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COMPETITIVENESS OF BRAZILIAN BIOETHANOL IN THE EUROPEAN UNION

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ABSTRACT. The new EU legislation on biofuels, which allows a full exemption of petrol tax in the member states, has led to a positive investment climate particularly in Germany. At the same time, the fact that bioethanol can be produced at much lower costs in other parts of the world than in Europe should not be ignored. This article, therefore, aims to analyse the production costs of bioethanol in Brazil, the world's largest producer and exporter.

Key words: bioethanol, biofuels, competitiveness

Tax exemption

Last year, EU institutions agreed that the energy-based share of biofuels should be 2% by the end of 2005, increasing 0.75 percentage points a year until it reaches 5.75% by the end of 2010. To achieve this objective, it was also decided that member states could grant exemptions from petrol tax as long as these did not lead to an overcompensation of the difference in production costs relative to conventional fuels.

Under the regulations, the proportion of renewables in fuels can reach up to 5% by volume without needing to be labelled. However, if bioethanol's share was to reach 5.75% by energy content, labelling would be required since the volumetric share would be more than 8%.

The petrol tax on 95-octane petrol in Germany is now 65.45 Euro cents per litre and is, therefore, the maximum ethanol tax reduction which the country would be permitted under EU law. This tax exemption has already been operative for several years but only for pure biofuels such as biodiesel. In accordance with the new German legislation, the renewable share in blended fuels is also tax exempt.

Rocz. AR Pozn. CCCLIX, Ekon. 3: 57-66

PL ISSN 1731-0261

Production costs of bioethanol in Germany

A calculation of the net production costs of bioethanol in Germany was presented in the article by **Henniges** and **Zeddies** (2003).

These costs worked out at 50 €/hl depending on plant configuration and raw material prices to which outlays on distribution and blending have to be added. This is the value which has to be compared with the long-term selling price of petrol of about 25 €/hl. However, it should be remembered that this price is currently significantly higher due to the increased price of crude oil.

In Germany, a full petrol tax exemption amounting to 65.45 €/hl was given the go ahead by the Bundestag (the German Parliament) and subsequently approved by the European Commission. In its approval statement, the Commission included bioethanol production costs at 69 €/hl. Given the lower energy density of bioethanol (only 65%), production costs would actually be 107 €/hl. The price of a litre of petrol at the pump including VAT and petrol tax is around that figure. In this regard therefore, the difference in production costs is officially even greater than the tax exemption.

At first sight, it might seem surprising that the production costs of 69 €/hl are so much higher than the 50 €/hl mentioned above. This can be explained by the fact that currently investments are in smaller plants which have higher production costs due their reduced economies of scale. Furthermore, investors assume shorter depreciation periods, so that the share of fixed costs per unit of output increases. This can be explained by the tax exemption which is currently set to expire by the end of 2009. In addition, there is no mention of what contribution is included in that figure for the sale of co-products.

However, it seems to be more important that the tax exemption is based on the lower energy value. So far, ethanol's supporters have argued that fuel consumption does not increase as long as the ethanol blend is low, since its positive characteristics, such as the higher oxygen content and better anti-knock properties, would compensate for the lower energy content.

Pressure from imports

One important reason underlying the tax exemption for biofuels is the assumption that they will be of EU origin and therefore that the added value will benefit the Community's farmers and processors. Nevertheless, the questions remains as to whether the full tax exemption will lead to a situation in which German bioethanol demand will be partially or even totally met by imports. However, as it stands at present, the only countries able to meet that demand are the US and Brazil.

In the above-mentioned article, US bioethanol production costs including state aids were calculated at 25 $/hl, assuming a corn price of 2.10 $ per bushel. Current US ethanol production amounts to 125 M. hl, all of which is used to satisfy national demand; in fact, the US is presently a net importer of ethanol. The world's most important ethanol producer and exporter is Brazil so the following sections will focus on that country.

Production costs of ethanol in Brazil

In 2002/03, about 317 M. t of sugar cane were delivered to Brazilian sugar and alcohol factories (Fig. 1). Of the total, 267 M. t came from the Centre/South region and the remaining 50 M. from the North-East. It should be mentioned that, in the state of São Paulo alone, 192 M. t were harvested. Processing of sugar cane is evenly split between sugar and alcohol. Of the 23.8 M. t of sugar produced, 14.2 M. were exported. Brazil is thus the world's largest sugar exporter, followed by the EU, Thailand and Australia. 70 M. hl of anhydrous and 55 M. hl of hydrous ethanol were produced from the remaining sugar cane, but only 7.7 M. hl were exported. In fact, the export potential is much higher not only because of the changes in EU legislation. The present high prices for crude oil mean that ethanol can be viewed not only as an option for climate protection but can also be considered for economic reasons.

