Factors of evolution of demand and methodological approach to identify pathways
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**PROJECT PARTNERS**

<table>
<thead>
<tr>
<th>No</th>
<th>Name</th>
<th>Short name</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Centre for Research and Technology Hellas Hellenic Institute of Transport</td>
<td>CERTH/HIT</td>
<td>Greece</td>
</tr>
<tr>
<td>2</td>
<td>TIS PT, CONSULTORES EM TRANSPORTES, INOVACAO E SISTEMAS, SA</td>
<td>TIS</td>
<td>Portugal</td>
</tr>
<tr>
<td>3</td>
<td>Fraunhofer - Institute for Systems and Innovation Research (ISI)</td>
<td>FHG-ISI</td>
<td>Germany</td>
</tr>
<tr>
<td>4</td>
<td>Karlsruhe Institute of Technology (KIT) - Institute for Technology Assessment and Systems Analysis (ITAS)</td>
<td>KIT-ITAS</td>
<td>Germany</td>
</tr>
<tr>
<td>5</td>
<td>Joint Research Centre – Institute for Prospective Technological Studies (IPTS)</td>
<td>JRC-IPTS</td>
<td>Spain</td>
</tr>
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</table>
FUTRE Deliverable 3.1: Factors of evolution of demand and pathways

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Authors: João Bernardino (TIS), João Vieira (TIS) and Hugo Garcia (Futures Lab). Additional inputs from the remaining FUTRE project team, participants in the Workshop “Transport Needs 2050” and interviewees.
Quality control: Maria Boile, Anestis Papanikolaou (CERTH/HIT), Max Reichenbach and Jens Schippl (KIT-ITAS)
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EXECUTIVE SUMMARY

This document describes the methodology and results from the FUTRE project on the study of factors of evolution of transport demand.

The aim of this task was to identify factors of evolution of demand behaviour and describe a range of plausible global futures affecting transport demand. This work sets a frame for the following tasks of identification of specific pathways on passenger and freight transport demand.

The methodology used was scenario analysis, with inputs from a literature review on futures studies on transport and related fields, a stakeholder consultation, and a consistency check based on a systems thinking approach. More specifically, the scenarios analysis followed the following steps:

1. Identification of possible mega-trends with impacts on transport
2. Identification of key factors of evolution of transport demand
3. Derivation of specific possible future insights on the world and transport demand
4. Drawing of possible global pathways with relevancy on transport

Megatrends are stable trends driven by global forces that impact several societal areas. By considering megatrends it is possible to try to assess how they will influence aspects of transport needs. The following megatrends were selected as the most relevant in the scope of transport:

- Globalization
- Urbanization
- Ageing
- Knowledge society
- Individualism
- Migration
- Connectivity
- Immediate needs: here & now
- Slow Movement
- Empowerment of Women
- Awareness / consciousness
- Consumption 2.0 – use, not own
- Ever Young
- Seeking for experiences
- Do it yourself

Based on the megatrends, related insights and an identification of aspects relevant for mobility systems, a set of key factors for the evolution of transport demand was identified. The key factors are related to different spheres of life and where arranged in the areas defined by the STEEP approach: Social, Technological, Economical, Environmental and Political factors. The factors are outlined in the table below:
<table>
<thead>
<tr>
<th>Table 1 – Factors of evolution of transport demand</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social</strong></td>
</tr>
<tr>
<td>Demography:</td>
</tr>
<tr>
<td>Population growth</td>
</tr>
<tr>
<td>Ageing</td>
</tr>
<tr>
<td>Global migrations</td>
</tr>
<tr>
<td>Living place flexibility</td>
</tr>
<tr>
<td><strong>Education and social capital:</strong></td>
</tr>
<tr>
<td>Level of education</td>
</tr>
<tr>
<td>Equality of cultural capital</td>
</tr>
<tr>
<td><strong>Preferences and awareness:</strong></td>
</tr>
<tr>
<td>Consumerism (VS spiritual needs)</td>
</tr>
<tr>
<td>Environmental awareness</td>
</tr>
<tr>
<td>Propensity to own VS share use</td>
</tr>
<tr>
<td>Social significance of travel choices (status)</td>
</tr>
<tr>
<td>Value of doing tasks while travelling</td>
</tr>
<tr>
<td>Rationality of choices</td>
</tr>
<tr>
<td>Value of safety</td>
</tr>
<tr>
<td>Value of health</td>
</tr>
<tr>
<td>Value of free time and leisure</td>
</tr>
<tr>
<td>More virtual than physical relations / communication</td>
</tr>
<tr>
<td><strong>Technological</strong></td>
</tr>
<tr>
<td>Ability to address energy, environmental and ageing challenges by technical developments</td>
</tr>
<tr>
<td><strong>Economical</strong></td>
</tr>
<tr>
<td>Economic development:</td>
</tr>
<tr>
<td>Level of economic growth</td>
</tr>
<tr>
<td>Economic stability</td>
</tr>
<tr>
<td>Volume of international trade</td>
</tr>
<tr>
<td>Economic equality</td>
</tr>
<tr>
<td><strong>Production and consumption patterns:</strong></td>
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<tr>
<td>Share of knowledge based work</td>
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<td>Purchasing channel paradigms (P2P and e-commerce VS local commerce...)</td>
</tr>
<tr>
<td>Scale of production: mass VS customised</td>
</tr>
<tr>
<td>Paid work time reduction</td>
</tr>
<tr>
<td><strong>Energy:</strong></td>
</tr>
<tr>
<td>Fossil energy scarcity - prices</td>
</tr>
<tr>
<td><strong>Urban development:</strong></td>
</tr>
<tr>
<td>Urbanisation</td>
</tr>
<tr>
<td>Urban density</td>
</tr>
<tr>
<td>Congestion</td>
</tr>
</tbody>
</table>
Following the megatrends and key factors considered, a number of **insights** was identified on specific trends or events that are somewhere between possible and likely to come in the future. The consideration of insights provided were, together with the megatrends and key factors, an input to the development of future pathways. Some potential wild cards – low probability, high impact events – were also identified.

The final step before the development of global pathways was the analysis of interrelations and **systemic behaviour** of the set of key factors. To this end, a systems thinking approach framed the analysis. The development of causal loop diagrams allowed showing the main relations between the factors in question and the direction of those relations. It also showed the existence of several relevant feedback loops. For example, it was seen that people’s preferences are influenced and reinforced by external conditions, whereby e.g. consumerism is made possible when there is abundance (economic growth) and environmental awareness is reinforced by the manifestation of environmental problems.

Different **pathways** were then iteratively developed and discussed. The final aim was to develop a set of pathways which better defined a range of plausibility with interest the study of transport demand futures.

The steps taken in the development of pathways included the identification of a short list of main driver factors, the identification of pathways based on possible trends and systemic coherence, and assessment of their level of coverage of plausible outcomes. This process was done iteratively until a satisfactory range of plausibility with interest to transport demand futures was achieved. The short list of main driver factors was composed of Climate change, Energy scarcity and price, Economic performance, Global cooperation and Social preferences (consumerism Vs spiritual needs).

The four global pathways developed are briefly described as follows:

**Unlimited**: In this pathway technology is able to solve the crucial environmental and energy problems. Without any constraint on them, current social practises may continue and even follow a path of increased
consumerism and thirst for travel. Global economic competition is the most important driver of societies.

**Passivity and chaotic collapse**: This pathway describes a world where society was not able to address the impending environmental and energy problems. Societies ultimately fall economically and politically. It emphasises the consequences of a collapse of every type and the inherent uncertainty and need to quick adaptation in an unstable world.

**Cooperation and degrowth**: In this pathway the prospect of environmental and economic collapse leads people and countries to cooperate to properly manage the global commons. This necessarily involves drawing back the economic output to a level consistent with sustainability. People consume and travel less, incentivised by various policy incentives concerted at international level.

**Smart & Spiritual**: This pathway emphasises the consequences of a shift of social preferences and culture towards different values, less focused on material things and more focused on immaterial spiritual satisfaction of all kinds. It is a more rational world, where people highly value long-term issues like health and safety.

The key factors, insights and global pathways developed will be inputs for the development of transport demand specific pathways/trends and the identification of related challenges for the passenger and freight transport sectors.
1. **INTRODUCTION**

This document describes the methodology and results from the FUTRE project on the study of factors of evolution of transport demand. It finally provides guidance for the following work on specification of pathways on transport demand.

The task in question identified factors of evolution of demand behaviour, studied and described their possible futures, and finally aggregated them into possible future pathways. The methodology used for this aggregation is scenario analysis. The identification of relevant factors relied on literature review, a workshop and interviews. The consistency check of the global pathways developed was framed by a systems thinking approach.

This work sets a global frame on global futures which will be the basis for the following tasks of identification of possible pathways on transport demand.

The adopted approach is described in detail in chapter 2. Chapter 3 provides a review of literature on future studies in the scope of transport and in the scope of other fields related to transport. Chapter 4 describes the process and results of the stakeholder consultation. Chapter 5 outlines the megatrends considered in the analysis, the key factors identified and specific insights obtained from them. It also provides a sketch and main observations from the system analysis of the factors considered. Chapter 6 describes four global pathways considered and explains the process by which they were created and details how the key factors intervene in each of them. Finally, chapter 7 details the next steps in the development of specific transport pathways following from the global pathways developed here.
2. **Approach**

The initial challenge of this task was to identify factors of evolution of demand behaviour and, for each of them, study and detail their possible futures. Factors of evolution refer to elements of the socio-economic systems that may contribute to drive future demand behaviour.

In order to identify long-term challenges for the EU transport industry, this task was built on the question “What will be the needs for transport in 2050?”

Demand behaviour is characterized by expectations and preferences. These derive from economic and social changes, values and supplied products. The later factor co-evolutes with demand preferences, a relation that will mostly be considered in WP5. This task attempted to benefit from multi-discipline approaches through involvement of experts from different areas and by reviewing literature of various fields of interest.

The general approach used was scenario analysis. Given the high level of uncertainty associated with the long-term, rather than foreseeing it is useful to consider alternative future worlds. The idea is to draw a space of plausible possibilities in order to define strategies that accommodate different possible paths.

More specifically, the method of pathway/scenario building departed from the consideration of possible global trends and converged to specific needs and importance of attributes on transport systems.

The steps carried out to come to a group of scenarios were the following:

1. Identification of possible **mega-trends** with impacts on transport
2. Identification of key **factors** of evolution of transport demand
3. Derivation of specific possible future **insights** on the world and transport demand
4. Drawing of possible **global pathways** with relevancy on transport

The tasks of WP3 will proceed with three additional steps:

5. Drawing of possible transport demand pathways (passenger and freight)
6. Identifying related challenges for the EU transport industry

Additionally, specific inputs for quantitative model simulations (WP5) will be provided.

To conduct the first four activities, the following tools were used:

- A literature review of future studies from transport sector and transversal sectors
- A workshop on the future of transport needs and selected interviews
- A system analysis of the factors of evolution of demand identified
In the first step, we conducted a research for possibilities of global change on the basis of literature review. The mega-trends identified at this stage were an input to the activities of the workshop (see Chapter 4).

The workshop gave the opportunity to discuss and identify other mega-trends relevant for transport. It was a creative exercise to find specific insights for transport and produced a first iteration on future pathways (Figure 1). The workshop was based on the involvement of experts from relevant fields and consisted of a set of exercises dealing with these three steps. Further inputs from experts came from additional interviews to other experts to further explore some previously raised possibilities and the involvement of the FUTRE Advisory Board.

The systems thinking exercise, which was based on the causal loop diagram approach, gave support in the identification of specific insights and mostly helped to build coherent pathways considering the interrelations of the varying factors of evolution of transport demand.

Global scenarios were finally built based in all the information gathered, with a focus on the impact on the transport sector.

Figure 1 – Steps of futures study on transport needs
3. **FUTURE STUDIES - LITERATURE REVIEW OF STUDIES RELEVANT TO TRANSPORT**

3.1.1. **Approach**

This review includes future studies in the transport field and on other fields which are key to the development of transport systems. The review covers four main aspects:

- Identification of key factors for the development of demand and its preferences in transport systems
- Identification of trends related to those key factors
- Identification of future transport related issues relevant for this project
- Identification of scenarios previously envisioned in transport and other relevant fields

Some studies cover all these issues while others cover only part of them. All studies reviewed were completed within the last 5 years.

The studies selected from a wider list and reviewed in detail in fields relevant to transport covered differences focuses, including several studies on global issues with no particular focus, to studies concerned with particular fields like economics, energy, environment, lifestyles, geopolitics and communications. The studies covered are the following:

- ZPunkt: “Megatrends Update” (focus: global)
- CSIRO: “Our future world - Global megatrends that will change the way we live” (focus: global)
- National Intelligence Council: “Global Trends 2030” (focus: geopolitics)
- OECD: “Looking to 2060: Long-term global growth prospects” (focus: economy)
- Shell: New lens scenarios (focus: energy)
- European Environmental Agency: “The European Environment - Assessment of Global Megatrends” (focus: environment)
- SPREAD Sustainable Lifestyles 2050 (focus: lifestyles)
- Alcatel-Lucent: “Megatrends - A Wave of Change Impacting the Future” (focus: communications)

The set of literature selected in the field of transport includes various studies of the European Commission as well as studies by relevant stakeholder groups and companies. The various studies offer different perspectives and interests - including the general public interest, global sustainability issues, or specific business interests - and sectoral areas of transport.

The studies which were selected to be reviewed in detail are the following:
3.2. Future studies on the transport field

3.2.1. TRANSvisions

<table>
<thead>
<tr>
<th>Project</th>
<th>TRANSvisions - How will Europe look like in 2050?</th>
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<tbody>
<tr>
<td>Organization</td>
<td>European Commission – DG TREN</td>
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<td>Objectives</td>
<td>To provide technical support to a debate on transport scenarios</td>
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<tr>
<td>Relevant tasks</td>
<td>Building scenarios on the futures of transport for 2050</td>
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<td>Year of finalization</td>
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<tr>
<td>Focus</td>
<td>Transport systems</td>
</tr>
<tr>
<td>Type of analysis</td>
<td>Identification of drivers of transport demand and development of exploratory scenarios</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Literature review, expert consultation, modelling</td>
</tr>
</tbody>
</table>

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

Transport drivers have been analysed through a comprehensive literature review on scenarios and drivers both in Europe and abroad. This review has focussed primarily on a “long term perspective” involving the years 2030 and 2050. The drivers which influence volume and composition of transport demand that were selected for analysis were:
• demographic trends including ageing, migration, household development and localisation patterns
• economic trends, including economic development, trade and globalisation, logistics and macroeconomic trends
• social change, including change in use of time, leisure and sustainable consumption
• energy trends
• technological trends including the “information society”
• infrastructural development and congestion
• environmental trends, including climate and internalisation of external costs
• policy issues, including EU transport policy, enlargement, climate and security

TRANSVISIONS constructed qualitative exploratory scenarios for 2050 and quantitative scenarios for 2030.

The four exploratory scenarios of future transport in Europe in 2050 have been produced with a participatory approach, involving a number of stakeholders in a DELPHI exercise and in a workshop. The scenarios were all developed:

• as alternative paths with reference to the same global reference scenario, which is derived as mere continuation of the tendencies (described in qualitative terms) in place when we entered the third millennium;
• keeping as predetermined element common to all the scenarios the priority given by the European Union to the fight against climate change and to improve the security of energy supply, and to the importance of making these two objectives complementary with the EU Lisbon competitiveness goals;
• differentiating the scenarios mainly in relation to two “axes of uncertainty” as indicated in Figure 4.16.
• the “economy/technology/market” dimension (red vertical axis) spans from an high growth of EU GDP to low or zero growth.
• the “society/environment” dimension (green horizontal axis) refers to the change of human well-being - that we assume measurable with a composite index of population health and quality of life - as it has been demonstrated that over a given income threshold this change starts to be decoupled from GDP growth.
The exploratory scenarios were formed by the two axes of uncertainty, economic growth and welfare (well-being) changes for the whole Europe. They are summarised below:

- “Moving alone” or Induced mobility (or Always-on, Emerging Technologies markets, Triumphant markets). High growth and a small increase of population due to migration from 2005 to 2050. Combines strong economic growth with risks on social sustainability. Emphasis on technology, supply-management and market spontaneous self-organisation. GDP growth allow for a higher investment on research and development, as well as in more productive infrastructure, leading to a reduction of CO2 when new more efficient technologies are implemented in the market place. CO2 still grows fast during the first's years.

- “Moving together” or Decoupled mobility (or Good governance, New social contract, Balanced planning). It is the continuation of 2030 scenario "Moderate growth and stable population", combining moderate economic growth with strong social sustainability. Balanced policies are applied, with emphasis on pricing and modal shift and Public-Private Partnerships. There is an overall optimism in the capacity of public institutions to implement cost-effective policies, and adapt themselves according to the subsidiarity principle. There is a gradual, cost-effective process to reduce CO2.
“Moving less” or Reduced mobility (or New communities, Alternative life styles, People trusting, Committed communities, Shared values). It is the continuation of 2030 scenario “Low growth and declining population”, combining weak economic growth with strong social and environmental sustainability. Behavioural policies reducing demand for motorised transport are applied, as well as speed limits of roads, and land-use regulations, leading towards an increase on Public Transport. Long distance traffics are reduced. There is a fast process to reduce CO2, since early stages, not cost-effective, and a reduction on GDP growth.

“Stop moving” or Constrained mobility (or bottlenecks ahead, or Carbon emergency). Very high growth in the short-term and an increase of population due to migration until 2030, until a “bottleneck” is reached because structural reasons (e.g. lack of public investment on infrastructure or failure on implementation of new technologies, leading to a dramatic reduction of private profitability, and a hard economic decline). It is attached to a pessimistic vision concerning the capacity of Europeans to carry on structural reforms. From 2030 to 2050, the scenario combines weak economic growth with weak social sustainability. The economy is depressed, transport prices and taxes are not raised. Regulations and bans are applied to constrain mobility, in order to release congestion and reduce emissions, such as strict Emission Trade Markets. This scenario can be understood as a failing “Moving alone” (or induced mobility) scenario.

3.2.2. ERTRAC Road Transport Scenario 2030+

<table>
<thead>
<tr>
<th>Project</th>
<th>ERTRAC Road Transport Scenario 2030+ – “Road to Implementation”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization</td>
<td>ERTRAC</td>
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<tr>
<td>Objectives</td>
<td>Define strategic research priorities in the scope of road transport</td>
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<td>Year of finalisation</td>
<td>2009</td>
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<td>Focus</td>
<td>Road transport</td>
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<tr>
<td>Type of analysis</td>
<td>Identification of drivers and scenario analysis</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Literature review, stakeholder consultation, system’s approach</td>
</tr>
</tbody>
</table>

ERTRAC - European Road Transport Research Advisory Council - developed a ‘road transport scenario’ which were on the basis of four selected ‘Strategic Research Priorities’ and related challenges.
The ‘Strategic Research Priorities’ defined by ERTRAC were:

1. **Energy, Resources and Climate Change**: to provide environmentally friendly road transport systems and a secure, renewable energy supply.

2. **Urban Mobility**: to achieve sustainable mobility for passengers and freight in the urban environment.

3. **Long-distance Freight Transport**: to provide (energy) efficient transport solutions (and vehicles) contributing to a reduced environmental footprint for the freight logistics chain, outside the urban environment.

4. **Road Transport Safety**: to reduce road transport injuries, fatalities, and accidents, and established Working Groups in each area to address major challenges for the future.

The primary purpose of the scenario is to provide a basis to update ERTRAC’s extensive R&D agenda that will extend to 2030 and beyond, in some areas, to 2050. The scenario-building process also provides a basis to translate these needs and objectives into realistic R&D road maps that distinguish between nearer-term priorities, such as the electrification road map to 2020, recently published by ERTRAC, and longer-term priorities for the coming decades.

The scenarios were prepared by ERTRAC stakeholders and other technical experts, and are based on a comprehensive review of previously published information related to energy, environment and mobility. The scenarios reflect ERTRAC’s opinion of the future of European road transport.

In order to describe the reference outlook and possible alternatives for each of the Working Groups in greater detail, it was first necessary to consider the impact of general factors on future regional and global decisions and how they are likely to impact road transport at the 2030+ time horizon. For each factor, a background trend was presented including an indication of upper and lower bounds.

### Table 2 – Factors considered by ERTRAC

<table>
<thead>
<tr>
<th>Public Policies</th>
<th>Business and consumer motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment and Economy</td>
<td>Climate change</td>
</tr>
<tr>
<td></td>
<td>Economic growth</td>
</tr>
<tr>
<td></td>
<td>Energy and resources</td>
</tr>
<tr>
<td></td>
<td>Environment and ecology</td>
</tr>
<tr>
<td></td>
<td>Mobility and transport costs</td>
</tr>
<tr>
<td></td>
<td>Globalisation</td>
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<tr>
<td>Society</td>
<td>Demographic change</td>
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<tr>
<td></td>
<td>Increasing urbanisation</td>
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<tr>
<td></td>
<td>Changing society and consumer trends</td>
</tr>
<tr>
<td>Technology</td>
<td>Technology development</td>
</tr>
<tr>
<td></td>
<td>Information and Communication Technologies (ICT)</td>
</tr>
</tbody>
</table>
The results of the assessment derived concrete consequences for the transport system and the road transport industry. They are summarised below.

**Common Observations**

The following observations for 2030 and beyond are common to all four areas.

By 2030, a harmonised policy framework concerning the European transport sector will be needed to achieve sustainable transport in the two decades leading up to 2050. Global framework agreements on trade, energy/resources, climate change and environment will have set clear objectives for the European Union to meet over time. The early standardisation of requirements and specifications will also be important in order to achieve successful and cost-effective transitions. Strategies will be needed to have the growth in energy and transport demand in a slower pace than economic growth. Such strategies must consider the demand for personal mobility within the limits of a sustainable society and avoid social segregation between urban and rural communities.

Perhaps the most important common element will be the ability to adapt the road transport system to meet society’s needs within the constraints of available finances.

