

Summary

Biofuels study

“Implications of political decisions on biofuels and raw materials markets”

Commissioned by:

The Union for the Promotion of Oil and Protein Plants
(Union zur Förderung von Öl- und Proteinpflanzen e.V.: UFOP),

The Association of the German Biofuels Industry
(Verband der Deutschen Biokraftstoffindustrie e.V.: VDB) and

The Association of the Oil Seed Processing Industry in Germany
(Verband der Ölsaatenverarbeitenden Industrie in Deutschland e.V.: OVID)

UNIVERSITÄT HOHENHEIM



Authors:

Professor Jürgen Zeddies

Dr Nicole Schönleber

Institute of Farm Management (410B)

70593 Stuttgart-Hohenheim

Telephone +49 (0) 5533 6414 /

+49 (0) 711 459 22573

Email juergen.zeddies@uni-hohenheim.de /

nicole.schoenleber@uni-hohenheim.de

Internet www.uni-hohenheim.de

Introduction

Climate change, related environmental disasters and the results of the climate negotiations in Paris have increased concern, public awareness and the pressure to act with regard to climate protection measures. Renewable energies play a key role in this. Almost without exception, renewable energies markets today are characterised by complex regulatory and funding policy framework conditions.

European and national climate protection laws have been changed frequently in recent years. This has resulted in changing economic framework conditions and has negatively impacted on willingness to invest in climate protection. For example, in the coming months and years, far-reaching political decisions about the future of biofuels will be made that will influence the entire value chain and, as a result, effect the contribution to greenhouse gas reduction that is already possible today. This study sheds light on the impacts of policy measures on biofuels and raw materials markets with the aim of deriving recommendations for action from this.

Funding policy framework conditions and subject of investigation

In April 2015, the European Parliament and the European Commission agreed on a compromise for changing the directives applicable to biofuels (2009/28/EC and 98/70/EC). The amending directive termed the “iLUC directive” (2015/1513/EC) stipulates that a cap of a maximum seven percent share for biofuels from grains, sugar, starch and oil plants be introduced on an EU level.

Implementation on a national level to achieve these targets in the member states is primarily based on a compulsory energy quota. This means that, measured against the overall quantities of fossil fuels used, a certain percentage share on the market must be biofuels, otherwise the oil companies under obligation will be faced with fines (penalties).

In 2015, Germany changed its funding measures on the basis of the changed Fuel Quality Directive (98/70/EC) to focus exclusively on the requirement to reduce greenhouse gases and is so far the only EU member state to have done so. Companies distributing fuels must demonstrate a percentage reduction in greenhouse gases (GHG reduction). In 2015 and 2016, the greenhouse gas reduction requirement equals 3.5 percent, from 2017 it will be 4 percent and from 2020 onwards 6 percent. Alongside biofuels, the EU directive presents additional options for meeting the greenhouse gas reduction requirements, for example other renewable energies (electricity-based fuels e.g. hydrogen, PtL, PtG), electromobility and measures to reduce greenhouse gases in crude oil production (UER measures).

Market prices and the specific greenhouse gas saving (optimised in terms of raw materials and process technology) are of key importance for the economic viability of biofuel production. Equally important are availability, raw materials prices, demand for biofuels and sales of by-products (protein feed, glycerine etc.). With the change to the greenhouse gas reduction requirement, it is intended that market prices will be oriented around biofuels' GHG savings (raw materials and climate protection efficiency). The aim of this study is to analyse the quota change as well as various policy measures and to assess their impacts on the points mentioned above in connection with the question: is the GHG reduction requirement introduced in Germany a model for the fundamental orientation of biofuel policy in the EU after 2020?

