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THE ECONOMIC FEATURE OF BIODIESEL PRODUCTION IN SERBIA

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INTRODUCTION

Exploring new energy resources, such as biodiesel fuel, is of growing importance in recent years. Biodiesel, derived from vegetable oil or animal fats, is recommended for use as a substitute for petroleum-based diesel mainly because biodiesel is a renewable, domestic resource with an environmentally friendly emission profile and is readily biodegradable *(Zhang et al., 2003)*. The biodiesel industry has been flourishing in Europe in recent years. Combinations of agriculture, tax, energy and environmental policies have coalesced to make biodiesel production and use a viable enterprise. In 2003, the European Union introduces a directive that sets targets for biofuel production and use. The target is 2% of fuel use in 2005 and rising to 5.75% by 2010 *(*Directive 2003/30/EC*)*. The production of biodiesel in the EU is estimated to have totalled 3.2 million tons in 2005, which is an increase by 65% compared to 2004. *(EBB, 2007)*.

Biodiesel in Serbia on the other hand is at a very early stage of development. Although our country has a great potential for biodiesel production, estimated to be 212,800 tons to 250,600 tons biodiesel annually *(Kiš, 2006)*, there have been only small quantities of transportation biodiesel produced mainly for demonstration purposes.

The experts explain this fact with high prices of biodiesel production. This statement is based on some earlier reports, which have estimated the economic feasibility of biodiesel production in Serbia. Calculated production costs (which included the cost of the feedstock and of its conversion to biodiesel) ranged from 0.56 €/l to 0.62 €/l depending on the capacity of the production facilities *(Furman et al., 2004)*. These estimates were for operations where the biodiesel production facility was integrated into an oilseed crushing and processing plant.

Jovanović et al. *(2004)* evaluated the economic feasibility of a plant producing 5,000 ton/year of biodiesel, when virgin rapeseed oil was used as raw material.

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Using an estimated process cost, exclusive of feedstock cost of 0.15 €/l for biodiesel production and estimating feedstock costs at 506 €/t for raw rapeseed oil. Jovanović *(2004)* estimated the production cost of rapeseed-based biodiesel at 0.61 €/l.

Considering the great fluctuation of feedstock and crude oil prices on the domestic market, the aim of this work is to reconsider the economic feasibility of biodiesel production under the latest financial and market conditions. This study is done with the aim to investigate the profitability of biodiesel production, considering several biodiesel taxation scenarios, knowing the fact that biodiesel production is not an explicit subject of any legislation form in our country at the moment.

METHODS

An economic model was developed applying theoretical knowledge and practical experience in order to evaluate the biodiesel production cost in Serbia. The economic model was developed by methods generally used to prepare conceptual cost estimates and is based on contemporary production processes using current best values for reagents, equipment, and supply costs.

The developed model will be used to assess the profitability of two biodiesel production scenarios. Model A supposed that the biodiesel production facility is integrated into a previously built oilseed crushing and processing plant which processes oil seed (sunflower, soybean, and rapeseed) and supplies the biodiesel plant with virgin oil. Model B supposed that the biodiesel plant is an independent industrial and economic unit which acquires the necessary sunflower, soybean or rapeseed oil on the free marketplace. Both of the models consider plant capacities with 10,000 tons, 20,000 tons, 40,000 tons and 60,000 tons per year. Since there are two scenarios, six types of feedstock and four production capacities, there are 24 biodiesel production scenario variations in total. All of them will be assessed in this paper.

RESULTS AND DISCUSSION

The detailed calculations are presented on a biodiesel plant of 10,000 tons capacity per year, using rapeseed grain or virgin rapeseed oil as raw material, while the final results of the calculations for the other options have only a graphic representation as given in figure 2. The total cost of biodiesel is consists of the capital related costs, the feedstock costs and other operating costs. For a range of plant sizes from 10,000 to 60,000 tonnes of biodiesel production annually the total investment costs are summarized in table 1. As shown the cost of the transesterification unit forms a significant part of the capital. The cost associated with this unit amounted to 56-71 % of the total fixed capital costs. Of the equipment cost 10-25 % is for biodiesel

and chemicals storage tanks. These were modelled at 12 day working supply capacity. Substantial savings would accrue from reducing storage capacity, as in the case of arranging for timely removal of product by rail, or accepting smaller inventory holding capacities.