The introduction of industrially-oriented ICT applications will greatly increase the economic and environmental efficiency of transport operators and the manufacturing industry in terms of their design, planning, operation and control processes.

By 2030, a highly integrated and service driven information society will have emerged in which the mobility consumer takes part actively and continuously regardless of his/her location (home, work, commuting, leisure). A wide variety of on-line services provided by advanced, cheap digital outlets, will bring on dramatic changes in consumer awareness, attitude and behaviour towards transport in general and personal mobility in particular. Available information will be updated in real time, based on consumers’ active responses or feedback to services being used. For those living in rural environments, this will reduce social exclusion and ensure consumer access to information and cost-effective mobility options.

**Energy and Environment**

By 2030, concerns about global climate change, combined with increasing demand for energy, will force public policy on a global and regional level, while environmental concerns related to air, water, and noise pollution will be prominent on a regional, country and local level. Energy conservation and diversification and materials recycling will be well-advanced, driven by climate change, energy security concerns and public policy. Energy consumption and greenhouse gas (GHG) emissions from road transport will stabilise due to efficiency improvements in the engine, vehicle and transport system and to the replacement of non-renewable fuels by renewable fuels. The biggest gains will be in the light-duty vehicle fleet. Climate change and competitiveness concerns will encourage greater intermodality of freight transport. For personal mobility, consumer expectations for transportation will be increasingly aligned with public policy directions.
Non-renewable fuels will continue to dominate the total energy demand, but global availability and climate change concerns will increase costs and drive innovation for renewable fuels and alternative energy sources. Electrification will become more important in urban transportation, benefiting from improvements in the electric grid and the increasing contribution from renewable energy sources. The cost of energy will be a critical factor for driving investments in renewable and alternative energy technologies. Energy demand and supply will increasingly be coordinated on a global scale.

There will be a greater diversification in the energy and fuel mix, including renewable and alternative fuels in the near term and greater use of electrification from renewable resources in the longer term, with an on-going need for pan-European vehicle and fuel specifications.

‘Non technological’ improvements will additionally add to transport fuel efficiency, ranging from subtle changes in engine and vehicle design to improvements in vehicle maintenance, changes in consumer driving habits, and improved traffic management and logistics.

**Urban Mobility**

By 2030, urban mobility will have changed due to socio-demographic evolution (ageing and immigration), urbanization, the increase of energy costs, the implementation of environmental regulations, and the further diffusion of sophisticated Information and Communication Technology (ICT) applications in virtually all aspects of life. The result will be a complex, diversified, integrated mobility system, managed with greater efficiency to answer the challenges of reducing environmental impact and minimising urban congestion, while providing comfortable mobility to the traveller.

The demand for public and collective modes of transport will increase considerably. Part of the answer will be provided by public transport (urban rail and bus systems). This will create financial pressure on the mobility system as a whole and on public transport services in particular, while at the same time public finances will have to cope with an increase of social spending, also due to socio-demographic changes.

Urban development and environment policies, land use and sustainable urban mobility planning will become increasingly integrated. Pan European efforts to generalize approaches for sustainable urban mobility plans will further support this trend. This will only partly contain urban sprawl and it will encourage an evolution towards polycentric urban areas.

Financial and spatial constraints will prohibit the full accommodation of the increase in (private) mobility demand. Hence, demand management, including pricing policies, will be implemented on a large scale in European cities as part of their mobility network management strategies, and as a way to influence consumer behaviour. Priority will be given to sustainable transport modes and services, including walking and cycling, which will be encouraged and considered as alternatives for certain trips. The use of personal cars in urban environments will nevertheless not decrease significantly. New services and business models will emerge for urban mobility, encouraging public and collective services, journey sharing, and shared
ownership of vehicles. Access to these services will be made much easier, e.g. by single ticketing concepts, allowing the urban consumer to travel leisurely and seamlessly from door to door.

Information services and e-commerce services will become fully integrated in the everyday life of the urban consumer. The demand for advanced (home) delivery of goods and services will increase. In response urban logistics strategies will aim for greater integration of urban freight challenges in urban planning. This will allow for the consolidation of freight delivery and the optimum use of the infrastructure. Transfer hubs will provide a smooth and efficient interface between long-distance freight transport and urban freight deliveries. The urban vehicle fleet (both passenger and goods delivery) will undergo a transition towards energy efficiency, electrification and diversification in design (e.g. modular), that ensures that vehicles are more suited to the urban environment and the diversified mobility demand. The diversified demand for public transport and urban goods delivery will have a strong influence on new vehicle design.

**Long-distance Freight Transport**

By 2030 the (freight) transport system will be highly integrated and able to balance energy efficiency and flexibility using ICT-based logistic solutions and business models.

Policy measures on the internalisation of external costs will have an impact on freight transport considerations, such as the distances over which goods are moved as well as on the current just-in-time principles and modal choice. New business models for logistics will have an impact on efficiency and flexibility such as transport capacity being offered on demand and enhanced cooperation between different organizations involved in the transportation of goods.

Road (and rail) transport between Europe and Asia will increase considerably as a consequence of the shift in Europe’s global trading partners towards those in much closer ‘low wage’ regions. However, this represents strong growth from a very low starting point and would require significant (expensive) improvements in infrastructure and removal of regulatory or institutional barriers that prevent the development of efficient transport services, such that ocean freight shipping will continue to dominate European-Asian freight transport. Different gateways to, and from, southeast Asia (ASEAN) will develop, concentrated in the eastern European Member States and connecting to the corridors to Asia.

European road infrastructure capacity will be stretched to its absolute limit. While rail and waterway systems will have grown substantially and increased their market share, rail infrastructure constraints and the economics of short-haul freight movements will mean that road remains the dominant freight mode. Short-term relief to the growing transport demand will be provided by full-scale and comprehensive traffic management of the congested corridors.

Additional long-term relief will be provided by ‘debottlenecking’ of the congested sections of the road infrastructure (e.g. short cuts, bridges and
viaducts, the use of ICT based systems). It is likely that legislation will be introduced to streamline the procedures for civil participation and ensure that such projects are completed in the least possible time.

The majority of EU Member States will voluntarily adopt new policies and standards on weight, dimensions and ICT that will allow for the development of new vehicle designs with significantly improved aerodynamics, fuel consumption, safety performance and driver comfort—features that will be employed in almost all long-distance freight transportation.

The concept of modularisation will be implemented by 2030 and will bring increased efficiency and flexibility to freight transport system as all freight transport modes can share the same interfaces and will be able to use the same freight modules.

By 2030 vehicles will be smart enough to ‘sense’ their surroundings and navigate through traffic safely and efficiently, while providing their occupants personalized comfort and convenience. The vehicle will be a ‘node on the internet’, and will be ‘on-line’ with other vehicles (V2V), with the transport infrastructure (V2I), and with homes, businesses and other sources (V2X). Support systems will assist the driver by offering automated responses to developing traffic situations, by coaching the driver to operate the vehicle in the most energy efficient way etc.

The ‘green corridor’ concept will have been introduced and will be used for highly populated highways throughout Europe. In these corridors, longer and heavier vehicles will be the majority, and ‘platooning’ (electronic coupling of trucks) will be widely used.

In 2030, tri-modal land hubs will provide fast (i.e., efficient) transhipment of people and goods between rail, inland waterways and road services. Especially in and around urban areas, these hubs will attract other commercial activities such as shopping, finance and office facilities.

Road Transport Safety

By 2030, road transport safety will still be an important social problem in spite of the wide introduction of sophisticated safety measures to the user, the vehicle and the infrastructure. Factors that are likely to contribute to an increase in road transport safety risks include the increasing number of vulnerable road users, an increase in accident incompatibility between vehicles, the increasing number of elderly people and an overall increase in mobility demand, particularly in the more critical context of urban road use. On the other hand, the introduction of safety systems, e.g. Advanced Driver Assistance Systems (ADAS) and cooperative systems, in vehicles and transport infrastructure, as well as increased consumer awareness and acceptance of these safety systems, will offset the aforementioned impacts on safety risk, but it is not clear whether the overall result will be positive, i.e. a net reduction of the safety risk.
3.2.3. **FREIGHTVISION**

<table>
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<tr>
<th>Project</th>
<th>FREIGHTVISION – Freight Transport Foresight 2050</th>
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<tbody>
<tr>
<td>Organization</td>
<td>European Commission</td>
</tr>
<tr>
<td>Objectives</td>
<td>Develop a vision and roadmap for long distance freight transport and technology policy in a forward looking process towards 2050</td>
</tr>
<tr>
<td>Year of finalisation</td>
<td>2009</td>
</tr>
<tr>
<td>Focus</td>
<td>European freight transport</td>
</tr>
<tr>
<td>Type of analysis</td>
<td>Identification of key drivers and trends</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Literature review, modelling</td>
</tr>
</tbody>
</table>

FREIGHTVISION had the intention to develop a vision and roadmap for long distance freight transport and technology policy in a forward looking process and at a time horizon of 2050.

It analysed the most relevant key drivers ("key impact factors, which trigger and shape the development in an area") and trends ("the most likely future of important aspects of this area, if we go on like in the past, but take into account the policy measures already defined at present") for long distance freight transport in Europe from different viewpoints.

- European policy
- National policies
- Key demonstration projects
- Infrastructure technologies & ITS
- Engine technologies
- Logistics technologies
- Socio-graphic and economic trends
- Transport demand and congestion
- Logistics trends
- Emission trends
- Energy trends

It further developed storylines on futures towards 2050 over specific factors. The factors chosen to be part of that exercise were:

- GHG
- Fossil fuel dependency
- Congestion
- Accidents
We describe here the views of FREIGHTVISION on the above key drivers which deal with the demand side (leaving out the ones more related to the supply side).

**European Policy**

**Key drivers**

*Increasing openness* of the Member states, the EU enlargement and the ambitious Lisbon Strategy were recognized as the three main drivers of most of the EU policies. Following this, environmental sustainability and efficiency have become priorities in the transport sector.

*Reducing dependency on road* for freight transport is the main driver of the EU policies relevant to long distance freight transport (LDFT).

Specific drivers that were of concern within FREIGHTVISION were: the costs of accidents; the increase of road freight transport which was expected to increase even more with the related congestion costs; the energy dependency issue and; greenhouse gas emissions.

**Trends**

Due to increasing environmental threats of road transport, the efforts have been made especially for modal shift in transport, i.e., moving freight off the road and for the use of alternative fuels.

Infrastructure financing is an important trend in European policies relevant for LDFT. The attempts to extend the use of road charging to heavy good vehicles, which are mainly used for LDFT, is also a key trend to achieve a modal shift in freight transport for sustainability. Furthermore, legislations on alternative fuel uses are becoming accepted. The policies are also inclined to achieve standardization of vehicles and their emission limits, the use of technology in LDFT communication and simplifying administrative processes.

In terms of safety, the emphasis has been on road safety measures due to increasing road fatalities. However, no significant measures have been undertaken.

**National policies**

The national transport policies focus on reliable, safe and sustainable freight transport, while maintaining the quality of life. Due to the different geographic, economic and financial situation, national policies' key drivers and trends differ between countries. Countries with a high economic dependence on international trade have a different focus than countries in environmentally sensitive areas in the centre of Europe. Countries with high congestion also have a different focus than new Member States with relatively low congestions. And infrastructure availabilities and financial capabilities have impacts on national policies.

**Key Drivers**

International competitive situation: Member States strive to strengthen their international competitive position as much as possible. A smooth transport system and accessible mainports are considered an indispensable condition.
Infrastructure financing: Due to budgetary restrictions Member States have to find new ways for financing their infrastructure.

Emissions: in order to meet EU directives on air quality – and not risk penalties – Member States must reduce emission levels.

Trends

According to FREIGHTVISION the most important trend in the Member States is probably to improve the efficiency of every mode. The second strong trend is to promote rail and inland navigation as alternatives for road transport. The third trend is toll charges. The reasons behind this measure differ per country (funding of new infrastructure, tackling the negative effects of traffic, improving social development and accessibility). Promotion of sustainable transport is the final trend.

**Socio-Economic Megatrends and Freight Transport Demand**

The objective was to elaborate long-term quantitative trends of freight transport performance for 30 European countries (EU 15, EU 12, Switzerland, Norway, Croatia), based on socio-economic trends (population, GDP, foreign trade etc.).

Key Drivers

The future development of population in EU countries is very different. Eastern Europe has to expect significant losses, whilst some of the old member states will have an increasing population. A certain shift of transport demand from Eastern to Western Europe is therefore to be expected for general demographic reasons.

The drivers of freight transport demand have always been the progressing spatial division of production. This will remain true, but change with regard to transport distances.

While in the past division of labour was a local or national trend mainly, since about 20 years it becomes more and more a European and even global phenomenon with respective foreign trade developments. For the future is expected, that labour division as well as the foreign trade, will continue to “globalize”.

The analyses of the origin of GDP by industry show the current and continuing great importance of the manufacturing industry, but also a big and increasing role of the service sector as a whole.

Trends

The annual growth rates of all mode freight transport performance in all study countries decrease up to 2050, but they will not be negative for the most countries.

Generally the growth in all 30 countries is much higher in international transport (export, import, transit) than in national transport.

The modal share for road transport in the past is quite important in the EU 15, Switzerland and Norway. For 2050 is estimated for almost all countries a decreasing road transport share.
TRANSPORT DEMAND & CONGESTION

The overall objective was to assign transport demand to the existing and planned transport network to estimate congestion and other network effects. The reference scenarios measure the most likely development given the assumptions put forward. Reference scenarios have been developed on the basis of the TRANSTOOLS model developed in the TEN-CONNECT study.

Key drivers

The key drivers influencing transport demand and thus congestion in the TRANSTOOLS model are: GDP growth; Infrastructure development; Transport costs.

Trends

The transport growth in Europe for road transport projects a moderate increase in central Europe whereas a more aggressive growth is expected in Eastern Europe, Balkan, the Baltic countries, and Turkey. At the overall European level, congestion is expected to rise through 2020 and 2030 from its current level. Road bottlenecks are primarily located around the large cities. It is expected that rail transport represent a 23.3% share in 2030 compared to 19.5% in 2005. More specifically, it is anticipated: Longer trips due to market specialisation; A move from national to international transports; Growth in specific bulk-corporis to Russia. In terms of congestion, it is expected that due to longer trips, rail transport will be more sensitive to regional bottlenecks and that the general increase in rail demand will put pressure, not only on the network but also on terminals and reloading centres which may increase waiting times. Congestion is not expected in inland waterways because there is free capacity.

EMISSION TRENDS

Relatively little information is available directly relating to the freight transport’s environmental problems, and therefore when data was not available, a wider perspective on transport as a whole is taken.

Key Drivers

Key transport related drivers affecting the environmental aspects include: transport volume; modal split; technology type and development state; fuel type and fuel consumption or energy efficiency.

Trends

Transport, and especially road transport has a significant negative impact on emissions and therefore it is expectable that as a consequence of growing transport volumes, a negative trend in these aspects is to be witnessed.

ENERGY DEVELOPMENT

The aim was to examine key trends in the broader energy system, with particular emphasis on these factors within it that are likely to influence energy demand for freight transport. The methodology for the analysis has concentrated on quantitative aspects, using two large scale models.

Key Drivers
Future energy demand in the freight sector of the EU will be primarily driven by the following factors: overall freight transport activity; pace and composition of economic growth; intermodal shifts; technological improvements; policy interventions such as taxation, fiscal incentives and types of infrastructure promoted; fuel prices.

Trends

Despite lower growth in both advanced and emerging economies the median growth of the world economy to 2050 will be very close to that experienced in the last four decades, as a result of the increasing weight of emerging economies. Under such conditions median oil prices in 2050 will be close to 2008 averages. According to the Baseline projection there is a 40% probability that World conventional oil production will peak before 2020. On the other hand nonconventional petroleum is very likely to compensate substantially. High or very high oil prices could provide a necessary stimulus for the transformation of the transport energy scene.

3.2.4. European Commission’s “A sustainable future for transport - Towards an integrated, technology-led and user-friendly system”

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<tr>
<th>Project</th>
<th>A sustainable future for transport - Towards an integrated, technology-led and user-friendly system</th>
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<tbody>
<tr>
<td>Organization</td>
<td>European Commission</td>
</tr>
<tr>
<td>Objectives</td>
<td>Stimulate debate aimed at identifying policy options in the transport White Paper of 2010</td>
</tr>
<tr>
<td>Period of development</td>
<td>2009</td>
</tr>
<tr>
<td>Focus</td>
<td>European transport systems</td>
</tr>
<tr>
<td>Type of analysis</td>
<td>Identification of main transport drivers and their trends</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Literature review, expert consultation within focus groups</td>
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</tbody>
</table>

To stimulate debate aimed at identifying policy options in the transport White Paper of 2010, the European Commission promoted a wide reflection on the future of the transport system comprising: 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 through a high level stakeholders‘ conference. The review outlined what were considered to be the main trends in transport drivers and the likely challenges they could pose to society. They were the following:

- Ageing
- Migration and internal mobility
• Environmental challenges
• Increasing scarcity of fossil fuels
• Urbanisation
• Global trends affecting European transport policy

3.2.5. World Energy Council: “Global Transport Scenarios 2050”

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<tr>
<th>Project</th>
<th>Global Transport Scenarios 2050</th>
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<tbody>
<tr>
<td>Organization</td>
<td>World Energy Council</td>
</tr>
<tr>
<td>Objectives</td>
<td>Construct and describe potential global transport scenarios that reflect potential developments in transport fuels, technologies, and systems over the course of the next four decades.</td>
</tr>
<tr>
<td>Year of finalisation</td>
<td>2011</td>
</tr>
<tr>
<td>Focus</td>
<td>Transport sector with a focus on energy output</td>
</tr>
<tr>
<td>Type of analysis</td>
<td>Analysis of driving forces and scenario analysis</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Stakeholder consultation and literature review</td>
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This study by the World Energy Council does an overview of the global transport sector, along with discussion of the related major driving forces, constraints, and uncertainties. This is followed by two scenarios, Freeway and Tollway, and the regional inputs.

The driving forces regarded as more relevant in the study are

• Economic Growth
• Demographic Trends
• Urbanization and Megacities
• Geopolitics
• Global Oil Reserve and Supply
• Environmental and Health Concerns
• Policies and Regulations
• Lifestyle Changes
• Alternative Fuels
• Fuel Efficiencies
• Innovations

The study considered two critical uncertainties in the development of future scenarios. They were:

• Government regulation
• Cooperation-integration

Regional inputs on transport policies, existing and potential developments in both fuels and technologies, in addition to major driving forces and critical
uncertainties were all examined and combined into two distinct transport scenarios “Freeway” and “Tollway.” The main difference between these two scenarios is the degree and style of government intervention in regulating future transport markets.

- The “Freeway” scenario envisages a world where pure market forces prevail to create a climate for open global competition.
- The “Tollway” scenario describes a more regulated world where governments decide to intervene in markets to promote technology solutions and infrastructure development that put common interests at the forefront.

According to the report the Freeway and Tollway scenarios describe the extreme ends of the potential futures envelope, where the reality will inevitably be between these two scenarios with regional differences playing a major role.

In quantifying these two scenarios, the study noted that by 2050:

- Total fuel demand in all transport modes will increase by 30% (Tollway) to 82% (Freeway) above the 2010 levels. The growth in fuel demand will be driven mainly by trucks, buses, trains, ships, and airplanes.
- Transport sector fuel mix will still depend heavily on gasoline, diesel, fuel oil and jet fuel, as they all will still constitute the bulk of transport market fuels with 80% (Tollway) to 88% (Freeway) in 2050.
- Demand for these major fuels will increase by 10% (Tollway) to 68% (Freeway) over the scenario period.
- Demand for diesel and fuel oil will grow by 46% (Tollway) to 200% (Freeway).
- Demand for jet fuel will grow by 200% (Tollway) to 300% (Freeway).
- Demand for gasoline is expected to drop by 16% (Freeway) to 63% (Tollway).
- Biofuels will also help to satisfy the demand for transport fuel as their use will increase almost four fold in both scenarios. Other fuels including electricity, hydrogen, and natural gas will increase six to seven fold.
- The additional transport fuel demand will come from the developing countries (especially China and India) where demand will grow by 200% (Tollway) to 300% (Freeway). In contrast, the transport fuel demand for the developed countries will drop by up to 20% (Tollway). The demand of the developing countries is expected to surpass that of the developed ones by the year 2025, if not earlier.
- The total number of cars in the world is also expected to increase 2.2 times (Tollway) to 2.6 times (Freeway), mainly in the developing world, where the number of cars will increase by 430% (Tollway) to 557% (Freeway) while the developed countries will see an increase of only 36% (Tollway) to 41% (Freeway).
At the end of the scenario period (2050) it is expected that conventional gasoline and diesel internal combustion engines (ICEs) will have a market share between 26% (Tollway) and 78% (Freeway). Other drive-train technologies will make up the rest with liquid hybrid, plugins, and electric vehicles leading in Tollway, while liquid hybrids, plug-ins and gas vehicles lead in Freeway.

The scenarios also show significant regional differences, with shale gas being a driver for natural gas fuelled transport in North America, biofuels with a continued high contribution in Latin America, and electric mobility having a particularly strong push in Asia/China where the growth of megacities is most dramatic.

### 3.2.6. TOSCA

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<tr>
<th>Project</th>
<th>TOSCA - Technology Opportunities and Strategies towards Climate friendly transport</th>
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<tr>
<td>Organization</td>
<td>European Commission</td>
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<tr>
<td>Objectives</td>
<td>Identify promising technology and fuel pathways to reduce transportation-related greenhouse gas emissions through mid-century</td>
</tr>
<tr>
<td>Year of finalisation</td>
<td>2011</td>
</tr>
<tr>
<td>Focus</td>
<td>Transport in Europe</td>
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<tr>
<td>Type of analysis</td>
<td>Quantitative scenarios</td>
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<tr>
<td>Methods applied</td>
<td>Scenario and modelling analysis, inputs from various sources</td>
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</table>

The TOSCA project aimed to identify promising technology and fuel pathways to reduce transportation-related greenhouse gas emissions through mid-century. An important building block of this project is the techno-economic specification of low-GHG emission transportation technologies, which are input into a scenario analysis.

