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STOA Project
The Future of European Long-distance Transport

Background paper for the Project-Workshop on 28.03.2007 at Brussels

Trends and targets for a 2047 scenario of long-distance transport

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Chapter 1 Objectives of Project and Background Paper

After the publishing of the last IPCC report on climate change in January 2007 there are nearly no doubts left regarding an upcoming period of global warming. It is evident that the reasons are the greenhouse gas emissions induced by human activities. In consequence, transport related GHG emissions are discussed intensively in the public sphere. At the same time, the extraordinary high oil prices as well as corresponding political instability in important oil-exporting countries made us aware that nearly the entire transport sector depends on oil – a finite fossil resource.

Despite of these developments, oil consumption and GHG emissions in the transport sector are still growing on a global scale. During the last decades the European transport sector has been characterised by an impressive increase in overall transport volume and by exceeding growth rates in road and air transport. Policy papers and statistical reviews indicate that this trend will go on in an even intensified way. Important driving forces are the enlargement of the EU, the expansion of the economy in modern societies and an improvement of the general standard of living. An efficient transport system plays a key role for economic growth and social wealth in modern societies. But the increase in congestions and bottlenecks in the European transport network restricts the free flow of goods and people especially in the centrally located and densely populated regions of the European Union. Such trends run counter the Lisbon strategy, which aims to make Europe the most competitive, and the most dynamic knowledge-based economy in the world – by 2010. At the same time, the increased amount of traffic has led to a strong reduction of the quality of life because of the large environmental consequences including emissions of air pollutants and noise as well as reduced spaces for living and the segregation effects caused by the expanding transport infrastructure. So, paradoxically one of the basic pillars of today's quality of life at the same time reduces that quality.

Below the line, the future of European transport will face a wide range of challenges if you look at it from various points of view. Transport is going to be on the European Parliament´s agenda in the years to come. Considering this background, the STOA project on "the future of European long-distance transport" aims at focusing on the challenges mentioned above in order to contribute to transparency and improved governance in this highly complex field. The project will work out a scenario for a sustainable, efficient and less oil dependent European transportation along with related policy options. The timeline for the scenario process is 2047. The focus is on long-distance transport including both passenger and freight transport. This focus excludes urban transport that is of different character under several aspects. Innovative technologies, in particular such as intelligent transport systems (ITS), modern infrastructures as well as cleaner fuels and propulsion technologies will be central elements in the scenario process. The project itself is divided into three phases:

1. “Scoping” workshop at the European parliament (Dec 06 – March 07)
2. Scenario building by an expert panel (April 07-March 08)
3. Optional phase: Citizens´ Consultation (January 08 – July 08)

The workshop in phase 1 should be useful as a basis for the scenario process conducted in phase two of the project. More precisely, the workshops aims at defining targets for the year 2047 as well a number of key-trends that should serve as a sort of backbone for the scenario process. It will be discussed with MEPs and experts what targets should be defined and what trends should be considered as being relevant for the scenario. Results of the workshop will be absorbed and further elaborated in a working paper that will be the basis for the process of the scenario building starting in summer 2007. The method will be based on an expert-working group in combination with extended expert meetings and peer sessions. The expert group will draft the scenario, which will be peer reviewed by a broader group of experts. A final report will present the scenario and a discussion of the implied trade-offs. A possible phase 3 of the project may consist of adding a cross-European citizens’ assessment of the scenario.

This paper is the background paper for the scoping workshop in phase 1 of the project. It provides a mapping of the policy field from different perspectives. It describes briefly the key-documents for European transport policy, which are the Commissions White Paper (WP) from 2001 and the related Mid-Term-Review (MTR) from 2006. It further gives an overview on central technological developments in the transport sector. In the final chapter it suggests some targets and formulates some key trends that might be suitable for the scenario process. The scoping workshop on 28.03.2007 will discuss and validate this targets and trends.

Chapter 2 Focus on Long Distance Transport (LDT)

It was decided that this project should not focus on transport in general but on long-distance transport (LDT). Several reasons of different character contributed to this decision, amongst them:

- A growing EU with new Member States goes along with the growing importance of long-distance transport. Considerable economic growth in central Eastern Europe will contribute to this.
- In the last decades, long-distance trucking has been a keyelement for economic growth.
- Long distance transport includes air transport: aviation provides for the largest growth rates in terms of passenger-kilometres, GHG-emissions and fossil fuel consumptions.
- It is discussed that long-distance transport has a huge potential for improved energy efficiency through improved intermodality.
- Increasing oil prices might bring more attention to rail and ship transport.

No clear definition can be found on what exactly is long-distance transport and what is not. Therefore, the following qualitative and quantitative indication will be used to identify long-distance transport. Quantitatively, in this project long-distance transport is characterised

- by distances of more than approx. 500 km; this definition is used in the MTR (Page 10); further it eliminates transport that takes place inside larger agglomerations. LDT should clearly exclude urban transport.
- by a travel time of more than 5 hours;
- by cross-border traffic; this highlights the European dimension and reveals challenges and problems coming up from different regulations and policy frameworks in European countries.

It should be discussed if all 3 criteria or only one or two of them have to be fulfilled for the identification of LDT.

From a more qualitative perspective, the following reflections related to long-distance transport (LDT) and short-distance transport (SDT) might be useful:

- Short distance transport often goes along with urban transport that faces its special set of measures that can not directly be transferred to longer distances. Such measures are, for instance, clean air areas in city centres, parking fees, improved public transport and cycling; optimised land-use planning. Typically, measures related to urban transport policies are not designed to tackle the challenges of long-distance transport.

- In principle, there is nearly no commuter traffic in LDT, but a lot of business and leisure journeys. Commuter traffic is a typical element of rush hours in urban agglomerations.
- Individualisation of life styles is a prominent factor for SDT but less relevant for LDT; at least when freight transport is concerned. There might be some relevance when it comes to demographic developments, such as the aging of society that goes along with retired persons who are more mobile and which induces leisure traffic in the LDT category.
- In terms of alternative fuels and propulsion technologies LDT has to be treated differently from SDT; for the latter electric engines would be an alternative no matter if they are powered by fuel cells/hydrogen, by batteries used as a component in a hybrid system or solely by batteries. For long distance trucking other alternative fuels must be used. For ship, rail, and air transport the options are different as well.
- In the rail sector, LDT faces different problems from SDT: exact timing in the range of minutes is less important whereas capacities and prices and reliability gain on importance. Major bottlenecks are not only related to urban areas but as well to the "hinterlands" of important harbours such as Rotterdam or Bremerhaven. A crucial point is the crossing of borderlines since this generally means moving from one technical and regulatory system to a different one.
- The air sector consists nearly exclusively of LDT.
- Ship transport is mainly focused on freight transport and not on passengers.

