than GDP, it falls more steeply than GDP during recessions. As trade and freight transport are two sides of the same coin, this rule also applies to freight transport, which can be seen when looking at EU freight transport activity over the last decade.
11. Between 2000 and 2007, intra-EU freight transport grew on average by 2.6% per year while GDP has gone up by 2.2%. International transport has grown faster than domestic transport. In the boom years, freight transport activity was boosted by deeper market integration inside the EU (following the introduction of the single currency and EU enlargement) and outside the EU (through the rise of emerging economies such as China and the general globalisation of production patterns). It should not be forgotten in this context that deeper market integration and the promotion of international trade are crucial ingredients for balanced economic growth and economic, social and territorial cohesion. These are key policy objectives of the EU.¹⁹¹
12. In 2008, when the recent economic crisis set in, intra-EU freight transport demand fell by 2.1% while GDP was still growing by 0.7%. Preliminary figures for 2009 show an even greater gap between GDP growth (which dropped by 4.2%) and the demand for intra-EU freight transport which in terms of tonne-kilometres is estimated to have collapsed by around 11%, wiping out almost all growth in freight transport since 2000. While intra-EU freight transport activity is nearly back to 2000 levels, GDP in the EU27 is still 12% higher than it was in 2000. Seen over the whole period 2000-2009, therefore, freight transport appears at first sight to have decoupled from GDP growth. This decoupling effect is however largely due to the economic crisis and likely to be of a temporary nature.
13. Intra-EU passenger transport has grown by less than GDP each year since 2000 (apart from 2009 when it didn't fall as dramatically as GDP). It increased on average by 1.4% per year between 2000 and 2007. In 2008, there was a slight decline in intra-EU passenger transport activity (-0.1%) followed by a somewhat stronger drop in 2009 (around -1%). This reduces the average annual growth rate to merely 1% between 2000 and 2009. It confirms the trend that motorised passenger transport activity in the EU has decoupled from GDP growth, despite an increase in the average mobility per person by more than 5% between 2000 and 2009¹⁹². The mobility of people was boosted by the liberalisation of air traffic within the EU, by the construction of high-speed rail lines in a number of countries and by the general increase in motorisation levels, above all in the countries which joined the EU in 2004 and 2007. These developments allowed EU citizens to travel faster and further afield in a given time. EU policies have hence contributed to an increase in the mobility of its citizens, the objective of decoupling transport and GDP growth notwithstanding. The link between personal mobility and economic activity is not as strong as that between freight transport and GDP.

¹⁹¹ See Art. 3 (3) TFEU.

¹⁹² As measured by the average amount of passenger-kilometres covered per inhabitant in the EU.



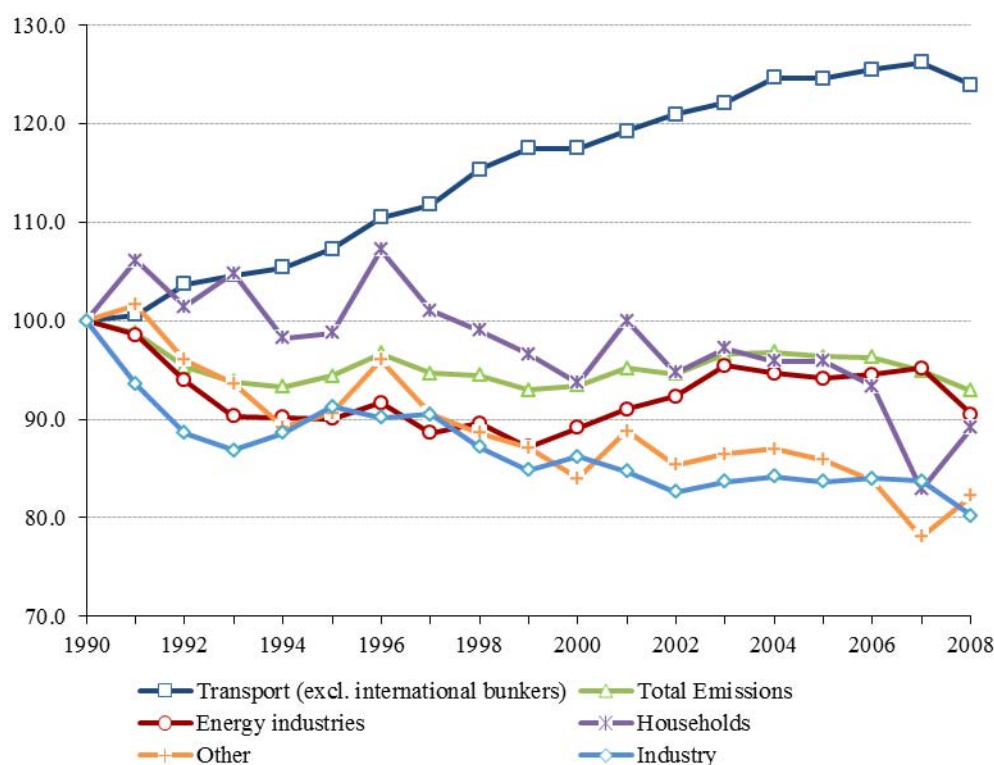
Source: Eurostat, DG MOVE

Figure 1: Evolution of GDP, population, passenger and freight transport in the EU27 between 2000 and 2009 (2000=100)

14. Over time, it had become clear that the objective of decoupling, as it was, needed to be refined. While the renewed EU Sustainable Development Strategy of 2006¹⁹³ kept the operational objective of “decoupling economic growth and the demand for transport with the aim of reducing environmental impacts”, the 2006 mid-term review of the White Paper modified the original target into one of decoupling the growth of transport from its negative effects such as congestion, accidents and the emission of pollutants, CO₂ and noise.
15. In view of this revised objective, the outcome has so far been mixed – at least as far as gaseous emissions from transport are concerned. CO₂ emissions from transport have been steadily growing over the last 20 years. Only in 2008 (and presumably 2009) was there a drop in CO₂ emissions from transport, but this was combined with a drop in transport activity, so there was no decoupling. New vehicles have become more fuel efficient and hence emit less CO₂ per km than earlier models did in the past, but these efficiency gains have been more than compensated for by rising vehicle numbers and increasing traffic volumes. It remains to be seen to what extent recently adopted measures to further improve the energy efficiency of passenger cars¹⁹⁴, to use more renewable fuels or to include aviation in the EU ETS will help in the future, given the expected rise in traffic volumes.

¹⁹³ Council document number 10917/06.

¹⁹⁴ Regulation (EC) No 443/2009.



Source: Eurostat, European Environment Agency.

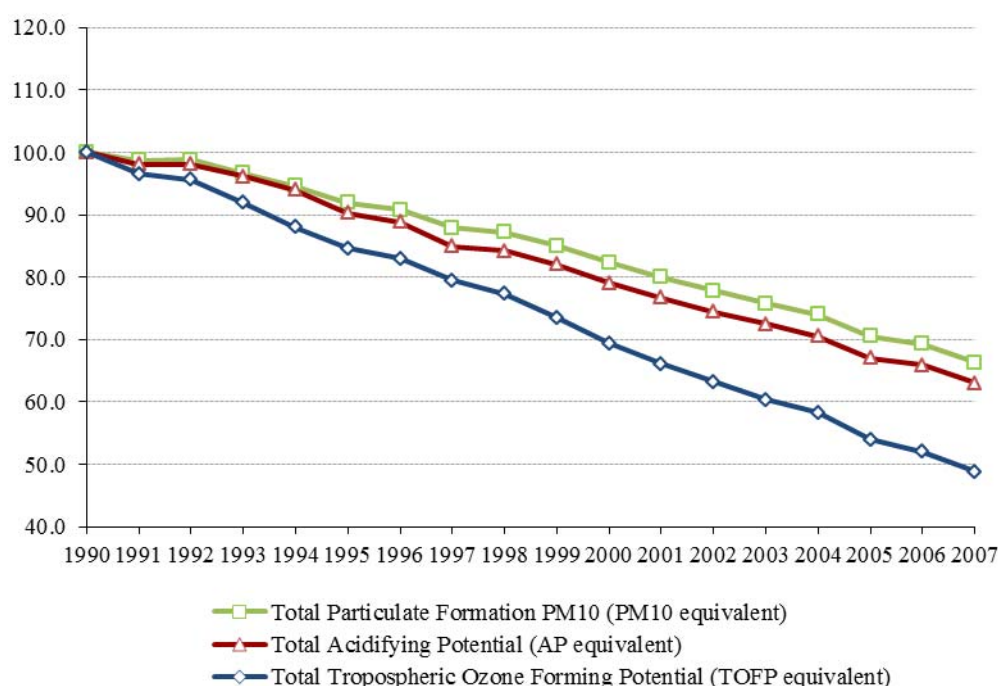
Figure 2: Evolution of CO₂ emissions by sector in the EU27 between 1990 and 2008 (1990=100)

16. The failure to reduce CO₂ emissions from transport is also linked to difficulties to switch to cleaner fuels. The high energy density of liquid hydrocarbon fuels represents a crucial advantage in all mobile applications and an essential requirement for those that are most sensitive to additional weight, namely aircraft.
17. Gasoline and diesel vehicles make up 97% of all road transport vehicles in the EU. In countries with a developed refuelling infrastructure, vehicles running on alternative fuels could make some inroads. In Italy, for example, more than 670,000 vehicles run on compressed natural gas (CNG), around three quarters of the EU total. Italy has 725 public refuelling stations for CNG which is around a quarter of the EU total.¹⁹⁵ As regards vehicles running on liquefied petroleum gas (LPG), Poland provides a similar picture: According to the European LPG Association, it has more than 2 million LPG cars, 40% of the EU total. A quarter of the roughly 25,000 LPG refuelling stations in the EU are in Poland. Between 2003 and 2008, the number of LPG vehicles has grown fastest in countries where the network of public refuelling stations has seen the biggest expansion. An almost nine-fold increase in the number of refuelling stations in Germany, for example, was met by a more than twenty-fold increase in the number of LPG vehicles. This proves the more general point that an adequate distribution network is essential for the promotion of alternative fuels.
18. Maritime and aviation continue to rely almost entirely on fossil fuels (in particular fuel oil and kerosene). There have however been first successful tests of blending

¹⁹⁵ Figures provided by NGVA Europe.

some algae-based biofuel into jet fuel. In short-distance waterborne transport, the use of liquefied natural gas (LNG) has also been tested. In rail some further electrification has taken place in the last decade, especially with the construction of new high-speed rail lines across Western Europe.

19. In contrast to the evolution of CO₂ emissions, the emissions of air pollutants from transport vehicles were reduced significantly despite rising traffic volumes: transport-related emissions of particulate matter (PM₁₀) and of acidifying substances have decreased by about one third between 1990 and 2006, those of ozone-forming substances have even halved. Emission reduction has been more successful in road transport than in other modes of transport. This success is mainly due to ever more stringent Euro emission standards for road vehicles. It should be noted, however, that road still accounts for the lion's share (more than two thirds) of total pollutant emissions from transport.



Source: Eurostat, European Environment Agency

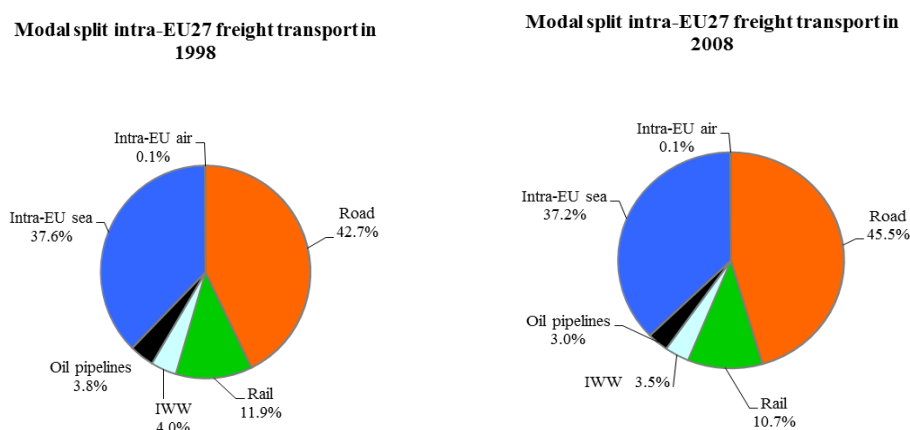
Figure 3: Evolution of pollutant emissions from transport between 1990 and 2007 (1990=100)

20. Even if the total amount of pollutants and particulates has been significantly reduced, their concentration in many urban areas is still often beyond what is considered to be healthy¹⁹⁶. More needs therefore to be done to reduce the emission of these harmful substances, most of which come from transport. A lack of co-ordination across the EU regarding local measures to achieve compliance with EU air quality targets has induced a patchwork of measures and restrictions.

¹⁹⁶ i.e. beyond the limit values of Directive 2008/50/EC.

1.2. Shifting the balance between modes of transport

21. The strong increase in road transport activity during the 1990s had led to high levels of congestion and air and noise pollution which were costing the European economy dearly¹⁹⁷ and which could not be sustained in the long run. Something had to be done to contain the increasing share of road transport. The 2001 White Paper therefore included a series of measures which were to allow the non-road modes to return by 2010 to their market shares of 1998 and prepare the ground for a shift in the modal balance from then on. Shifting the balance between the modes of transport had become one of the main objectives of the White Paper. This was to be achieved by regulating the competition between the modes (creating a level playing field between them) and by promoting intermodal transport.
22. The objective of bringing the modal share of road by 2010 back to where it was in 1998 has not been achieved. In fact, the share of road haulage in total intra-EU freight transport increased from close to 43% in 1998 to almost 46% in 2008. This was partly due to the quick expansion of road transport in the new Member States and their more limited overall access to sea transport.



Source: Eurostat, DG MOVE.

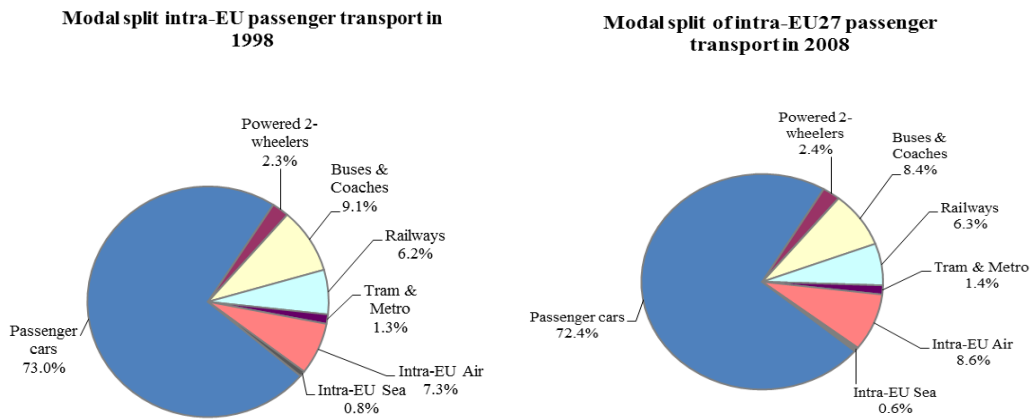
Figure 4: Modal split in intra-EU27 freight transport in 1998 and in 2008

23. In passenger transport, the private car is still by far the most dominant mode of transport. It accounts for almost three quarters (more than 72%) of all motorised intra-EU passenger transport. Compared with 1998, however, its share has gone down by almost 1 percentage point. This is mainly due to intra-EU aviation, which has grown by more than a third (+37%) between 1998 and 2008. The passenger car is however as popular as ever in the EU: The motorisation level has continued to increase¹⁹⁸, mainly boosted by developments in the 12 new Member States where it has grown by almost 60% since 1998¹⁹⁹. Except for 2009, more than 4 million cars have been added to the vehicle stock in the EU every year since 2005.

¹⁹⁷ Congestion alone was estimated to cost the equivalent of around 1% of GDP.

¹⁹⁸ From 396 to 470 cars per 1,000 inhabitants in the EU27 in 1998 and 2008, respectively.

¹⁹⁹ At 352 passenger cars per 1,000 inhabitants, it is however still only at 70% of the level in the EU15.



Source: Eurostat, DG MOVE.

Figure 5: Modal split in intra-EU27 passenger transport in 1998 and in 2008

1.2.1. Improving quality in the road sector

24. In road transport, price de-regulation and free access to the international haulage market considerably increased efficiency in the 1990s. Shippers enjoyed cheaper and more flexible services, which triggered an expansion of road transport activity to the detriment of other modes. The opening of the road cabotage market²⁰⁰, albeit only on a temporary basis, contributed to the reduction of empty returns from international deliveries. The rules had however been rather unclear which made it difficult to enforce them. They have recently been somewhat clarified²⁰¹ but still do not allow a completely free movement of heavy goods vehicles within the EU despite the advantages which this would bring to the European economy.
25. For some time, the European road haulage sector has been characterised by intense competition. At times, this has led to practices which put safety at risk and which distorted competition between modes. In 2001, social rules on driving time and working time were deemed to be insufficient and, moreover, they were not properly enforced. The 2001 White Paper therefore proposed a number of measures which would both improve the working conditions of drivers and also create a level playing field between the modes²⁰².

1.2.2. Revitalising the railways

26. At the start of the 21st century, all transport modes but the railways were liberalised in the EU. The absence of any competitive pressure on rail operators was believed to be one of the main reasons why the railways had become relatively uncompetitive and lost significant market shares during the 1990s. The three railway packages adopted in 2001, 2004 and 2007²⁰³ included the most important initiatives at EU level through which the sector was to be revitalised. This was to be achieved

²⁰⁰ Through Council Regulation (EEC) No 3118/93; "Cabotage" is the transport of goods within one Member State by a haulier from another Member State.

²⁰¹ See Art. 8 ff of Regulation (EC) 1072/2009.

²⁰² See section 3.3 below.

²⁰³ For more information on the three packages see http://ec.europa.eu/transport/rail/index_en.htm

essentially by opening up the rail market in the EU, by introducing common safety rules and standards and by improving the interoperability of national railway networks. As a result, both national and international rail freight services were opened up to competition in 2007 and international passenger services were liberalised in early 2010. Safety rules have been strengthened, the European Railway Agency has been created and the removal of technical barriers hindering the development of rail transport has started. The development and deployment of ERTMS offers a common rail traffic management system that can significantly improve the performance of cross-border rail connections.

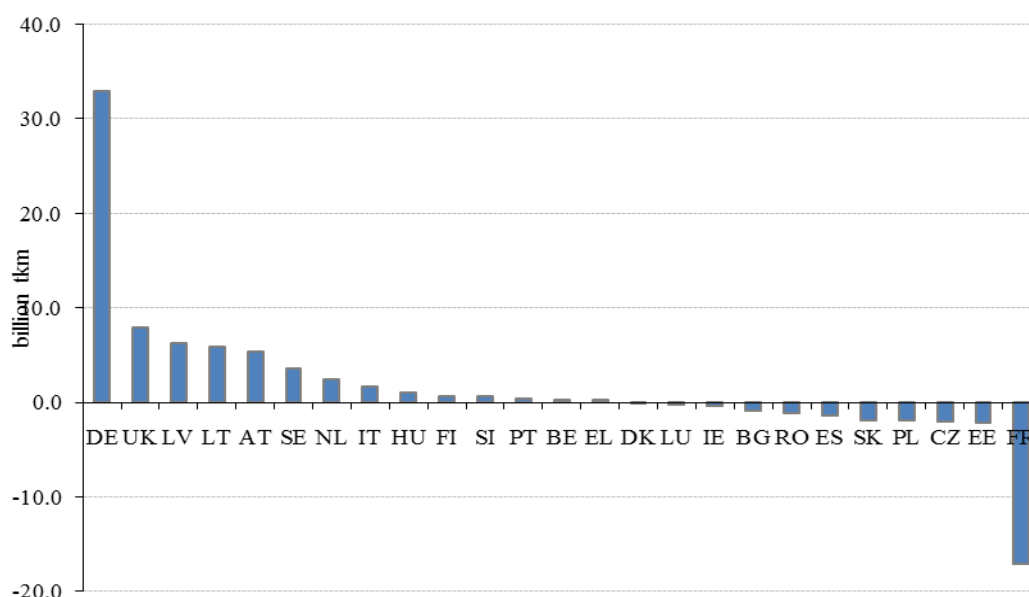
27. In addition, the EU promoted the construction of high-speed rail (HSR) lines to bring citizens closer together and to offer them a viable alternative to planes on distances up to 1,000 km. The EU promoted interoperability between HSR infrastructure, equipment and rolling stock²⁰⁴ with a view to enabling high-speed trains to run safely and seamlessly throughout the trans-European rail network. Moreover, the priority projects of the trans-European transport network (TEN-T) included a number of HSR lines, some of which have been completed by now. HSR already accounts for about a quarter of all rail passenger traffic in the EU. Measured in passenger-kilometres, HSR traffic has more than doubled between 1998 and 2008. The European HSR network currently comprises around 10,000 km of lines. By 2020, it is expected to be twice as long. Once completed, it will consist of more than 30,000 km of lines.
28. One of the priority projects co-funded by the TEN-T budget is the Betuwe line, a rail freight dedicated line between Rotterdam and the German border that was opened in 2007. It will form part of the rail network for competitive freight which is about to be created to improve the competitiveness of rail freight transport in the EU, in particular along international corridors.²⁰⁵ The network should enhance co-operation between infrastructure managers and provide a more integrated service to customers along a given corridor (one-stop shop). Moreover, rail freight traffic is to be given sufficient priority along corridors shared with passenger traffic.
29. Revitalising the railways appears to have been successful to some extent: After losing one percentage point between 1998 and 2001, the share of railways in intra-EU freight transport has then remained roughly the same at close to 11%. In intra-EU passenger transport, railways could also keep their market share of slightly more than 6% which they had at the beginning of the decade.
30. While rail could keep its modal share during the last decade in the EU as a whole, this success has not been evenly spread. Between 2000 and 2008, rail freight transport activity rose by 54% in the Netherlands, by 40% in Germany and by 37% in the United Kingdom while it shrank by 30% in France. There is a positive correlation between market opening and increasing volumes. Rail has gained market share mostly in those countries which liberalised their rail market early on. Some countries which delayed market opening struggled to keep the market share of their rail sector at the level at which it was at the start of the century. In 19 EU countries, the market share of non-incumbent railway undertakings is still below 15%. This relatively low penetration of newcomers is a sign of persisting market entry barriers.

²⁰⁴

Essentially through Directive 96/48/EC, recently repealed and replaced by Directive 2008/57/EC.

²⁰⁵

Following the rules set out in Regulation (EU) No 913/2010.



Source: Eurostat.

Figure 6: Evolution of rail freight transport activity by country between 2000 and 2008 (in billion tkm)

31. It may be argued that the rail sector could have performed even better had market opening not been postponed in many countries and had the market access directives – in particular those of the first railway package – been properly implemented. The unsatisfactory level of implementation and application of these Directives has led to many complaints by new operators who were facing obstacles where there should have been none. Some provisions of the first package left some scope for interpretation which resulted in unequal transposition of the directives in the various Member States.
32. The greatest strengths of rail freight lie in longer distance transport. It is therefore essential to remove all obstacles that may hinder border-crossing traffic. Operators need equal access conditions to the rail network of all Member States. Too many rules and restrictions are still in place which make border-crossing transport more cumbersome than it needs to be. The full implementation of the provisions of the three railway packages is crucial in ensuring a level playing field for all operators. More simplification and harmonisation of rules may be needed. The recast of the market access directives recently proposed by the Commission²⁰⁶ aims at clarifying, simplifying and modernising the existing rules to facilitate their implementation and thereby improve the functioning of the market.

1.2.3. Addressing the challenges from growing air transport

33. Air transport has shown the strongest growth of all modes of transport in Europe at the end of the 20th century. According to figures provided in the 2001 White Paper, passenger numbers in the EU15 had increased five-fold between 1970 and 2000. The liberalisation of air transport in the EU in the 1990s accelerated this process. It

²⁰⁶

COM(2010)475.

significantly increased competition in the sector, lowered air fares and widened the range of choices for passengers as the number of intra-EU routes offered by airlines more than doubled. The share of air transport in the modal split of intra-EU passenger transport was expected to double between 1990 and 2010 (from 4 to 8%) – a scenario that has actually come true, despite a temporary slowdown of air traffic growth in the wake of the terrorist attacks in 2001, the SARS outbreak in 2002/03, the economic crisis in 2008/09 and the volcanic ash cloud in 2010.

