

The Future of European long distance transport

Information material for interview meeting

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TEKNOLOGI-RÅDET

Foreword

This information material is produced to support the Interview Meetings on The Future of European long distance Transport. These meetings are part of a project that The Danish Board of Technology is conducting on behalf of the STOA-Panel at the European Parliament. (STOA: Science and Technology Options Assessment). The objective of the STOA project is to contribute to policy clarification for sustainable, efficient and less oil dependent long distance transport in Europe, including both passenger and freight transport.

The interview meetings focus on long distance transports contribution to CO2 emissions and thus climate change.

The information material includes the following:

- Two articles written by a science journalist given an overview of some of the challenges from long distance transport regarding oil dependency, CO2 emissions and infrastructure expansions to enable mobility
- The stories of John and Maria, illustrating different views on the possible solutions to long distance transport and climate change
- A list of technologies and policy measures mentioned in the stories of John and Maria.

We encourage you to read and reflect upon the articles and stories before the meeting, as many of the questions and much of the discussion at the meeting will relate to the dilemmas presented here. If you do not overcome it all, we recommend reading the stories of John and Maria.

The information material is based on a report produced in the STOA project. For the facts, Wikipedia has been used to add information where it was not covered by the report. The articles are from a special transport issue of a magazine published by The Danish Board of Technology called Technology Debate.

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Introduction

During the past decades the European transport sector has been characterised by impressive increase in overall transport volume and by exceedingly growth rates in road and air transport. The European enlargement, expansions of the economy in modern societies and improvements of general standards of living are driving forces for the growth in both freight and passenger transport. An efficient transport system plays a key role for economic growth and social wealth in modern societies. But the increases of congestions and bottlenecks in the European transport network restrict the free flow of goods and people, especially in the centrally located and densely populated regions of the European Union. At the same time, the increased amount of traffic has led to a strong reduction of the quality of life because of the major environmental consequences.

The climate change and the human activity induced CO₂ emissions have set focus on the contributions to this development from the transport sector and the growing transport volume. To this can be added the fact that nearly the entire transport sector depends on oil. Oil that is a finite resource, vulnerable to political instabilities and dramatic changes in price, and a source for greenhouse gas emissions.

The EU has stated that to keep the impacts of climate change at a manageable level, meaning that we will be able to adapt to them, the global temperature should not exceed the pre-industrial level by more than 2 C. To achieve this target, developed countries and regions, including EU, should reduce their emissions by 60-80% over the period 1990 – 2050. EU's environmental ministers agreed in 2007 to reduce GHG emissions by 20% in 2020 – and if a global agreement would be made at the Copenhagen Summit in 2009, EU would oblige itself to reduce emissions by 30%. The European Commission confirmed this in January 2008.

In line with the general European targets for reducing CO₂ emissions from the use of fossil energy, the transport sector using big shares of fossil fuels should live up to similar targets. For the STOA project targets were set in line with this:

- The consumption of oil should be reduced by 80%.
- CO₂ emissions should be reduced by 60%.
- Accessibility: to offer an efficient, effective transportation system at affordable prices

These targets should be achieved within **long distance transport**, meaning transport **exceeding 150 km**. Long distance transport includes both passenger and freight transport on road, rail, via air, rivers and sea.

To meet these targets and yet provide mobility in terms of transport is a huge challenge. What are the options?

Basically, there are three possible ways to reduce oil consumption and CO₂ emission from long distance transport.

- Decrease transport volumes, eg by spatial planning in order to prevent transport growth without jeopardizing citizens mobility, or by substituting transport with virtual mobility
- Shift to sustainable transport modes.
- Transport efficiency, improve transport technologies and transport flows, Improving energy efficiency and carbon intensity

These different options have been investigated in two slightly different scenarios:

- Strong and rich High-Tech Europe, with focus on technologies
- Slow and reflexive lifestyles, with focus on changing transport behaviour

The stories of John and Maria reflects the differences of the two scenarios.

Transport in Europe – it must be changed!

The growing traffic in Europe will be out of the question in the long run. Global warming, energy supply, security and waste of resources limit the future possibilities. The demands of the future transport system involve far more effective means of transport, independency of oil, prevention of waste of resources, limitation of unnecessary traffic and development of flexible and environmental-friendly transport systems of high capacity.

BY JOURNALIST EBBE SØNDERRIIS

Shopping in Vienna or Rome, holidays at the Mediterranean, studying in Czechoslovakia or Spain, working far away from home – all this is part of living in modern Europe. As well as being able to buy fresh strawberries and chantarelles flown in, Italian design and French wine – the European common market means distribution of local goods to all European citizens. And of exotic goods from remote countries, distributed from the big harbours of Antwerp, Genoa etc. We import flowers from Kenya, Colombia, India– and each bunch of flowers travels 54,000 km by air before being sold at our local florist (counted as the added number of kilometres of each individual flower).