Chapter 3 Key-trends and measures described in WP and MTR

3. 1 Growing demands and overloaded capacities

Over the last decades, transport volume in Europe has increased rapidly in relation to all modes of transport such as road, rail, air and shipping (see figure 1). Especially freight transport volumes grew in the last decade - by 43% since 1992 - but similar figures can be found for passenger transport in many areas. According to the WP, the MTR and the Assess study the rapid growth in transport volumes is likely to go on over the next decades. In relation to the time span 2000-2020 the following key trends can be found as a baseline in the MTR (EC, 2006, 26):

- GDP + 52%
- overall growth in freight transport 2000-2020 +50%
- overall growth in passenger transport 2000-2020 +35%
- Road freight transport: + 55%
- Road rail transport: + 13%
- Short sea shipping: + 59%
- Inland navigation: + 28%
- Private car: + 36%
- Rail passenger transport: +19%
- Air passenger transport: + 108%

According to Rothengatter, the following driving factors and determining factors for growth in the transport sector can be identified:

- "Tourism will be the main driver of passenger transport, while travel motives such as business or visits to friends and relatives are less dynamic." (Rothengatter 2006,6)
- Main reasons for growth in freight transport will be increasing trade on European and on global scale along with industrial exchange (ebd. 2006,7).

Increasing energy consumption and GHG emissions are linked to such growth rates, at least in a business-as-usual scenario. Furthermore, there is a growing need in extending infrastructure capacities in order to avoid massive congestions. In this context it is not surprising that congestion is a central issue in both the MTR and the WP: "If most of the congestion affects urban areas, the trans-European transport network itself suffers increasingly from chronic congestion: some 7.500 km, i.e. 10 % of the road network, is affected daily by traffic jams.” (EC, 2001, 12). Various calculations indicate that congestion has a large impact in the terms of economy. Looking at road transport, it gets increasingly difficult to meet the required just-in-time principle because of these heavy congestions on the motorway, especially in central Europe. For example the German carmaker Porsche recently decided to switch to rail transport on highly frequented corridors.

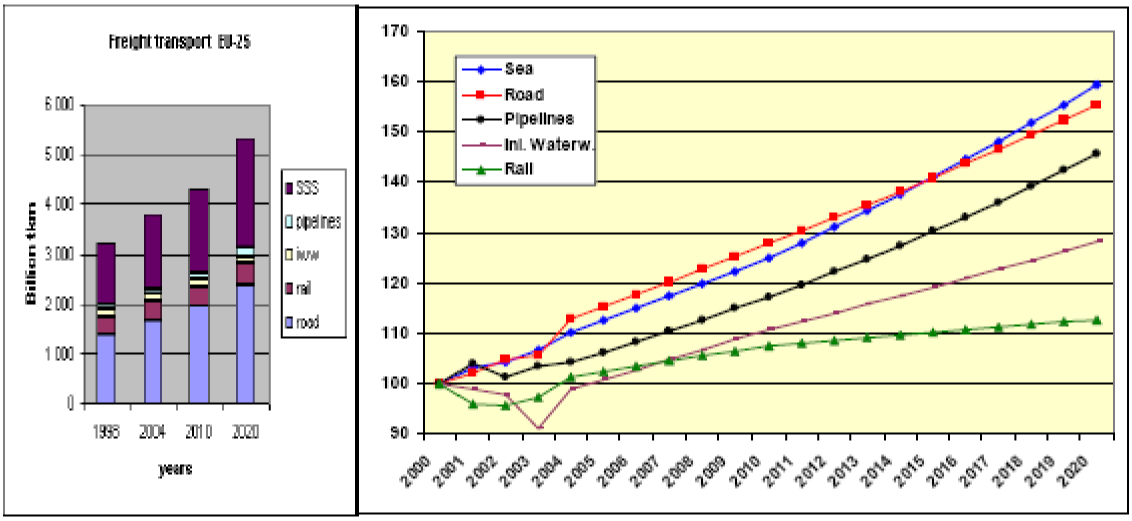

Figure 1: growth rates in freight transport (source: EC 2006a)

In particular growth rates in the air sector are conspicuously high and have led to saturation related to airport infrastructures. Not only passenger but also freight transport becomes increasingly attractive for air carriers (see figure 2). Also on a global scale, airborne cargo is growing rapidly and represents a remarkable large and growing share of trade by value. Hummels (2006, 5) identifies factors which are of special importance for this trend: “Timely delivery has become more valuable, the absolute and relative cost of air shipping has declined precipitously, goods are getting lighter, and consumer incomes are rising, especially at the upper end of the income distribution.”

Obviously, already today there is a gap between the growing demand and the infrastructural needs. For the scenario process in this project it is important whether this gap will either go on growing or can be diminished or even be closed in the decades to come. In the next chapters, some measures form the WP and the MTR, which aim at closing the gap, are mentioned.

	1980	1985	1995	2000	2002	2004	Annualized growth rates
North America							
Within North America	57	64	52	317	276	258	6.5
with Europe	725	1027	1595	2764	2594		6.0
with Asia	190	346	1030	2259	3345		13.9
with Central America	108	113	98	337	361	156	1.6
with South America		194	146	406	600	1086	9.5
with the Middle East	24	34		85	59		4.2
with Africa	9	11	10	18	17		2.7
Europe							
Within Europe	586	654	1011	1414	1264	2036	5.3
with Asia	216	305	1290	2530	3029	3343	12.1
with Central America	27	40	100	141	145		8.0
with South America	101	110	114	320	234		3.9
with the Middle East	256	372	337	583	716	908	5.4
with Africa	389	434	382	602	588	591	1.8
Others							
Within Asia	114	232	1545	2104	3886	5386	17.4
North America Domestic			1749	7847	8767	9649	20.9
Europe Domestic			318	340	280	263	-2.1
Asie Domestic			1404	2402	2535	2490	6.6
World	3258	4674	12575	26896	31793	36111	10.5

Figure 2: Air cargo by region (thousand tonnes carried)
(Source: adopted from Hummels 2006; IATA World Air Transport Statistics, various years.
Annualized growth rates are calculated from first to last year available in each row)

3.2 Focus of the WP: A shift to rail and ship

The White Paper proposes 60 measures to overhaul the EU's transport policy in order to make it more sustainable and avoid huge economic losses due to congestion, pollution and accidents. It identifies as a main reason for Europe's transport problems an imbalance regarding the modes of transport along with a lack in connectivity between the single modes. Therefore, the key objective of the WP is to shift the balance between modes of transport and to improve intermodality. Two priority corresponding objectives are mentioned (EC 2001, 21):

1. regulated competition between modes: the growth in road and air traffic should be brought "under control", and rail and other environmentally friendly modes given the means to become competitive alternatives.