Scenarios and political strategies

In the scope of a scenario analysis, the following climate protection measures in the transport sector will be investigated with regard to their influence on the biofuels value chain, their by-products and raw materials markets:

- Change from the energy quota to the GHG reduction requirement in Germany
- Stages in the GHG reduction requirement (4, 6, 8, 10 and 12 percent)
- Assessment and development of the biomass and/or biofuel mix (influence of greenhouse gas efficiency and price)
- Consideration of iLUC factors
- Preservation of historical sales volumes
 - 10 percent renewable energies goal in the transport sector in 2020 (with a 7 percent cap for biofuels from grains, sugar, starch and oil plants)
- Additional sales potential for the fuel types E20, B30 and B100
- Increasing proportion of electromobility
- Impacts of the GHG reduction requirement on oil production, so-called 'upstream emission reduction' (UER measures)
- Not promoting biofuels from grain, sugar, starch and oil plants
- Introduction of a GHG reduction requirement in other EU member states following the German example

Methodology and procedure

Within the framework of this study, a linear programming approach was developed which allows the domestic consumption of fuels and raw materials to be presented alongside the formation of by-products and also allows for the optimum supply structure for fuels under various prices and political goals as well as legal guidelines and directives to be determined.

Using a linear programming approach, optimum organisational structures for various (bio)fuel production methods and their raw materials usage can be determined depending on their economic success. This aim is to utilise various production procedures to their full capacity in a way that is technologically appropriate and to combine the various production factors in a targeted way within the framework of the prescribed fixed factors. The linear programming approach is an optimisation model based on mathematical equations that solves a minimum or maximum problem.

The study presents the linear system of equations for all fuels available on the market as usage options (activities) with their technical coefficients, including energy values, GHG emissions, raw materials requirements and by-product formation. The equations define the relevant maximum and minimum limitations for the individual biofuels and the relevant maximum and minimum quantities or proportions for energy, GHG emissions and other legal requirements.

The optimisation operates under the following target function: minimising the costs of fuel supply as a whole for domestic consumption in the transportation sector in Germany. With this process, fuels are rated according to their GHG efficiency and the most favourable fuel blends are used as far as the fuel standards allow. As part of this, all standardised fuel blends (E5, E10, E85, B7, B30, B100, vegetable oil) and E20 were considered.

Depending on the scenario, the following restrictions are taken into account: Required fuel quantities for petrol and diesel vehicles, energy quota, GHG reduction requirement, maximum and minimum proportions (E85) in admixtures, winter qualities.

The year 2014 serves as a reference for the biofuel energy quota and for calibrating the model. The year 2015 serves as a model for the GHG quota. The impacts of political measures and/or proposals in the various scenarios were quantified and assessed on the basis of this.

Alongside the fuels mentioned, HVOs (hydrogenated vegetable oils), waste-based biofuels and electric vehicles were also considered. All of the options mentioned above are in competition with one another to meet the GHG reduction requirement; a possible penalty payment was also taken into consideration in the study. The raw materials and by-products from biofuels are also represented according to their quantities as well as their origins and their effects on the animal feed sector.

For the individual scenarios, the added or reduced value of various policy measures was derived using the overall costs for the fuel provision, for example the change to a GHG reduction requirement.

The fuel supply for domestic consumption in passenger and goods transportation was optimised in the model calculations. It is assumed that the mineral oil industry endeavours to keep the so-called "product prices" (consumer price without transportation and storage costs) as low as possible. The companies that produce and/or distribute fuels implement optimisation measures with the aim of maximising profit/profit margins.

Summary of results

- In 2014, the mineral oil industry in German had fulfilled the energy quota for biofuels that had been imposed on it by law. Accepting the GHG standard values, the GHG reduction from biofuels equalled 2.7 percent (5.4 million tons CO₂-equivalents) one year before the introduction of the GHG quota.
- According to the calculations in this study, the newly introduced GHG reduction requirement of 3.5 percent was met in 2015 with biofuels (6.6 million tons CO₂-equivalents) and transfers from the prior year (0.8 million tons CO₂-equivalents). **The quantity of biofuels used fell by 4.5 percent for bioethanol and by 7.3 percent for biodiesel.**