TOSCA Work Package 6 integrates the technology, fuel, and infrastructure studies carried out through a scenario and modelling analysis. The first step in the scenario analysis consisted of a systematic review of existing European transport scenarios. Consequently, a set of scenario variables that affect future passenger and freight transport demand was determined. These were used to formulate four distinct scenarios (three detailed scenarios and one sensitivity case). The TOSCA scenarios provide a set of self-consistent projections of exogenous factors which have an impact on EU27 transportation demand. Policy measures are excluded from these scenarios, as they are considered in a further part of the project.
Following an extensive literature review of existing scenarios, GDP growth and oil prices were identified as the most important uncertain driving forces for changes in demand for transport, and the carbon intensity of electricity generation as a further important and uncertain factor affecting future transport emissions. Trends in these variables were projected for a Baseline scenario, a Challenging scenario (representing a future in which it will be particularly hard to reduce transport emissions) and a Favourable scenario (representing a future in which emissions reductions from transport will be relatively easy). These scenarios are designed to cover the full range of likely variation in future EU27 transportation emissions. They were used as input to demand modelling using existing transport demand models such as Transtools and Aviation Integrated Modeling (AIM). Based on the output of these models it was concluded that:

- Demand for transportation increases in all scenarios, even in the Favourable scenario, both in passenger and freight transport.
- In all scenarios the modal shares of freight demand per mode are similar (82% for road and 18% for rail, excluding maritime and air freight demand). Changes in the input assumptions as used in TOSCA do not have a strong effect on the output for the freight model in Transtools.
- The modal shares of passenger demand show greater differences across scenarios, with road transport remaining the dominant transport mode. The greatest trend change concerns the Challenging scenario which shows a considerable stronger growth of the modal split in aviation compared to the Baseline (26% of the total demand in 2050, while the Baseline grows up to 18%).

The scenarios and demand projections generated in this report are used to estimate technology uptake and transportation emissions. The impact of changes in policy on demand emissions and technology utilised is then considered.
3.2.7. **OPTIMISM**

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<tr>
<th>Project</th>
<th>OPTIMISM – optimising passenger transport systems</th>
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<tr>
<td>Organization</td>
<td>European Commission (FP7 Coordination and Support Action FP7- 284892)</td>
</tr>
<tr>
<td>Objectives</td>
<td>Propose a set of strategies, recommendations and policy measures, through the scientific analysis of social behaviour, mobility patterns and business models, for integrating and optimising transport system.</td>
</tr>
<tr>
<td>Period of development</td>
<td>2012</td>
</tr>
<tr>
<td>Focus</td>
<td>Passenger transport systems</td>
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<tr>
<td>Type of analysis</td>
<td>Identification of Megatrends and key factor trends affecting the passenger transport systems.</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Literature review, expert consultation</td>
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</table>

For the purpose of building scenarios, the OPTIMISM project identified Megatrends relevant for transport and key factor trends affecting the passenger transport systems.

Based on the results of the analysis of literature on key factors combined with expert knowledge eleven Megatrends have been identified:

1. Urbanisation
2. Shortage of Resources
3. Globalization 2.0
4. Climate Change and Environmental Ethics
5. Technology Change
6. Crisis of Mobility and European Policy Reaction
7. World Population Growth
8. Demographic and Social Change Europe
9. European Market Deregulation
10. Increase of Inter- / Intra-national Social Disparities
11. Knowledge Society and -Economy Europe

As for key factors affecting passenger transport systems, they were grouped into three types: External key factors; Policy actions and; Key characteristics of the passenger transport system. The key factors chosen by OPTIMISM are outlined below.

**External key factors**

- ICT for information society and ICT enabling technologies
- Socio-demographic and cultural factors
- Spatial Structure
To get an idea how Megatrends will influence the transport system an impact analysis has been done. Experts were asked to link Megatrends with key factors (related to them) and to estimate the related impact. This allowed assessing the relative importance of Megatrends and the vulnerability of key factors.

The Megatrends were assessed to have quite different impact on the factors of the transport system. Urbanization has been rated as the most important Megatrend with impact on the transport system, followed by Shortage of Resources and Globalisation 2.0.

In terms of the vulnerability analysis of key factors, all parts of the transport system, “urban” and “individual public transport” as well as “air transport”, seem to be vulnerable to the developments described by the most important Megatrends. A large impact on the transport system may also occur through effects on “regional differences in economies”, which has been ranked highest. The impact of the megatrends will also affect the policy reaction in different fields, such as “definition of aims in strategic transport planning”, “priorities in infrastructure investment policies” and “infrastructure planning”. Also “technology development and innovation diffusion” and “transport behaviour” are supposed to be highly affected by Megatrends.
3.2.8. **FORD: “The future of sustainable transport in Europe”**

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<tr>
<th>Project</th>
<th>The Future of Sustainable Transport in Europe</th>
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<td>Organization</td>
<td>Ford</td>
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<tr>
<td>Objectives</td>
<td>Look at the trends and consumer attitudes that will shape the future of the sustainable transport industry to 2025</td>
</tr>
<tr>
<td>Year of finalisation</td>
<td>2012</td>
</tr>
<tr>
<td>Focus</td>
<td>Passenger transport in Europe, consumer attitudes</td>
</tr>
<tr>
<td>Type of analysis</td>
<td>Identification and analysis of key drivers framing the sustainable passenger transport sector</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Literature review, expert consultation, international quantitative research, own proprietary knowledge</td>
</tr>
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</table>

The project’s objective was to look at the trends and consumer attitudes that will shape the future of the sustainable transport industry to 2025. The report identified potential consumer solutions for a sustainable transport future regarding individual transport needs, and an explanation about what will work and what will not, based on the research findings.

The building blocks of the approach were:

- A review of over 40 published research reports on the transport industry.
- Expert interviews with pan-European commentators including transport experts, leading-edge automotive industry representatives, social trends experts, as well as Ford’s own leading automobile representatives.
- International quantitative research conducted in July and August 2012 with consumers in six different markets; Denmark, France, Germany, Italy, Spain and the UK, to explore consumer needs and attitudes, and the barriers to the use and spread of sustainable transport.
- The author’s (Futures Company) own proprietary knowledge base of the social, technological, environmental, economic and organisational drivers of change, as well as our knowledge of sustainable transport.

The key drivers currently influencing the sustainable transport sector as regarded by Ford were the following:

1. Economic pressures
2. Environmental anxieties
3. Changing mobility demands
4. Changing journeys
5. Reframing ownership
6. Market making
7. Collaboration  
8. Vehicle development  
9. People-to-machine interactions

We describe the essential Ford’s views on these drivers:

1. **Economic pressures**: For many consumers, the current sluggish economic performance in Europe is generating an ongoing anxiety about the future, which is creating conservative and risk-averse attitudes to spending. These general trends are likely to be exacerbated in the transport industry, as a result of increasing oil prices and growing pressures upon energy suppliers, which are leading to high and fluctuating fuel costs. These rising costs are having a direct impact on consumers; the economic crisis has led 32% of the six-market total to use their car less.

2. **Environmental anxieties**: Environmental issues remain a growing area of concern and interest for many consumers. As the travelling public and governments become increasingly informed and engaged, companies will be under rising pressure to adopt manufacturing and production processes that minimize their environmental impact.

3. **Changing mobility demands**: As the makeup of households and communities change, and social attitudes to age and gender evolve, consumer mobility needs and attitudes towards different forms of transport are undergoing both subtle and dramatic changes. For example, single-occupant households have risen to 15% worldwide and 31% in Western Europe. The number of households in the world’s major cities is expected to grow 2.3 times faster than the cities themselves.

4. **Changing journeys**: The types of journey made by individuals, businesses and objects are evolving in a variety of ways. Flexible working is growing in popularity and remote collaboration is reducing the emphasis upon the traditional “city commute”. Flexible working is most popular among employees in the US and Europe, with self-employment preferred in emerging markets. Changing approaches to city planning are leading to new types of urban mobility, often moving away from the traditional dominance of the car. As a result of these changes, a growing uptake of alternative methods of transport is emerging, from the traditional bike to more experimental formats.

5. **Reframing ownership**: Driven by both continued economic pressures and changing values in society, the traditional assumptions and values of vehicle ownership are evolving. This includes both changes to the ways in which people make decisions about which mobility choice to purchase, alongside the emergence of new ways in which people can access, use and finance their travel.

6. **Market making**: As governments and institutions increasingly seek to move away from fossil fuel-based transport, a range of public, private and third sector initiatives are exploring sustainable approaches to transport and energy provision. In doing so, they are helping to create a series of potential markets for EV systems, often integrated with broader urban frameworks and transport systems, such as the development of “smart cities”.

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7. **Collaboration**: EV automobile manufacturers are seeking new ways to collaborate with both their competitors and the consumer in order to increase the mainstream appeal and viability of EVs. The overarching question is, ‘who is the main driver of the EV market?’ There is a challenge here to the traditional business models of automotive manufacturers.

8. **Vehicle development**: After a period of relative stability, the form and function of the traditional car may be on the brink of more dramatic change, as new materials, energy sources and mobility demands create a proliferating range of vehicle forms. At the same time, new challenges such as scarcity of raw materials and the growing resistance to noise pollution may necessitate new forms of innovation and development.

9. **People-to-machine interactions**: Transport and mobility is gradually being reinvented by a range of technological developments, particularly driven by mobile and geo-locative capabilities. Complex functionality is likely to be increasingly integrated in the individual travel experience.

### 3.2.9. Go-Ahead Group and Passenger Focus: “The Future of Transport”

<table>
<thead>
<tr>
<th>Project</th>
<th>The Future of Transport</th>
</tr>
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<tbody>
<tr>
<td><strong>Organization</strong></td>
<td>Go-Ahead Group and Passenger Focus</td>
</tr>
<tr>
<td><strong>Objectives</strong></td>
<td>Explore potential social, economic and technological changes and how these might influence passengers’ use of, and relationship with transport in the future.</td>
</tr>
<tr>
<td><strong>Year of finalisation</strong></td>
<td>2012</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>Passengers’ preferences (UK)</td>
</tr>
<tr>
<td><strong>Type of analysis</strong></td>
<td>Trend analysis</td>
</tr>
<tr>
<td><strong>Methods applied</strong></td>
<td>Identifying drivers of change and scoping travel and mobility trends</td>
</tr>
</tbody>
</table>

This study explored potential social, economic and technological changes and how these might influence passengers’ use of, and relationship with transport. The work aimed to look beyond what passengers need now and instead look at the longer term trends that the transport industry needs to prepare for. The horizon of analysis was until 2025. It focuses on the UK, but we find that its results are generally representative to other European countries.

The research had three core objectives:

1. To understand key future trends impacting on public transport in the UK
2. To interpret how these trends might manifest themselves in evolving passenger mindsets, needs and behaviours
3. To identify implications for types of services and experiences (including technology) that passengers will expect.
The stages of the study were the following:

- Identifying drivers of change
- Scoping travel and mobility trends
- Developing key ideas and themes

The analysis of drivers of change and trends was divided into macro and micro trends.

**Macro trends**

1. **A growing, older population**: The population is growing and putting increased strain on infrastructure. It is also ageing, but many ‘new seniors’ will be more active than we’ve known in the past: working, travelling and participating across spheres of society.

2. **Splintering social structures**: Social structures are in flux, driven by fragmentation and individualisation. The traditional family unit will continue to decline with lower fertility rates, delayed marriage and increasing divorce rates. This coincides with an increasingly networked mindset which forms virtual networks and communities. As knowledge work increases, the financial and cultural void between skilled and low-skilled workers widens. Here, transport is key - workers of all levels need practical and affordable methods for travelling to work.

3. **Environmental squeeze**: The need to control rising global temperatures will inevitably have a large impact on lifestyles. Environmental awareness is rising but ethical attitudes do not necessarily translate into ethical behaviour. Change will likely be driven by government and urban planning policies. Scarcity and cost of energy sources will also drive change. Limitless car use will not be an option for many.

4. **The end of assumed affluence**: The period of ‘assumed affluence’ - steadily increasing national and personal wealth - is coming to an end. New ideas about value are emerging: taking greater care with the fewer purchases we are making, and an end to seeing the world as a supermarket of possibilities. A key characteristic of this is purchasing with consideration for quality and longevity.

5. **Blurred boundaries between online/offline life**: As we increasingly become an ‘always-on’, 24/7, society this trend is on an inexorable forward path and will manifest itself across increasingly diverse parts of our lives. Work, socialising, travelling, and exercising will all increasingly be carried out in the digital and ‘real’ world. The importance of the digital space to human connections will only increase - especially with the millennial generation born into Facebook.

6. **Shifting balances of power from above to below**: The empowerment of the individual (and individual as consumer), and their influence on corporate and public decision-making, will grow. Public and private organisations will need to be prepared to react to challenges on
traditional hierarchies, no longer ‘talking at the consumer’. Consumers are increasingly informed, savvy, discerning and questioning, with less trust in ‘the institution’. There will be a movement from ‘command and control’ to ‘open-source’ models of behaviour.

7. **The feminisation of society:** We are experiencing increased female participation in the workforce and in education, which has far-reaching hard and soft implications for our society. A greater emphasis on certain (traditionally thought of as ‘female’) values in society: greater emphasis on notions of health, well-being and support and empathetic models of management and working. Women’s greater presence will ask great questions of working patterns, working styles, leisure patterns, family structure and parental roles.

**Micro trends**

8. **Self:**
   - **Seamless ‘always on’ living:** The overarching shift in the way we live our day-to-day lives will be ever-greater seamlessness. Days will increasingly move from compartmentalised, fragmented frames of time, to free-flowing, flexible timeframes. Waiting/dead time will be minimised.
   - **Life through the lens of health and wellness:** Consciousness and enthusiasm for health will be woven more tightly into everyday life and increase in the future as the population ages and people seek ways in which to manage their health better to stay active and productive for longer. This will shape the Government agenda, as happiness indicators become measurements of economic and personal health.

9. **Relationships:**
   - **Strength in networks:** As society abandons vertical, top-down power structures, networks and ‘the collective’ become increasingly important. This is facilitated largely by technology, with significant impact on shopping, music and video sharing, online trading, social initiatives, political protest and much more. ‘Productive relationships’ are initiated online and based on mutual interests, mutual desires, connections related to business and so on. Companies are far more ‘open’ to consumers and consumers have much greater power to influence companies.
   - **The enduring need for face-to-face time:** Digital connections in spaces like Facebook and Twitter do not replace physical relations; they enhance them and increase opportunities to nurture them. A net effect of the rise of one-person households will be the desire for more socialising and more frequent activities with others.
10. Work:
   o **More flexible working**: Experts forecast that it is far more likely that companies will negotiate more flexible hours with their employees, as well as switching between time in and out of the office, than move wholly towards home working. This will lead to many people being able to choose their start and finish times for the working day, plus the days they spend at their company office.
   
   o **Working in the company of others**: Knowledge workers gather in cities to collaborate and compete. Companies will continue to need to be based in business hubs. This enhances the need for services, entertainment and public transport in these areas. Another developing trend is a ‘third space’ of ‘hubs’ between home and the workplace. As technology advances, experts spot an opportunity for transport and its infrastructure to meet future flexible working needs.

11. Places:
   o **The pull towards the city**: Cities and regions could increasingly become, in both physical and political terms, more like an amalgamated ‘megalopolis’. However, there may also be a regional surge as new knowledge industry clusters grow. In recent years we have seen the flourishing of the city centre as a residential space. We are experiencing a suburban renaissance. 80% of Britons live in suburbs, and planners are getting behind the strategy of using suburbs to make towns and cities more resilient in coping with future congestion stresses.
   
   o **Navigating digital urban landscapes**: Technology and what is being described as the ‘internet of things’ will transform how we move around future ‘smart cities.’ Environments will become immersed in real-time information flowing seamlessly around locations and people. ‘Augmented Reality’ merges the online and offline worlds, creating a wealth of opportunities for services. The vision is that any ‘thing’ – from fridges to buses and buildings - will be able to share data and adapt to suit our needs. Local authorities will be able to deliver much more efficient services, such as reducing waste, traffic lights could respond to changing traffic flows, or people could see how full a train is before they leave for the station.

12. **My things**:
   o **Desire for filtering and customisation**: In an age of information and data overload, there is an increasing desire for filtering and customisation. Technologists talk about the ‘Age of Personal Informed Reality’ - the notion of the internet being a
customised resource. Data is both pushed and pulled to the individual. It is increasingly displayed visually, often having an immersive game-like feel, is real-time and is highly socialised and interactive. This, of course, has profound implications for relationships with brands and services. We are increasingly going to ask questions of them based only on our needs and we will only want to hear from them about matters relevant to us.

- **Pick-up and put-down ownership:** Concepts of ownership will continue to develop from the current proliferation of hiring and rental schemes into a culture of ‘pick up and put down’, where people can’t afford and don’t desire the volume of things owned by past generations. (e.g. cars). It is likely to be easier to adapt to shared ownership models when it comes to transport in urban areas, as residents of rural areas have a greater dependence on their cars, and it would be more difficult to attain a critical mass of people to make it viable.

### 3.2.10. Deutsche Post: “Delivering Tomorrow - Logistics 2050, A Scenario Study”

<table>
<thead>
<tr>
<th>Project</th>
<th>Delivering Tomorrow - Logistics 2050, A Scenario Study</th>
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<tbody>
<tr>
<td>Organization</td>
<td>Deutsche Post</td>
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<tr>
<td>Objectives</td>
<td>Explore potential social, economic and technological changes and how these might influence passengers use of, and relationship with transport in the future.</td>
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<tr>
<td>Year of finalisation</td>
<td>2012</td>
</tr>
<tr>
<td>Focus</td>
<td>Logistics</td>
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<tr>
<td>Type of analysis</td>
<td>Scenario analysis</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Environmental analysis and scenario analysis</td>
</tr>
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</table>

The study “Logistics 2050” developed explorative scenarios of the future for the logistics industry with a long-term and global perspective. The study aims to foster dialogue about the future of logistics by describing a number of different pictures of the world in 2050.

First, through an environmental analysis, all relevant influencing factors were compiled. The next step was to estimate - with the help of internal and external experts - the key factors, or main drivers, and their further development (future projections). This formed the basis for the construction of the raw scenarios using software based consistency analysis. The purpose of this was to check which projections of a key factor “match” which projections of the other key factors. This resulted in five internally consistent future scenarios that are substantially different from each other. A final impact
analysis then helped to determine the strategic implications of the various scenarios for logistics.

The Key Factors identified by Deutsche Post were the following:

1. **Level and Distribution of Income** Level and inequality of household incomes and wealth within and between countries.

2. **Dominant Consumer Needs** The development of the most dominant consumer preferences and purchasing decision criteria for products and services (e.g., price, prestige, functionality, security, health, sustainability, education, entertainment).

3. **Quality of Urban Development** The way in which urban areas will develop in the developed world and in the emerging countries in terms of infrastructure maintenance or expansion, the financial capacity of local authorities and the demographic change within cities’ populations.

4. **Distribution of Production and World Trade** Global dissemination of production facilities, the resulting trade flows of commodities and goods, and the organization of supply chains.

5. **Energy Price and Energy Mix** Fuel and energy price level and the share of fossil and renewable fuels in the energy mix.

6. **Availability and Price of Raw Materials and Resources** Companies’ and peoples’ access to (critical) materials (e.g., water, metals, rare earths) and the price level of resources.

7. **Level of Climate Change** The level of global warming as well as the number and impact of natural disasters.

8. **Regulatory and Spending Policies** The level of and balance between spending and regulatory policy, the former including social redistribution, subsidies and public investments, the latter referring to the general economic framework (property rights, competition policy, etc.).

9. **Trade Regulation** The rules and the framework which apply to the international exchange of goods and services (e.g., WTO rules, import restrictions, or customs).

10. **Logistics and Transport Regulation** The rules, norms, and standards applying to the transportation of goods, with a focus on security, environmental and monetary objectives.

11. **Political Stability and Economic Security** Political stability with regard to the international institutional framework, political cooperation, (inter-)national conflicts, terrorism, and corruption. Economic security in terms of property rights, criminality, and piracy.

12. **ICT Systems and Robotics** Precision, reach and general functionality of information, communication and knowledge management systems, including tracking and tracing, geodata and robotics.
13. **Material Technology** Structure and functionalities of materials in regard to goods, vehicles, vessels, packaging, and 3D-fabrication.

14. **Infrastructure for International Exchange** Density and quality of road, train, shipping, flight, energy, and information infrastructure (also ports and airports) including funding, maintenance, and operation.

The following table outlines 3 to 4 projections made for each key factor.
The final scenarios built in this study, and their consequences for the logistics sector, are described below:

**Scenario 1, Untamed Economy - Impending Collapse**, looks at a world characterized by unchecked materialism and consumption, fed by the
paradigm of quantitative growth and the rejection of sustainable development. Global trade has flourished through elimination of trade barriers. Global economic power has shifted to Asia and the formerly “emerging” countries have surpassed the West. A global transportation supergrid ensures rapid exchange of goods between centers of consumption. This untamed economy, propelled by unsustainable lifestyles and uncontrolled exploitation of natural resources, carries the seeds of its own demise: as massive climate change inches closer, natural disasters occur more often and disrupt supply chains frequently.

The implications for the logistics industry include a massive increase in the demand for logistics and transport services. Companies even outsource production processes to logistics companies. While climate change opened up shorter and more efficient trade corridors through the Arctic ice, an increase in extreme weather events interrupts trade routes on a frequent basis and raises capital costs for logistics companies.