Carbon footprint

Roses from Kenya are six times better for the climate than roses from Holland. This is the result of a survey by researchers at the Bedford University. In Holland, roses are grown in greenhouses by artificial light. In Kenya, the climate is warm and the sun is shining, also in the month of February. Kenyan rose gardening has 70 percent better output than Dutch - and part of the energy is geothermal.

The survey was ordered and paid for by the company World Flowers and the supermarket chain Sainsbury's. Nevertheless, the point is not revolutionary. It has been known for a long time that the worst scenario is to grow fruit and vegetables as well as flowers in a greenhouse in the middle of winter. Transport by flight is number two. Truck and vessel are number three. The best is to use the vegetables of the season and stay away from summer flowers in the wintertime. Sir Terry Leahy, head of the major supermarket chain Tesco, carrying 31.3 percent of the British retailing, has promised that all Tesco's goods will in future be labelled, informing the consumer how heavily the goods influence negatively on the global climate - called carbon footprint labelling.

And especially, the consumers want experiences. They will not settle with the growing number of offers from the media industry to have virtual experiences from the entire world. They want to go there themselves, and they prefer low fare air tickets. Tourism is growing explosively.

Just-in-time and internationalisation

The companies earn more and more by splitting up production and move goods and components around. Even simple things are made up by components from all over the world.

Online connections and technical standardisation make it possible to take advantage of both large and small differences in wages. This goes for the world as a whole as well as within the new borders of the EU. More and more things are produced at one specific location for the entire world. Containers keep arriving at Europe's major deep-water ports from which they are redistributed, mostly by truck.

Because of this development, logistics are becoming more and more important. It is expensive and ineffective to manufacture for storage. Both manpower and goods should be mobile. The products should arrive at their destination just in time and in the correct amount and quality. The companies and customers do not have time to wait for governmental commissions promising improved freight trains, if they can solve their transport problems right away with an extra truck and driver.

Intermediate and end warehouses are stationed on rubber tyres.

Transport is increasing

For the last 15 years, freight transport has increased by 43 percent and passenger transport by 20 percent, says the European Environment Agency in its 2007 report on transport and environment. Air passenger travel alone has increased by 49 percent between 1995 and 2005, and freight transport by road has increased by 38 percent in the same period. In the new EU countries, road transport has increased from 40 to 60 percent and traffic by rail has decreased accordingly. In the air territory of the EU, traffic of passenger flights has doubled and airfreight increased even more. The airports of the EU now carry almost 800 million passengers and more than 11 million tons of freight a year. The prognosis of the EU Commission for the years 2000-2020 predicts 50 percent more freight transport (mostly by road, least by railway) and 35 percent more passenger transport, thereof a doubling of transport by air.

To continue this development without other technologies and changed behaviour is out of the question. The EU has realised that the global warming must be kept below two degrees in order to avoid the risk of catastrophic, self-increasing disturbance of the climate. It presupposes that the emissions of greenhouse gases are reduced by one third for the next twenty years, and by four fifths for the next forty years.

But in the area of transport in particular, words and action are far from each other. It does not help to make limitations of the emissions for all other sectors, if the emission from transport will still increase. Over the last 15 years, it has grown by 26 percent, whereas the emissions from energy supply, business and households have fallen.

The oil dilemma

Furthermore, the development is out of the question because of the insecure future energy supply. In theory, there is oil, gas and coal for still many years. In practise, the growing imbalance of an increasing demand and a stagnant production of cheap crude oil present a limitation that can already be felt.

About one third of the final energy consumption in the EU-25 (today's level) is related to transport. The transport market today is almost entirely dependant on oil-based fuels and is responsible for about 70 percent of the final oil demand in the EU-25 (both urban and long-distance transport). Emissions from the transport sector are significant and contribute increasingly to the EU's overall GHG emissions: in 2005, transport contributed to the total GHG emissions in the EU-27 with a share of 24.1 percent (one fourth).

If the world consumption of crude oil will increase by just 1.5 percent a year, it will take 100 million barrels of oil a day in ten years. Many oil experts consider this unrealistic, even if they include unconventional sources such as Canadian oil sands and discover new oilfields, for instance in Greenland and the deep sea.

The price of oil will increase dramatically when production can no longer meet the growing demand. This will affect all other pricing. Furthermore, the world will see millions of environmental refugees because of global warming as well as an increasing tension between wealthy and poor people.

Security policy is another reason to find new ways of sustainable development, also within the transport sector.

New energy to the EU transport politics

The present means of transport use only a small part of the energy for the actual purpose - mobility. And they drive around with empty cargo space and seats. Part of the time they stand still, not only in the densely populated urban areas, but also on the trans-European highways and motorways.

