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HOP!

Macro-economic impact of High Oil Prices in Europe

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Angelo Martino
TRT Trasporti e Territorio
Milano (Italy)

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Partners: TRT - Trasporti e Territorio SRL, Milan, Italy (coordinator)

ISI - Fraunhofer Institute Systems and Innovation Research, Karlsruhe, Germany

IPTS - Institute for Prospective Technological Studies, DG-JRC, Seville, Spain

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Authors: Angelo Martino, Giuseppe Casamassima TRT

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1 Introduction

After more than a decade of cheap oil around 20 US$/barrel, prices have steeply risen lately. Today's oil prices reflect the increasing demand from fast-growing economies like China and India as well as supply shortages originating from geopolitical tensions and short-term market speculative movements. The reduction of oil production from OECD countries, as well as political instability in the Gulf region, Nigeria, and Venezuela contributed to higher oil prices. The prices for natural gas followed the oil price trends in general. Shortages in the natural gas supply from Russia, which emerged from a dispute between Russia and Ukraine, contributed to this development and have raised major concerns about energy supply security.

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 DG JRC (Spain).

In order to quantify direct and indirect impacts on the transport, energy and economic systems, a modelling approach has been applied by combining the global partial equilibrium energy model POLES with the ASTRA model, developed over the last decade as a strategic tool for the analysis of the interaction between transport, economy and environment. According to an already tested methodology, the two models are used in an interlinked way to run alternative scenarios corresponding to different sets of assumptions about cost of oil and alternative energy and transport technologies, making reference to the time horizon of the year 2050.

Given the features of the two models, the approach in HOP! was based on the assumption that market mechanisms allow energy supply to cater for energy demand. In particular, the models simulate that supply of alternative energy sources depends on price competitiveness and that investments are directed to alternatives and efficiency technologies such that energy is produced in the requested quantity. Government support of investments in response to high oil prices is not anticipated, though the debate on market failure suggests that designing suitable policies to either channel private investments into the required direction or directly invest public resources should be a major and urgent task for the EU.

2 Project team

The HOP! project involves three partners with a long record of common research projects, with one partner providing expertise in energy policy and modelling (JRC-IPTS), one partner with expertise in macro-economic and technologic assessment (Fraunhofer-ISI) and one partner being expert in transport policy analysis, transport and socio-economic modelling (TRT, coordinator).

The experts involved in HOP! workshops, composed by high profile members of the European scientific community, provide valuable feedback that is taken into account for development of the project methodology.

3 Project contact details

The project is coordinated by Angelo Martino, director of TRT Trasporti e Territorio. The contact details and the project website are as follows:

Angelo Martino
TRT Trasporti e Territorio
Via Rutilia 10/8 20141 Milano
Tel: +39 02 57410380
Fax: +39 02 55212845
E-mail: martino@trttrasportieterritorio.it.

HOP! project website**:** www.hop-project.eu

HOP! project logo:

The HOP! logo is displayed on all the documentation related to the HOP! activities as well as on the website.

4 Project background: high oil prices and their consequences

Oil has become expensive or, from another point of view, oil is no more extraordinarily cheap as it has been for several years. At the beginning of the HOP! project (January 2007) the oil price was of about 50 $/bbl, at the end of project (June 2008) price has risen up to 130 $/bbl or even more (figure 1). There is a general consensus among the experts that the rise of energy prices should be regarded as a structural condition due to the foreseeable trend of demand and supply[1]. 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 form the assumption of continuous growth of oil prices and look at the consequent impact on the economic system of Europe, paying particular attention to the transport and energy systems.

The global primary energy demand is projected to increase. According to Energy Information Administration (IEO 2008), the world energy consumption growth is projected at 1.6% to 2030, with fossil fuels being still dominant to 2030. In the reference scenario of the same study , the global oil consumption reaches 96 Mbbl per day in 2015 and 112 Mbbl/d in 2030. Transport demand, which uses up 95% of petroleum products, is projected also to increase.

To what extent the oil supply will meet the demand at reasonable oil prices is quite controversial. There is general uncertainty in defining the oil and gas reserves and resources, as oil proven reserves estimates can range from 800 to 1580 Bbl, while the amount of oil and gas discoveries that will be added to the reserve base as commercially exploitable in the next 30 years is also uncertain. It is generally acknowledged that OPEC members, who own 70% of world oil reserves and have relatively low production costs, can accommodate sizeable increases in oil demand. However, the actual OPEC response to demand pressures is difficult to predict and recent declarations of OPEC representatives do not prospect sensible increase of oil production. In addition, geopolitical tensions in Middle Eastern and other world regions may occur, provoking oil supply disruption despite the actual oil availability.

