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Mobility in a Globalised World

Jan Werner, Eric Sucky, Niels Biethahn, Gerd Grube
(Hrsg.)



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Relevance of oil prices for mobility today and in the next decades

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Abstract

The paper discusses the role of crude oil prices as an important cost factor for individual and collective mobility. After a short introduction, there will be three further sections. Section 2 covers a general discussion of the relevance of oil today and also several scenarios for the future demand development will be discussed. In section 3 some oil price forecasts will be presented and compared to fundamental cost parameters. The paper ends with a conclusion section.

1 Introduction

Mobility is an important factor in a globalized world. This paper focuses on the cost aspects of an increasing need for mobility, here translated into transport costs.

Even if the recent discussion on is dominated by alternative technologies and fuels (E-cars, CNG, biofuels, fuel cells, hydrogen etc.), most of the worldwide energy needs in the transport sector is still covered by oil products such as Diesel, gasoline or fuel oil. As these product prices are fully correlated with the crude oil price, fluctuations on the world oil market are fully passed on to the transport sector.

This paper first (section 2) discusses the current role of oil in covering the world demand and the transport sector. Also some future scenarios are discussed with special emphasis on the future energy demand and the supply mix in the transport sector. Afterwards some oil price forecasts will be discussed. This will be supplemented by a fundamental view on the physical and commercial availability of oil resources (section 3). Conclusions will be drawn in section 4.

2 Oil demand today and in future

2.1 World primary energy consumption

Oil is nowadays still the most important primary energy source worldwide (see left side of Figure 1). Even a drop in demand after the oil crises in the 1970s/early 1980s and an increase of other conventional fuels (especially coal and gas) in the last decades haven't challenged the role of oil as the leading energy. And it is also worth to mention that the latest world financial crisis starting in 2008 hasn't eroded the growth of energy demand (which of course accounts for all energy sources and not only for oil).

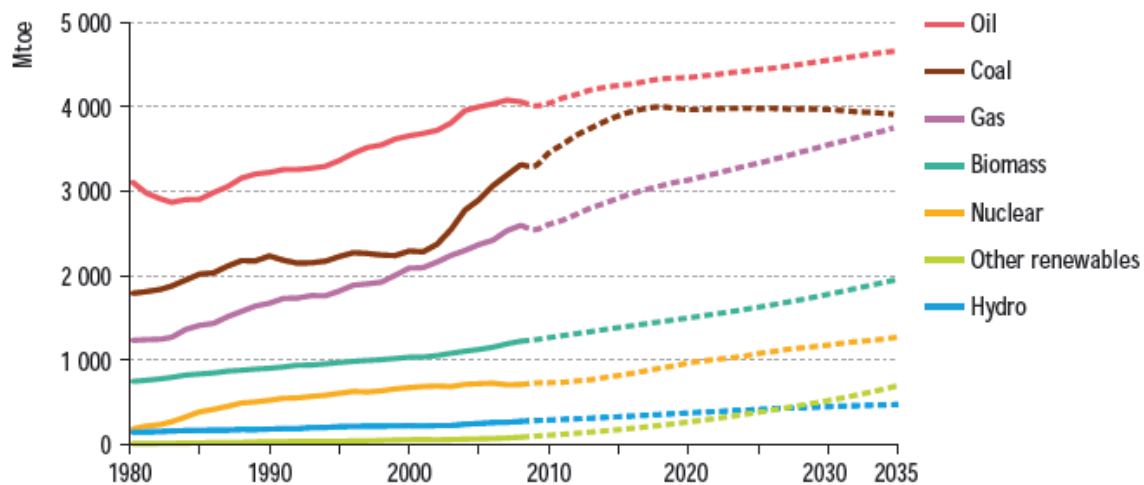


Figure 1: World primary energy demand in the past and in IEA's New Policy Scenario¹

¹ See IEA, 2010a, page 84.