Table 1 Capital cost estimates for biodiesel plant (in 000 €)

	Description	Plant capacity (tonne/year)			
		10,000	20,000	40,000	60,000
I	Equipment	3,846	4,899	6,267	7,950
1.	Transesterification unit	3,200	3,800	4,300	5,100
2.	Storage facilities	370	690	1,330	1,971
3.	Infrastructure	100	200	400	600
II	Buildings	225	250	275	290
III	Tariff and transportation	176	209	236	280
IV	Projecting and engineering	379	474	590	736
V	Fixed capital cost	4,450	5,623	7,132	8,977
VI	Working capital	308	820	1,640	2,460
VII	Total investment	4,758	6,443	8,773	11,438

The projected annual operating costs for the modelled biodiesel production facilities are shown in Table 2. This analysis calculates a final biodiesel production cost of 0.52 €/l when rapeseed seed is used as a feedstock, and 0.59 €/l when the production is based on virgin rapeseed oil. The cost of feedstock comprises up to 59.6% of the total operating costs when rapeseed seed is used as feedstock (Model A). Applying virgin rapeseed oil as raw material results in 78.5% of the total operating cost (Model B). Consequently, raw material costs appear to play the most important role in manufacturing costs, which in turn substantially affects the total manufacturing cost.

Biodiesel plants obtain revenue from at least two by-products glycerine and potassium sulphate fertilizer and in some cases a third, oilcakes. Glycerol and oilcakes for livestock feeding are by-products that might help to offset the cost of biodiesel production. However, the importance of glycerine is usually overestimated. Income from the sale of this material resulted in an estimated 2.1% reduction in production costs. Glycerine prices have fluctuated from 780 € to 200 € per tonne in the last ten years and have been significantly affected by the production of biodiesel in Europe. The oversupply of glycerol caused a sharp reduction in its price *(Kiš, 2006)*.

Table 2 Annual costs and expected profit for the annual production of 10.000 t of biodiesel from rapeseed seed and oil (in 000 €)

Phase	Item	Model A		Model B	
		€	%	€	%
Feedstock	Rapeseed grain/ oil	4,444	59.6	5,400	78.5
Processing of raw oil	Expenses to oil plant	554	7.4	-	0.0
	Storage	88	1.2	-	0.0
	Processing	896	12.0	-	0.0
	Total	1,540	20.6	-	0.0
Esterification	Materials	629	8.4	629	9.2
	Depreciation	401	5.4	401	5.8
	Maintenance	118	1.6	118	1.7
	Insurance	59	0.8	59	0.9
	Labour	92	1.2	92	1.4
	Interest	82	1.1	82	1.2
	Management expenses	90	1.2	90	1.3
	Total	1,475	19.8	1,475	21.5
Gross operating costs		7,460	100.0	6,875	100.0
Oilcake		1,388	16.1	-	-
Glycerine		150	1.7	150	2.1
Fertilizer		22	0.3	22	0.3
Biodiesel		7,075	81.9	7,075	97.6
Revenues (€/year)		8,637	100.0	7,248	100.0
Annual profit		1,176		372	
Net annual profit after taxes (10%)		1,059		335	

The profitability of biodiesel production, beside production costs, greatly depends on the expected retail price of biodiesel. The selling price of biodiesel is related to the retail price of D2 diesel fuel. Diesel fuel prices have been rising from 0.55 €/l to 0.92 €/l over the past 4 years *(NIS, 2007)*. The average price has been 0.73 € per litre for the same period. Recently the diesel fuel retail price is decreasing and is formed at 0.81 €/l.