34. The increase in air traffic has put some strain on the available capacity, above all in the sky. Traffic density resulted in an increasing number of delays. The saturation of the skies and shortages in airport capacity needed therefore to be addressed. Moreover, air transport needed to become cleaner and less noisy if its growth was not to be thwarted by environmental and health concerns.
35. The creation of a Single European Sky (SES)²⁰⁷ was one of the main measures to address the rising density of air traffic and to rationalise air traffic management (ATM) in Europe. It was to put an end to the fragmentation of the European airspace which was highly inefficient and cost the industry dearly. A single sky would also have positive environmental effects as airplanes would be able to fly more direct routes and hence consume less fuel per flight. Once established, it is expected to triple capacity, increase safety by a factor of ten, halve ATM costs and reduce the environmental impact of each flight by 10%.
36. Slow and insufficient progress in the implementation of the SES prompted the Commission to strengthen the existing legislative framework through the adoption of the “SES II package” in 2008²⁰⁸, which, among others, introduced a firm deadline (December 2012) for the creation of functional airspace blocks (FAB), a crucial element of the SES initiative. The FABs will be based on operational requirements rather than national borders and contribute to a substantial consolidation of ATM activities in Europe. The reluctance of Member States to pool their sovereignty in this field needs to be overcome. Some progress appears to have occurred in the wake of the ash cloud crisis in spring 2010, when the Council has given the highest priority to the acceleration and anticipation of the implementation of the SES.²⁰⁹
37. The SES II package also foresees the creation of an independent performance review body which defines EU-wide targets with a view to improving the performance of ATM in the areas of safety, environment, capacity and cost efficiency. The need for such a body has become apparent in the last couple of years when airlines increasingly complained about the rising costs of, in their view, relatively unproductive and inefficient ATM services and when the need to improve the environmental performance of air traffic has become more and more urgent.
38. In 2007, the Commission adopted an Action Plan on airport capacity, efficiency and safety in Europe²¹⁰ to avoid an expected capacity crunch at airports. It called, among others, for a better use of existing capacity at airports, a coherent approach to air safety operations at aerodromes and the promotion of ‘co-modality’ (stressing the

²⁰⁷ Based on Regulation (EC) No 549/2004 (Framework Regulation) and others.

²⁰⁸ Cf. COM(2008)389; resulting in Regulation (EC) No 1070/2009.

²⁰⁹ See Council document 6269/10.

²¹⁰ COM(2006)819.

need for better air-rail connections). While many of the proposed actions have been carried out in the meantime (e.g. the work done by Eurocontrol in the areas of air traffic flow management, the creation of an observatory for airport capacity planning in 2008 or the extension of EASA's role in the field of aerodrome safety²¹¹), there are still some shortcomings as airport-rail connections are still often inadequate or completely missing.

39. The allocation of landing and take-off slots at congested airports in the EU is governed by EU legislation dating from 1993.²¹² An amendment in 2004²¹³ contained a number of technical improvements such as provisions with regard to enforcement, clearer definitions, better monitoring tools and stricter sanctions against abuse or non-compliance with the allocation rules. Nevertheless, experience shows that some problems still exist: new entry takes place with difficulty because the turnover of slots into the allocation pool is insufficient. At congested airports, pool slots tend only to be available at unattractive times or they are not available as series. This is impeding the creation of strong competition to the incumbent carriers and hence the optimal use of airport capacity.

1.2.4. *Promoting the use of waterborne transport and of intermodal transport*

40. Other measures intended to favour modal shift were targeted at maritime transport (in particular short-sea shipping), inland navigation and intermodal transport in general. The promotion of short-sea shipping was to shift transport away from road onto ships. One major obstacle to this shift has been the complexity of administrative procedures and reporting formalities. This obstacle should be reduced through the foreseen creation of a European maritime transport space without barriers²¹⁴ and the introduction of electronic documents. Short-sea shipping also benefits from the creation of "Motorways of the Sea" (MoS) and from the Marco Polo Programmes.
41. The MoS were to become a real competitive alternative to road transport. Certain shipping links, particularly those providing a way around the bottlenecks in the Alps and the Pyrenees were to become part of the trans-European transport network. A critical mass of goods was to be concentrated on certain ports to increase the economic viability of frequent regular maritime connections between them. In addition, the intermodal connections in the ports and the hinterland connections were to be strengthened to allow for a smoother transport chain.
42. The success of the MoS concept has so far been limited. The need to better integrate the hinterland connections of the ports into the concept to avoid them becoming bottlenecks has not always been understood. Some of the projects funded so far do not really contribute to a modal shift as there is no viable land alternative and/or they do not contribute to a reduction of harmful emissions. Moreover, any MoS funding is bound to raise competition issues between ports. A revision of the MoS policy would therefore be appropriate.

²¹¹ Through Regulation (EC) No 1108/2009.

²¹² Regulation (EEC) No 95/93.

²¹³ By Regulation (EC) No 793/2004.

²¹⁴ COM(2009)10.

43. Other initiatives to promote maritime transport, such as those to open up the market access to port services²¹⁵ have however failed. Following fierce demonstrations by dockers, the European Parliament rejected the Commission proposal in early 2006 and called instead for a directive on transparency and fair conditions of competition between ports. The Commission issued a Communication on a European Ports Policy²¹⁶ in 2007 which contains an Action Plan that addresses a number of issues relevant to ports. The proposed actions are meant to support an improvement in port performance, a potential increase in port capacity, the modernisation of port activity, the improvement of the environmental credentials of ports and the attractiveness of ports both for workers and for the surrounding cities.
44. After road, maritime freight transport recorded the strongest growth of all modes during the last decade. Intra-EU shipping increased by more than 20% between 1998 and 2008. This is partly due to globalisation which boosted some shipping markets – in particular container shipping. Intra-EU shipping benefited from feeder traffic for these global connections as well as from the supporting policies mentioned above.
45. Inland waterways are among the safest and most environmentally friendly modes of transport. Moreover, they still have plenty of free capacity to transport goods along the extensive inland waterway network in Europe. The Commission has therefore been eager to support this mode of transport. In early 2006, it adopted an Action Programme for inland waterway transport, called NAIADES²¹⁷. The Programme included a number of legislative (harmonisation of rules), policy (e.g. TEN coordinator, market observation) and support instruments (such as the Reserve Fund, research and support programmes). Overall, the fruits of this work have not been reaped yet. Between 1998 and 2008, inland waterways transport in the EU has grown by a total of 9.3% or 0.9% per annum. At 3.5% its share in intra-EU goods transport is lower than in the 1990s.
46. The Marco Polo programmes²¹⁸ promoted a general shift of transport activities away from road (i.e. to short-sea shipping, rail and inland waterways). The idea behind the Marco Polo concept is that operators are reimbursed for each tonne-kilometre (tkm) moved away from road. The first Programme which went from 2003 to 2006 had the objective of moving 12 billion tkm per year off the road. While the contracts concluded did meet that target on paper, not all projects succeeded. With altogether about 31 billion tkm shifted over four years, the overall target has been missed by more than a third. The second Programme has so far been somewhat more active: The planned amount of freight to be shifted from projects funded in the first three years (2007-2009) is 61.8 billion tkm.

1.2.5. *Modal shift in the new Member States of Central and Eastern Europe*

47. The Central and Eastern European countries that joined the EU in 2004 and 2007 had traditionally a higher share of rail transport in the modal split. In 1998, rail still accounted for over 40% of inland freight transport in these countries. This relatively high share is even more remarkable when considering that it reflected the situation

²¹⁵ COM(2004)654.

²¹⁶ COM(2007)616.

²¹⁷ COM(2006)6.

²¹⁸ Regulation (EC) No 1382/2003 (1st programme) and Regulation (EC) No 1692/2006 (2nd programme).

after a precipitous drop both in transport volumes – which nearly halved – and in market shares during the 1990s. The fall in rail activity during the 1990s was mainly due to the economic restructuring in these countries away from heavy industries. As the Central and Eastern European countries still had an extensive rail network and a lot of expertise in rail transport, however, the EU set itself the target of maintaining a high share of rail in these countries. By 2010, rail should still account for 35% of all inland freight transport in new Member States.

48. After the sharp decline during the 1990s in rail transport activity in the Central and Eastern European countries that joined the EU in 2004 and 2007, rail freight transport in these countries started to increase again in the course of the last decade, albeit at a snail's pace (+2.6% altogether between 2000 and 2008). As road transport activity had more than doubled during the same time, however, rail continued to lose market share. By 2008, the share of rail in inland freight transport of the new Member States had gone down to an estimated 34%²¹⁹. The share of rail in these countries is hence still fairly close to the target value for 2010. This should not hide the fact that the rail network in the new Member States is mostly in a bad shape, following years of underinvestment.
49. The accession of the Central and Eastern European countries to the EU and the integration of their economies into the wider EU economy had a dramatic effect on road transport. Its share in all inland transport activities of the new Member States has gone up from around 43% in 1998 to about 55% in 2008²²⁰. The international transport activities of Central and Eastern European road hauliers showed the most spectacular growth rates over the last decade: In terms of tonne-kilometres, they almost tripled (+190%) between 2000 and 2008. National and international activities of road hauliers from the new Member States more than doubled while those of hauliers from the EU15 only increased by 10%.
50. The success of hauliers from the new Member States can be explained in part by their relative cost advantage. Lorry drivers in the new Member States earn a fraction of their colleagues' pay in the EU15. The salary of a lorry driver in Romania, for example, is less than a quarter of that of a driver in Germany. This also explains why, in terms of tonne-kilometres, more than 90% of all road transport operations between EU15 and EU12 countries are carried out by hauliers from the new Member States.
51. Polish hauliers have in 2008 become the biggest cross traders in the EU, i.e. they transport most goods from one foreign country in the EU to another. More growth of the activities of road hauliers from Central and Eastern Europe can be expected, in particular given that all special restrictions on the cabotage market inside the EU – which had been imposed on a temporary basis upon accession on hauliers from most of the countries that joined the EU in 2004 – have been lifted on 1 May 2009.
52. Rapidly rising motorisation levels in the new Member States make it more difficult for other modes of transport to keep their market shares. The volume of passenger transport by rail in the new Member States, for example, has fallen by 20% between

²¹⁹ This share has been calculated without taking the transport activities of road hauliers from the EU-12 into account which took place outside the territory of the EU-12. This step is necessary to be able to compare road transport data with data from the other modes.

²²⁰ See previous footnote.

2000 and 2008. This is in stark contrast to the evolution in the EU15 where railway passenger transport increased by about one sixth (+16%) during the same period. The relative success of rail in the old Member States can mainly be attributed to the attractiveness of the ever expanding high-speed rail network. The new Member States still do not have such a network.

53. Bus and coach operators in the new Member States are also losing market share to the passenger car. Their transport activities have slightly gone down (-4%) since 2000. In the EU15, by contrast, bus and coach operators were able to increase their transport activities by more than 8%. It should be noted, however, that bus and coach transport is still about 1.5 times more important (in terms of modal share) in the new Member States than it is in the old ones.

1.2.6. *The 2006 mid-term review and the concept of co-modality*

54. The existence of alternative modes is a precondition for shifting transport activities from the road to other modes. Often enough, however, there is no economically viable alternative to the road. In the mid-term review of the White Paper, it was acknowledged that, in an integrated transport system, modes of transport do not necessarily compete against each other but rather complement one another. Improving the efficiency of each mode of transport on its own and in combination – in short: co-modality – was to become the leitmotif of European transport policy since then. Modal shift was still an objective – but only where it was most needed, such as over long distances, on congested corridors and in urban areas.
55. In 2007, the Commission adopted a Freight Transport Logistics Action Plan²²¹ which aimed at making freight transport in the EU more efficient and more sustainable. It contained a number of measures which were to increase the attractiveness of non-road modes, e.g. through the creation of a European maritime space without barriers, the development of a freight-oriented rail network or the definition of green corridors. Other measures looked at the whole logistics chain and tried to reduce the administrative hurdles in intermodal transport by developing a single transport document. In addition, the use of new technologies such as e-freight and intelligent transport systems in freight transport was to be promoted. The rules on vehicle dimensions and standards in road transport were also to be reviewed. Some of the measures have only recently been adopted or are still in the pipeline; it is therefore too early to assess any measurable impact from them.

2. **ELIMINATING BOTTLENECKS**

2.1. **TEN-T**

56. The TEN-T policy goes back to the Maastricht Treaty which gave the Community the powers and instruments to establish and develop the trans-European networks. Their main purpose is to contribute to the smooth functioning of the internal market and the strengthening of economic, social and territorial cohesion. In general terms, the TEN policies promote the interconnection and interoperability of national networks and support projects of common interest.

²²¹ COM(2007)607.

57. The European Council in Essen in 1994 has adopted a list of 14 transport projects of common interest. The selection of the 14 projects was largely based on national priorities (bottom-up approach) rather than European ones (top-down approach). The TEN-T guidelines adopted in 1996²²² included these 14 projects which were to be completed by 2010.
58. By the time of the 2001 White Paper, only 3 of the 14 projects had been completed (Malpensa airport in Milan, the Øresund fixed link between Denmark and Sweden and the railway axis Cork-Dublin-Belfast-Stranraer). Some other projects had made significant progress, but a number of projects were far behind schedule. While the EU15 countries struggled to make progress on their own projects, the upcoming accession of the then candidate countries called for even greater efforts as their infrastructure needs were much bigger.
59. A revision of the TEN-T guidelines in 2004 took account of EU enlargement: it expanded the list of priority projects to 30, with the horizon for completion set to 2020. At the same time, the original projects were revised and, typically, extended; their target date has also been postponed. Moreover, European co-ordinators were appointed for the most important priority projects. They were to promote the projects and thus speed up their completion.
60. By 2010, a total of 5 out of 30 TEN-T priority projects have been completed. Only two railway projects (the Betuwe line in the Netherlands and the west coast main line in the UK) have been finished since 2001. Other projects, while not completed, did make significant progress. Out of the nearly 400 billion € of projected costs for the 30 priority projects, around 164 billion € have been invested until the end of 2009, and close to 80 billion € are projected for the period 2010-2013. The remaining 37% of the investments are foreseen after 2013.
61. The opening of high-speed lines in Germany, Italy, Spain, France and the Benelux countries has considerably improved accessibility and brought people closer together. Rail could capture market shares from aviation and from the passenger car. These successes should however not hide some disappointments: a couple of projects such as the trans-Alpine rail tunnels on Brenner and Fréjus have been designated as a 'priority' for more than 15 years but construction has not even started yet. These points have been critical bottlenecks since then. The elimination of bottlenecks – one of the key priorities of the 2001 White Paper – is work in (slow) progress.

2.2. Infrastructure funding

62. Infrastructure financing is supported by various financial instruments at EU level, including the TEN-T budget, the Structural Funds and the Cohesion Fund, and loans from the European Investment Bank (EIB). The Structural Funds and the Cohesion Fund have been a major source of finance for the investment needed to reduce imbalances in transport endowment in lagging regions across the EU. The TEN-T budget currently co-finances projects on the TEN-T network. It contributes up to 10% of costs of works on the comprehensive TEN-T network, up to 20% of the costs of works in priority projects and traffic management systems (except for rail) and up

²²² Decision No 1692/96/EC, recently repealed and replaced by Decision No 661/2010/EU.

to 30% of the costs of works in cross-border sections of priority projects. Moreover, they finance up to 50% of preparatory, feasibility, evaluation and other studies related to projects and of costs related to the development and deployment of ERTMS.²²³

63. Although the TEN-T financing thresholds have been raised in 2007, Community financial instruments in their current form have so far not been able to bring about a full and timely completion of all projects involved. Insufficient finance – both public and private – and insufficient access to long-term finance are among the most important obstacles in infrastructure development. This has been identified as one of the main reasons for lack in progress in certain TEN-T priority projects.²²⁴ Higher financing thresholds may have helped for certain projects, but in an overall limited (and insufficient) budget this has come at the cost of financing capabilities of other projects.
64. Expanding the financing capacity available for investment in infrastructure in general and in the TEN-T in particular has been one of the major tasks in the past and will likely remain so in the future. One way to address this issue is to mobilise private investment in infrastructure projects. The involvement of private capital in public-private partnerships (PPP) enabled the completion of a number of projects (e.g. the Øresund fixed link). To strengthen the organisational capacity of the public sector to engage in PPP, the Commission and EIB set up a European PPP Expertise Centre in 2008.
65. The budgetary resources at EU level have grown somewhat over time. At just 8 billion € between 2007 and 2013, however, the TEN-T budget only covers a fraction of the needs. The commitment of the EIB has also been expanded over the years, both through the amount of financing provided and through the development of specialised financing instruments such as the Loan Guarantee instrument for TEN-T projects (LGTT).²²⁵
66. Finding more money to finance transport infrastructure projects in mountainous areas was also one of the objectives of the amendment of the Eurovignette Directive in 2006.²²⁶ It allows a mark-up of tolls on specific road sections in mountainous areas to finance projects of high European value, including those involving another mode of transport along the same corridor. This allows for instance Austria to charge more from heavy duty vehicles using the Brenner Pass. The money thus collected is to be used to finance a part of the upcoming Brenner base tunnel, a TEN-T priority rail project. This allows a kind of pre-financing of important new infrastructure projects and has as such been foreseen in the 2001 transport policy White Paper to relieve the headache of funding.

²²³ Cf. Regulation (EC) No 680/2007.

²²⁴ Cf. COM(2009)44.

²²⁵ LGTT has been developed in 2008 and partially covers the revenue risks in the early operational period of a project and hence improves the financial viability of TEN-T investments.

²²⁶ Through Directive 2006/38/EC.

3. PLACING USERS AT THE HEART OF TRANSPORT POLICY

3.1. Transport safety

67. As long as people get accidentally killed or seriously injured while moving from one place to another, ensuring and improving transport safety will remain a key theme of any transport policy. At EU level, such policies have already been pursued in the 1970s and 1980s in the context of safety features being included in the type approval process of new road vehicles. The breakthrough in the EU policy on transport safety came with the Maastricht Treaty of 1993, which explicitly gave the EU competence in this field. Improving transport safety has become one of the main objectives of EU transport policy ever since²²⁷.

3.1.1. Road

68. Producing the highest number of casualties, road is the main challenge with regard to transport safety. The Commission has adopted two Road Safety Action Programmes in the 1990s, one going from 1993 to 1997²²⁸ and the other from 1997 to 2001²²⁹. At the beginning of the 21st century, progress in road safety had been somewhat slower than planned. The target of 38,000 road fatalities in the then EU15 by 2000 had been missed by more than 3,000. In addition to the more than 41,000 people who died on EU15 roads at the start of the decade, around 15,000 lost their lives on the roads of the countries that were to join the EU in 2004 and 2007. It was clear that more ambitious measures had to be taken to reduce the number of people killed on European roads.

69. In the 2001 White Paper, the EU set itself the ambitious target of halving the number of road deaths by 2010. In 2003, the Commission adopted the third Road Safety Action Programme²³⁰ to this end, a document with a list of 62 measures and initiatives which were to be adopted and carried out until 2010. Although the 50% reduction target initially only covered the EU15, it was extended to the new Member States upon their accession.

70. Improvements in road safety were to be achieved through action at different levels of government. The concept of shared responsibility was introduced. Member States adopted national road safety plans; some did so for the first time. This helped to focus minds and to target policies and hence to reduce the number of road casualties.

71. There has been significant technological progress in active and passive safety of vehicles over the last decade with the introduction by the industry of a wide range of technical safety elements, in particular in passenger cars and heavy duty vehicles. Often, EU legislation helped spread the improvements to all vehicles. Next to vehicle safety, EU legislation also helped to improve infrastructure safety (e.g. road tunnels

²²⁷ See Art. 91 (1) c) TFEU.

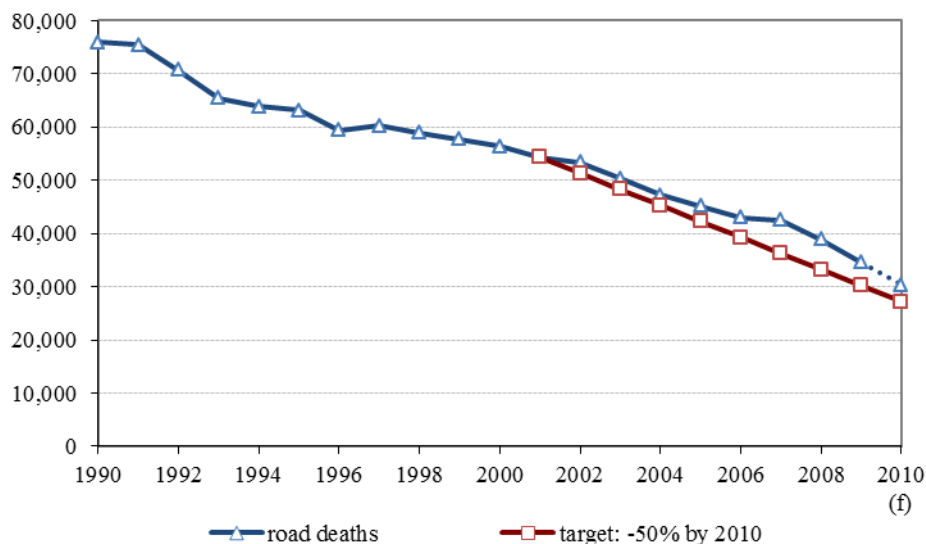
²²⁸ COM(93)246.

²²⁹ COM(97)131.

²³⁰ COM(2003)311.

on the TEN-T network²³¹) and driving behaviour (e.g. recommendation to lower the blood alcohol limit to 0.5 mg/ml of blood²³²).

72. In 2009, around 34,500 people were killed on the roads of the EU27. While this was the lowest figure ever recorded, it was still only 36% below the reference level of 2001, when about 54,300 people lost their lives on the roads of what is now the EU27. Preliminary data for 2010 suggest that the overall target of halving the number of road deaths in the EU by 2010 has not been met.



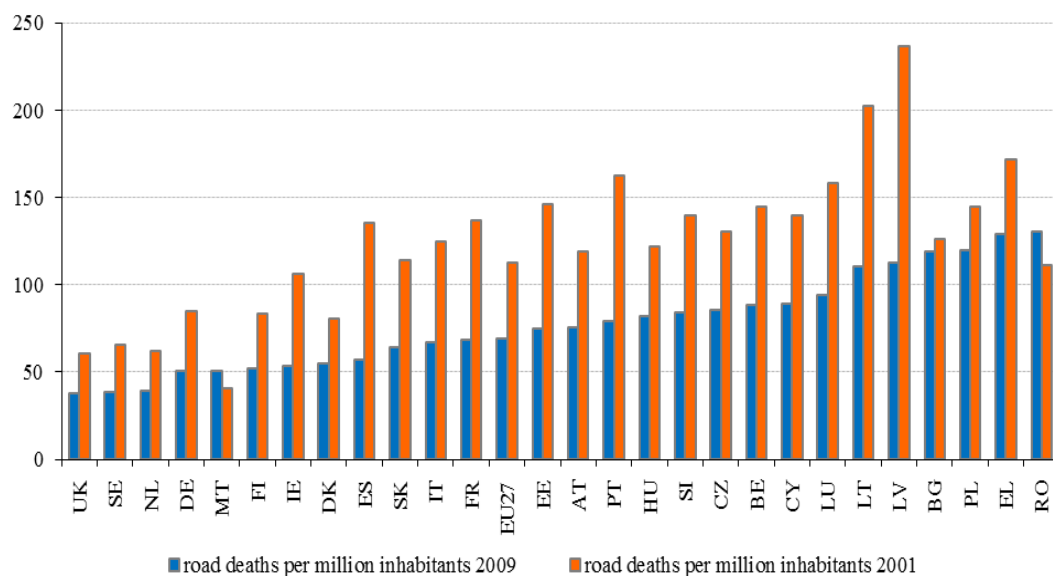
Source: CARE database, DG MOVE.

Figure 7: Evolution of the number of road deaths in the EU27 compared with the target of the 2001 White Paper

73. There are still big differences in the performance of individual Member States. The worst performers (Romania, Greece) have more than three times as many road deaths per million inhabitants than the best performers (United Kingdom, Sweden and the Netherlands). There should therefore be a huge scope for improvement just by applying best practice throughout the Union. If all countries were as 'safe' as the best performing ones, the annual toll of people killed in road accidents in the EU27 would already now be below 20,000. All new Member States except for Malta and the Slovak Republic show a worse record than the EU27 average of 69 deaths per 1 million inhabitants. Adequate and safe road infrastructure that can cope with rising motorisation levels is often missing in these countries: their below-average performance can partly be attributed to this phenomenon.

²³¹ Directive 2004/54/EC.

²³² Commission Recommendation 2001/15/EC.



Source: DG MOVE calculations

Figure 8: Road deaths per million inhabitants in 2001 and 2009 by country

74. As road safety is a policy area with shared responsibilities, also involving national, regional and local authorities as well as associations, stakeholders and the citizens themselves, the failure to reach the 50%-reduction target cannot be blamed on the EU alone. The new Member States had little time to improve their road safety performance but start showing encouraging results²³³. Moreover, several EU legislative acts adopted towards the end of the period covered by the third road safety action programme will only show their full impact during this decade.