Scenario 2, Mega Efficiency in Megacities, describes a world in which megacities are both the main drivers and beneficiaries of a paradigm shift towards green growth. To overcome the challenges of expanding urban structures, such as congestion and emissions, megacities have become collaboration champions, fostering open trade and global governance models in partnership with supranational institutions. Rural regions have been left behind and the nation-state has become a second-tier actor. Robotics has revolutionized the world of production and services. Consumers have switched from product ownership to rent-and-use consumption. Highly efficient traffic concepts, including underground cargo transport and new solutions for public transport, have relieved congestion. Zero-emission automated plants have helped to cut carbon emissions. A global supergrid with mega transporters, including trucks, ships and aircraft, as well as space transporters, has opened important trade connections between the megacities of the world.

The logistics industry is entrusted to run city logistics, utilities, as well as system services for airports, hospitals, shopping malls and construction sites, along with part of the public transport infrastructure. It also manages the complex logistics planning and operations for advanced manufacturing tasks. In response to “dematerialization” of consumption, logistics companies offer an array of renting and sharing services, as well as secure data transfer. Thus, advanced logistics services not only encompass the fast and reliable delivery of goods, but also the safe transfer of information and knowledge.

Scenario 3, Customized Lifestyles, describes a world where individualization and personalized consumption are pervasive. Consumers are empowered to create, design and innovate their own products. This leads to a rise in regional trade streams, with only raw materials and data still flowing globally. Customization and regional production are complemented by decentralized energy systems and infrastructure. The new production technologies like 3D printers accelerate the customization trend and allow developing countries to leapfrog classical industrial production patterns. However, the extensive production of personalized products has increased energy and raw materials
consumption overall, resulting in a global climate on course to a 3.5°C temperature increase by the end of the century.

The implications for logistics include a vastly reduced need for long-distance transportation of final and semi-final goods due to the localization of value chains. At the same time, logistics providers organize the entire physical value chains. They also handle the encrypted data streams required for the transmission of construction and design blueprints for 3D printers, and have expanded into the online fabbing market. The decentralized organization of production turns strong regional logistics capabilities and a high quality last-mile network into important success factors.

Scenario 4, Paralyzing Protectionism, describes a world where, triggered by economic hardship, excessive nationalism and protectionist barriers, globalization has been reversed. Resources are scarce, technological development is lagging and economies are in decline. High energy prices and dramatic scarcities lead to international conflicts over resource deposits. Under these circumstances, scant effort is made to reduce greenhouse gas emissions and the world climate is on the path to a 3.5°C temperature increase by the end of the century.

Implications for the logistics industry include challenges posed by the decline in world trade and the resulting regionalization of supply chains. Governments view logistics as a strategic industry. As relations between some blocs and countries are extremely strained, logistics providers in bloc-free countries act as intermediaries in international trade brokerage. The growing complexity and length of the customs clearing process increases demand for specialized customs brokerage and consulting services.

Scenario 5, Global Resilience - Local Adaptation, describes a world initially characterized by a high level of consumption thanks to cheap, automated production. However, due to accelerated climate change, frequent catastrophes disrupt supply chains and lean production structures, resulting in repeated supply failures for all kinds of goods. The new economic paradigm is distinguished by a shift away from efficiency maximization to vulnerability mitigation and resilience. This radical move towards redundant systems of production and a change from global to regionalized supply chains allows the global economy to better weather troubling times.

The resilient world in 2050, with regionalized trade, relies on a logistics sector that ensures supply security as a top priority, with backup infrastructure to guarantee reliable transport in unstable and hazardous times. However, such extensive backup systems are asset-heavy and conflict with the aim of carbon reduction. To counter this effect and balance energy efficiency and supply chain resilience, sophisticated logistics planning is used to achieve high capacity utilization. In addition, instead of complex just-in-time delivery processes, huge warehouse structures located close to the manufacturer are seen as indispensable buffers.
3.3. Future studies on related fields

3.3.1. Z Punkt: “Megatrends Update”

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<thead>
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<th>Project</th>
<th>Megatrends Update</th>
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<tbody>
<tr>
<td>Organization</td>
<td>Z Punkt</td>
</tr>
<tr>
<td>Objectives</td>
<td>Providing a source for strategic foresight at corporate level.</td>
</tr>
<tr>
<td>Year of finalisation</td>
<td>2013</td>
</tr>
<tr>
<td>Focus</td>
<td>Global issues relevant to corporations</td>
</tr>
<tr>
<td>Type of analysis</td>
<td>Identification of megatrends</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Z Punkt’s internal intelligence base</td>
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</table>

Z Punkt is a leading strategy and foresight consultancy, focused on corporate foresight. It regularly updates and presents a Megatrends update. Its latest version highlights the following 20 Megatrends and related trends:

1: Demographic change
- Growing global population
- Ageing populations
- Declining populations in the West
- Increasing migration streams
- Demographic shifts

2: Individualisation reaches a new stage
- Individualism, a global phenomenon
- Changing relationship patterns: Few strong, many loose relationships
- Complex biographies and identities
- From mass markets to micro markets
- Self-sufficiency and DIY-economics

3: Social and cultural disparities
- Growing polarisation of the rich and poor
- Precarious lifestyles becoming the norm
- Social fragmentation across different life situations
- Competing and merging value systems

4: Reorganisation of healthcare systems
- Increasing health awareness and higher personal responsibility
- Changing disease patterns
- Sharp increase in health expenditure—greater privatisation of costs
- Reorganisation of the healthcare sector
- New approaches to diagnosis and treatment
- New converging markets

5: Changes to gender roles
- Breakdown of traditional gender roles
- Increasingly important role played by women in the workplace
| 6: New patterns of mobility | • Appreciation of social and communicative skills  
|                            | • Growing importance of a healthy work-life balance  
|                            | • New family structures and lifestyles  
| 7: Digital culture | • Mobility increases worldwide  
|                        | • Barriers to mobility increase  
|                        | • Intermodal mobility patterns  
|                        | • Digital networking of traffic  
|                        | • New vehicle concepts and drive technologies  
|                        | • Intelligent logistics solutions  
| 8: Learning from nature | • Digital technologies pervading and connecting all aspects of daily life  
|                         | • Greater differentiation between digital lifestyles  
|                         | • Digital natives: New forms of social communication, participation and organisation  
|                         | • Web 3.0 is on its way  
| 9: Ubiquitous intelligence | • Natural structures and processes becoming a key characteristic of innovation  
|                          | • Bionics incorporated into design and technology  
|                          | • Swarm intelligence  
|                          | • Influence of biology on production systems—decentralisation and the closed-loop economy  
| 10: Technology convergence | • Miniaturisation and nanotechnology becoming key drivers of technology convergence  
|                           | • Dynamic innovation for new materials and construction methods  
|                           | • Expansion of biotechnology  
|                           | • Greater NBIC-convergence to achieve the vision of a “second nature”  
| 11: Globalisation 2.0 | • Transition towards cloud-based IT  
|                         | • New interfaces and intelligent environments  
|                         | • Emergence of the Internet of Things  
|                         | • Creation of intelligent infrastructures  
|                         | • Breakthroughs in artificial intelligence and robotics  
| 12: Knowledge-based economy | • Shift in the location of economic power centres  
|                            | • Volatile economy  
|                            | • Emergence of a global middle class  
|                            | • Globally fragmented and distributed value chains  
|                            | • Globalised flow of capital – Unrestrained financial sector  
| 13: Business ecosystems | • Rising levels of education around the world  
|                          | • Innovation as a key driver and competition factor  
|                          | • Data and knowledge-based value creation  
|                          | • New global knowledge elite—the creative class  
|                          | • Lifelong learning  
|                          | • New value-chain partnerships  
|                          | • System innovations  
|                          | • Business mash-ups—interfaces give rise to new markets  
|                          | • Creation of the fourth sector  

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### 14: Changes in the work world
- Complexity management
- Highly dynamic and flexible working practices
- New managerial and organisational patterns
- Collaborative methods of working
- Advances in automation

### 15: New consumption patterns
- Shifts in consumer spending and consumer preferences
- Third World enjoying greater prosperity
- Catch-up consumption in newly-industrialised countries
- Sustainable consumption in the West
- Change in buying habits — hybrid and virtual models
- Growing importance of collaborative consumption

### 16: Upheavals in energy and resources
- Growing energy and resource consumption
- Strategic resource scarcities
- Use of alternative sources of energy and renewable resources
- Revolution in resource efficiency
- Decentralised infrastructures

### 17: Climate change and environmental impacts
- Rising temperatures and CO₂ emissions
- Growing risks posed by environmental problems in newly-industrialised and developing countries
- Increased food shortages
- Stricter regulations
- Cleantech investments
- Strategies for mitigating and adapting to climate change

### 18: Urbanisation
- Strong growth of megacities and urban conglomerations
- Greater structural problems in rural areas
- Development of adapted infrastructure solutions
- Sustainable urban development
- New forms of residence, living and participation

### 19: New political world order
- China and India join the ranks of world powers
- Crisis of Western democracies
- New strategic alliances in a multipolar world
- Transformation of systems
- Africa awakes

### 20: Global risk society
- Growing vulnerability of technical and social infrastructures
- Greater number of natural disasters
- Asymmetric conflicts
- Global organised crime and cybercrime
- Surveillance and monitoring in the transparent society
3.3.2. *CSIRO*: “Our future world - Global megatrends that will change the way we live”

<table>
<thead>
<tr>
<th>Project</th>
<th>Our future world - Global megatrends that will change the way we live</th>
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<tbody>
<tr>
<td>Organization</td>
<td>CSIRO - Commonwealth Scientific and Industrial Research Organisation</td>
</tr>
<tr>
<td>Objectives</td>
<td>Inform internal and long range investment planning choices</td>
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<td>Year of finalisation</td>
<td>2012</td>
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<td>Focus</td>
<td>Global issues relevant to the Australian industry, government and community organisations</td>
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<td>Type of analysis</td>
<td>Definition of megatrends</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Literature review, Stakeholder consultation</td>
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In 2009 the Commonwealth Scientific and Industrial Research Organisation (CSIRO) started a global foresight project to inform internal and long range investment planning choices. Our Future World is the flagship publication of CSIRO Futures. The report presents a succinct narrative of the future. The core of the narrative is a set of interlinked global megatrends. They are refined through regular updates to accommodate new issues, new data and new events. The concentrates on relevant issues to the Australian industry, government and community organisations, but it has a global focus. The timeframe of the megatrends and trends identified is twenty years, out to the year 2032.

The global megatrends identified by CSIRO are the following:

1. **More from less**

   The earth has limited supplies of natural mineral, energy, water and food resources essential for human survival and maintaining lifestyles. Data are revealing many of these resources are being depleted at often alarming rates. At the same time population growth and economic growth are placing upward pressure on demand. Companies, governments and communities will discover new ways of ensuring quality of life for current and future generations within the confines of the natural world’s limited resources. Science, technology, business processes, government policy, lifestyle patterns and cultural norms will all play a role.

2. **Going, going, ... gone?**

   Many of the world’s natural habitats, plant species and animal species are in decline or at risk of extinction. The actions taken by human beings in the coming decades will set the scene for global biodiversity over coming millennia. This megatrend explores the perilous situation of the world’s ecological habitats and biodiversity. It also captures the issue of greenhouse
gas emissions and climate change. Much in the natural world, that humans value and depend upon, is at risk of being lost forever. However, there is a positive story and a potentially bright future. The megatrend is purposefully posed as a question. Whilst the state of biodiversity is in decline and the pressure is rising so too is the human response.

3 The silk highway

Coming decades will see the world economy shift from west to east and north to south. Rapid income growth in Asia and, to a lesser extent, South America and Africa will see billions of people transition out of poverty and into the middle income classes. The powerhouses of the new world economy are China and India. +Tourists, funds and ideas will increasingly flow out of Asian countries and into Australia’s economy and society. We are stepping into the Asian Century.

4 Forever young

The ageing population is an asset. Australia and many other countries that make up the Organisation for Economic Cooperation and Development (OECD) have an ageing population. Elderly citizens provide a wealth of skills, knowledge, wisdom and mentorship. Nevertheless, there are some challenges associated with an ageing population and associated demographic trends. This will change people’s lifestyles, the services they demand and the structure and function of the labour market.

5 Virtually here

This megatrend explores what might happen in a world of increased connectivity where individuals, communities, governments and businesses are immersed into the virtual world to a much greater extent than ever before. We are increasingly moving online to connect, to deliver and access services, to obtain information and to perform transactions such as shopping and working. Digital media is allowing people to form new connections and selectively access information with subsequent erosion of trust in traditional information sources.

6 Great expectations

This is a consumer, societal, demographic and cultural megatrend. It explores the rising demand for experiences over products and the rising importance of social relationships. This megatrend also captures the expectation people have for personalised services that meet their unique needs and wants whilst being delivered en masse. People of the future will seek higher-end experiences due to income growth and the oversupply of mass consumables. Social relationships will hold increased importance given the potential for social media and digital communication burnout and the desire for face-to-face interaction. Conversely, for the billions of impoverished people in the world the expectations are still for the basic necessities of life such as water, food, clothing, shelter and personal security. Many will have great expectations, but many will still have basic expectations.
3.3.3. National Intelligence Council: “Global Trends 2030”

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The National Intelligence Council (NIC), from the United States of America, produced a report intended to stimulate thinking about the rapid and vast geopolitical changes characterizing the world today and possible global trajectories during the next 15-20 years.

According to the NIC the world of 2030 will be radically transformed from our world today. By 2030, no country—whether the US, China, or any other large country—will be a hegemonic power. The empowerment of individuals and diffusion of power among states and from states to informal networks will have a dramatic impact, largely reversing the historic rise of the West since 1750, restoring Asia’s weight in the global economy, and ushering in a new era of “democratization” at the international and domestic level. In addition to individual empowerment and the diffusion of state power, we believe that two other megatrends will shape our world out to 2030: demographic patterns, especially rapid aging; and growing resource demands which, in the cases of food and water, might lead to scarcities. These trends, which are virtually certain, exist today, but during the next 15-20 years they will gain much greater momentum. Underpinning the megatrends are tectonic shifts—critical changes to key features of our global environment that will affect how the world “works”.

Extrapolations of the megatrends would alone point to a changed world by 2030—but the world could be transformed in radically different ways. NIC believes that six key game-changers—questions regarding the global economy, governance, conflict, regional instability, technology, and the role of the United States—will largely determine what kind of transformed world we will inhabit in 2030. Several potential Black Swans—discrete events—would cause large-scale disruption. All but two of these—the possibility of a democratic China or a reformed Iran—would have negative repercussions.

Based upon what is known about the megatrends and the possible interactions between the megatrends and the game-changers, NIC has delineated four archetypal futures that represent distinct pathways for the
world out to 2030. None of these alternative worlds is inevitable. In reality, the future probably will consist of elements from all the scenarios.

**Megatrends**

**Megatrend 1: Individual Empowerment**

Individual empowerment will accelerate substantially during the next 15-20 years owing to poverty reduction and a huge growth of the global middle class, greater educational attainment, and better health care. The growth of the global middle class constitutes a tectonic shift: for the first time, a majority of the world’s population will not be impoverished, and the middle classes will be the most important social and economic sector in the vast majority of countries around the world.

**Megatrend 2: Diffusion of Power**

The diffusion of power among countries will have a dramatic impact by 2030. Asia will have surpassed North America and Europe combined in terms of global power, based upon GDP, population size, military spending, and technological investment. China alone will probably have the largest economy, surpassing that of the United States a few years before 2030. In a tectonic shift, the health of the global economy increasingly will be linked to how well the developing world does—more so than the traditional West. The shift in national power may be overshadowed by an even more fundamental shift in the nature of power. Enabled by communications technologies, power will shift toward multifaceted and amorphous networks that will form to influence state and global actions. Those countries with some of the strongest fundamentals—GDP, population size, etc.—will not be able to punch their weight unless they also learn to operate in networks and coalitions in a multipolar world.

**Megatrend 3: Demographic Patterns**

MIC believes that in the world of 2030, four demographic trends will fundamentally shape, although not necessarily determine, most countries’ economic and political conditions and relations among countries. These trends are: aging—a tectonic shift for both for the West and increasingly most developing countries; a still-significant but shrinking number of youthful societies and states; migration, which will increasingly be a cross-border issue; and growing urbanization — another tectonic shift, which will spur economic growth but could put new strains on food and water resources. Aging countries will face an uphill battle in maintaining their living standards. Demand for both skilled and unskilled labor will spur global migration. Owing to rapid urbanization in the developing world, the volume of urban construction for housing, office space, and transport services over the next 40 years could roughly equal the entire volume of such construction to date in world history.
Megatrend 4: Growing Food, Water, and Energy Nexus

Demand for food, water, and energy will grow by approximately 35, 40, and 50 percent respectively owing to an increase in the global population and the consumption patterns of an expanding middle class. Climate change will worsen the outlook for the availability of these critical resources. Climate change analysis suggests that the severity of existing weather patterns will intensify, with wet areas getting wetter and dry and arid areas becoming more so. We are not necessarily headed into a world of scarcities; but policymakers and their private sector partners will need to be proactive to avoid such a future. Many countries probably won’t have the wherewithal to avoid food and water shortages without massive help from outside. Tackling problems pertaining to one commodity won’t be possible without affecting supply and demand for the others. Agriculture is highly dependent on accessibility to adequate sources of water as well as on energy-rich fertilizers. Hydropower is a significant source of energy for some regions while new sources of energy—such as biofuels—threaten to exacerbate the potential for food shortages.

**Tectonic Shifts between now and 2030**

**Growth of the Global Middle Class**

Middle classes most everywhere in the developing world are poised to expand substantially in terms of both absolute numbers and the percentage of the population that can claim middle-class status during the next 15-20 years.

**Wider Access to Lethal and Disruptive Technologies**

A wider spectrum of instruments of war—especially precision-strike capabilities, cyber instruments, and bioterror weaponry—will become accessible. Individuals and small groups will have the capability to perpetrate large-scale violence and disruption—a capability formerly the monopoly of states.

**Definitive Shift of Economic Power to the East and South**

The US, European, and Japanese share of global income is projected to fall from 56 percent today to well under half by 2030. In 2008, China overtook the US as the world’s largest saver; by 2020, emerging markets’ share of financial assets is projected to almost double.

**Unprecedented and Widespread Aging**

Whereas in 2012 only Japan and Germany have matured beyond a median age of 45 years, most European countries, South Korea, and Taiwan will have entered the post-mature age category by 2030. Migration will become more globalized as both rich and developing countries suffer from workforce shortages.
Urbanization

Today’s roughly 50-percent urban population will climb to nearly 60 percent, or 4.9 billion people, in 2030. Africa will gradually replace Asia as the region with the highest urbanization growth rate. Urban centers are estimated to generate 80 percent of economic growth; the potential exists to apply modern technologies and infrastructure, promoting better use of scarce resources.

Food and Water Pressures

Demand for food is expected to rise at least 35 percent by 2030 while demand for water is expected to rise by 40 percent. Nearly half of the world’s population will live in areas experiencing severe water stress. Fragile states in Africa and the Middle East are most at risk of experiencing food and water shortages, but China and India are also vulnerable.

US Energy Independence

With shale gas, the US will have sufficient natural gas to meet domestic needs and generate potential global exports for decades to come. Increased oil production from difficult-to-access oil deposits would result in a substantial reduction in the US net trade balance and faster economic expansion. Global spare capacity may exceed over 8 million barrels, at which point OPEC would lose price control and crude oil prices would collapse, causing a major negative impact on oil-export economies.

Game Changers

Game-Changer 1: The Crisis-Prone Global Economy

The contrasting speeds of growth across different regional economies are exacerbating global imbalances and straining governments and the international system. The key question is whether the divergences and increased volatility will result in a global breakdown and collapse or whether the development of multiple growth centers will lead to resiliency. The absence of a clear hegemonic economic power could add to the volatility.

A return to pre-2008 growth rates and previous patterns of rapid globalization looks increasingly unlikely, at least for the next decade. Across G-7 countries, total nonfinancial debt has doubled since 1980 to 300 percent of GDP, accumulating over a generation. Historical studies indicate that recessions involving financial crises tend to be deeper and require recoveries that take twice as long. Another major global economic crisis cannot be ruled out.

Earlier economic crises, such as the 1930s’ Great Depression, hit when the age structures of many Western populations were relatively youthful, providing a demographic bonus during the postwar economic boom. Such a bonus will not exist in any prospective recovery for Western countries.

A critical question is whether technology can sufficiently boost economic productivity to prevent a long-term slowdown.

Game-Changer 2: The Governance Gap
During the next 15-20 years, as power becomes even more diffuse than today, a growing number of diverse state and nonstate actors, as well as subnational actors, such as cities, will play important governance roles.

The increasing number of players needed to solve major transnational challenges—and their discordant values—will complicate decisionmaking. The lack of consensus between and among established and emerging powers suggests that multilateral governance to 2030 will be limited at best. The chronic deficit probably will reinforce the trend toward fragmentation. However, various developments — positive or negative—could push the world in different directions. Advances cannot be ruled out despite growing multipolarity, increased regionalism, and possible economic slowdowns. Prospects for achieving progress on global issues will vary across issues.

The governance gap will continue to be most pronounced at the domestic level and driven by rapid political and social changes. The advances in health, education, and income will drive new governance structures. Transitions to democracy are much more stable and long-lasting when youth bulges begin to decline and incomes are higher. However, many countries will still be zig-zagging their way through the complicated democratization process during the next 15-20 years. Countries moving from autocracy to democracy have a proven track record of instability.

Game-Changer 3: Potential for Increased Conflict

Though by no means inevitable, the risks of interstate conflict are increasing owing to changes in the international system. The underpinnings of the post-Cold War equilibrium are beginning to shift. During the next 15-20 years, the US will be grappling with the degree to which it can continue to play the role of systemic guardian and guarantor of the global order. A declining US unwillingness and/or slipping capacity to serve as a global security provider would be a key factor contributing to instability, particularly in Asia and the Middle East. A more fragmented international system in which existing forms of cooperation are no longer seen as advantageous to many of the key global players would also increase the potential for competition and even great power conflict. However, if such a conflict occurs, it almost certainly will not be on the level of a world war with all major powers engaged.