Analysing the production history of oil fields around the world, the Association for Peak Oil (ASPO) foresees the inevitable eventual decline in output from all fields. ASPO sees most scenarios for the growth of oil supply, including those of the IEA and IPCC, as over-optimistic, in the sense that they tell us more about where demand "would like to go" than where supply will be able to meet demand. The ASPO view that non-OPEC production is already in

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[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.

irreversible decline, contrasts to the analyses of IEA, which foresees a prolonged plateau in non-OPEC production levels. Also views on potential production in the Middle East diverge sharply, largely because data on reserves in the region are poor: while ASPO foresees an imminent peak, other analysts believe the peak might be far enough away.

On the basis of this general scenario, the HOP! project assumes that oil price will continue to be high in the short and long term future and investigates the impact of such a condition for the European Union.

4.1 Differences with previous oil shocks

In the discussions about the consequences of high oil prices the focus is most often on the experiences made during the oil crises during the 1970ies and the 1980ies. However, this reference may be misleading since conditions have changed since then.

First, in relation to major economic aggregates like total imports and GDP and despite continuous growth of oil consumption since the 1970ies, the imports of oil and fuel reach lower levels of relevance then in the oil price crises in the 1970ies and the 1980ies. Further, the overall economic setting today differs significantly from the past oil price crises.

Another significant difference today is the fact that the two largest countries in terms of population, China and India, are experiencing a fast economic development, which brings wealth to part of their population and stimulate the world economic development by both reducing the cost of many goods and services by cheaper production in these two countries and by increasing world demand through their imports, in particular of investment goods. The last two points can also be summarized by concluding that the past oil price crises were caused by a *supply shock* i.e. forced/voluntary reduced supply and higher prices, while the situation today is rather characterized by a *demand shock*, i.e. the strong growth of oil demand from the developing countries, in particular China and India.

Finally, two further issues play an important role to make the outcome of today's high oil prices different from those of the past: first, is the expectation on the duration of the period of high oil prices. In the past it was assumed that within a limited period of time oil prices would reduce to low levels again. This time the majority of economic agents begins to expect a sustained increase of high oil prices (in particular this becomes obvious by the annual IEA forecast, which each time in the last few years significantly increased their baseline forecast). Of course, policies and investment strategies can be designed quite different expecting sustained or only short-period high oil prices. Second, the number of alternative energies and technologies for energy conversion and use is much higher today than at the time of the past crises.

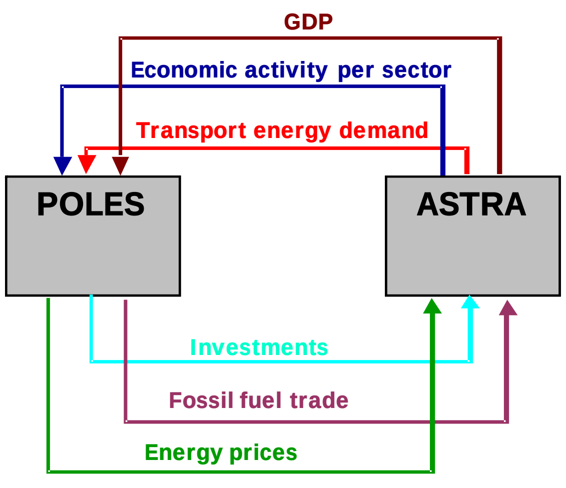
The case of the transport system is different from the other sectors of the EU economy, as transport is still fundamentally strictly dependent on oil. From this perspective it is interesting to mention that, as suggested by The Economist (May 31st 2008), “The first two oil shocks banished oil from power generation. How fitting if the third finished the job and begun to free transport from oil's century long monopoly".

5 Methodology

There are numerous direct and indirect impacts of high oil prices on the various sectors of the economy, even if focus is to be put only on the most relevant effects. Furthermore, many of the issues are interlinked and some impacts may lead the system to even turn into opposite directions. For instance, the impact of higher costs of energy and transport are expected to be negative on economic growth, whereas investments in alternative energy sources are expected to provide a positive contribution. According to which of the two effects is stronger and faster, the economy can react more positively or negatively. Overall, the final result can hardly be predicted on a qualitative basis and is likely to change over time.

