Ifo Institute for Economic Research
at the University Munich

Poschingerstr. 5
81679 München
Tel.: (089) 92 24-0
Fax: (089) 98 53 69

Economic effects of the production of biodiesel for use as fuel

Final Report
ifo Schnelldienst 59(17)
English version

Munich, November 2006

Economic effects of the production of biodiesel for use as fuel

Manfred Schoepe

In no other country of the EU has the production and consumption of fatty acid methyl ester grown as strongly as in Germany. Policy decisions are the major factors behind the success of biodiesel, mainly produced from rape seed, with energy- and environmental-policy aspects gaining in importance alongside agricultural-policy considerations. In 2003 the EU issued a Directive with the goal of achieving a 5.75 percent share for biofuels in overall fuel consumption by 2010. In Germany, the tax benefits for biogenous fuels have played an important role. The Ifo Institute, using an input/output analysis, examined the macroeconomic effects to be expected from the increasing use of biodiesel, also under the conditions of a gradual reduction of tax benefits. Scenarios for 2007 and 2009 were developed as to how the value added chain of biodiesel from rape-seed production up to the diesel pump has direct and indirect effects on production, employment and the public budgets.

Biodiesel – a rapidly developing industry

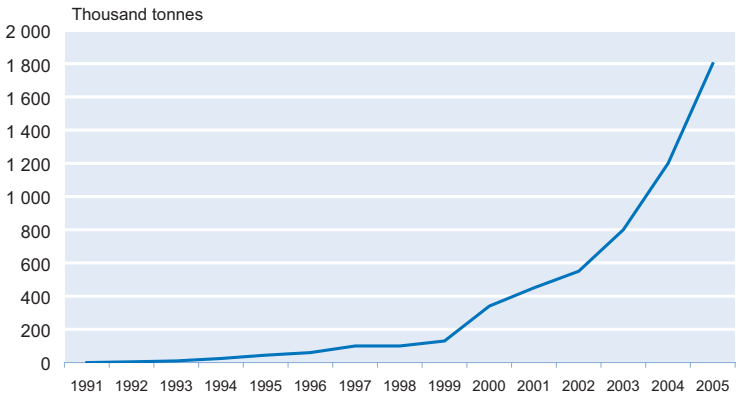
In Germany at the beginning of the 1990s, only a few oil-mill specialists devoted themselves to the development and production of a new fuel produced from agricultural raw materials: fatty acid methyl ester, or biodiesel, as it was generally called. Early on, farmers and their federations recognised the additional sales potentials for agricultural products, in this case of rape seed, which seemed important in light of EU-wide surpluses for conventional cultivation. An organisation was created whose goal it was to develop an alternative source of income for farmers by taking land »set aside« from food production and using it for renewable raw materials such as rape seed in the context of a reform of the Common Agricultural Policy. In the meantime, these organisations have built up an extensive information network that offers professional and organizational support along the entire value added chain of biodiesel. They are making a major contribution to ensure the raw material supply of the still young industry, to organise marketing, to gain the co-operation of the motor vehicle industry and to set and maintain high quality standards. Policy-makers, both in the EU and the German Federal Government, were prepared to support the development of this new industry branch, taking into consideration not only agricultural-policy aspects but increasingly also energy- and environmental-policy considerations. In light of climate protection obligations and geopolitical uncertainties, in particular regarding the supply of crude oil, the Federal Government converted into national law the authorization leeway provided in EU Energy Tax Directive (2003/96 EC) as from 1 January 2004 by amending the mineral oil tax law regarding tax concession for biofuels. Subject to inspection for overcompensation, biofuels became virtually tax exempt to compensate for the higher production costs in comparison with fossil diesel fuel and to provide initial assistance for the young industry. Furthermore, with the constantly increasing volume of traffic and given the current state-of-the-art in technology, only biomass fuels can ensure future mobility that takes full account of environmental concerns. The roughly equally high energy density in comparison with diesel fuel as well as the exceptionally high efficiency of biodiesel production from rape seed oil (transesterification) were the natural presuppositions for substituting a considerable part of growing consumption of diesel fuel (also in coming years) with biodiesel.

It was the sum of these positive conditions that contributed to the unusually dynamic growth of the biodiesel industry in Germany (see Figure). Domestic production grew to 1.5 million tonnes (2005), and consumption amounted to 1.8 million tonnes, which corresponds to 6.3 volume percent of consumption of mineral diesel fuel (3.15 volume percent of total fuel consumption). With a total of 53%, commercial vehicles had the largest share with 15% using public fuelling stations. Turnover for autos amounted to 14% in 2005.

The mineral oil industry, which had already begun to mix small portions of biodiesel in its diesel fuel, accounted for 33% of the amount of biodiesel consumed in Germany. In 2005/2006 large capacities for the production of biodiesel were either being planned or under construction. The Union for the Promotion of Oil- and Protein Plants (UFOP) spoke of production capacities in Germany of more than 3 million tonnes in 2006.

