Cogeneration with rapeseed oil for the German Reichstag
Ecological aspects and controversies

Dipl.-Ing. Detlef Loy

Loy Energy Consulting
Georg-Wilhelm-Str. 18
10711 Berlin - Germany
tel. +49-30-891 94 58
E-mail: dloy@compuserve.com

Abstract of the contribution to the
International Conference on Biofuels
Starbienino/Poland, June 12 - 14, 1997

With the parliament decision to transfer the German government from Bonn to Berlin the cabinet approved the target to cover at least 15 % of the total energy demand of all government buildings by renewable energies and to minimize effectively CO_2-emissions.

The Energy Plan that evaluated different strategies to meet this target for the central area came soon to the conclusion that all types of direct solar energy use (mainly with installations on roofs and facades) would not be able to reach the necessary percentage. The selected proposal was therefore to use biomass energy in the form of rapeseed oil to run local cogeneration plants within one or more of the buildings.

At present the former and future parliament building (the German Reichstag) is being totally refurbished and partially reconstructed. Before the opening in 1999 the Reichstag will receive a modern heating and cooling system that is supplied by three rapeseed-supplied engines. Because of the unparallel demand for heat and electricity a seasonal thermal storage system with pipes drilled into the ground in front of the building will be added.

A first plan to install engines suitable for natural rapeseed oil had to be abolished since motors of the required size were still in the pilot phase. The risk of motor failures within an unexperienced field appeared to be to large. Instead it was decided to use regular diesel engines and feed them with rapeseed methyl ester (RME). This shift has aroused fears that the ecological benefits could be offset because of higher energy input needs to produce and supply RME.

Expert meanings on this topic in recent years have shown a variation of results depending on the figures being used for the various production steps, the integration or negligence of a thermal or other use of by-products and of course determined by the individual interests for the outcome. A very fearce debate circled around the publication of a study by the Umweltbundesamt (UBA - Federal Environment Agency) that gave RME rather low ecological notes because of minimal climate protection benefits compared to the costs involved and in relation to other possible measures to reduce emissions within the transport sector (the main consumer market for rapeseed oil).

Significant for the energy balance is the input/output-ratio for the production and supply of RME (Tab. 1). A first analysis by ifeu/Heidelberg (Institute for Energy and Environmental Research) in 1991 had shown a variation of between 1 : 1,17 and 1 : 4,99 depending on different options for fertilizing technologies and the use of by-products.

		Rape seed oil			RME		Diesel
		UBA '93 ifeu '91	BUND '92	BML '95	UBA	BML	Ufop, GET '93
Input in GJ / (ha a)	**Low** (with manure)	22,3		14,7	29,1	18,8	
	High (without manure)	29,5	30,0	21,0	36,3	25,1	
Output in GJ / (ha a)	**Low** (only rapeseed oil/RME and rapeseed cake as food)	53,1	48,0	-	53,2	-	
	High (with maximum use of all by-products)	133,7	98,0	140,3	144,9	143,9	
Input : Output	**Low** (worst scenario - no manure)	1 : 1,8	1 : 1,6	-	1 : 1,5	-	1: 5,55
	Medium (no manure, max. use of by-products)	1 : 4,5	1: 3,3	1 : 6,7	1 : 4,0	1 : 5,8	
	High (best scenario, with manure, max. use of by-products)	1 : 6,0	-	1 : 9,5	1 : 5,0	1 : 7,7	

Tab. 1: Input-output ratio for the rapeseed chain (source: Drees & Sommer 1995 on the basis of other publications)

Abbreviations:

UBA = Umweltbundesamt
BUND = Bund für Umwelt- und Naturschutz Deutschland
BML = Bundesministerium für Ernährung, Landwirtschaft und Forsten
Ifeu = Institut für Energie- und Umweltforschung
Ufop = Union zur Förderung von Oel- und Proteinpflanzen
GET = Gesellschaft für Entwicklungstechnologie

One of the main factors is the thermal utilisation of the remaining straw since half of the energy is bound in this part of the rape plant. A further option is concering the use of the rape cake (the remainings after extracting the oil from the seeds) either as animal food or as a biomass fuel. Another by-product is the generation of glycerol during the esterification process that can either substitute synthetic products or be thermally used.

The analysis was based on the assumption that RME production will require centralized factories, since a substantial output will be needed to minimize the specific investment costs.

The energy balance was extended to the CO_2-emission effects (Tab. 2). Ifeu calculated that without any benefits from the use of by-products RME would cause appr. 35 % less CO_2-emissions than using Diesel oil. Taking a realistic view on the use of by-products the UBA estimated in its report in 1993 the CO_2-reducing potential with 60 % (input of fossil fuels for production and transportation assumed). This percentage is also the basis of a recent study evaluating the effects on environment, agriculture and economy by the use of rapeseed oil for the government buildings (Drees & Sommer 1995).

		Rapeseed oil	RME	Diesel oil
CO_2-emissions	t/GJ			
	direct	None	None	0,0729
	preceding	0,0096 - 00151	0,0105 - 0,0179	0,0068
	sum			0,0797
CO_2-savings (with substitution of Diesel oil)	t/GJ	0,070 - 0,065	0,069 - 0,062	-
Market prices	DM/l	0,60 - 0,80	0,80 - 1,00	0,37 (HEL)
Energy prices	DM / GJ	17,50 - 23,4	24,50 - 30,60	10,40
Surplus costs (compared to Diesel oil)	DM / GJ	7,10 - 13,00	14,10 - 20,20	-
Surplus costs per t CO_2-reduction	DM/t CO_2	100 - 200	200 - 325	-
	kg CO_2 / DM	10 - 5	5 - 3	-

Table 2: CO_2- and Cost balances

Energy balances as well as CO_2-emissions in this context are based on equivalents that rapeseed oil and its by-products could substitute. The above mentioned CO_2-reduction potential takes Diesel oil as the reference fuel according to the main purpose of using vegetable oils in the transport sector. In practice this is not a valid method for stationary motors that in the majority of cases would be run on natural gas instead or be replaced by other types of heat and electricity production. Drees & Sommer mention that compared to Diesel fuel the use of natural gas would lead to a 52 % reduction in CO_2-emissions. Thus the advantage of the rapeseed power plant is clearly dwindling.

But in the case of the Reichstag the situation is even more disadvantageous for rapeseed oil as an appropriate fuel to propagate climate protection strategies. The central area of Berlin, including part of the government district, is being supplied with electricity and heat from a recently built modern power station with a combined gas and steam turbine with high efficiency. Experts from different institutions have come to the conclusion that CO_2-emissions per unit of delivered heat from this power station are at least in the reach of local cogeneration plants if not even better.

What remains to be seen after all is the positive quality of rapeseed oil as a sustainable and domestic energy source. A rapeseed oil industry can strengthen the weakening agriculture and the local economy. The effects of an intensified planting of rapeseeds and the possible introduction of genetically altered plants have certainly to be discussed.

References:

Umweltbundesamt: Ökologische Bilanz von Rapsöl bzw. Rapsölethylester als Ersatz von Dieselkraftstoff (Ökobilanz Rapsöl), Berlin 1993

Drees & Sommer: Studie zur Verwendung von Pflanzenöl bei den Bauten des Bundes und der Regierung im Bereich des Spreebogens, Berlin 1995

Gesellschaft für Entwicklungstechnologie: Herstellung von Methylester aus Planzenölen in Europa als Alternative zur Verwendung von fossilem Dieselkraftstoff, Jülich 1995