For this reason, an analytical toolbox consisting of the two interconnected models – POLES (including the Biofuels model BioPOL) and ASTRA – is applied to simulate in a consistent way 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, as only POLES is a global model.

Figure 1 The interlinked models ASTRA and POLES/BioPOL



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.

The simulation of scenarios is an iterative process: POLES starts the simulation to provide starting results for ASTRA, whose interface results are transferred to POLES. Scenario run is then replicated in POLES to produce updated outcomes for ASTRA and so on. At the end of each iteration, results are compared with those of the previous iteration and the process was stopped when in both models differences are sufficiently small.

5.1 Key assumptions

As any other tool, also the HOP! models are a simplified description of the real world based on some theoretical approach and empirical findings. This means that not all impacts are covered at the same level of detail and that various assumptions are used in the structures of the model. Table 1 reports a summary of key elements that should be taken into account in the perception of the modelling results. As a whole, they describe a world where market is able to generate a peaceful development and where investments ensure economic growth and energy supply or reduce the need for energy. This is the perspective assumed in the HOP! models. If this perspective was not confirmed, i.e. if some of the assumptions adopted were not representative of the real world, energy scarcity could emerge and high oil prices could give rise to different results.

Table 1 Key elements for the simulation of the HOP! scenarios

Item		Modelled	Notes
A	Competition for oil supply	Yes	Only market competition. Military crises/wars are not considered.
B	Physical scarcity of energy supply	No/Indirectly Sensitivity analysis	As market operates to balance demand and supply, the latter cannot be significantly lower than the former (see also C). As military crises are not considered (see A), supply is always available from all producer countries to all import countries. Scarcity impacts are analysed with a sensitivity analyses.

Item		Modelled	Notes
C	Alternative energy sources filling gap of conventional oil supply	Yes	It is assumed that availability of alternative sources depends on price competitiveness, so when oil price grows and alternatives become competitive investments are directed to alternatives and efficiency technologies such that energy is produced in the requested quantity. Government support of investments in response to high oil prices is not anticipated, though the debate on market failure suggests that this would be an option for policy-makers.
D	Investments in additional oil supply and alternative energy sources	Yes	Changes of energy supply (technology) require investments. These lead to changes of energy costs affecting the consumption split and maintaining the budget constraint of households as well as the input structure of energy in the input-output tables for industry. Thus investments are assumed to be both funded by revenues of energy producers and by redirection of investment flows.
E	Energy price affects prices of other goods and services and therefore aggregate demand	Indirectly	An indirect mechanism to simulate inflation in case of high oil price increases has been implemented thus reducing disposable income and aggregate demand. Further, shifts of transport demand affect aggregate demand due to the different taxation of both the various transport modes and the transport and non-transport consumption.
F	Aggregate demand affects investments and employment	Yes	Investments are affected directly via changed sectoral consumption and indirectly via aggregate effects (i.e. the budget constraint of households reacting to energy price increases and the rough estimation of inflation). Employment reacts to the sectoral changes on the demand side i.e. changes of consumption, investment and exports (see also I)
G	Global trade flows	No / Exogenously	Would be important in order to deduce net impact for EU countries. Trade flows from EU to rest-of-the-world can only be exogenously affected to consider the impact of energy prices on world level (e.g. reduced world GDP growth -> reduced trade, increased exports to oil exporting countries),
H	Monetary and macroeconomic policy	No / Partially	It affects exchange rates, wages and therefore export, internal demand, etc. Varying exchange rates are not part of the models. Increases of government debt over Maastricht criteria levels reduce investments (crowding out).
I	Sectoral economic structure	Yes	Higher energy prices and transport cost affect directly the sectoral consumption and sectoral exports as well as indirectly the sectoral investment. Thus the sectoral structure of the economies are adapted by the higher energy prices.
J	Impacts on different income / person groups	No	High energy costs are expected to hit hardest the less well-off income / person groups. The models do not consider different impacts on different income groups and thus neglect this negative impact.

Item		Modelled	Notes
K	Biofuels demand outside EU	No	While the BioPOL model projects important biofuels shares in transport fuel demand as a result of the high oil price, no detailed prediction is made for the development of biofuels consumption in the rest of the world.