The retail price of petroleum diesel beside the production cost of fossil fuel, consists of trade allowance (0.06 €/l), which belongs to the fuel distributors, the excise duty (0.21 €/l) and the value added tax, VAT (18%). The price structure analysis of fossil fuels shows that the petroleum diesel price is overloaded with excise duty and other taxes, and its real value to a great extent depends on governmental measurements *(Figure 1)*. In Serbia, a country without policy regulations for biodiesel production, the investigation of different taxation scenarios is of great importance. It is supposed that biodiesel production will be liberated from excise duty; taking into account that biodiesel is a fuel which has no

fossil origin. Biodiesel will be taxed with VAT (18%) and loaded with the usual allowance of 0.06 €/l. In this case the retail price of biodiesel fuel produced from the rapeseed grain would be 0.7 €/l, which is 0.11 €/l less than the actual price of D2 fossil fuel. Under the assumption that biodiesel will be sold for the same price as fossil D2 fuel, the biodiesel producer can expect a profit of 0.11 €/l. In the case when the usual excise duty for fossil fuels is included in biodiesel price formation the selling price of biodiesel would be 0.93 €/l. This price is higher than the price of fossil D2 fuel for 0.12 €/l. The economical feasibility of biodiesel production from virgin rapeseed oil is questionable even in the case of total liberation of biodiesel production from excise duty *(Figure 1)*.

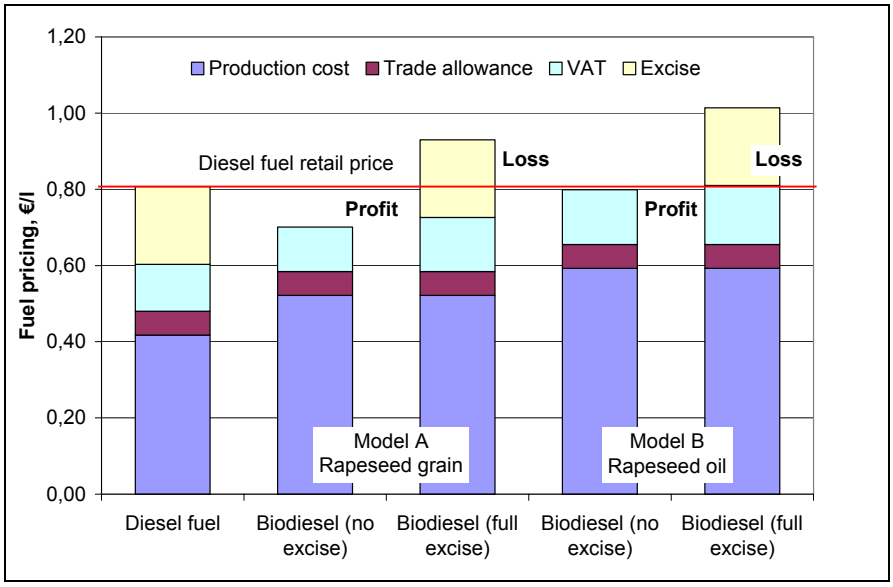

Figure 1 Fuel pricing

Inserting the actual market prices, the basic consumptions and the final products in the computerized mathematical model the profitability of 24 assumed scenarios of biodiesel production in Serbia were analyzed. Depending on of the raw material type and the capacity of biodiesel plant the production costs vary between 0.47 and 0.63 € per litre *(Figure 2)*.