Overview of the most important quantitative results of the 2014-2020 scenarios

	Reference GHG standard	3.5% GHG reduction (without E20, B30)	4% GHG reduction (without E20, B30)	Potential for 2020 Biofuels without cap of 7% with E20 and B30 GHG reduction requirement in %				
Unit	2014	2015	2017	6%	8%	10%	12%	
Domestic fuel consumption								
Fossil Petrol	Million tons		1.05		10.23			
Bioethanol		1.22	1.17	1.18	1.18	3.22	3.22	1.00
E 5		15.71	15.16	15.35				11.01
E 10		2.59	2.90	3.52	3.3			3.66
E 20					3.42	16.61	16.61	3.62
Fossil Diesel								
B 7		33.27	34.85	36.31	29.70	29.70	29.70	19.92
B 30					7.69	7.69	7.69	15.38
Biodiesel		2.31	2.53	2.73	3.96	3.86	3.86	7.32
Thereof rapeseed		1.30	1.31	1.55	2.48	2.48	2.48	3.55
Admixture proportions								
Renewable energy	%	5.29	4.86	5.48	8.67	11.01	11.01	12.58
Energy crops		5.24	4.06	4.47	6.89	9.22	9.22	10.03
Biodiesel		6.66	5.94	7.01	11.78	11.78	11.78	17.21
Bioethanol		6.26	5.76	5.58	6.13	15.37	15.37	8.10
GHG reduction	%	2.7	3.3	4.0	6.0	7.9	10.1	12.1
	Million tons	5.4	6.6	8.4	12.9	17.3	22.4	27.2
Raw materials requirement								
Rapeseeds	Million tons	3.42	3.16	3.74	5.97	5.97	5.97	8.55
Cereal grains		3.37	3.18	2.10	3.34	11.12	11.12	3.63
Sugar beets		3.07	3.07	2.61	2.61	2.61	2.61	3.24
Oil meals (excluding palm kernel cake) and DDGS		3.38	3.11	3.07	5.18	7.92	7.92	7.18
Energy crop area	Million hectares	1.86	1.74	1.73	2.72	4.19	4.19	3.67
Release of foraging area	Million hectares	0.53	0.50	0.48	0.77	1.26	1.26	1.03
Payment transfers, benefits, costs								
Penalty	EUR million					490	2,913	3,974
GHG saving at 70 EUR/t CO2 equivalent	EUR million	380	461	545	902	1,136	1,136	1,313
Same per ton of biofuel	EUR	107	125	161	189	160	160	158
Value creation (gross)	EUR million	1,385	1,300	1,243	1,907	3,081	3,081	2,532
Same per ton of biofuel	EUR	392	352	367	399	435	435	304
Fuel costs	EUR million	38,388	29,627	35,759	37,422	38,489	40,912	42,163

SOURCE: OWN CALCULATIONS

- In 2017, the GHG reduction requirement of four percent will necessitate an overall higher use of biofuels and the utilisation of possible admixture limits in petrol and diesel

fuels. Around **1.1 million tons of bioethanol and 2.6 million tons of biodiesel and HVO are needed to achieve a 4 percent GHG reduction**. In 2014, 1.2 million tons of bioethanol and 2.4 million tons of biodiesel and HVO were already used.

- In **2020, new fuel types** (with higher proportions of biofuels) will be required in order to meet the higher GHG reduction requirement of six percent, as long as other options (above all electromobility, electricity-based fuels and UERs) are unable to make a significant contribution. One solution would be an increased use of E20 and B30. A B30 standard for vehicle fleets already exists.
- A **GHG reduction requirement of eight percent for the mineral oil industry** could only be met if the cap specified in the iLUC directive (2015/1513/EC) for biofuels from grains, sugar, starch and oil plants was exceeded and the 10 percent renewable energies goal was also exceeded. Bioethanol would have to be mixed with petrol fuels E5 and E20 and reach a proportion of 8.8 vol%. A prerequisite is that E20 is standardised and made financially attractive for the consumer. Biodiesel would be sold for passenger cars as B7 and for vehicles fleets as B30 (3 million tons in 50 percent of diesel for heavy goods vehicles). The average admixture proportion would be 14 vol% for diesel fuels.
- A further increase in the **GHG reduction requirement to ten percent** and even **twelve percent** could be achieved if all use of diesel in goods transport was switched to B30 or a proportion of heavy goods vehicles used B100 (pure biodiesel). The proportion of biodiesel could rise to an average of over 20 percent.
- Against the backdrop of the goals of fuel policy, the results reveal the assignment of policy priorities to biofuel potential:
 - If adherence to the 7 percent cap is the primary focus, a GHG quota of 6 percent must be aimed for; if the GHG quota of 6 percent is exceeded, this requires an improvement in the GHG savings from conventional biofuels (maximum seven percent from grains, sugar, starch and oil plants) and the introduction of advanced biofuels (so-called second generation biofuels).
 - If fulfilment of the 10 percent goal for renewable energies is the primary focus, a GHG reduction requirement of 8 percent should be aimed for.
 - If a maximum contribution to climate protection in the transport sector is the primary focus, then a GHG reduction of 11 to 12 percent is possible; this requires the cap of seven percent to be removed.