2. a link-up of modes for successful intermodality.

In other words this means fostering the modes rail and water transport since these seem to have a potential to enlarge capacities and to increase overall efficiency of the entire transport system. This is of special interest for this project since advantages of rail and shipping in terms of efficiency and environmental impact are most often indicated for long-distance transport (see TERM 2007, 12). In relation to rail transport the WP formulates the following "fiction or prediction for 2010"

Fiction or prediction? Rail transport in 2010 (WP, 2001, 33ff)

The *railway companies* enjoy access to the railway network on equal terms, published by the infrastructure managers: capacity is allocated in real time with reference to the entire European network, and charging principles are harmonised.

Railway equipment manufacturers ought to be benefiting from the introduction of Community provisions on the

interoperability of the railway system to gain non-discriminatory access to the European market and enjoy the possibility of using innovative technology rapidly.

Engine drivers can drive anywhere on the trans-European network and are trained for European routes at European training centres open to all railway companies.

The *national infrastructure managers* are organised at European level and jointly decide the conditions for access to the network. Observing the competition rules, they decide on investment priorities together and establish a dedicated infrastructure network exclusively for goods.

The *railway regulators* meet regularly to exchange information on the development of the rail market and propose measures to adapt to competition from other modes.

All *rail operators* offer travellers integrated online services covering information, bookings and payment for both leisure and business travel.

The European network offers high safety standards, backed up by a Community structure responsible for ongoing appraisal of safety levels in the European rail system and for recommending any improvements necessary. An independent body investigates any accidents or incidents on the network and makes appropriate recommendations to reduce the risks.

Train punctuality is guaranteed and passengers and customers receive compensation if trains run late.

Average speeds for international goods trains in Europe are up to 80 km/h, four times faster than in the year 2000.

It is surely not possible to turn that fiction into a prediction until 2010 since there are only 3 years left. But the central question in this context is whether the illustrated fiction could serve the 2047 requirements.

Regarding shipping the WP highlights the huge potential of Intra-Community maritime transport and inland waterway transport: “Up until now these two modes have been underused, even though the Community has huge potential (35 000 km of coastline and hundreds of sea and river ports) and virtually unlimited transport capacity.” (EC 2001, 41). In addition, the WP points at the fact that ships carry about 70% of all trade between the community and the rest of the world. Short sea shipping offers a comparatively good performance in terms of energy balance and emission of pollutants and is considered as being a competitive alternative to land transport. “In terms of energy efficiency and the weight of goods which can be moved one kilometre by one litre of fuel, the figure for road haulage is 50 tonnes, for rail haulage 97 tonnes and for inland waterways 127 tonnes.” (EC 2001, 41). A key notion is developing so-called “motorways of the sea”. In order to establish such a trans-European shipping network priority should be given at a national level to ports which have a good connection to the inland network.

The second priority of the WP concentrates on a link-up of modes for successful intermodality. A broader range of measures is described; a key element surely is the programme Marco Polo which was proposed in the WP and launched in 2003. It puts the focus on goods traffic and aims at inducing a shift of goods transport from road to water and rail by supporting intermodal initiatives and alternatives. Among them are technical measures on containers, loading units and measures that focus on the standardisation of containers and swap bodies. The importance of such measures can not be underestimated, since, apart from some exceptions, the only mode of transport that is able to serve directly between sender and addressee, or form door to door respectively, is road transport. Transport via air, sea and rail in general, needs at least one change in mode at the port, airport or train station. The practicability and efficiency of such modes is of utmost importance for their performance.

The central importance of road transport is recognised by the WP. Road transport offers a high degree in flexibility at comparatively low costs, which makes it highly interesting especially for goods transport. The WP states: ”This sector is irreplaceable but its economic position is shakier than it might seem.” (EC 2001)

3.3 Focus of the MTR: Optimising the single modes of transport

However, in the time span between the publishing of the WP in 2001 and the publishing of the MTR in 2006 there are no figures indicating a modal shift away from the road. On the contrary, road transport gains in both, relative and absolute numbers. In consequence, the MTR points out that the measures described in the WP five years ago are not sufficient to fulfil the WP goals. The MTR moves away from the modal shift paradigm towards the notion of co-modality which means that the single modes of transport should become optimised. “The MTR modifies the modal shift aim so that it is now stated that a shift to more environmentally friendly modes should be sought 'where appropriate'." (TERM 2006, 9). It is discussed that there have been not enough activities in the rail sector during the last 5 years. However, other observers point out that much more time is needed to change a structure that has been built over several decades.

Annex 1 gives an overview on the actions that are included in the MTR. At least the following main categories can be distinguished:

- Financial instruments;
- Policy instruments (regulations, directives);
- Technologies that can be summarised under the umbrella of ITS;
- Alternative fuel and propulsion systems.

Many of these instruments aim at harmonising technical and regulative systems in different countries and thus, at eliminating barriers that especially cross-border transport is facing. Prominent examples are harmonisations in the air (SESAR) and rail sector (ERMTS). Another focus is on enabling competition in a free market. Further, and in contrast to the WP, energy related issues are reflected in the MTR.

The MTR asks in a more general way for a broad debate on transport scenarios with a time horizon between 2025 and 2045. The current STOA project fits well with this appeal. However, this claim for further debates can as well be interpreted as a hint that the MTR does not fully believe in its own set of measures – given the dramatically growing demands in transport described in the beginning of chapter 3.1.

3.4 Energy security and climate change in WP and MTR

In principle, there are three basic options to reduce oil consumption and GHG emissions in the transport sector

- technical measures, such as establishing cleaner fuels and propulsion technologies or increasing efficiency;
- reduction in transport demand;
- a shift from less efficient to more oil-efficient modes of transport.