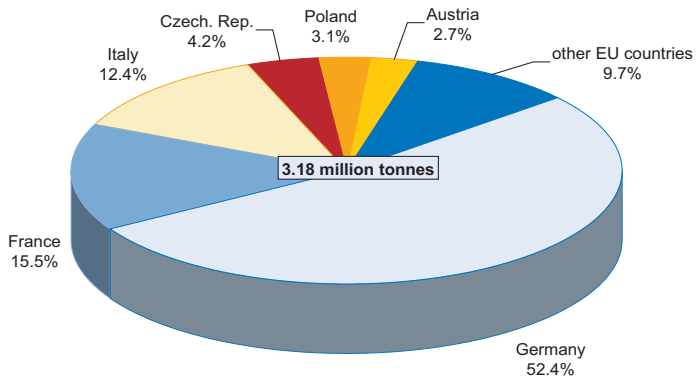
In no other country of EU has biodiesel had such a market career. Germany is not only the international leader in the production of biodiesel but also in the necessary plant technology. However, ever since the EU Directive on the promotion of biodiesel (European Union 2003a), which aims at an increase in the (energy) portion of bio-fuels to 5.75% of EU-wide fuel consumption, many other countries are making serious efforts in this area. France, for example, is planning to achieve this share already by 2007 and is constructing plants that will ensure a share of 7% by 2010 and 10% by 2015.

Biodiesel turnover in Germany



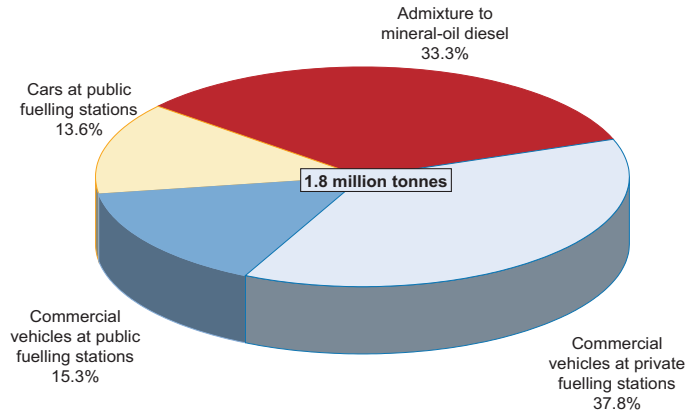
Source: Union zur Förderung von Öl- und Proteinpflanzen e.V.

Biodiesel production in the EU in 2005



Source: European Biodiesel Board.

Use of biodiesel - user groups in Germany 2005



Source: Arbeitsgemeinschaft Qualitätsmanagement Biodiesel e.V.

Policy as the promoter and challenger of the biodiesel industry

The promotion of the entire biodiesel sector was a main objective of the German government of the 15th legislative period. This policy was supported emphatically by the agricultural federations. The long-standing practice of tax exemption for biodiesel in Germany was retained under the legal framework of the EU. As of 1 January 2004 the mineral-oil tax concession was extended to all biofuels as well as to the biogenous content in mixtures with fossil fuels (see Mineral Oil Tax Law of 21 December 1992 in the version of 1 January 2004). This regulation was intended to remain valid until the end of 2009 to give planning security to the biodiesel industry and to the bioethanol industry, which was just in the investment phase. The goal of these tax measures was to equalise the differences between the costs for biofuels and the price for corresponding fossil fuels. Both the corresponding EU Directive (European Union 2003b) and the German Mineral Oil Tax Law demanded that an overcompensation be avoided. According to Article 2a (3) of this law, the Federal Finance Ministry along with various other ministries in this area was obligated to submit a report to the Bundestag on this matter.

With the outlook for a continuing promotion of biological fuels and in anticipation of further, increasing demand, considerable funds were invested in the expansion of production capacities with the result that an indivi-

dual production and marketing branch developed for biodiesel. But also for the mineral oil industry, the commitment to biodiesel began to be more attractive especially as the domestic demand for diesel fuel for autos increased and in light of the growing amount of freight traffic. Thus, with the niche product biodiesel, that had been developed with the intention of supporting German agriculture, a significant industry developed whose production and sales are today no longer limited to the German market. The net imports of biodiesel, according to industry estimates, amounted to ca. 355,000 tonnes in 2005 (nearly 20% of domestic consumption). In order to ensure an increasing production, the industry assumes that raw material supplies will also be drawn from non EU-countries. In addition to imported rape seed oil from abroad, also soybean oil and cracked palm oil are bought on world markets. However, the possible uses of materials not based of rape seed are limited, conditional on the stipulations of the European quality standards for bio diesel – EN 14214 – which was the result of intense harmonisation efforts between the automobile, mineral oil and biodiesel industries. Faced with the demonstrated growth potential, objections have been voiced, not only in the German Finance Ministry, of whether such tax concessions are still fair to the German taxpayer

