HIGH OIL PRICE, THE TRANSPORT SYSTEM AND THE EUROPEAN ECONOMY: SOME RESULTS FROM A MODEL-BASED ANALYSIS

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INTRODUCTION

The fast growth of the oil price is increasingly seen as a structural element rather than a short-term phenomenon. Expanding oil supply is becoming more and more problematic and, even assuming the availability of new resources, their exploitation requires massive investments. On the other side, oil demand is significantly growing in countries like China and India. Given their size and their current level of consumption and economic activity, such countries could easily sustain oil demand for a long future. A pressure is exerted on both on the supply and on the demand side and, therefore, on oil price.

The HOP! research project has been co-funded by the European Commission DG Research to provide quantitative and qualitative analysis of direct and indirect impacts on the European economy of long term oil price escalation. The study has been undertaken by three partners, with TRT Trasporti e Territorio (Italy) taking the lead and collaborating with Fraunhofer Institute Systems and Innovation research (Germany) and the Institute for Prospective Technological Studies of the European Commission Joint Research Centre (Spain).

The study is based on an integrated modelling approach that combines the worldwide energy supply model POLES and the ASTRA model, developed in the last decade as a strategic tool for the analysis of the interaction between transport, economy and environment.

The paper has the following structure: section 1 introduces the methodology of HOP!, section 2 presents the main results relative to the transport sector and section 3 reports main conclusions.

1. THE HOP! METHODOLOGY

There is a general consensus among the experts[1] that the rise of energy prices should be regarded as a structural condition due to the foreseeable trend of demand and supply. Temporary fluctuations, which are sometimes associated to financial market speculative movements or geopolitical events, will add to such a general trend leading to price instability, with possible sharp spikes and troughs. The HOP! study starts from the assumption of continuous growth of oil prices and looks at their consequent impacts.

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Impacts of high oil prices can be separated into direct effects on the energy system and the transport system as well as indirect effects on the overall economic system. Of course, changes taking place in one system also affect the other systems . For instance, if alternative transport fuels enter the market to a large extent, the composition of the vehicle fleet and the transport costs of different transport modes will be affected. As a consequence, the increase of transport costs has an impact on the production costs and, hence, on GDP. Changes in GDP, investments and trade volumes would then change energy and transport demand .

Given the numerous direct and indirect impacts of high oil prices and their linkages, the final result of an oil price peak can hardly be predicted on a qualitative basis and is likely to change over time. For this reason, in HOP! an analytical toolbox consisting of the two interconnected models – POLES (in an adapted version for the HOP! project including the Biofuels model BioPOL) and ASTRA – is applied to simulate the effects of various scenarios assuming high oil prices, taking into account various feedback loops and the dynamics of impacts. The time horizon of the simulations ends in 2050, the assessment being focused on the EU.

The POLES model covers the energy field with supply of energy resources on world level, energy demand and development of energy prices with an exogenously given economic development, while the ASTRA model deals with i) the transport field with infrastructure supply and transport demand as well as with ii) the macroeconomic system, with a module that endogenously forecasts economic development under varying policy conditions. The two models are linked as follows: ASTRA receives from POLES: fuel prices, the value of investments for developing alternative energy sources and the trade of fossil fuels; POLES receives GDP development, energy demand for the transport sector and the economic activity per sector from ASTRA. A short description of the two models is provided in the two following paragraphs[2].

1.1 The POLES model

The POLES (Prospective Outlook for the Long term Energy System) model is a global sector simulation model for the development of energy scenarios until 2050. The dynamics of the model are based on a recursive (year by year) simulation process of energy demand and supply with lagged adjustments to prices and a feedback loop through international energy prices. It contains technologically-detailed modules for energy-intensive sectors as well as modal transportation sectors.

The world is subdivided into 47 regions, for which the model delivers detailed energy balances. A single world oil market is assumed (the "one great pool" concept), while three regional markets (America, Europe and Asia) are identified for coal, in order to take into account different cost, market and technical structures. Natural gas production and trade flows are modelled on a

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bilateral trade basis, thus allowing for the identification of a large number of geographical specificities and the nature of different export routes.

Energy prices are determined endogenously in POLES. Oil prices in the long term depend primarily on the relative scarcity of oil reserves (i.e. the reserves-to-production ratio). In the short run, the oil price is mainly influenced by spare production capacities of large oil producing countries. Furthermore, in the HOP! version a 'market power' price add-on is simulated in dependence of the geographical distribution of oil reserves. It must be noted that the endogenous price forming mechanism cannot model the price volatility induced by short term market expectations.

A biofuels model (BioPOL) has been connected to POLES within the HOP! project in order to cover a potentially relevant alternative source of energy for the transport sector. The biofuels model is based on recursive year by year simulation of biofuels demand and supply in the EU-27 until 2050. For each set of exogenously given parameters an equilibrium point is calculated at which the costs of biofuels equal those of the fossil alternative they substitute, taking into account the feedback loops of the agricultural market and restrictions in the annual growth rates of capacity.

1.2 The ASTRA model

ASTRA stands for Assessment of Transport Strategies. The model has been developed since 1997 with the purpose of strategic assessment of policies in an integrated way i.e. by considering the feedback loops between population, the transport and energy system and the economic system. The model is based on the System Dynamics methodology (Schade, 2005) and follows system analytic concepts, which assume that the implemented real systems can be conceived as a number of feedback loops that are interacting with each other. The spatial coverage extends over the EU27 countries plus Norway and Switzerland. Each country is further disaggregated into at maximum four functional zones classified by their settlement characteristics.

The ASTRA model consists of nine modules, linked together in manifold ways. The modules are all implemented applying the Vensim® system dynamics software. They can be run stand-alone and within one integrated model, which is the case for HOP!. Relevant features of ASTRA for the objectives of the study include:

- A representation of the inter-sector links between 25 economic sectors by means of input/output tables at the country level. In this way, the relationships between the energy sector and the other sectors can be simulated, analysing how changes of energy demand impact on the energy production sector as well as the effects of higher energy prices on value added and employment of other sectors;

- A detailed description of the transport sector, including transport cost calculations based on technologies (A detailed fleet module where innovative vehicles can enter as result of the changes of relative prices) and therefore the capability of describing manifold changes both on the supply and the demand side;

- Multiple linkages between the transport sector and the economy sector, which allow to take into account different economic impacts of changes of the amount and of the characteristics of transport demand and supply;

- A trade model that considers the changes of energy trade flows as provided by POLES and the changes of transport cost (e.g. induced by energy price changes) for trade within the EU.

1.3 The HOP! scenarios

A large number of scenarios with high oil prices have been constructed and assessed compared to a reference scenario. This allowed to obtain a comprehensive picture of the impacts for various oil price levels, distinct shapes of the oil prices and different policy actions.