On the right hand side of the figure above, a future view of the energy demand for the next 25 years is indicated. The forecast presented is the “New Policy Scenario” published by the International Energy Agency (IEA) of the OECD. It represents a moderate set of assumptions, considering measures to reduce energy demand and CO₂-emissions – but on an economic reasonable basis. Other scenarios published in the latest issue of the “World Energy Outlook” are defined as more extreme variations of the future development: a “Current policy scenario”, which assumes no further enhancement of environment and climate policy and the so called “450 scenario”, which includes massive measures to reduce CO₂ emissions. The first one sees an even stronger increase of world energy needs, the latter end up with a demand in 2035 which is slightly lower than today. But however, oil will be the most important energy source in all scenarios.²

Of course, other forecasts exist - and other assumptions usually produce other results. But the most comparable studies, meaning such covering the whole world and all sectors and which are based on (at least some kind of) economic modeling, tend to support the general conclusion that oil will keep its position at least until 2030.³

Some more regional focused studies (as well as those only focused on one sector, e.g. electricity generation) could tend to see higher shares of renewables or other sources or even replacement of oil by alternative sources. But once again, usually the role of oil as the world’s leading primary energy source is not challenged within the next 20 or more years.⁴

2.2 *Energy demand in the transport sector*

Since the oil crises in the 1970s/1980s the position of oil has been challenged in several sectors. Especially in the electricity sector, oil products are more or less fully displaced in most countries. In other sectors, oil loses massive market shares to competing fuels - but is not (yet) displaced. This is e.g. the case in the space heating sector in the majority of industrialized countries, where gas or district heating overtaking oil-fired heating. In contrast to these applications, only very small limited achievements have been made in the transport sector. As been shown in Figure 2, oil products (Diesel, gasoline, jet fuel and heavy fuel oil) still cover the vast majority of energy needs.

Forecasts focusing on the transport sector provide very wide ranges of the future share of oil products. In principle, two key parameters influence the result: the total demand and the share of alternative energy sources in the supply mix. As with the primary energy forecasts discussed above, results for smaller geographic regions or countries could show a more or less full displacement of oil, but in worldwide dimensions this is realistically not possible. Figure 2 summaries the results of several scenarios from the IEA.

² See IEA, 2010a, page 80.

³ E.g. see EIA, 2011, ExxonMobil, 2010, or Shell, 2008.

⁴ Examples for country or regional specific analysis are EU (2010) and EWI et al. (2010).