The EU transport politics do also aim at increasing the efficiency of the means of transport, decreasing pollution, developing alternative fuels and moving cargo from truck to rail or vessel. The collective traffic and the express rail connection should be strengthened. The capacity of the trans-European net of rails, roads and waterways should be improved.

The railroads have experienced a certain success of passenger transport in express trains on time. But by far enough to equal the growing car traffic and the low fare air tickets. It looks worse when it comes to cargo. The load of a freight wagon moves through Europe with an average speed of 20 kilometres an hour. And it does not arrive on time.

An effective and modernised rail service could solve many of the European transport problems. In theory, time, energy and money could be saved. But the EU's attempt to move cargo from road to rail has been a disaster. Now, they have lowered their ambitions and instead emphasise an improved combination of the means of transport.

More asphalt in Eastern Europe

The economic growth in the new member countries of the EU is far higher than in the former countries. The Eastern Europeans want jobs and wages, cars and roads, consumption and holidays like in the Western countries. They repete the same mistakes on their way.

BY JOURNALIST EBBE SØNDERRIIS

- 'We recognise Poland's need for an improved infrastructure, but the development must conform to the EU legislation', says Marta Wisniewska from The World Wide Fund for Nature in Poland about the motorway that the Polish government wants to construct through a protected nature resort in the Rospuda valley. The road will cross a wet area rich in bird and plant life. It is protected under the Natura 2000 regulations.

The organisation CEE Bankwatch Network has similar examples from Czechoslovakia and Bulgaria. 'The countries in Central and Eastern Europe follow the Western model, without restraint, of being car dependant. The breakneck speed of the development is alarming. The EU funds and banks such as the European Investment Bank and the European Bank for Reconstruction and Development help supporting the controversial change of the transport sector of the area. From 1998 to 2003, they gave ten billion Euro as subsidies and loans, primarily for transport infrastructure that is not sustainable', writes the CEE Bankwatch on their website. The European Investment Bank themselves inform that 65 percent of the money goes to the construction of roads, and only 27 percent for railways.

The road is undermined

In the case of the Polish motorway the EU Commission is determined. And the Court of Justice of the European Communities sustained the decision. In April 2007, the court decided that the road construction in the protected nature area should discontinue until further notice. Since then, a new Polish government has stopped the project and summoned all parties involved, also environmental organisation, to a meeting about an alternative route.

The contested road section is part of the Via Baltica from Tallinn to Warsaw, the connecting road of Finland, Estonia, Latvia and Lithuania to the EU inner market. And it needs severe improvement, concludes the Finnish journalist Esko Nurmi to the newspaper The Helsingin Sanomat. Certain sections in the Baltic countries are quite as good as a motorway, whereas other sections have big holes in the road. The very foundation of the road has broken down from the weight of heavy

traffic. The number of trucks has tripled in ten years, he writes. In Poland, the road quality is even worse than in the Baltic countries.

More traffic in the future

The big need for improved roads is closely linked to the economic growth and the economic inequality of Eastern and Western Europe.

The wages in the new member countries of the EU are typically less than half the wages in Western Europe. In Poland, it is 47 percent below average. In Rumania and Bulgaria 62-63 percent below average, the latest figures from Eurostat show. Therefore, it is highly beneficial to move production to the new member countries. At the same time (and partly for the same reason), their economic growth is far higher than in Western Europe. The growing affluence is converted into cars, construction, consumer goods and travels. But even if the growth in the East will in future stay two-three times bigger than the growth in the West, it will take 15 to 30 years until the eastern EU countries will reach the western purchasing power. Until then, the road traffic (and air traffic) will grow. More Eastern Europeans will have time to drive a car. They will buy more goods transported from Western Europe. But at the same time, it will still be economical to move production to the east. And transport the goods back to the west, where the major purchasing power will still be present for a long time.

Meet John and Maria

Europe some 5-10 years ahead of now

John loves life in the fast lane and believes that technology will be the solution to climate change

John is 33. He lives in the south of Spain. He is a logistics manager at a large transport company distributing vegetables to all of Europe.

Being married and having 2 small children, he sometimes misses the free life as a bachelor. He loves life 'in the fast lane', always being on-line, travelling a lot and driving fast cars. Stress is not an issue – he likes to be very active and to change environment often.

He likes to go on weekends alone and with his family, to visit far-away holiday resorts, buy exotic foods, clothes and cheap electronic equipment from all over the world.

New fuel and propulsion technologies will help us

John knows that climate change also originates from human activity including transport. But he is very optimistic about technological solutions. He expects that researchers and engineers in a few years will provide us with clean technologies for transport. Perhaps something new like **hydrogen powered fuel cells** or **purely electric vehicles (1)**. From his point of view, electricity can be supplied from nuclear power plants or windmills, as long as it has the required impact on the CO2 emission.