3.1.2. Maritime

75. In recent years, the EU and its Member States have been at the forefront of actions to improve maritime safety legislation and to promote high-quality standards. The aim has been to eliminate substandard shipping, to increase the protection of crews and passengers, to reduce the risk of environmental pollution, and to ensure that operators who follow good practices are not put at commercial disadvantage by others who are prepared to take short cuts with vessel safety.

76. The EU has so far adopted three legislative packages with the aim of improving maritime safety: the so-called “Erika I”²³⁴ and “Erika II”²³⁵ packages, and the third maritime safety package²³⁶. The Erika I and Erika II packages were a direct result of the catastrophic impact which the sinking of the single hull oil tanker Erika had in December 1999 off the coast of Brittany. It was felt that the Community needed to adopt stricter safety rules than those set by the International Maritime Organisation (IMO) to prevent similar disasters from happening again. The first package (Erika I) involved more rigorous inspection of ships at Community ports, stricter monitoring

²³³ In 2009, the 12 new Member States had 16% fewer road fatalities than in 2008.

²³⁴ COM(2000)142.

²³⁵ COM(2000)802.

²³⁶ COM(2005)585.

of the classification societies and a ban on single hull tankers. The second package (Erika II) established a Community monitoring, control and information system for maritime traffic, a fund for the compensation of oil pollution damage and the European Maritime Safety Agency (EMSA).

77. In general terms, EMSA provides technical and scientific assistance to the Commission and the Member States in the fields of maritime safety, maritime security, prevention of pollution and response to pollution caused by ships. Its assistance is particularly relevant in the continuous process of updating and developing new legislation, monitoring its implementation and evaluating the effectiveness of the measures in place. In order to monitor the implementation of the Community acquis, the specialised staff of the Agency carries out inspections to Member States and, in specific areas, to third countries. Such inspections started in 2004 and intensified over the last years.
78. Another disaster, the sinking of the oil tanker *Prestige* off the coast of Galicia in November 2002, prompted more legislative action that resulted in the third maritime safety package which the Commission adopted in 2005 and which finally was adopted by the European Parliament and the Council in 2009. It seeks to improve the effectiveness of existing measures to prevent accidents and to better manage their consequences in case accidents do happen.
79. Apart from the *Prestige* accident in 2002, there has been no major catastrophic oil spill in European waters over the last ten years. The accelerated phasing-in of double hull tankers has significantly reduced the risk arising from the transport of heavy fuel oil in single-hull tankers. Moreover, the work done by EMSA and the stronger roles of national safety authorities helped improve safety in European waters.
80. In its Maritime Accident Review 2009, EMSA reports that the total number of vessels involved in accidents and the loss of life in and around EU waters were at historically low levels in 2009. 52 people on board commercial vessels were killed in 2009, close to 37% less than in 2007 and 2008.²³⁷ It is not clear though what part of the positive evolution in 2009 can be attributed to EU action in this area and what part is due to the economic crisis: with lower traffic volumes and less pressure on crews to meet tight deadlines a reduction in accidents was to be expected. In any case, there is room for improvement as there were still hundreds of accidents and (minor) oil spills in and around EU waters in 2009.

3.1.3. Rail

81. Rail is a relatively safe mode of transport. The number of railway passengers killed per year in the EU is usually counted in dozens, not in thousands as in road transport. There were two main reasons for the EU to become involved in railway safety: first of all, safety rules across Member States had been so different that it was very cumbersome for a railway operator from one country to be granted a safety certificate from another one which is a prerequisite for market access. For the opening of the market, it was essential to harmonise safety rules and to ensure interoperability between different safety regimes in the Member States.

²³⁷ Comparable figures for earlier years are not available.

82. Later, with the opening of the railway market, it was feared that safety would suffer under the pressures of a competitive environment. In the 2001 White Paper, the EU therefore set itself the target of guaranteeing a level of safety that is at least equal to, if not higher than, that achieved in the national context. So far, this objective has been met: figures provided by the International Union of Railways (UIC) suggest that the number of railway passengers killed in the EU15 has even fallen slightly: while between 2001 and 2004, an average of 91 rail passengers died every year in the EU15, this figure went down to 43 in the period 2005 to 2008 (when on average 91 passengers died in the whole EU27, not just the EU15).
83. Generally, rail is considered to be a relatively safe mode also when it comes to the transportation of dangerous goods. In an integrated European rail market, both infrastructure and rolling stock, in particular those carrying dangerous goods, have to meet high and comparable safety standards across the EU. The tragic accident in Viareggio in June 2009²³⁸ showed a number of shortcomings in existing rules. Distance-based controls for train wagons and a stronger role for the European Railway Agency (ERA) in accident investigations appear necessary.
84. ERA has been created as part of the second railway package²³⁹. It supports the Commission in setting up and enforcing common safety standards and in improving the interoperability of the European railway system. At Member State level, it is supported by independent national rail safety authorities.
85. The certification and authorisation process is still managed by the national rail safety authorities. However, the cost and duration of the related procedures are significant. Moreover, the procedures differ from one country to another, and they lack transparency and predictability.

3.1.4. *Air*

86. Europe has a relatively good track record when it comes to safety in air transport. The number of air crashes and related casualties is lower than on most other continents. The White Paper of 2001 saw the need to establish a European Aviation Safety Agency (EASA) which was to work on all aspects of air transport activities, from aircraft certification to the operational rules. The co-operation within the Joint Aviation Authorities, which had been dealing with these issues before, had reached its limits. EASA was created in 2003²⁴⁰ and became fully operational in 2008. It supports the Commission among others in the implementation and monitoring of safety rules through inspections in the Member States, in the type certification of aircraft and in the authorisation of third-country operators.
87. To protect European citizens from potentially unsafe aircraft originating from third countries, the procedures for ramp inspections for third-country aircraft landing at EU airports have been harmonised,²⁴¹ as announced in the White Paper. Moreover, the Commission has created a black list where all airlines with some safety concern

²³⁸ On 29 June 2009, a couple of wagons of a freight train carrying LPG derailed and exploded at Viareggio station in Tuscany, Italy. As a result, 32 people in the vicinity of the station were killed.

²³⁹ In fact, by Regulation (EC) No 881/2004.

²⁴⁰ Based on Regulation (EC) No 1592/2002; later repealed and replaced by Regulation (EC) No 216/2008.

²⁴¹ Directive 2004/36/EC, later repealed and replaced by Regulation (EC) No 216/2008.

are listed.²⁴² These airlines are banned from European airspace. The list is regularly being updated.

88. Given the relatively good level of air safety, there have been only very few major air crashes by EU carriers and over EU territory. Individual crashes often dominate the casualty statistics of a given year. Based on figures provided by EASA, the annual number of lives lost by any airline over EU27 territory has fluctuated between 0 and 154 in the last 20 years, those lost on board an EU carrier anywhere in the world has been somewhere between 0 and 278 since 1990. Compared with the 1970s and the 1980s, air transport has become significantly safer, especially in relation to the volume of air traffic: air traffic in the EU has more than doubled during the last two decades while the number of people getting killed remained at very low levels.

3.2. Transport security

89. While transport safety deals with the prevention of accidents, the protection of passengers and workers from unlawful interference or intentional attacks is being subsumed under the term transport security. Transport security is not mentioned in the White Paper of 2001. It has however become a great concern in the wake of the terrorist attacks of 11 September 2001 in the United States. Soon thereafter, the EU has established common rules and common basic standards in the field of civil aviation security²⁴³. Harmonised rules across the EU created a ‘one-stop security’ regime where passengers arriving from one EU airport do not have to be re-screened when transferring at another EU airport. Unannounced Commission inspections at EU airports help ensure the implementation of the security measures.
90. The absence of any terrorist attack in European air transport may be attributed to EU action in this area. Actions taken so far may therefore be considered to have been effective to date. It should be noted however that several attempted attacks since 9/11 were committed by passengers boarding an aircraft in the EU²⁴⁴. New security rules usually followed attempted or successful attacks which exposed shortcomings in existing rules. The ban of liquids in containers larger than 100 ml on planes, for example, followed a terrorist plot in 2006 involving explosive liquids²⁴⁵. As the ban was rather costly and caused a lot of misery to ordinary travellers, its proportionality has been called into question²⁴⁶. The ‘Christmas Day bomber’ in 2009 is another example: his failed attempt has stirred up the debate on the use of security scanners at airports.
91. In maritime transport, the EU has been active in enhancing ship and port facility security²⁴⁷. The Commission carries out inspections to monitor the correct

²⁴² Based on Regulation (EC) No 2111/2005.

²⁴³ Regulation (EC) No 2320/2002, later repealed and replaced by Regulation (EC) No 300/2008.

²⁴⁴ The “shoe bomber” in December 2001, who tried to detonate some explosives hidden in his shoes, was flying from Paris Charles de Gaulle to Miami. The “Christmas Day bomber” in 2009, who had some plastic explosives hidden in his underwear, was on board a flight from Amsterdam to Detroit.

²⁴⁵ It was imposed after a plot by British terrorists had been unveiled who wanted to blow up several trans-Atlantic flights from London using liquid explosives concealed in soft-drink bottles.

²⁴⁶ In view of the upcoming installation of new screening technology at airports, it has been decided to lift that ban in April 2013. See Commission Regulation (EU) No 297/2010 amending Regulation (EC) No 272/2009.

²⁴⁷ Essentially through Regulation (EC) No 725/2004 and Directive 2005/65/EC.

application of the legislation. The fight against piracy is another EU activity in the field of maritime security. The EU is currently involved in the operation Atalanta off the coast of Somalia to protect vessels sailing in the area and to end acts of piracy and armed robbery, if needed. While the effect of EU action in this field may be considered as overall positive, the pressing problem of piracy is far from solved.

92. In addition to legislation in air and maritime security, the Commission also proposed some measures to improve the security of surface freight transport in order to have unified security rules across the supply chain²⁴⁸. They included the concept of a 'secure operator' who would benefit from fast-track treatment at security checks. The European Parliament was however of the opinion that the revision of the Community Customs Code which was going on at the same time and which foresaw a similar certification for secure operators was sufficient.
93. There appears to be a clear need in increasing the security of surface freight transport in general and of road freight transport in particular. Lorry drivers are frequently attacked, often while staying at unsecured parking spots. The lack of secure parking areas is a growing problem which the EU is trying to address through a number of projects such as SETPOS²⁴⁹ and LABEL²⁵⁰. In November 2010, the Council adopted a resolution on preventing and combating road freight crime and providing secure truck parks.²⁵¹
94. Next to surface freight transport, surface passenger transport is another area without existing security rules at European level. The devastating terrorist attacks on the public transport systems in Madrid in 2004 and in London in 2005 killed almost 250 people altogether and exposed the vulnerability of these networks. With the gradual integration of the European transport system, common security rules also in inland transport may be warranted.
95. In many cities, public transport suffers from a lack of security due to some anti-social behaviour. That goes from spraying graffiti via damaging carriages to attacking ordinary passengers. Pickpockets are another common threat in a number of public transport networks. It should be ensured that public transport is a no-go zone for thugs and criminals. Public transport must be perceived to be safe and secure if it is to succeed in convincing more people to leave the car at home and use public transport instead.

3.3. Working conditions and social dialogue

96. One of the fundamental objectives of the EU is the promotion of employment as well as the improvement of living and working conditions. The EU may to this end adopt Directives which set minimum requirements regarding several aspects of working conditions (e.g. health and safety at work, social protection, information and consultation of workers). The European social partners play an important role in the formulation of EU social legislation, as agreements between them at EU level on matters covered by the Treaty may become binding EU law. The Commission

²⁴⁸ COM(2006)79.

²⁴⁹ <http://setpos.eu>

²⁵⁰ <http://truckparkinglabel.eu>

²⁵¹ See Council document 12083/4/10.

encourages the social partners to find solutions at EU level and consults them on policy measures.²⁵²

97. In the transport field, sectoral dialogue committees were set up in 1999 for road, rail, inland waterway and maritime transport, and in 2000 for civil aviation.²⁵³ In sea ports, however, no such committee has so far been established despite the Commission explicitly encouraging such a step.²⁵⁴ The committees dealing with maritime, civil aviation and rail transport have since found agreements on the working conditions of (at least some of) the employees in their specific sectors. These agreements have been transposed into EU law.²⁵⁵ In the areas covered by such agreements, the general working time rules²⁵⁶ do not apply.
98. In road transport, however, no such agreement could be found. The EU social dialogue in the road transport sector was deadlocked among others over the question whether self-employed drivers should be covered or not. Here, the EU has come up with its own rules on the working time of persons performing mobile road transport activities²⁵⁷ which – in a compromise fashion – temporarily exempted self-employed drivers during the first seven years after the Directive entered into force (i.e. until March 2009).
99. In 2008, the Commission proposed to amend the Directive in order to maintain the exclusion of genuine self-employed drivers from the scope of the Directive while strengthening its enforcement in the case of so-called “false self-employed”²⁵⁸ drivers in addition to employed professional drivers.²⁵⁹ Among the reasons for not covering self-employed drivers were the difficulties and costs involved in enforcing such rules, particularly among this group. The European Parliament was however of the opinion that the rules on working time should uniformly apply to all drivers, including the self-employed ones. The Commission then withdrew its proposal and is now faced with the challenge of ensuring a proper enforcement of the existing rules.
100. The road transport sector is highly fragmented and the bulk of the operators are very small undertakings or even one-man companies. To make their production capacity more flexible and demand-responsive and to save costs, larger undertakings often subcontract the work to drivers who were previously employees. Such drivers are then however socially vulnerable as they occupy a ‘grey area’ between labour law and commercial law. E.g. current rules forbid payments by transport undertakings to employed drivers on the basis of distance travelled and/or the amount of goods carried if that payment endangers road safety.²⁶⁰ Any circumvention of this rule, for

²⁵² Cf. Art. 151 to 155 TFEU.

²⁵³ Following Commission Decision 98/500/EC. The sectoral dialogue committees replaced previously existing Joint Committees which were found to be over-institutionalised, inefficient and ineffective.

²⁵⁴ See, for example, COM(2007)616.

²⁵⁵ Directive 1999/63/EC for seafarers, Directive 2000/79/EC for mobile workers in civil aviation and Directive 2005/47/EC for mobile workers engaged in interoperable cross-border services in the railway sector.

²⁵⁶ According to Directive 2003/88/EC.

²⁵⁷ Directive 2002/15/EC.

²⁵⁸ i.e. drivers who are not tied to an employer by an employment contract but who do not have the freedom to have relations with several customers.

²⁵⁹ COM(2008)650.

²⁶⁰ Art. 10 of Regulation (EC) No 561/2006.

instance by declaring (false) self-employment, should be prevented. According to the social partners, however, the phenomenon of ‘false’ self-employed drivers has become increasingly frequent.

101. Next to the overall working time, EU legislation also regulates maximum driving time and minimum rest periods in road transport. These rules are meant to avoid driver fatigue and hence to contribute not only to better working conditions but also to road safety. In 2006, the rules have been substantially updated.²⁶¹ Moreover, the enforcement of the rules has been strengthened by an increase in the number of inspections, by more co-ordination and co-operation between national enforcement bodies and by introducing the digital tachograph in road vehicles, a device which automatically records the driving time of a driver and which cannot be manipulated as easily as traditional recording equipment.
102. Right now, virtually all goods transport vehicles and buses have to be equipped with the digital tachograph if they are used to cover distances longer than 50 km. For regionally operating small and medium-sized craft businesses, however, this produces an enormous amount of red tape. Their administrative burden could be substantially reduced if the installation of the tachograph was not required in vehicles that are used by them on distances up to 150 km.²⁶²
103. There is still an important gap between the remuneration of lorry drivers from the new Member States and those from the old ones which is also one of the reasons of the current limitation of cabotage²⁶³. This difference in labour costs decreases, but it will for a number of years continue to put pressure on road haulage undertakings established in the old Member States, unless they diversify their activity in logistics activities with higher value added.
104. Differences between Member States in applying and enforcing existing social rules in road transport (e.g. there is a huge variance in penalties for breaching the rules²⁶⁴) may distort competition in the sector and lead to a potential exploitation of workers. A more harmonised control and sanctioning system would allow the legislation to deploy its full benefit in particular for drivers and undertakings. The new possibilities offered by the Lisbon Treaty should be used in this context. Generally low levels of compliance with the social rules by both employers and by workers (e.g. undeclared work, incorrect records) add to the enforcement challenge.
105. In some areas, such as maritime transport, there is a growing shortage of qualified staff of European origin. The problem has already been identified in 2001²⁶⁵ and the situation has not improved since. The ageing of existing crews is bound to further increase the scarcity of European officers in the near future. More actions to improve the working conditions at sea and to emphasise the attractiveness of the maritime profession appear necessary to attract more young Europeans and thus ensure the competitiveness of the European shipping sector. This requires better perspectives

²⁶¹ Through Regulation (EC) No 561/2006.

²⁶² As suggested by the German Confederation of Skilled Crafts (ZDH) in 2009 – which earned them the “Best Idea for Red Tape Reduction Award” at the time. See also IP/09/754.

²⁶³ Cf. Art. 8 ff. of Regulation (EC) No 1072/2009.

²⁶⁴ See COM(2009)225.

²⁶⁵ COM(2001)188.

for a life-long career that includes assignments on board and on the ground. The inland navigation sector faces similar problems which the NAIADES Action Programme²⁶⁶ tries to address.

106. The European Commission has actively supported the negotiations on the 2006 Maritime Labour Convention (MLC) of the International Labour Organisation. The MLC, also called the seafarers' "bill of rights", provides for minimum social standards for seafarers worldwide. An Agreement concluded by the European Community Shipowners' Associations (ECSA) and the European Transport Workers' Federation (ETF) on the MLC has meanwhile been implemented²⁶⁷ and will enter into force together with the MLC.²⁶⁸

3.4. Passenger rights

107. There was a risk that the increasing competitive pressure in the wake of the opening of the transport market would at times lead to practices that were not in the interest of the passengers. Such practices had above all been observed in air transport where cases of denied boarding, flight cancellations and considerable delays had become frequent. The EU has therefore extended the rights of air passengers in these cases. They have now a right to care, to reimbursement and to compensation if needed. The enforcement of the rules is to be carried out by national designated bodies. The air passenger rights²⁶⁹ entered into force in 2005. The rights of passengers using other modes followed: those of rail passengers entered into force in 2009,²⁷⁰ those of ferry passengers will apply from late 2012²⁷¹ and those of bus and coach passengers from March 2013.²⁷²
108. There is no doubt that air passengers enjoy better protection today than they did before EU legislation in this area entered into force. An evaluation of the air passenger rights regulation carried out in 2009-2010²⁷³ came however to the conclusion that there were some shortcomings in the application and enforcement of the rules. Differences in length and duration of the national sanction schemes in case of non-compliance reduce the effectiveness of the legislation. Moreover, sometimes the interpretation of the rules also differs between Member States so that there is no level playing field. Further measures to improve enforcement and a more harmonised application of the rules appear necessary.
109. Some rules in the Regulation would need to be clarified so that there is less room for interpretation. The Court of Justice of the EU has been called to interpret already a

²⁶⁶ COM(2006)6.

²⁶⁷ Through Council Directive 2009/13/EC.

²⁶⁸ The MLC enters into force once it has been ratified by at least 30 countries representing at least 33% of world gross tonnage. While the tonnage requirement has been exceeded in 2009, the number of countries having ratified the MLC was still only at 11 in late 2010. Although the Council urged Member States in 2007 to make efforts to ratify the MLC by the end of 2010 (see Council Decision 2007/431/EC), only two EU countries have done so by that time.

²⁶⁹ Regulation (EC) No 261/2004.

²⁷⁰ Regulation (EC) No 1071/2007.

²⁷¹ Regulation (EU) No 1177/2010.

²⁷² Regulation (EU) No 181/2011.

²⁷³ "Evaluation of Regulation 261/2004" Final report, February 2010; the study may be downloaded from http://ec.europa.eu/transport/passengers/studies/doc/2010_02_evaluation_of_regulation_2612004.pdf

number of key issues, such as the rights in case of long delays²⁷⁴ or the notion of “extraordinary circumstances” under which airlines are not obliged to pay compensation when cancelling a flight.

110. The air passenger rights legislation was put to a test in spring 2010 when a volcanic ash cloud led to air space closures in most of Europe which left millions of passengers stranded. The European Commission reminded the passengers of their rights. It made clear that passengers had a right to care (i.e. provision of meals and accommodation, if necessary) even in extraordinary circumstances like these. Airlines however were opposed to having to pay for something which was outside their control. A more balanced approach, which takes both the needs of stranded passengers and the interests of airlines into account, is needed.
111. Air passengers’ rights already start while booking a ticket: Passengers are entitled to know the final price to be paid from the start of the booking process. Some airlines had advertised much lower ticket prices only to add taxes and charges later on. This was thought to be misleading and hence it has been outlawed²⁷⁵. Joint EU ‘sweep’ exercises have revealed that compliance has greatly improved and that the legislation is effective.
112. It is probably too early to assess the effectiveness of the rail passenger rights that entered into force in December 2009. Eurostar passengers who were affected by train breakdowns due to technical problems during the cold winter 2009/2010 were among the first to benefit from them. In general, the implementation of this new legislation does not seem to have given rise to major problems. Some experience from Germany suggests though that the number of delays officially lasting 59 minutes has gone up considerably²⁷⁶. In case of delays lasting 1 hour or more, passengers are entitled to get a part of the ticket price reimbursed. Proper monitoring and enforcement will be key in all areas where passengers have been given rights.
113. Passengers with reduced mobility also benefit from extended rights. It is no longer possible to discriminate against them. Equal access to transport services is a necessary prerequisite to a full participation in the modern society. Rules for the protection of and provision of assistance to disabled persons and persons with reduced mobility travelling by air have been adopted in 2006 and took full effect in July 2008.²⁷⁷ A recent study²⁷⁸ found out that the implementation of the regulation is generally good. There is however a big variation in the quality of services provided and in the severity of sanctions in case of non-compliance. The very similar rights of disabled passengers and of passengers with reduced mobility using other modes of transport have been or are about to be granted in the corresponding passenger rights legislation. It is too early to assess any impact at this stage.

²⁷⁴ Joined cases C 402/07 (*Sturgeon vs. Condor Flugdienst GmbH*) and C 432/07 (*Böck/Lepuschitz vs. Air France SA*); <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:62007J0402:EN:HTML>
²⁷⁵ By Regulation (EC) No 1008/2008.

²⁷⁶ Cf. the following article on Zeit Online: <http://www.zeit.de/2010/25/Bahnverspaetungen>

²⁷⁷ Regulation (EC) No 1107/2006.

²⁷⁸ “Evaluation of Regulation 1107/2006”. Final Report, June 2010; the study may be downloaded from http://ec.europa.eu/transport/passengers/studies/doc/2010_06_evaluation_regulation_1107-2006.pdf

4. URBAN TRANSPORT

114. Traditionally, EU transport policy has aimed at simplifying and enabling cross-border traffic within the EU. National borders have increasingly ceased to be obstacles to the free movement of people and goods. Similarly, however, free movement should not be unduly hindered at city borders. As the majority of people live in urban areas and as economic activities are concentrated there, most journeys, including international ones, start or end in urban areas. In an integrated transport system, there is a need to look at the whole transport chain – including the ‘last mile’.
115. Competence for urban mobility is shared between authorities at local, regional, national and European level. The subsidiarity principle²⁷⁹ exposes any EU action in this field to close scrutiny. A lot of issues and challenges in urban transport are however common in many towns and cities across Europe and have a direct link to key EU policy objectives. Increasing road congestion, air pollution and noise are just a few examples. The EU can help to solve such issues and add value, e.g. by providing a framework for action, by supporting initiatives that improve local transport systems and by promoting the exchange of ideas and examples of best practice.
116. EU action in urban and regional transport goes back to the Green Paper “The Citizens’ Network” of 1995²⁸⁰ which focused on the issue of public passenger transport in general and public transport in urban areas in particular. It resulted in the launch of a series of initiatives based upon a ‘best practice’ approach. The CIVITAS initiative²⁸¹ about cleaner and better transport in cities, launched in 2000 and financed by the EU research budget, is one of the more prominent activities in this respect. It has brought together a number of cities and supported them in implementing and evaluating technology- and policy-based measures to achieve a more sustainable, clean and energy-efficient urban transport system.
117. Most road transport vehicles purchased by public authorities mainly run in an urban environment. The promotion of green public procurement was hence thought to also contribute to a cleaner urban environment – something badly needed given the fact that the air in many cities still is not sufficiently healthy. The EU has recently adopted new rules which stipulate that energy consumption, CO₂ and pollutant emissions linked to the operation of vehicles over their whole lifetime will have to be taken into account in all public purchases of road transport vehicles²⁸². The market for clean and energy-efficient road transport vehicles is thus to be stimulated.
118. These new rules were one of the outcomes of a broad debate in the wake of the adoption of another Green Paper on urban mobility in 2007²⁸³ and a thorough consultation of stakeholders. Another one was an Action Plan on Urban Mobility which the Commission adopted in 2009²⁸⁴. It contains a list of 20 actions which

²⁷⁹ Art. 5(3) TEU.