In addition, the first report of the Federal Government on tax concessions for biofuels (German Bundestag 2005) – a cooperative effort of several ministries, (BMF, BMU, BMVEL, BMWi) – determined that there was a tax overcompensation of 5 cent/litre for pure biodiesel and 10 cent/litre for mixtures with biodiesel. In the report, the Federal Government thus proposed to tax a portion of biodiesel but with a »moderate« procedure that would take into consideration a price difference of 10 cents per litre so that the sale of biodiesel as a pure fuel would still have a chance in future. After intense discussions between the affected groups and the Federal Government as well as a laborious process of decision-making in the government coalition and parliament, the new energy tax law was passed in July 2006. It replaces the stipulations of the mineral oil tax law and regulates the future taxation of biofuels. Effective 1 August 2006, pure biodiesel fuel is taxed at a rate of 9 cent/litre; as of 2008 the rate will increase annually by a further 6 cent/litre until it reaches 45 cent/litre in 2012. Biodiesel in mixtures is to be taxed to the end of 2006 at 15 cent/litre and as of 2007 according to the standard rate for diesel fuel in accordance with the government draft for the amendment of the energy tax law as of 2007. Biodiesel that is used as a pure fuel in agriculture remains exempt from the energy tax.

This unexpectedly fast retreat from tax preferential treatment for biofuels as well as the introduction by policy-makers of an obligatory market share for biofuels has led to considerable uncertainty in the biodiesel industry. On the one hand, it is not clear whether the volume expansion in the market for biodiesel will proceed as most industry experts expected in the first half of this year. It is thus likely that the demand for biodiesel as a pure fuel will be regressive with increasing taxation, and that at the same time pressure on prices will come from the production plants. The arising demand gap can surely not be closed by agriculture alone. Not only the efficiency of existing production capacities and those still under construction would be called into question but also the investments in the marketing network of the mid-sized mineral oil traders could be lost. On the other hand, demand will clearly increase as a result of the admixture obligation. This regulatory measure creates a de facto dependency of the oil industry, which in future will be the largest domestic customer. Faced with the comparably weaker market position, at least of the mid-sized biodiesel manufacturers, many fear that price pressure could increase along the entire value added chain.

Economic implications of the creation of a new industry

Any new industry, insofar as it produces income for employers and employees, has a positive effect on a country's economy. The effects are all the greater if this involves a new activity that has no negative effects on any existing industry and that replaces previous imports with domestic value added. It assumes its place in the complex, total economy by creating jobs, demanding intermediate products of other economic sectors and by inducing demand for capital goods, consumer goods and services. It thus contributes directly and indirectly to an increase of national value added and creates, via different taxes (income, trading, corporation and value-added taxes) and fiscal charges, additional revenue for the state's coffers and for the social insurance carriers. Simultaneously, it brings about public savings in various areas: unemployment insurance and market regulation costs for the previous surpluses in agricultural commodities markets. This is the case in the production of agricultural raw materials for use as a source of energy.

Previous studies (Schoepe and Britschkat 2002) have focused on the question of the extent to which the revenue shortfalls as a result of tax exemption for biodiesel could be compensated by the positive effects, i.e. additional tax receipts, trade tariffs, additional revenue for social insurance and various other attributable savings. This study pursues this question for the selected reference year 2005, which is of interest since it was the last year of complete tax exemption and also the year of the most recent, necessary economic data. For 2007 and 2009 analogous calculations were made, with less emphasis on the flowbacks of the granted tax subsidies than on quantifying the total economic impact. To do this, assumptions had to be made on the probable development of production, consumption, foreign trade, etc.

The uneven development in the production of renewable energy is frequently viewed under the aspect of competing procedures. The various sources are compared with each other from different standpoints viewed under different considerations, so for example from the viewpoint of CO^2 reduction, their energy balances, a comprehensive ecological balance, etc. An additional aspect is cost efficiency, i.e. which type achieves the greatest effect with the least subsidy requirements. It is to be noted that the efficiency calculations are not only a matter of government spending but that revenue and savings aspects must also be included. This aspect is the key objective of the study. To avoid too much complexity, only the direct economic effects were considered. Aspects that were not included were cross-country effects (e.g. climate protections, etc.) even though they may well have a long-term economic impact.