He and his business colleagues often discuss the issue of fuels for transport in the light of the rising oil prices that put hard pressure on the freight sector. He always speak in favour of using all possible energy sources and CO2 lean propulsion technologies. “If necessary, and I think it is, Europe must buy energy from other parts of the world. Also **biofuels (1)**. This was what we did with oil, to make our economic growth possible. And why not import electricity from northern Africa, where the sun always shines”?

John thinks that the market will solve the problems. If it becomes even more expensive to buy oil, well, then new technological solutions will be profitable to invest in. With CO2 lean technologies at hand, John sees no problem in expanding the European infrastructure: highways from east to west, south to north, airports, harbours and 'motorways of the sea' for big bulk freight transport. He knew from experience, that transport is a growing trade, but the positive development can only continue, if bottlenecks, for instance through the Pyrenees, are removed and the roads become accessible.

Of course, better use of existing capacity is also on his want list, and therefore he would go for more investments in **Intelligent Traffic Systems (2)** as well. When driving his own car, he likes very much to use Global Positioning system for route guidance, and of course for supply chain management in his job it is crucial. Combining RFID tagging of the vehicles and loads with GPS or GSM would really make a difference for tracking and tracing goods and improve reliable and just-in-time delivery.

There must be a limit to pricing and taxing transport

John is not really in favour of more taxes, but he can accept the idea of **road pricing (3)**, if it is used for optimising transport flows and reducing congestion. It worked in London and other European cities and it is now the plan to implement road pricing on certain motorways in Europe, based on the German MAUT model. He hopes this will provide more room for trucks that cross

Europe. It will of course make long-distance transport by truck more expensive. But transport prices are on their way up anyway due to increasing oil prices. And the consumers should pay for this.

John could also accept to have a general **carbon tax (4)** for the entire transport sector – this seemed to be a fair solution as a polluter-pays-principle. But to put extra carbon tax on air transport within Europe at the expense of passengers who need to travel a lot across Europe for business purposes, or even for leisure, he could not accept. The real effect was an increase in costs of the services delivered to customers, and this would limit the development of the intra-European market and cooperation.

Fast transport for shopping tours - virtual meetings for business?

He was aware that his personal preference for flying was perhaps at stake here. Having a busy working life, he really would prefer fast transport. He also liked to take his wife and children on weekend trips to European cities. Not only for shopping, but also to experience a different atmosphere. He likes the idea of eating the best Italian food in the outskirts of Florins, to buy the best red wines from Bourgogne after a personal visit to the local vineyard. And he liked to make his children think like Europeans by getting familiar with the different cultures of Europe. He was also for aviation inclined to believe in salvation through technology. He had read about the so-called **flying wing (5/12)** for energy efficient and fast CO₂ lean air transport – this sounded promising.

For business purposes, **virtual meetings (6)** could be a way to reduce air transport. John's company has made an internal agreement with all business relations to keep physical meetings at a minimum. The objective is that 80 percent of all meetings in 2020 should take place virtually. To meet that objective, improvements in ICTs would be necessary, John thought. Today, it was not that easy to share ideas on virtual whiteboards together with a bunch of colleagues sitting in offices far away - or to check the look on the face of someone not saying anything.

And John would miss the beer-sessions of old-time physical meetings. Being relaxed and sharing jokes was not just fun; it also established a trust needed for achieving a fruitful cooperation.

High speed rail is an option

John does see the point of climate change. Of course he does. He would like to see his children grow up in a safe world, which would also mean a world not dominated by serious climate change and consequences of lack of food, increasing poverty and health problems, wars on fresh water supplies etc. When travelling distances of 5-600 km, **high-speed rail (7)** in some parts of Europe could be a better option than air transport. 'I will take the train when the rail network starts living up to the standards that were promised years ago', he usually argued, when his wife appealed to his bad conscience.

John is not sure that further investments in rail infrastructure were really the answer to the growing transport demand. To his knowledge, there was still a hidden potential in using the existing capacity more efficiently. One should really consider the costs before just building more railways. How about improving the rail management systems? There were still huge differences between the European countries, creating unnecessary waiting time. John believed that the rail system should be privatised. Only in this way will the rail operators be forced to become more efficient and to improve the rail infrastructure.

Maria prefers a relaxed life and is worried about climate change

Maria is 46 and lives in North-eastern Germany with her teenage son. She works as a consultant for the government's healthcare programme. Lately, she has taken up a more relaxed lifestyle with a good working life balance, meditating each morning and mainly enjoying vegetarian food.