6 Project scenarios

To get a comprehensive picture of the economic impacts a series of scenarios have been defined and compared with a reference projection. In the reference scenario it is expected that the European economy continues to grow in the coming decades, where growth is measured as the growth of GDP in constant prices. The relative growth rate is expected to be much stronger for the new member states than for the member states before the year 2004 (EU15). For the new member states an average annual growth of about +2.7% is expected, while the EU15 grows by less than half of this speed with about +1.2%.

With respect to oil reserves and oil production the reference scenario refers to the optimistic assumptions that stem from the estimation of USGS on the worldwide oil and gas fields. USGS estimates an amount of ultimate recoverable resources of oil of about 3000 Bbbl of the world for the year 2020. Nearly half of such recoverable resources consists of reserve growth and undiscovered resources. This might result in an increase of world oil production. In the case of synthetic fuels and other fuels, we assume that they substitute transport fuels. Under these conditions it is expected that the oil price remain at a level of 70 $€_{2000}$/bbl until 2020 and might increase slowly towards 130 $€_{2000}$/bbl in 2050. It 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.

Individuals and freight mobility is expected to increase at different speeds when EU15 and more recent EU Member States are considered. The latter are forecasted to grow faster in the near future as impact of faster economic growth, higher incomes and motorisation rates. However, the expected decreasing of population in the Eastern Europe countries partially offsets these determinants resulting in a diminished growth rates for personal mobility. Air is expected to grow more than any other mode, almost doubling the total number of passengers-km at horizon of the year 2050.

Table 1 HOP! modelling scenarios

Scenario	Oil price in 2020 (€$_{2000}$/bbl)	Investment size	Investment target	Fuel taxes	Price growth path
Reference 70	70	Low	Efficiency & New Sources	EU directives	Stable
150 smooth	150	High	Efficiency & New Sources	EU directives	Smooth rise
150 smooth no invest	150	**Low**	**Neither**	EU directives	Smooth rise
150 smooth reduced tax	150	High	Efficiency & New Sources	**Reduced Tax**	Smooth rise
150 smooth Carbon tax	150	High	Efficiency & New Sources	**Carbon Tax**	Smooth rise
150 early	150	High	Efficiency & New Sources	EU directives	**Early Step**
150 late	150	High	Efficiency & New Sources	EU directives	**Late Step**
220 smooth	**220**	Very High	Efficiency & New Sources	EU directives	Smooth rise
600 early	**600**	High	Efficiency & New Sources	EU directives	**Early Step**
800 early	**800**	High	Efficiency & New Sources	EU directives	**Early Step**

Table 1 provides an overview on the HOP! scenarios. It should be noted that in all scenarios, oil prices are expressed in Euros$_{2000}$ 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. Given the difficulty about making assumptions on the exchange rate, a reasonable value was selected fixed throughout the simulations.

Additionally, oil price development in the HOP! project scenarios is not an input of the modelling tools, but it is endogenously calculated by POLES/BioPOL on the basis of the exogenous assumption on oil reserves availability and competitiveness of alternative energy sources.

- The reference scenario assumes high amounts of oil reserves and can be seen as an optimistic scenario. It reaches an oil price of about 70 €$_{2000}$/bbl in 2020, smoothly rising to 140 by 2050. Energy investment in energy efficiency and alternative sources follows a business as usual trend. Taxation takes the current excise duties plus the changes through the diesel directive into account.

- The 150 smooth scenario assumes a smoothly increasing oil prices which reaches a level of 150 €$_{2000}$/bbl in 2020. This leads to increased investment in energy efficiency as well as in alternative sources. A carbon value rising from 5 €/tCO_2 to 30 €/tCO_2 is taken into consideration.

- 150 smooth no invest scenario assumes that the level of investments remain more or less the same as in the reference run.