The White Paper with its strong focus on modal shift only implicitly addressed the interdependence between transport and energy consumption. This reflects the global situation of the late nineties with low oil prices and a continuous phase of geopolitical stability (see Schippl/Fleischer/Dieckhoff 2007). Since the beginning of this decade, the development has somewhat changed – issues of energy security, and especially security of oil supply, returned on the agendas of policy-makers in the European Union and its Member States. This is due to a number of current developments. The recently surging oil demand in large economies such as China, India or the USA has reduced spare capacity. The instability in some key producer countries (Iraq, Iran, Venezuela, Nigeria) has continued and increased, especially after the events of September 11, 2001 and the following military actions. At the same time, the oil infrastructure has become a new target for – and more vulnerable to – terrorist attacks. Recently, issues such as the general finiteness of fossil resources or the peaking of world oil resources are at the centre of many energy-related discussions. As a result of these trends, oil prices rose from a historical low of around $10/bbl in 1999 to well above $70/bbl in 2006. These developments may have significant implications for the transport sector in general and for EU transport policy. This can be illustrated by Commission and industry statistics:

- Recently, the transport sector in the EU has been 98% dependent on oil and accounted for 71% of all oil consumption and 30% of total energy consumption in the EU;
- 45% of EU oil imports originate from the Middle East; by 2030, 90% of EU oil consumption will have to be covered by imports;

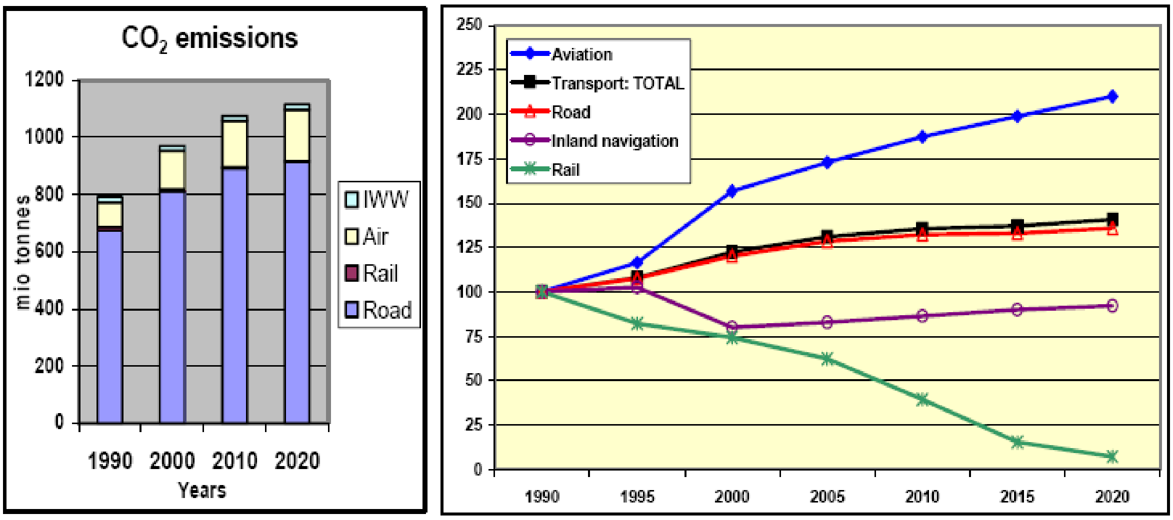

Figure 3: Expected evolution of CO2 emissions from transport by mode (1990 = 100)
Source: EC, 2006, 28. PRIMES model

So, in the meantime it is obvious that technological alternatives to replace oil in transport are urgently needed as well.

An evaluation of the future European oil supply can be found in Annex 2 of this paper. This evaluation concludes, that a parallel push on increased fuel efficiency and use of alternative motor fuels is urgently needed. A discussion of exactly when global oil production will start to fall might be less important than realizing that global oil consumption is already now on a trend that cannot be sustained for decades and that the time needed to adjust our transport system is longer than the time horizon for 'comfortable oil', writes Jorgen Henningsen, senior advisor for European Policy Centre

The EU has started a number of research efforts such as technology platforms (on biofuels, hydrogen, etc.) to address the tremendous technological challenges that are linked to the development and diffusion of new alternative fuels and power train technologies. For the first time the MTR introduces a section on energy and demonstrates figures on CO2 emissions (see figure 3). It recommends actions to be taken on various fronts, such as increasing energy efficiency in transport by reducing fuel consumption, supporting research, and bringing mature new technologies to the market through standard setting and regulations. The MTR also recognises that much is still to be agreed at EU level. However, new initiatives are under way: for example the EU demands in its Energy Packet a mandatory target of 10% of the European fuel consumption to be covered by biofuels in 2020.

Recently the issue of transport related GHG emissions strongly gained on importance. The reason is the IPCC reports on global change that was published in early 2007. It stresses that there is a very urgent need to take action. At the moment, it looks as if a reduction of CO2 emissions will be adopted by the EC-members. The discussed target is a reduction for 20% in 2020 compared to 1990. However, consistent policy instruments are needed in order to materialise such targets.

Chapter 4 Key-technologies: ITS, infrastructure and cleaner fuels

A wide range of technologies to tackle Europe transport problems is being discussed. This chapter will provide a closer look on certain technologies and instruments, which are considered as being of special relevance for this STOA project and thus/therefore for the scenario building.

4.1 Intelligent Transport Systems (ITS)

The objective of a flexible and efficient use of the existing infrastructure is mainly driven by two factors: the combination of increasing traffic volume and budget restraints in many European countries. Secondly, new options offered by technological progress and by breakthroughs in the field of Information and Communication Technology. Prominent examples are the real time information for public transport passengers, intelligent infrastructure such as dynamic speed control on highways or the development of the Galileo satellite navigation system and its potential applications for both individual navigation and collective transport management or road pricing. Intelligent transportation systems (ITS) or telematic systems encompass a wide range of wireless and wire line communication-based information and electronic technologies. They can contribute to tap the full potential of the existing infrastructure. Looking at the purpose of the systems ITS /telematics can be divided into the following categories:

- Collective systems for intelligent infrastructure (mainly road transport);
- Systems used for public transport and freight transport in bus, rail, air;
- Intelligent systems for individual vehicles.

ITS is strongly related to optimised infrastructure under different aspects: It enables an optimised use of infrastructure in terms of capacities and it enables new options for financing infrastructure – which can as well lead to an extension of capacities. Apart from that other benefits are related to improved security and improved environmental performance. ITS technologies focus on better organisations of transport through information and communication; on the steering of traffic flows and an optimised use of infrastructure capacities; on optimising logistic chains in freight transport. So, there are different applications for the single modes of transport as well as for passenger and freight transport. The following examples might become relevant for a 2050 scenario:

- Road pricing schemes tend to become a more widespread means to finance infrastructure and to control traffic flow.

- Train management systems (ERTMS) aim at improving interoperability between national networks. It is crucial to ensure an efficient long-distance transport on the railway lines in Europe. ERTMS which includes the European Train Control System (ETCS) is a key technology for an integrated and efficient rail transport in Europe
- Further, in the rail sector, ITS will enable the introduction of modern technology to substitute the hundred years old block-based system for organising the traffic on the tracks. Such a "revolution" would enlarge capacities considerably.
- The river information system (RIS) follows a similar approach for water transport.
- One single European sky for air transport: SESAR (Single European Sky ATM Research Programme) is an initiative that was setup by the European Commission to reach certain standards of harmonisation in European aviation. In this context it should be noted that air cargo is gaining market shares.
- More flexibility in logistic chains will be enabled by RFID technologies.
- The Galileo Navigation System will be useable in this context from approximately 2010 on. It will provide for a wide range of options to improve the coordination and management of transport in Europe.