It is about behaviour, not technology

Both through her work and among her friends she has met many people with stress who, she believes, have burned out due to stress at work and a too active life as such. Some years ago, she chose to reduce her working hours and consequently also her income. Because of that, she also chose not to have her own car and joined a **car sharing service (8)**. She is no fan of luxury goods and prefers locally produced food and quality goods. To her, buying new things all the time is not the road to happiness. She tends to keep things until they are really worn out.

Maria is worried about the climate change. She thinks that it is about time Europeans take responsibility for their CO₂ producing travelling and consumer habits in general. She is sceptical about technological solutions. No technology has so far been capable of solving the CO₂ negative impact that transport has. She fears that the demand for CO₂ lean technological solutions such as electrification of the railways will increase the demand for CO₂ lean electricity to an extent that paves the way for building more nuclear power plants in Europe.

Europe should go for sustainable energy

She obviously finds it wise to strive for electrically driven cars and trains. She is reluctant to fill her shared car with **biofuel (1)** when she wants to take the long drive to visit her parents. Even if the **labelling of biofuels (9)** was added, and she could at least check how the biofuels had been produced, she would often feel uncomfortable. Could one be sure that land used for biofuel crops has not been used for producing food before? Can those Brazilian heads of government really be trusted in this matter? She thinks that Europe should be pioneers and strive to have the total energy consumption covered by all kinds of sustainable energy.

Air carbon allowance could give priority to rail transport

She supports regulation, preferably for the entire Europe, forcing people to change their consumption of transport in a CO₂ lean direction. She finds it reasonable to pay a particularly high **air carbon tax (4)** when you know how much air transport damages the environment. Air transport had really become a major problem after the enormous growth caused by low fare tickets. Before, she and her son often went by air. Maria had spent some years working and studying in Italy and here she met the father of her child. They were together for some years, but then decided to split up. When Maria went back to Germany with her son it involved visits to the father several times each year – and flying was simply the cheapest and fastest way of travelling. Nowadays, her son travels alone, but still prefers to travel by air, though Maria has tried to convince him to take the train.

Instead of higher prices, she personally better liked the idea of **individual carbon allowances (10)**. This, she thought, would make it easier to convince her son to take the train and save some of his carbon credits for the big tour around the world he was planning to do, when finishing school in some years. Frankly, it would also save her some money.

Road pricing and social inequality

Recently, she discussed the price of protecting the environment with one of her friends who is a single mother just like Maria. This friend lives in the countryside, in the same village as her parents. She wants her children to grow up in close contact with nature and the animals. And her parents could look after the children sometimes, so she could go out on her own.

With the new suggestion of **road pricing (3)** in most of the road network, Maria's friend feels that she is financially punished for her choice of living in the countryside. There is no railway station and no public transport that can bring her to the city in a cheap way, without having a lot of waiting time. She is dependant on her car. Of course the rising oil prices had made car driving more expensive. This made her invest in a hybrid model. Road pricing would really be a problem for her. 'It isn't fair', she said.

Maria shared her critique to some extent. 'I find that the cars that use most fuel and produce the largest CO2 emission should pay most. People like you, who live in the countryside, should of course be compensated, if there is no alternative transport'. Maria, on the other hand, found it acceptable that prices of goods that were transported thousands of kilometres on the roads were more expensive as a consequence of road pricing. 'It makes sense to adjust the prices in this way according to the carbon footprint of the goods', she said.

The slow speed train to pleasure and comfort

Maria's own favourite mode of transport was the train, and not just the expensive **high-speed rail (7)** like the one from London to Paris. She enjoys the cheap and **slow trains (7/11)** because they are very comfortable. On holiday trips, she did not mind spending some days on a train in a very nice compartment, having a massage and watching and listening to operas in the best sound and 3-D quality. She could also lean back into the soft armchair and watch the shifting landscapes passing by through the panorama window and read small leaflets on the various locations on the screen next to the window. Though she lived in a big city, she enjoyed nature sceneries very much. She really hoped that much of Europe's wild nature would be protected. And not only the wild nature; she also liked to see the small villages and farms, and rivers that were not changed into some sort of water motorways. The eagerness lately of having the **infrastructure (12)** extended and developing new industrial areas had left too much scandalous damage to nature, in Maria's opinion.

To her, it seemed to be really urgent to allocate more **investments in the railway infrastructure (12)**, and to make international agreements to make sure this would happen. This should be given higher priority than to build roads and tunnels to remove all the bottlenecks in Europe. Would it not just give more traffic, if the accessibility to motorways and highways was improved?

Facts about technologies and policy measures

The highlighted words in the stories about John and Maria are explained, discussed and illustrated in the following text. Numbers refer to the numbers in the text, to clarify where this information is relevant.