The reference scenario

The reference scenario assumes an oil price remaining at a level of 70 €2000/bbl until 2020 and slowly increasing afterwards so as to reach 130 €2000/bbl by 2050. The European economy would experience a continuous growth over the coming decades (measured by the growth of GDP in constant prices). Given the different starting points, the relative growth rate is expected to be much stronger in the new Member States than in the pre-2004 EU Member States (EU15). t should be stressed that rather than being a "best guess" estimate on how oil market is likely to evolve, the reference scenario has to be seen as the case for non-high oil price to measure differences against.

Personal mobility is expected to increase at different speeds in the EU15 and the new Member States . In the latter group, personal mobility is forecasted to grow faster in the near future due to higher incomes and motorisation rates. However, the expected decrease of population in the Eastern Europe countries partially offsets these determinants resulting in diminished growth rates and ultimately also in a reduced mobility in absolute terms. Nevertheless, more recent EU12 Member States would experience an average annual growth rate of 0.6% which compares to the lower annual growth rate of 0.4% in the EU15 area). Air is expected to grow more than any other mode, almost doubling the total number of passengers-km at horizon of the year 2050.

The difference between the two groups of countries is even more significant for the mobility of goods. For the EU15 countries, the HOP! Reference

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scenario assumes that in the year 2050 the amount of tonnes-km will be doubled with respect to the year 2000. This forecast corresponds to an average growth rate of 1.4% per year. Instead, for the EU12 countries, the average growth rate of freight transport for the whole simulation period is 2.8% per year in reference scenario. Mode shares do not change much over time in the HOP! Reference scenario.

The high oil price scenarios

Table 1 The HOP! scenarios

Scenario	Oil price in 2020 (€$_{2000}$/bbl)	Investment size	Fuel taxes	Price growth path
Reference 70	70	Low	EU directives	Stable
150 smooth	150	High	EU directives	Smooth rise
150 smooth no invest	150	**Low**	EU directives	Smooth rise
150 smooth reduced tax	150	High	**Reduced Tax**	Smooth rise
150 smooth Carbon tax	150	High	**Carbon Tax**	Smooth rise
150 early	150	High	EU directives	**Early Step**
150 late	150	High	EU directives	**Late Step**
220 smooth	**220**	**Very High**	EU directives	Smooth rise
600 early	**600**	High	EU directives	**Early Step**
800 early	**800**	High	EU directives	**Early Step**

Source: HOP ! project

Table 1 provides an overview of the HOP! scenarios. The scenario 150 Smooth assumes a smoothly increasing oil price which reaches a level of 150 €$_{2000}$/bbl[3] in 2020. This leads to increased investment in energy efficiency as well as in alternative sources. The other HOP! scenarios vary one or more parameters to investigate the impacts of specific economic responses to high oil prices:

- the scenario 150 Smooth no invest assumes that the level of investments remain more or less the same as in the reference scenario.
- 150 Smooth reduced tax and 150 Smooth carbon tax vary the taxation level: they simulate a tax reduction (-20% of excises) with the purpose to limit the increase of transport costs and a carbon taxation additional to Ref 70 scenario (40€/TonCO_2) aiming at higher tax revenues to compensate higher governmental investments.
- 150 Early and 150 Late vary the way oil prices increase: this could happen either in an early step between 2010-2013, which enables to look at the impacts of a short-term steep rise of high oil prices, and with a late step to look at the impacts if we assume a moderate oil price development, which suddenly turns out to be false.
- 220 Smooth investigates a higher oil price than 150 Smooth (> 220 €/bbl in 2020).
- Two variants of scenario 150 Early explore the impacts of extraordinarily high oil prices reached with a step in the year 2020. 600 Early assumes a price of 600 €/bbl in 2020, while 800 Early assumes a price of 800 €/bbl in 2020.

Investment assumed in all scenarios are supposed to be directed to both alternative energy sources and energy efficiency.

It should be highlighted that oil price development in the HOP! project scenarios is not an exogenous input of the modelling tools, but it is endogenously calculated depending on reserve-to-production ratio, spare production capacities of large oil producing countries and by the impact of 'market power' of a few oil producing countries. It should be clear: the HOP! project did not aim at assessing the oil reserves but focuses on the assessment of the impacts of high oil prices, in case availability of oil is scarce and prices would soar. For this reason, a set of elevated oil price levels were defined up-front for the year 2020, and reserves and other parameters were then adjusted so as to reach those levels.

2. IMPACT OF HIGH OIL PRICES ON THE TRANSPORT SECTOR

2.1 The impact on transport demand

The transport sector is highly oil intensive and therefore the impact of higher oil prices – translated into higher fuels prices – can be readily seen.

It is generally believed that transport demand is very rigid and thus, only minor adjustments should be expected. However, when fuel prices climb to unusual high values and remain high, people may change behaviour. Even if mostly anecdotic, some evidence of transport demand reactions is already available for USA. For instance, The Wall Street Journal wrote last March 3rd 2008[4] that "in the past six weeks, the nation's gasoline consumption has fallen by an average 1.1% from year-earlier levels […] that's the most sustained drop in demand in at least 16 years, except for the declines that followed Hurricane Katrina in 2005 […] There is evidence that Americans are changing their driving habits and lifestyle". Also USA Today reported last May 16th 2008[5] a statement from ExxonMobil Corp chief executive Rex Tillerson saying that "We're already seeing some demand slackening in gasoline demand in terms of miles driven"[…] So I think we're very near, if we're not already at, the price where people clearly are altering their daily behaviour".

Such reaction of the transport demand to higher fuel prices can also be observed from the model results. In Figure 1 the trend of total passengers-km in EU27 is shown, while figure 2 reports the expected change of total tonnes-km in EU27 compared to the reference scenario. Both are reduced as consequence of manifold reaction patterns like mode-shift, change of destinations and reduced distances as well as lower economic activity.

In general, inherent transport system reactions are stronger for passenger transport, while The impact of energy prices on freight performance is only able to slow down the growth of tonnes-km for some year (between 2010 and 2020) but not to reduce freight traffic. The relative constancy of freight traffic is strictly linked to the economic growth, which involves the industrial sector and is the main determinant of goods movements. Since the economic growth is expected to continue even in case of high oil prices (see section 2.4), the freight traffic performance is largely maintained.

However, this overall result can be analysed in more detail to show that even if the freight traffic performance is not largely decreased, some changes in the traffic structure are induced. One component of freight transport demand is the mobility of goods caused by import/export flows. With rising energy prices, and then transport costs, the growth of intra-EU export is slowed down with respect to the reference scenario. At the same time, high oil prices have a different economic impact on different sectors. The production of goods is increased in sectors like energy and construction, which generates significant amounts of bulk goods on short distances (e.g. ores, building materials). The combination of such two effects shorten the average distance of transported goods. Thus, even if the traffic performance changes only slightly, the total number of tonnes-km is made of more tonnes and less kilometres.