The following examples from countries outside the EU could as well be interesting for the scenario process (see Halbritter et al. 2005).

- USA: Since 2003 charging of all vehicles via GPS is tested in the US State Oregon
- USA: High occupancy lanes become established in several sates
- South Asia / South-East Asia: In many states road pricing is a common tool used for the financing of urgently needed infrastructure.
- Korea: Congestions pricing in Seoul
- Singapore: Electronic Road Pricing (ERP) is aimed at managing transport demand through road pricing. Today, major city axes, arterial roads and expressways use ERP to regulate traffic flow and congestion through differentiated pricing measures.
- Japan: Integrated railway system

4.2 Extending infrastructure and removing bottlenecks: examples

According to the Eurostat yearbook the length of the European motorway network has more than tripled over the last 30 years. Within the EU15 the motorway network grew from 45.264 km in 1995 to 53.267 km in 2002, which is approx. 18% in 7 years. However, in the same period the German network grew from only 11.190 to 12.037 and the Italian one from only 6435 to 6478km. This illustrates that a large part of the overall growth did not take place in the very central European countries such as Germany, Northern-Italy or Austria which suffer most from the strong increase in East-West traffic induced by European enlargement. Furthermore, it goes without saying that increasing kilometres of road network do not automatically mean an increase in capacities and accessibility. The crucial point is to remove bottlenecks that restrict the growth in capacities of the overall network. Some examples are given here:

- A central problem is the hinterland of larger seaports. The amount of goods that is being dealt with in ports and hinterland is growing rapidly. As mentioned above, around 70% of the EU's trade with other countries is transported via sea. New solutions are required, amongst them the establishment of railway lines that are exclusively or at least partly reserved for freight transport. Other innovative solutions are being discussed. For example, a recent study looks at the feasibility of double-deck container transport by rail on selected routes within Germany. This is connected to plans that call for a network of double-deck containers to be set up in the hinterland of Germany's seaports which could mean a relatively cost efficient way of extending capacities (Koch, 2006, 526).
- New ports for large containers (13.000 TEU). Because of the rapid increase in long-distance container transport an extension of port infrastructure is needed. First of all, investments in deep sea ports will be necessary to handle the new mega-liners that up to now are not able to go into the large European ports such as Antwerp, Hamburg or Rotterdam. These mega-liners can have 13.000 TEU on board which extends older standards heavily.
- Another central problem are large mountain areas such the Alps or the Pyrenees. The construction of tunnels is a crucial element in such regions. For example, in the near future, the 35 km long Switzerland's Lötschberg base tunnel will be put into operation as the first of such rail tunnels across the Alps. It will notably augment the freight transport capacity and reduce journey times for long-distance passenger service (Anreiter, Barth 2007).
- Regarding inland water lines, high expectations are related to the upgrading of the Rhine-Main-Danube canal. This canal connects the river Danube with the North Sea and could serve as a perfect backbone for the European waterway-network.

However, these plans have to overcome many obstacles (technical, but also environmental, political and financial).

- Improved airport capacities for the growing demands also in freight transport are required urgently.

A central element of the Commissions strategy to remove such bottlenecks and enlarge capacities is the TEN-T network concept: 29 corridors plus the satellite navigation system Galileo were identified as being of particular interest for Europe. 75 projects along these corridors are considered as being important. It includes upgrading and building new airports, new high-speed railway lines, motorways of the sea and many other projects. The TEN was originally launched in 1996. This first phase was not to successful, so the program was updated in 2004. In the meantime the EU finances up to 30 percent of investment costs for cross-border projects, and 50% of planning costs. Such measures include facilities that help to improve intermodal transport chains.

Apart from these examples of extending the existing infrastructure another crucial issue is the maintenance and modernisation of existing infrastructure. "Reflecting the fact that politicians in general prefer to launch new projects rather than upgrade existing ones, it is safe to assume that even in periods of scarce budget funds, new projects are still preferred and upgrading, reinvestment and maintenance is neglected." (Rothengatter, 2006, 16)

The bottlenecks mentioned above are mainly related to geographical parameters. At least of the same importance are logistic bottlenecks, whereby the most crucial point is the shift of goods from one mode of transport to another, e.g. form truck to train, from train to ship or others. Technical improvements that allow more efficient operations at such interfaces are of utmost relevance for the success of intermodal transport chains. There is still a large potential for highly profitable innovations in this area. For example, advanced ITS together with RFID-technology could significantly facilitate competitiveness of intermodal logistic chains.

However, for example the TERM (2007, 12) report indicates, that improvements in one mode such as the rail sector, might attract additional transport and thus increase the overall volume instead of decreasing road transport. This illustrates that transport demand is a highly flexible factor.

4.3 Cleaner fuels and propulsion technologies

A wide range of non oil-based options for road and air transport has been developed in the last decade, and some technologies are already commercialised. However, it is currently impossible to predict which technologies will emerge as the front-runners for Europe. Five technological mainstreams are discussed today, mainly in relation to passenger transport (Schippl et al 2007; JRC 2006):

1. Hydrogen and fuel cells
2. Hybrids
3. Battery Electric Vehicles
4. Biofuels
5. Natural Gas and LPG

In the long run, hydrogen combined with fuel cells seems to be a promising technology whereby serious technological problems remain unsolved, amongst them for instance questions concerning the performance of fuel cells, or from where large amounts of “clean” hydrogen may be taken. Different routes are being discussed including the generation of hydrogen from natural gas, from renewable sources, from coal and from nuclear power. Recently, the only affordable way of large-scale hydrogen production is via steam-reformation from natural gas. From a mid-term perspective, this route might support the market penetration of hydrogen and of fuel cells. The crucial point is that, in this case, hydrogen is derived from a fossil source. Hydrogen production from renewable sources (wind, photovoltaic, solarthermal, water) via electrolyses is often regarded as a kind of silver bullet since it enables close to zero emissions of greenhouse gases (GHG). But it is not clear if, at which time, and in which regions the production of hydrogen from renewable sources will be feasible at larger scales and at reasonable costs. A “clean” production of hydrogen from nuclear power is feasible as well. Controversies are related to nuclear power itself and to the finiteness of uranium resources. In terms of climate security the coal-route will be only suitable if it is combined with CO_2 sequestration and storing (CSS) – a technology that is still in the stage of basic research.