1. Fuels and propulsion technologies to reduce CO2 from transport

A wide range of non oil-based options for transport has been developed for the last decade, and some are already in use. The following technological mainstreams for road transport (cars, trucks, busses) are discussed today:

Hydrogen and fuel cells. It sounds like a very good idea, simply to put hydrogen in the car and make fuel cells turn the hydrogen into electricity and only water as output. However, it takes energy to produce the hydrogen for the car. Hydrogen-powered vehicles are only as clean as the energy that is used to produce electricity or hydrogen. So, the crucial question is where the "clean" hydrogen or "clean" electricity is taken from – will it be from renewable sources, from fossil sources like coal and natural gas, from nuclear power?
Experts estimate that it will take 15-20 years from now, until we see the hydrogen car take over.

Hybrid technology. A hybrid car is run by means of a combination of a fuel motor (petrol or diesel) and an electricity motor. Through stop-and-go driving energy is loaded into the battery. Hybrid cars are already on the market. The hybrid technology is also under development for trucks. Plug-in hybrids are discussed as an interesting alternative for long-distance car transport.

Battery electric vehicles. The purely electrically driven vehicle depends on the development of suitable devices for the storage of electric energy (batteries or condensators) and would therefore mainly be related to car transport. Considerable improvements in battery technology (range and loading times) are needed to enable a significant commercialisation of battery electric vehicles. Now they are mainly for urban transport. And as for hydrogen and fuel cells, the question is where the "clean" electricity comes from.

The next two technologies should mainly be considered as bridges till new solutions such as hydrogen and fuel cells will penetrate the markets sometimes in the future.

Biofuels. First generation fuels made by corn and grain, soy and oilseed rape such as bio-diesel and bio-ethanol used to blend with diesel or petrol, are already commercially deployed. Second generation biofuels based on straw and other bio waste are still under development. To use biofuels for transport in Europe we need to import biomass, which might go at the expense of ecologically sensitive areas and might be in competition with the production of food. The EU commission is currently discussing, if the target of 10 percent biofuels of all road vehicle fuel by 2020 should be changed, when considering the present food crisis. The restricted potential of domestic biomass might be used mainly for long-distance trucking, while urban transport should use other fuels and propulsion technologies.

Natural gas and LPG (autogas). Gaseous fuels based on fossil feedstock offer environmental benefits at a relatively low cost. The technology is popular in many European countries, and is already used for trucks.

Fuel and propulsion technologies for rail

For rail transport, both passenger and freight, electrification seems to be the simplest way ahead to CO₂-free transport. As for hydrogen, the question is how the electric power is generated. Higher load capacities, longer trains and double-deckers are measures to optimise capacity use.

Fuel and propulsion technologies for aviation

For air transport research on alternative fuels and propulsion technologies is at a very early stage. There is currently no promising fuel alternative for kerosene. Hydrogen is discussed, but for many reasons, and most importantly security reasons since hydrogen is an explosive, it has a very long-term perspective. Bio-kerosene is discussed as well. But again, tough security standards hamper

commercialisation. Furthermore, it seems to be easier to use the limited amount of biomass for road transport or power generation.

Fuel and propulsion technologies for shipping

For ships, hydrogen and fuel cells might be relevant and first prototypes are being tested. Recently, the so-called Skysails systems offer promising potentials to reduce energy and emissions. The system is a wind propulsion system based on large towing kites. It is said that by using the SkySails-System, a ship's fuel costs can be reduced by 10- 35% on annual average, depending on wind conditions. Market penetration of this system is just about to start.

2. Intelligent Transport Systems – ITS

Intelligent Transport Systems focus on better organisation of transport through information and communication such as real time information for public transport passengers; on the steering of traffic flows for example by dynamic speed control on highways and route guidance; on optimising logistics chains in freight transport. It is strongly related to optimised use of infrastructure in terms of capacity, and it enables new options for financing infrastructure via road pricing. The Global Positioning System can be an integrated part of ITS both for route guidance and road pricing purposes.

Towards reducing the CO₂ emissions from transport, ITS has the potential to reduce fuel consumption by making traffic run more smooth and reduce stop-and-go driving. ITS can also be used for intelligent air management, eg for issuing landing slots and avoid that airplanes are circulating for a long time before landing.

Visions are that some day cars and trucks will join to form road trains of automatically controlled vehicles that travel closely together. In such automated highways one could imagine a centrally controlled speed system.

3. Road pricing

Road pricing is an economical concept regarding the various direct charges applied for the use of roads. The road charges include tolls and congestion charges, which may vary by time of day, by the specific road, or by the specific vehicle type, being used. Road pricing has two distinct objectives: revenue generation, usually for road infrastructure financing, and congestion pricing for demand management purposes.

Congestion Road pricing in urban areas has been introduced in European cities such as London and Stockholm. The LKW-MAUT was introduced in Germany on 1st January 2005, followed by Austria and Switzerland. **MAUT** is a toll for freight vehicles based on the distance in kilometres, the number of axles and the emission category of the vehicle. The toll is restricted to highways and some specific roads. In Germany, it has been discussed to also include passenger cars.