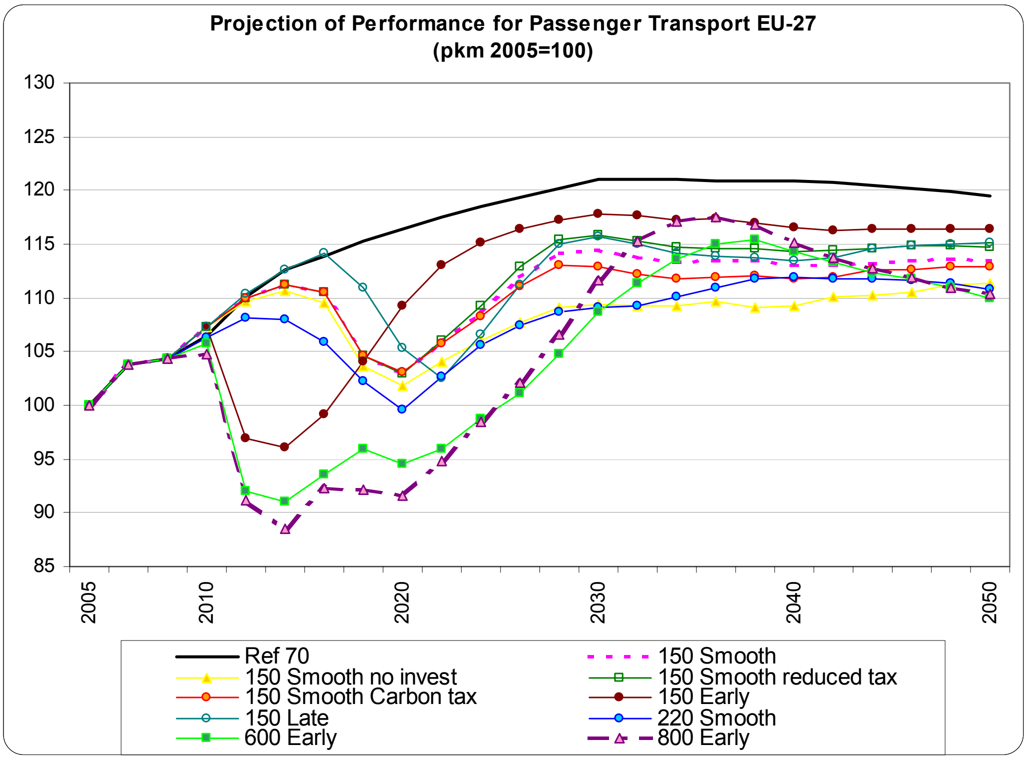

Figure 1 EU27 passenger transport demand

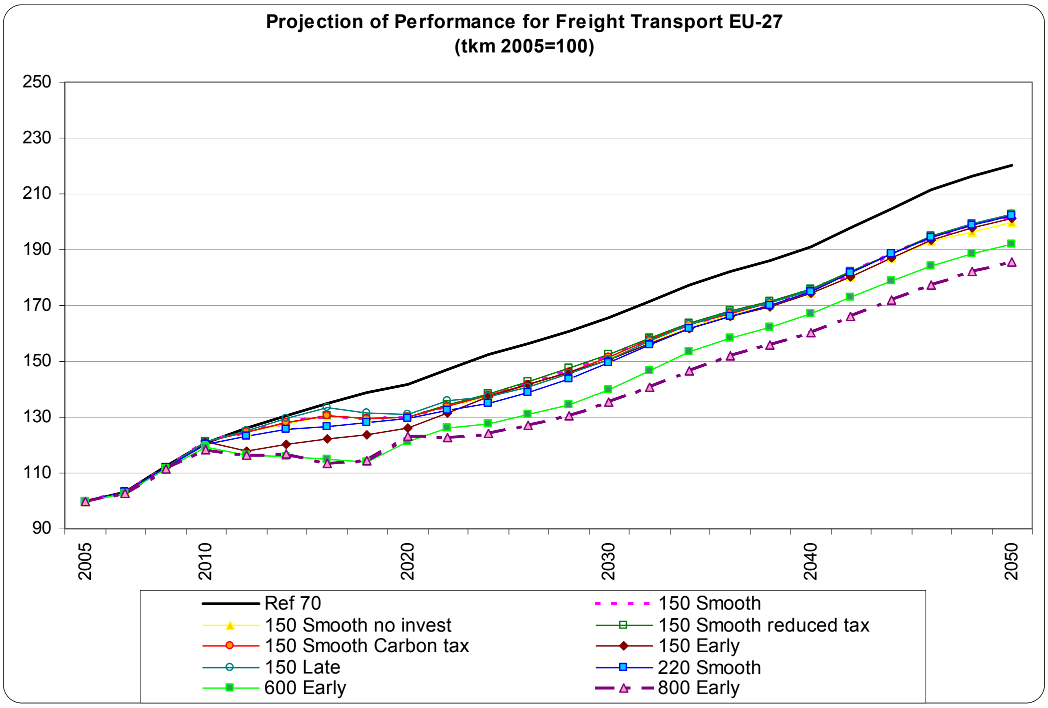

Figure 2 EU27 freight transport demand

The passenger mobility reduction is associated to a different mode split (figure 3) with car and air losing mode share whereas public transport and slow modes would gain demand. Car share could be reduced to 67%-68% (so car would remain the dominant mode anyway) at the year 2020, to recover some share lately but staying below the current level. Air demand growth would be significantly stopped: air market could lose about 20% of its demand between 2014 and 2020. At the same time, train may attract more additional demand than any other alternative, reaching a share of 11%-12% in the year 2020 and remaining over 10% even when fuel prices are reduced.

Minor changes are expected on the mode split side for the freight transport. Road freight cost is increased more than other modes' but a large (and increasing, as discussed above) share of transport takes place on short distances where road freight has no competition.

It can be seen from figures 1 and 2 above that the impact of energy taxation on traffic would be minor. A 20% reduction of fuel taxes on the top of the *150 smooth* scenario would not change road transport costs dramatically. Also the assumed additional carbon tax of 40 € per Tonne of CO_2 would only slightly rise the transport user cost. The impact of energy taxation on government revenues is not negligible however as discussed later in section 2.3.