Table 1
Characteristics of the biodiesel market in 2005–2009 scenarios

Biodiesel production and market (Starting point for all calculations)	Unit	2005	2007	2009
Production	1 000 t	1 465	2 900	4 000
of which not from rape seed oil	1 000 t	100	600	1 400
Total consumption	1 000 t	1 800	2 900	4 400
as admixture	1 000 t	625	1 500	2 800
as biodiesel (B100)	1 000 t	1 175	1 400	1 600
Imports	1 000 t	355	100	500
Exports	1 000 t	20	100	100
Market price for biodiesel	Cent/litre	68	74	85
Market price for fossil diesel (incl. mineral oil tax)	Cent/litre	85	90	100
Substitution of fossil diesel	1 000 t	1 362	2 697	3 720
of which from imports	1 000 t	1 362	2 197	2 720
from foreign products	1 000 t	–	500	1 000
Value of biodiesel vis-à-vis fossil diesel	Factor	0.93	0.93	0.93

Source: Ifo Institute 2006.

Methodology

In order to determine the economic effects of the production of biodiesel for Germany, an input-output analysis was used as a tool. The most recent complete input-output tables of the German Federal Statistical Office are for 2002. The table contains the advance payment structures of 71 production areas, the value added of these sectors and the final demand. The complete tables are divided into domestic production and imports. For every production area the average number of employed persons is also provided.

In the three years between the reference year 2005 and the base year of the input-output tables, important changes took place that must be taken into account. Nominal labour market productivity of the input-output tables of 2002 must be corrected in a twofold respect in order to determine current estimated values for employment effects. On the one hand, the price development of capital goods (nominal effect) must be considered, and, on the other hand, the productivity development (real effect). Without these corrections, the effects on the labour market would be considerably overestimated. The determined economic figures for 2007 and 2009 are weighted at constant prices of 2005.

The analysis of the economic effects of the production of biodiesel is done by means of three multipliers: the Leontief multiplier, the Keynesian earnings multiplier and the accelerator. The Leontief multiplier shows how the demand for purchased materials and services of the production of biodiesel affects the production and the value added components of the other domestic production areas. The demand for domestic products is transferred completely into the following primary factors:

- imports
- goods taxes, production taxes
- pay to domestic employees
- depreciations
- operational surpluses

The resulting revenue (employee pay, operating surpluses) are partially spent again and thus give rise to further economic effects. This causal chain is described by the Keynesian multiplier. In order to compute the effects, firstly the net incomes are determined from the gross incomes, which then, taking the saving rates into consideration, lead to the income that is spent. The transition from gross income to net income – broken down into employee and entrepreneur income – is done using the National Accounts figures. The saving rates are determined separately for both kinds of income since they differ considerably. The source of information is the income and consumer samples of the Federal Statistical Office and the publications of the Bundesbank. The general structure of private consumption is used as the basis for additional demand.

The accelerator is applied to depreciations. The consumption of capital goods leads to substitute investments, which in other production areas, in turn, lead to depreciations and thus to further substitute investments. For the determination of the accelerator, a depreciation matrix would be necessary that would define the demand for capital goods in a specific area. This information is not available for the current input-output tables. It is assumed here that capital goods are demanded in a similar pattern in all sectors.

Scenarios for 2007 and 2009

The starting point of this study is the actual situation in 2005 with a domestic biodiesel production of 1.465 million tonnes and total consumption of ca. 1.8 million (see Tab. 1). Even if already in 2005 a small portion of the domestic biodiesel production (7%) was made on the basis of imported non-rape seed oils, a base scenario for 2005 is formulated that neglects the imports of production oils and thus quantifies the effect, without this distortion, of rape-seed-oil based value added chain of agricultural raw material up to the distribution level. For 2007 and 2009 scenarios are used that reflect the overall conditions expected by market experts, that is we work with the conditions in production and consumption that are regarded as likely from the viewpoint of spring 2006. This also includes assumptions pertaining to the development of relevant prices and trade relationships. For all of these years, for example, an extension of domestic biodiesel production for these two years to 2.9 and 4.9 million tonnes, respectively, is anticipated. It is also assumed that manufacturers resort, to a certain extent, to other raw materials, such as soybean oil from the international market. Thus, biodiesel production that is not based on rape seed oil might amount to 35% in 2009. In the opinion of the experts, consumption could increase to 2.9 million tonnes by 2007, which would put the market in equilibrium. For 2009 consumption is estimated to be 4.4 million tonnes, which means, under the assumed production development that on balance 0.4 million tonnes would have to be imported.

Table 2
Features of agricultural production and bee-keeping in the scenarios 2005–2009

Agriculture and apiaries	Unit	2005	2007	2009
Set-aside rape seed fields	1 000 ha	322	325	325
Non set-aside rape see fields	1 000 ha	532	1 083	1 180
Yields of rape seed per hectare	dt/ha	40	40	41
Rape seed harvest used	1 000 t	3 721	6 256	7 063
Rape seed imports for biodiesel production	1 000 t	300	500	750
Yields of winter wheat per hectare	dt/ha	75	75	75
Displaced wheat production	1 000 t	3 989	3 989	3 989
Difference in marginal income: rape vs. wheat	€/ha	50	75	83
Pre-crop value: rape vs. wheat	€/ha	130	130	130
Difference in marginal income: rape vs. setting-aside land	€/ha	265	383	439
Energy bonus	€/ha	45	45	45
Energy bonus areas	1 000 ha	122	100	100
Operational profits of bee-keeping	€/ha	150	150	150
Operations expenses of bee-keeping	€/ha	85	85	85
Marginal income from bee-keeping	€/ha	65	65	65
Land use (50% of rape area without set-aside land)	1 000 ha	304	593	676
Savings from grain-market intervention	1 000 t	4 563	9 068	10 546
Assumed intervention costs	€/t	35	10	5

Source: Ifo Institute 2006.