Three different baskets of risks could conspire to increase the chances of an outbreak of interstate conflict: changing calculations of key players — particularly China, India, and Russia; increasing contention over resource issues; and a wider spectrum of more accessible instruments of war. With the potential for increased proliferation and growing concerns about nuclear security, risks are growing that future wars in South Asia and the Middle East would risk inclusion of a nuclear deterrent. The current Islamist phase of terrorism might end by 2030, but terrorism is unlikely to die completely. With more widespread access to lethal and disruptive technologies, individuals who are experts in such niche areas as cyber systems might sell their services to the highest bidder, including terrorists who would focus less on causing mass casualties and more on creating widespread economic and financial disruptions.
Game-Changer 4: Wider Scope of Regional Instability

Regional dynamics in several different theaters during the next couple decades will have the potential to spill over and create global insecurity. The Middle East and South Asia are the two regions most likely to trigger broader instability. In the Middle East, the youth bulge—a driving force of the recent Arab Spring—will give way to a gradually aging population. With new technologies beginning to provide the world with other sources of oil and gas, the region’s economy will need to become increasingly diversified. But the

Progress toward greater regional cohesion and integration in Latin America and Sub-Saharan Africa would promise increased stability in those regions and a reduced threat to global security. Countries in Sub-Saharan Africa, Central America, and the Caribbean will remain vulnerable, nevertheless, to state failure through 2030, providing safe havens for both global criminal and terrorist networks and local insurgents.

Game-Changer 5: The Impact of New Technologies

Four technology arenas will shape global economic, social, and military developments as well as the world community’s actions pertaining to the environment by 2030. Information technology is entering the big data era. Process power and data storage are becoming almost free; networks and the cloud will provide global access and pervasive services; social media and cybersecurity will be large new markets. This growth and diffusion will present significant challenges for governments and societies, which must find ways to capture the benefits of new IT technologies while dealing with the new threats that those technologies present. Fear of the growth of an Orwellian surveillance state may lead citizens particularly in the developed world to pressure their governments to restrict or dismantle big data systems. Information technology-based solutions to maximize citizens’ economic productivity and quality of life while minimizing resource consumption and environmental degradation will be critical to ensuring the viability of megacities.

New manufacturing and automation technologies such as additive manufacturing (3D printing) and robotics have the potential to change work patterns in both the developing and developed worlds. In developed countries these technologies will improve productivity, address labor constraints, and diminish the need for outsourcing, especially if reducing the length of supply chains brings clear benefits. Nevertheless, such technologies could still have a similar effect as outsourcing: they could make more low- and semi-skilled manufacturing workers in developed economies redundant, exacerbating domestic inequalities.

Breakthroughs, especially for technologies pertaining to the security of vital resources—will be necessary to meet the food, water, and energy needs of the world’s population. Key technologies likely to be at the forefront of maintaining such resources in the next 15-20 years will include genetically modified crops, precision agriculture, water irrigation techniques, solar energy, advanced bio-based fuels, and enhanced oil and natural gas extraction via fracturing.
Last but not least, new **health technologies** will continue to extend the average age of populations around the world, by ameliorating debilitating physical and mental conditions and improving overall well-being. The healthcare systems in developing countries may be poor today, but by 2030 they will make substantial progress in the longevity potential of their populations.

**Game-Changer 6: The Role of the United States**

How the United States’ international role evolves during the next 15-20 years—a big uncertainty—and whether the US will be able to work with new partners to reinvent the international system will be among the most important variables in the future shape of the global order. Although the United States’ (and the West’s) relative decline vis-a-vis the rising states is inevitable, its future role in the international system is much harder to project: the degree to which the US continues to dominate the international system could vary widely. The US most likely will remain “first among equals” among the other great powers in 2030 because of its preeminence across a range of power dimensions and legacies of its leadership role. More important than just its economic weight, the United States’ dominant role in international politics has derived from its preponderance across the board in both hard and soft power. Nevertheless, with the rapid rise of other countries, the “unipolar moment” is over and Pax Americana—the era of American ascendancy in international politics that began in 1945—is fast winding down.

### 3.3.4. OECD: “Looking to 2060: Long-term global growth prospects”

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<td><strong>Objectives</strong></td>
<td>Sketch the possible transition from the current conjuncture to growth developments in OECD and non-OECD G20 countries up to 2060</td>
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This OECD report sketches the possible transition from the current conjuncture to growth developments in OECD and non-OECD G20 countries up to 2060 focusing on the interaction between technological progress, demographic change, fiscal adjustment, global imbalances and structural policies. A baseline scenario assuming gradual structural reform and fiscal consolidation to stabilise government-debt-to GDP ratios is compared with variant scenarios assuming more ambitious policies.
The growth scenarios for the global economy over the next 50 years are, according to OECD's vision, shaped by developments in education, technological progress and labour force participation based on a framework in which GDP per capita in each country is expected to converge to the long-run path that is consistent with its own endowments, policies and institutions. Once this path is reached, all countries are expected to keep growing at the same pace determined by the worldwide rate of technical progress. Nonetheless, cross-country GDP per capita gaps would remain, mainly reflecting differences in technology levels, capital intensity and human capital. These in turn would partly depend on differences in structural conditions and policies. Over a time-horizon covering several decades structural conditions and policies are likely to adapt to changing economic circumstances, in particular those induced by continuing globalisation. Therefore, the baseline long-run scenario for the global economy incorporates a number of policy developments in several areas that would lead to some degree of structural convergence across countries. Reforms in labour and product markets are assumed to continue and, on the fiscal side, it is assumed that government-debt-to-GDP ratios stabilise over the medium term.

Consequently, changes in policies play an important role in the scenario presented here. The scenario also takes into account global macroeconomic influences by ensuring that global saving and investment remain aligned, with imbalances at the national level reflected in current accounts. Whereas the policy changes embedded in the baseline are significant there still remains scope for deeper reforms to improve trend growth, as pushed for within the context of the G20 mutual assessment process. This is explored in variant scenarios.

The assumption underlying this report is that the crisis has only reduced the level of trend GDP, currently and over the next few years, and has had no permanent effects on trend growth rates. Moreover, in keeping with the long-term focus, possible repercussions on trend output of prolonged period of deficient demand are ignored. Thus, the resulting long-term scenario provides a relatively benign long-term outlook for the global economy. Indeed, a number of other factors are also ignored, including the possibility of disorderly debt defaults, trade disruptions and possible bottlenecks to growth due to an unsustainable use of natural resources and services from the environment.

The main determinants of economic growth considered and respective assumptions were:

- Population ageing will reduce the share of the working-age population in most countries
- Net migration will only modestly lower old-age dependency ratios
- Structural reforms will be needed to sustain labour force participation
- Unemployment will return to pre-crisis levels
- Human capital will continue to improve
- Capital intensity is assumed to gradually stabilise
• Efficiency improvements will be the main driver of growth
• Global growth will be sustained by emerging countries, though at a declining rate
• The relative size of economies will change dramatically over the next half century
• GDP per capita gaps will shrink but significant cross-country differences will persist

The policy messages that resulted from this vision and analysis were:

• Once the legacy of the global financial crisis has been overcome, global GDP could grow at around 3% per year over the next 50 years. Growth will be enabled by continued fiscal and structural reforms and sustained by the rising share of relatively fast-growing emerging countries in global output.

• Growth of the non-OECD will continue to outpace the OECD, but the difference will narrow over coming decades. From over 7% per year over the last decade, non-OECD growth will decline to around 5% in the 2020s and to about half that by the 2050s, whereas trend growth for the OECD will be around on average 1⅓ to 2⅔% per year.

• The next 50 years will see major changes in the relative size of world economies. Fast growth in China and India will make their combined GDP measured at 2005 Purchasing Power Parities (PPPs), soon surpass that of the G7 economies and exceed that of the entire current OECD membership by 2060.

• Notwithstanding fast growth in low-income and emerging countries, large cross-country differences in living standards will persist in 2060. Income per capita in the poorest economies will more than quadruple by 2060, and China and India will experience more than a seven-fold increase, but living standards in these countries and some other emerging countries will still only be one-quarter to 60% of the level in the leading countries in 2060.

• In the absence of more ambitious policy changes, rising imbalances could undermine growth. As the current cycle unwinds, the scale of global current account imbalances may increase and return to pre-crisis peaks by 2030. Government indebtedness among many OECD countries will exceed thresholds at which there is evidence of adverse effects on interest rates and growth. Global interest rates may therefore start to rise over the long-term.

• Bolder structural reforms and more ambitious fiscal policy could raise long-run living standards by an average of 16% relative to the baseline scenario of moderate policy improvements. Ambitious product market reforms, which raise productivity growth, could increase global GDP by an average of about 10%. Policies that induce convergence towards best practice labour force participation could increase GDP by close to 6% on average.
3.3.5. **Shell: New Lens Scenarios**

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In the line of Shell’s well known tradition of foresight, in 2013 Shell released new scenarios that explore complexity and ask searching questions about how to create a more reflective, responsive, and resilient business. Shell’s New Lens Scenarios provide quantified insights and a language for executives to apply when grappling with increasingly unfamiliar and challenging conditions. They aim to be thought-provoking yet plausible, highlighting matters already in the foreground and also, crucially, background developments that should be brought to the fore.

It looks through the lenses of three **paradoxes** which help to highlight key features of the emerging landscape.

**The Prosperity Paradox**

Economic development is raising living standards for hundreds of millions of people. But it also imposes environmental, resource, financial, political, and social stresses that can undermine some of the benefits of prosperity. Private gains can flourish while public costs mount, and greater comforts today can lead to greater risks tomorrow. Globalisation has tended to reduce income inequality between nations yet increase inequalities within them. Increasing efficiency can stimulate increases in consumption. Beyond a point, increasing prosperity does not raise subjective wellbeing, which can even decline. For example, the more people prosper or see others prosper, the greater their desires and expectations for themselves and for their children - and the greater their possible discontent.

**The Connectivity Paradox**

Growing global connectivity stimulates creativity but also puts intellectual property at risk. Connectivity facilitates individual expression and empowerment, but also encourages herd behaviour and amplifies swings in confidence and demand. The burgeoning availability of information has the capacity to bring insight and transparency, but data overload is equally likely to generate confusion and obscurity. In many ways, the Connectivity Paradox drives the other two paradoxes. The deployment of information and communications technology has been a driver of economic globalisation,
extending and deepening trade, financial, and research links, spreading prosperity, and generating leadership challenges. Economic, political, and social volatility may have always been with us, but this unprecedented degree of connectivity is contributing to unusual intensity in part because growth in connectivity empowers individual players.

The Leadership Paradox

Addressing global stresses requires co-ordination among increasing constituencies of decision-makers. But the more diverse the groups that are involved, the more vested interests tend to block progress. Grappling with growing stresses requires going fast and far—implying a paradoxical need to go alone and together. Fresh forms of collaboration are required that cut across familiar national, public–private, and industry-sector boundaries, but there are no strong models for such collaborations, and they are immensely difficult to get off the ground because different parties remain focused on their individual foreground issues and responsibilities. Profound policy dilemmas face the leaders of all nations. Governments, by their nature, are slower to act than the speed of contemporary life often requires. Electoral mandates generally trump management of long-term, complicated, or unpopular issues. The larger and more technical the problems facing society, the less likely it is that governments alone can solve them without help from business and other sectors. In advanced democracies, the more capacity people have to band together in special interest groups to influence government, the harder it is for government to work primarily for the common good. In many parts of the world, the more new media technology empowers citizens, the more it also empowers governments to monitor those citizens. Globalisation itself raises a paradox for government leaders: the greater the forces of globalisation, the less the autonomous power of national governments. Similarly, leaders face a paradox that arises from human nature itself, except in times of immediate danger: the greater the need for communal, long-term solutions, the less the appetite for individual, short-term sacrifices.

Following these paradoxes that shape future challenges, Shell identifies two possible achetypal pathway lenses:

- Room to Manoeuvre: Financial, social, political or technological capital encourage early action and result in effective change/reform.
- Trapped Transition: Financial, social, political or technological capacity prove inadequate to withstand stresses. Behavioural responses delay change, causing conditions to worsen until ultimately a reset is forced or a collapse occurs.

Finally, Shell’s panoramic scenarios highlight broader patterns in possible future landscapes. According to Shell the world in the future will be defined by how people and governments meet the challenges posed by institutions, inequality, and insecurity in relation to the paradoxes of prosperity, leadership, and connectivity.

- Which paradoxes will become more acute?
- Which will be resolved?
- Which industries, businesses, nations, and groups of people will have room to manoeuvre?
- Which will be trapped?
- How will the capabilities of capital, collaboration, and creativity develop?
- How will power and influence be distributed?

Two scenarios or panoramas are designed to provide new lenses through which to explore these issues:
- high Mountains: where the benefits of an elevated position are exercised and protected, and those who are currently influential hold on to power;
- wide Oceans: with rising tides, strong currents, and a volatile churn of actors and events with an irregular accommodation of competing interests.

These panoramas have distinctive social, economic, and political features that can be discerned over the next 20 years or so, with consequences for energy developments over half a century. Together these shape ecological outlooks beyond 2100.

Mountains – a view from the top

Mountains is a world in which those occupying commanding advantage (at the top) generally work to create stability in ways that promote the persistence of the status quo. There is a steady, self-reinforcing, lock-in of incumbent power and institutions. This lock-in constrains the economic potential of some sectors of society, but enables established sectors aligned with market forces to unlock resources that require significant capital and new technology. As for the less fortunate, the thinness of social safety nets is not completely offset by the growth in philanthropy, characterised by an eruption of foundations endowed by increasing numbers of billionaires.

Latent opposition to the power of political, business and social elites is minimised through a combination of incentives and sanctions, and social mobility continues to decline. But supply-side investments are stimulated. Even with new investments, however, the absence of major structural and financial adjustments in developed countries begins to slow GDP and discourage trade. Some fast-emerging economies fall into the ‘middle income trap’, where growth plateaus and stagnates after a significant proportion of the population reaches middle-income levels, largely because institutions cannot adapt to a more complex economy.

This moderation of economic growth, however, alleviates some pressure for energy demand. Demand growth is slowed even further as progress is made with supply-side energy policies, such as the encouragement of compact city development.

Tight/shale gas and Coal Bed Methane (CBM) enjoy widespread success and grow to form a new ‘gas backbone’ to the global energy system. With
slowing growth in demand for liquid fuels, oil prices remain moderate, and overall production growth limited.

Sluggish economic growth in the early period, the relative displacement of coal by gas over the longer term, and supply-side incentives for deploying carbon capture and storage (CCS) technology and renewable energy, all contribute to a moderation in greenhouse gas emissions. Nevertheless, the global average temperature rise overshoots the current 2°C goal.

Oceans – A View of the Horizon

Oceans is a world in which competing interests and the diffusion of influence are met with a rising tide of accommodation. This trajectory is driven by a growing global population with increasing economic empowerment, and a growing recognition by the currently advantaged that their continued success requires compromise. Steady reform of economic and financial structures keeps pace with the development of fast-emerging nations and progressively unlocks the productivity of broader sectors in society. But volatility and multiple constituencies impede policy developments in other areas, so tight resources are unlocked primarily by market forces.

At first, economic pressures strain social cohesion, forcing changes in economic and political structures. Reforms raise aspirations and, when they are successful, also raise expectations for further shifts in welfare, social structures, and significant international institutions. Aspirations rise and expectations of continued improvements in quality of life become locked in. Globalisation strengthens; developing countries sustain their catch-up growth trajectories; and the key fast-emerging economies move to more balanced growth.

Gradually increasing stresses around food, water, energy and other resources become a new focus for social and political tension. Political churn and the growth in empowered constituencies now hamper policy development, and resource scarcity is addressed almost completely through market forces acting within old policy frameworks that price externalities inadequately.

With emerging economies continuing to surge and boost energy demand, and without effective policy mechanisms in place, demand begins to squeeze supply. The noose is tightened further when tight/ shale gas and CBM production do not meet initial expectations, with relatively limited success outside North America – partly because of patchy policy support and partly because of geological and technological disappointments.

Growth in oil production from a few major resource holders is also initially constrained in Oceans as leadership transitions take their toll. But investment ultimately picks up once stability is restored. Periods of high oil prices unlock new resources and technology options and a long oil game ensues.

With gas volume growth more modest than anticipated, coal maintains a strong role in heat and power generation. Resource stresses become severe, and high prices plus crises eventually stimulate strong demand-side investment in utilisation efficiency. These measures are not sufficient to address environmental concerns, as greenhouse gas emissions follow a
pathway towards a high degree of climate change and the need for significant adaptation.


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<tr>
<td>Focus</td>
<td>Global issues with a focus on environmental issues</td>
</tr>
<tr>
<td>Type of analysis</td>
<td>Identification and characterization of megatrends</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Literature review, stakeholder consultation, STEEP analysis</td>
</tr>
</tbody>
</table>

This ‘assessment of global megatrends’ is part of The European environment — state and outlook 2010 (SOER 2010). SOER 2010 is aimed primarily at policymakers, in Europe and beyond, involved with framing and implementing policies that could improve Europe's environment. The information can also help European citizens to better understand, care for and improve their environment.

This assessment of global megatrends focuses on the impact of global pressures on Europe. A global-to-European perspective is relevant for European environmental policymaking because Europe's environmental challenges and management options are being reshaped by global drivers such as demographics, technologies, trade patterns and consumption.

The approach used for this assessment has included:

- A public call for evidence on global megatrends of relevance for Europe's long-term environmental context.
- Setting up an external advisory group to guide the progress of the work, comprising representatives of international and national organisations in the field of environmental assessment as well as the EEA’s Scientific Committee members.
- Reviews of academic and non-academic information sources in the form of eight targeted background reports produced between autumn 2009 and 2010.
- Consolidating the information base following the STEEP (social, technological, economic, environmental and political) framework for classifying drivers of change.
• Structuring the information base into information sheets including indicators.

The trends assessed by EEA were the following, as described:

Increasing global divergence in population trends
The global population will still be growing midway through the 21st century but at a slower rate than in the past. People will live longer, be better educated and migrate more. Some populations will increase as others shrink. Migration is only one of the unpredictable prospects for Europe and the world.

Living in an urban world
An increasingly urban world will probably mean spiralling consumption and greater affluence for many. But it also means greater poverty for the urban underprivileged. Poor urban living conditions and associated environmental and health risks could impact all areas of the world, including Europe.

Disease burdens and the risk of new pandemics
The risk of exposure to new, emerging and re-emerging diseases, to accidents and new pandemics, grows with increasing mobility of people and goods, climate change and poverty. Vulnerable Europeans could be severely affected.

Accelerating technological change: racing into the unknown
The breakneck pace of technological change brings risks and opportunities, not least for developed regions like Europe. These include in particular the emerging cluster of nanotechnology, biotechnology, and information and communication technology. Innovations offer immense opportunities for the environment but can also cause enormous problems if risks are not regulated adequately.

Continued economic growth?
Rapid growth accelerates consumption and resource use. But it also creates economic dynamism that fuels technological innovation, potentially offering new approaches to addressing environmental problems and increasing resource efficiency.

From a unipolar to a multipolar world
Global power is shifting. One superpower no longer holds sway and regional power blocs are increasingly important, economically and diplomatically. As global interdependence and trade expands, Europe may benefit from improving its resource efficiency and knowledge-based economy.
Intensified global competition for resources
How will Europe survive in the intensifying scramble for scarce resources? The answer may lie in more efficient production and resource use, new technologies, innovation and increasing cooperation with foreign partners.

Decreasing stocks of natural resources
A larger and richer global population with expanding consumption needs will place growing demands on natural systems for food, water and energy. European resource stocks may likewise face increasing pressures.

Increasingly severe consequences of climate change
Accelerating climate change impacts will threaten food and water supplies, human health, and terrestrial and marine life. Europe may also see more human migration and aggravated pressure on resources supplies.

Increasing environmental pollution load
An increasingly complex mix of pollutants threatens the Earth’s regulatory mechanisms. Particulates, nitrogen and ground-level ozone merit particular attention because of their complex and potentially far-reaching effects on ecosystem functioning, climate regulation and human health. In addition, many other chemical substances are released into the environment, with effects — in isolation or combined — that are still poorly understood.

Environmental regulation and governance: increasing fragmentation and convergence
The world is devising new governance models, including multilateral agreements on numerous issues and public-private ventures. In the absence of global regulation, advanced European standards and procedures have often been adopted worldwide. But will this situation continue in the future?

3.3.7. **SPREAD Sustainable Lifestyles 2050**

<table>
<thead>
<tr>
<th>Project</th>
<th>SPREAD Sustainable Lifestyles 2050</th>
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<tbody>
<tr>
<td>Organization</td>
<td>European Commission</td>
</tr>
<tr>
<td>Objectives</td>
<td>Developing a roadmap for strategic action that will identify opportunity spaces for policy, business, research and civil society to take action to enable more sustainable lifestyles across Europe</td>
</tr>
<tr>
<td>Year of finalisation</td>
<td>2012</td>
</tr>
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<td>Focus</td>
<td>Sustainable Lifestyles</td>
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<tr>
<td>Type of analysis</td>
<td>Backcasting scenarios</td>
</tr>
<tr>
<td>Methods applied</td>
<td>Stakeholder consultation, literature review</td>
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</table>
SPREAD Sustainable Lifestyles 2050 was a European social platform project where different societal stakeholders – from business, research, policy and civil society – have been invited to participate in the development of a vision for sustainable lifestyles in 2050. This process resulted in a roadmap for strategic action that will identify opportunity spaces for policy, business, research and civil society to take action to enable more sustainable lifestyles across Europe.

The SPREAD project’s journey to future scenarios for more sustainable lifestyles began by taking stock of existing knowledge on sustainable lifestyles. Through this initial research we identified the challenges and barriers to more sustainable living today, as well as promising trends, drivers and opportunities to encourage more sustainable ways of living in the future. It was concluded that Modern European lifestyles are unsustainable. They have become associated with overproduction and overconsumption. The impacts of current lifestyles are putting too much pressure on natural resources and have adverse environmental, economic, social and health effects.