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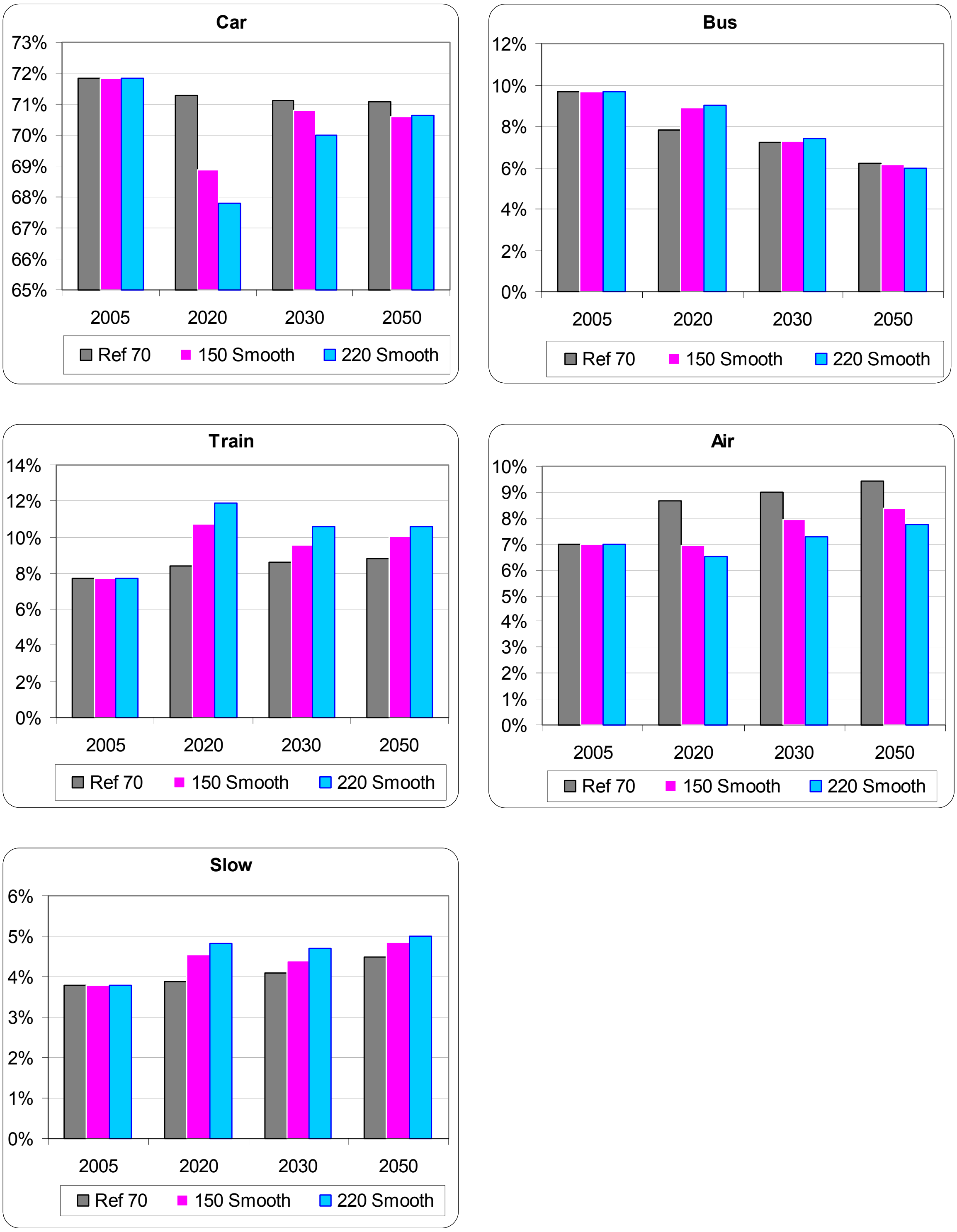

Figure 3 EU27 passengers-km mode shares

The mode shift can be easily explained by the relative change of user costs across transport modes. As shown in Figure 4, in the year 2020 car perceived cost would grow up to more than 150% of 2005 cost level and also air average fare would double or more. The renewal of the car fleet (see below) with the adoption of alternative fuels and improved efficiency explains why the

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growth of car costs is much lower in the year 2050, while for the air sector cost is steadily higher. The impact of fuel costs is also quite high for the overall costs in bus transport, while trains are less much affected since direct energy costs are only a small percentage of total operating costs.

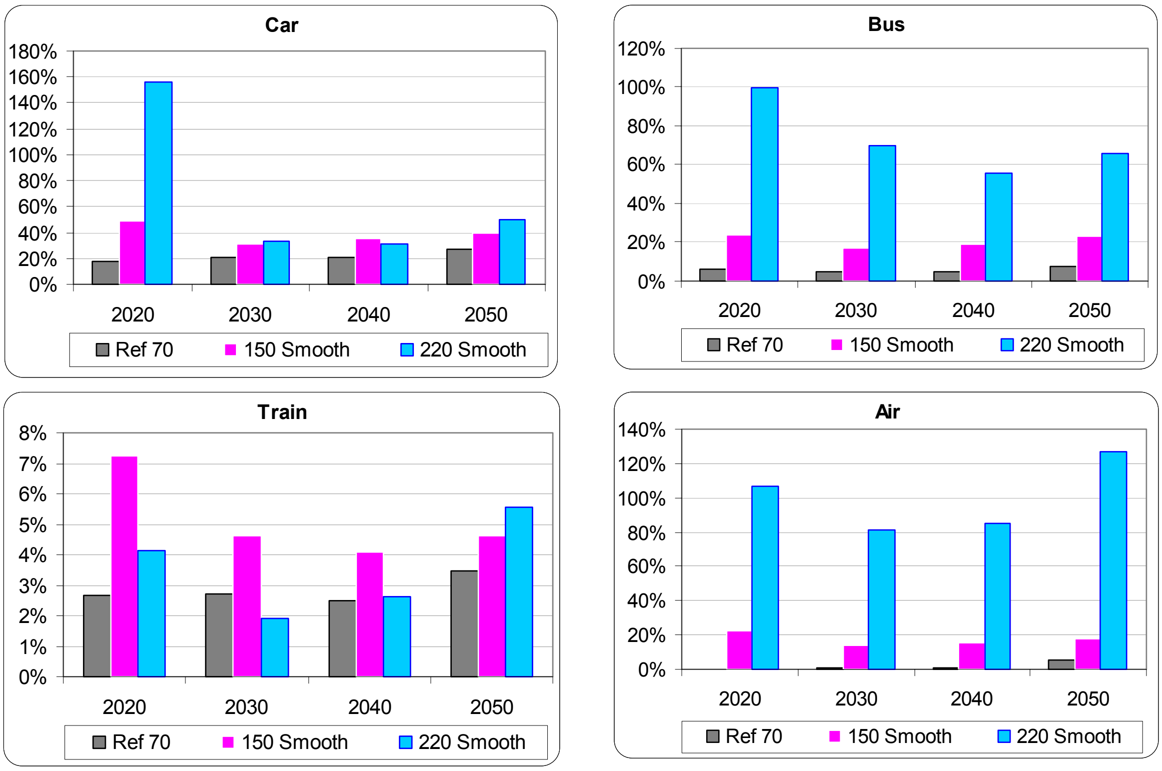

Figure 3 Relative change of the EU27 average cost per passenger-km with respect to the year 2005

Estimation of transport elasticity

The results presented above depend on transport elasticity. Here we report a comparison between the transport elasticities in ASTRA and literature values.