Conclusions and policy proposals

Comprehensive quantitative analyses were conducted as part of the study. These lead to the following conclusions:

1. The **GHG reduction requirement** introduced in 2015 is, **in terms of regulatory policy, the appropriate tool** for achieving climate protection efficiency in the fuel sector.
2. Since the GHG quota came into force in 2015, considerable **efficiency increases** in biofuel GHG savings have been made. Biofuel prices are dependent on the level of

GHG savings. The GHG reduction requirement results in the replacement of less efficient products and manufacturing processes.

3. The **GHG reduction requirement** stipulated for 2015 and 2016 of **3.5 percent** was a cautious start. It would have been possible to implement a higher GHG reduction requirement.
4. The fulfilment of the **GHG reduction requirement of four percent in 2017 and six percent in 2020** will also not present a problem in terms of the provision of biofuels and raw materials. For a further increase in biofuel usage, partial use of B30, E85, B100, biomethane or higher proportions of HVO will be necessary alongside the use of fuel types E5, E10 and B7.
5. A market that is subject to a GHG reduction requirement regulates the production and use of biofuels by assigning prices to fuels in a way that is oriented towards greenhouse gas efficiency. The GHG reduction savings of 50 percent (existing plants) and 60 percent (new plants) required by the **Biofuel Sustainability Ordinance** will, therefore, be rendered obsolete by the introduction of a GHG reduction requirement.
6. A **Europe-wide introduction of a GHG reduction requirement** would further **facilitate** the **efficiency increase** from biofuels. The sooner this harmonisation is achieved, the fewer inefficient trade diversions there will be with biofuels and their raw materials.
7. The calculation of **iLUC factors** contains **lack of robustness**. Taking iLUC factors into account would inhibit fulfilment of the GHG reduction requirement. Considerable GHG reduction shortfalls would have to be covered by other, more expensive options and penalty payments. iLUC factors increase the costs of fuel provision and reduce the benefits from GHG savings, value creation and employment by about 60 percent.
8. The existing biofuel production does not lead to any additional demand for raw materials, meaning no indirect land usage effect could arise. In order to **prevent** increased **market turbulence** and negative displacement effects (agriculture, raw materials markets, value creation, workplaces), **preservation of the iLUC-free rate of seven percent** must be maintained (analogous to the “iLUC directive”).
9. **Electric passenger cars** do not fare well with a high GHG reduction requirement, because, taking the current electricity mix into account, they result in more GHG emissions than the combustion engines they replace. Whether electric vehicles will in fact win through depends on whether the annual costs for the user can be lowered considerably.
10. **Biofuels could make a greater contribution to GHG reduction** if the sale of available bioethanol fuels was forced (E10, E20) or if biodiesel admixtures, which are harmless to vehicle engines, were offered for heavy goods vehicles (B30). A European biofuel strategy is required here.
11. The **GHG reduction of biofuels is not reaching its full potential**. The fuel suppliers are following sales strategies to meet the GHG reduction requirement at low costs.
12. Biofuel policy has a considerable impact on the **prices and sales opportunities for raw materials** from domestic cultivation and animal feed markets. The demand for rapeseed for the production of 1.3 million tons of rapeseed biodiesel was around 3.15

million tons in 2014. This equalled around 35 percent of the rapeseeds processed in Germany. In addition, 3.3 million tons of grains and 3.1 million tons of sugar beets for bioethanol is required and the animal feed market is provided with around **3.4 million tons of soya meal equivalents**.