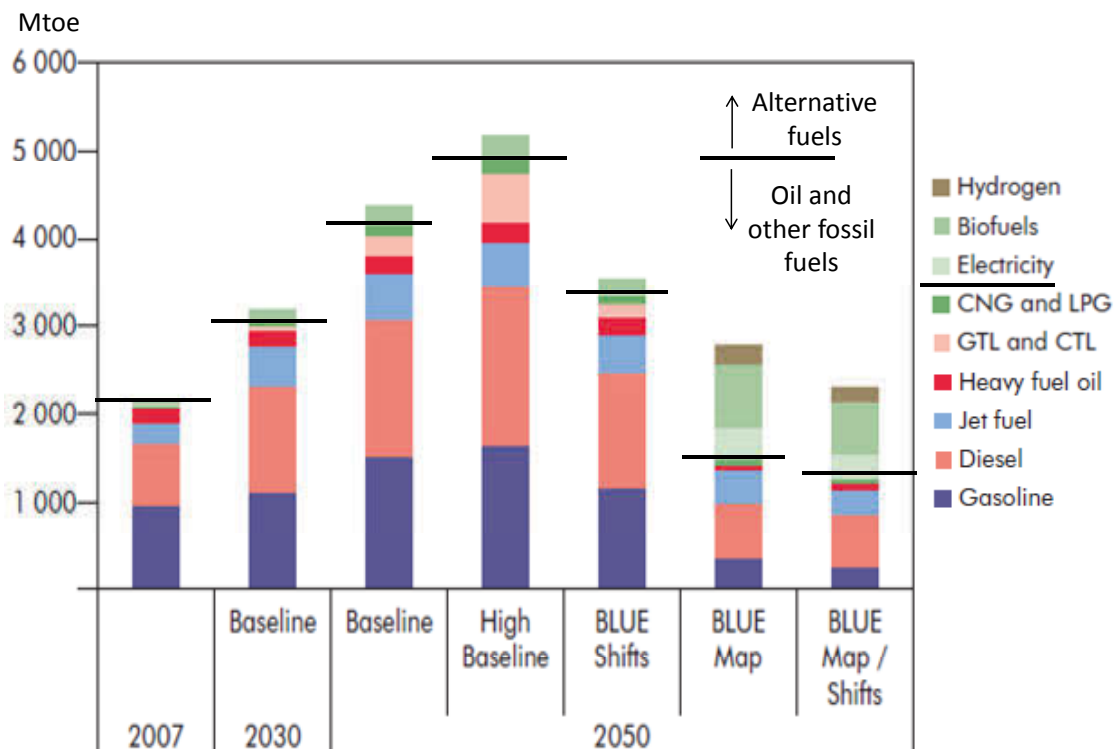


Figure 2: Evolution of fuel demand in the transport sector in various scenarios⁵

The “Baseline” scenarios see only a gradual replacement of oil which, in combination with a strong increase in total demand, leads to significant higher oil consumption than today. The “Blue” scenarios are more optimistic about the potential of new energy sources (especially electricity and biofuels) – but none of them forecasts a full replacement of oil products, even in 2050. In contrast, in all scenarios oil products stays the most important fuel type. Depending on the specific scenario assumptions, the combined share of Diesel and other oil products is forecasted to be between around 50% and nearly 95%.

2.3 Impact of oil prices

As shown in section 2.2, oil will remain the most important source to cover energy needs in the transport sector. When discussing the development of the future costs of mobility, it is obvious that the oil price will be the key element. A very important fact to consider is that the oil price is not only relevant for the share of oil products - which is already very high in all scenarios. Also other fuel types are directly or indirectly influenced by the world oil market.

Given the recent price developments this is not an unproblematic circumstance. As shown in the figure below, a dramatic price increase has taken place between the very

⁵ See IEA, 2010b, page 265.

low price level after the Asian financial crises in 1997 and just before the emerging of the latest world economic crisis which starts in 2008. This increase by a factor of approx. 10 is very notable, but not the first time in history of oil prices such a price boost has happened. A comparable situation has taken place in the early 1970s, when crude oil prices exploded from less than 2 USD/bbl to 12 USD/bbl in context of the so called first oil crises. Even if the absolute level of the prices (not only in nominal but also in real terms) is quite low, the impact on the economy has been more dramatic the last price increase. This is driven by the fact that in the early 1970s the share of oil on the primary energy supply was significantly higher than today. Since then, several measures, especially in the OECD countries, have been implemented to reduce dependency from oil. Of course, as discussed in the section above, the transport sector was more or less exempted from this demand trend.