Global Positioning Systems (GPS or Galileo) enable the MAUT sort of road pricing system. The pricing can be differentiated in a way that the highest prices are in the peak hours and on certain sections of high congestion risk. It could be free of charge to travel by night and thus spread out the use of the roads over 24 hours.

Benefits and disadvantages: Road pricing could mean better accessibility, because of less congestion; increasing average travel speed without increasing absolute speed. Road pricing will have an impact on transport volume by reducing the number of travels and reduce long-distance weekend trips. This will save energy and reduce CO₂-emissions.

Road pricing like the MAUT system for freight transport by road will increase prices for trucking and thus make the railways more competitive.

If road pricing only includes some roads, there is a risk of trucks and cars taking detours to avoid the charges.

Road pricing has potentially negative consequences in terms of social and geographical inequalities. People with low income commuting to jobs in the cities will need to find alternatives, meaning that public transport should be cheaper. People living in rural areas with no alternatives to car transport should be offered compensation. Otherwise, the rural population will decline faster.

For the consumer, road pricing on freight transport means higher prices for goods that have been transported over long distances by truck.

4. Carbon tax and emission trading

Carbon tax is a taxation based on how large emissions of CO₂ and other greenhouse gases are. It can be used for transport, for power stations using coal etc. Taxing something that is undesirable is a method to confront users with the external cost of carbon and hence reduce emissions to efficient levels.

Carbon tax could have an immediate impact on CO₂ emissions, but only if the price is high enough. Benefits and disadvantages are somewhat similar to roadpricing.

Emission trading and **carbon allowances** are administrative approaches used to control pollution by providing economic incentives for achieving reductions of the emissions of pollutants. It is sometimes called **cap and trade**. A central authority sets a limit or *cap* on the amount of a pollutant that can be emitted. Companies receive an emission permit and are required to hold an equivalent number of *allowances* (or *credits*), which represent the right to emit a specific amount. The total amount of allowances and credits cannot exceed the cap, thereby limiting the total emission to a certain level. Companies that need to increase their emissions must buy credits from those who pollute less.

Air carbon tax and ETS

The European Parliament and the Commission are currently negotiating the Green Paper on market-based instruments for environment and related policy purposes. One suggestion is to include air transport should be included in the EU's Emissions Trading Scheme (ETS). This is strongly supported by the European Parliaments Environment committee, who voted for a proposal to include airline traffic in the (ETS) by 2011. It was discussed if this would be in conflict with having a specific air carbon tax – which some MEP's thought, and others disagreed. So far, aviation has not been exposed to energy taxation but it is brought up as a proposal in the Green Paper.

5. The flying wing

The so-called '**flying wing**' has long been a designer's dream of an energy efficient form of air travel. It owes its efficiency to the fact that it has no fuselage and therefore a smaller area exposed to drag from the wind. There are expectations of reducing CO₂ emissions by 30-40 percent (by increasing the energy efficiency per passenger kilometre), but the demands for investments in research and demonstration are high. Long lifetimes for airplanes, up to 40 years, means that designs like the flying wing will have an even longer time perspective.

6. Virtual mobility

It is often discussed whether improved communication facilities for virtual mobility in the future will substitute transport to some extent. Typical examples are videoconferences, teleworking, online shopping. So far, experience has shown that this will not be the case. Telephone calls, letters and e-mails are not known to have reduced transport; and having more international contacts to keep in touch with via new information technologies seems to induce more transport. But when transport gets more expensive, virtual mobility could be an alternative.

A breakthrough for virtual mobility could be *telepresencing*, combining videoconference and virtual reality to create a three-dimensional, high-speed, free-flow interaction across different geographical locations.

7. High-speed rail

Generally high-speed is defined as greater than 200 km/h- applying to both the train's maximum speed and the track's dimensions. Most modern high-speed trains do not exceed 350 km/h and trains exceeding this speed encounter several physical and electrical challenges; in the future this may lead to a separate designation for these even higher-speed trains. The key technologies are already available, but investments in infrastructure and a higher degree in international standardisation are missing.

High-speed rail is best suited for journeys of 2 - 3 hours (150-600 km or about 100-400 miles), for which the train can beat both air and car in this range. The speed is much higher than possible for a car. And for air, the process of checking in and going through security screening at airports, as well as the journey to the airport itself makes the total air journey time no faster than HSR.

High-speed trains are more energy efficient than aircraft on a same load factor basis, as trains consume less energy per passenger-kilometre. Compared to slow-speed trains, the energy efficiency is not as good – and neither the CO₂ emissions.