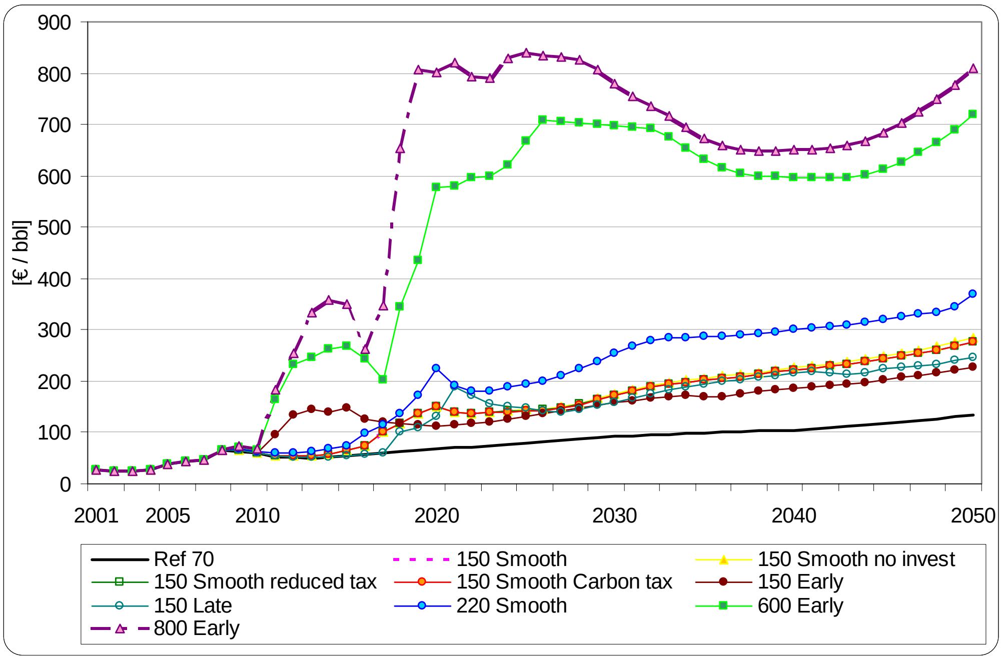
- 150 smooth reduced tax scenario and 150 smooth carbon tax scenario vary the taxation level: a tax reduction by 20% with the purpose to limit the increase of transport costs is assumed in the former and a carbon taxation raised to 30 €/tCO_2 aiming at higher tax revenues to compensate higher governmental investments is considered in the latter.

- 150 early scenario and 150 late scenario vary the way oil prices increase: in an early step between 2010-2012, which enables to look at the impacts of a steep rise of high oil prices right now, 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 scenario investigates a higher oil prices than HOP! 1 scenario (> 220 €/bbl in 2020).

- Two last scenarios 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.

Figure 2 Trend of oil price in various scenarios (Euro$_{2000}$/barrel)



Source: POLES calculations in HOP!

7 Summary of results and policy implications

In summary, the impacts of high oil prices on the EU economy during the peak periods are presented in Table 2[2]. Roughly a 1-percentage point loss of GDP would amount to a GDP of EU27 that is 100 billion € lower than in the reference. In most scenarios the GDP losses can be observed over at least one or two decades, in some even until 2050. Linking the results with the conclusions of the sensitivity tests it could be that the annual loss of GDP would reach even over 1 Trillion € for the EU27.

Table 2 Overview on GDP and employment loss in EU27 during the peak oil price period

Price peak	Characteristic	Loss in peak	
		GDP	Employment
Doubling	smooth increase	-1.5%	-4.8%
Doubling	smooth + limited investment	-2.1%	-5.4%
Doubling	smooth + reduced fuel taxes	-1.3%	-4.8%
Doubling	smooth + increased carbon taxes	-1.6%	-4.8%
Doubling	early + steep increase	-2.1%	-8.5%
Doubling	late + steep increase	-1.1%	-5.4%
Tripling	smooth increase	-2.2%	-7.8%
Extreme	early + steep increase	-3.8% to -5.1%	-22% to –32%
Sensitivity to specific shocks induced by oil crises			
World recession		additional loss: -1% to -5%	
Insufficient energy supply		additional loss: -5% to -11%	

Source: ASTRA calculations in HOP!

In terms of employment the numbers are more dramatic: a 1-percentage point loss of employment amounts to 2 million less employed persons in Europe, which means that even in the less drastic scenarios about 10 million jobs get lost in the EU27. Here, also the timing plays a crucial role such that with the early price peak the loss of jobs is nearly double than with the later peaks. This shows the important role of adaptation of the energy system, which for the later price peaks has developed further than in the early peaks.