²⁸⁰ COM(95)601.

²⁸¹ <http://www.civitas-initiative.org/>

²⁸² Directive 2009/33/EC.

²⁸³ COM(2007)551.

²⁸⁴ COM(2009)490.

together form a comprehensive support package for local, regional and national authorities in their efforts to make urban mobility more sustainable. The actions will be launched until 2012. They include initiatives to increase the knowledge about urban mobility issues and how to share it. It is still too early to assess any effects of the actions.

5. PROMOTION OF RESEARCH AND TECHNOLOGICAL DEVELOPMENT IN TRANSPORT

119. Technological innovation plays a key role in ensuring sustainable, efficient and competitive mobility in Europe. It has the potential of speeding up the achievement of the objectives of the Common Transport Policy. The EU has therefore been active throughout the last decades in promoting research and technological innovation in the area of transport.
120. One of the areas where EU promotion has been particularly intense is the development and deployment of Intelligent Transport Systems (ITS), i.e. the application of Information and Communication Technologies (ICT) in transport. The 2006 mid-term review of the White Paper acknowledged the role of ITS in making transport more efficient, safer and greener. EU action in this field avoids the emergence of a patchwork of ITS applications and services and ensures interoperability across borders and, possibly, systems.
121. ICT are crucial elements in all kinds of traffic management systems. Technological innovations such as satellite and radio navigation and identification systems are available today and allow improved monitoring and management of flows of goods, passengers and vehicles. The EU supports the development and deployment of pan-European traffic management systems in all modes and also between modes. A better management of transport flows helps to avoid congestion and to make better use of existing infrastructure capacity.
122. In air transport, a new generation European air traffic management system is being developed within the SESAR project.²⁸⁵ It is the technological pillar of the Single European Sky initiative (see above). SESAR is currently in the development phase (until the end of 2013) which will be followed by the deployment phase. It should be fully deployed by 2020.
123. In maritime transport, the development and deployment of Vessel Traffic Monitoring and Information Systems (VTMIS)²⁸⁶ such as the Community maritime information exchange system SafeSeaNet make it possible to locate at source and communicate to any authority accurate and up-to-date information on ships in European waters, their movements and their dangerous or polluting cargoes, as well as marine incidents. Automatic Identification Systems (AIS) and the establishment of the Long-Range Identification and Tracking (LRIT) of ships will further improve maritime safety and efficiency in Europe.

²⁸⁵ SESAR = Single European Sky ATM Research; Regulation (EC) No 219/2007 established a Joint Undertaking to this effect.

²⁸⁶ In the wake of Directive 2002/59/EC.

124. In inland waterways, the introduction of harmonised River Information Services (RIS)²⁸⁷ and their implementation along all the main inland waterways helps improve safety and efficiency of transport by inland waterways. RIS comprise services such as fairway information, traffic information, traffic management and calamity abatement support. They provide information for transport management, statistics and customs services as well as waterway charges and port dues.
125. In rail transport, the development and deployment of the European Railway Traffic Management System (ERTMS) across the rail network in the EU, starting with six priority corridors, is expected to improve safety and significantly enhance the efficiency of cross-border traffic. Cross-border trains will in future only need to be equipped with ERTMS instead of a range of mutually incompatible national systems. ERTMS will gradually replace the currently over 20 train control systems in the EU.
126. In road transport, the deployment of ITS has been relatively slow and fragmented. Many safety-enhancing features such as lane keeping support, emergency braking system or the pan-European in-vehicle emergency call system eCall²⁸⁸, for example, are available but not in widespread use. The development of electronic tolling systems is another field where the EU can add value by ensuring that the various national schemes are co-ordinated and, possibly, integrated. A better link up of information flows across intermodal logistics chains and a better integration with systems used in other modes also needs to be promoted.
127. To speed up and to co-ordinate the deployment of ITS in road transport and its interfaces with other transport modes, the Commission adopted an Action Plan in 2008.²⁸⁹ It contained 24 initiatives related to the optimal use of road, traffic and travel data, the continuity of ITS services along major corridors, ITS applications to improve road safety and security, the integration of various vehicle-based applications in one platform, data protection issues and the co-ordination of ITS deployment across the EU. The Action Plan was accompanied by a Directive that provides a framework in support of a co-ordinated and coherent deployment and use of ITS within the Union.²⁹⁰
128. Many ITS use satellite-based radio navigation and positioning services currently provided by the Global Positioning System (GPS) run by the US military and by the Russian GLONASS system. In 1999, the EU decided to set up its own global positioning system, Galileo²⁹¹. In 2004, Galileo has become one of the 30 TEN-T priority projects. Funding and governance issues have delayed the project which originally should have become operational in 2008 but which is now expected to be operational by 2014.
129. Technological solutions are essential for cleaning up the transport system. Vehicles and vessels have become cleaner by using new technologies. Many EU-funded projects have contributed and continue to contribute to this objective. A prominent

²⁸⁷ Following Directive 2005/54/EC

²⁸⁸ To push the deployment of eCall, the Commission issued COM(2005)431 in September 2005.

²⁸⁹ COM(2008)886.

²⁹⁰ Directive 2010/40/EU.

²⁹¹ See COM(1999)54.

example is the Clean Sky Joint Technology Initiative²⁹², a PPP research project that aims at improving the environmental performance of the air transport system. The budget of around 1.6 billion € is equally shared between the public (EU FP7 research funding) and the private sector (aeronautics industry). Another noteworthy example is the European Green Cars Initiative²⁹³, a PPP that supports research in greening road transport vehicles. A total of 1 billion € is jointly funded by the EU FP7 research budget, the Member States and the vehicle manufacturing industry. The Ocean of tomorrow is another FP7 joint research initiative, following the adoption in 2008 of the "European Strategy for Marine and Maritime Research", which highlights the importance of integration between established marine and maritime research disciplines in order to reinforce excellence in science and to reconcile the growth of sea-based activities with environmental sustainability.

130. Numerous ex-post evaluations of past research projects (i.e. AGAPE, AIMS, MEFISTO, METRONOME, SITPRO PLUS) have confirmed the European added value in transport research: it is often only at European level that a critical mass in terms of both scale and scope of a project can be reached. Moreover, research at European level avoids duplication of efforts and fosters the exchange of ideas and knowledge across Europe.

6. THE EXTERNAL DIMENSION OF TRANSPORT

131. Transport connects Europe with the outside world. The external dimension of transport is obvious in particular in maritime and air transport. With the exception of the immediate neighbours in Europe, almost all transport activities between the EU and the rest of the world are either by air or by sea.
132. The EU has developed an external transport policy distinguishing between neighbouring countries on the one hand and other important partners – such as the United States – on the other. In line with the European Neighbourhood Policy, neighbouring countries are to be better connected and integrated in the internal transport market of the EU.
133. In 2007, the Commission adopted Guidelines for transport in Europe and neighbouring regions which extended the major trans-European transport axes to the neighbouring countries.²⁹⁴ It identified five transnational axes to connect the EU with its neighbours, four of which are land-based: a Northern axis connecting the northern EU with Norway, Russia and Belarus; a central axis linking central Europe to Ukraine and the Black Sea; a South-Eastern axis linking the EU with the Western Balkans and Turkey and with the countries of the Southern Caucasus, the Caspian Sea and the Middle East, including Egypt and the Red Sea; and a South-Western axis linking the EU with Switzerland and the Maghreb countries. The fifth axis deals with “Motorways of the Sea”, i.e. efficient maritime transport links between the neighbouring countries and the EU. In addition, the Guidelines included horizontal measures to approximate the neighbouring countries’ standards, legislation and policies to the EU and hence promote interoperability. In its dealings with the

²⁹² <http://www.cleansky.eu>

²⁹³ <http://www.green-cars-initiative.eu>

²⁹⁴ COM(2007)32.

neighbouring countries, the Commission was to follow a two-step approach: exploratory talks first which, if successful, may later be followed by concrete recommendations.

134. A progress report of 2008²⁹⁵ found that the exploratory talks with the neighbouring countries were progressing well. There was a general approval of the approach taken by the EU. Progress in the co-operation and adoption of the Community acquis had been most advanced in the Western Balkan countries – mainly due to the fact that these countries are all actual or potential candidate countries.
135. In mid-2008, the Commission started negotiations on a treaty establishing a Transport Community with the Western Balkans. It aims to better integrate the respective transport systems and to create an integrated market for land, inland waterway and maritime transport by aligning the relevant legislation in the Western Balkan countries with EU legislation. The negotiations are still ongoing.
136. In aviation, the EU has created a European Common Aviation Area (ECAA) with the Western Balkan countries as well as with Norway and Iceland. The ECAA Agreement²⁹⁶ has been signed in May 2006. It aims at integrating these countries into the EU's internal aviation market. The EU has set itself the target of developing a wider Common Aviation Area (CAA) by 2010 that covers also other neighbouring countries from Morocco in the West to Kazakhstan in the East. Some agreements with third countries have already been signed – notably the Euro-Mediterranean air transport agreement with Morocco which provides for a high degree of regulatory convergence and should serve as a blueprint for similar agreements with other countries in that region.
137. In 2008, the Commission published a progress report on the Common Aviation Area with neighbouring countries.²⁹⁷ It recognised the progress that had been made but acknowledged that the completion of the wider CAA will probably be delayed. Moreover, it found that the implementation of the agreements would require more efforts. Being “mixed agreements”, they have to be ratified by all EU Member States as well as by the partner countries. Ratification in some EU Member States is however progressing only slowly.
138. The CAA is one of altogether three pillars of the EU's external aviation policy. The other two pillars are bringing existing bilateral air service agreements (ASA) concluded between EU Member States and third countries in line with EU law and negotiating comprehensive air transport agreements with important third countries.
139. The need for bringing bilateral ASA in line with EU law followed directly from the “open skies” judgement of the European Court of Justice in November 2002.²⁹⁸ Up to then, ASA had been governed by bilateral agreements between states. These bilateral agreements however regularly breached EC law, especially as regards the principle of non-discrimination. Every EU Member State is required to grant equal market access for routes to destinations outside the EU to any EU carrier with an

²⁹⁵ COM(2008)125.

²⁹⁶ See OJ L285 of 16 October 2006.

²⁹⁷ COM(2008)596.

²⁹⁸ See OJ C323 of 21 December 2002.

establishment on its territory (so-called “EU designation clause”), not just to companies owned and controlled by nationals of that Member State.

140. The existing ASA between the Member States and third countries had thus to be brought in line with Community law. This could be done either by bilateral negotiations between each Member State concerned and its partners, amending each bilateral ASA separately, or the negotiation of single “horizontal” agreements, with the Commission acting on a mandate of the EU Member States. To date, over 900 bilateral agreements have been modified accordingly. Moreover, 45 horizontal agreements have been signed with partner countries worldwide.
141. A comprehensive so-called “Open Skies” agreement has been signed with the USA in 2007. It allows open market access for air services between all 27 Member States and the US. Some leftovers of this first agreement, above all in the area of airline ownership and control, have been addressed in second-stage negotiations which resulted in a draft agreement in March 2010. A similarly wide-ranging air transport agreement with Canada has been signed in December 2009. Negotiations with Australia, New Zealand and Brazil are currently ongoing.
142. Good external relations in maritime transport are essential in ensuring the stability of the global seaborne trade system. The Commission is in regular contact with key shipping and trading partners around the world and participates in talks in international organisations related to issues of safety, the protection of the marine environment or labour standards. Moreover, bilateral working groups with the US, Japan, Russia, China and Korea meet regularly to discuss issues related to maritime transport security.
143. As the world’s leading commercial power, the EU needs to play a strong role in the adoption of international rules which govern a large part of international transport. Moreover, the internal transport market requires an effective and co-ordinated representation towards the outside world, also to promote and effectively defend European interests and standards worldwide. It is important for Europe to speak with one voice in international transport fora. The increasing EU competence in defining also the external dimension of European transport policy should be better reflected in the Commission’s role in representing the EU in bodies such as the International Civil Aviation Organisation (ICAO) in Montreal and the International Maritime Organisation (IMO) in London. At their meetings, the Commission has so far merely played the role of observer with the right to speak. A recommendation to the Council of April 2002 to authorise the Commission to negotiate with ICAO and with IMO the conditions and arrangements for the accession of the EU to these organisations²⁹⁹ has so far been blocked by the Member States.
144. In the absence of further action on the mandate for membership at ICAO, the Commission has taken a more pragmatic approach along the following three lines: It opened an EU office in Montreal in 2005 to provide permanent representation of the Commission at ICAO and to develop a closer co-operation with the UN body. In matters of EU competence, it co-ordinates the EU position in the Council and on the spot in Montreal. Moreover, a Memorandum of Co-operation between the EU and

²⁹⁹

SEC(2002)381.

ICAO has been initialled during the 37th ICAO Assembly in autumn 2010. The Memorandum provides a framework for strengthening the co-operation between both organisations and should enhance the influence of the EU in ICAO decision making.

7. CONCLUSION

145. Looking back over the last ten years, it is fair to say that a lot has been achieved and even more has been done to make the European transport system more efficient, more integrated and more sustainable. Not all that has been done has so far had a measurable impact. This is mostly due to the fact that in some cases more time is needed for any impact to become visible (because a number of measures have only recently been adopted) or to the fact that, in some other cases, implementation has been insufficient and slow.
146. Progress has been slow in areas such as the opening of the rail market, the creation of the SES or the completion of the TEN-T priority projects. Moreover, the development, deployment and application of technological innovations such as intelligent transport systems have also been rather slow and are in some cases behind schedule (e.g. Galileo). The internalisation of the external costs of transport is another area where there has not been much progress to date.
147. Some objectives have not been fully achieved because European transport policy had only a limited influence on them (e.g. decoupling transport growth and GDP growth) or because of the general inertia of the transport system (e.g. modal shift). But things are generally moving in the right direction: passenger transport is now growing more slowly than GDP (in a context of still growing mobility) and the relative fall of rail transport could be stopped.
148. While some ambitious targets have not been fully achieved (e.g. halving the number of road deaths by 2010), significant progress has been made: transport in the EU has become a lot safer than it was 10 years ago, despite growing traffic volumes. Transport has also become more secure, in particular in aviation. Moreover, passengers in air and rail transport now benefit from new and extended rights, those using ferries or coaches will have similar rights soon. Proper monitoring and enforcement of the existing rules is important, in particular when it comes to passenger rights and to social legislation.
149. Transport is still producing too many negative side effects for the environment. The emission of air pollutants could be reduced significantly, but in many cities, the concentrations are still at unhealthy levels. Moreover, when it comes to CO₂ emissions, transport is the black sheep in the family as its emissions have almost continuously increased over the last 20 years while those of other sectors have been falling. In the light of growing concerns, among others about climate change, the objective of a (relative) decoupling of the negative effects of transport from the growth in transport activity, as expressed in the 2006 mid-term review of the White Paper, appears not to be sufficient.

Appendix 3: Reference scenario (2010-2050)

1. In the EU, transport services contribute 4.6% of gross value added and account for 4.5% (10.2 million people) of total employment^{300, 301}. Road and rail together employ around 60% of all persons in the transport services sector and provide more than 50% of gross value added. Around two thirds of the people working in road transport enterprises are active in moving freight around, one third in moving passengers³⁰².
2. Transport is closely interrelated with the rest of the economy: around 30% of the total output of the transport services sector is bought by the manufacturing sector and 18% by retail and wholesale trade³⁰³. By enabling trade, transport allows competition and thus fosters competitiveness and innovation and facilitates economic growth.
3. In formulating the future EU transport policy, it is necessary to conduct a thorough analysis of possible developments in the EU transport sector in a “no-policy change” scenario, also called the baseline or “Reference scenario”. This appendix examines the challenges which Europe’s transport sector will likely face in the future, covering the economic, social and environmental dimension. The appendix first presents the Reference scenario assumptions, followed by a discussion of the main results.

Box 1 - The Reference scenario

The Reference scenario is a projection of developments in absence of new policies beyond those adopted by March 2010. The transport-specific policies adopted by March 2010 as well as the 2008 Climate and Energy Package are included in this scenario³⁰⁴.

The Reference scenario is a benchmark for evaluating new policy measures against developments under current trends and policies. It builds on a modelling framework including PRIMES, TRANSTOOLS, the PRIMES-TREMOVE transport model, TREMOVE and GEM-E3 models³⁰⁵. This framework allows exploring developments in the transport sector from two different angles:

- A top-down perspective, which looks at the relative contribution of transport to economy-wide energy consumption and CO₂ emissions using the PRIMES model and employment developments using the GEM-E3 model;
- A bottom-up perspective, which enables the analysis of transport-specific issues using TRANSTOOLS, the PRIMES-TREMOVE transport model and TREMOVE.

³⁰⁰ Source: Eurostat. This figure does not include own account transport (transport services that firms in all sectors provide for themselves, i.e. with their own vehicles). The construction and maintenance of transport infrastructure and of transport means (i.e. road vehicles, ships, trains) is not included either.

³⁰¹ According to Eurostat, the manufacturing of transport equipment provides an additional 1.7% to value added and 1.5% to employment.

³⁰² European Commission, DG Mobility and Transport: The future of transport - Focus groups’ report, 2009.

³⁰³ Source: Eurostat Input-Output tables.

³⁰⁴ A list of policy measures is provided in Appendix 4.

³⁰⁵ A short description of these models is provided in Appendix 5.

1. REFERENCE SCENARIO ASSUMPTIONS

4. The Reference scenario builds on assumptions related to population growth, macro-economic projections and developments in the oil price, which are presented in the following sections.

1.1. The demographic challenge

5. Demographic change is transforming the EU with inevitable consequences also for the transport sector. In the Reference case, the population projections draw on the EUROPOP2008 convergence scenario (EUROPEan POPulation Projections, base year 2008) from Eurostat, which is also the basis for the 2009 Ageing Report (European Economy, April 2009)^{306,307}. The key drivers for demographic change are: higher life expectancy, low fertility and inward migration.

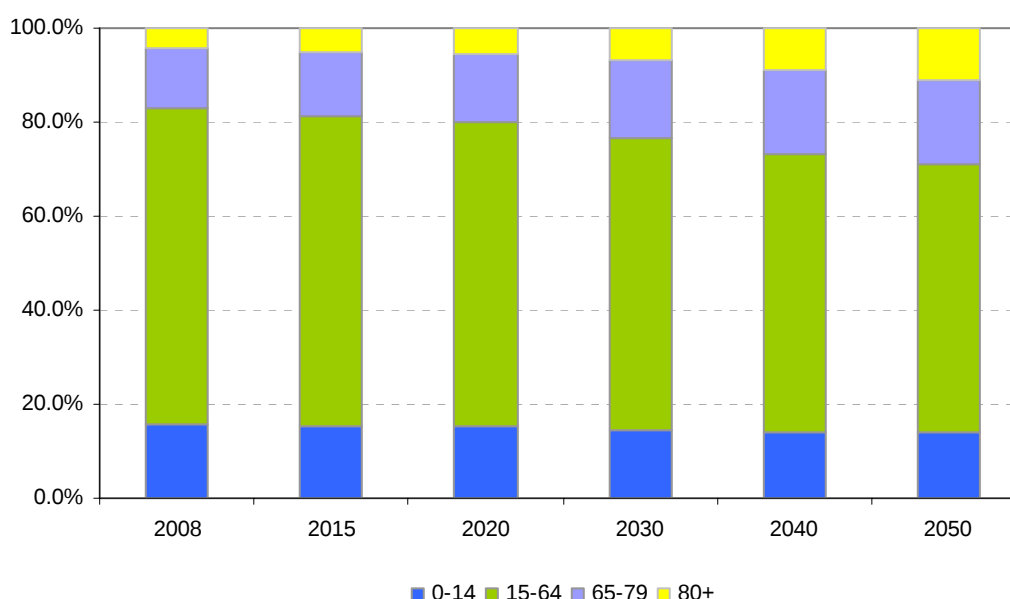
1.1.1. Ageing

6. The EU-27 population is expected to grow by 0.2% per year by 2035 and slightly decline afterwards, remaining fairly stable in number at around 500 million in the next 40 years. Elderly people, aged 65 or more, would account for 24% of total population by 2020 and 29% by 2050 as opposed to 17% today.
7. Around a sixth of EU population has a disability. More than 20% of elderly people aged over 75 are severely restricted. Ageing and the extended longevity of people can be expected to lead to increasing numbers of elderly people with severe disabilities³⁰⁸.

³⁰⁶ European Commission, DG Economic and Financial Affairs: 2009 Ageing Report: Economic and budgetary projections for the EU-27 Member States (2008-2060). EUROPEAN ECONOMY 2|2009, http://ec.europa.eu/economy_finance/publications/publication14992_en.pdf. The “baseline” scenario of this report has been established by the DG Economic and Financial Affairs, the Economic Policy Committee, with the support of Member States experts, and has been endorsed by the ECOFIN Council

³⁰⁷ Demographic projections in the Reference scenario are common in PRIMES, TRANSTOOLS, PRIMES-TREMOVE transport model, TREMOVE and GEM-E3.

³⁰⁸ European Commission, DG Employment: People with disabilities have equal rights - The European Disability Strategy 2010-2020, <http://ec.europa.eu/social/main.jsp?catId=738&langId=en&pubId=591&type=2&furtherPubs=no>



Source: Eurostat, EUROPOP2008

Figure 11: Changes in the structure of the population by main age groups, EU27 (in %)

8. Age-related public expenditures are projected to increase by about 4 percentage points of GDP by 2050 due to the higher ratio of older people which require more public resources for pension payments, health care and long-term care³⁰⁹. As a consequence, through its effect on public finance, ageing will put a strain on the funds available to finance the construction and maintenance of transport infrastructure and the provision of public transport.
 9. The provision of transport services with a high level of perceived security and reliability will gain a prominent role in an ageing society. Appropriate solutions for users with reduced mobility will also require increased focus because frailty and disability rise sharply at older age, especially amongst the 80+ which will be the fastest growing segment of the population in the decades to come.
- 1.1.2. Migration and internal mobility*
10. Migration already plays the predominant role in population growth today: in many Member States, the size of net migration determines whether the population still grows or has entered a stage of decline. Net migration might add 30 million people to the EU population by 2030 and an additional 20 million by 2050³¹⁰.
 11. Migrants will further intensify Europe's ties with neighbouring regions by creating cultural and economic links with their country of origin. These links could entail more movement of people and goods. However, the inward net migration would not be able to sustain the EU population growth after 2035, due to its assumed decelerating trend.

³⁰⁹ European Commission, DG Economic and Financial Affairs: 2009 Ageing Report: Economic and budgetary projections for the EU-27 Member States (2008-2060). EUROPEAN ECONOMY 2|2009.

³¹⁰ Net migration is accounted in the projections on population growth.

12. In 2008, only about 2.3% of the total EU population (11.3 million EU citizens) were living on the territory of another EU Member State³¹¹. Nevertheless, mobility of workers within the Union is expected to increase with the gradual removal of administrative and legal barriers and further deepening of the internal market.

1.1.3. *Shortage of skills*

13. Increasing labour force participation rates in most EU Member States and rising net immigration levels in some can only moderate the fall in employment caused by the ageing of the population and the negative population growth after 2035. Overall employment in the EU is projected to shrink by 12 million by 2050.
14. The share of transport services in total employment in the EU is projected to roughly maintain its current levels by 2050³¹², resulting in fewer people working in the sector. With growing transport activity demand, the lower employment level may negatively affect the workload and working conditions. A scarcity of labour and skills may arise, further aggravating the shortage of skilled labour already experienced in some segments of the transport sector. In absence of innovative alternatives, this may result in higher transport costs for the society.

1.2. **Macro-economic projections**

15. The macro-economic projections reflect the recent economic downturn, followed by sustained economic growth resuming after 2010. The medium and long-term growth projections follow the “baseline” scenario of the 2009 Ageing Report (European Economy, April 2009)³¹³.
16. The Reference scenario assumes that the recent economic crisis has long-lasting effects, leading to a permanent loss in GDP³¹⁴. The recovery from the crisis is not expected to be sufficiently vigorous to compensate for the current GDP losses. In this scenario, growth prospects for 2011 and 2012 are subdued. However, the economic recovery enables higher productivity gains, leading to somewhat faster growth from 2013 to 2015. After 2015, GDP growth rates mirror those of the 2009 Ageing Report. Hence the pattern of the Reference scenario is consistent with the intermediate scenario 2 “sluggish recovery” presented in the Europe 2020 strategy³¹⁵.
17. The average annual GDP growth rate for the EU-27 has been estimated at only 1.2% for 2000-2010, while the projected rate for 2010-2020 is expected to recover to 2.2%, similar to the historical average growth rate between 1990 and 2000. In the medium run the higher expected growth rate is due to the higher productivity growth assumed in Member States that are catching up. The average annual GDP growth rate in the EU-27 is projected to fall to 1.6% during 2020-2050 because demographic

³¹¹ Eurostat (population and social conditions), Statistics in Focus No 94/2009.