Hybrid technology is currently high on the agenda and extends its market shares. It offers a possibility to save energy and emissions by using established technologies and infrastructures. Whatever fuel and propulsion technology will be dominant in 20-30 years, it seems to be highly likely that hybrid technology will be part of the propulsion system. It is an important component of most fuel cell concepts and there seems to be a high potential to further improve the efficiency of conventional fuels. This “hybridisation” at the same time means an “electrification” of the drive train technology and, thus, supports a more dominant role of the electric engine in general.

The commercialisation of pure electric cars (Battery Electric Vehicles) strongly depends on the development of suitable batteries. In spite of decades of research and development activities, decisive technological breakthroughs regarding batteries are not in sight. Yet, a surprising breakthrough in battery technology is not completely impossible and would surely entail radical changes to both the transport and the energy sector.

Biofuels can be derived from a wide range of biomass and might serve as a relatively clean "bridging" or "additional" technology. So-called first generation fuels, mainly biodiesel and bioethanol, are the only renewable transport fuel option that is commercially deployed toady. The production process is comparatively uncomplicated. Second generation biofuels are produced by synthesis, in most cases from synthesis gas, which is then treated in a so-called "biomass-to-liquid" process (BTL). A decisive benefit of BTL is the opportunity to define the properties of such "designer fuels" by setting the synthesis parameters; engine and fuel can be very well adjusted to each other. For second generation biofuels the whole plant or other forms of biomass can be used to produce fuel, in contrast to the production of "first generation" biofuels where only parts of the plants (oil, sugar, starch) are used. Biogas as well has the potential to contribute to climate and energy security. Blends with natural gas are imaginable. It is estimated that roughly between 20% and 30% of EU27 road transport fuels in 2030 could be covered by biofuels derived from European biomass (e.g. energy crops, agricultural and forestry residues, organic fraction of municipal solid waste). Imports of biomass are critically discussed since they might go at the expense of ecologically sensitive areas.

Natural gas technology (CNG) is feasible in the transport sector and has the potential to bring at least mid term improvements in terms of energy security and GHG emissions – whereby it is crucial that real "gas-engines" are being developed. But in particular its possible contribution to energy security strongly depends on the overall demand on natural gas. It is likely, that CNG vehicles will become at least established for niche applications (e.g. in larger fleets, in inner cities). Autogas (LPG) is a relatively uncomplicated technology. It offers environmental benefits at relatively low costs. It is becoming rather popular in several European countries. Since both CNG and LPG are based on fossil feedstock they must be considered as bridging technologies. They might help to pave the way for "cleaner" gaseous fuels such as hydrogen, bio-methane or DME.

Hybrids and Battery Electric Vehicles are not suitable for freight transport on roads. The potential of hybrids can only be fully tapped in urban transport and not in long-distance transport. For long-distance trucking biofuels, CNG, LPG or blends of those fuels in combination with improved conventional engines (ICE's) appears to be the most suitable solution at least from a short and mid-term perspective. The situation in 2047 might be different. However, one suitable solution might be to use the restricted potential of domestic biomass mainly for long-distance trucking and other options for urban transport.

Regarding the air sector, presently there can not be seen an alternative propulsion system to the gas turbine. Research on alternative fuels and alternative fuel sources as well as on new propulsion technologies is at an early stage. The same is true for the rail sector where the use of fuel cells is discussed for some special situations. However, regarding the rail sector the central question in terms of energy and climate security is where the electric power is coming form. For ships, hydrogen and fuel cells might be more relevant and first prototypes are being tested.

The technologies mentioned above are all promising but all have clearly weak points and bottlenecks. Each single technological pathway faces difficulties in terms of serving the complete future fuel demand of the EU27. Innovations will be needed in order to tackle the three central challenges in this field: climate change, energy security and competitive challenges. However, in the long run the predicted phase-out of oil would make business-as-usual impossible for all oil-based technological contexts. A phase-out of oil would, at the same time, exert pressure on European innovation regimes – “something new” has to come. Policy strategies should remain flexible and open enough to support ground-breaking innovations (see Schippl et al. 2007).

Chapter 5 Targets and trends for a 2047 scenario

The chapters above described some key-trends of European transport and how they are framed in the WP and MTR. Chapter 4 summarises technological trends which seems to be crucial for the future development of European transport. On that basis, in the following some targets for the year 2047 and some key-trends are suggested as being relevant for the scenario process. At EP workshop on 28.03.2007 these targets and trends will be discussed and modified.

It should be clarified that these trends and targets on the on hand indicate developments which appear to become relevant in the future according what is written in the preceding chapters. That's does not have to mean that these trends have been relevant in the past – focus is on the future. On the other hand it should be noted that these trends and targets must be regarded as an input for the discussion on the EP workshop on 28.03.2007. It might well be an output of this workshop that the trends and targets formulated here have to be changed considerably or substituted by others. But the result of the workshop should be a number of realistic key-trends and targets for the year 2047 which will serve as a sort of backbone for the scenario process.

Targets are both quantitative and qualitative guidelines that the scenario should try to live up to. At least targets for oil consumption, mobility/accessibility and GHG emissions should be suggested. Targets should be ambitious, taking into account what needs to be achieved and what is wished. During the scenario work it might turn out, that some targets are in conflict or can only be achieved with strong political interventions. In a way, this is part of the overall objective of the STOA project.

Possible targets could be:

- In 2047 oil consumption is reduced by 80% compared to 2007 level
- In 2047 GHG emissions are reduced by 60% compared to 1992 level
- In 2047 energy efficiency is increased with a factor 10
- In 2047 travel times for passengers and goods are faster than today
- In 2047 accessibility is higher and more evenly distributed than today
- In 2047 security is higher than today
- Others…?

We suggest the following long-term trends as being relevant for the scenario:

TREND 1: Demand for long distance transport is growing

Important questions: Is it likely that we have the same growth rates until 2047? What are the determinants for the growth rates and how can these be influenced?

TREND 2: Climate changes puts pressure on the transport sector

Important questions: What are the consequences of climate change on the transport sector? To what extent will a "visible" global warming intensify policy activities in the transport sector?

TREND 3: Extension and maintenance of infrastructure: growing need for infrastructure on the one hand, less public money on the other hand.

Important questions: To what extent can capacities be increased by an extending infrastructure? How to technically improve the capacities of the single modes? How can this be financed?

TREND 4: The use of ITS/Telematics will increase

ITS is needed to optimise the utilisation of existing infrastructure and to finance the maintenance and extension of infrastructure.

Important questions: Which technological progress can be expected and how to make use of it? Which new options are imaginable?

TREND 5: Growing importance of intermodal transport

Important questions: What is the potential of intermodal transport? What are the main bottlenecks? Which technologies will improve the interfaces between the modes of transport?