The expected oil-GDP response to an oil price shock relationship would be, however, less pronounced than those observed for the oil price shocks in the 1970s and 1980s. This is due to the large variety of dampening effects on both the oil price and its economic impact. Compared to past oil price shocks, the oil intensity of the European economy has halved and the service sectors have increased their importance at the expense of the more energy-intensive industrial

[2] Due to the way scenarios are defined in HOP!, the point of time of this price peak differs, see paragraph above.

sectors. A broad variety of alternative energy technologies have become available, many of which would become competitive at the higher oil prices analysed. A crucial issue in this respect is the timing of measures to tackle high oil prices i.e. both investment into energy efficiency technology and investment into alternative non-fossil energy production technology. It is even realistic that due to these investments that would replace imported goods (fossil fuels) by domestic goods (e.g. renewable technology and maintenance of this technology), the overall impact on the economy would be positive. On the other hand, too late investment into such measures would make the impact of high oil price significantly worse.

The results of the HOP! scenarios may have several implications for the definition of future policies in the domains addressed by the analysis: transport, economy, energy. The main factors for the oil-price induced lowering of GDP growth are the shift in domestic consumption towards the energy sector, the reduction of value-added of the non-energy sectors due to higher cost of energy inputs into their products, which is not fully compensated by the increased revenues of the energy sector as this reveals a high import share, and the reduction in transport activity. The latter is particularly pronounced for passenger transport activity (some -14% points by a doubling of oil price and some -17% points by a tripling), but can also be observed for the transport of goods (some -11%). The high oil price would also reduce the dominance of road transport in the modal split, even if it still remains the most important mode. As a result of the decreasing activity but also due to the introduction of energy efficiency measures, final energy consumption in the energy sector would reduce by around -16% by 2030 (compared to the reference trend) for a doubling of the oil price, and around -26% at a tripling.

The HOP! results suggest that investments in alternative energy sources and energy efficiency are the key factor for dampening negative impacts of high oil prices. If investments were either not available or too late, the macroeconomic impacts of high oil prices in the EU-27 would be significantly greater. A first policy issue is therefore how to promote investments in the required size either directly through public budgets or by creating incentives that encourage investments of the private sector.

There are several channels through which policy affects investments. A government may decide to dedicate public budget to finance both research in the energy sector and implementation of new infrastructures and technologies or it may set the incentives to affect investment decisions.

Nevertheless, it is obvious that the private sector will need to carry large parts of the additional investment needs. There are a number of arguments that this would also be in the interest of the private sector. First, with the framework of the high fossil fuel prices investments into alternative energy technologies become more profitable as the prices of competing technologies increase. Second, the last decade saw a lack of promising investment opportunities e.g. documented by the fact that significant investment capital went into low productive real estate investment and into mergers and acquisitions. This means, lack of investment capital should not be the problem, presupposing that governments do not disturb the price signals and the expectations of a sustained high oil price. Third, uncertainty prevails in the energy markets with respect to two aspects: the actual price path of fossil fuels and the set of energy technologies that become successful in the medium to long run. Risk management of these uncertainties would also suggest the private sector to increase the portfolio of non-fossil energy technologies and thus invest into a diversity of alternative energy technologies. Fourth, due to the already existing legislative framework for renewable energies and the stimulated technology and market development the EU is in a lead market position for these technologies offering promising export opportunities and thus providing a further incentive to invest into the new technologies.

Policy can support investments of the private sector through various means: Fiscal and monetary policies can be used to influence investments from the private sector. For instance a differential taxation could be imagined for capital invested in energy efficiency and for capital gains obtained e.g. on the real estate market, in order to affect the expected net rate of return of the investments. Feed-in tariffs have been proven to be successful to develop new markets for renewable energy. Specific loans for house owners could provide the incentives for insulation of buildings, either together with the cyclical renovation of buildings or with the purpose to speed-up the renovation cycles. Such a measure would also be a promising element of a package to tackle the loss of employment as it would positively affect sectors with high labour intensity.

Moreover, the adoption of standards may prompt technical progress as standards create additional incentives for private businesses and enterprises to invest. Even though such a framework may be less needed in the times where very high oil prices already provide sufficient incentives for investments, they create a more stable, predictable framework than the fluctuating global oil prices. Standards for insulation of buildings and heating appliances would be one example. Energy consumption limits for vehicles would be another one.