German agriculture as a raw material supplier

In 2005 the oil mills processed 3.65 million tonnes of rape seed for the subsequent production of biodiesel. EU import crops were also used, whose volume was estimated to be 0.3 million tonnes. With a rape seed yield of 40 dt/ha of cultivable area, the cultivable area amounted to 854,000 hectares for rape seed from domestic farms, taking cleaning losses and other factors into consideration (see Tab. 2). Nearly 38% of the cultivable area (322,000 hectares) was from so-called »set-aside« land, which according to EU law can be used for the cultivation of renewable raw materials. For cultivation on »food areas«, an EU energy bonus of €45/ha is available (European Union 2003c), which in 2005 was claimed for 122,000 hectares.

For farms in many regions, rape cultivation was an alternative that proved to be economically beneficial in comparison to other crops and particularly in comparison to setting aside land. In contrast to the cultivation of winter wheat, there was a difference in marginal income of €50/hectare and in contrast to setting-aside land a difference of €265/hectare. In addition it should also be noted that rape seed is excellently suited for crop rotation. If rape seed is grown before wheat, farming practice sees an additional utility that consists of different components such as increased harvests at lower inputs. This so-called pre-crop value is estimated at €130/hectare.

If, as we assume, rape cultivation for the production of biodiesel replaces crops of winter wheat, it must also be taken into consideration that much larger areas with blossoming plants are available for apiculture. Since rape fields, despite their high nectar yields, are only used by a portion of bee-keepers, only 50% of rape cultivation has been included in the calculation as food fields for apiculture (see Tab. 2).

For 2007 and 2009 not only increasing rape seed imports (500,000 and 750,000 tonnes, resp.) are expected but particularly oils of other vegetable origin. To simplify things, a calculation was made with soybean oil: 0.64 million for 2007 and 1.49 million for 2009. In this respect, domestic rape seed cultivation for biodiesel production would expand only to 1.4 million hectares and 1.5 million, respectively. Cultivation on set-aside land is estimated at 325,000 hectares

for both years, and claims for the energy plant bonus for only 100,000 hectares.[1]

The oil extraction and estrification levels

The size structure of oil mills in Germany is very heterogeneous. Large firms use, as a rule, extractors that remove the oil almost completely from the rape seed with an oil yield of 41%. Industrial expeller plants have yields of 36% and decentralized oil mills yields of 34%. With reference to the raw material from domestic oil extraction used for the production of biodiesel, the extractors have a share of about 82%, the industrial expeller plants a share of 11% and the decentralized oil mills a share of 7%. A distinction based on the technologies used and the plant sizes proved to be necessary, since this is linked not only with a different raw material efficiency but also with different qualities of the co-products (rape cake, rape extraction meal) and particularly with different cost structures.

Whereas in the early development phase of the biodiesel value added chain in Germany industrial-sized enterprises were the only participants, in recent years, in the wake of the spread of decentralized concepts of energy production, also decentralized biodiesel manufacturers have emerged. In this study the decentralized oil extraction and the decentralized biodiesel production are viewed as operationally related. The different cost structures of large industrial and the decentralized biodiesel production were correspondingly taken into consideration.

The various stages of oil extraction and estrification in the biodiesel value added chain are closely linked with the other sectors of the economy. This includes both the demand for purchased material and services, for example from the power industry or the chemical industry (extracting agents, methanol, catalyst materials), as well as the sale of co-products, for example protein fodder, glycerine and potassium sulphate (fertilizer) or the areas of transport and commercial services. Thus 35% of the production capacities for biodiesel in 2005 were in so-called annex plants, that is oil extraction and conversion to biodiesel took place in proximate technical facilities. In the case of the so-called stand-alone plants, transport and commercial services for the purchase of the oil raw material must be added to the calculation.

Biodiesel turnover and displacement effects

In 2005 1.465 million tonnes of biodiesel was produced in Germany, including ca. 0.1 million tonnes from raw materials other than rape seed. Limiting the analysis to the rape-seed-based production alone, 1.36 million tonnes of fossil diesel fuel was displaced (see Tab. 1). In the model we assume that imports of fossil diesel fuel have decreased. In accordance with the assumed production development of biodiesel and including imported raw materials, in 2007 2.7 million tonnes and in 2009 3.72 million tonnes of fossil diesel fuel will be displaced. Since we cannot assume that a substitution of this proportion will come at the sole disadvantage of imported fossil diesel, a lump-sum production reduction because of biodiesel was included of 0.5 million tonnes for 2007 and 1.0 million tonnes for 2009.