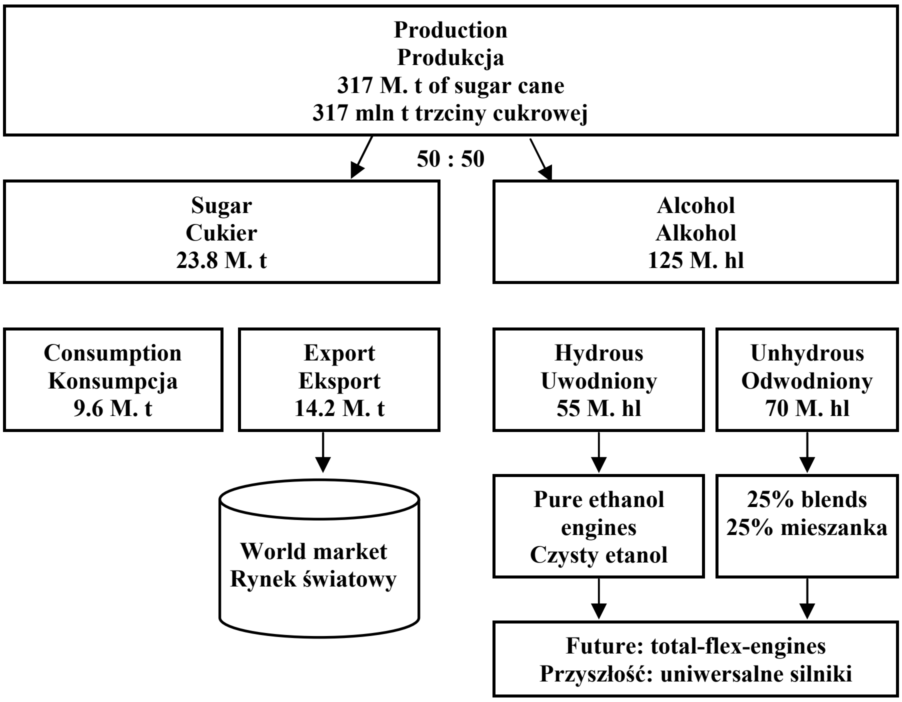

Fig. 1. Sugar cane production in Brazil
Ryc. 1. Produkcja trzciny cukrowej w Brazylii

Sugar cane production

In the case of Brazil, the assumption is that the year of cane planting is followed by six harvesting seasons and the following calculations are based on cane production in a favourable area in the state of São Paulo. The yield from the first harvest is 120 t/ha, decreasing by 10 t/ha every so-called ratooning, down to 70 t/ha in the sixth harvesting season. This gives an average yield of 95 t/ha, which, compared with the average yield in Brazil's main sugar cane area, the Centre/South region, is quite high. In the North-East, yields are only half of the average due to poor climatic conditions and the hilly landscape.

Table 1 shows a model calculation for the variable costs of sugar cane production in US \$. Administration and other fixed costs (buildings etc.) are not included as they are not considered particularly significant.

Table 1

Sugar cane production costs in the Centre-South region of Brazil (exchange rate: 3 R\$/US \$) (on the basis of Agrianual 2004)
Koszty produkcji trzciny cukrowej w środkowopołudniowym regionie Brazylii (kurs wymiany: 3 R\$/US \$) (na podstawie Agrianual 2004)

	The first year of planting Pierwszy rok uprawy	Harvest – Zbiory					
		the first pierw-szy	the second drugi	the third trzeci	the fourth czwar-ty	the fifth piąty	the sixth szósty
Yield (t/ha) Plon (t/ha)		120	110	100	90	80	70
Mechanical processes (US \$/ha) Procesy mechaniczne (US \$/ha)	207	439	408	376	345	313	229
Manual processes (US \$/ha) Procesy ręczne (US \$/ha)	122	15	15	15	15	15	2
Pesticides, fertilizers (US \$/ha) Pestycydy, nawozy (US \$/ha)	228	95	95	95	95	95	0
Subtotal (US \$/ha) Razem (US \$/ha)	557	549	518	486	455	423	231
Depreciation of planting (US \$/ha) Amortyzacja (US \$/ha)		116	116	116	116	116	116
Total (US \$/ha) Razem (US \$/ha)		665	634	602	571	539	347
Costs (US \$/t) Koszt (US \$/t)		5.54	5.77	6.02	6.35	6.74	4.96
Average costs (US \$/t) Przeciętny koszt (US \$/t)				5.90			
Costs including interest for farm land (US \$/t) Koszty łącznie z oprocentowaniem ziemi (US \$/t)				8.53			

In the year of planting, costs of 557 $/ha are incurred which are averaged over the six following harvesting years assuming an interest rate of 10%. Thus, within the cost calculation, 116 $/ha are allowed for each year. Since in this case it is assumed that the cane is harvested mechanically, the largest share of the variable costs is machinery related.

