Substitution of biofuels for fossil fuels

Short Study

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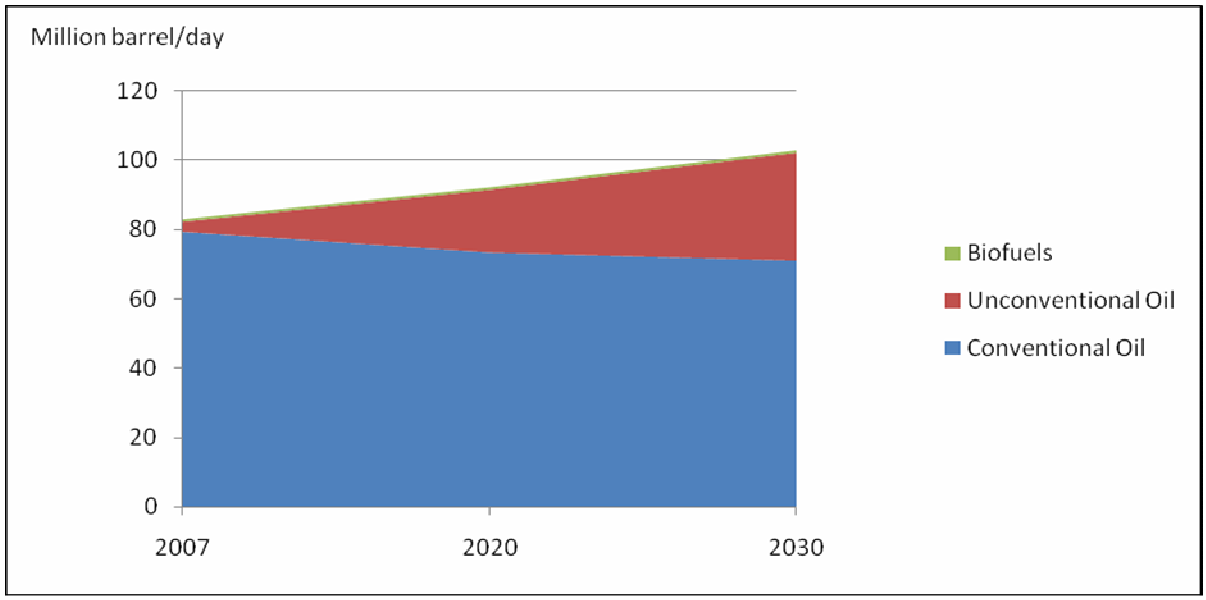
1. Topic

This short study examines whether biofuels replace the production of marginal crude oil resources. For this purpose the factors that influence the substitution process are determined and short-term, medium-term and long-term effects are considered. The study examines the period of 2007-2030.

2. Comparing scenarios

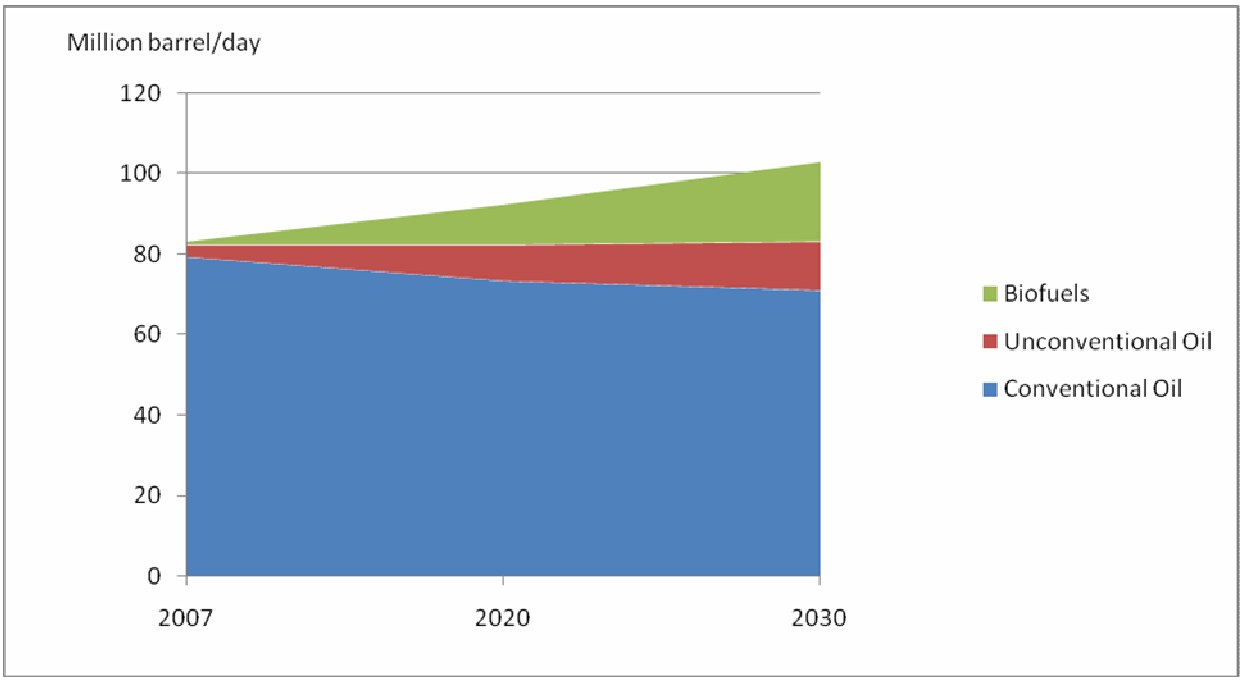
The marginal-oil-thesis will be examined by means of two scenarios. In the first scenario the production of unconventional crude oil highly increases, as the production of conventional oil decreases until 2030 and cannot cover the rising demand[1]. In the second scenario the increase of unconventional oil is mostly replaced by biofuels[2].