Table 2 reports the summary of the elasticities estimated. Intervals are provided as elasticities differ from scenario to scenario and also from country to country. The table reports elasticities for those modes whose demand is negatively affected by higher fuel prices. For remaining modes, substitution effect is larger than income effect so demand is higher. The formula used for estimating elasticity from the HOP! scenarios is the following:

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$$e = \frac{\frac{DS_{t+k}/DS_t}{DB_{t+k}/DB_t} - 1}{\frac{PS_{t+k}/PS_t}{PB_{t+k}/PB_t} - 1}$$

Where:

DS_{t+k}: Demand in the scenario *S* at the year *t+k*.

DS_t: Demand in the scenario *S* at the year *t*.

DB_{t+k}: Demand in the baseline scenario at the year *t+k*.

DB_{t+k}: Demand in the baseline scenario at the year *t*.

PS_{t+k}: Fuel price in the scenario *S* at the year *t+k*.

PS_t: Fuel price in the scenario *S* at the year *t*.

PB_{t+k}: Fuel price in the baseline scenario at the year *t+k*.

PB_{t+k}: Fuel price in the baseline scenario at the year *t*.

As in most of the scenarios, the fuel price shows a peak between 2016 and 2020, the estimation has considered this period of time.

Table 2 ASTRA transport elasticities

Demand category	Estimated energy price elasticities
Total passenger demand (pkm)	-0.2 / -0.5
Total freight demand (tkm)	-0.1 / -0.2
Car demand (pkm)	-0.15 / -0.3
Air demand (pkm)	-0.35 / -0.8
Truck demand (tkm)	-0.05 / -0.3

Elasticity of overall passenger demand is higher than elasticity of freight demand. The upper threshold of passenger demand elasticity is computed when a composite index of energy sources including electricity is considered. If one takes into account that the most relevant fuels for passenger transport are gasoline, diesel and kerosene and compute the elasticity with respect to an index of the weighted average price of such three sources only, the value of elasticities is generally below –0.2.

The elasticity of car demand is similar to the elasticity of whole passenger demand, while air demand elasticity is larger. Truck demand elasticity is of the same size of overall freight demand but with a larger variance (e.g. it is higher for Germany, where more alternatives are available, than for Slovenia).

Table 3 reports some literature values. Most of the available measures concern car, while other modes are much less covered. All road values come from a survey carried out by ITS Leeds for the Different study. From the table, it can be concluded that the elasticity of road vehicle traffic with respect to fuel price is quite low in the short run, but larger over the long-run. For the long run a typical value is about –0.3 both for cars and for trucks. ASTRA elasticities seem therefore quite in line with the literature values. For air elasticities, there is few literature, but it is quite a common view that air demand is more elastic then road demand and this is the case in ASTRA.

Table 3 Reference transport elasticities values

Source	Elasticity	Notes
Car vehicle-km		
Graham and Glaister (2000)	-0.15 (short-run) -0.3 (long-run),	
De Jong and Gunn (2001)	-0.02 / -0.20	Based on EU literature
The Netherlands National Model System	-0.02 / -0.25	
Hanly, Dargay and Goodwin (2002)	-0.05 / -0.17 (short run) -0.1 / -0.6 (long run)	Time series estimation based on 69 studies from various countries
Matas and Raymond	-0.34 (short run) -0.53 (long run)	72 road section in Spain, data from early 1980s to late 1990s
Johansson and Schipper (1997)	-0.05 / -0.55	
Air demand		
Gillen, Morrison and Stewart (2008)	-1.0 / -1.2	Air elasticity with respect to air own price
TREMOVE model	-0.9 / -2.0	
Truck vehicle-km		
Small and Winston (1999)	-0.25 / -0.35	Truck elasticity from a mode split model

Source: Erba et. al. 2007

2.2 The impact on the fuel market

High oil prices alter the relative competitiveness of various fuels towards less oil-intensive options. Changes in the fuel mix are therefore one of the most direct impacts of high oil prices, both in the transport and the overall energy system. The other main effect would be a reduction in energy demand particularly in transport but also of primary energy consumption that would be in-between 5% and 10% below reference levels in the period following the oil price shock.

Regarding the fuel mix of primary energy consumption, renewable energy carriers, coal and nuclear power would benefit most from the oil-price induced changes in the fuel mix in the order mentioned. Renewables would provide more than one third of the overall energy consumption, partly due to biofuels but also to renewable energy sources in electricity production, given that electricity will further gain in importance.

If we look more specifically at the fuel mix for transport, the fast deployment of biofuels become obvious as their relative competitiveness to the fossil substitute improves (see Figure 4). This, however, depends on whether investments in biofuels production facilities will be available: Scenario *150 Smooth no invest* shows that the biofuels share would hardly increase from reference levels despite the much improved competitiveness to the fossil alternative, if investments were insufficient.

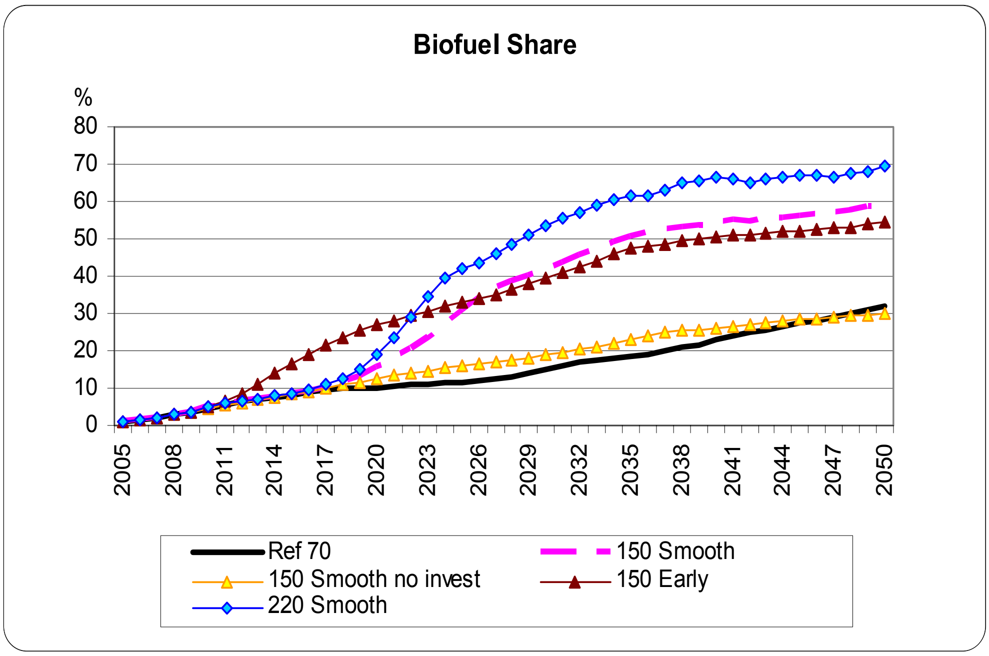

Figure 4 Share of biofuels in EU27 transport fuel demand

According to the model outcomes, the share of biofuels in transport gasoline and diesel demand would rise to 15% by 2020 if the oil price reached 150 €/bbl. Assuming a continuous increase of the oil price to 270 €/bbl by 2050, the share of biofuels would increase even further to deliver almost 60% of the transport fuel demand. The realism of such elevated biofuels shares may seen as questionable, in particular when having in mind the current discussion's about the EU's 10% biofuels target for 2020. Some key issues should be kept into account:

- Elevated oil price reduce transport fuel consumption. In the scenario 150 Smooth, transport fuel demand would be some 20% below reference levels, and 37% below its 2005 levels. Thus, a 60 % share by 2050 equals to 120 Mtoe. In the reference scenario, similar amounts of biofuels consumption would represent a share of 47 %.