Over time, as the result of decreasing marginal yields, the costs per tonne of sugar cane increase from 5.54 $/t in the first season to 6.74 $/t in the fifth season. However, they drop to 4.96 $/t in the last year because no further costs for pesticides, fertilizers and their application are incurred. On average, the variable costs of production add up to 5.90 $/t. The fixed costs which have to be apportioned are dependent on individual farm sizes and the equipment used. For ease of comparison, they will be ignored for the purposes of this exercise. As a consequence of the favourable conditions for sugar cane growing, the price for farm land in the state of São Paulo at an average value of 2500 $/ha is by far the highest in Brazil. Hence, at an assumed interest rate of 10%, an additional 250 $/ha or 2.63 $/t have to be included as opportunity costs. As a result, the notional cost of production rises to 8.53 $/t.

In 2003, the average price for sugar cane was about 10 $/t which will be considered as a benchmark in the following calculations. As a basic principle, the price of sugar cane is still primarily dependent on the world sugar price. Since it has fallen to very low levels in recent years, the cost of the cane used for ethanol production has also declined.

Ethanol production

The following calculations assume an ethanol recovery of 85 l/t of sugar cane, which is about the average for the state of São Paulo. Therefore, sugar cane costs per hl of alcohol amount to 11.76 $/hl. (Table 2 shows the breakdown of costs in relative and absolute terms). Since most of the factories produce both sugar and alcohol, certain benefits from synergies can be assumed. For the production of ethanol, B-molasses and thin juice are used. Thus, sugar of low solubility is fed into fermentation instead of being recovered at a higher cost.

The following example is based on a factory processing 1.3 M. t of cane per year. Of the total, 650 000 t are used for alcohol production. According to the opinion of one expert consulted, the cost of constructing an attached distillery with a capacity of 550 000 hl of anhydrous ethanol per year is 6.4 M. $. This figure breaks down into 20% for buildings which have an economic life of 20 years, and 80% for machinery which is used for ten years. This results in an investment cost share of 1.63 $/hl, assuming an interest rate of 10% per year. This portion of the costs would be higher if the investment expenditure for the sugar refinery was to be proportionately charged to ethanol production. On the other hand, it must also be acknowledged that, for the most part, the facilities are in practice utilised for considerably longer than is assumed above.

A plant of this scale employs about 300 people, half of whom can be charged to ethanol production, which results in labour costs of 0.34 $/hl. Expenditure on insurance, repairs and fees contribute another 0.58 $/hl to total costs.

Further costs of 2.78 $/hl are incurred for operating inputs including steam and energy. It is obvious that, as the result of burning bagasse, operating costs are very low compared with ethanol plants based on sugar beet or grains, which have comparably high levels of expenditures on steam.

Table 2

Production costs of bioethanol in Brazil (plant size – 550 000 hl ef ethanol, required feedstock – 0.65 M. t of sugar cane)
Koszty produkcji bioetanolu w Brazylii (zdolność produkcyjna – 550 000 hl etanolu, wymagany zasób surowca – 0,65 mln t trzciny cukrowej)

Specification Wyszczególnienie	Price Cena	Share Udział (%)
Buildings – Budynki	0.25 $/hl	1.4
Machinery/Inventory – Maszyny	1.38 $/hl	7.9
Total investment – Inwestycja ogółem	1.63 $/hl	9.4
Labour – Praca	0.62 $/hl	3.6
Insurance, fees, repairs – Ubezpieczenie, opłaty, naprawy	0.58 $/hl	3.3
Raw material – Surowce	11.76 $/hl	67.7
Other operating costs – Pozostałe koszty operacyjne	2.78 $/hl	16.0
Gross production costs – Koszt produkcji brutto	17.37 $/hl	100.0
By-product: bagasse – Produkt uboczny: bagasse	for energy needs na potrzeby energii	
By-product: vinasse – Produkt uboczny: vinasse	1.00 $/hl	5.8
State and federal subsidies – Dotacje państwowe i federalne	0.00 $/hl	0.0
Net production costs – Koszt produkcji netto	16.37 $/hl	94.2
Export price (fob São Paulo) – Cena eksportu (fob São Paulo)	18.37 $/hl	105.8
Import price (cif Rotterdam) – Cena importu (cif Rotterdam)	23.37 $/hl	134.5
Import price (cif Rotterdam) – Cena importu (cif Rotterdam)	19.48 €/hl	
+ Tariff on non-denatured ethanol – + Cło na czysty etanol	19.20 €/hl	
+ Transport to Germany – + Transport do Niemiec	1.00 €/hl	
Total costs until rafinery – Koszt całkowity przed rafinerią	39.68 €/hl	