13. The **political framework conditions for climate protection in the transport sector safeguard the existing sales opportunities** for the raw materials used **up to 2020**. With a GHG quota of six percent (as of 2020) the potential demand for raw materials for bioethanol and biodiesel will increase as long as the additional requirement for GHG savings is not met by other options.
14. **Without the use of biofuels** to meet the quota, the 3.5 million tons of biofuels used up to now would be **replaced by an additional use of around 0.33 million tons of petrol and 2.2 million tons of diesel**. This would reduce the procurement costs for fuels by around EUR 1 billion. The use of biofuels would, therefore, only be economically feasible if the price for rapeseed biodiesel fell to the same level as fossil fuels. With rapeseed biodiesel, for example, this would correspond to a reduction of around EUR 290/t and a price reduction in the raw material rapeseed of EUR 120/t. For grain raw materials for bioethanol production, the price difference would be around EUR 100/t. However, farmers would no longer deliver at these prices.
15. Without the use of biofuels to meet the quota, the sales of rapeseed oil for domestic consumption of biodiesel of around 1.3 million tons and the **demand for rapeseed of 3.2 million tons** would fall through. The raw materials for bioethanol amounting to **3.2 million tons of grains** and **3 million tons of sugar beet** would also no longer be required and, finally, **3.1 million tons of animal feed** from domestic biofuel production would have to be **replaced** by soya imports and domestic grain produce.
16. Policy-makers must decide whether it is justifiable to **forego biofuels**. The additional costs mentioned above must be compared with the benefits of the GHG saving and the value creation of biofuels produced within Germany. Without conventional biofuels, the mineral oil industry is faced with the problem of nonetheless meeting the GHG quota. This results in high penalty payments, which must ultimately be included in the consumer price without this bringing any climate protection benefit. The **added value exceeds the additional costs** of biofuels. With a valuation base of EUR 70/t CO₂-equivalents, the benefit of GHG reduction is, on average, EUR 106 per ton of biofuel used. In addition, each ton of biofuel contributes to gross value creating with EUR 386.
17. New global political climate protection goals (such as COP21) justify the change to the more efficient GHG reduction requirement. **New fuel types (e.g. E20 and B30) facilitate higher GHG reduction goals** of ten to twelve percent. They also require changes to the mineral oil industry and the automotive industry, which could certainly be put into effect by 2025 with timely notification.
18. The proposal by the biofuels associations of **increasing the GHG reduction requirements by 0.5 percent every year** would send clear signals. In the development from 2015 to 2025, biofuels could increase greenhouse gas reductions from 6.6 million tons to 27 million tons CO₂-equivalents.
19. Taking by-products into account, the **demand for raw materials for bioethanol and biodiesel** would increase roughly threefold with a GHG reduction quota of ten percent.

The net area requirement would increase from 0.75 million hectares currently up to 1.6 million hectares. The markets for grains and rapeseeds are closely linked with the European surplus countries France, Poland and Hungary, as well as Ukraine and through to southern Russia, where they have a high and growing raw materials potential that cannot exclusively be offset by export to food markets with sufficient prices. Germany has an efficient vegetable oil industry, which currently has considerable over-capacities and fulfils the requirements for an expansion of biofuels in the transport sector better than most other countries.

20. An important argument against the expansion of biofuels in the transport industry is the current **cost differences between fossil fuels and biofuels**. These either do not reflect the macroeconomic costs and benefits at all or do not reflect them with a comprehensive focus on sustainability objectives.
21. The results of investigations show that **biofuels** will be indispensable for years in achieving notable GHG savings through **renewable energy in the transport sector**.

This study is a first, comprehensive attempt to analyse, quantitatively represent and optimise the situation and potential for development of biomass in the transport sector. As prices for fuels, their raw materials and by-products as well as supply situations, political strategies and new technologies in the transport sector change, accompanying quantitative investigations into the transport sector are a helpful tool for analysing the complex interdependencies in order to be able to react to them at an early stage. This raises the question of whether the methodical approach developed in this study should be further developed in order to ensure the consistency of evaluations.