- The shift to advanced biofuels is a key factor for achieving the high biofuels shares estimated. If only first generation biofuels were considered,

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their production would rise until around 2030, but stagnate afterwards. Indeed, cultivation of crops as a feedstock for first generation biofuels and food and fodder production can come into competition. Such competition effects are much less pronounced for second generation biofuels, which can make use of a much broader range of feedstock, including residues.

- The HOP! scenarios assume that around one third of the overall biofuels consumption is provided by imports rather than domestic production. In 150 smooth scenario, total domestic production of first generation biofuels in the EU would rise to 30 Mtoe by 2020 and 53 Mtoe by 2050. A number of studies indicate that in theory, such potential can be provided (see Thraen et al., 2006).

- This means first that all investments that are necessary for expanding the biofuels production capacity would be made available. In reality, this assumption can be doubted.

- Last, but not least, the biofuel share comes out of a market-based approach, ignoring value decisions between biofuel feedstock production, food cultivation and nature conservation requirements. As such, constraints in the availability of biofuel feedstock or of land are not explicitly dealt with.

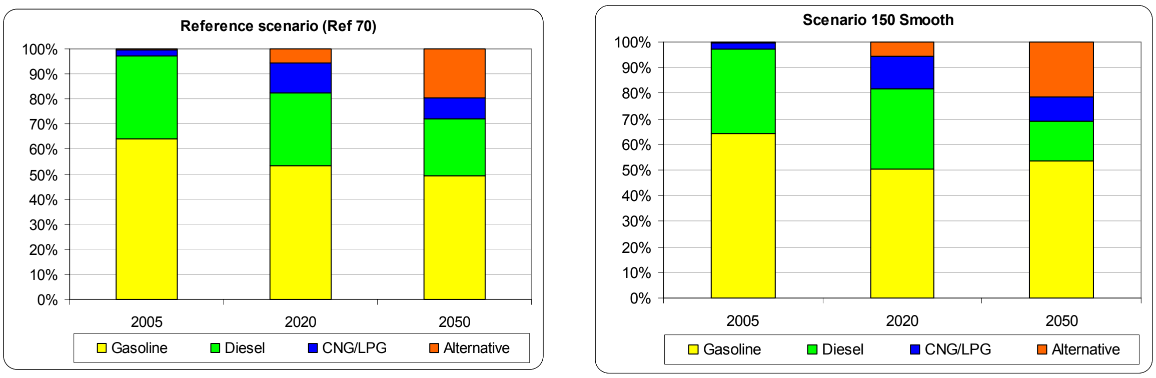

Figure 5 EU27 car fleet composition

Coherently, the car fleet is also changing. Figure 5 shows that innovative cars enter the fleet more significantly when oil price is high or very high. Including within the innovative cars: biofuels, hybrid, electric and fuel cells vehicles, their share is expected to be about 15% in the year 2050 in the reference case, while in case of high and very high oil price the share grows up to 21% and, respectively 30%. At the same time, also the size of the vehicle fleet is a bit lower in the high price scenarios. Nevertheless, even in the case of very high oil price, three out of four cars would be still conventional cars in the year 2020 and more than half of the fleet would rely on fossil fuels in the year 2050. Furthermore, a significant share of alternative cars would be biofuels car, i.e. using alternative fuels rather than innovative technologies. These results indicate that high oil prices alone will not induce major changes in transport to

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low carbon technologies even if they can accelerate the penetration of alternative vehicles.

Given all the response described above, transport fuel prices would change as depicted in Figure 6. The assumed oil prices of 150 €/bbl would lead to gasoline and diesel prices above 2 €/bbl in 2020, taking into consideration current and agreed fuel taxes[6]. Transport fuel prices increases remain below those of the oil price due to the dampening effects of fuel taxes and of substitutes such as biofuels that . Also the use of natural gas as transport fuel would rise despite an increase in natural gas prices due to the assumption of a certain link between oil and gas prices. Hydrogen prices would remain almost stable as the most important cost component for hydrogen are the investment costs. However, it has to be kept in mind that the main factor of the competitiveness of hydrogen as transport fuel are the hydrogen vehicle cost.

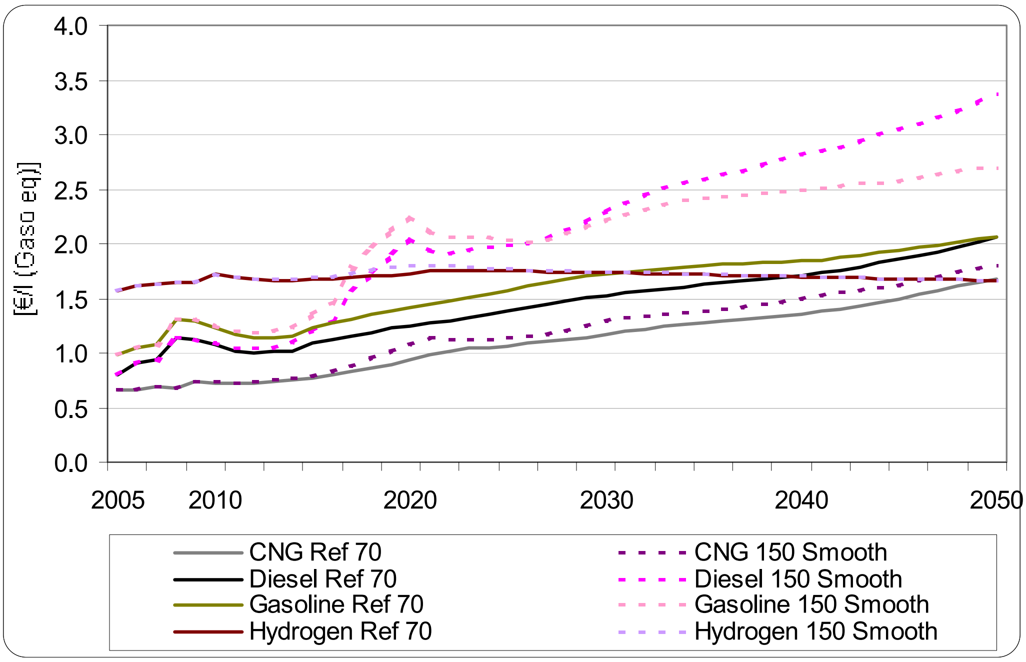

Figure 6 Average EU27 transport fuel prices

2.3 The impact on transport-related CO_2 emissions

Given the significant reduction of transport activity caused by the high oil prices and increased efficiency, transport energy consumption is reduced. Besides, the role of non-oil transport fuels would be strengthened, the most important of which would be biofuels (in the short run) with in general relatively lower specific CO_2 emissions than the fossil fuels they substitute.