Graphic 1: Scenario “Unconventional fuels”

[1] Like the BGR and Meyer-Renschhausen, this study employs a more precise definition and only refers to unconventional petroleum as those deposits that are costly to develop in order to attain the characteristics of crude oil. According to this definition, unconventional petroleum includes bitumen or crude oil from tar sands, extra heavy oil and pyrolysis or crude oil made from oil shale. Extra heavy oil has a density of over 1 g/cm³ (or less than 10° API). This study also refers to synthetic fuels made from natural gas (GTL) and coal (CTL) as unconventional fossil fuels. Meyer-Renschhausen 2007, BGR 2009.

[2] Both scenarios are based on the calculations of the study „The impact of fossil fuels – Greenhouse gas emissions, environmental consequences and socio-economical effects“ (ERA 2009). The scenario “Unconventional fuels” corresponds to the scenario “Rising Demand”. The development of conventional and unconventional fuels in the scenario “Bio fuels replace unconventional fuels” corresponds to the scenario “Constant demand”. Total consumption is the same for both scenarios.



Graphic 2: Scenario “Biofuels replace conventional fossil fuels”

3. Examining the thesis

Factors that influence the replacement of marginal crude oil with biofuels are described. For that matter the common substitution process is explained, followed by a definition of short-term, medium- and long-term factors that influence the process. The last part of the analysis examines the question whether marginal crude oil is the fossil fuel with the highest emissions and environmental pollution.

The examination concludes the following results:

1. **Biofuels replace fossil fuels.**
2. **Biofuels don´t replace the most expensive fuel in the short term.**
3. **Biofuels replace the most expensive oil in the medium and long-term.**
4. **The most expensive oil is not the dirtiest oil.**
5. **The most expensive oil is only the dirtiest oil when external costs are completely internalized.**
6. **Considering greenhouse gas emissions does not suffice to evaluate the indirect effects and environmental impact of oil production.**

1. Biofuels replace fossil fuels

A simplified explanation of the substitution process: The production of biofuels increases the global supply of fuels, causing the global oil price to decrease. As the price elasticity of crude oil demand (PED) is low, the higher supply and lower price only cause a marginal increase in demand. Instead crude oil production is reduced and adjusted to demand. The oil price will return to its previous level.

The price elasticity of oil demand has decreased continually in the past decades, as the structure of demand has changed[3]. After the price increased in 1973, the so called "low hanging fruits" have been harvested first, which means the easiest measures to reduce consumption were installed. These mainly concerned the reduction of crude oil in the heat sector, leading to a strong decrease in crude oil consumption for heat purposes in OECD nations since 1973. In the traffic sector however only few alternatives are available. Despite efficiency measures fuel consumption increased due to a rise in traffic and vehicle weight. Furthermore the price elasticity of oil demand decreased due to a growing demand in the traffic sector of Non-OECD countries.