In Brazil, most plants burn bagasse to meet only their own energy requirements. As a result of low selling prices of about 3.3 US-cents for 1 kW·h, investments in more efficient but also more expensive co-generation systems would hardly be profitable. At present, steam-operated, low-pressure systems burn all the bagasse which is produced. In the future, gas-operated turbines which work at 82 bar and higher temperatures could be viable if, in addition, the resultant trash is burnt.

Since the total energy content of sugar cane can be evenly split between the sugar, the bagasse and the trash, respectively, the potential for energy production would increase considerably. On the other hand, it would not be practicable to collect 100% of the trash.

The conversion of trash and bagasse into ethanol can also be considered. Theoretically, a tonne of cane could produce an additional 38 l per of ethanol, if a yield of 140 kg dry matter is assumed for each bagasse and trash.

Only when technologies which allow either greater energy recovery or a higher ethanol yield become available will the co-products have to be brought into the cost calculation. For the time being, there is therefore no income from the bagasse as a co-product. Equally, no costs are included in the calculation for "bagasse" as the energy feedstock.

In this context, it should be remembered that no fossil fuels are required for the production of bioethanol in Brazil. This is one of the reasons why both the CO_2 and energy balances turn out to be more favourable than those for ethanol production in Europe. With regard to a cost efficient mitigation of green house gases in terms of the **Kyoto Protocol...** (1997), the use of Brazilian ethanol looks a promising option.

Another co-product from ethanol production is the vinasse, of which about 1300 l per 1 hl are produced. Calculating the substitution value of the N, P_2O_5 and K_2O content of vinasse results in a credit about 1 $/hl of ethanol. In this context, the higher application costs compared with mineral fertilizer have to be taken into account.

According to repeated official assertions, no direct subsidies are granted for the production of ethanol in Brazil so the net production costs in this example amount to 16.37 $/hl.

Although there are no direct subsidies, other mechanisms which indirectly help the ethanol industry must be mentioned. Firstly, there is a blending obligation on the petrol companies which have to add between 20% and 25% ethanol to fossil petrol depending on the situation in alcohol market. This means that the demand for ethanol is controlled by the government. Secondly, the total of VAT, petrol tax and other taxes on ethanol is only about half as much as that applied to petrol. Consequently in 2003, the total of federal and state taxes applied to petrol containing 25% ethanol was about 0.30 $/l and only approximately 0.17 $ for hydrous alcohol. Thirdly, the motor vehicle tax for ethanol-powered cars is slightly lower than for their petrol-fuelled equivalents.

The net production costs of 16.37 $/hl have to be compared with the market price for anhydrous ethanol in Brazil, which was around only 15 $/hl in May 2004, indicating that the commodity was in oversupply. Therefore, it seems that higher demand generated through biofuel programmes in other countries would be of potential benefit to Brazilian producers.

Adding another 2 $/hl for transport to the port of shipment, Brazil could export bioethanol from São Paulo for about 18-19 $/hl fob without profit margin to which the freight to Europe of around 5 $/hl would have to be added. Due to booming Chinese import demand, freight costs have increased considerably in recent years. Thus, a cif import price in Rotterdam of about 23-24 $/hl would result. At an exchange rate of 1.20 $ for 1 €, the price would be around 19.5 €/hl.

Since the German Parliament decided that only non-denatured ethanol would be permitted as a biofuel, an import tariff of 19.2 €/hl would have to be added. In this example, the alcohol would be transported to a German refinery by barge for about 1 €/hl. Hypothetically, this means that, including all the costs, Brazilian ethanol could be brought to Germany for about 40 €/hl excluding VAT (currently 16% in Germany) assuming no profit margin for the producers. This is far below the costs of production in Europe.

For Brazil, Europe in general and Germany and Sweden in particular could be attractive markets, even though there are other promising export opportunities including Japan, the USA and China. Moreover, it should be remembered that the tax reductions vary across the EU; in France, for example, the reduction is only 37 €/hl.