As a consequence, transport CO_2 emissions would fall below reference levels. By 2020, the oil-price (150 €/bbl) induced changes in the transport sector would mean that transport CO_2 emissions were 2% below year-1990 levels instead of experiencing a continuous increase to be some 14% above 1990 in

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the reference case. Further emissions reductions are found for the periods thereafter as well as in scenarios with even higher oil prices.

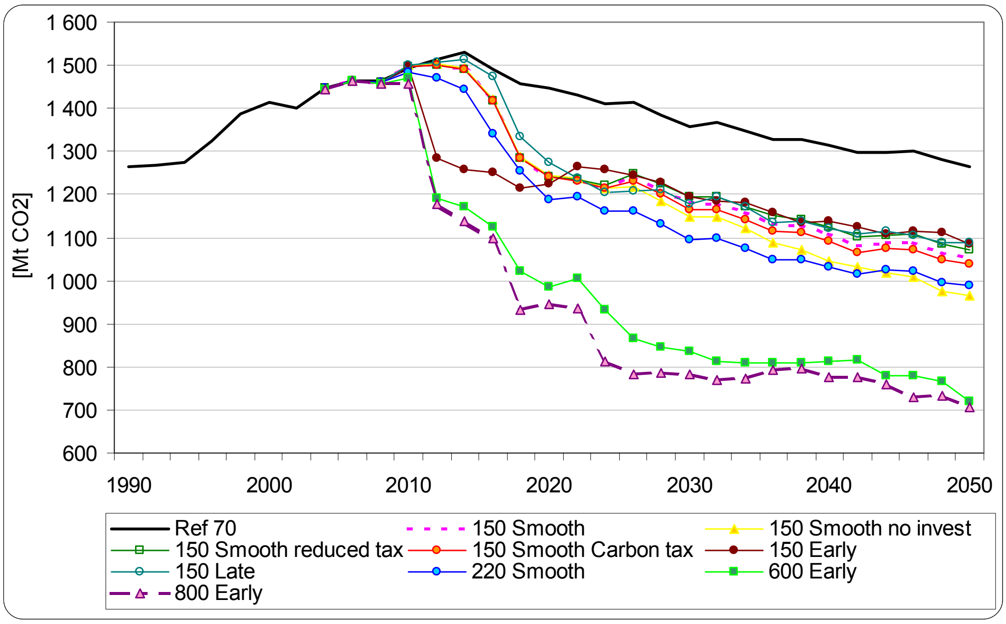

Figure 7 EU27 transport CO_2 emissions

Overall energy-related CO2 emissions would decrease even more compared to 1990 levels, largely reflecting fact that between 1990 and today, the transport sector showed the largest increase in emission. In scenario HOP! 150 Smooth, emissions would be reduced by some 7% in 2020 compared to the reference levels. Compared to 1990 levels this would mean that energy-related CO2 emissions could be reduced by some 14%

Note that POLES considers only the downstream emission and does not consider the emissions over the whole life-cycle. But even disregarding additional upstream emissions from carbon-intensive oil and transport fuel substitutes, the scenario results indicate that high oil prices alone will not be sufficient for reducing *overall* energy-related emissions to such a level that allows meeting the EU targets for 2020. It is thus important to maintain or even strengthen an active climate policy in times of high oil prices.

2.4 A transport-related impacts on the economy

One of the most significant outcome of HOP! is that even if economic development is affected by the high oil prices, a number of compensating mechanisms, such as investments into alternative energies, dampen the negative impacts of the high oil prices on the economy. In the end, even in the most extreme scenarios, GDP growth is stopped only temporarily[7].

Here we only report two specific results concerning the role of the transport sector. The first is the contribution of transport consumption to the development of GDP. The modelling results showed that the economic development in *150 Early* scenario is more favourable than in *150 Smooth*, i.e. if the oil price peak arrives in few years in the short term rather than progressively until 2020, the overall economic result for EU27 is better (despite an initial stronger negative impact).

Some reasons for this comes from the transport system. In *150 Smooth* scenario the consumption expenditures for transport net of all taxes increase by about 50 Billion €, which means that this amount of money has to be spent less for other sectors and this has negative economic impacts. Including taxes the amount is even higher since transport on average has a higher tax level than the other sectors. Instead, transport consumption in 150 Early remains at the level of the Reference Scenario.

The reason for this difference is that the smooth oil price increase causes in the peak a reduction of -7% new registration of cars compared with the reference Scenario, which is caught-up in the long-term. Though in *150 Early* scenario the same level of oil price is achieved the much steeper slope of the price increase causes a different reaction. The peak of reduced new registration of cars reaches -27% compared with the Reference Scenario and the new registrations never catch-up to the reference, such that transport consumption remains at the level of the Reference Scenario and the shift from non-transport consumption to transport consumption does not occur.

The second aspect linking the transport and the economic sector concerns the trend of government fuel tax revenues. Due to the reduction of energy consumptions, revenues from fuel taxes are expected to decrease (Figure 8). The reduction reaches levels between -15 and -30%, or in absolute terms 20 to 50 Billion € less revenues annually.