³¹² Result of the GEM-E3 model.

³¹³ European Commission, DG Economic and Financial Affairs: 2009 Ageing Report: Economic and budgetary projections for the EU-27 Member States (2008-2060). EUROPEAN ECONOMY 2|2009, http://ec.europa.eu/economy_finance/publications/publication14992_en.pdf

³¹⁴ GDP projections in the Reference scenario are common in PRIMES, TRANSTOOLS, PRIMES transport model, TREMOVE and GEM-E3.

³¹⁵ Communication from the Commission: Europe 2020. A strategy for smart, sustainable and inclusive growth. COM(2010)2020, Brussels, 3.3.2010.

ageing, with a reduction in the working-age population, is expected to act as a drag on growth. Over time, labour productivity will become the only driver of growth in the EU³¹⁶. Nonetheless, there is considerable uncertainty concerning the medium-term economic outlook.

18. The recent economic crisis has added to the challenges regarding the sustainability of public finances. Overall, as an effect of both the economic crisis and the ageing population, without fiscal consolidation the gross debt-to-GDP ratio for the EU as a whole could reach 100% as early as 2014 and 140% by 2020^{317,318}. The recent economic crisis will therefore limit further, in addition to age-related public expenditures, the funding available for the construction and maintenance of transport infrastructure and for public transport.

1.3. Increasing scarcity of fossil fuels

19. Transport depends heavily on oil and oil products: for more than 95% of its needs worldwide and 96% in EU-27³¹⁹. At the same time, more than 60% of the petroleum products used in OECD countries and about half of those used in non-OECD countries are used as transport fuels³²⁰.
20. The high oil dependence of the transport sector can be explained by the high energy density and relatively easy handling/transportation characteristics of oil products, the low oil prices compared to available alternatives over the past 20 years and the extensive oil-based infrastructure and vehicle stock already in place. By contrast, most alternative fuels require extensive investments in infrastructure and fuel delivery systems as well as new types of vehicles, which make it difficult for alternative fuels to compete with oil products.
21. The high oil dependence of the transport sector constitutes a risk to a low-cost, uninterrupted and large-scale fuel supply due to the concentration of proven reserves in politically less stable regions, the depletion of reserves and growing global demand. This leads to a high uncertainty surrounding oil price developments. Reserves in the Middle East alone account for 57% of the world's proven reserves while the EU merely contributes 0.5%³²¹. Security of supply is particularly important because oil products would still cover 90% of the EU transport sector's energy needs in 2030 and 89% in 2050 in a "no-policy change" scenario.

³¹⁶ European Commission, DG Economic and Financial Affairs: 2009 Ageing Report: Economic and budgetary projections for the EU-27 Member States (2008-2060). EUROPEAN ECONOMY 2|2009, http://ec.europa.eu/economy_finance/publications/publication14992_en.pdf.

³¹⁷ European Commission, DG Economic and Financial Affairs: Sustainability Report 2009. EUROPEAN ECONOMY 9|2009, http://ec.europa.eu/economy_finance/publications/publication15998_en.pdf.

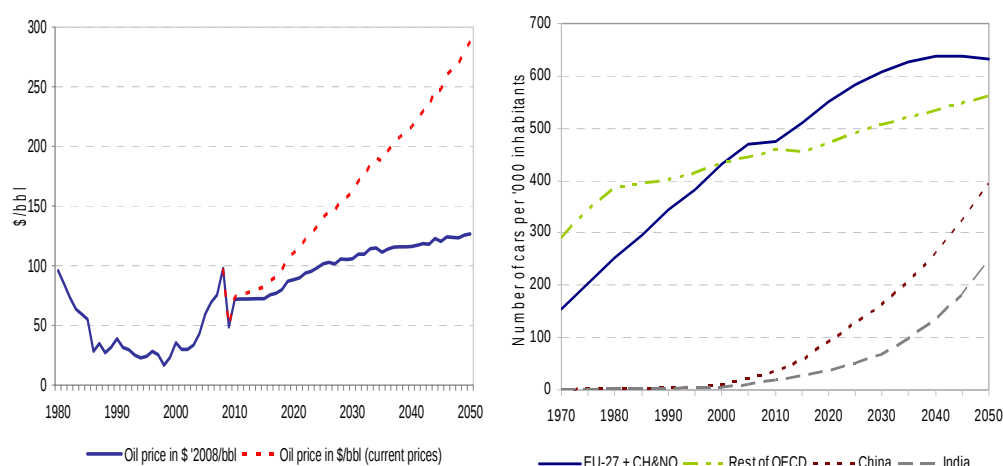
³¹⁸ European Commission, DG Economic and Financial Affairs: Public Finances in EMU 2010. EUROPEAN ECONOMY 4|2010, http://ec.europa.eu/economy_finance/publications/european_economy/2010/pdf/ee-2010-4_en.pdf.

³¹⁹ European Commission, EU Energy and Transport in Figures, 2010 http://ec.europa.eu/transport/publications/statistics/statistics_en.htm.

³²⁰ International Energy Agency, Transport, Energy and CO₂: Moving Towards Sustainability, 2009.

³²¹ BP, Statistical Review of World Energy 2010, <http://www.bp.com/productlanding.do?categoryId=6929&contentId=7044622>

22. The Reference scenario assumes a relatively high oil price environment compared with previous projections. The assumptions are however similar to recent projections by the International Energy Agency (IEA)³²²: From 59 \$/barrel in 2005, the oil price is expected to rise to 106 \$/barrel in 2030 and to 127 \$/barrel in 2050 (in year 2008-dollars)^{323,324}. In this scenario, total fuel costs for the transport sector would be about 300 bn € higher in 2050 relative to 2010.
23. However, there is uncertainty related to the oil price projections due to the timing and pace of economic recovery and the rebound in oil demand, the investments in oil productive and refining capacity and the expansion of non-conventional production. Therefore, beyond 2020 there is a sharp increase in the likelihood of prices exceeding 100\$/barrel³²⁵.



Source: Prometheus, National Technical University of Athens (E3MLab)

Figure 12: Oil price and car ownership projections in the Reference scenario

24. Similarly to IEA estimates, the oil price projections are based on only a moderate increase in the passenger light duty vehicles ownership in the emerging economies. For example, by 2050 the car ownership in China is assumed to reach 394 cars per thousand inhabitants, similar to levels in the EU-15 in the 1990s. The relatively moderate increase in car ownership could be explained by limits on infrastructure, greater income disparities and greater urbanisation combined with lower suburbanisation than in OECD countries³²⁶. Higher motorisation levels in the emerging economies than assumed for the projections constitutes an upside risk to the current oil price projections and thus to the transport cost projections.

³²² The IEA Energy Technology Perspectives 2010 assumes 115 \$/barrel in 2008 prices for 2030 and 120 \$/barrel for 2050. The IEA 2010 World Energy Outlook assumes an oil price around 110 \$/barrel for 2030 in the “New Policies Scenario”.

³²³ The oil price projections are the result of world energy modelling with the PROMETHEUS stochastic world energy model, developed by the National Technical University of Athens (E3MLab). The oil price assumptions are common in PRIMES, TRANSTOOLS, the PRIMES-TREMOVE transport model, TREMOVE and GEM-E3 models.

³²⁴ This would translate into an oil price of 91 €/barrel in 2030 and 118 €/barrel in 2050.

³²⁵ Result of the PROMETHEUS stochastic world energy model.

³²⁶ International Energy Agency, Transport, Energy and CO₂: Moving Towards Sustainability, 2009.

1.4. Technological improvements

25. Battery costs for plug-in hybrids and electric vehicles are assumed to remain high by 2050, at about 560-780 €/kWh³²⁷, but further improvements in the efficiency of both spark-ignition gasoline and compression-ignition diesel are assumed to take place. In addition, the market share of internal combustion engine (ICE) electric hybrids is expected to go up due to their lower fuel consumption compared with conventional ICE vehicles. However, there is high uncertainty related to technological developments.

2. REFERENCE SCENARIO MAIN RESULTS

2.1. Overall transport developments and accessibility

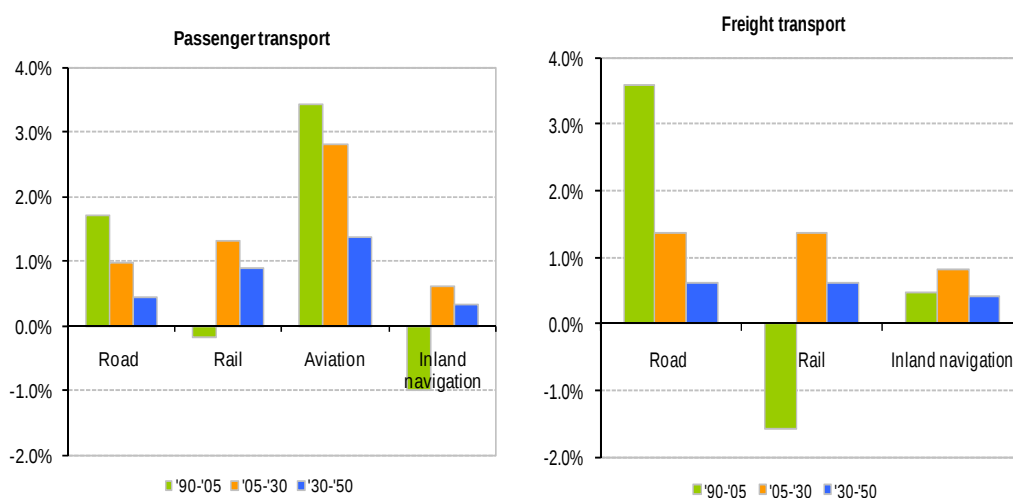
26. Total transport activity continues to grow in line with economic activity in the Reference scenario. Even though a decrease is visible for 2008-2009 as a result of the recent economic crisis, the recovery foreseen starting with 2010 is reflected by transport activity returning to its long-term trends. Road transport is expected to maintain its dominant role in both passenger and freight transport within the EU. Passenger transport by rail would grow slightly faster than passenger transport by road, while the growth rates in road and rail freight transport are expected to be similar. Air transport would grow significantly and increase its share of overall transport demand.
27. Total passenger transport activity is expected to grow by 34% between 2005 and 2030 in a “no-policy change” scenario, equivalent to an average growth of 1.2% per year. However, growth is not distributed proportionally among transport modes, with air transport activity almost doubling by 2030. The weaker growth in passenger transport compared to GDP per capita (1.4% per year) is explained by the assumption that passenger car activity in some EU-15 Members States is close to saturation levels and by national and EU policies to reduce the transport intensity of the economy.
28. Rail competes with both road and air, but the results on its performance differ considerably between the EU-15 and the EU-12. In the EU-15, given the expected saturation of passenger car demand, a large share of potential additional demand could be covered by (in most cases high-speed) rail, at least in the Member States where investments in (high-speed) rail are foreseen. At the same time, high-speed rail attracts traffic from air transport. In the EU-12, the competitive situation of rail relative to air and road is expected to worsen,³²⁸ resulting in slower growth than the other two main modes. After 2030 the slight decline in population combined with a

³²⁷ The Reference scenario does not cover the European Commission CARS 21 (Competitive Automotive Regulatory System for the 21st century) initiative. In addition, the Reference scenario was finalised in 2009/early 2010 and does not capture the recent initiatives of car manufacturers as regards electric vehicles (hereinafter “EV”).

³²⁸ Whereas most EU-15 Member States seem to reach a saturation level for growth in passenger car activity, the results of faster economic growth and rising car ownership levels would translate into higher growth in passenger car activity in the EU-12.

slowdown in GDP growth and the saturation of passenger car demand leads to somewhat lower growth rates in passenger transport activity.

29. The various modes are in general expected to maintain their relative importance at EU level. Passenger cars would represent almost 70% of total passenger activity in 2030 and 67% in 2050, although this would correspond to a decrease of 6 percentage points in modal share by 2050 compared to 2005³²⁹. Air transport on the contrary is expected to increase its share, reaching almost 15% of total activity in 2050 and consolidating its position as the second most important passenger mode³³⁰. The increase in air transport demand is a result of the expected increase in: the number of trips per person and year and the average distance per trip. Rail would improve its share moderately, gaining less than 1 percentage point by 2050, up to 8% of passenger transport.



Source: PRIMES-TREMOVE transport model

Figure 13: Passenger and freight transport projections (average growth rate per year)

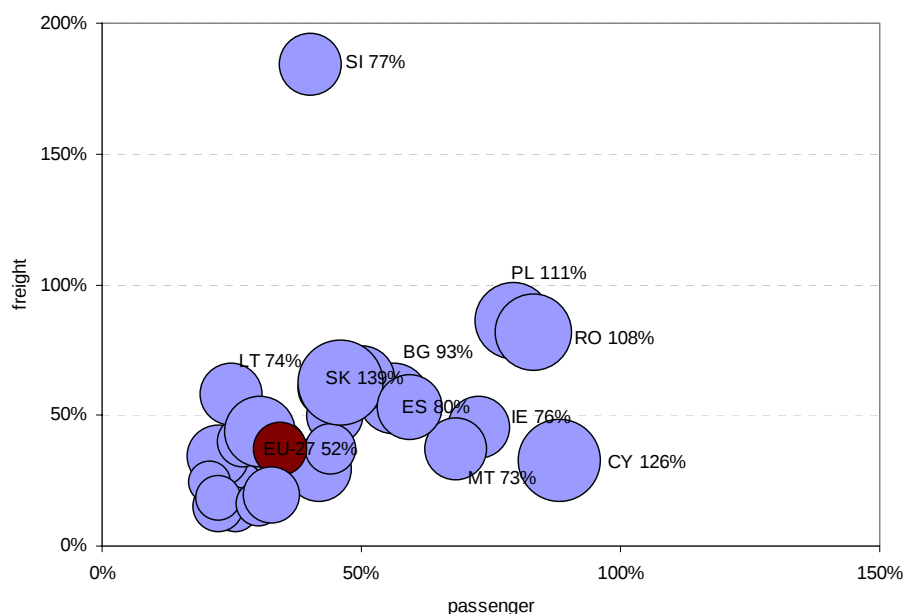
30. Several factors influencing the freight transport sector, including the restructuring of logistics systems, the realignment of supply chains and the rescheduling of product flows, are expected to change gradually during the period 2005-2050 but without affecting much the overall trends. The developments in production and consumption patterns would lead to an increase in the average transport distances and a larger share of unitized /non-bulk goods.
31. Total freight transport volumes are expected to grow by about 38% by 2030, with road and rail growing at comparable rates. The developments in rail freight are sustained by a slower increase in fuel costs and the positive impacts of the opening of the rail markets. Road transport would maintain its dominant role in inland freight transport, contributing 73% in 2030, followed by rail (with 17%). Both road and rail

³²⁹ The share of total road transport (including buses and coaches and powered 2-wheelers besides passenger cars) in total passenger transport would be about 79% in 2030 and 77% in 2050.

³³⁰ The shares are expressed in passenger-kilometres.

slightly increase their shares between 2005 and 2030 to the expense of inland navigation, which is expected to grow at a lower pace.

32. The geographic distribution of freight transport growth is not uniform. In absolute terms, road transport in the EU-15 will attract most of the growth in demand. However, in relative terms, the transport volumes in the EU-12 will increase much faster. Growth is expected to be high for all modes in the new Member States, with road being the fastest growing one. Inland waterways traffic, especially on the Danube, is also expected to grow by more than 80% by 2030.



Source: PRIMES-TREMOVE transport model

Note: Bubble size corresponds to relative GDP growth between 2005 and 2030 (in %)

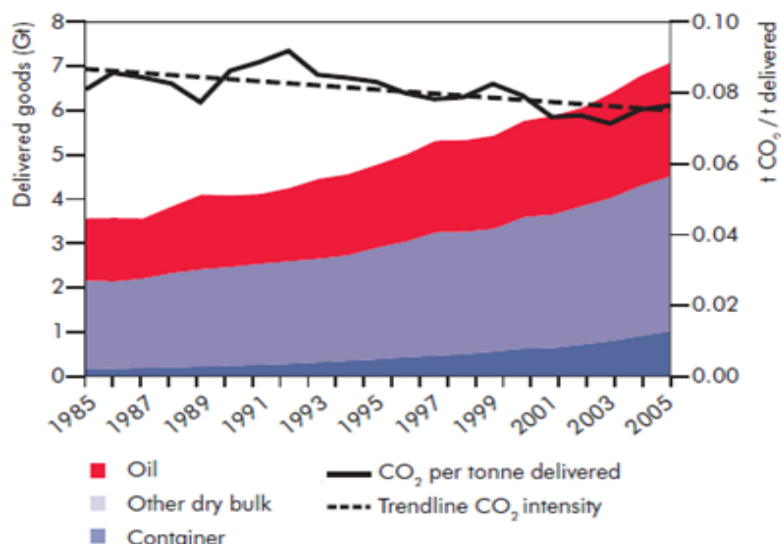
Figure 14: Growth in passenger and freight transport activity and GDP growth per Member State (2005-2030)

33. Beyond 2030, a certain weakening in freight transport activity is expected relative to 2005-2030. Several factors contribute to this outcome: weaker growth prospects after 2030, shifts in GDP composition towards service and information activities³³¹, shifts in value-to-weight ratios and limits to distant sourcing and off-shoring.
34. The international shipping industry carries about 90% of world trade. In recent years, international maritime activity has grown significantly, driven in particular by the growth in globalisation. Maritime trade is expected to continue growing with rising demand for oil, coal, steel and other primary resources – which will be more distantly sourced. For example, with the plateauing of iron ore production in Australia, China has started to source iron ore from Brazil and Africa³³².

³³¹ Result of the GEM-E3 model.

³³² International Energy Agency, Transport, Energy and CO₂: Moving Towards Sustainability, 2009.

35. The growth projections regarding international shipping are highly uncertain because they depend heavily on the growth in the production and consumption of raw materials and manufactured goods, and the location of these activities. At global level, growth projections vary by up to 300% in 2050 depending on the specific assumptions used. The IEA assumes slightly more than a doubling of shipping tonne-kilometres between 2005 and 2050³³³, based on growth projections from the International Maritime Organisation.



Source: IEA, 2010 Energy technology perspectives

Figure 15: Trends in maritime transport volumes and related CO₂-equivalent emissions

36. Almost 90% of the EU external trade is seaborne. In 2008, Europe accounted for about 15% of the global goods loaded and 24% of all goods unloaded at ports globally³³⁴. In the Reference scenario maritime and road freight transport activity are projected to grow at comparable rates up to 2030. Maritime transport activity is expected to almost double by 2050 relative to 2005³³⁵.
37. Recent evidence on agglomeration economies suggests that economic growth, labour migration and accessibility are closely interrelated³³⁶. High accessibility to raw materials, suppliers and markets is positive for the competitiveness of regions³³⁷. Accessibility is however a necessary but not a sufficient prerequisite for the positive economic development of regions.

³³³ International Energy Agency, Transport, Energy and CO₂: Moving Towards Sustainability, 2009.

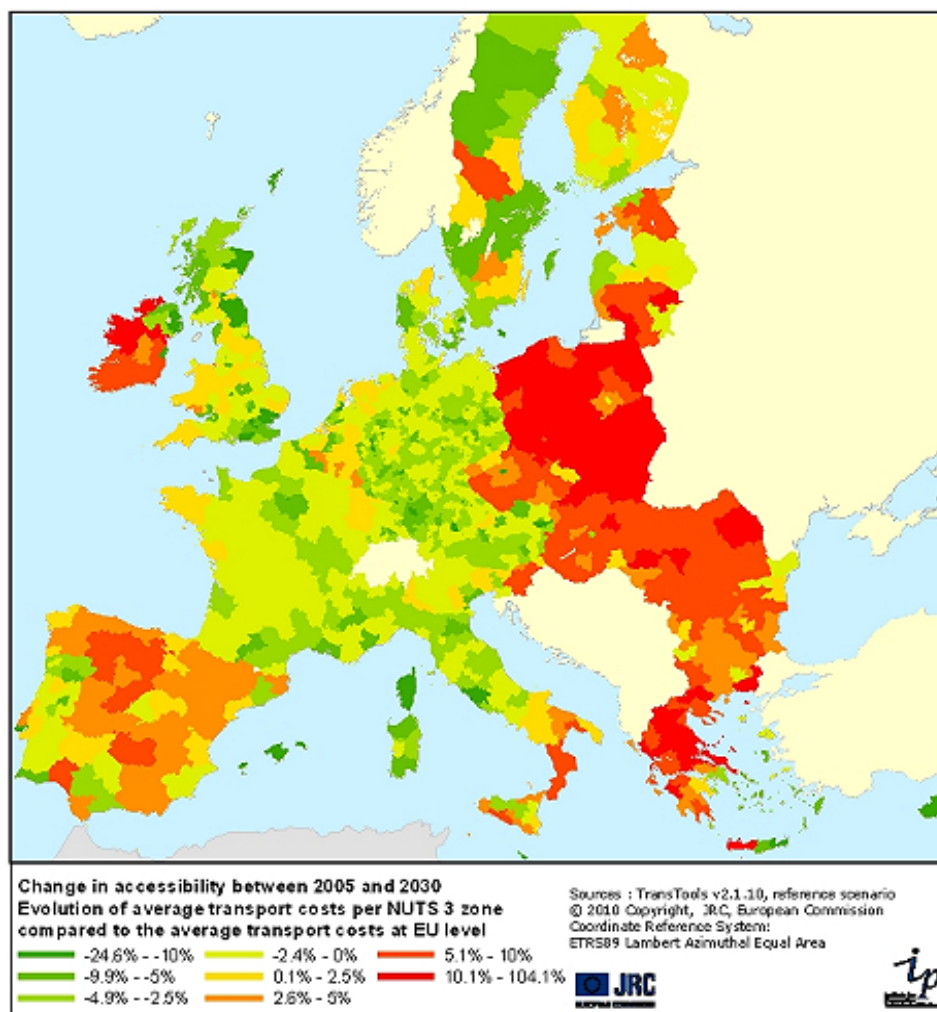
³³⁴ United Nations Conference on Trade and Development (UNCTAD), Review of maritime transport 2009.

³³⁵ An increase in the consumption of biofuels may also trigger higher demand for the transport of agricultural bulks to supply bio-refineries.

³³⁶ World Bank, World Development Report 2009: Reshaping economic geography.

³³⁷ ESPON project, Territorial Dynamics in Europe: Trends in Accessibility, Territorial Observation No. 2, 2009.

38. The current situation in terms of accessibility³³⁸ in the EU suggests that there is a marked division between central and peripheral areas as regards their transport connectivity and costs as a result of geography and patterns of economic activity. Peripheral areas require longer average trips to reach the rest of the EU using, in most cases, more expensive modes and networks than those available in central areas. As a result, their average transport costs are higher.
39. Fuel costs and congestion levels are expected to rise significantly by 2030, leading to further divergences in accessibility. The situation of peripheral areas with a high share of road transport is expected to worsen as they face higher average transport cost increases than central areas.



Source: TRANSTOOLS

Figure 16: Change in accessibility between 2005 and 2030 in the Reference scenario

³³⁸ Accessibility here is based on the concept of “potential accessibility”, which assumes that the attraction of a destination increases with size, and declines with distance, travel time or cost. More specifically, accessibility is defined as the generalised transport costs from zone i to zone j for segment r (commodity group or trip purpose) in year t , weighed with the traffic volumes.

2.2. Urbanisation and congestion

40. There are around 5,000 towns with a population between 5,000 and 50,000 and almost 1,000 cities with a population above 50,000 in the EU. Economic, social and cultural activity is concentrated in these places³³⁹. Urbanisation has followed a clear trend in the past decades, which is expected to continue: the proportion of the EU population residing in urban areas is expected to increase from 74% in 2009 to about 80% in 2030 and 85% in 2050³⁴⁰.
41. Economic activity in the EU is far more concentrated than the population. In a knowledge-based economy, knowledge spillovers, which require proximity, become important. Services are also spatially concentrated because they tend to use less land per employee and because of external economies³⁴¹. Services already represent about 72% of the EU gross value added and their share is projected to increase in the Reference scenario to 76% by 2050. Therefore, proximity of people and activities as well as the shift towards a knowledge-based and services-oriented economy are major sources of advantages that will continue to drive urbanisation in the EU.
42. Urban sprawl is the main challenge for urban transport, as it brings about a greater need for individual transport modes, thereby generating congestion, environmental problems and land take for roads and parking areas. After 2035, due to the projected decline in the European population, many cities may have to cope with the problems of low-density settlements³⁴².
43. Transport demand and modal choice differ widely between European cities, and depend to a large extent on urban design and infrastructure³⁴³ (i.e. the location of facilities necessary on a daily basis and their accessibility by different transport modes influences the travel patterns). However, other factors such as income, family size and structure, employment, speed, culture and behaviour also affect transport demand³⁴⁴.