Another aspect to be taken into consideration is the current low world sugar price, which means that the incentive to produce alcohol could increase, provided domestic and international demand continued to rise. Finally, in the current EU-Mercosur negotiations, the implementation of a preferential import quota for Brazil of 1 M. t of ethanol (12.7 M. hl) which is currently being discussed would represent around 10% of the 5.75% target requirement for the EU-15. Given potential imports of this order of magnitude, it will come as no surprise that the German Minister of Agriculture has demanded a transition period in order to minimise the risk for domestic investments in bioethanol capacities, which have been financially supported by the state.

On the other hand, total-flex-vehicles which have now been on the Brazilian market for little over one year, have been a stunning success. These cars can run on any mix of hydrous, anhydrous ethanol and petrol and have stimulated domestic demand for ethanol in Brazil.

By contrast, the risk of large ethanol imports from the USA is much less. Since the domestic tax incentives for ethanol production are not granted for exports and corn prices are currently around 3 $ per bushel, the import price of US alcohol including tariff would be on a par with Community production costs. Furthermore, due to changes in legislation and high petrol prices at the pump, domestic fuel ethanol demand in the US is itself rather high at present.

Ethanol's competitiveness against petrol

In addition to the relative competitiveness of ethanol of various origins, the key question is whether it is competitive against petrol. Table 3 breaks down the present selling price of petrol in Germany and also shows a possible pricing structure for ethanol. Experts assume that bioethanol will be priced the same as petrol, so that petrol blended with 5% ethanol will also cost about 1.13 €/l. Thus, the advantage for the consumer might be limited to the possibility that the increase in the price of fuel might not be so great.

Table 3

Composition of selling prices of petrol and ethanol in Germany
Struktura ceny sprzedaży benzyny i etanolu w Niemczech

	Gasoline Benzyna (€/hl)	Ethanol Etanol (€/hl)
Prise at the pump (EU ethanol) Cena w dystrybutorze (etanol UE)	113	113
Purchase price – Cena zakupu	25	50-70
VAT	16	16
Petrol tax – Podatek od paliw	65	0
Distribution – Dystrybucja	5	5
Denaturation/blending – Denaturalizacja/mieszanie	0	2
Profit margin – Marża zysku	2	20-40

This calculation shows that the potential profit margin for ethanol in Germany could be between 20 and 40 €/hl, so that the oil companies are being given a substantial incentive to use ethanol blends. However, it is also clear that this profit margin would even be higher if imported Brazilian ethanol was to be used. There is, therefore, a risk that, based on these potential profits, the authorities might reduce the tax exemption for biofuels at some stage.

Conclusions

In the preceding sections, it has been shown that Brazilian ethanol production costs are not only much lower than in the EU, but are also lower than petrol prices. Brazil's superiority is underlined by the fact that there is a great potential for expanding production by limiting sugar output and/or increasing the area planted to sugar cane. However, it has to be borne in mind that a significant expansion in production can only be achieved with higher production costs. Thus, the import of bioethanol from Brazil seems to make sense from an economic point of view.

Under these circumstances, since EU bioethanol production is supported by a number of national governments, it can only be maintained if major tax reductions are granted and high import tariffs imposed.

The question remains as to who should benefit from the tax reductions in Germany. From a Community standpoint, it does not make much sense for tax revenues to be transferred to a few Brazilian companies. In this regard, it will be interesting to see what comes out of the Mercosur negotiations.

From an environmental point of view the option of using ethanol from sugar cane should be considered in any case, be it by direct imports or indirectly by applying the flexible mechanisms of the **Kyoto Protocol...** (1997).

If the biofuel targets of the EU Commission are achieved with the instrument of tax reductions alone, heavy tax losses for the member states' budgets will occur in any case. On the other hand ethanol promises a huge potential for value adding in the agricultural and processing sector. On behalf of the European ethanol industry, that is still in its infancy the present, ideal fiscal conditions should be maintained.

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KONKURENCYJNOŚĆ BRAZYLIJSKIEGO BIOETANOLU W UNII EUROPEJSKIEJ

S t r e s z c z e n i e

Nowe ustawodawstwo dotyczące biopaliw, które pozwala na zwolnienie z podatku od paliw w krajach członkowskich Unii Europejskiej, prowadzi do powstania sprzyjającego inwestycjom klimatu w Niemczech. Jednocześnie nie można ignorować faktu, że w innych regionach świata koszty produkcji biopaliw są niższe, stąd celem niniejszego artykułu jest analiza kosztów produkcji bioetanolu w Brazylii, kraju, który jest największym światowym producentem i eksporterem tego paliwa.