HOP! results indicate that the behaviour and the treatment of the energy sector is crucial for the impact of high oil prices. Two particular reasons have been identified: first, especially the vertically integrated large energy companies are able to increase their profits drastically and thus would be one of the first players in the private sector who should undertake the strategic investment into a less fossil dependent and resilient energy system. Second, the way the energy sector forwards the oil price increase to the other sectors has been identified as a key for the negative impacts on employment. Only a halved forwarding of the price increase to the other sectors would reduce the employment loss by about 40%. The question here is: do the society interest to mitigate the impact of high oil prices and the private interest of the energy sector converge? Or in other word what to do, when the energy sector, and in particular the large vertical integrated companies, would not invest a large share of its additional profits derived from the high oil prices into alternative energies and energy efficiency?

The HOP! results actually would support government intervention, in particular as several market failures in the energy sector have been identified, which usually are a prerequisite for government intervention. Such intervention should only happen under certain conditions, of which the first would be that the energy sector would not significantly increase its investment into alternative energies and efficiency. In this case, an additional taxation of the profits seem to be justified, eventually together with a moderate limitation of price forwarding by the energy sector to dampen the impact on employment. The tax revenues clearly would have to be dedicated only to support measures to increase the investment into energy efficiency and alternative energies. Of course, the better solution would be that governments manage to set the incentives right such that the energy sector invests driven by its own private interest.

The third policy-sensitive aspect concerns lower income households. In the HOP! analysis it could not be analysed the impact of high oil prices on different groups. In Germany, it has been shown that inflation rates differ at least by a factor of two between low and high income groups, as e.g. the former have to spend about 14% of their income for energy while high income groups spend about 6%, only. It is likely that even if on average the European economy can live with higher energy prices, less well-off households will not be able to cope with significantly higher expenditure for heating, electricity, car fuel, etc. Furthermore, the modelling simulations suggest that even if GDP growth can be maintained with high oil prices, employment is more at risk due to structural change that favours sectors with higher productivity and thus lower labour intensity e.g. energy sector. In case of jobless economic growth, the inequality of income distribution would rise as well as the number of less well-off households. This prospect suggests that if the promotion of investments in energy efficiency and alternatives should be on the top of the political agenda in a high energy price world, the definition of specific policy to address social impacts should also be ranked high. With this respect it is important that lowering the energy cost by tax reductions did not cause a positive stimulus in macroeconomic terms. Similar should hold for direct subsidies. Instead, following the HOP! line of arguments that investments are they key to solve the problems, the less well-off households should better be supported by adapting their technology and behaviour. One suggestion would be a kind-of micro-credits funded by the government and (partially) paid back by the energy savings. The micro-credits would be used e.g. to finance energy efficient appliances (e.g. A++ fridges). A further example from Germany would be energy consulting where an energy consultant directly advices the households how to save energy (e.g. offering a package of energy saving lamps, electricity metering and regulating appliances). In the German case it is estimated that such a package would cost about 60 € but saves 120 € energy cost annually.

If high oil price is one of the critical issues at the global level, climate change is another one. It is important to note that even though investments in oil substitutes can contribute to high global warming, this is not necessarily the case. If, on the one hand, high oil prices would lead to a massive exploitation of unconventional oil resources and the use of coal-based transport fuels (CtL), emissions would rise compared to a reference scenario that is based on conventional oil. On the other hand, a number of technological options can simultaneously decrease oil consumption and lower greenhouse gas emissions. Such options include renewable energies and fuels, and above all, energy savings.

In order to guide investments into low-carbon alternatives, it is important to maintain or even strengthen an active climate policy in times of high oil prices. This can be challenging as there is pressure to reduce “green” taxation in order to dampen the effect of high oil prices on the end user.

The historically singular boost of oil prices together with an increasing spectrum of technological options leads to a restructuring of the energy sector and can push technologies that currently play a minor role. Policy action will have to respect that those innovative technologies might exert important side-effects when entering the market in large quantities, much larger than those expected to be realistic in times of moderate oil prices. Those side-effects of e.g. biofuels or unconventional oil and CtL may put at risk the achievement of overarching EU policy goals, such as stopping the loss of biodiversity or further reducing GHG emissions. Detecting such negative impacts rapidly and ultimately introducing policies to limit them to acceptable levels is a challenge to policy-making that indirectly results from the high oil prices.