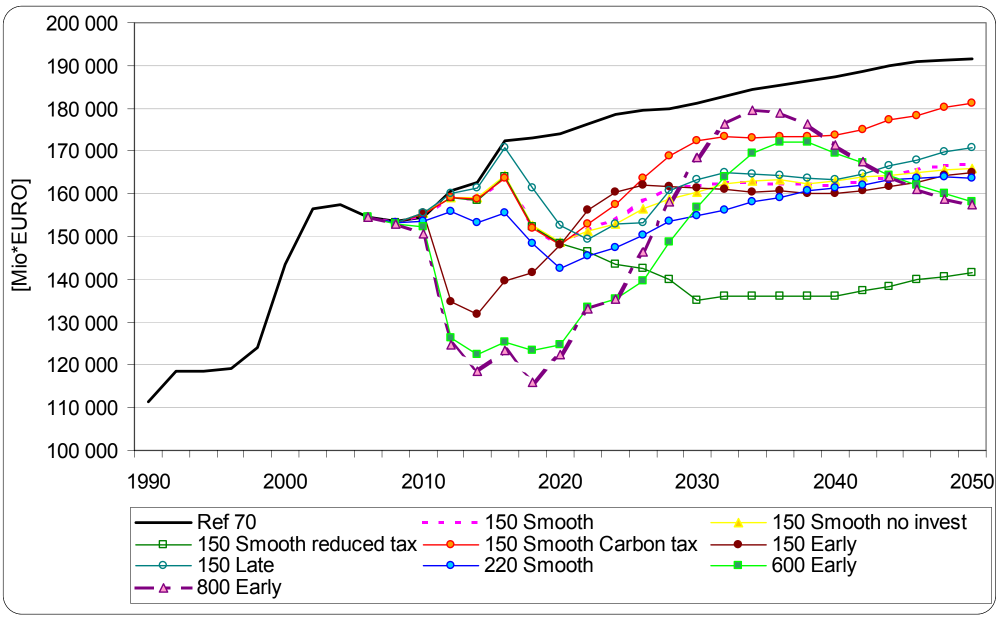

Figure 8 EU27 fuel tax revenues

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While the impact of a tax discount is minor in terms of demand activity (see paragraph 2.1), the effect is not so low if the revenues from the fuel taxes are considered. In *150 smooth reduced tax* scenario, revenues are lowered to even a lower amount than in the year 2000. This result can have some significant implication for transport policy.

Using the leverage of pricing and taxes to lead the transport system towards sustainability is one priority of the European policy as well as of national policies of at least some Member States. The effectiveness of pricing policies is linked to other objectives like fairness (e.g. polluters pay) but also to financial considerations since transport taxes provide a significant contribution to public budgets. For instance, the Dutch Government is studying a reform of the transport taxation where fixed taxes like registration taxes are abolished and the use of the vehicles is charged and, at the same time, guarantees budget neutrality.

However, fuel taxes amount to more than 50% of all transport tax revenues. When fuel taxes revenues are reduced as effect of lower transport demand, eliminating car-ownership fixed taxes would cut total revenues of about one third or more and even an additional carbon tax of the size simulated in *150 Smooth carbon tax* scenario would not alleviate significantly the loss, while larger taxes could be politically impracticable.

This suggests that the room for effective and viable taxing measures designed to meet transport sustainability targets could be quite narrow in a high oil price environment. This can be seen in the current developments of UK transport policy, where perceptions of high fuel prices are leading to the government cancelling some of its proposed tax increases on fuels for environmental purposes.

3. CONCLUSIONS

This paper presents several results from the HOP! project that assessed the impact of high oil prices on EU economy and transport sector by means of the application of strategic models. The results suggests that higher energy prices will likely have significant impacts on the transport sector, requiring it to to adapt to the new conditions. The main conclusions concerning the transport sector can be summarised as follows:

- Transport demand is reactive to higher fuel prices. Passenger demand is generally more elastic than freight demand;

- Transport fuel substitutes that currently occupy a niche market only, can enter the market in large quantities. Leaving aside sustainability considerations, i.e. if not constrained by food security or environmental considerations but left to market forces alone, biofuels could gain very high

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shares at oil prices of 150 €/bbl and above. Also hydrogen and natural would experience a boost in deployment.

- In the moderate HOP! Scenarios, high oil price contributes to the reduction of energy-related CO2 emissions. Yet substantial, the reduction caused by the high oil prices alone will not be sufficient for reducing GHG emissions so as to meet the EU target for 2020 and proposals for further reductions thereafter This indicates the need for maintaining active climate policies also in times of high oil prices.

- While the impact of a fuel tax discount is minor in terms of demand activity, the effect is not so low if the revenues from the fuel taxes are considered since they can be easily be reduced to even a lower amount than in the year 2000. This suggests that the room for effective and viable taxing measures designed to meet transport sustainability targets could be quite narrow in a high oil price environment.

Bibliography

Environment Council (2005): 2647th Council Meeting, Environment, 9. March 2005, Brussels, 6693/05. http://ue.eu.int/ueDocs/cms_Data/docs/pressData/en/envir/84322.pdf

European Council (2007): Presidency Conclusions of the Brussels European Council 8/9 March 2007. 7224/07. http://www.consilium.europa.eu/ueDocs/cms_Data/docs/pressData/en/ec/93135.pdf

Erba, S., Chiffi, C., Fiorello D., Suter, S., Hajdul, M., Matthews, B., Evangelinos, C. (2007) *Interim Report on Motorway Case Studies*, Deliverable 8.2 of DIFFERENT. Funded by European Commission 6th RTD Programme. Edinburgh, UK.

IPCC (2007) *Climate Change 2007: Synthesis Report*, Intergovernmental Panel on Climate Change, Vienna, Valencia.

Krail, M., Schade, W., Schade, B., Fiorello, D. (2007) *Outlook for Global Transport and Energy Demand*, Deliverable 3 of TRIAS (Sustainability Impact Assessment of Strategies Integrating Transport, Technology and Energy Scenarios). Funded by European Commission 6th RTD Programme. Karlsruhe, Germany.

Schade, W. (2005) *Strategic Sustainability Analysis: Concept and application for the assessment of European Transport Policy*, Nomos Verlag, Baden-Baden.

Thraen, D. et al. (2006) *Sustainable Strategies for Biomass Use in the European Context – Analysis in the charged debate on national guidelines and the competition between solid, liquid and gaseous biofuels*, IE-Report.

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Notes

[1] "The world faces the daunting combination of surging energy demand, rising greenhouse gas emissions and tightening resources. A global energy technology revolution is both necessary and achievable; but it will be a tough challenge" Nobuo Tanaka, Executive Director of the International Energy Agency (IEA) at the launch of the latest edition of Energy technology Perspectives (ETP), 6 June 2008.

[2] More details on POLES/BioPOL and ASTRA can be found in Krail et. al. (2007)

3 It should be noted that in all scenarios, oil prices are expressed in constant Euros2000 per barrel rather than in Dollars per barrel. This choice does not imply any assumption concerning the use of Euro as intentional oil trade currency. It is just the simplest way to focus the attention on the key aspect to be investigated in HOP!: how much oil will cost for the EU and what this will mean for the EU economy. Given the difficulty about making assumptions on the exchange rate, a reasonable value was selected fixed throughout the simulations.

[4] http://online.wsj.com/article/SB120451858896807177.html

[5] http://www.usatoday.com/travel/news/2008-05-15-memorial-day-travel_N.htm?csp=34

[6] Diesel and gasoline price are given as a mix of fossil fuel and biofuels.

[7] Results are much less positive for employment however. This requires to consider the sustainability (if not the feasibility) of a jobless growth. Furthermore, sensitivity tests demonstrated that the impact on the EU economy of oil price growth could be much higher if it caused an economic recession outside EU.