In recent years, sustainable lifestyle choices have started to become a more relevant and accessible option for some European consumers thanks to a rise in localised social innovation experiments, the improved supply of eco-efficient goods and services, and increased coverage of sustainability issues in the media raising awareness in the public debate. SPREAD called these signals of progress, “promising practices” of more sustainable living practices, and they were regarded as a good foundation for exploring the future of sustainable lifestyles.

The scenarios for sustainable lifestyles 2050 present four different prototypes of possible future societies that all support more sustainable lifestyles. SPREAD’s lifestyle scenarios are based on the foundations of sustainable systems, and explore different options in an attempt to acknowledge the diversity among European citizens.

**Scenarios on sustainable lifestyles**

The scenarios developed by SPREAD present different options for sustainable living choices that will suit the diverse needs, desires and cultural considerations of citizens from across Europe. The four scenarios present differing pathways to reach alternative societies where sustainable ways of living are supported.

In order to develop stories of the future, SPREAD first identified the most critical variables – the critical drivers necessary to create sustainable lifestyles.

The specific scenario methodology adopted is outlined:

1. The scenarios aim to demonstrate how various situational and behavioural factors contribute to the development of sustainable lifestyles.

2. The scenarios enable to analyse the potential of current promising sustainable living practice in relation to the various factors driving alternative sustainable futures.

3. The scenarios provide a starting point for identifying opportunity spaces for the development of creative strategies to not only mainstream current
sustainable practices, but also to develop new solutions for more sustainable living societies. The scenarios offer insights into how different drivers of change interact, shape lifestyles and help in identifying the role of various gatekeepers who facilitate the change through scaling up and multiplying the current, promising practices on different stages of development.

In order to establish four sustainable lifestyle scenarios for Europe in 2050, SPREAD used the backcasting. A premise used is that there are factors that set limits to meaningful future living such as:

- limited global crude oil reserves that force production to decline at some point (peak oil)
- a limited “carbon budget” of greenhouse gas concentration in the atmosphere. Exceeding these or other relevant limits would create feedback effects that would very likely reduce the resources and capabilities available to people living in the coming decades. Hence the scope of desirable, but achievable futures would also be more limited in the future.

For the backcasting exercise, a material footprint of a sustainable lifestyle at 8000 kg per annum (p.a.) for one person was defined. This quantified target forms the fundamental assumption on which each of our four developed and previously described scenarios is built.

In order to establish four scenarios that would significantly differ from each other, at the outset four future landscapes were defined through which the scenarios would be constructed. This was done by combining the two critical variables, called uncertainties. The two uncertainties and assumptions about them were that:

- Technology is either pandemic or endemic.
Society’s governing principle is either human-centric or meritocratic. At later stage of the work SPREAD defined four additional drivers for each scenario, with the help of which it was possible to give a reasonable explanation on how sustainable lifestyles and the sustainable society can be reached in each scenario.

The scenarios developed are described below.

**Singular Super Champions:** In the scenario Singular Super Champions Europe has made the leap to a new type of sustainable, competitive and equitable economy: a result of numerous treaties, declarations and official goals starting from 2035. The leap is achieved with the deployment of market instruments that also radically reform many conditions that have shaped European lifestyles over the past decades. Cleantech and upcycling businesses flourish as sustainability has become the business opportunity of the century. Europe of Singular Super Champions is a society that celebrates an ethos of learning, achieving and self-mastery.

**Governing the Commons:** Governing the Commons is a scenario mostly in digital reality that helps people to break free from many cultural constraints and, eventually, to reach sustainability. Ubiquitous computing enables the smart use of resources and, at the same time, redirects people’s behaviour and focus of attention from material consumption and their physical surroundings to interaction in the digital realm. People abandon many institutions of the 20th century, liberate themselves in order to lead more meaningful lives and engage in new forms of collaboration.

**Local Loops:** Local Loops is a scenario in which a radical energy crisis forces societies to re-evaluate fundamentally the foundations of their well-being. Energy and resource systems are increasingly seen though “Local Loops”, which is a technical concept that can be applied in the context of local and
People build their lifestyle and ways of belonging around their work, while technology is better adapted through local design solutions, which create room for new kinds of professionalism. A new ethos of craftsmanship and professional communities shape the way people live, organize their work and spend their leisure time.

**Empathetic Communities:** Empathetic Communities is a scenario where Western societies faced a crisis they had long dreaded, and how the change turned out to be easier and more fruitful than anyone had expected. It is a story in which the global economy as we knew it in 2012 fails, followed by paralysis of nation states and their political decision-making structures. By 2050 this all leads to lifestyles in which the community and neighbourhoods have an important role in everyday life. New forms of collaboration and governance grow on the level of cities and towns making them the most powerful level of public decision-making. In Empathetic Communities the many fruits of global culture and advancements in latest technological innovation are enjoyed, although people in general focus on communicating and developing solutions on the local level.

### 3.3.8. Alcatel-Lucent: “Megatrends - A Wave of Change Impacting the Future”

<table>
<thead>
<tr>
<th>Project</th>
<th>Megatrends - A Wave of Change Impacting the Future</th>
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<tbody>
<tr>
<td>Organization</td>
<td>Alcatel-Lucent</td>
</tr>
<tr>
<td>Objectives</td>
<td>Articulate megatrends for the Alcatel-Lucent community, as well as external audiences, and foster debate and the exchange of ideas.</td>
</tr>
<tr>
<td>Year of finalisation</td>
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<td>Type of analysis</td>
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</tr>
<tr>
<td>Methods applied</td>
<td>Deductive reasoning based upon empirical evidence</td>
</tr>
</tbody>
</table>

Alcatel-Lucent and the ENPC School of International Management have completed a joint research project created to identify and investigate megatrends that have the potential to fundamentally transform society in general and the information and communications technology industry (ICT), in particular.

This research initiative identified seven megatrends:

- **168 (24x7 Connectivity)**, refers to the “always on” generation of people, but increasingly of objects too, which are connected to the “net”. In a world in which technology is nearly ubiquitous, connectivity is now the expected norm and nonconnectivity carries a price (real or imagined, social or professional). The blurring of lines between work and private lives fueled by wireless access.
combined with the proliferation of devices like smartphones and tablets is driving the demand for universal internet access, increased wireline and wireless broadband strength/availability and access to the cloud.

• **Digital native acceleration**, refers to the recent mainstreaming of generations who have grown up with digital technology and the rapidly rising percentage of these “Digital Natives” who will hold key management and leadership positions. To these Digital Natives, “Internet time” and “network speed” are the new normal and this is also the expected speed of change. In addition to speed, this generation expects to always have internet/broadband access, to communicate in short 140-character bursts and to spend much of their time and concentration in a virtual as opposed to a physical world. Educational institutions and the workplace will need to adapt to this generation’s expectations.

• **Ed-you-cation**, refers in part to the on-going shift, facilitated by ICT, from institution based learning to individual-centred learning by which each individual has increasing control over the choice/timing/Scope/depth of skills he/she wishes to acquire throughout their lives. The proliferation of online learning can have a positive impact in reaching remote populations where traditional schools are not practical. One challenge is assuring that online education, especially at the primary and secondary levels, provides an experience truly equivalent to that of traditional classrooms.

• **Netizens to Government (N2G)**, refers to the new ways in which citizens are using digital media to interact with elected officials, governments and the public sector to induce or oppose change, and as was seen in 2011, sometimes in extremely impactful ways. Beyond giving citizens a powerful tool to express their views, the impact of the internet, broadband and mobile communications on how government operates has also been significant in other ways such as providing online services and managing emergency situations. Governments have been active forces in driving internet/broadband connectivity to previously remote areas to foster an improved quality of life and wealth creation opportunities. Increased use of the cloud will bring greater efficiencies to government operations and information sharing.

• **Neo-urbanization**, describes the mutations that are changing the face of urbanization as we know it, and considerably blurring the boundaries between traditional definitions of urban, suburban, and rural regions. Global trends such as the continued expansion of megacities, the development of previously rural corridor regions between large cities and the creation from scratch of relatively small but sustainability trendsetting smart cities will all employ new technology for communications and transportation on a massive scale. Development of large urban projects will require active collaboration between governments and ICT providers.

• **Rejuvenaging**, refers to the frontiers of aging and rejuvenation, as well as the farreaching implications of rapidly-increasing life expectancies in many parts of the world. The expectation of a life trajectory of education, career and retirement is changing as people have multiple careers and work much longer than previous generations. As life expectancy increases so do the
demands on global health care systems. ICT can play an important role in enabling remote services such as 24/7 monitoring of patients, diagnosis and surgical coaching in order to stretch limited health care resources.

- **Sustainable by design (SBD)**, refers to the accelerated transition from “sustainability” as a source of competitive advantage to a competitive imperative that must be included in most aspects of modern business across all industries. Without engaging in a sustainable approach the growing numbers of global consumers will soon deplete the world's resources. The trend toward the use of smart devices and the creation of smart cities is a direction in which the ICT industry can dynamically support the Sustainable by Design movement. “The next challenge for ICT lies not in making our lives easier, and more integrated but in making our lives more sustainable.”

According to Alcatel-Lucent, all of the megatrends in this study were found to have a significant impact on many aspects of our world, including politics, government, economics, society, technology, environment, and regulation. More pronounced is the noticeable convergence of economies and communities: the over-riding impact of these megatrends is that they are rapidly narrowing the divide between developed and developing economies. The ICT sector is increasingly at the nexus of all of these developments, as a catalyst and a beneficiary, as well as a potential victim of the rapid change ICT has induced across all areas of the economy and in modern lifestyles. It appears more important than ever that the stakeholders in the ICT sector dedicate time, efforts and resources to continually stay abreast of these megatrends and their ramifications.
4. EXPERT CONSULTATION

4.1. Workshop “Transport Needs 2050”

4.1.1. Introduction

This section describes the method and results for the workshop “Transport Needs 2050” that took place on the 17th-18th March, in Convento da Arrábida, Portugal, aimed at building scenarios for the demand for transport in 2050.

For this Workshop, a panel of specialists from different backgrounds were invited to provide different insights and perspectives on what the future might unfold. This document provides an overview of the main results from the discussions.

4.1.2. Approach

The workshop was structured in three exercises that were developed in the 18th of March, preceded by a quick discussion of the mega trends in the evening before, which served mostly as a warm-up to get experts in the right mood. The first exercise has been the exploration of mega-trends, deriving into a wide range of insights. In the second exercise those insights were categorized first into a STEP matrix: Social, Technological, Economic and Political. The third exercise was the categorization based in probability and impact. The participants were then given the chance to vote on the most important insights. The most voted insights were grouped by the organization team based on coherence criteria. In the final exercise, each group of experts was given one of the sets of insights and elaborated a scenario based on them. The four final scenarios were then presented by the respective expert groups.

4.1.3. Activities & Results

On the 17th, a brief description of the exercises and the mega-trends to start from was given to all the participants. A long-list of mega trends had been shared in advance by e-mail and both the Members of the FUTRE consortium and experts were asked to comment on a selection of the most important trends. This preliminary list of megatrends (see the complete list of megatrends considered in this work in section 5.1, following from all the inputs including the expert consultation; the list prepared for the workshop was developed on the basis of a former literature review). The FUTRE consortium asked for the concept of “Inequality” to be developed in the first exercise (Future’s Wheel) due to its strong implication in Transport policies. The participants asked to include “Mass Migrations” and “Knowledge Society”. As a result the following Mega-trends were selected for discussion:
• Individualism
• Experientialism
• Slow Movement
• Scarcity of Global Resources
• Connectivity
• 3D Printing
• DIY
• Globalization
• Consumption 2.0
• Urbanization
• Ageing
• Knowledge Society
• Mass migrations
• Inequality

On the 18th, the participants were randomly divided into 4 groups.

The first exercise was Future’s Wheel, where participants were asked to find possible consequences on the Mega-Trends identified. The objective of this exercise was twofold: first it aimed to provide a list of insights for further development in the next methodological steps; second this discussion was a great mechanism for experts to engage in futures about the future while reducing their focus on previous positions or pre-defined ideas.

The second exercise, STEEP analysis, consisted in a gathering of insights both from the previous exercise and the participants knowledge, separated into 5 different contexts:

• Social
• Technological
• Economical
• Environmental
• Political

This approach enabled a more structured review of the insights experts considered more important and its organisation according to these five
categories. This allows the experts to start thinking not only on what may impact future demand for transport but also how it may expresses itself.

After the gathering of all insights, participants voted for the most powerful insights (probability and impact) to be used in the following exercise. Each expert was given 10 votes, which they could freely distribute between the insights. Each person was also given a vote to elect a wild card.

![Figure 5 - Results from the vote on insights, where ageing and environmental awareness emerge as clear winners on the social area.](image)

The most voted insights were then clustered into different contexts to be used in the preparation of scenarios. Groups were rearranged in an attempt to match insights with professional profiles.

**The four scenarios**

The building of possible scenarios for transport demand drivers in 2050 was one of the main objectives of the workshop. Accordingly the afternoon session targeted this aspect. The experts were divided in four groups that were tasked with the construction of a future scenario based in a set of insights that were amongst the most voted. The results of this process were the establishment of four visions for future development and an initial discussion of how transport may look like in these “worlds”. The next section briefly presents each scenario, being loyal to what the group presented at the workshop. This means that the type of description varies across groups, e.g. with some focusing more on the transport related dimensions and others with the the description of the overall social and political situation.
Forced sustainability

This Scenario can also be called “Back to Basics” and describes a reality where the scarcity for energy and water demand for major social and political shifts.

The main drivers of change are the increasing prices for both energy and water worldwide, creating an unsustainable situation, mostly for the poor groups of society, boosting crime and social instability.

Water desalinization becomes a standard practice, but is still unable to reduce price of water due to high dependence on energy, which is also expensive. There is also a great effort in water preservation, especially inside the territory.

Governments look to innovation as a possible escape, searching for efficiency, recycling and self-sufficiency. Citizens also make a contribution to comply with the goal of self-sufficiency, modifying their patterns on consumption.

Alternative Energies boost, but coal still assumes a central part in electricity production. Organic matters progressively replace plastic for a more sustainable production.

Cities grow tall, achieving the highest density possible and inverting sprawl, in order to reduce mobility energy consumption, promoting more efficiency and responsiveness in public transport systems, with more investment from governments. Car sharing works as a complement to public transport, achieving better space usage. Most people decide to work very close to home to avoid expenses with daily transport.

As an answer to growth in crime, neighbourhood armed defences arise as security technology while personal security remains as a central issue.

Governments take central stage boosting protectionism, reducing imports, but also managing exports to protect natural resources.

Politics on sustainability become very strong, with forced application.

International freight is reduced to a minimum, associated with this reduction in exports and imports, but national freight transport increases. Remaining international trade becomes more difficult with heavy and slow custom procedures and more based on bi-lateral agreements than market forces.

Migrations and tourism also decrease caused by restrictions on mobility but also rising costs of transport. Strong anti-emigration policies arise.

For efficiency reasons, habits of co-production and co-consumption grow.

Global Shock

This Scenario is the result of a serious of catastrophes, including nuclear meltdowns that shocked the world population and pushes policy makers to find more inclusive and environment protecting measures.

On top of those disasters there is a global shortage on resources, and the population is strongly aware of environmental problems and the limits of natural resources.
This awareness brings society to a change on moral values, towards:

- Community led
- Open inclusive
- Life within ecological limits
- Post consumption
- Environmental Awareness

Political priorities shift to “Localism”, pressured by the population who wants to block imports. In some situations there is also blockings on exports, in a reaction to scarcity on global resources.

Awareness on sustainability brings society to a post-consumption era, with more conscious choices.

On travelling, long distance is strongly reduced and for local context new models for shared transport erupt. Owning personal cars becomes socially unacceptable.

Self-driving cars allows for shared service, working as a Taxi service.

Virtual reality grows as an alternative to travels providing experiences like Virtual Safaris without leaving Home.

3D Printing is used as a way to reduce freight, by transferring the small industry to local production.

Passenger public transport and freight transport become more flexible and adaptive.

Concerning innovation, although there is some promoting more efficient consumption, there is an overall reduction on innovation, as it is not driven by consumerism.

**Resiliency**

The Scenario Resiliency is built on the perception that society will need to be much more adaptive and resilient in order to deal with the increasing speed of change, catastrophes and social inequality.

Population reaches the level of 9000 million, with more than 85% living in cities.

Climate change cause Sea level rise and other catastrophes that may destroy entire cities, creating phenomena of mass migrations.

Inequality within countries with bursts of unemployment also creates mass migrations to cities with better possibilities.

Along and because of global warming and climate change, there is great scarcity of resources. This brings great pressure to cooperate on recycling and more responsible consumption patterns. Where there is failure to engage in compromise and negotiation, conflicts erupt, causing even more mass migrations from refugees.

All of these social pressures bring back strong segregation from social groups, gender, age or religion. These kinds of segregation act as a positive feedback creating even more mass migrations, which leads back to more segregation.
The most important political capacity starts to be adaptability. Made by this context of constant instability governments from different levels (local, national, regional) need to respond and adapt fast for big variations in population, climate change and social instability. Governments also have to make an extra effort to protect more vulnerable people (elderly, children and disabled).

This context of fast adaptability has a great impact in the transport industry, which has to respond to scarcity and mass migrations, collecting as much resources as possible from abandoned cities to growing ones. The new paradigm on recycling emerges with outstanding capabilities on deconstructing back to its original elements.

**The Urbanized Connectivity**

This scenario describes a reality where cities are a space for great interaction, collaboration and sharing.

The philosophy of “using without owning” takes central stage, and strict possession becomes unpopular.

Distinction between collective and private becomes blur, as the ones who possess products or real estate engage in renting and sharing services.

With self-driving vehicles, a shared service takes central stage in the urban mobility context, working in a similar way to a cab-service. The cost varies in a pay-as-you ride system according to congestion, achieving higher prices in peak hours.

3D printing takes the main part in industry, but at different levels. At home there will be small products like clothes, kitchen appliances or decoration items. At a neighbourhood level bigger and more complex printers will make products like home appliances or furniture. At a regional level, there will be factories operating with 3D printers building the biggest and more complex elements like vehicles or homes. The neighbourhood and regional production methods engage in cooperative systems, using open source schemes, and shared or rented printers.

International freight will be extremely reduced as most products are produced/printed locally. Some freight maintains, but mostly for raw materials.

Following the non-possession philosophy, public spaces are more valued, where people interact and engage in shared consumption. It naturally becomes harder and unpleasant to stay at home as possession desire disappears.

For long distance travelling, trains become the main transport without short distance stops, as they will only be used to travel between large cities. The need for the final mile connection between the station and the final destination will be answered with shared autonomous vehicle, which will be available everywhere.
Walking and cycling also become very convenient and popular, in consequence of the valued public space and safety improvements resulting from autonomous driving vehicles.

Cities and citizens are very vulnerable to Electro-Magnetic Impulse Guns, as both production and transport rely on digital systems.

**Figure 6 - Prof. David Banister presenting one of the scenarios to the group**

**Wildcards**

When voting on the most important insights experts were also requested to highlight one insight as a wild card: an event that has a very low probability of occurrence but which, if occurring, may cause a very large impact.

Only one Wild Card stood out, which described a situation where a biggest participation from citizens in politics would create difficulties to large investments, due to difficulty in generating consensus and accepting long term return investments.

Considering that models of direct democracy are gaining popularity, although it is still considered a low probability, this may gain plausibility in the future.

**4.2. Interviews**

To get additional insights on fields of relevance, three interviews to academic experts were made. They focused on social preferences, political outcomes and economic pathways. The experts in question were Elisabeth Shove (University of Lancaster), Daniel Hausknost (Institute of Social Ecology, University of Klagenfurt) and Linda Nierling (Institute for Technology Assessment and Systems Analysis), respectively experts in the fields of:

- The relation of social practises and consumption patterns
• Political science in the context of global natural resource constraints and climate change
• Change processes in work and technology in the scope of sustainable development

The interviews gave additional insights on factors of relevance to the development of future with relevance to transport.
5. MEGATRENDS, KEY FACTORS AND INSIGHTS

5.1. Megatrends

Megatrends are stable trends driven by global forces that impact several societal areas. By considering megatrends it is possible to try to assess how they will influence aspects of transport needs. Based on the literature review and on inputs from the expert consultation we identified a number of megatrends which were deemed as particularly relevant to transport. We describe them below.

**Globalization**
This is a well known pattern of economic, political and social integration across countries and cultures at global level. The flows of people, capital and goods between countries have been and are expected to keep increasing, especially to/from the emerging markets of Asia, Africa and South America.

**Urbanization**
Growing percentage of people living in cities and the appearance of numerous megacities. Rural areas are abandoned and population concentrates in relatively small areas, exacerbating several problems both in cities and the countryside.

**Ageing**
Increasing life expectancy and lower birth rates is driving a global ageing of populations. This trend is creating a great market for the so-called “senior” activities while the number of elderly people that remain active in the labour market increases.

**Knowledge society**
The increasing importance of education, know-how and information for economy and society as a whole is a megatrend around the world.

Is characterized by rising levels of education, innovation as a key driver and competition factor, data and knowledge-based value creation, the creative class as a new global knowledge elite and lifelong learning.

**Individualism**
Contrarily to common sense, individualism is not about selfishness. Individualism is a trend towards recognizing people as unique entities which may result in lower group awareness, lower identification with groups (being them religious, nationalities, urban tribes, etc). Individualism may induce a construction of the ego increasingly based on personal achievements and less on stable interpersonal relations (more relations but less stable).
Migration
Globalization, inequality, the population growth in developing countries, ageing in developed countries and knowledge flows have been and will continue to putting pressure towards migration flows across World regions. This happens both with blue and white collar workers.

Connectivity
It is about the trend for people to be online on a 24/7 basis and the sense that infinite information is available all the time. This trend is also associated with the “Google-It” culture, a large tendency for multi-tasking and a high level of info-dependence.