³³⁹ European Commission, Directorate-General for Regional Policy (2009), Promoting Sustainable Urban Development in Europe: Achievements and Opportunities, http://ec.europa.eu/regional_policy/sources/docgener/presenta/urban2009/urban2009_en.pdf.

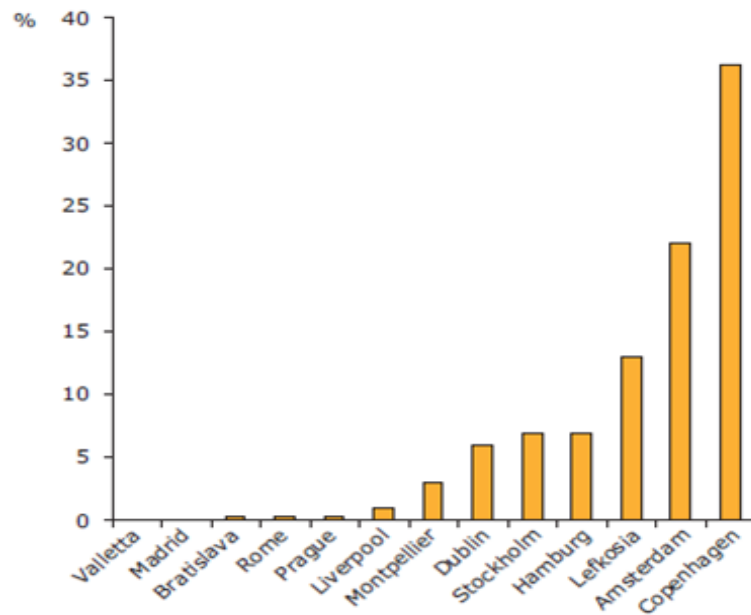
³⁴⁰ United Nations, Department of Economic and Social Affairs/Population Division (2009), World urbanisation prospects - The 2009 revision, <http://esa.un.org/unpd/wup/index.htm>

³⁴¹ World Bank, World Development Report 2009: Reshaping economic geography.

³⁴² EEA, 2010. The European environment — state and outlook 2010: urban environment. European Environment Agency, Copenhagen.

³⁴³ EEA, 2010. The European environment — state and outlook 2010: urban environment. European Environment Agency, Copenhagen.

³⁴⁴ Clifton, K., Ewing, R., Knaap, G. and Song, Y., 2008. Quantitative analysis of urban form: a multidisciplinary review. *Journal of Urbanism*. Vol. 1, No. 1, March 2008.



Source: EEA (2010) based on Urban Audit database (Eurostat, 2010).

Figure 17: Proportion of cycle trips to work in a selection of European cities, 2004

44. At EU level, urban transport is responsible for about 23% of total CO₂ emissions from transport^{345,346}. About 70% of the CO₂ emissions in urban transport come from passenger cars, followed by goods transport vehicles which provide another 27%. The Reference scenario shows diverging trends for passenger and freight CO₂ emissions at urban level: while the emissions from passenger transport decrease by about 22% by 2050, mainly due to the Regulation setting emission performance standards for new passenger cars³⁴⁷, CO₂ emissions from road freight transport would increase by some 16%. Overall, urban transport CO₂ emissions would shrink by about 9% by 2030 and another 3% between 2030 and 2050.
45. An important share of EU's urban population is exposed to air pollution concentration exceeding the EU air quality limits. Sensitive groups, including people with respiratory diseases or heart conditions and older adults suffer from air pollutants even at moderate concentrations. In many European urban studies air pollution, especially particulate matter and O₃, has been associated with increases in morbidity and mortality. Transport is a main source of PM₁₀ and NO_x emissions (which contributes to ozone creation) together with industry, commercial and residential sources).³⁴⁸ In the Reference scenario, the NO_x and particulate matter emissions attributed to urban transport would decrease by about 60% by 2030 and roughly stabilize afterwards.

³⁴⁵ Total CO₂ emissions include international bunkers (aviation and maritime) but exclude combustion emissions from pipeline transportation, ground activities in airports and harbours, and off-road activities.

³⁴⁶ No statistics are available for the share of CO₂ emissions from urban transport. The current estimates are based on the PRIMES transport model and TREMOVE results.

³⁴⁷ Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO₂ emissions from light-duty vehicles, OJ L 140, 5.6.2009, p. 1–15.

³⁴⁸ EEA, 2010. The European environment — state and outlook 2010: urban environment. European Environment Agency, Copenhagen.

Table 18: The 10 most polluted cities in 2008 for daily PM₁₀, O₃ concentrations and NO₂ annual mean concentration in the urban area

Number of days of PM ₁₀ exceedances of EU limit value of 50 ug/m ³ (daily mean)		Number of days of O ₃ exceedances of EU target value of 120 ug/m ³ (maximum daily 8 hours mean)		NO ₂ annual mean concentrations in ug/m ³ (the EU limit value is 40 ug/m ³)	
Plovdiv, Bulgaria	208	Turin, Italy	77	Brescia, Italy	62
Pleven, Bulgaria	185	Campobasso, Italy	74	Turin, Italy	60
Sofia, Bulgaria	176	Bologna, Italy	72	Brasov, Romania	58
Krakow, Poland	152	Bergamo, Italy	69	Modena, Italy	50
Timisoara, Romania	136	Athens, Greece	68	Milan, Italy	49
Rybnik, Poland	122	Novara, Italy	65	Trieste, Italy	48
Nowy Sacz, Poland	116	Cremona, Italy	64	Rome, Italy	43
Craiova, Romania	112	Brescia, Italy	64	Athens, Greece	42
Zabrze, Poland	108	Milan, Italy	62	Padua, Italy	41
Turin, Italy	106	Reggio nell Emilia, Italy	61	Genoa, Italy	41

Source: EEA and AirBase, 2010

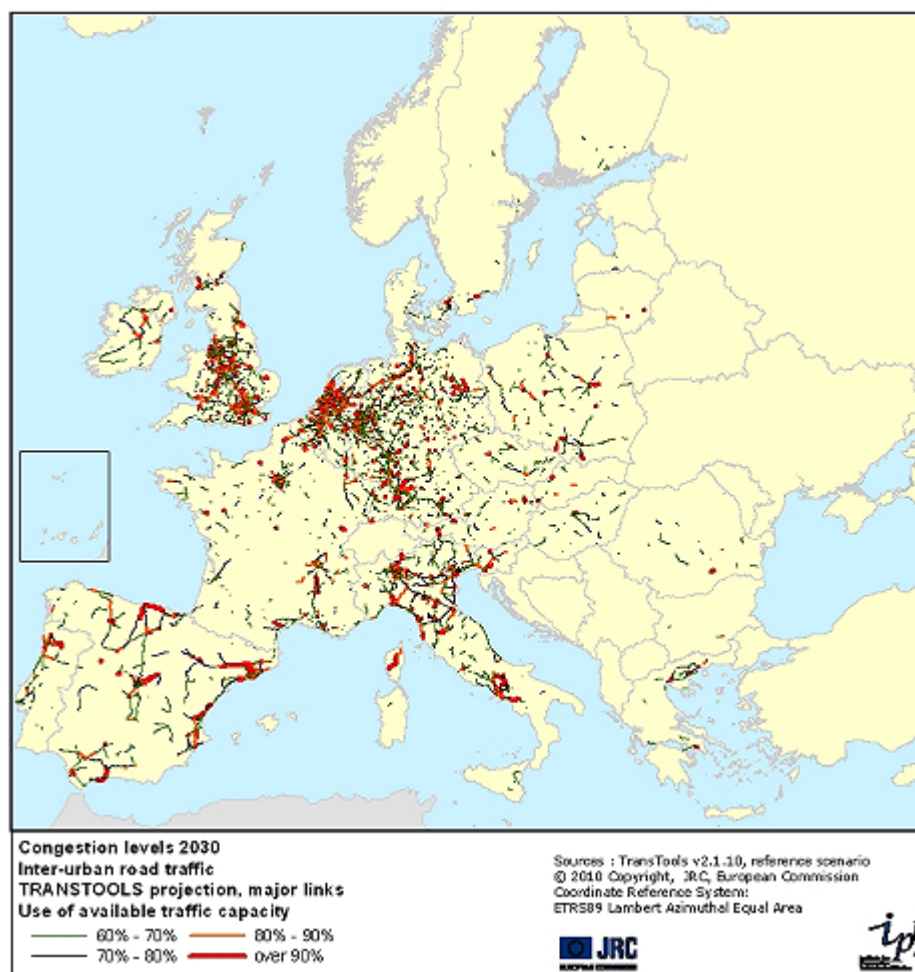
46. About half of the citizens in the EU-15 are estimated to live in areas which do not ensure acoustical comfort for residents: 40% of the population is exposed to road traffic noise exceeding 55 dB(A) during daytime, and 20% to levels exceeding 65 dB(A). At night, more than 30% are exposed to sound levels that disturb sleep (>55 dB(A)). The WHO Night Noise Guidelines for Europe³⁴⁹ describe levels above 55 dB L_{night} as ‘increasingly dangerous to public health. However, for the primary prevention of sub-clinical adverse health effects related to night noise, the guidelines recommend that the population should not be exposed to night noise levels greater than 40 dB L_{night} outside. This can thus be considered a health-based limit. The target of 55 dB L_{night} outside is not a health-based limit, being equivalent to the lowest observed adverse effect level, and should be considered only as an interim target for situations where the achievement of the guidelines is not feasible in the short run. Existing studies show that noise exposure increases the risk for high blood pressure and heart attacks. Surveys also show that (environmental) noise is a relevant reason for people moving out of cities into the suburban area (e.g. for every third household moving out of Cologne, noise and air pollution in the city was a crucial reason)³⁵⁰. In the Reference scenario, increasing traffic volumes in absence of additional policies may exacerbate the existing problems³⁵¹.
47. Congestion that is prevalent in agglomerations and in their access routes is the source of large costs in terms of delays and higher fuel consumption. Denser cities are better served by collective modes of transport but the availability of land and public acceptability to construct new infrastructures for public or alternative means of transport remains a great challenge. Urban congestion also negatively impacts on inter-urban and cross-border travel because most freight and passenger transport starts or ends in urban areas.

³⁴⁹ http://www.euro.who.int/__data/assets/pdf_file/0017/43316/E92845.pdf

³⁵⁰ SILENCE project (Integrated Project co-funded by the European Commission under the 6th Framework Programme for R&D): SILENCE Practitioner Handbook for Local Noise Action Plans, 2008, http://www.silence-ip.org/site/fileadmin/SP_J/E-learning/Planners/SILENCE_Handbook_Local_noise_action_plans.pdf

³⁵¹ EEA, 2010. The European environment — state and outlook 2010: urban environment. European Environment Agency, Copenhagen.

48. High congestion levels are expected to seriously affect road transport in several Member States by 2030 in the absence of effective countervailing measures such as road pricing. While urban congestion will mainly depend on car ownership levels, urban sprawl and the availability of public transport alternatives, congestion on the inter-urban network will be the result of growing freight demand across specific corridors at their points of intersection with links serving local traffic.
49. The largest part of congestion will be concentrated near densely populated zones with high economic activity such as Belgium and the Netherlands – to a certain extent as a result of port and transshipment operations – and in large parts of Germany, the United Kingdom and northern Italy. Congestion patterns differ significantly among Member States though, since their hourly, daily and seasonal variation depends on local conditions.
50. Estimating the costs of congestion is not straightforward, because it occurs mostly during certain times of the day, often caused by specific bottlenecks in the network. In the Reference scenario, congestion costs are projected to increase by about 50% by 2050, to nearly € 200 billion annually.



Source: TRANSTOOLS

Figure 18: Congestion levels for inter-urban road traffic in 2030

2.3. Environmental impacts and other externalities

2.3.1. CO₂ emissions

51. Transport accounts for over 30% of final energy consumption and about one fourth of CO₂ emissions^{352,353}. In the Reference scenario, the final energy demand of transport is projected to increase by 5% by 2030 and an additional 1% by 2050, driven mainly by aviation and road freight transport. By contrast, the energy use of passenger cars would drop by 11% between 2005 and 2030 due to the implementation of the Regulation setting emission performance standards for new passenger cars³⁵⁴.
52. CO₂ emissions from transport are projected to be 1% below their 2005 level by 2030 and roughly stabilise afterwards. This outcome is sustained by the implementation of the Regulation setting emission performance standards for new passenger cars, the penetration of biofuels in road transport and the further electrification of rail. Renewable energy sources would cover 10% of the energy needs of transport by 2020, reflecting the implementation of the Renewables Directive³⁵⁵. Their share would gradually increase to 13% by 2050³⁵⁶. However, the pace of the electrification in the sector is projected to remain slow in the Reference scenario: electric propulsion in road transport would not make significant inroads by 2050³⁵⁷.

³⁵² The CO₂ emissions include international maritime and aviation but exclude combustion emissions from pipeline transportation, ground activities in airports and harbours, and off-road activities.

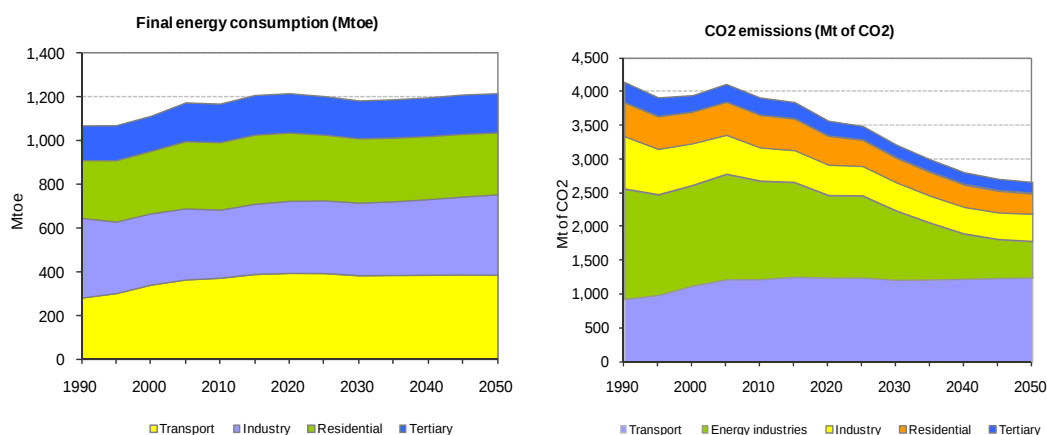
³⁵³ There is also concern regarding aviation's total climate impact which has been estimated by the IPCC as being two to four times higher than the effect of CO₂ emissions alone due to releases of nitrogen oxides, water vapour, sulphate and soot particles (excluding cirrus cloud effects).

³⁵⁴ Regulation (EC) No 443/2009 of the European Parliament and of the Council of 23 April 2009 setting emission performance standards for new passenger cars as part of the Community's integrated approach to reduce CO₂ emissions from light-duty vehicles, OJ L 140, 5.6.2009, p. 1–15.

³⁵⁵ Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, OJ L 140, 5.6.2009, p. 16–62.

³⁵⁶ The share of renewables in transport reported here follows the definition from the Directive 2009/28/EC.

³⁵⁷ The Reference scenario does not cover the European Commission CARS 21 (Competitive Automotive Regulatory System for the 21st century) initiative. This initiative may trigger a higher uptake of electric propulsion vehicles by 2050 in the Reference scenario which is currently negligible. In addition, the Reference scenario was finalised in early 2010 and does not capture the recent initiatives of car manufacturers as regards electric vehicles. As a result, the penetration of EVs might be higher and transport sector oil dependency might be lower in the Reference scenario.



Source: PRIMES and projections based on TRANSTOOLS for maritime

Figure 19: Final energy consumption and CO₂ emissions projections³⁵⁸

53. The share of CO₂ emissions from transport would continue increasing, to 38% of the total by 2030 and almost 50% by 2050. This is due to a relatively lower reduction of CO₂ emissions from transport compared to other sectors such as power generation over the projection period. Overall, CO₂ emissions from transport would still be 31% higher than their 1990 level by 2030 and 35% higher by 2050, owing to the fast rise in the transport emissions during the 1990s. Aviation and maritime transport would contribute an increasing share of emissions over time.
54. The overall trend in transport emissions is determined by three broad components: transport activity levels, the energy intensity of transport and the carbon intensity of the energy used. Following this approach, it has been evaluated how much the projected transport emissions³⁵⁹ will increase/decrease (in percentage terms or Mt of CO₂) between 2005 and 2050 due to transport activity growth, improvements in energy intensity and carbon intensity^{360,361}.
55. Overall, CO₂ emissions from passenger transport decrease by 8% (60 Mt of CO₂) between 2005 and 2050 in the Reference scenario.
56. Transport activity growth results in a 47% (345 Mt of CO₂) increase in passenger transport emissions, with demand for interurban and intercontinental transport being responsible for most of these additional emissions.

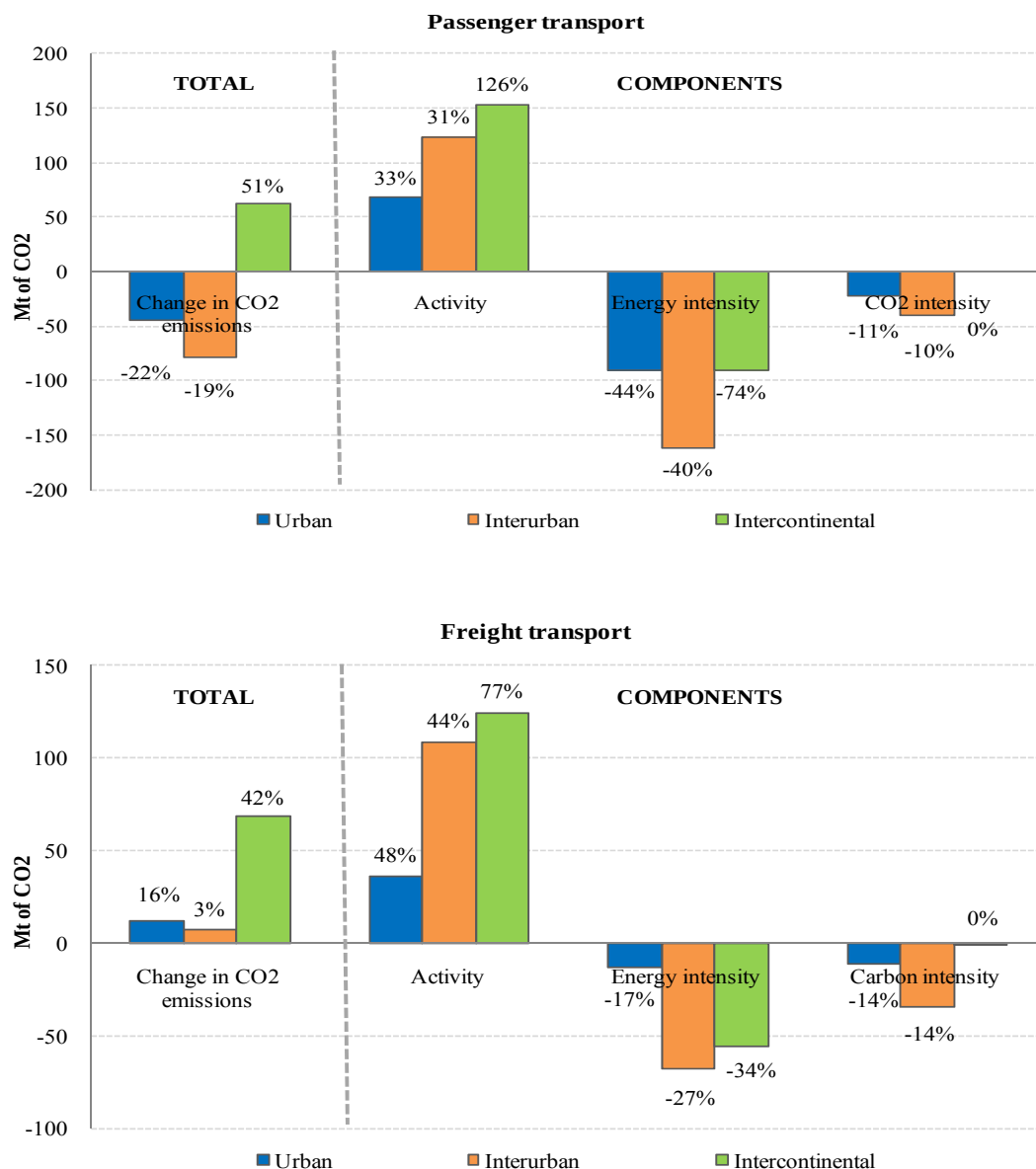
³⁵⁸ The CO₂ emissions from transport include international maritime and aviation but exclude combustion emissions from pipeline transportation, ground activities in airports and harbours, and off-road activities.

³⁵⁹ The CO₂ emissions from transport include international maritime and aviation but exclude combustion emissions from pipeline transportation, ground activities in airports and harbours, and off-road activities.

³⁶⁰ The proposed method is the Montgomery decomposition. For a recent application of the method see: De Boer, P.M.C. (2008) Additive Structural Decomposition Analysis and Index Number Theory: An Empirical Application of the Montgomery Decomposition, *Economic Systems Research*, 20(1), pp. 97-109.

³⁶¹ The decomposition analysis only takes into account the tank-to-wheel emissions, under the assumption that biofuels are carbon neutral.

57. Improved energy intensity reduces passenger transport emissions by 46% (342 Mt of CO₂), compensating the expansion of emissions due to transport activity growth. Efficiency improvements are triggered by the implementation of the Regulation setting emission performance standards for new passenger cars and by efficiency gains in aviation. For rail passenger transport, efficiency gains play a limited role due to the uptake of high-speed rail on larger scale.
58. The improvement in carbon intensity through the use of less GHG_intensive fuels has a more limited impact on passenger transport emissions, with CO₂ emissions decreasing by 9% on a tank-to-wheel basis (63 Mt of CO₂) between 2005 and 2050. The penetration of renewables in road transport (mostly biofuels) contributes to a large extent to the carbon intensity gains on a tank-to-wheel basis, followed by rail transport electrification. However, the GHG emissions for the production of biofuels are not included in this analysis.
59. Summing up, the 8% decrease in CO₂ emissions from passenger transport is due to transport activity growth (+47%), improvements in energy intensity (-46%) and in carbon intensity (-9%). The trend for the three components and their contribution to emissions is different in the various transport modes. Efficiency gains play a decisive role in reducing emissions in road transport, while in aviation they would not offset the activity growth leading to higher fuel use and emissions. The use of less GHG intensive fuels contributes to a reduction of emissions for road and rail passenger transport with no effect on aviation in the Reference scenario.
60. For freight transport, the 18% (88 Mt of CO₂) increase in CO₂ emissions between 2005 and 2050 is the result of transport activity growth (+55%, equivalent to 269 Mt of CO₂), improvements in energy intensity (-28%, equivalent to 136 Mt of CO₂) and in carbon intensity (-9%, equivalent to 45 Mt of CO₂).
61. The trends in projected emissions of different freight transport modes are also diverging. On one hand, the efficiency gains and the uptake of alternative fuels for road transport and the efficiency gains in maritime transport are not sufficient to offset the effects of activity growth, resulting in growing emissions. In the Reference scenario the pace in the electrification of the transport sector is slow: electric propulsion vehicles do not make significant inroads by 2050. On the other hand, the electrification in rail has positive effects on emissions, despite the growth in traffic volumes.



Source: PRIMES-TREMOVE transport model

Note: The figures report the changes in CO₂ emissions due to the three broad components (transport activity levels, energy intensity of transport and carbon intensity of the energy used) in two ways: in levels and in relative terms compared to 2005. The size of each column bar, read on the left axis, represents the change in terms of CO₂ emissions compared to 2005, expressed in Mt of CO₂. The percentage changes reported above the column bars represent relative changes in these emissions compared to their respective 2005 levels. Provided that CO₂ levels for 2005 corresponding to each transport mode are not comparable in size, the percentage changes reported in the figures are not directly comparable. The figures above include only tank-to-wheel emissions.