Co-products as essential elements of the economic benefits

Rape seed meal and cake protein fodder are the co-products with the greatest economic importance within the biodiesel value added chain. They are purchased directly by cattle farms or are included in fodder mixtures by the animal food industry. As a source of protein, they replace particularly soy meal, which must be imported from third countries. In 2005 2.2 million tonnes of protein fodder resulted from rape seed oil extraction (see Tab. 3). Taking the varia-

Table 3
Features of the markets for co-products in the scenarios 2005–2009

Secondary products and their markets	Unit	2005	2007	2009
Rape cake production (expeller)	1 000 t	491	781	849
Rape meal production (extraction)	1 000 t	1 704	2 906	3 310
Soy meal displacement, total	1 000 t	1 712	2 813	3 176
Soy meal market price	€/t	196.40	196.40	196.40
Rape meal market price	€/t	107.95	100.00	95.00
Rape cake market price	€/t	125.65	116.40	110.58
Generation of raw glycerine	1 000 t	183	363	588
of which GMO	1 000 t	25	100	240
Generation of pharmaceutical glycerine	1 000 t	60	75	100
Market price of raw glycerine, non-GMO	€/t	150	60	40
Market price of raw glycerine, GMO	€/t	100	20	10
Market price of pharmaceutical glycerine, non-GMO	€/t	450	360	350
Potassium sulphate production	1 000 t	8	11	17
Sale price ex works	€/t	50	50	50

Source: Ifo Institute 2006.

[1] Only a limited area (1.5 million hectares) is included in the EU energy plant bonus. In light of increasing competition with regard to use – crop cultivation for biogas or bioethanol – and competition between countries, restrictions are inevitable, which could lead to a reduction of the bonus per hectare and thus to a weakening of the appeal of this measure.

tion in quality into consideration (protein content), more than 1.7 million tonnes of imported soy meal can be replaced. Even if the markets for protein fodder are very much more complex in reality – for example, the soy meal stemming from German oil mills is also displaced or the soy meal displacement occurs in neighbouring countries that import rape seed meal for their intense cattle farming from Germany – we also calculated for 2007 and 2009 the displacement of soy meal imports. This amounts to about 2.8 million and 3.18 million tonnes, respectively.

For the animal feed industry and also for agriculture it has proved to be positive that the value determining element in the rape seed fodder, protein, is currently less expensive than soy meal. This effect might intensify in future since market experts expect a falling price trend for rape seed fodder. Corresponding reductions were included in the calculations. At the assumed prices, cattle raising receives a cost advantage of €63.5 million for 2005, €132 million for 2007 and €174 million for 2009.

Table 4
The economic effects of the biodiesel value-added chain

	Unit	Scenario 2005 [a]	Scenario 2007 [b]	Scenario 2009 [b]
Starting data				
Sales of biodiesel from manufacturer	1 000 t Mn €	1 365 1 055	2 900 2 439	4 000 3 864
Domestic demand for biodiesel	1 000 t	1 700	2 900	4 400
Economic effects				
Production	Mn €	3 506	6 945	9 623
– directly attributable [c]	Mn €	2 381	4 783	6 735
– via multiplier/accelerator	Mn €	1 125	2 162	2 888
Domestic added value	Mn €	1 891	3 621	4 817
– directly attributable [c]	Mn €	1 233	2 357	3 130
– via multiplier/accelerator	Mn €	658	1 264	1 687
of which employee remuneration	Mn €	609	1 187	1 601
– directly attributable [c]	Mn €	308	609	828
– via multiplier/accelerator	Mn €	301	578	773
Net operational surpluses	Mn €	860	1 605	2 093
– directly attributable [c]	Mn €	701	1 300	1 686
– via multiplier/accelerator	Mn €	159	305	407
Depreciations	Mn €	322	637	867
– directly attributable [c]	Mn €	224	449	617
– via multiplier/accelerator	Mn €	98	188	250
Import demand	Mn €	375	839	1 381
– directly attributable [c]	Mn €	187	476	895
– via multiplier/accelerator	Mn €	188	363	486
Employment	1 000 pers.	22.4	40.5	50.5
– directly attributable [c]	1 000 pers.	11.5	20.2	24.3
– via multiplier/accelerator	1 000 pers.	10.9	20.3	26.2

[a] Biodiesel generation from rape-based raw materials alone. - [b] Biodiesel generation from rape and other oils. - [c] Including indirectly attributable effects from advance purchases of goods and services.

Source: Ifo Institute 2006.