Immediate needs: here & now
In the here & now culture people have a continuous feeling of urgency and clearly prefer short-term to long-term thinking. This is likely to impact societies by decreased planning capacity, by a sense of need to be busy at all time and a greater tendency for multi-tasking.

Slow Movement
To a large extent this is a counter-trend force which gives great importance to quality of life and puts health and mental health as a priority. People give more valuation to real and spiritual things, privilege the availability of time and own developed activities and may be associated with a move away from urban areas.

Empowerment of Women
Following the increased mixing of the work force progressive women achieve a higher role in society (both at political and professional level). This may generate a change in values, towards a more feminine set of values and a move towards a better integration of professional and personal lifes.

Awareness / consciousness
This trend reflects the increased awareness of global social and environmental hazards. Increased information on systemic threats drives the developments of a deeper global consciousness. This trend may result in a higher focus on sustainable development and benefit fair trade and social responsibility initiatives.

Consumption 2.0 – use, not own
According to this trend consumers are privileging the use of goods in relation to their possession. This may be reflected in a higher tendency to rent rather than buying (houses, cars, computers, music,...) generating a growth of pay-per-use systems, cloud storage systems and a strong need to feel that we are using the latest version of each new technology.

Ever Young
While there seems to be a trend for children to mature at earlier ages there is also a tendency for older citizens to go on with a lifestyle which is more typical
of the younger, with adventure, gaming and a strong desire for freedom. This may create a certain convergence of generations and the generalization of a youth lifestyle.

**Seeking for experiences**
This megatrend reflects the increased desire for experience rather than possessions. These are reflected in a strong willingness for travelling and for meeting people and engage in different cultures. It generates business opportunities for radical sports and activities but may also result in more prevalent risk-taking attitude.

**Do it yourself**
Instead of buying finished products people may increasingly engage in co-development activities. Forums and online reviews become major sources of product validation while “crowd funding” and “crowd sourcing” increase their magnitude. Companies feel the need to deeply involve consumers in all stages of development of their products and services.

### 5.2. Key Factors

A set of key factors for the evolution of transport is identified. The selection was based on the literature review on transport futures, the stakeholder consultations and the own analysis of the project team.

The definition of the key factors is specific about a given phenomenon and the direction it may take. For example, the factor “value of safety” is specific about the direction of the trend (it may increase or decrease), while calling it “safety preferences” would be an abstract term not directly associated with a specific possible trend. This facilitated the definition of global pathways by clearly defining the direction of the factors’ trends in each pathway.

Technological factors directly related to innovations within the transport system are not considered, as that is the scope of WP4.

The key factors are related to different spheres of life. They were arranged in the areas defined by the STEEP approach:

- Social factors
- Technological factors
- Economical factors
- Environmental factors
- Political factors

The following table outlines the 39 factors considered.
### Table 3 – Factors of evolution of transport demand

<table>
<thead>
<tr>
<th>Social</th>
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<tbody>
<tr>
<td><strong>Demography:</strong></td>
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<tr>
<td>Population growth</td>
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<td>Ageing</td>
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<td>Global migrations</td>
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<tr>
<td>Living place flexibility</td>
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<tr>
<td><strong>Education and social capital:</strong></td>
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<tr>
<td>Level of education</td>
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<tr>
<td>Equality of cultural capital</td>
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<tr>
<td><strong>Preferences and awareness:</strong></td>
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<tr>
<td>Environmental awareness</td>
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<tr>
<td>Propensity to own VS share use</td>
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<tr>
<td>Social significance of travel choices (status)</td>
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<tr>
<td>Value of doing tasks while travelling</td>
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<tr>
<td>Rationality of choices</td>
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<tr>
<td>Value of safety</td>
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<tr>
<td>Value of health</td>
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<tr>
<td>Value of free time and leisure</td>
</tr>
<tr>
<td>More virtual than physical relations / communication</td>
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<tr>
<td><strong>Technological</strong></td>
</tr>
<tr>
<td>Ability to address energy, environmental and ageing challenges by technical developments</td>
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<tr>
<td><strong>Economical</strong></td>
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<tr>
<td><strong>Economic development:</strong></td>
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<tr>
<td>Level of economic growth</td>
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<tr>
<td>Economic stability</td>
</tr>
<tr>
<td>Volume of international trade</td>
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<tr>
<td>Economic equality</td>
</tr>
<tr>
<td><strong>Production and consumption patterns:</strong></td>
</tr>
<tr>
<td>Share of knowledge based work</td>
</tr>
<tr>
<td>Purchasing channel paradigms (P2P and e-commerce VS local commerce...)</td>
</tr>
<tr>
<td>Scale of production: mass VS customised</td>
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<tr>
<td>Paid work time reduction</td>
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<tr>
<td><strong>Energy:</strong></td>
</tr>
<tr>
<td>Fossil energy scarcity – prices</td>
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<tr>
<td><strong>Urban development:</strong></td>
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<tr>
<td>Urbanisation</td>
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<tr>
<td>Urban density</td>
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<tr>
<td>Congestion</td>
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</table>
5.3. Insights

We identify insights on specific trends or events that are somewhere between possible and likely to come in the future. They are not so sure to happen as megatrends. Considering the existing megatrends, we had the challenge of identifying insights directly or indirectly relevant to transport. This was done by experts in the workshop and by the project team based on the basic material considered. The consideration of insights provided ideas for the identification of key factors and were an input to the development of future pathways.

Wild cards are low probability, high impact events. They are usually not considered in scenarios, but because of their large consequences are worth being considered. During this work we identified and listed some wild cards with relevance to transport.

The insights and wild cards identified are described below.
5.3.1. Insights on possible trends and futures

Climate Change

Our way of life is set to face strong limitations due to climate change and other environmental threats. It would be a really tough guess to whether mankind will find solutions to address these challenges in the next decades. The problem has four main possible outcomes:

- **Catastrophes and adaptation** – We fail to reach agreements, and the world present us with successive catastrophes, causing mass migrations, conflicts and strong social problems;
- **Limitation** – Progress, as we know it, is stopped and society turns to low consumption ways of life;
- **Replacement** – Techniques like alternative sources of energy and organic materials allow us to keep developing in an environment friendly way;
- **End-of-line solutions**: Finding ways (conscious or spontaneous) to invert or control global warming (e.g. Carbon sequestration)

Energy scarcity and high prices

This is a probable trend. Conventional fossil fuel sources are depleting. Fossil fuels currently account for about 90 percent of the world’s energy consumption. They provide around 66% of the world’s electrical power, and 95% of the world’s total energy demands. Although non-conventional reserves of oil and natural gas are being found which are postponing the peak of
production, they are more expensive to get and are offset by the economic growth of emerging countries. Coal use is increasingly unacceptable. Renewable energies are an alternative but at higher costs. Energy scarcity will increase and its price will go up.

**Scarcity of natural resources**
Apart from energy sources, other types of natural resources are being depleted at unsustainable rates. This is the case of some minerals and water. Like fossil fuels, their scarcity may constrain production capacity and supply of basic commodities. Their unevenly distribution around the world puts a stress on international relations and may lead to geopolitical conflicts.

**Mass-migrations**
This phenomenon is not new but is set to increase. Mass-migrations may occur from difficulties like extreme inequality, climate change or armed conflicts, but may also occur in a scenario of economic development where migrants go to fast growing economies, making cities grow faster than they can adapt.

Seasonal migrations might occur from tele-workers, who move from country to country, basing their choices mostly on weather conditions.

In a not so near future, we may witness pop-up cities for big events (e.g. Olympic Games) or driven by bursts of popularity.

Possible implications for this trend are:

- Need to build urban transports in a record time
- Need for adaptive and complex logistics systems

**Powerless national Governments**

*...due to international competition:* In a World of increasing globalization, where national identities get less important, people easily communicate with from distant regions with their friends and family, individualism plays a higher role and capital flows easily, the competition about trade and attracting highly skilled people may take the power away from governments to raise taxes on companies and skilled labour. This takes the power away from the States to finance their activities. It also promotes inequality within and across countries.

*...due to loss of legitimacy:* The lack of power of the State together with its failure to address the coming energy, climate and economic crises will turn away their legitimacy as a means to solve social problems. This will bring an extreme political crisis in the developed countries and some kind of political revolutions. The form of this revolution and what comes next is highly uncertain. In the process national Governments further lose their power, perhaps to regain it later under a new political framework at the international level.

For transport this would mean less capacity of Governments to invest in infrastructure and pay for subsidised public transport. Transportation is more dependent on private initiative.
The economic Degrowth in developed countries

The economic growth paradigm of the 20th century may be coming to an end. With the rise of economic activity in developed countries, several arguments arise that question the persistence of a positive relation between economic growth and wellbeing, including global environmental constraints, scarcity of global resources and the happiness of people. The point might have been reached in the economically more developed world where additional growth is conducting to less and not more wellbeing. The idea that economic growth in the most developed countries should not be seen as a political priority has been increasingly raised among economists (e.g. Daly 1977, Latouche 2007, Jackson 2009). At the political level, the issue that economic growth as measured by GDP is not an appropriate indicator of wellbeing, and should be replaced, has been subject to highly publicised studies by the European Commission (2013), the French government (Commission on the Measurement of Economic Performance and Social Progress et al. 2009) and the British government (Beaumont, 2011).

Work sharing and more labour intensive activities

A crucial barrier to the occurrence of interruptions in economic growth is the undesirable systemic outcomes of no growth, like unemployment, reduction of public revenues and consequently its welfare services and/or the collapse of the public finances; in the short run, interruption of growth causes social instability. Societies may thus be faced with a ‘growth dilemma’, whereby a conflict arises between long-term wellbeing and the short-term imperative of economic growth motivated by the need of social stability.

Jackson and Victor (2011) identify possible macroeconomic pathways for conciliation of no growth scenarios with social stability, particularly how to avoid unemployment. Since as a consequence of the increase of productivity growth, unemployment rises whenever total output does not keep pace with that growth, they identify two possible pathways to avoid the decrease of employment under stagnated production:

- by reducing working time - in order to share the work among the population;
- by changing the structure of production towards lower labour-, higher resource productivity

This insight envisions these two outcomes. They would likely cause:

- More free time for non-work activities
- Lower volume of freight transport

Technology solves energy and environmental problems

There is a possibility that technological development will solve most energy and environmental problems. This is somewhat unexpected following from a continuation of past technological development trends. The current rate of energy efficiency improvement is largely insufficient to meet the needs of climate change avoidance and increasing wealth in emergent regions (Jackson, 2009). But technological breakthroughs have happened in the past and may happen again. Large R&D investments in multiple solutions driven by
these growing needs are being made around the world, which could trigger alternatives to current technological paradigms or drastic performance improvements.

**Social Pressure Vs. Political Pressure**

The paradox between bottom-up and top-down is an endless debate, as democracy is one of the biggest signs for development, but at a very high level, giving too much power to citizens disables governments to make decisions. This seriously affects the transport industry, where investments are very high and take too long to achieve Return on Investment.

**Multi-Tasking**

There is a clear and strong trend on using travelling time to perform valuable tasks. Previously the only opportunity was to read a book or the newspaper. Now with the developments of portables such as smart-phones and tablets, travelling time might be almost as useful as time at the office.

Some possible implications for this trend are:

- Pressure for non-driving
- Speed or travelling time becomes less important
- Waiting time or commuting time becomes more important
- Comfort and silence become more important
- Uninterrupted Wi-Fi connection and plug-in charging becomes important characteristics of transport services

**Nomadism**

Living as a nomad has a very romantic sense and might become common in the next decades, following individualism, experientialism and consumption 2.0 values and lifestyles.

A modern nomad lifestyle (in this context) would mean to live in different cities by a few weeks or month each time, and avoid repetition. Such a person would carry all of his physical belongings each time, although they might be less than we would expect today.

If Nomadism becomes common we could have:

- Unlimited passenger growth
- Need for new solutions in passenger luggage

**3D Printing**

With the emergence of 3D printing a higher ability to produce goods at local level will emerge. This may affect global trade and movements of goods and induce a contraction of industrial activity. Products produced through 3D printing are potentially unique and personalized, fitting exactly each consumer needs. There is still some debate whether 3D printing will be such a revolution as the internet, or just some wishful thinking that promises more than can ever deliver. Nonetheless, there are projects running that allow for such big creations as printed cars or houses, and this should not be ignored.

Some implications for this trend would be:
• Higher transport needs for raw materials
• Increase in short distance and short objects logistics
• Possible decrease on great lines logistics (e.g. China-EU, China-USA)
• Massive decrease in freight (counter argumented by the increase by replacement phenomenon)

Economic-Transport Decoupling

In an old paradigm, increase of commerce was seen as the only way to achieve economic growth. Imports would reduce prices or increase quality and available goods, as exports would increase financial income. This meant that freight growth was necessary to economic development.

Now, with Information technologies, there is an alternative by achieving growth with digital services.

In reaction to this change it would make sense that governments reduce investment on Freight, as they channel it to digital development (infrastructures and education).

But if freight is not such a big cause for development, this says nothing about it being a consequence. It requires other trends that reduce the desire for freight to reduce the correlation.

The consequences for this trend would be:

• Reduction in freight investment by governments
• Possible contraction on freight volumes, specially main intercontinental lines

Passenger Peak

The first decade of the 21st Century saw, even before the financial and economic crisis, some of the most developed countries in several continents to reduce the use of car. The reasons given for this phenomenon include the increase of oil prices, the lack of interest of the Millennial generation in cars and the increasing congestion of road infrastructure with no possibility for further capacity enlargement. Will this trend continue?

No more time travelling

Studies have argued that, for anthropological reasons, the average amount of time spent travelling each day is relatively constant over time, irrespective of changes in urban planning and transport and demographic patterns (Newman and Kenworthy, 2012; Marchetti, 1994). This puts a limit on the amount of possible travel under a given speed. At the same time, as capacity constraints and congestion put a cap on speed it may be inferred that there is a limit to car travel (the most space occupying mode) in cities.

Since there are rebound effects – people get back to other places to live or modes of transport after seeing their car travel time increase above the initial time – hitting the Marchetti Wall can be foreseen to cause a car use peak (see related insight).
The safety imperative

The increasing concern for the protection of human life is a century-long hypertrend. In transport, safety has been increasing very clearly in the last decades, responding to this type of pressure. But still transport, particularly road traffic, is one of the main causes of death, and the most important cause of unnatural death in the EU27 (1.1%) and the World (2.2%). The problem seems to be still overlooked by citizens considering its relative severity in relation to other safety and security problems high in the public agenda. It seems likely that, despite the improvements, safety will continue to be priority for citizens and a crucial political pressure in the field of transport. We may imagine a future where the existence of road deaths and severe injuries will be deemed unacceptable by people and authorities.

This would have important implications for transport. There are two broad possibilities to address the needs under a safety imperative:

- By drastically reducing volume and speed in road transport
- By avoiding accidents through automatic driving technologies

Increasing by replacement (on passenger)

Information Technology is often seen as an alternative for passenger mobility. However just like the computer increased the use of paper, so may internet increase the need to travel. It allows us to have personal and professional relations worldwide easily, but the outcome is to increase our desire and need to go there. It also brings us awareness of places to visit. There is also a viral effect on visiting places.

The consequences for this trend are:

- Increased travelling needs
- Spread of destinations

Non Driving

There is an increasing pressure for non-driving. The main reasons for this growth are: Safety, people unable to drive (children, elderly, handicapped, drug or alcohol influence), multi-tasking (also include rest).

Non-driving might be answered by public transport, cabs, autonomous driving, railed means of transport or combined versions of the previous.
Releasing space for pedestrians

There is an increasing social tension to release space for pedestrians. Local residents want to have free, safe and clean space to enhance their quality of life. All around Europe and in other developed countries the promotion of walking and cycling has been increasing. City centres are becoming increasingly car free. Considering the trends for increasing concerns over health, comfort, safety and life quality, the pressure to reduce and separate vehicle routes from pedestrian areas is likely to increase increase.

Sharing Space with pedestrians and bicycles

Currently most means of transport (cars, bus and even trains) share a space with pedestrians and Bikes. Concerns with safety are strongly linked to development.

There is already some pressure to create car-free walking streets, but there is always a need for intersections between pedestrians and vehicles. The only solution to reduce these intersections is to think in 3 Dimensions (elevated or underground routes).

Another possible solution is to force maximum speed inside residential cities to 30km/h, channeling most transit to highways.

Whatever paradigm we may find, the pressure to separate pedestrians and vehicles is set to increase, linked to development.

Fading Peak Hour traffic

The Peak Hour phenomenon results from 2 paradigms that are slowly fading out. Traditional sprawling, where people live in the suburbs, and work in the big city, is showing some signs of disappearing. Better means of communication (internet) are allowing for professionals to work at home or in coworks, as well as companies to move away from the city centers.
Also, the traditional working time shows signs of fading, as technical workers choose to work in different schedules according to their personal preferences.

This doesn’t mean that peak hours will disappear, but it’s probable that they’ll be softened.

**City structure - low or high density, segmented or mixed use**

Maybe the biggest uncertainty for the needs on transport is the growth of Cities. Although there has been a mega-trend on cities-growth, there is uncertainty for continuity on this trend, and also if they grow Higher or larger. This gives us 3 possible outcomes:

**Sprawl** - The 20th century (mega)trend has been towards high urban sprawl. Citizens turned from the busy city center into the peripheral area, where they expected a better lifestyle and cheaper prices but keep access to all that the city has to offer. Sprawl has an interdependent relation with transport supply, which needs to accommodate the mobility needs of the population.

**Reversal of Urban Sprawl** - The data on density of cities suggests that the peak in decline of city density has occurred and cities are now coming back in faster than they are going out (Newman and Kenworthy, 2012). After the growth of car use and the related congestion, masses of people might have realized that car dependence and large commuting distances have high costs and prefer to come back to city centres. The shift back to city centres is happening mostly with younger generations. In the future cities might grow higher, with very high levels of density. This usually means that people live in smaller environments, where the level of interactions is very high and there are fast-lifestyles. Higher cities also mean more energy efficient, and in the current transport paradigm tall cities make more efficient transport as they tend to have a higher share of public transport use.

**Segmented or mixed use** - There is uncertainty as to whether residential and working areas will merge, changing the current paradigm of suburbs. Having companies inside the city, and residences in the suburbs is an inefficient solution from the point of view of transport capacity. If companies also move to the suburbs, and citizens back to the centre, a better balance is achieved.

**The 3rd Wave - back to the countryside**

Alvin Toffler called the agricultural society the first wave, and the industrial revolution the 2nd wave in which citizens moved to the cities to find jobs. The 3rd wave (Tofier, 1980) would be when communications and transport would have evolved so much that people could get away from cities for choice. He didn’t predict the internet, but predicted its potential as today a lot of office workers can work from any place they want. However, now we have that possibility and there are still great doubts whether people will choose to live away from cities. But even if we accept this idea, we should just consider it as a desire, as transports capacity will determine if it is possible.
Cities abandonment
A darker side of mass-migrations and back to the country may be the fast abandonment of Big cities who fall into oblivionness.
This may lead in these cities to dismantling of transport structures, in order to save resources.

Recycling
The scarcity of resources will necessarily lead to increasing rates of recycling of a variety of materials.
Increasing recycling has impacts on transport related production processes and materials used.

Organic Matter
Still at an early stage of development, organic matter is slowly becoming a central resource that can be used to produce everyday items to energy.
This brings us to new uncertainties:
- One type of products or many?
- Circuits for grouping and distributing
- Time concerns and transport conditions

Home Deliveries
Home deliveries are strongly dependent on the use of internet. On a direct effect we need to be strong users of internet to be able to perform orders. But there is also an indirect effect, as strong users value less the personal experience of shopping. In a reality where virtual relations become mainstream, consumers may see personal shopping as a burden. However, there are weak signals that younger generations might drift back away from internet.

P2P commerce
P2P commerce from individuals who have small businesses, the used market and very specific products buying require more complex and adaptive logistic systems.
Some consequences for this trend are:
- Intermodal Freight Automation
- Sub-Teu standard sizes needed
- Better use of logic artificial intelligence

On-grid Vs. Off-grid
On-grid Vs. Off-grid describes the difference between means of transport that are connected to the electric grid comparing to the ones which are not. Tramps and Buses are very similar except for this point.
Altough connecting to the grid reduces freedom in its movements it is much more efficient in energy, cost and in an environmental perspective.
The current trend is that on-grid connection increases it's importance as oil is becoming more expensive, and electricity production is becoming cheaper and sustainable due to alternative energies (i.e., solar, hydro-electric and wind) and nuclear.

However, there is a very plausible possibility for disruptive breakthroughs in alternative off-grid systems such as bio-fuels, hydrogen, low weight non-lithium batteries, fuel cells or others.

**Providing internal low voltage**

Personal technologies use mostly low voltage (8 volts). However, considering that the domestic grids are usually 220V in Europe, and 110 in America, our gadgets are connected to a plug adapter. Pressures already exist to create low voltage systems that could even function wireless charging. Low voltage systems would provide more efficiency, and wireless would promote comfort.

This shift is an uncertainty, but if it comes true, then passenger transport will be required to offer this to passengers.

**End of Big Lines**

Today there are very big logistic lines (e.g., China-Rotherdam). With 3D printing and a more balanced economy, centres of production will be more distributed as well as packaging and shipping.

Logistic centers would disappear as well as the biggest ships. This would also mean that ships would lose efficiency comparing to trains.

**Personal Luggage**

Personal Luggage is the middle term between passenger and freight. Nowadays is just considered as part of the passenger transport. But as passenger transport increases and freight becomes more flexible, it might make sense to consider luggage as freight transport allowing for independent transport from the passenger.

Ex: one passenger would ship is luggage one day before is trip, and would find it in the hotel of his destination waiting for him.

Such systems would mean highly flexible freight system, brought down to the individual costumer.

**5.3.2. Wild Cards**

**Reversion of globalization**

Although globalization as been presented as a mega-trend, or even a hyper trend (considered to be started with the Greek Empire), there is always the possibility for inversion.