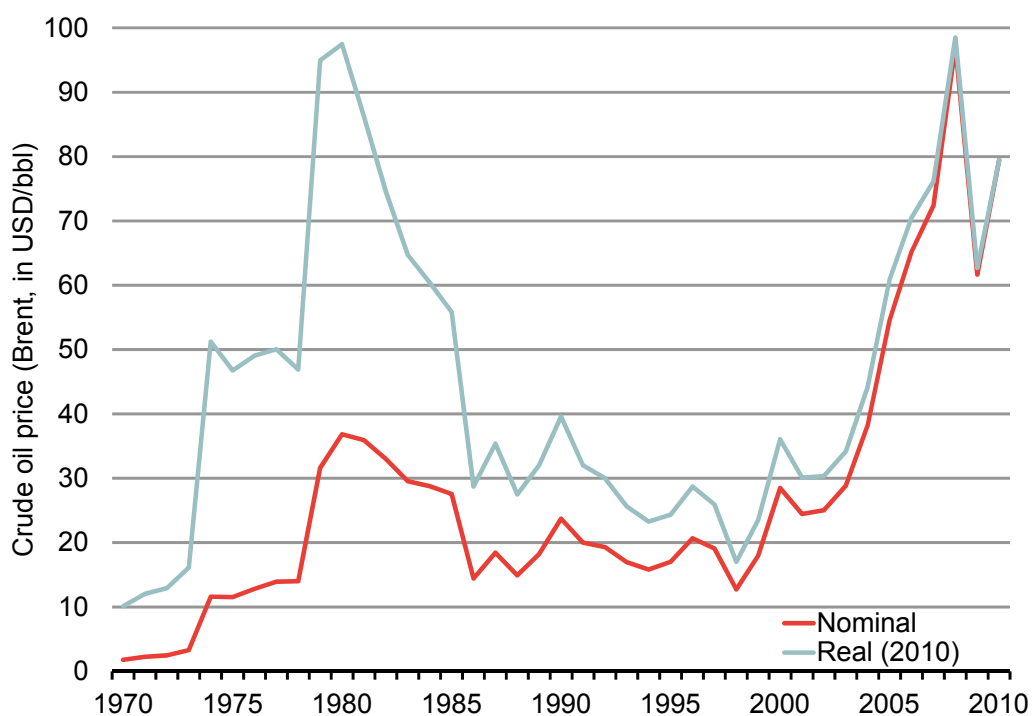


Figure 3: Historic price development of crude oil⁶

As discussed in section 2.2, oil products will also satisfy the majority of energy needs in the transport sector. The presented scenarios provide a wide range of possible shares from approx. 50 to nearly 100% of the demand. Of course, other scenarios from other institutions would produce an even wider range. However, the direct share of oil products is not the only relevant figure that gives an indication over future impact of oil prices on the mobility costs. Also other fuels rely on the oil price and by this consumers of these fuels also suffer from increases of this price (and of course, in turn would benefit from price declines). The economic relationships could be summarized as followed:

⁶ Data source: BP, 2011.

- Oil products: all products are fully correlated with crude oil (depending on the product, the correlation coefficient is between 0.96 and 0.99). Diesel, gasoline and gasoil have prices above the crude price (plus refinery margin and product specific factors), fuel oil is traded below the crude oil price (as it is a residual product with unfavorable environmental characteristics and has only limited applications). Also LPG (Liquefied Petroleum Gas) is an oil product and fully correlated with crude oil.⁷
- Natural gas: usually gas prices are highly correlated with oil prices. In most countries this is driven by price formulas with oil indexation in long-term import and domestic supply contracts. This is the case for most countries worldwide (e.g. Asia, Eastern Europe, and Latin America). Also in Western Europe, the majority of gas is still priced under the regime of oil-indexation, even if in recent years progress has been made in establishing gas markets where supply and demand situation of gas is the driver and not the price of another energy source (oil in that case). Nevertheless, with the exemption of the UK, oil indexation is still a key parameter for gas prices, especially in medium and longer terms. But also in the UK and the US (the country with the by far most developed gas market) the supply and demand driven gas prices show a high correlation to oil prices. In their case it is not forced by formulas but by downstream competition between oil and gas as well as a lot of similarities and common factors on the upstream side (e.g. same producers, fields producing both gas and oil).⁸ This applies also for GTL (Gas-to-Liquids), which is the production of synthetic Diesel with gas as input parameter.
- CTL (Coal-to-Liquids): Synthetic fuel produced by converting coal is (and most likely will always be) a rather exotic product. However, even if it will gain significant market shares from oil products, the dependency on oil prices will not fully be cut. Long-term price analysis show that also coal prices react on oil price movement, although to a much lower extent as for gas.⁹
- Electricity: In modern electricity markets the price is formed by the competition of different generation technologies. As renewables are usually outside this market process and supported by subsidies conventional power plants define the electricity price for the majority of hours in a year. As lignite and nuclear power have very low variable costs, gas and hard coal are the most important price drivers for electricity (modified by CO₂ prices). As discussed before, both energy sources are correlated with the oil price. By this, also the electricity price is in the long-run influenced by the oil prices. But given the indirect impact chain the relation is less close as for gas or coal. Also short-term prices could vary significantly.¹⁰
- Alternative fuels: Biofuels are to be expected to become an important energy source in the future. In principle, no direct relations between biofuels (e.g. by us-

⁷ See Frontier Economics/EWI, 2010, p.174.