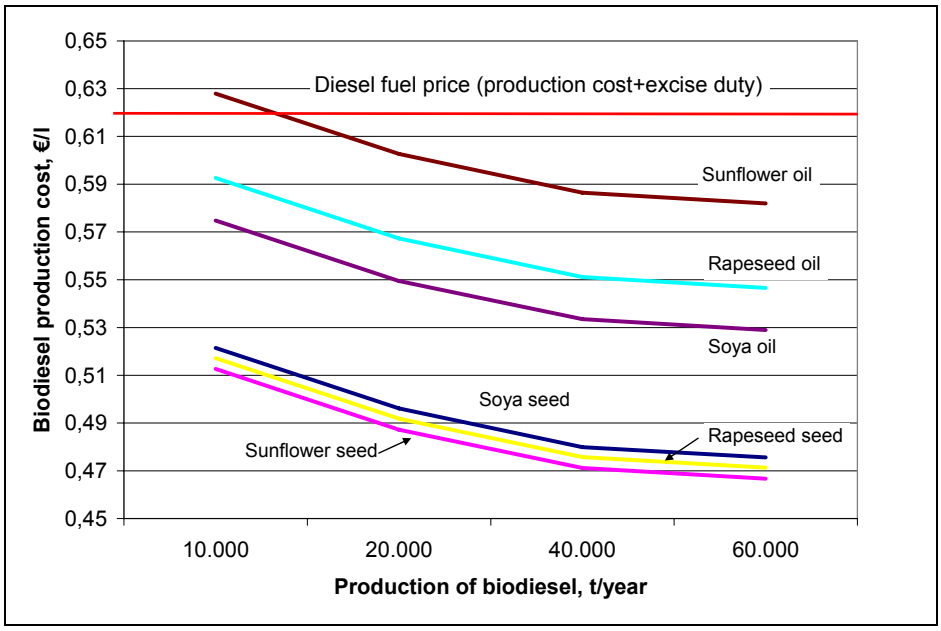

Figure 2 Production costs of biodiesel depending on raw material and plant capacity

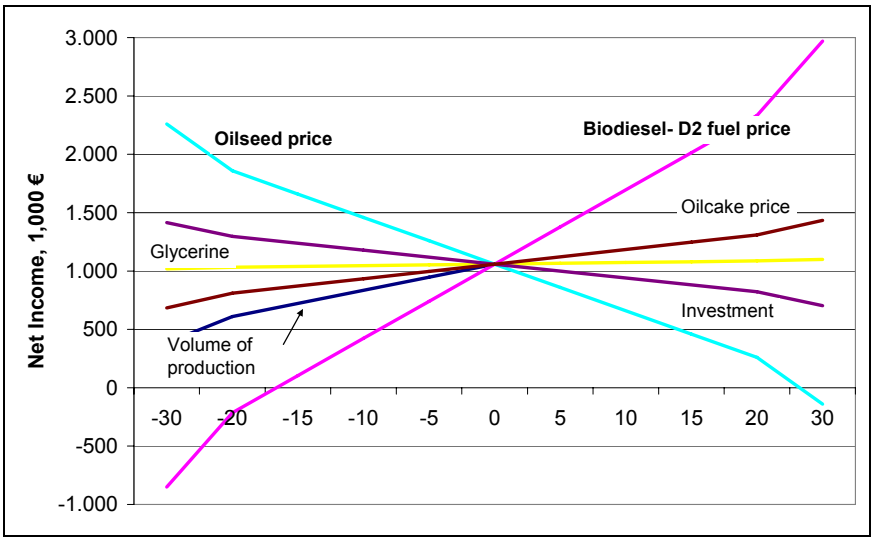

Figure 3 Sensitivity analysis results for a plant capacity of 10,000 t/year when rapeseed grain is used as feedstock

A sensitivity analysis was carried out to determine the impact of key variables on the net income of biodiesel production. The results reveal that biodiesel produced from rapeseed grain is most sensitive toward anticipated selling prices of biodiesel *(Figure3)*. These results also show that biodiesel production is highly sensitive toward the changes of the purchase prices of raw material-rapeseed grain. The results show that the net income is less sensitive to selling prices of the obtained glycerine. This can be explained by low participation of glycerine in total incomes. The same conclusions stand when rapeseed oil is used as feedstock.

CONCLUSION

Considering the shown results the following conclusions can be drawn:

- Biodiesel production on the basis of oil seeds is more profitable than its production on the basis of virgin vegetable oils.
- The unit cost expenses have a significant drop with the increase of the plant capacity independently of the applied raw material.
- Based on the actual prices of raw materials biodiesel production is most justified from sunflower seed and least justified from virgin sunflower oil.
- The profitability of biodiesel production from oil seed is possible only with the assumption of partial or total excise liberation. However, the biodiesel production is not profitable on the basis of virgin sunflower oil even at total excise exemption.

Although biodiesel cannot entirely replace petroleum-based diesel fuel, the government must take into consideration different ways of biodiesel promotion. There are at least four reasons which justify the development of biodiesel production and its promotion: 1) Biodiesel is renewable and does not contribute to global warming due its closed carbon cycle 2) It provides a market for excess production of vegetable oils and animal fats 3) It decreases our country's dependence on imported petroleum 4) It offers potential improvement of rural economies.

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