It is now possible to travel from London to Paris in 2 hours 15 minutes. Spain and France are currently working on a high-speed rail corridor at the Pyrenees and connecting existing french and spanish high speed rail. Germany, Italy, Belgium, Sweden all have high-speed rail. The EU TEN-T programme plans for more high-speed rail corridors in the Southwest and East of Europe.

While high-speed rail is designed for passenger travel, some high-speed systems offer also some kind of freight service. For instance, the French mail service *La Poste* owns a few special TGV trains for carrying postal freight.

8. Car sharing

Car sharing is a relatively new concept starting to spread. On a voluntary basis, citizens in several European cities have established networks for standardised car sharing services. In Germany, nearly all cities with more than 100,000 inhabitants have established car sharing. Since 1998, people in Switzerland have been able to ride trains at half price with the Mobility Rail Card, which, at the same time, gives access to car sharing countrywide. In Berlin, since 2000, the Metrocards combines public transport and car sharing.

9. Labels for carbon footprint and biofuels

Carbon footprint label

The Carbon trust issues Carbon Reduction Label and describes the purpose as follows: The label shows you the amount of CO₂ and other greenhouse gases emitted as part of a product's

manufacture, distribution, use and disposal otherwise known as its carbon footprint. Those companies who label their products and services are committed to reducing their carbon footprints from the figure shown within two years. As more companies sign up to Carbon Reduction Labelling, you'll be able to make a more informed choice.

Biofuel social label

There exist a label which is a quality warning for consumers, but there is no label explaining if the biofuel was produced in a socially and ethically responsible way. However, such a label could be a way to increase awareness of the conflict of using crops for food or fuels.

10. Individual carbon allowances

Individual carbon allowance is not an implemented policy measure, as the cap and trade system is. The basic principle could be that each citizen has the right to produce a certain amount of CO₂. Car, coach, airplane etc. can be carbon-credited differently, depending on how much CO₂ they emit per passenger km. The result could be that trains would be more attractive than airplanes, if a person wants to travel a lot; or that she would make fewer trips, but for a longer period at a time. The allowance can be used by the owner, or sold to others. This system would benefit the poorest part of the population who do not have the means to travel a lot and who would consequently not use their carbon allowances. There should be a cap for individual allowances as well.

11. Slower speed for road and air transport

Slower speed is a “low-tech” and cheap measure that can be quite efficient for reducing CO₂ emissions. For **cars** driving on motorways and trunk roads, there is a potential for 15-20% reduction in carbon emissions if a maximum speed limit of 80 km/hr is introduced. Similar speed limits could be introduced for **trucks**. It should be combined with better driving techniques – ecological driving – to reduce the fuel use.

In **aviation**, to fly 700 km/hour instead of 900 km/hour could reduce CO₂ emissions by 25 %. The best airplane for this would be a Turbo-propeller aircraft. Some companies already use reducing speed in conventional airplanes, but the CO₂ effect is lower than for a turbo-propeller.

12. Infrastructure and research - EU investments

Trans-European transport networks

The Trans-European transport network is a European Union strategy closely linked to the creation of the inner market with free movement of goods, people and services within its borders. It is also seen as an important element for economic growth and the creation of employment.

A central element of the strategy is to remove bottlenecks and enlarge capacities; TEN-T is a list of 30 prioritised projects to be started before 2010. It includes upgrading and building new airports, new high-speed railway lines, motorways of the sea and many other projects. Examples are the upgrading of the Rhine-Main-Danube canal. This canal connects the river Danube with the North Sea. Other examples are:

- The motorway corridor Igoumenitsa/Patra-Athina-Sofia-Budapest
- The railway corridor Lyon-Trieste-Divaca/Koper-Divaca-Ljubljana-Budapest-the Ukrainian border
- The Fehmarn Belt railway corridor between Denmark and Germany

FP 7 funding for transport research:

FP7 is the short version of the seventh framework programme for research and technological development. It is the EU's main instrument of financing research in Europe and runs from 2007 to 2013. Under the FP7, at least 4.1 billion EUR are granted to finance EU research with the aim of developing safer, 'greener' and 'smarter' European transport systems at the benefit of all citizens.

Planned activities in FP7 include:

- Aviation and air transport (to reduce emissions, development work within motors and alternative fuel, management of air traffic, security aspects of air transport, environmentally efficient aviation)
- Sustainable surface transport - rail, road and water (development of clean and efficient motors and electrical railways, i.e. reduction of the impact of transport on climate change, intermodal regional and national transport, clean and safe vehicles, buildings and maintenance of infrastructure, integrated architecture)
- Grants to the European global satellite navigation system - Galileo and EGNOS (navigation and timing services, efficient use of satellite navigation)

In addition, 2.3 billion EUR are granted for research in energy, among others including hydrogen and fuel cells.