High fuel price subsidies in many crude oil producing countries as well as in developing and emerging nations restrict the price elasticity of oil demand even further[4]. In these countries fuel consumption is completely isolated from international market developments.

2. Biofuels don´t replace the most expensive fuel in the short term

a. Instead a higher biofuel supply would result in OPEC Production cuts.
b. The most expensive oil (such as tar sands or deep water oil) will continually be produced as long as the retail price is higher than the production costs.

When the worldwide recession caused the oil price to decline in the 3rd quarter of 2008, it demonstrated that low oil prices do not reduce the production of the most expensive oil for the short term. In September 2008 the OPEC reduced their quota by over 3 million barrel/day, while non-OPEC production remained on a constant level[5]. Therefore the production of the most expensive oil, such as tar sands and deep water oil, which are mainly produced in non-OPEC countries, did not decrease. An increase in biofuel supply would also reduce the OPEC quota to avoid decreasing oil prices.

c. National oil companies (NOCs) secure mainly risky and marginal oil reserves.
d. Oil supply increasingly depends on credit agreements, such as the delivery of 0,5 million barrel/day from Venezuela to China (Equity Oil)[6].

National oil companies (NOC), especially in China and India, secure crude oil reserves[7]. NOCs do not have to refinance on the financial market and use public financial sources instead, thus reducing investment risks that mainly concern oil reserves. These investments are part of a strategy of the emerging countries China, India and Brazil to globally secure commodities in developing nations.

[3] Dargay J. M. and Gately D. 2010.
[4] Global Subsidies Initiative 2009.
[5] Energy Comment 2010. Barclays Capital 2010
[6] Petroleum Economist 2010a.
[7] Goldthau, A. and Witte, J. M. 2008

The substitution of biofuels for the most expensive crude oil is also restricted by national energy supply objectives regarding regional commodities. Jordan and Morocco are highly interested in exploiting their oil shale reserves to become more independent of oil imports[8]. Jordan already signed contracts with Shell and the Estonian company Eesti Energia to start exploiting oil shale reserves for their own energy consumption within the next years[9].

The increasing nationalization can also complicate investments in the increase of conventional oil production, when profits from oil exports are used to subsidize national fuel consumption or other national expenses – such as the social programs in Venezuela – and are withdrawn from the investment programs of the NOCs[10].

The fact that over 80% of the conventional crude oil reserves are controlled by NOCs can make exploitation rather difficult and the pressure on IOCs (Independent Oil Companies) to invest in projects with marginal oil sources (tar sands, deep water oil, Arctic oil) rises[11]. On a properly functioning market however, easily obtainable reserves would be exploited before more problematic oil sources.

3. Biofuels replace the most expensive oil in the medium and long-term

a. OPEC cutbacks are only temporarily and quantitatively possible.

Even today only half of OPEC's demands to cut production are met, and the OPEC will continue to lose its influence in the future[12]. Bilateral contracts between OPEC-countries and NOCs will increase and therefore aggravate production shortenings of the OPEC, as contractually appointed oil supplies have to be delivered[13]. Singular interests of the OPEC members will prevent long term production cutbacks, as the OPEC countries depend on income from oil export. OPEC members will also have to increase their production to compensate for their own national increase in oil consumption.

b. Biofuel objectives already prevent future investments in very expensive oil technologies of international oil companies (IOCs).
c. In the future biofuel objectives will also prevent investments in very expensive oil technologies of national oil companies (NOCs).

Profit chances on future crude oil production decrease due to biofuel objectives. Those biofuel objectives therefore especially endanger yields of very expensive and risky marginal sources, causing international oil companies (IOCs) to invest less in these technologies, as they act upon yields, are liable to strict accountancy rules and have to refinance on the financial market. Furthermore the yield orientation of

[8] Sladek, T. 2010.
[9] Hafidh, H. 2010.
[10] Deutsche Bank 2009.
[11] Deutsche Bank 2009, Goldthau, A. and Witte, J. M. 2008
[12] Energy Comment 2010.
[13] Goldthau, A. and Witte, J. M. 2008.

demand-NOCs increases, e.g. for PetroChina, which already sells a significant amount of its crude oil to the global market and does not supply its own national market past that[14]. When biofuels can create an alternative to marginal oil, NOCs will participate in biofuel markets. Other sectors of renewable energies are already experiencing these developments. China for example became the biggest wind energy market within only a few years[15]. The national interests in unconventional crude oil sources for energy consumption can only be weakened by strong price signals through large international biofuel amounts. Furthermore regional production of crude oil alternatives has to be encouraged.