⁸ Energy Charter Secretariat, 2007, chapter 4, provides an elaborate overview over pricing mechanisms for natural gas.

⁹ See IEA 2010a, p.73.

¹⁰ The economic fundamentals of modern electricity markets are described in Kreuzberg, M., 2001.

ing biomass such as sugar or rapeseed) is economically inherent. However, the country specific regulations and technical implementation often not allow the establishing of a fully independent pricing system. This could be the case if biofuels are used as an addition in oil products (e.g. E10 in Germany). But also for the case that in future a separate market for biofuels (i.e. a mass market and not a niche) one could expect that retailers and traders also keep an eye on the main competitor oil. By this economic substitution competition the oil price is always of importance for alternative products, but to a lower extent as for gas. This argument also accounts for hydrogen technologies.¹¹

Summarizing these economic relationships between the various substitutes it is obvious, that the oil price will keep its important role in the transport sector. This could be either on a direct (by using oil products) or on an indirect way (by using substitutes which are price correlated or at least face competition to oil). Of course, higher portions of non-oil fuels limit somehow lower the impact but could not eliminate this completely.

3 Oil price forecasts

As oil prices will keep its impact on transport costs on direct or indirect channels it is important to have an - as far as possible – clear view on the future developments. International institutions as the IEA, EIA or EU regular publish price forecast which are based on models (or are used as a model input). Usually several scenarios are defined (e.g. the above introduced scenarios by the IEA) covering several possible variations of input parameters (e.g. GDP, population growth, reserve situation).¹²

Figure 4 illustrates a range of price forecasts as derived from recent IEA, EIA and EU scenarios. It is somehow amazing, how wide the range of these forecasts is. In 2030 the difference between the lowest and the highest price path is more than 230 USD/bbl, which is around double as high as the price level today (around 115 USD/bbl as of September 2011).

The forecasts from the institutions are not the only available views on the future development. There are numerous publications by bank analysts, academics, lobby associations, energy companies and self-proclaimed “experts”, to name only a few. Their views are not shown in the graph, as

- usually the validity duration of these forecasts is very low (especially banks and “experts” tend to overstress recent developments and not focus too much on fundamentals and long-term trend),
- their assumptions and methodology is often unclear, and
- the price forecasts are often formulated somehow vague (like “I could imagine the oil price will be more than 200 USD/bbl in the future” without going too much into details like real or nominal prices, which oil quality, which year and so on).

¹¹ See Bukold, S., 2009, for an overview over biofuels and other alternative fuels.

¹² See Energy Charter Secretariat, 2007, for oil market fundamentals.

But also if only focus on transparent and reliable forecasts as shown in the figure the spread is much too wide for inspiring confidence. And it doesn't really provide a helpful guidance for policy makers or investors.