TREND 6: Alternative fuels and propulsion technologies gain market shares

New alternative technologies will enter the market. A diversification of technologies will become visible.

Important questions: Which technologies will be suitable for long-distance transport? How can innovations and commercialisation of new technologies be fostered?

Chapter 6 References

Anreiter, Wilfried; Barth, Markus (2005): Alpentransit – BLS nimmt 2007 Lötschberg Basistunnel Betrieb auf. In: Internationales Verkehrswesen (75), 10/2005, 430-433.

ASSESS (2005): Assessment of the contribution of the TEN and other transport policy measures to the mid-term implementation of the White Paper on the European Transport Policy for 2010'. A study for the European Commission, Directorate-General for Transport and Energy, Unit B1. Main contractor: Transport & Mobility Leuven. Brussels & Leuven 2005

European Commission (2001): "White Paper - European transport policy for 2010: time to decide", COM(2001) 370.

European Commission (2006)a: COMMUNICATION FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT. Keep Europe moving - Sustainable mobility for our continent Mid-term review of the European Commission's 2001 Transport White Paper.

European Comission (2006b) On the Intelligent Car Initiative - "Raising Awareness of ICT for Smarter, Safer and Cleaner Vehicles". COMMUNICATION FROM THE COMMISSION TO THE COUNCIL, THE EUROPEAN PARLIAMENT, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS. COM(2006) 59 final

European Commission (2006c): Biofuels in the European Union – A Vision for 2030 and beyond. Final Report of the Biofuels Research Advisory Council.

European Commission (2006d): An EU Strategy for Biofuels {SEK(2006) 142}; COM (2006) 34.

Eurostat Yearbook 2005: Europe in Figures.

Hummels, D. (Halbritter G.; Fleischer, T.; Kupsch, Chr.; Kloas, J.; Voigt, U.; unter Mitarbeit von Fulda, E. und Gödel, J.(2005): Innovationsstrategien für neue Techniken und Dienste zur

Erreichung einer "nachhaltigen Entwicklung" im Verkehr im internationalen Vergleich. Karlsruhe: Forschungszentrum Karlsruhe (Wissenschaftliche Berichte, FZKA 7157)

2006): Global Trends in Trade and Transportation. Paper presented at the 17th International Symposium on Theory and Practice in Transport Economics and Policy; BERLIN, 25-27 OCTOBER 2006

JRC (2006): Well-to-Wheels analysis of future automotive fuels and powertrains in the European context WELL-to-WHEELS Report Version 2b, May 2006. European Commission, Directorate General, Joint Research Centre (JRC) in cooperation with EUCAR and CONCAWE

Koch, Joachim (2006): Doppelstockcontainerverkehr in Deutschland. In: Internationales Verkehrswesen (58), 11/2006, Page 526-528

Rothengatter, W (2006): International Transport Infrastructure Trends and Plans. Paper presented at the 17th International Symposium on Theory and Practice in Transport Economics and Policy; BERLIN, 25-27 OCTOBER 2006

Schippl, J; Dieckhoff, C; Fleischer, T. (2007): Alternative Technology Options for Road and Air Transport. Final Report of a project commissioned by STOA (Scientific Technology Options Assessment Panel of the European Parliament) and carried out by ETAG (European Technology Assessment Group)- forthcoming.

TERM (2006): Transport and environment: on the way to a new common transport policy. Indicators tracking transport and environment in the European Union. European Environment Agency. EEA Report No 1/2007

Appendixes

Appendix I Overview of actions formulated in the MTR

SITUATION IN THE TRANSPORT SECTOR	
Transport growth The impacts of transport	Action: in order to devise and evaluate tomorrow's policies, stimulate a wide-ranging debate on transport scenarios with a 20 to 40 year time horizon, to develop tools for an overall sustainable transport approach.
SUSTAINABLE MOBILITY IN THE INTERNAL MARKET – CONNECTING EUROPEANS	
Land Transport	Action: examine experience in the internal road market and propose improvements to market access rules and rules on access to the profession where needed; address the issue of excessive differences in exise tax levels; implement the rail transport *acquis* with the help of strong regulatory bodies in the Member States; accelerate efforts to remove technical and operational barriers to international rail activities with the help of the rail industry and the European Railway Agency; examine a possible programme to promote a rail freight oriented network within a broader transport logistics policy; rail market monitoring including a scoreboard
Aviation	Action: continue to monitor the state aid and competition aspects of restructuring and integration; review the functioning of the internal market and propose adjustments where needed; complete the single sky regulatory framework and implement the modernisation of air traffic management; develop policy measures to contain emissions from air transport services.
Waterborne Transport	Action: build on a broad public consultation of stakeholders to develop a comprehensive strategy for a "common European maritime space"; develop a comprehensive European ports policy; action to reduce pollutant emissions from waterborne transport; continue to promote short sea shipping and motorways of the sea, with particular emphasis on landward connections; implement the NAIADES action plan for river transport..
SUSTAINABLE MOBILITY FOR THE CITIZEN – RELIABLE, SAFE AND SECURE TRANSPORT	
Employment and working conditions	Action: encourage training and take-up of transport professions by young people; examine in consultation with stakeholders the rules on working conditions in road haulage and propose adjustments where needed; encourage dialogue between social partners across borders, notably to apply the ILO Convention in the maritime field.
Passenger rights	Action: examine, together with stakeholders, how increased quality of service and assurance of basic passenger rights can be promoted in all modes of transport, notably as regards passengers with limited mobility
Safety	Action: implement an integrated approach to road safety which targets vehicle design and technology, infrastructure and behaviour, including regulation where needed; organise awareness efforts, annual road safety day; continuously review and complete safety rules in