Figure 20: Decomposition of CO₂ emissions in the Reference scenario (2005-2050)

2.3.2. Air pollution and other externalities

62. Emissions of air pollutants result in risks to human health and the natural environment. For example, exposure to particulate matter is linked with respiratory problems such as asthma, impaired lung development and lower lung function in children, acute and chronic cardiovascular effects, reduced birth weight and premature death^{362,363}, while emissions of nitrogen oxides (NO_x) contribute to acidification and eutrophication of ecosystems as well as to the formation of ground level ozone. There have also been numerous articles showing the linkages between air pollutants and climate change and how short-term climate change mitigation can be achieved by tackling some of the most potent air pollutants: ground level ozone (including methane as an important precursor) and particulate matter (including “black carbon”) are particularly relevant.
63. Air quality standards and targets exist in the EU for a range of pollutants, with the aim of protecting human health. However, the limits and targets for particulate matter (PM₁₀), nitrogen dioxide (NO₂) and ozone (O₃) are or are expected to be widely exceeded. In 2008, 296 (out of 821) zones in 21 Member States did not comply with daily limits for particulate matter (PM₁₀) and most of the Member States have made use of the possibility to notify a time extension for compliance, as provided in the Directive 2008/50/EC on ambient air quality³⁶⁴. A similar situation is expected to emerge for NO₂, where 188 (out of 822) zones have reported exceedances of the legally binding annual limit value laid down in that Directive.
64. About 12 Member States are also expected to exceed their limit under Directive 2001/81/EC on national emission ceilings for certain atmospheric pollutants, which applies from 2010³⁶⁵, some by as much as 50%³⁶⁶.
65. Road transport contributes significantly to the difficulties many Member States have in attaining their NO_x ceilings, through higher than anticipated emissions. Around 40% of total NO_x emissions in EU-27 come from road transport, and their reduction has not met the original expectations although overall emissions have decreased compared to 1990. The main reasons were the higher than expected growth in road transport activity and the fact that those vehicle emission standards have not always delivered the foreseen level of NO_x reductions (i.e. higher real world emissions than the limits in the type approval)³⁶⁷. In the Reference scenario, the implementation of the current vehicle emission standards (up until Euro VI) is expected to lead to a

³⁶² WHO, 2005. Air Quality Guideline. Global update 2005. World Health Organisation Regional Office for Europe.

³⁶³ WHO, 2007. Health relevance of particulate matter from various sources. Report on a WHO Workshop Bonn, Germany, 26–27 March 2007. World Health Organization Regional Office for Europe.

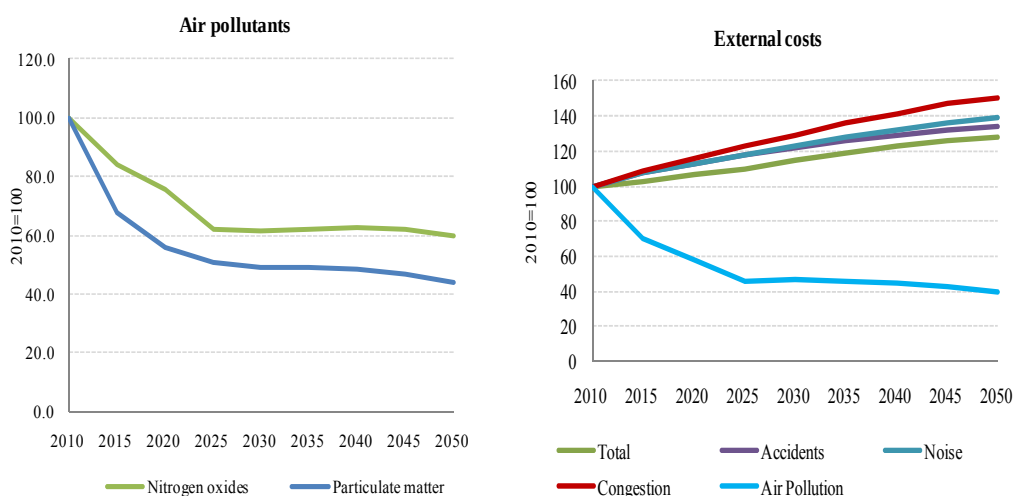
³⁶⁴ Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe, OJ L 152, 11.6.2008, p. 1–44.

³⁶⁵ Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, OJ L 309, 27.11.2001, p. 22–30.

³⁶⁶ EEA, 2010. The European environment — state and outlook 2010: air pollution. European Environment Agency, Copenhagen.

³⁶⁷ EEA, 2010. NEC Directive status report 2009: Reporting by the Member States under Directive 2001/81/EC of the European Parliament and of the Council of 23 October 2001 on national emission ceilings for certain atmospheric pollutants, No 10/2010.

further decline in the emissions of air pollutants by 2030, and a stabilisation afterwards assuming a full fleet renewal. However, the expected magnitude of the decline may be reduced by higher real world emissions and slower turn-over rates of the vehicle fleet than expected in particular in the period up until 2020.



Source: PRIMES-TREMOVE transport model

Figure 21: Evolution nitrogen oxides and particulate matter and external costs in the Reference scenario

66. Transport infrastructure, along with energy infrastructure, and land use changes such as uptake by urban sprawl and agricultural intensification contributes to the fragmentation of ecosystems. The EU is the most fragmented continent in the world: nearly 30% of land in the EU is moderately, highly or very highly fragmented. This has a significant impact on habitats and ecosystems. If ecosystems become too small or isolated, they might not deliver their services to people anymore, such as water and air purification and flood water retention, climate change adaptation and mitigation, nutrient cycling, tourist values etc.³⁶⁸ This depletion of ecosystems is exacerbated by climate change impacts. Fragmentation and land consumption by transport infrastructure also leads to the loss of significant areas of fertile soil and useful agricultural land due to soil sealing.

³⁶⁸

More in TEEB (The Economics of Ecosystems and Biodiversity): <http://www.teebweb.org/> and http://ec.europa.eu/environment/nature/biodiversity/economics/index_en.htm

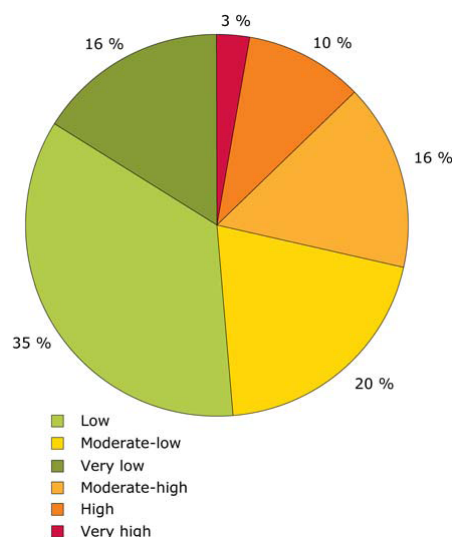


Figure 22: Fragmentation as percentage of total EU terrestrial area shows that nearly 30 % of EU land is moderately-high to very high, mostly due to urban sprawl and infrastructure development³⁶⁹

67. In the Reference scenario external costs of transport will continue increasing. The increase in traffic would lead to a roughly 20 bn € increase of noise-related external costs by 2050 and external cost of accidents would be about 60 bn € higher³⁷⁰. The external cost of accidents associated with urban transport would increase by some 40%. Only the external costs related to air pollutants would decrease by 60% by 2050 assuming a full implementation of current EURO standards.

2.4. Global trends affecting the European transport sector

68. Global GDP is projected to increase more than threefold between 2006 and 2050³⁷¹. Faster economic growth can be expected in industrialising and developing countries than in the developed economies. This higher growth will lead to an increased importance in world trade of emerging economies such as China, India and Brazil. The tangible result will be a change in trade flows and volumes.

69. A doubling of global traffic is projected for both motorised passenger travel and for surface freight transport by 2050, mainly driven by the developing economies. International shipping activity would follow a similar trend³⁷².

70. Global maritime transport will be influenced by the increasing size of vessels, by the expansion of the Panama Canal (completion foreseen in 2014) and by the development of new transshipment hubs, e.g. in North Africa. Projections for aviation show an increase by a factor of four for passenger and freight transport between 2005 and 2050³⁷³. While the biggest growth in both air and maritime traffic will occur

³⁶⁹ <http://www.eea.europa.eu/publications/eu-2010-biodiversity-baseline/eu-2010-biodiversity-baseline>

³⁷⁰ The costs are expressed in year 2005-€.

³⁷¹ See e.g. PWC (2008), The world in 2050.

³⁷² http://www.pwc.com/en_GX/gx/world-2050/pdf/world_in_2050_carbon_emissions_08_2.pdf

International Energy Agency 2010, Energy Technology Perspectives: 2010. Please note that the IEA MoMo model currently does not enable a projection for shipping and air cargo transport. Therefore, international shipping activity in the Energy Technology Perspectives 2010 is based on growth projections from the International Maritime Organisation.

³⁷³ International Energy Agency, Transport, Energy and CO₂: Moving Towards Sustainability, 2009.

outside Europe, the EU's main gateways for international traffic – airports and ports – will be seriously affected, and increasingly short of capacity. Traffic on the hinterland connections to these entry points will also be affected, leading to possible additional congestion and pollution. In addition, the possible melting of the Arctic permafrost during the summer may temporarily open up new routes and possibilities.

Appendix 4: Inventory of policy measures relevant for the transport sector included in the 2050 Reference scenario

	Measures		How the measure is reflected in PRIMES and TRANSTOOLS
1	Biofuels directive	Directive 2003/30/EC	Support to biofuels is reflected in the model
2	RES directive	Directive 2009/28/EC	10% target for RES in transport is achieved for EU27; sustainability criteria for biomass and biofuels are respected
3	GHG Effort Sharing Decision	Decision 406/2009/EC	National targets for non-ETS sectors are achieved in 2020, taking full account of the flexibility provisions such as transfers between Member States. After 2020, stability of the provided policy impulse but no strengthening of targets is assumed.
4	EU ETS directive	Directive 2009/29/EC	Inclusion of aviation in EU ETS starting with 2012
5	Fuel Quality Directive	Directive 2009/30/EC	Modelling parameters reflect the Directive, taking into account the uncertainty related to the scope of the Directive addressing also parts of the energy chain outside the area of PRIMES modelling (e.g. oil production outside EU).
6	Energy Taxation Directive	Directive 2003/96/EC	Tax rates (EU minimal rates or higher national ones) are kept constant in real term. The modelling reflects the practice of Member States to increase tax rates above the minimum rate due to i.a. inflation.
7	Regulation on CO ₂ from cars	Regulation No 443/2009	Limits on emissions from new cars: 135 gCO ₂ /km in 2015, 115 in 2020, 95 in 2025 – in test cycle
8	Regulation on CO ₂ from vans ³⁷⁴	Part of the Integrated Approach to reduce CO ₂ emissions from cars and light commercial vehicles.	Limits on emissions from new LDV: 181 gCO ₂ /km in 2012, 175 in 2016, 135 in 2025 – in test cycle

³⁷⁴

On 28 October 2009 the European Commission adopted a new legislative proposal to reduce CO₂ emissions from light commercial vehicles (vans). The draft legislation is closely modelled on the legislation on the CO₂ emissions from passenger cars (Regulation 443/2009) and it is part of the Integrated Approach taken by the Commission in its revised strategy to reduce CO₂ emissions from cars and light commercial vehicles (COM(2007) 19 final).

9	Labelling regulation for tyres	Regulation No 1222/2009	Decrease of perceived costs by consumers for labelling (which reflects transparency and the effectiveness of price signals for consumer decisions)
10	Regulation EURO 5 and 6	Regulation No 715/2007	Emissions limits introduced for new cars and light commercial vehicles
11	Regulation Euro VI for heavy duty vehicles	Regulation No 595/2009	Emissions limits introduced for new heavy duty vehicles
12	Directive on national emissions' ceilings for certain pollutants	Directive 2001/81/EC	Checked with RAINS/GAINS modelling regarding classical pollutants (SO ₂ , NO _x)
13	Implementation of MARPOL Convention ANNEX VI	2008 amendments - revised Annex VI	Amendment of Annex VI of the MARPOL Convention reduce sulphur content in marine fuels which is reflected in the model by a change in refineries output
	Additional measures implemented in TRANSTOOLS		How the measure is reflected in TRANSTOOLS
14	Eurovignette Directive on road infrastructure charging	Directive 2006/38/EC	No additional link based charges. Assumed current level of internalisation through fuel taxes and existing infrastructure charges (tolls or vignettes) where applicable
15	TEN-T guidelines	Decision 884/2004/EC	Priority projects introduced in TRANSTOOLS network according to expected completion date
16	Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles	Directive 2009/33/EC	Emission factors, impact on costs per km
17	Emission standards for diesel trains (UIC Stage IIIA)		Emission factors, impact on costs per km
18	ICAO Chapters 3 (emissions)		NO _x and CO emission standards for airplanes built after 2007. Updated emission factors from EXTREMIS database (http://www.ex-tremis.eu) applied on TRANSTOOLS demand projections
19	Single European Sky II	COM(2008) 389 final	Decrease in fuel consumption, emissions and ticket prices

20	Directive on inland transport of dangerous goods	Directive 2008/68/EC	No significant impact
21	Third railway package	Directive 2007/58/EC	Assumed discount on user prices and decrease in rail passenger costs after 2010
22	Port state control Directive	Directive 2009/16/EC	Decrease in transshipment costs
23	Regulation on common rules for access to the international road haulage market	Regulation No 1072/2009	More efficient international road freight transport (reduced empty returns) reflected through a decrease in international transport costs
24	Directive concerning social legislation relating to road transport activities	Directive 2009/5/EC	Exclusion of self-employed drivers from the working time directive, simplification of the tachograph rules, use of targeted electronic controls; reflected through a decrease in inter-urban road transport

Appendix 5: Short description of the models used in the Impact Assessment

GEM-E3

1. The GEM-E3 (World and Europe) model is an applied general equilibrium model, simultaneously representing World regions and European countries, linked through endogenous bilateral trade flows and environmental flows. The European model is including the EU countries, the Accession Countries and Switzerland. The world model version includes 18 regions among which a grouping of European Union states. GEM-E3 aims at covering the interactions between the economy, the energy system and the environment. It is a comprehensive model of the economy, the productive sectors, consumption, price formation of commodities, labour and capital, investment and dynamic growth. The model is dynamic, recursive over time, driven by accumulation of capital and equipment. Technology progress is explicitly represented in the production function, either exogenous or endogenous, depending on R&D expenditure by private and public sector and taking into account spillovers effects. The current GEM-E3 version has been updated to the GTAP7 database (base year 2004).

TRANSTOOLS model

2. TRANSTOOLS is a European Transport Network model covering all modes of transport for passenger and freight. The model is used to assess the level of congestion and of accessibility and the impact of (the pricing of) transport infrastructure. TRANSTOOLS estimates transport costs generated by policy measures and simulates impacts on demand for transport services by mode, on network links and corridors, for origin-destination pairs, commodity type, on emissions and other externalities, regional GDP and welfare.
3. TRANSTOOLS estimates transport demand for each NUTS 3 zone and distributes it on the networks of the various modes available. The main steps of the approach include the estimation of: the trip generation, the trip distribution, the mode choice and the route assignment.
4. The trip generation represents the transport demand that each zone generates or attracts and depends on the socio-economic characteristics of each zone, as well as on the economic and industrial structure. The trip distribution reflects the demand for transport between each pair of zones in the system and depends on trade and travel patterns, as well as on the availability and costs of transport between the zones. The mode choice provides the part of the demand for each pair of zones that will use each available mode and depends on the relative costs, speed and capacities of the various alternatives. The route assignment gives within each mode, the links of the network where transport demand will be distributed and depends on costs, speed and capacities of the available route options.

TREMOVE model

5. TREMOVE is a policy assessment model for the emissions and environmental impact of transport. The model is used to estimate the effects of various policy measures on transport demand, the resulting modal shifts, the vehicle stock renewal, the emissions of air pollutants and the effects on welfare. The model can be applied for the analysis of different policies such as road pricing, public transport pricing,

emission standards, subsidies for cleaner cars, etc. TREMOVE models both passenger and freight transport.

6. The model consists of 31 parallel country models, each of them consisting of three inter-linked modules: a transport demand module, a vehicle turnover module and an emission and fuel consumption module. The transport demand module describes transport flows and the users' decision-making process in terms of modal choice. The vehicle stock turnover module describes how changes in demand for transport or changes in vehicle price structure influence the share in the stock by age and vehicle type. The fuel consumption and emissions module calculates fuel consumption and emissions (greenhouse gas and air pollutants emissions), based on the structure of the vehicle stock, the number of km driven by each vehicle type, and the driving conditions using the COPERT methodology. In addition to the three core modules, the TREMOVE model includes a well-to-tank emissions and a welfare cost module. The well-to-tank emissions module calculates the emissions during the production of fuels and electricity. The time horizon of the model is 2030.

*PRIMES model*³⁷⁵

7. PRIMES simulates the response of energy consumers and the energy supply systems to different pathways of economic development and exogenous constraints. It is a modelling system that simulates a market equilibrium solution in the European Union and its member states. The model determines the equilibrium by finding the prices of each energy form such that the quantity producers find best to supply match the quantity consumers wish to use. The equilibrium is static (within each time period) but repeated in a time-forward path, under dynamic relationships. The model is behavioural but also represent in an explicit and detailed way the available energy demand and supply technologies and pollution abatement technologies. The system reflects considerations about market economics, industry structure, energy /environmental policies and regulation. These are conceived so as to influence market behaviour of energy system agents. The modular structure of PRIMES reflects a distribution of decision making among agents that decide individually about their supply, demand, combined supply and demand, and prices. The market integrating part of PRIMES then simulates market clearing.

*PRIMES-TREMOVE transport model*³⁷⁶

8. The PRIMES-TREMOVE transport model projects the evolution of demand for passengers and freight transport by transport mode and transport mean, based on economic, utility and technology choices of transportation consumers. Operation costs, investment costs, emission costs, taxes and other public policies, utility and congestion influence the choice of transportation modes and means. The model further projects the derived fuel consumption and emissions of pollutants.
9. It is essentially a dynamic system of multi-agent choices under several constraints, which are not necessarily binding simultaneously. Various policies and energy and environment related topics may be studied including:

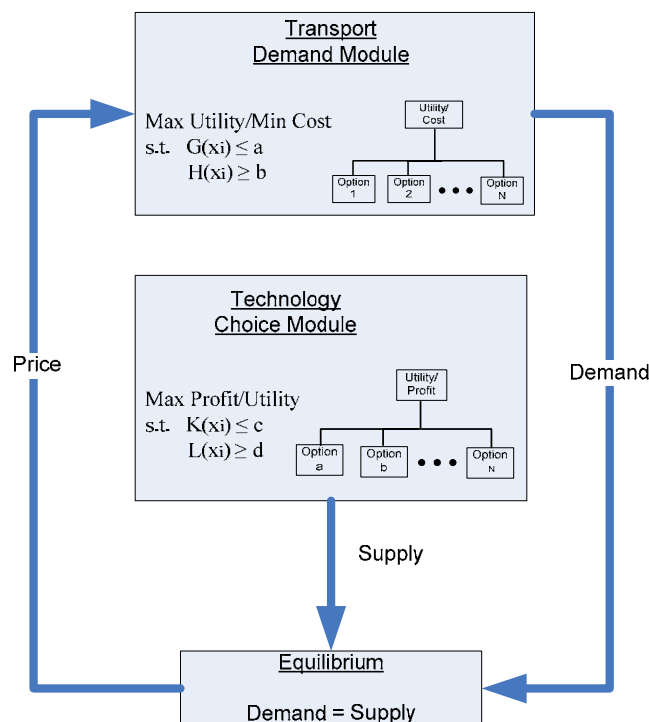
³⁷⁵ The model has been developed by the Energy-Economy-Environment modelling laboratory of National Technical University of Athens.

³⁷⁶ Ibid Footnote 381.

- Pricing policies, e.g. charges, subsidies and taxes
 - Technology diffusion
 - Development of new transport fuels (e.g. bio-fuels, hydrogen etc)
 - Climate change policies (e.g. carbon tax, ETS)
10. The model can either be used as a stand-alone model or may be coupled with the rest of the PRIMES energy systems model. Linkage with PRIMES core model and the biomass supply model allow for consistency in scenario building and well to wheel analysis. The model covers EU27 by Member State with a 2050 time horizon.

Model structure

11. The model consists of two main modules, the transport demand allocation module and the technology choice and equipment operation module. The two modules interact with each other and are solved simultaneously.
12. The transport demand module simulates decisions regarding allocation of transport activity to the various modes, identifying transport service by mode of transport for both individuals and firms. The decision process is simulated as a utility maximisation problem in the case of the individual private passenger and as a cost minimisation problem in the case of firms.
13. The technology choice module determines the vehicle technologies (generally the transportation means) that will be used in order to satisfy each modal transport demand. It also enables the computation of energy consumption and emissions of pollutants from the use of the transportation means. The choice of technology is generally the result of a discrete choice problem in which consideration of both cost and utility is taken into account.



14. Both modules are dynamic over time, simulate capital turnover with possibility of premature replacement of equipment and keep track of equipment technology vintages.
15. The simulation of the transport market is formulated as a simplified Equilibrium Problem with Equilibrium Constraints (EPEC) transformed into a single Mixed Complementarity Problem (MCP). The transport demand module and the technology choice module are solved simultaneously in one single mathematical model, using the MCP algorithm PATH. As the model is a single complementarity problem, it can handle overall constraints, for example to reflect environmental restrictions, the dual variable of which influence the endogenous choices of individuals and firms simulated by the model.

The transport demand module

16. The transport demand module simulates the decision process of the representative agent regarding the choice of transport activity. There is a distinction between private passenger transport and transport related to direct economic activity, such as transportation of commercial products and business trips. This distinction is triggered by the differences in the decision process between the individual passenger deciding on his/her own way of transport and the decision of a firm regarding budget allocation on logistics expenditures.
17. In passenger transport the representative individual, i.e. the passenger, is seeking to maximise a general utility function subject to a budget constraint that represents the total income. The cardinal expression of the individual's utility is assumed to be determined by modal transport cost, a individual's income and expenditure characteristics as well as historical behavioural features. The decision process of the private passenger is represented by a nested utility CES function³⁷⁷.

³⁷⁷ PRIMES-TREMOVE transport model uses mathematical formulations which are not based on single price elasticity, as reduced-form models do. Price elasticities are quantified ex-post based on the results of the whole model, and their ex-post value changes with the policy and technology assumptions that are included in each scenario. In other words the modeling approach is based on variable (not fixed) price elasticities.