A further essential co-product is glycerine, which results from the estrification process. Whereas in the first years of the creation of the value added chain, biodiesel was still a product that was sold at comparably high market prices, especially to the chemical industry, with the progressing expansion of biodiesel production, the prices it commands have become increasingly lower so that alternative exploitation options are being sought. The assumed production of raw glycerine as well as pharmaceutical quality glycerine can be seen in Table 3. For the base scenario 2005, sales of nearly €50 million resulted; for 2007 and 2009 similar amounts were calculated due to the assumed fall of prices of almost the same extent. A further co-product, potassium sulphate, which can be used as a fertilizer in agriculture, contributes sales of less than €1 million to the overall economic calculations.

The economic effects that can be attributed to the biodiesel value added chain

The rape-seed-based biodiesel production of 2005 represents a production value of ca. €1.06 billion (see Tab. 4). Adding up all production values that the firms create in a direct or indirect connection with the biodiesel value added chain, a much higher value of €3.5 billion results. The achieved value added amounts to ca. €1.9 billion. This value includes not only the production of biodiesel and all co-products such as rape seed meal or glycerine, it also contains the indirect effects that stem from the already presented multipliers. A good 45% of value added in 2005 went to the net operating surpluses of the companies; the share of employee remuneration stood at 32%; and 17% was for depreciation. About 35% of the domestic value added of the biodiesel chain resulted from the effect of the multipliers. With the component of employee remuneration, the effect of the multiplier with a share of 49% is just as high as the direct performance of the biodiesel value added chain. With increasing biodiesel production, as is assumed for 2007 and 2009, domestic added value increases correspondingly without any clear changes in the relationships.

As a result of the assumptions made, the direct import demand also grows with increasing biodiesel production (in particular, imports of rape seed and vegetable oils). The links between the domestic economy and foreign countries also means that via the multipliers impulses for the demand for imported goods are also created.

In the base scenario of 2005, the existence of 22,400 jobs is attributed to the biodiesel value added chain, of which on-

ly 10,900 resulted from the multiplier effect. Most jobs arose in the services (40.5%); agriculture accounts for 27% that were either created or safeguarded due to the earnings achieved; in manufacturing it is 24%. The other shares are distributed in the remaining sectors of the economy. In the course of the production extension of biodiesel, the job creating effect increases to 50,500 jobs by 2009.

Positive effects on the income and expenditure sides of the public budgets

For the base scenario of 2005, revenue for the public budgets are calculated at €257 million (see Tab. 5). They result basically from growth in revenue from various taxes, import tariffs, dividends and similar things. Social insurance can also expect additional income. For 2005 they amount to €165 million. Even though the social insurance contributions are offset by future payment claims, they can be regarded as the same as public revenue. This is justified, among other things, because the various social insurance systems are, as a rule, in deficit and depend on subsidies, which with the additional contributions would be lower. Under the general conditions of the scenarios for 2007 and 2009, the revenue of the public budgets increases as a result of the assumed development of the biodiesel value added chain from €495 million to €681 million and the income of the social insurance carriers from €320 million to €431 million.

As already pointed out, as the value added chain for biodiesel establishes itself, jobs will be created or at least not lost (agriculture). This represent a positive, albeit in the light of the large number of unemployed, a minimal contribution to the reduction of unemployment. Nevertheless, this effect will lead to considerable savings in governmental services for the unemployed, amounting to €236 million for the base scenario year 2005 and €620 million for 2009. This was calculated on the basis of the first level of unemployment compensation (Arbeitslosengeld I), which pays the unemployed about 62% of their last net pay.

Tab. 5
Changes in the public budgets caused by the biodiesel value added chain

Positive effects on public budgets	Unit	Scenario 2005 [A)]	Scenario 2007 [b)]	Scenario 2009 [b)]
State revenues from taxes, fees, dividends minus import duties	Mn €	257	495	681
of which goods taxes, production levies minus subsidies	Mn €	101	191	256
Wages and income tax (employees)	Mn €	76	148	200
Earnings, corporation tax (Enterprises)	Mn €	95	177	230
Social insurance revenue	Mn €	165	320	431
of which from employees	Mn €	152	297	400
from employers	Mn €	13	24	31
Savings in unemployment insurance	Mn €	236	460	620
Savings in grain-market intervention	Mn €	140	83	46
Sum of positive effects for the public budgets	Mn €	**798**	**1 359**	**1 779**
Mineral oil tax[)]				
Losses in mineral oil tax on mineral diesel and/or displaced diesel components	Mn €	787	1 597	2 366
Tax revenue on biodiesel B100	Mn €		146	341
Tax revenue on biodiesel admixture	Mn €		954	1 781
VAT on price increase caused by admixture	Mn €	33	107	206
Remaining tax burden	Mn €	754	390	39
Subsidy: energy plant bonus	Mn €	5	5	5
Total burden on public budgets	Mn €	**760**	**395**	**43**
Balance: effects on public budgets (positive in all cases)	Mn €	**38**	**964**	**1 735**
Relationship of positive effects to burdens on the public budgets	%	**105**	**344**	**4 105**
Memo item: If tax exemptions were retained	%	105	91	82

[a)] Biodiesel generation from rape based raw materials alone. - [b)] Biodiesel generation from rape and other oils. - [c)] Including VAT

Source: Ifo Institute 2006.