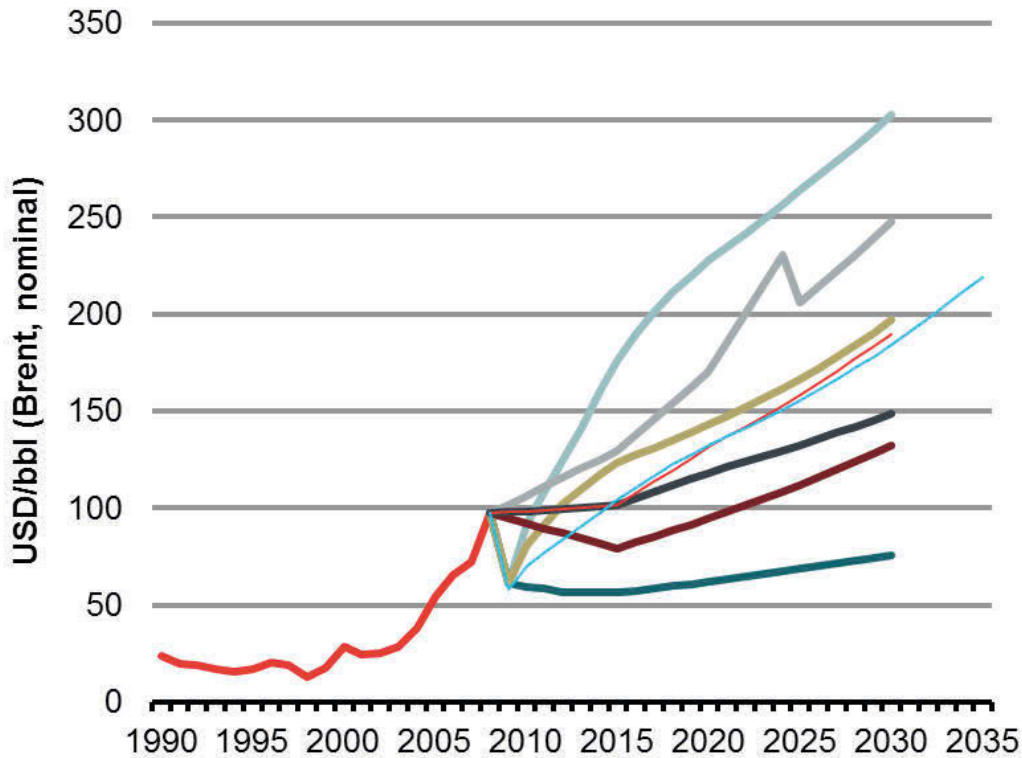


Figure 4: Historic price development of crude oil (red) and selected forecasts¹³

Most high price oil forecasts are driven by the assumption that the world is facing a physical scarcity of oil. In such cases often a mismatch of short-term production capacity and actual demand is mixed with long-term resource availability. By comparing reserves and resources of oil with assumed future demand, it becomes obvious that no physical shortage will occur in the long-run. Figure 5 illustrates this by using the above introduced New Policy Scenario as an example for future demand development. The red bar summarizes the cumulated demand between 2010 and 2035. By comparing this with the total volume produced in the past (the yellow bar) one could see that in the next 25 years mankind will consume more than 50% of the oil used since the start of commercial oil business around 150 years ago. Nevertheless, when focusing on the remaining resources instead, the ratios change. In theory, the demand in the next decades could be completely sources by low-cost oil sources (labeled “MENA” = oil from Middle East and North Africa and “Other conventional”) – as it has been the case in the 1980s and 1990s.

¹³ Based on IEA, 2010a, EIA, 2011, and EU, 2010.

Production costs (USD/bbl, real 2008)