4. But the most expensive oil is not the dirtiest oil

a. Cost development and carbon intensity of fossil fuels do not run parallel but depend on many factors (such as energy input costs, conversion costs and developing technology). This can make a less carbon consuming process (such as EOR (Enhanced Oil Recovery) where gas injections increase oil exploitation) magnificently more expensive than carbon liquefaction with inferior lignite[16].
b. Yet biofuels can also avoid very expensive measures to reduce greenhouse gas emissions in oil production, such as adding renewable energies to supply production and refinery plants.
c. External costs for oil extraction are only internalized by a small amount. The few regulations that exist (for example Ecological taxation, the planned GHG emissions limits for cars in the European Union) do not consider previous stages of oil production , therefore all production measures are considered equal and independent from carbon emissions in previous steps.

The comparison of the greenhouse gas balances of various fossil fuels with their production costs shows that there is no direct correlation between the level of greenhouse gas emissions and production costs[17]. Although fuels made from coal and oil shale are among the most expensive unconventional fuels, and also have the highest emissions, the maximum production costs for GTL, the unconventional fuel with the best climate balance, are located in the same range[18]. In contrast, GTL from

[14] Goldthau, A. and Witte, J. M. 2008.
[15] WWEA 2010.
[16] IEA 2008. Bartis et al. 2008.
[17] ERA 2009.
[18] IEA 2008. The IEA indicates a broad range of production costs for GTL between 40 and 120 dollar/barrel. The conversion costs of GTL are considerably lower than CTL because costs for gasification no incur. But the total productions costs of GTL depend mainly on the market price of the natural gas. If the natural gas can also be used in the electricity and heat sector and the chemical industry, then these alternatives determine the price of GTL.

synthetic gas or underground gasification shows almost the highest emissions but also represents the unconventional fuel with the lowest production costs.

For example the high energy input costs of tar sand production result in the development of methods with higher gas emissions, such as the in-situ-combustion of tar sands or the petroleum coke usage to create process heat.

5. The most expensive crude oil is only the dirtiest oil when costs are completely internalized

The internalization of external costs depends on international and national decisions, which are influenced by many different aspects: Social perception of risks and visible environmental impact, energy provision interests, geopolitical interests, regional conflicts, almost non-existing international regulations, national regulations that do not keep up with technological developments, national regulations that are corrupted and circumvented, priority settings for environmental, economical or sociopolitical objectives.

Examples:

- Stricter environmental regulations increase the costs of deep water drilling[19]. Deep water oil will become more expensive than tar sands or extra heavy crude oil and will be the first to get replaced by an increasing biofuel production.
- Global dependency on tar sands and extra heavy crude oil avoids stricter climate protection protocols. For example the USA doubled the import of Canadian crude oil to 2 million Barrel/a within the past 9 years. Crude oil from tar sands accounts for the largest part of the increase[20].

6. To consider greenhouse gas emissions does not suffice when evaluating the indirect effects and environmental impacts of crude oil production.

The oil spill in the Mexican Gulf proves that today's methods to evaluate indirect effects have many deficits. To consider greenhouse gas emissions does not suffice to evaluate the environmental consequences of oil production. Adequate methods to evaluate environmental effects of catastrophes like in the Mexican gulf and in the Niger Delta need to be examined. Further indicators such as aquatic toxicity are needed.

[19] Petroleum Economist 2010b,c.
[20] Petroleum Economist 2010d.

4. Conclusion

The study shows that the replacement of fossil fuels with biofuels depends on many factors. It is to be expected that biofuels will replace marginal crude oil production in the medium term and in the long term. Whether fossil fuels with the highest greenhouse gas emissions and environmental impact can also be avoided, depends on the internalization of costs and therefore on political decisions. The biggest environmental benefits that biofuels can provide, will only be achieved in cooperation with international climate and environment protection objectives. The opposite is also true: international climate and environmental policy can only be achieved when alternatives to conventional and unconventional oil resources are created. For that matter enviromental standards for oil production must created, ambitious efficiency measurements have to be undertaken and the development of electric mobility has to be intensified. Yet these measures can only lessen rather than avoid the increase of fuel consumption, as the global demand for mobility rises. More than one billion vehicles worldwide are expected in 2013. The massive development in biofuels is therefore necessary to prevent unconventional oil production and to achieve climate protection objectives.

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