Environmental concerns, economic crises and international conflits may make us take a few steps back, reducing both passenger and freight transport to much lower volumes.
**Freezing capacity of direct democracies to decide on investments**
In a model of direct democracy, it would be harder to reach consensus, especially for long periods of time, as population tends to change opinion faster than traditional governments. They also tend to focus more on the present, than long term thinking. In a scenario of direct democracy there would probably be no great investments. Also corruption or constant instability could result in the same outcome.

**Destruction of satellites**
Satellites are destroyed by a natural catastrophe (e.g. solar flare) or terrorism acts, leading to the disruption of communications.

**Biodiversity losses explode before 2050**
The impacts of biodiversity losses are highly uncertain and could have unforeseen drastic consequences. This wildcard says that biodiversity losses will have harsh consequences on land and water ecosystems before 2050, causing severe disruptions in food supply and other biological resources.

**Info Terrorism**
Info terrorism becomes usual and manages to disrupt critical information systems. GNSS based and other information systems are not reliable and are not an option for many applications.

**Mega-city destroyed by nuclear weapon**
A nuclear attack turns the world into an ultra-security concerned placed, where every activity and every person are controlled and there are great restrictions to trade and the movement of people.

**Epidemic kills a million people**
A severe epidemic causes frontiers to be highly controlled and some regions of the world to become locked for a significant period of time.

**A safe, unlimited and clean energy production form is discovered**
A safe, unlimited and clean energy production form is discovered, such as nuclear fusion.

**Robotics substitutes work**
Robotics develops to a level which allows replacing most physical and some intellectual human work.

**The technological singularity comes**
Artificial intelligence progresses to the point of a greater-than-human intelligence before 2050. The consequences of this event are very unpredictable.
5.4. **System analysis**

Beyond the simple analysis of factors of change individually, it was relevant to take into account the complexity shaped by the interrelations between those factors. For example, it is possible to expect that socioeconomic structures, like social equity, influence the evolution of values (e.g. towards status behaviour) and conversely values influence social equity by way of social behaviour and political action; or it is unlikely that a future scenario where the implications of human action on climate change will have been proved inexistent at the same time is driven by consumer values strongly framed by the issue of climate change. Therefore, additionally to the futurology for each of the factors of change individually, the mapping of their likely interrelations was a tool for scenario building. To this end, a systems thinking approach framed the analysis.

The figure below is a causal loop diagram of the key factors identified above. A causal loop diagram identifies the main relations between the variables in question and the direction (positive or negative) of those relations.
Legend: arrows follow a System Dynamics notation. + (-) means a positive (negative) effect from the precedent to the pointed variable.

Figure 9 – Causal loop diagram of key factors
The systemic view of the key factors allowed assessing coherence and plausibility of different possible pathways.

We highlight the following insights taken from the system analysis and considered in the development of future pathways:

• Preferences are influenced and reinforced by external conditions. For example, consumerism is made possible when there is abundance (economic growth) and environmental awareness is reinforced by the manifestation of environmental problems. However, it may be assumed that preferences may have a certain degree of autonomy from external conditions in their evolution.

• Population growth is the more constrained the more resource scarcity and environmental problems there are. If these are solved, there need to be no limits of population growth. If there is more population growth, the ageing phenomenon will be reduced.

• The continuation of urbanization makes less sense in a world with more virtual relations and stronger preferences over health.

• The value given to health is increased by ageing, environmental awareness and rationality of choices.

• Urban density makes sense in a world with scarce energy and more value given to free time.

• More equality of cultural capital tends to reduce the social significance of consumer (travel) choices and inherently the rationality of those choices.

• Rationality of choices also makes more sense in a world with economic constraints and instability. This may lead to a more long term thinking by people, who will for example value more things like health, safety and multitasking while travelling.

• Connectivity enhances education and the political power of the people, which contribute to environmental awareness and global cooperation on global issues.

• Less consumerism is related to more value given to time and leisure. Both factors lead to a willingness to work less time, contributing to a lower economic output and less environmental damage and natural resource scarcity.

• Security concerns are amplified by international conflicts and cultural inequality.
6. **GLOBAL PATHWAYS**

6.1. **Approach**

This chapter presents four different future pathways towards 2050. The pathways chosen are meant to bound a range of plausibility on global futures with interest to transport.

The pathways will be later used to develop specific transport system pathways (Tasks 3.2 for passenger transport and 3.3 for freight transport). They are defined in terms of the evolution of key factors. Each pathway is supposed to be internally consistent, i.e. the main key factors driving those pathways, and their direction, are consistent according to the interrelations defined in the system analysis.

Contrarily to other future studies, the main key factors which drive the course of the pathways are not fixed. Each scenario is driven by particular factors which, in other scenarios, have a secondary role. We believe that the uncertainty about the future relates not only with the direction that some factors will take, but that it is also about which factors will play the most decisive role. Therefore we chose to make the factors’ weight variable in the definition of course of each pathway. To a great extent, the scenarios were characterized by this choice of factors playing a main role.

The next section presents a storyline for each of the four pathways developed. The third section further explains the rationale used in the choice of the four pathways. The later section characterizes each pathway in detail in terms of the key global factors.

6.2. **Four pathways**

**Unlimited**

Society has overcome the biggest barriers to consumption and growth. Global Warming and natural resources scarcity have been overcome by breakthrough technological developments. Social stability continues to be pursued through economic growth. The objective of green growth is fully achieved. Investment and consumption keep increasing globally to unprecedented levels.

Less developed countries find their way to economic development and poverty is mostly abolished. Reasonable standards of living are assured across the whole world, with the exception of a few autocratic countries. Inequality between countries is strongly reduced, even though global economic power keeps concentrating on few corporations. The industry is well distributed through the various regions of the World, as there are no more massive sources of cheap labour.

Life runs fast and must be used to the limit. Time is the scarcest resource. Individualism keeps growing - individuals are more and more characterised
by their personal experience than from group belonging. “Seeking for experiences” preferences increase, as people seek more and more life-changing experiences. Travelling is seen as an important part of personality building and a sort of “nomadism” erupts as a mainstream lifestyle. It becomes normal to change city, country or continent every few weeks or month.

The average person doesn’t identify with any country as hers, and has no answer to the question “Where are you from?”. She does not own a personal way of transport, and reduces her overall possessions to the minimum allowing for easy travelling.

Not having a specific work place becomes normal. People combine their travelling with work needs, building a network in their travels. Work life and private life are mixed, and impossible to separate. Working time is an unknown concept, and might be adjusted to biological preferences, client time zones and unplanned events.

Speed of travel is an important preference. Comfort and Wi-Fi also are, as time is not wasted. There is intolerance for multi-modal and waiting times.

3D Printing evolves from a cool practice to mainstream, offering diversity and fast production. Instead of having to wait for a personalized item or parts for home appliances, any shop can just produce what it needs on the spot.

**Passivity and Chaotic Collapse**

This pathway is based on the fact that the impending climatic and environmental crisis is not sufficiently embedded into the concerns of citizens to legitimate the bold political worldwide action necessary to mitigate and adapt to it. Action is further put off by the appearance of new natural gas and oil reserves accessible to exploration, which postpone energy scarcity. The economic crisis is not easily escaped and dominates public attention for many years. Political action towards the global sustainability of the environment is only legitimated after extreme events actually occur.

By 2035 climate change and other environmental problems (biodiversity...) eventually cause extreme events (weather, food/water scarcity...) that are socially unacceptable. By the same time, energy prices finally surge due to scarcity, increasing prices and a new wave of economic growth. The world economy busts and there are severe social problems led by environmental degradation, particularly food scarcity.

Mass migrations take place as a result of local scarcities, inequalities and climatic conditions. Many countries draw into protectionism. The consequent decreasing trade and reduction of productivity lead to even worse consequences for the world economy. There might be wars for resources. Terrorism events are exacerbated. The inaction of governments and the dramatic social tensions drastically damage the credibility of institutions and eventually lead to political (r)evolutions.

The world is unprepared for the consequences. The chaotic outcomes - political, environmental, economic, social - lead to drastic changes in lifestyles which are very unstable.
The two main characteristics of change are scarcity of resources and the need for quick adaption to economic, social, environmental and climatic change. The future is uncertain, planning is short-term, investments are low. Flexibility is highly valued among people, businesses and governments. Resilience is the dominant paradigm.

**Cooperation and De-growth**

Bold global cooperation on environmental, energy and resources comes to reality before 2020. Governments and international institutions agree and enforce global restrictions to the use of global resources and deployment of pollutant energy sources.

There is a global internalization of environmental and social costs compatible with the stabilization of environmental risks and sustainability of the use of global natural resources. This causes much higher costs of types of consumption, investment or travel which depend on the consumption of scarce natural resources or environmental burden. The economy restructures towards less resource intensive and more labour intensive activities.

This path necessarily involves de-growth of the most advanced economies, particularly the North-American and European blocks. Governments learn to provide the institutions to make this happen while at the same time maintaining employment, financial sustainability and social stability. In order to guarantee employment levels under continuing productivity growth and reduction of economic output, policies are implemented to reduce working time. People have more time to spend on leisure or flexible non-paid work activities, but do not enroll in activities that involve resource consumption.

The changes in climate are restrained to acceptable levels and extreme weather events are generally manageable. Energy crises are relatively small and of minor impact. Inequality is reduced within countries and especially across countries.

There is greater solidarity, cooperation, confidence, and ultimately peace. Minimum levels of education reach nearly every part of the World. Events of terrorism are rare and localized.

The citizens of the Western World eventually accept to live with a lower level of resource availability and adapt towards lifestyles less based on consumption and resource intensive travel. Emerging economies grow smoothly and sustainably, while its citizens do not ever reach the resource intensive lifestyles that were followed in the West.

**Smart & Spiritual**

Society evolves into a new social paradigm where materialism and consumption are less relevant, and moral values, life quality and spirituality come to centre stage.

Most people reduce working time, leaving more time to leisure, learning and quality time with friends and relatives. Such extra time raises educational levels and reinforces moral values along. The smarter people get, the smarter their choices are.
People choose responsibly and consciously. Decisions are more rational and less influenced by social practices and social significance of travel modes. They also incorporate concerns about safety, environmental protection, social cohesion and life quality into their decisions. If status concerns are still embedded in decisions, they are much more aligned with collective interests.

The centuries long hyper-trend of increasing value attributed to human life continues through an ever stronger safety imperative. The current trends of aging, increasing disabilities, mental disorders (or at least awareness), stress caused disorders and pure irresponsibility show incompatibility with increasing needs for mobility and safety requirements. This results into drastic restrictions on car use inside cities to protect pedestrians and cyclists.

The trend of freeing space from the car inside cities is reinforced by an increasing willingness of citizens to have public space returned to people, particularly children and disabled people. The mainstream social and political paradigm is that the urban surface belongs to pedestrians. The elites, who primarily used the car in the 20th century and supported its use, are now a fundamental driver of this new view of urban space.

Owning a personal vehicle is increasingly seen as a burden rather than an advantage. Driving is perceived as a life-quality reducer, as other means of transport might actually give better spirituality opportunities through contacting other people, reading or enjoying pathway. Travelling is not only about going from A to B, it is also a spiritual activity. This influences mobility choices also outside cities.

The individuality of people continues to evolve, and there is great diversity of choices and lifestyles. While many people continue to live in urban areas, there are fluxes of new inhabitants in rural areas. This is favoured by teleworking, but still lower wages are not a problem for them since they are highly compensated by the contact with nature and the quality of life outside cities. Inside and outside cities, local communities have again strong bonds.

6.3. Rationale

Different pathways were iteratively developed and discussed. The final aim was to develop a set of pathways which better defined a range of plausibility with interest the study of transport demand futures. To that purpose, they should differ as much as possible between each other within boundaries of plausibility.

Steps in pathway development

The conceptual steps taken in the development of pathways were the following:

1. Identification of a short list of main driver factors;
2. Identification of pathways based on possible trends of a limited number of main driving factors;
3. Detailed definition of those pathways covering the remaining factors and considering their systemic consistency;

4. Assessment of the level of coverage of plausible outcomes by the set of pathways considered;

5. Back to step 2. Iterative development of pathways until a satisfactory range of plausibility with interest to transport demand futures is achieved.

Main driver factors
Taking into account the various inputs, the FUTRE team identified a shorter list of five factors which were more persistently referred as crucial in the development of future pathways. They were:

- Climate change
- Energy scarcity and price
- Economic performance
- Global cooperation
- Social preferences – consumerism Vs spiritual needs

These factors are the main drivers of the dynamic development of the pathways considered. Their relative importance varies per pathway identified. It was assumed that a reduced number of factors (one to three) would be the driving forces of each pathway, and that the direction of the remaining factors would develop around that course in a systemically consistent way.

We outline possible trends and consequences considered for each driver factor and their possible implications:

- **Climate change**: there is some uncertainty as to the level and impacts that climate change will take, but by now it is scientifically safe to say that it will have a significant impact under a business as usual course. Climate change could be averted by two possible means. The first would be some kind of technological developments (like energy production technologies or carbon capture) that would stop most carbon emissions in the medium term. The second would be the reduction of human activities (like driving a car) and production processes (carbon based energy sources) to a sufficiently low level. If climate change is not avoided, then consequences like extreme weather events and mass migrations are expected.

- **Energy scarcity and price**: The level of scarcity and price of energy is uncertain and depends on other factors like new discoveries of fossil fuels, technological processes to prospect and collect fuels, technological developments on alternative energy sources and technological developments in conventional energy use efficiency. If the issue of energy scarcity is not solved in time, the increasing demand by the emergent economies will cause energy prices to dramatically increase. This may trigger a global economic crisis,
international conflicts and ultimately a radical forced change in social practices and production.

- **Economic performance**: It is uncertain whether economic output in developed economies will continue to increase like has happened in the 20th century. There are important feedbacks between economic growth and the issues of energy and climate change. Economic growth is made possible by low energy costs or is halted by energy scarcity. Economic growth – and the inherent carbon intensity – negatively contributes both to energy scarcity and climate change. According to the present data, economic growth can only be sustained if energy and environmental issues are solved by technology, and conversely it will contribute to amplify those problems if it is not sufficiently reduced.

- **Global cooperation**: Global cooperation is a major condition to overcome issues including environmental and energy scarcity problems. The sustainability of global commons issues are jeopardized by competitive races for wealth and resources. Only a collective consent to slow down the consumption of global resources and greenhouse gas emissions will stop a tragedy of the commons. The extent of global cooperation will also define the level of economic social and cultural interactions between different world regions.

- **Social preferences - consumerism Vs spiritual needs**: preferences over goods have a meaning beyond the practical utility of those items and confer social significance and/or are a part of routine social practises. This fact has fundamental impacts on what and how much is produced and more specifically on the use of material resources and the need to work rather than use the free time of individuals to other purposes. There are several signals that social preferences are getting less consumerist and there is an important uncertainty over how this factor will evolve in the future. If social preferences definitely evolve towards a spiritual focus, this will contribute to avoid energy and environmental problems and will have a radical impact on consumption and travel preferences.

**Development of pathways**

The pathways selected were developed and discussed within the project team iteratively until the purpose of capturing the range of plausibility of global futures was considered to be met. The pathways were developed on the basis of systemically consistent combinations of factors according to the system analysis described in Section 5.4, both for the main driver factors and for the remaining factors (Section 6.4).

In the four pathways considered, the driver factors follow different trends and roles and have distinct consequences for social, economic and political aspects. We describe the main rationale of each pathway:

- **Unlimited**: This is the pathway where technology is able to solve the crucial environmental and energy problems. Without any constraint on them, current
social practises may continue and even follow a path of increased consumerism and thirst for travel. Global economic competition is the most important driver of societies.

Main drivers: economic growth, consumerism

**Passivity and chaotic collapse:** This pathway describes a world where society was not able to address the impending environmental and energy problems. Societies ultimately fall economically and politically. It emphasises the consequences of a collapse of every type and the inherent uncertainty and need to quick adaptation in an unstable world.

Main drivers: extreme energy scarcity and climate change, economic and political collapse

**Cooperation and degrowth:** In this pathway the prospect of environmental and economic collapse leads people and countries to cooperate to properly manage the global commons. This necessarily involves drawing back the economic output to a level consistent with sustainability. People consume and travel less, incentivised by various policy incentives concerted at international level.

Main drivers: economic de-growth, international cooperation

**Smart & Spiritual:** This pathway emphasises the consequences of a shift of social preferences and culture towards different values, less focused on material things and more focused on immaterial spiritual satisfaction of all kinds. It is a more rational world, where people highly value long-term issues like health and safety.

Main drivers: rise of spiritual needs as opposed to material consumption

### 6.4. How factors play in each pathway

In this section we describe in detail how all considered factors evolve in each pathway.

The pathways chosen are not meant to be exhaustive on the possible combinations of factors. It would be possible for example to have a pathway where technology solved the energy and environmental problems (like Unlimited) but still had a drift towards lower consumerism and smarter and higher spiritual preferences (like Smart & Spiritual). But it would have been difficult to see preference characteristics of Unlimited in any other scenario. The objective, again, is to make the pathways diverse enough in order to draw borders of plausibility.

The table below describes the behaviour of each factor of evolution within each pathway. The signals indicate the direction of the factor. The shaded cells make a distinction between more decisive factors in the definition of the course of each pathway and the remaining factors, which are considered to be mostly driven by the decisive factors.
Table 4 – Direction and decisiveness of key factors within the FUTRE demand pathways

<table>
<thead>
<tr>
<th></th>
<th>Unlimited</th>
<th>Passivity and Chaotic Collapse</th>
<th>Cooperation and De-growth</th>
<th>Smart &amp; Spiritual</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Social</strong></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Demography:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Population growth</td>
<td>+</td>
<td>+</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ageing</td>
<td>+</td>
<td></td>
<td>+</td>
<td></td>
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<tr>
<td>Global migrations</td>
<td>+</td>
<td>+</td>
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<td></td>
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<tr>
<td>Living place flexibility</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Education and social capital:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level of education</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Equality of cultural capital</td>
<td></td>
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<tr>
<td><strong>Preferences and awareness:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumerism (VS spiritual needs)</td>
<td>+</td>
<td>+</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Environmental awareness</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Propensity to own VS share use</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social significance of travel choices (status)</td>
<td>+</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Value of doing tasks while travelling</td>
<td>+</td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Rationality of choices</td>
<td>-</td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Value of safety</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value of health</td>
<td></td>
<td></td>
<td></td>
<td>+</td>
</tr>
<tr>
<td>Value of free time and leisure</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More virtual than physical relations / communication</td>
<td></td>
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</tr>
<tr>
<td><strong>Technological</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to address energy, environmental and ageing challenges by technical developments</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Economical</strong></td>
<td></td>
<td></td>
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</tbody>
</table>
### Economic Development

<table>
<thead>
<tr>
<th>Factor</th>
<th>+</th>
<th>-</th>
</tr>
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<tbody>
<tr>
<td>Level of economic growth</td>
<td></td>
<td></td>
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<tr>
<td>Economic stability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Volume of international trade</td>
<td></td>
<td></td>
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<tr>
<td>Economic equality</td>
<td></td>
<td></td>
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</tbody>
</table>

### Production and Consumption Patterns

<table>
<thead>
<tr>
<th>Factor</th>
<th>+</th>
<th>-</th>
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</thead>
<tbody>
<tr>
<td>Share of knowledge based work</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchasing channel paradigms (P2P and e-commerce VS local commerce...)</td>
<td></td>
<td></td>
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<tr>
<td>Scale of production: mass VS customised</td>
<td></td>
<td></td>
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<tr>
<td>Paid work time reduction</td>
<td></td>
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</tbody>
</table>

### Energy

<table>
<thead>
<tr>
<th>Factor</th>
<th>+</th>
<th>-</th>
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</thead>
<tbody>
<tr>
<td>Fossil energy scarcity – prices</td>
<td></td>
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</table>

### Urban Development

<table>
<thead>
<tr>
<th>Factor</th>
<th>+</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urbanisation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban density</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Congestion</td>
<td></td>
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</tbody>
</table>

### Environmental (perceived problem of...)

<table>
<thead>
<tr>
<th>Factor</th>
<th>+</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiversity and other environmental issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Local pollution (air, noise)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Political

<table>
<thead>
<tr>
<th>Factor</th>
<th>+</th>
<th>-</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global cooperation on global issues</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power of the State</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power of the people and civil organizations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>International conflicts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security concerns</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market liberalization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure development</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**  
+ (-) indicates a positive (negative) evolution of the factor  
Shaded cells indicate decisive factors in the development of the scenario
7. EXPLORING IMPACTS ON TRANSPORT - APPROACH

Tasks 3.2 and 3.2 of FUTRE will respectively explore impacts on transport respectively in the scope of passenger and freight. Their main tasks are the following:

a) Identifying specific pathways/consequences for passenger and freight transport;

b) Identifying challenges for the industry (specific for each scenario and general);

c) Providing inputs for WP5, particularly the modelling exercises.

In the scope of the first activity, a list of key issues specific to transport futures will be identified. These are issues relevant to the transport industry and for European policy making. They are distinguished from the key factors identified in this report in that they go into more detail in exploring specific consequences of relevance for the identification of challenges and quantitative modelling exercises in WP5. Some factors may coincide with the global factors previously identified.

Plausible behaviour of each factor within each of the global pathways will be assessed. In this way, each global pathway will originate a more specific transport related pathway featuring concrete consequences for transport systems and European Competitiveness. Like in the global pathways, the choice of behaviour for each factor should be consistent and should aim to cover the limits of plausibility. A storyline will be made for each pathway.

The specific pathways, and the consideration of insights already presented in this report and others that may be added, will be the basis for the identification of challenges for the European transport industry. The challenges to identify are of two types:

- Challenges related to each specific pathway
- General challenges considering the uncertainty about the future

Both the pathways and challenges identified here do not correspond to the final pathways/scenarios and challenges of the project FUTRE. They are a first iteration considering the transport demand side issues only.

To deliver usable inputs for WP5, a table comprising input variables of the ASTRA model will be filled in with information that can be translated into quantitative inputs in the model.
8. REFERENCES