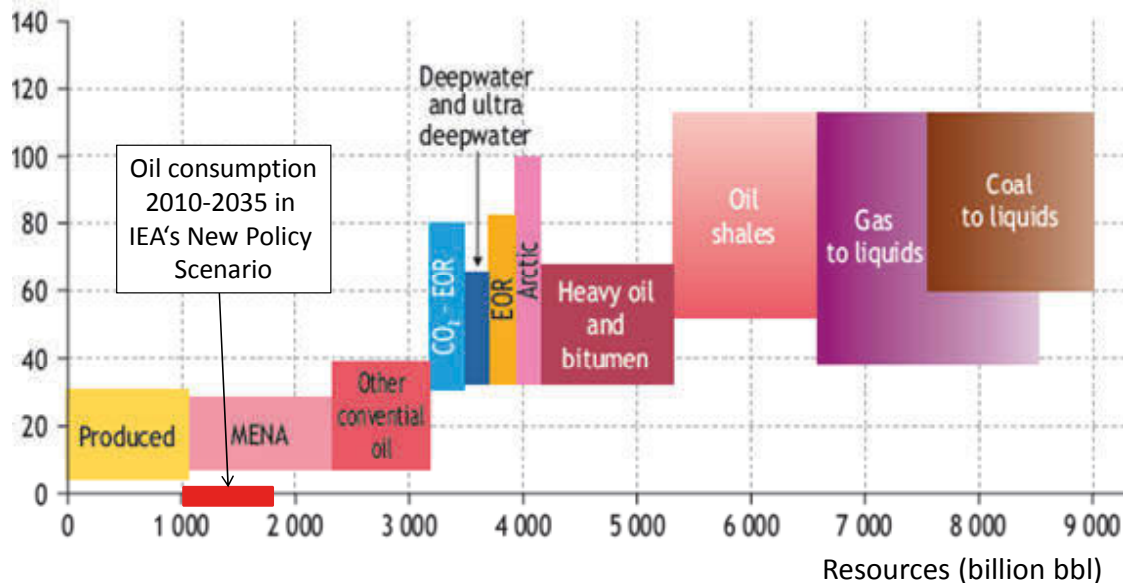


Figure 5: Estimation of world oil reserves and resources¹⁴

Unfortunately (from consumer's perspective) technical, economic, environmental and political constraints exist which prevents a production that strictly follows the cost structure. Instead of first produce from the low-cost sources until they are depleted and then switch to the next fields in the cost curve, sources from various cost categories are needed to cover actual demand. So are at present beside the traditional sources (MENA and conventional) also deepwater, heavy oil, bitumen, EOR (Enhanced Oil Recovery measures) and oil shales needed to meet the demand.

When considering the economic rule that the last needed or marginal supplier defines the market price then one could conclude that, even if in all cost category only the low-cost sources will be produced first (at least in the first years), the future oil price is unlikely drop below 50 USD/bbl again. One could consider this as a long-term lower price bound. In short-term (e.g. in times of a world economic crisis) the price could fall below, but this should not last very long.

As the oil market is by far not a perfect competitive market, this lower price bound will not be reached or undercut very often. In contrast, given the market structure and other specific characteristics of the world oil market, a premium on the marginal supply cost will be the rule. How much this premium will be is of course difficult to predict and subject to various parameters. However, given the fundamental settings, an oil price of 200 USD/bbl (or more) as predicted in some scenarios and by some "experts" is rather unlikely in longer-terms (but possible in very short-time frames, e.g. after some supply shocks).

¹⁴ See IEA, 2008, p. 218.

4 Conclusions

Oil is today the world's leading energy source and will keep this position most likely be in the next few decades. When looking at the transport sector, oil is with around 95% the dominant fuel type. Even if also in this sector technological changes and fuel substitution will take place, like in the heating sector or electricity generation, the role of oil as the most important fuel will remain unchanged. This is also the case if optimistic scenarios come true, where oil's share on energy needs from the transport sector will drop to around 50%. But also in such an environment, oil's importance will be higher than the market share, which is nevertheless still high enough to remain the leading fuel for transport. This could be explained by the role of the oil price as the energy "leading currency", meaning that the oil price directly or indirectly defines or at least influences the price of the competing fuels. As oil price forecasts are more art than science, a high uncertainty over the future oil price and by this also over the future costs of mobility exist. But fundamental parameters indicate that the price will never drop back to the low level which could be observed during the 1980s and 1990s. Given this, the key for lower costs for mobility is not a simple shift from one fuel to another. Significant efforts are needed to reduce the total demand. And presumably even moderate efficiency gains in conventional motor technologies and an efficient utilisation of existing infrastructure is a more adequate tool to keep mobility costs controllable than introducing a completely new technology and infrastructure (such as hydrogen) before it is really necessary. And given the resource situation this will not happen in the next decades.

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