Given the importance of energy savings, policies addressing consumer behaviour also play an important role in limiting the effects of high oil prices. Transport is a key sector where policy can play a role to drive positive changes. On the passenger side different mobility choices (e.g. reduced distances travelled, different modal split) require availability of alternatives (public transport, bike lanes, land use). On the freight side, logistics optimisation requires cooperative approach among players and agreed energy footprint metrics.

Thus the plea for investments into new technologies should not conceal the findings of many earlier studies that the conglomerate of major problems (e.g. high oil price, climate change, poverty and hunger) could not only be solved by technology, but also requires behavioural changes. Thus governments should also take care to stimulate behavioural change by increasing awareness of the problems and the solutions, educating the youth accordingly and provide the people the instruments to consider the problems in their daily decisions e.g. by simple tools as labelling energy efficient and CO_2 lean products or by setting the prices right to reflect negative external effects.

8 Conclusions

The HOP! research project has estimated the direct and indirect effects of a long term future oil price escalation on the EU's economy, energy and transport systems based on a combined systems dynamics modelling approach. Different high oil price scenarios have been tested using the ASTRA transport and macroeconomic model and the POLES partial equilibrium global energy model in an iterative modelling process until the year 2050. The modelling application is based on the confidence that market mechanisms and alternatives to oil can avoid energy scarcity at the global level.

The overall conclusion of the project is that high oil prices have a significant economic impact in the short-term and may have a limited impact in the medium- and long-term. In general the impact on employment is more severe than on GDP. The effects on investments are critical to shape the final macroeconomic outcome. In the first instance a high oil price will have a negative effect due to increases in costs in many areas of the economy, but this can be offset by the boost of investment induced by the search for alternatives to fossil fuels and for efficiency technologies. The key messages derived from the HOP! scenario analyses can be summarized as:

- GDP and employment are negatively affected during the peak period of the oil price increase with employment being reduced significantly stronger.

- The impact after the peak period of oil price increase strongly depends on the mechanisms kicked-off by the price increase. Mitigating the impacts by investing into energy efficiency and alternatives could even lead to a positive economic impact in the medium to long-term, while a world recession or a situation with insufficient energy supply could multiply the negative impacts by factors of 5 to 10.

- A rapid price increase over a few years, if not reaching the extreme levels of 600-800 $€_{2000}$/barrel, would be advantageous compared with a smooth price increase since the shock most effectively triggers the compensating mechanisms in particular the investments into energy efficiency and alternatives. This presupposes that investors expect a sustained oil price increase and not a temporary one, and that governments do not take actions to lower the fossil fuel prices artificially distorting the price signal.

- The most relevant impact to counterbalance the negative impact of high oil prices are investments into energy efficiency and alternatives, as first they directly provide a positive stimulus for the economy as part of final demand and as second they indirectly help to reduce the vulnerability of the economy to oil price increases by reducing energy demand, energy cost and imports of fossil energy. If investments were either not available or too late, the macroeconomic impacts of high oil prices in the EU-27 would be significantly greater.

- In terms of impacts on employment the most important issue is how the energy sector can forward the price increase to other sectors. Full forwarding of the price increase causes the strong losses observed for employment and boosts the profits of the vertically integrated large energy companies. Limiting price forwarding, either indirectly by the energy companies reinvesting their profits into efficiency technologies and alternatives that are produced domestically in the EU or directly by the government taxing the profits and creating investment incentives into efficiency technologies and alternatives by subsidies, would strongly reduce the negative impacts on employment.

Overall, the conclusion is that oil scarcity and oil price shocks can have significant negative impacts on the EU – but they need not, if the EU prepares itself adequately. A first policy issue is therefore how to promote investments in the required size either directly through public budgets or by creating incentives that encourage investments of the private sector. Looking at the fast decreasing mid-term oil production forecast, the EU should have enough reasons to prepare.

9 Project dissemination

The project dissemination activities developed mainly along three channels (see also the Annex Final plan for using and disseminating the knowledge):

a. the website explaining the project, disseminating results, providing deliverables for download and distributing information about the two project workshops;

b. the participation at a number of conferences to present HOP! (e.g. the Economic Modelling Conference in July 2008, the conference of the Italian Association of Energy Management in September 2008, the European Transport Conference ETC on October 2008, The Energy and Sustainability 2009 Conference in Bologna);

c. the organization of the two project workshops in Brussels.