	all other modes; strengthening the functioning of the European safety agencies and gradually extend their safety-related tasks.
Security	Action: examine the functioning and costs of current security rules in air and maritime transport, propose adjustments where needed on the basis of experience and in order to avoid distortion of competition; reflect on need to extend security rules to land and intermodal transport and critical infrastructure.
Urban Transport	Action: publish a Green Paper on urban transport to identify potential European added value to action at local level.
TRANSPORT AND ENERGY	
	Action: promote energy efficiency at EU level on the basis of the forthcoming action plan, encourage EU actions, including voluntary agreements; support research, demonstration and market introduction of new technologies such as optimisation of engines, intelligent vehicle energy management systems or alternative fuels, such as advanced biofuels and hydrogen or fuel cells or hybrid propulsion; launch user awareness actions on smarter and cleaner vehicles and a major future-oriented programme for green propulsion and energy efficiency in transport.
OPTIMISING INFRASTRUCTURE	
Two challenges: reducing congestion and increasing accessibility	Action: encourage and coordinate when necessary investment in new or improved intelligent infrastructure to eliminate bottlenecks and prepare for the introduction of cooperative systems, to enable co-modal transport solutions and to connect peripheral regions and outermost regions with the mainland; ensure a balanced approach to land use planning.
Mobilising all sources of finances	Action: maximise investment in trans-European infrastructure of European interest by mobilising all available sources of financing including the TEN budget, Structural and Cohesion Funds and capital market lending (including from the European Investment Bank, the European Bank for Reconstruction and Development, public-private partnerships); and using common implementation initiatives.
Smart charging	Action: launch a broad process of reflection and consultation on smart infrastructure charging and propose an EU methodology for infrastructure charging that builds on the road charging directive.
INTELLIGENT MOBILITY	
Transport logistics	Action: develop a framework strategy for freight transport logistics in Europe, followed by broad consultation and leading to an action plan.
Intelligent transport Systems	Action: continue intelligent mobility programmes road transport (Intelligent Car Initiative and eSafety), in aviation (SESAR), railways (ERTMS), waterborne transport (RIS and SafeSeaNet); making the best use of Galileo navigation signals, develop further similar initiatives in the maritime field ("e-maritime") and launch a major programme to roll out intelligent infrastructure for road transport.
THE GLOBAL DIMENSION	

	Action: continue to develop differentiated EU transport cooperation and policy and industrial dialogues with main trading partners and regional groupings, including by concluding agreements; continue to develop external relations in the field of aviation building on the forthcoming EU-US aviation agreement; promote the EU's major transport industrial projects; further develop cooperation; review on a case-by-case basis the EU's interaction with international cooperation mechanisms, ranging from better policy coordination over an enhanced observer status to EU membership in relevant international organisations or even special relationships between the EU and such organisations; develop a strategic framework for extending the main axes of the internal transport market and network to neighbouring countries that so wish.

Apendix II What does the future EU oil supply situation look like?

An assessment by Jorgen Henningsen, senior advisor, European Policy Centre

The debate about so-called 'peak oil production' has picked up in recent years, however mainly about whether the combined effect of the size of remaining reserves and reservoir geology will physically restrict possible oil production in a few years time (less than 10) or more likely rather in a 20 years perspective. A discussion of exactly when global oil production will start to fall (since oil is after all a finite resource) might be less important than realizing that global oil consumption is already now on a trend that cannot be sustained for decades and that the time needed to adjust our transport system is longer than the time horizon for 'comfortable oil'.

This is really nothing new. Below are presented the observations and calculations describing the European oil situation. The calculations have ignored one, however important, numerical aspect: The quantity of oil needed to get (decently) out of a certain level of oil consumption. If one assumes, that this would happen through a (demanding) reduction in annual consumption of 2%, the present consumption level of 31 billion barrels pr year corresponds to a need for approximately 1550 billion barrels for the 'exit tail', a quantity well above the 1200 billion barrels recorded as proven recoverable reserves worldwide. With just another 10 years of increased consumption as forecasted, in addition to the cumulative consumption of 335 billion barrels over the 10 years, the 'exit tail' will increase to 1800 billion barrels (because of the higher consumption level, from which to exit). All in all, 2100 billion barrels will be needed, against an (optimistic) expectation of totally 200 billion available. It is worth noting that whereas adding some hundred billion barrels (even 500 billion) to the reserve estimates does change the numbers, the future (or present) supply challenge described above will only move by a few years. Qualitatively the problem remains the same. It is also worth remembering, that some of the suggested 'supply side' solutions (counting on massive production on the basis of tar sands, heavy oil or shale oil) come with a significant CO_2 penalty, not exactly the development to pursue.

It seems difficult to avoid the conclusion that a parallel push on increased fuel efficiency and use of alternative motor fuels is urgently needed.

1 Observation

Oil is traded in a global market. Therefore, the EU as well as US, Japan, China and other oil importers is basically dependent on one global market.

The key numbers

- Present global oil consumption: 31 billion barrels pr. year (85 million barrels pr. day)

- Proven recoverable reserves globally: Approx. 1200 billion barrels (roughly 40 times annual consumption).
- New discoveries over the last ten years: On average around 10 billion barrels pr year.

2 Observation

Because several major OPEC producers report unchanged reserves year after year, in spite of considerable production and no new discoveries, reported global proven recoverable reserves have stayed more or less constant for several years. This reflects the fact, that the size of the larger part of global oil reserves is highly uncertain, officially reported numbers reflecting political priorities rather than geological realities. When in the 1980'es OPEC introduced quota allocation on the basis of reported reserves, many OPEC countries increased their 'proven' reserves in the order of 100% and these numers are more or less unchanged for 20 years (general pattern).

Conclusion

Nobody really knows the quantity of oil available in the reservoirs on which officially reported reserves are based.

More key numbers:

- US Geological Survey assessment (2000) of remaining recoverable conventional oil to be discovered (much of this in the Arctic): Approx. 800 billion barrels
- Expected future growth in oil consumption: 1.5% pr year.

Where does this take us?

<u>In a 10 years time perspective:</u>

- Expected consumption 2017: 36 billion barrels pr year (present consumption + 15%)
- Cumulated consumption 2007 -17: 335 billion barrels
- Assumed new discoveries (at 10 bill barrels pr year): 100 billion barrels
- Remaining proven reserves (if properly adjusted for production): 965 billion barrels

This corresponds to 27 times annual consumption (against 40 times at present).If adjusted for the additional production from unconventional oil (Canadian tar sands) of roughly 2 million barrels per day over present levels, remaining reserves will correspond to 28 times annual production of conventional oil.

Conclusion: This will not lead to physical shortages, but the trend in the ratio between reserves and production (or consumption) is highly worrying. Decline in non-OPEC production would mean a significantly increased dependency on OPEC, particularly Middle east OPEC where most of the remaining reserves are concentrated. Many oil specialists doubt, that a 100 million barrels per day production scenario (corresp. to 36 billion barrels pr year) is at all realistic.

In a 20 years perspective:

- Expected consumption 2027: 42 billion barrels per year
- Cumulative consumption 2007-27: 725 billion barrels
- Assumed discoveries 2007-27: 200 billion barrels
- Remaining proven reserves: 675 billion barrels
- Reserves to production ratio: 675:42 = 16 times annual consumption

Conclusion: This 2027 scenario is unlikely to be allowed to develop, albeit a dream for oil companies or exporting countries holding significant reserves. Continuation of the trend would mean, that all global oil reserves would be gone in approx. 15 years. In addition to political action to be expected, simple reservoir geology would also prevent a development with increased growth as described. Unless action is taken urgently the trend in future oil demand will contrast with supply capabilities way before the 2047 horizon in the STOA project.