It was also assumed in the calculation that the cultivation of rape seed for biodiesel production would displace the cultivation of winter wheat in the so-called food fields. The result is that in the year in question less grain is subject to market intervention and that these costs for market regulation can be saved. For calculating the market intervention costs, all the cost positions of intervention for 2005 were determined and several example distances of different intervention warehouses to the export ports were calculated (Straubing–Rotterdam; Mehltheuer–Hamburg; land transport 255km). The example calculations showed that for 2005 it was realistic to apply intervention costs of €35/tonne, an order of magnitude that has also been confirmed by grain-trade specialists. The rape seed cultivation on food fields for the production of biodiesel thus led in 2005 to savings in intervention costs of €140 million. For the following years 2007 and 2009, clearly reduced market regulation costs were assumed, firstly, because the EU is currently sharpening the intervention conditions and, secondly, because worldwide more and more fields are being used for energy production (in addition to biodiesel also biogas and bioethanol) and this will reduce the supply pressure in the grain markets. In this way claims to intervention will be less frequent in future and also the level of the export refunds might sink. For 2007, market regulation costs were estimated at €10/tonne and for 2009 €5/tonne; in comparison with 2005 clearly lower savings would result (see Tab. 2).

Adding up the various positive effects of the biodiesel value added chain on the public budgets, an amount of €0.8 billion for the base scenario 2005 results. Since the use of biodiesel in the fuel sector displaces fossil diesel fuel, the state suffers losses from mineral oil taxes to the extent that biodiesel is tax-deductible. In 2005 biofuels were completely excluded from the mineral oil tax so that the state had to forgo revenue of €787 million.[2] Already in 2005, the mineral oil industry used ca. 625,000 tonnes of biodiesel as an admixture. It is assumed that the industry succeeded in receiving compensation for the additional costs of the raw material biodiesel and the process costs of mixing through correspondingly higher prices. For the base scenario 2005 a rise in prices of 0.58 cent/litre of diesel fuel induced by the admixture was calculated. The value-added tax on this led to revenue in an order of magnitude of €33 million. In total the state suffered revenue losses from the missing mineral oil tax and the bonus paid for energy plants, which was reduced by additional revenue from the value-added tax. The so determined burden on the public budgets of €760 million for the base scenario 2005 is thus lower than the previously determined »positive effects«. In the final result, there was not an overall deficit for the variously involved public budgets but a redistribution that was largely at the expense of the Federal Ministry of Finance.

For 2007 and 2009 the tax deficit will be reduced considerably as a result of the new energy-tax law. For 2007 the burden on the public budgets will amount to only €395 million, which is set off by »positive effects« of €1.36 billion. For 2009 it is assumed that the burden for the public budgets will be largely insignificant, but the positive effects, amounting to €1.78 billion, will remain. For this calculation it was assumed that, to a certain extent, German agriculture itself will purchase biodiesel as a pure fuel, which will remain tax exempt when used for agricultural purposes. For 2009 a demand of 0.4 million tonnes was assumed, which corresponds to approximately a quarter of the current diesel consumption in German agriculture. The agricultural consumption for 2007 was estimated at 0.2 million tonnes, since agriculture can only gradually convert to alternative fuels.

Literature

Deutscher Bundestag (2005), »Bericht zur Steuerbegünstigung für Biokraft- und Bioheizstoffe, Unterrichtung durch die Bundesregierung«, Drucksache 15/5816, 21 June 2005, Berlin.

European Union (2003a), »Directive 2003/30/EC of the European Parliament and of the Council of 8 May 2003 on the promotion of the use of biofuels and other renewable fuels for transport«, *Official Journal of the European Union*, Brussels, L123, 42–46.

European Union (2003b), »Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for the taxation of energy products and electricity«, *Official Journal of the European Union*, Brussels, L283/51–70.

European Union (2003c), »Commission Regulation (EC) No 2237/2003 of 23 December 2003«, *Official Journal of the European Union*, Brussels, L339/52–69.

Schöpe, M. and G. Britschkat (2002), »Gesamtwirtschaftliche Bewertung des Rapsanbaus zur Biodieselproduktion in Deutschland«, *ifo Schnelldienst* 55(6), 14–21.

[2] These figures apply to the basic scenario, which is limited exclusively to the production of biodiesel from rape-seed-based raw materials. Total lost tax revenues for 2005 amount to €833 million.