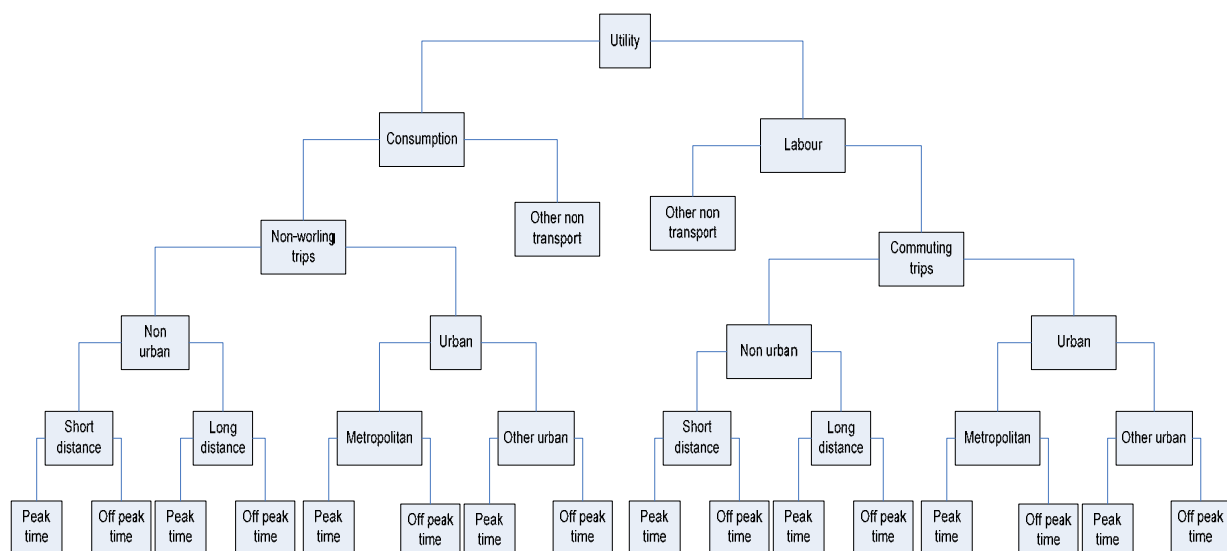


Figure 23: Private passenger primary decision tree

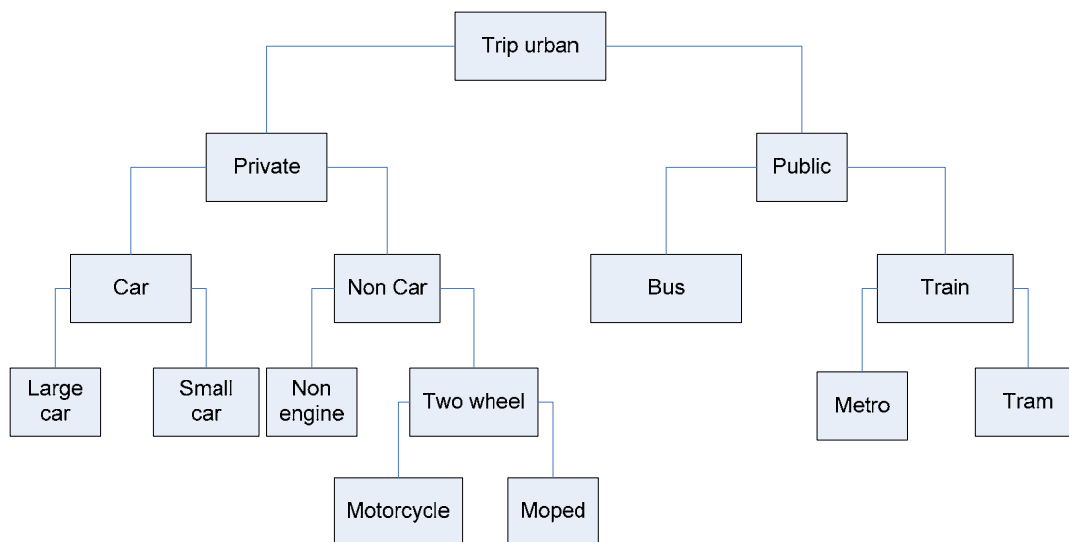


Figure 24: Private passenger secondary decision tree on urban transport

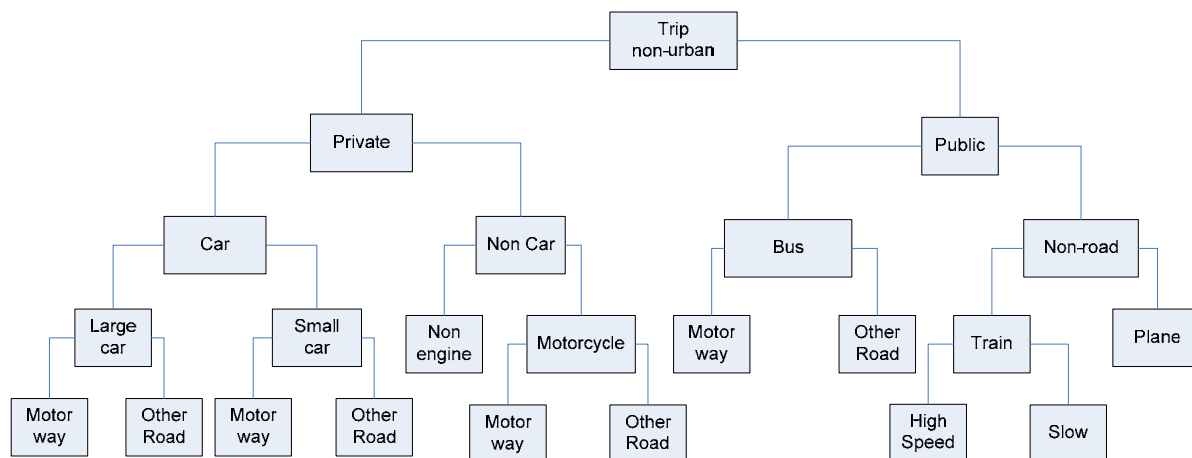


Figure 25: Private passenger secondary decision tree on non-urban transport

18. Initially the individual is deciding between the modal transport choices, i.e. whether to make a trip or not, the geographical and temporal identification of the trip etc. Each branch of the initial decision tree is further subdivided into several branches representing various modal choices. Two general decision processes of this type are identified depending on the geographical identity of the initial modal choice, namely urban and non-urban decision trees. The result of this secondary decision process is a more detailed modal identification of the agent's decision up to the level of the choice of general vehicle (mean) category.
19. In a similar way the representative firm seeks to minimise total cost of satisfying its transport needs either regarding transportation of goods or business trips. The overall decision process of the firm is modelled as a nested CES cost function. The secondary decision process regarding the modal choice of business trips is similar to the decision process of the private passenger therefore they are not shown separately. As regards freight transport a representative secondary decision process is represented including all relevant modes of freight transportation.

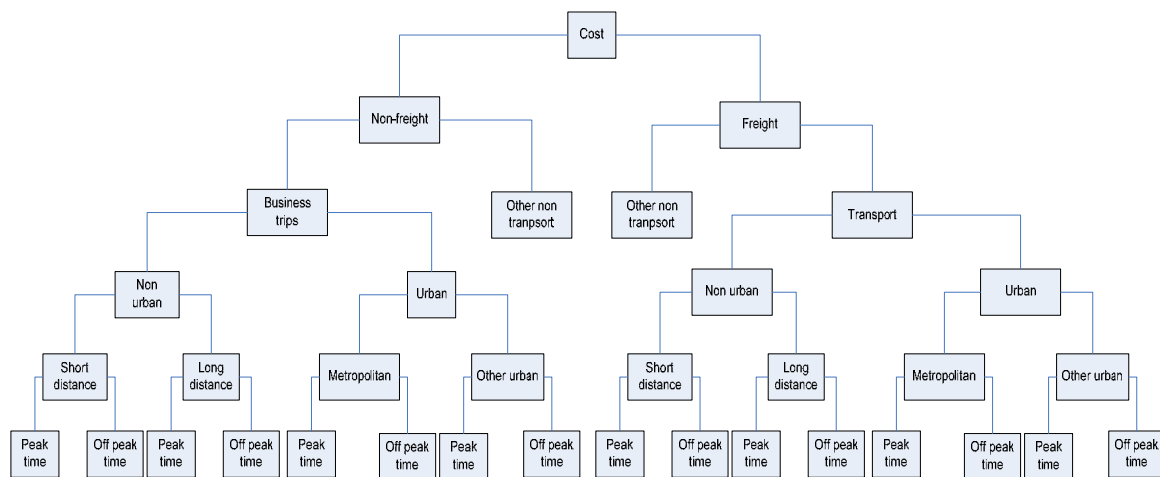


Figure 26: Firm's primary decision tree

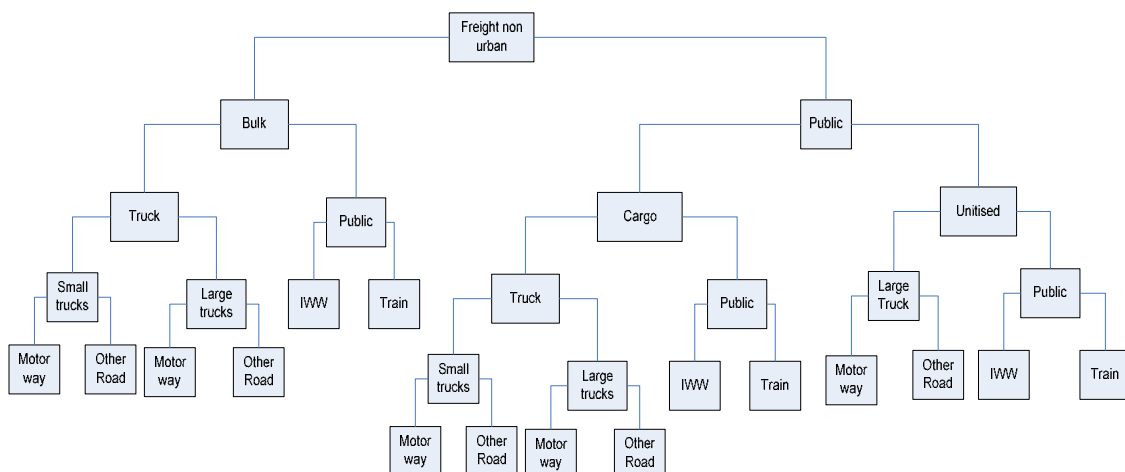


Figure 27: Firm's secondary decision tree on non-urban freight transport

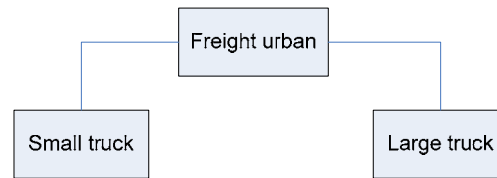


Figure 28: Firm’s secondary decision tree on urban freight transport

Generalised Price of Transportation

20. The decision of the each individual or firm depends on preference characteristics, described by the elasticities of the CES functions, as well as on the endogenously defined “generalised price of transportation”, which differs among the various modes of transportation.
21. In the case of private transportation, (i.e. personal cars and motorcycles for individual passenger and business trips as well as road vehicles for freight transport) the generalised price of transportation corresponds to total perceived costs of satisfying transportation demand at the level of each transport mode. These costs depend on actual cost of transportation as well as on the cost of time (travel time and congestion). Actual transport cost consists of:
 - the capital cost of the vehicles
 - fixed cost that include annual maintenance, insurance, registration, etc.
 - cost of fuel
 - taxes and subsidies
22. Given that the endogenously defined vehicle stock satisfies the relevant modal transport demand (i.e. private cars satisfy all geographical and temporal modes of road transport) based on fixed annual utilisation indices, the aforementioned costs refer to the effective vehicle technology mix that serves each transport mode, which is endogenously determined by the model.
23. In the case of public transport (both for private passengers and for firms) the generalised price of transportation currently represents the sum of the average operational cost of the representative public transportation supplying firm and the cost of time. Average cost pricing of public transportation services is chosen because of the increasing returns to scale prevailing in this sector and because often public transportation forms incur budget deficits. Average operational costs include the cost of the purchase and maintenance of the transport vehicle fleet, fuel cost, labour, taxation etc. Public transportation ticket prices are determined by using a Ramsey-Boiteux formulation which defines ticket prices by consumer type so as to recover total cost of the transportation service.
24. The technology choice model uses data reflecting the technical-economic characteristics of various vehicle technology and transportation means. The technology mix is endogenous to the model; hence the generalised price of transportation results from an interaction between the demand and the technology choice modules.

25. Cost of time represents the value of travel time which differs between the individual passenger and the firm, and depends on temporally and geographically differences between transport modes. Travelling time for non-road transport is exogenously defined taking into account average mileage and speed. In the case of road transport a congestion function is used in order to calculate travelling time.

The technology choice module

26. The technology choice model defines the structure of the vehicle fleet that is optimum to deliver the transportation service as demanded for by the transport demand module. The technology mix and its operation is determined and so the model computes actual transport costs, energy consumption and pollutant emissions. The technology choice model is very detailed for road and rail transport, and less detailed for inland navigation and air transport.

Road transport

27. For road transport the actual vehicle stock is split into several vehicle types, and categories including passenger cars, motorcycles and mopeds, busses and coaches, light and heavy duty trucks. Different vehicle technologies and vintages depending on consumption, fuel type and emission standards are identified.
28. In general, the choice of new vehicles is simulated using a nested logit utility function. The optimal share of each vehicle type for new registration depends on total lifetime cost of vehicle, vehicles characteristics (e.g. acceleration, safety, speed, luxury etc.), preferences indicators and expected operation costs. Turnover of vehicle fleet is represented as a detailed vintage model with premature scrapping. The model takes into account existing fleet structure and exogenously defined scrapping rates of vehicles based on calibrated Weibull distributions, expressing the probability that a vehicle of certain type is still in service at a certain point in time.
29. The choice about whether to satisfy activity with existing or with new vehicles is not exogenously predetermined but is endogenous depending on relative costs and utilities.

Rail transport

30. A similar discrete choice methodology is formulated for determining the structure of the train fleet, which distinguishes between metro, tram, urban and non-urban trains. Choice of new types of rail transport is simulated through a logistic share function that depends mainly on total operational costs, taken into account capital costs, fuel consumption, emissions, etc. The pre-existing rail infrastructure is taken into account through an aggregate indicator and influences the degree of renewal of the train fleet.

Energy consumption and emissions

31. Consumption of transport fuels is endogenously determined by the model and is subject to environmental policy constraints.
32. For road transport, fuel consumption and emissions of non-CO₂ pollutants are calculated by using the COPERT methodology. The computation covers a wide range of pollutants including NO_x, CO, PM, CH₄, Non-Methane VOCs, N₂O, NH₃,

PAHs (Polycyclic Aromatic Hydrocarbons), POPs (Persistent Organic Pollutants), Dioxins, Furans and heavy metals.

33. The COPERT methodology enables calculation of fuel consumption of road vehicles as a function of their speed, which is determined as function of the endogenously determined travelling time and the average mileage of trips per type of road transport mode. The complete COPERT methodology has been integrated into the model providing a strong analytical tool for the calculation of the consumption of various fuels and consequent calculations of costs. For the technology choices not included in COPERT other data sources have been used such as results of the SAPIENTIA project.
34. For non road transport modes, i.e. rail, inland navigation and air transport, average mileage and specific fuel consumption factors are used for calculating fuel consumption and CO₂ emissions.

Source of Data

35. Historical data on vehicle stock for road and rail transport are taken from the TREMOVE database. Vehicle stock data for road transport have been updated in the framework of the FLEETS program. Data on vehicle costs, occupancy factors and average mileages are taken from the TREMOVE and SAPIENTIA databases. All other statistics are taken from EUROSTAT and DG MOVE publications.

Table 19: Classifications in the PRIMES-TREMOVE transport model (road and rail)

Vehicle Category	Vehicle Type	Vehicle Technology
Small cars (<1.4 l)	Gasoline	Pre ECE, ECE, Conventional, Euro I-V
	Pure Bio-ethanol	Pure Bio-ethanol technology
	Hybrid Gasoline	Euro III-IV
	Plug-in hybrid Gasoline	Plug-in hybrid technology
	Diesel	Pre ECE, ECE, Conventional, Euro I-V
	Pure Bio-diesel	Pure Bio-diesel technology
	Hybrid Diesel	Euro III-IV
	Plug-in hybrid Diesel	Plug-in hybrid technology
	LPG	Conventional, Euro I-V
	CNG	CNG thermal, CNG fuel cell
	Hydrogen	Hydrogen thermal, Hydrogen fuel cell
Medium Cars (1.4 - 2.0 l)	Gasoline	Pre ECE, ECE, Conventional, Euro I-V
	Pure Bio-ethanol	Pure Bio-ethanol technology
	Hybrid Gasoline	Euro III-IV
	Plug-in hybrid Gasoline	Plug-in hybrid technology
	Diesel	Pre ECE, ECE, Conventional, Euro I-V
	Pure Bio-diesel	Pure Bio-diesel technology
	Hybrid Diesel	Euro III-IV
	Plug-in hybrid Diesel	Plug-in hybrid technology
	LPG	Conventional, Euro I-V

Vehicle Category	Vehicle Type	Vehicle Technology
	CNG	CNG thermal, CNG fuel cell
	Hydrogen	Hydrogen thermal, Hydrogen fuel cell
Big Cars (>2.0 l)	Gasoline	Pre ECE, ECE, Conventional, Euro I-V
	Pure Bio-ethanol	Pure Bio-ethanol technology
	Hybrid Gasoline	Euro III-IV
	Plug-in hybrid Gasoline	Plug-in hybrid technology
	Diesel	Pre ECE, ECE, Conventional, Euro I-V
	Pure Bio-diesel	Pure Bio-diesel technology
	Hybrid Diesel	Euro III-IV
	Plug-in hybrid Diesel	Plug-in hybrid technology
	LPG	Conventional, Euro I-V
	CNG	CNG thermal, CNG fuel cell
	Hydrogen	Hydrogen thermal, Hydrogen fuel cell
Motorcycles	Capacity <50cc	Conventional, Euro I-V
	Capacity 50-250 cc	
	Capacity 250-750 cc	
	Capacity 750cc	
Mopeds	Moped Conventional	Conventional, Euro I-III
Light Duty Vehicles (<3.5 ton)	Gasoline	Conventional, Euro I-V
	Diesel	Conventional, Euro I-V
	CNG	CNG thermal, CNG fuel cell
	Hydrogen	Hydrogen thermal, Hydrogen fuel cell
Heavy Duty Trucks (> 3.5 ton)	Capacity 3.5-7.5 ton	Conventional, Euro I-V
	Capacity 7.5-16 ton	
	Capacity 16-32 ton	
	Capacity >32 ton	
Busses-Coaches	Diesel	Conventional, Euro I-V
	CNG	CNG thermal
	Hydrogen	Hydrogen thermal
Metro	Metro Type	Metro Technology
Tram	Tram Type	Tram Technology
Passenger Train	Locomotive	Locomotive diesel
		Locomotive electric
	Railcar	Railcar diesel
		Railcar electric
	High speed train type	High speed train technology
Freight Train	Locomotive	Locomotive diesel
		Locomotive electric
	Railcar	Railcar diesel
		Railcar electric

Table 20: Energy carriers in PRIMES-TREMOVE transport model

Energy Carriers for Transport		
Gasoline	Diesel	LPG
CNG	Bio-ethanol	Bio-diesel (RME, Fischer Tropsch, etc)
Bio-methanol	Hydrogen	Electricity

Appendix 6: Detailed analysis of the lack of efficiency of today's EU mobility system

1. The achievement of a single, interconnected and efficient transport system has been delayed by a number of remaining regulatory and market failures which hamper the competitiveness of multimodal transport.

Market access is still restricted

2. Transport infrastructure has been historically designed to serve national rather than European goals and cross-border links constitute bottlenecks that are likely to become increasingly costly as the EU economy continues integrating. Cross-border transport is additionally hindered by protectionist regulations, which refuse or restrict access to national markets by foreign operators.
3. Some transport market segments are not yet fully and de facto liberalised. This is the case for instance for the port services market (such as technical-nautical or cargo handling) which typically remain in the hands of local monopolies and for the rail domestic passenger transport, the access to which is restricted to national operators in most Member States and in practice to incumbent companies. In road transport, access to the national markets of Member States by hauliers established in another Member State ('cabotage') may only be carried out "on a temporary basis".
4. In markets which have already been opened up to competition by EU legislation, inherited national regulations and market structure create obstacles to the entrance of new players.
5. In some liberalised market segments, a complete and correct implementation and enforcement of EU legislation by Member States is still missing. This is particularly the case for rail freight transport, which has been open to competition since January 2007. The principal problematic issues in rail stem from the relations between infrastructure managers and operators, which in many cases are still not fully independent, and the effectiveness of the regulatory oversight of market functioning. For instance, new rail freight operators often face discrimination in access to infrastructure or rail related services, due to the historic integration of the providers of such services and infrastructure managers with incumbent operators.
6. Market functioning is also hampered by a number of regulatory barriers, which have a protectionist effect. For example, relevant national rail authorities are reported to be reluctant to accept rolling stock certificates issued by other Member States, with the effect of hindering the free flow of trains across Europe and increasing red tape linked to the certification process. Market integration both within and between transport modes is still far from being achieved. Intermodal infrastructure – multimodal transshipment platforms for freight and integrated rail-air-public transport nodes for passengers – is not sufficiently developed. Exchanging data between the modes is difficult because of the co-existence of non-compatible modal IT systems.
7. As a result, the EU transport system fails to exploit the full network benefits and economies of scale that a completed continent-wide transport grid would offer. At the same time, national transport markets are hindered in their optimisation by the often state-led protection of inefficient incumbent monopolies against the competition from new market entrants. The functioning of the transport system is suboptimal in the routing (due to missing infrastructure links), modal choices

(because of the barriers to multimodality) and organisational efficiency (as inefficient incumbent operators – notably in rail transport – are protected from international and national competition).

8. Besides, the lack of universally approved standards on traffic management and data exchange systems, vehicle weights and dimensions, power supplies and educational requirements for transport workers are further obstacles to cross-border traffic. For example in the rail sector, the most striking evidence of such barriers is different track gauges, electricity supply and signalling systems. The deployment of ERTMS, the European signalling system, is progressing slowly; so far, only discontinued sections of lines are equipped, and locomotives still need to be additionally equipped with national systems. Also, the length and weight of trains is not harmonised across Europe whereas the weights and dimensions of road vehicles could be optimised, reflecting the progress in ITS and infrastructure design and considering opportunities for reducing GHG emissions of heavy duty vehicles.
9. All these regulatory and technical barriers contribute to higher than necessary transport costs, in particular in rail which is considered a relatively environmentally friendly land transport mode, particularly when transporting passengers on high-occupancy lines, or bulk goods.

Efficient cross-border network not yet completed

10. The EU transport network is fragmented, with a general lack of efficient and effective intermodal terminals, different service levels across modes, a lack of standards, particularly for rail freight transport and missing infrastructure links, especially across borders.
11. The missing links in the European transport network and its inefficient functioning can be attributed firstly to the lack of coordination of policies and investment decisions between Member States and to the absence of a comprehensive funding strategy with sufficient leverage and conditionality to provide support for the completion of the TEN-T core network as well as other infrastructure programmes.
12. As indicated in the Monti report dated 9 April 2010, there is a need for a clear and transparent legal framework in the field of State aid as regards infrastructure investment and financing.

The supply of transport services is not sufficiently quality-driven

13. Whereas quality services for passengers and businesses have been promoted over the years, a number of market and regulatory failures prevent transport services to be consistently of high quality, hampering thereby the efficiency of the transport system. It is therefore no surprise that the Consumer Markets Scoreboard of October 2010, identified railways as one of the top four services markets where consumers experienced most problems³⁷⁸.

³⁷⁸ The others were internet access, real estate services and investments, pensions and securities. http://ec.europa.eu/consumers/strategy/docs/4th_edition_scoreboard_en.pdf

14. “Changes in commerce and personal travel patterns have increased the importance of a reliable transport system. Reliable transport networks and services are required because of more complex and inter-related supply chains and increasingly complex scheduled activities. The physical way that the economy operates has changed, facilitated by – and demanding – transport system enhancements. [...] The importance of scheduling in personal and freight activities has grown, so that transport unreliability has an increasingly-marked effect on downstream activities. The expectation from these demand trends is increasingly that transport should provide high levels of reliability.”³⁷⁹
15. Poor reliability of today’s transport services is linked to the lack of a common vision for the provision of services across transport modes and Member States. Transfers between different transport modes often result in duplicated information efforts, loss of comfort and time, and higher costs. Information systems for the end user are also very often conceived in such a way that details are provided for the single transport mode, but not for the overall multimodal door-to-door travel. “Where performance is inconsistent, network users may simply have to accept the consequences of the delay, albeit it may have ripple-effects or, worse, snowballing (compounding, or growing) effects, affecting other activities or stages in the personal or logistics chain, constituting a cost to those involved.”³⁸⁰
16. In addition, transport safety remains an issue, particularly so for road transport. Notwithstanding the progress made in terms of reducing the number of road casualties since the adoption of the third European action programme for road safety in 2003, around 35,000 citizens were killed on the roads of the EU in 2009.
17. Transport security has become a great concern in the wake of the terrorist attacks of 11 September 2001. In addition to air and maritime security, there appears to be a clear need in increasing the security of surface freight transport, in particular on the road. The devastating terrorist attacks on the public transport systems in Madrid in 2004 and in London in 2005, which killed almost 250 people, exposed the vulnerability of surface passenger transport. In many cities, public transport suffers from a lack of security due to some anti-social behaviour. Public transport must be perceived to be safe and secure if it is to succeed in convincing more people to move away from the car and use public transport instead.
18. The existing *acquis* concentrates on aviation and maritime transport security. Security measures have been developed for managing both passengers and cargo transport in these fields. Security measures in Europe reflect the international nature of both terrorist threats and transport. In relation to land transport security, efforts have been made to spread best practices, for example in emergency planning, through regular contacts with Member State officials.
19. At the EU level, transport security translates into two main strategies: policy formulation and regulation, and monitoring (inspection) activities, covering national competent authorities, airports, port facilities and ships, to ensure correct implementation of the *acquis*. A comprehensive and harmonised policy approach on

³⁷⁹ OECD, 2009. Improving Reliability on Surface Transport Networks
³⁸⁰ *idem*.

security for all transport sectors is needed which addresses the question of financing of transport security at EU level and assesses and if necessary modifies the scope of current inspection regimes. Consideration should be given to the application of Article 222 TFEU, which envisages the Union and its Member States acting jointly in a spirit of solidarity if a Member State is the subject of a terrorist attack or the victim of a natural or man-made disaster.

Transport labour market is not completely integrated

20. Diverging national health, social, safety and security standards in transport hamper the harmonised social development of Europe and of the sector itself. The variety of rules increases the vulnerability of certain categories of transport workers, encumbers heavy bureaucracy on transport operators, distorts competition by basing it on differences in working conditions, raises the unpredictability and insecurity risks related to performing transport activities and finally renders some pieces of EU law unenforceable in practice.
21. In addition, barriers due to gender, age, nationality and training hamper the availability of an appropriate labour force. In an ageing society where the labour force will soon start shrinking, the transport labour force is ageing more than the average in the EU (26% aged over 50 versus 22%). A higher participation rate of women may help fill the gap left by ageing male workers, but in transport their share has traditionally been much lower than on average (21% versus 35%, while in land transport only 13%). The attractiveness of transport professions is also hampered by a relatively high rate of accidents and by often difficult working conditions.
22. The availability of a skilled and highly motivated labour force in the transport sector is essential for the supply of efficient and competitive transport services. Without tackling the aspect of job quality, optimal progress towards a sustainable transport system is unlikely to be achieved.