Alternative Fuels from Renewable Resources

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Summary

Following the 1997 Kyoto Conference on Climate Change, many industrialised countries have adopted strategies to reduce CO_2-emissions. The EU-member states have decided in June 1998 a reduction of 8.1 % on the basis of 1990 emissions for 2012, a goal which can only be realised with an important share of renewables where biomass will play a major role.

Engine fuels from biomass have shown in the past years a considerable market penetration. Almost 0.45 MtOE of Biodiesel and 191,000 t of ETBE were produced in 1997 in Europe, but a possible substantial increase is heavily hindered by missing regulations on taxation of biofuels and the agricultural policy on production of the raw-material on set-aside land.

1. INTRODUCTION

The 1997 Kyoto Conference /1/ and the Buenos Aires Conference of November 1998 are landmarks in a world wide strategy on fighting global warming.

As a result from these rather political demonstrations we find as accepted common sense:

- global warming is driven by man-made climatic gases,
- mainly CO_2-emissions[1] are a consequence of energy production for fossil resources,
- world wide energy production, the pre-requisite of development from a growing world population, will increase and in consequence CO_2-emissions,
- rational use of energy is of primary importance,
- sustainable use of renewable energy has a high potential in combating global warming.

In the meantime, a bunch of political decisions has been taken:

- the creation of the Intergovernmental Panel on Climate Change (IPCC) /2/,
- international monitoring of CO_2-emissions,
- several proposals for CO_2-related taxation for fossil energy,
- national and international agreements on reduction of CO_2-emissions /3/

The international scientific community for many years has demonstrated the necessity of implementing efficient instruments to stop global warming, and to shift from fossil resources to renewables. Here should be mentioned the very consistent work of IPCC /2/ and the last energy scenario provided by Shell /4/.

This latter shows clearly that the role of fossils in the next century will decrease - not only for environmental concern, but due to epuration of actually known reserves.

Despite this alerting analysis, only few countries have taken the necessary legislative measures to introduce renewable energy into their markets.

As positive example, I would mention the Government of the United States of America who - among other supporting measures to renewables - on 22 May 1998 have adopted the ethanol tax incentive through 2007 /5/ of $ 0.54/gal (0.235 DM/l).

2. THE CASE OF THE EUROPEAN UNION

On 11 November 1997, the European Commission has prepared the so-called „White Book“ /6/, a strategic paper on renewable energy resources where the target of 12 % renewables in Europe’s primary energy consumption by the year 2010 is defined. This means an increase of 100 % compared to the situation of 1997, or taking into consideration the expected increase of the overall energy demand in the Community, there shall be 127 Mio TOE (tonnes of oil equivalent) from renewables by the year 2010.

Deducting from this the potential share of hydropower, wind energy and solar, about 90 Mio. TOE must come from biomass - agricultural residues, forestry and agriculture.

To provide this amount of biomasse, the White Book claims for 12 % granted and subventioned set-aside land, taken out of the agricultural surface of EU-15 (138 Mio. ha) /7/ or 16.6 Mio. ha. But only a fraction of this is available as set-aside land under the actual regulation (7.2 Mio. ha in 1994/95, 6 Mio. ha in 1995/96 and 4 Mio. ha in 1996/97). According to the planned new agrarian order (Agenda 2000), no obligatory set-aside scheme is foreseen at all.

Nevertheless, farmers are free to convert a part of their fields to non-alimentary production, and they will do so if the expected revenue is sufficiently attractive. Such decisions will depend on a mutitude of non-correlated factors, e.g.

- the world market price of main crops (wheat, barley, oilseeds, etc.),
- the international food market regulation,
- the world market price for oil, gas and coal,
- local restrictions following environmental regulations (restriction on transgenic crops, fertilisation, use of herbicides and pesticides, etc.).

From this follows that under the actual situation no continuous and reliable supply of agricultural raw material for the production of biofuels can be expected.

3. BIOFUELS

3.1 Fuels from vegetable oils

Up to date, two types of green fuels from biomass have reached technical maturity and acceptation on the market:

- Biodiesel from vegetable oils,
- Ethanol fuels.

Diesel fuel from vegetable oils - BIODIESEL or DIESTER - is produced from chemically modified triglycerides in form of monoalcohol fatty acid esters, mainly methylesters.

Feed material in the EU up to now mainly is rapeseed oil, but promising trials are under way with sunflower

[1] in the following CO_2-emission stands for emission of CO_2 from fossil sources

oil (France and Spain), soybean oil (USA, Italy), palm-oil (only useable in countries with sufficiently high temperatures, i.e. Malaysia) and with used frying oils (Austria, Germany).

The conversion technology of rapeseed oil into BIODIESEL has reached a high and reliable industrial standard. The licensed industrial capacity in France is 230,000 t/a and in Italy 120,000 t/a. In Germany, Austria, the Scandinavian countries, Belgium, the Netherlands and non-EU European countries unlicensed production is possible. The technical capacity reported is well above 1.3 Mio. t/a /8/, but has been used in the past years only partly. In 1997, approximately 545,000 t /9/ were produced from which ca. 350,000 t have been sold as heating oil and 195,000 t as engine fuel.
National standards for BIODIESEL have been set up in Germany (E DIN 51606: 1997-../), France, Italy, Austria, Sweden and the Czech Republic. Work on a US-standard for Soy-Diesel is under way.

Since 1998, a CEN-working group was set-up to work out standards for vegetable oil methylesters as straight diesel fuel, as additive up to 5 % to conventional diesel, as straight heating oil and as additive to conventional heating oils including all analytical methods necessary to determine the properties defined in the standards.

The applicability of mineral oil taxes in the EU-member states is inhomogeneous.

In Germany and Austria there is no taxation on straight BIODIESEL but the full tax applies if voluntarily or accidentally mixed to mineral oil products during manufacturing and/or distribution but not in the reservoir of the vehicle.

France allows for a strongly reduced tax if mixed up to 5 % to mineral diesel and up to 30 % for registered trials in town fleets which are grouped in the “Club des Villes de Diester”. A similar law reigns in Italy.

In both countries, BIODIESEL can be mixed to heating oil (or used as straight heating oil) with the similar tax advantages.

Up to now, there is no EU-regulation or tax-incentive for BIODIESEL which is considered as engine fuel under the same tax regime as mineral oil diesel fuel.

Straight vegetable oils may be used as fuel with specially constructed engines characterised by modified combustion chambers, injection systems, filters and fuel systems. There is only a limited market for this technology in vehicles, but several stationary systems are working as cogeneration units.

3.2 Ethanol fuels

Ethanol is produced by fermentation from sugar containing vegetable materials (sugar cane, sugar beet, sugar millet). Materials rich in starch (corn, wheat, barley, cassava) can be fermented after enzymatic or chemical transformation of starch into glucose. Cellulosic materials (wood, straw, etc.) represent a large source for ethanol production. Here, an additional step of hydrolisis is necessary.

Ethanol containing 5 % of residual water (E-95) can be used as straight fuel in spark ignition engines. Dehydrated (100 %) ethanol (E-100) needs an adapted engine if used straight, but can be mixed at 5 to 22 % into gasoline (gasohol) as oxygenate and octane improver. No modification of engines is necessary.

ETBE (ethyl-tertio-butyl-ether) is etherified ethanol and may replace MTBE as oxygenate in gasoline at a rate of 8 to 15 % representing 1.2 to 2.3 % of oxygen in these mixtures.

In diesel engines E-95 can completely replace mineral oil based fuels, or can be mixed at a rate of 15 % to gasoil.

Bioethanol as fuel for spark-ignition engines has a long history. Brazil has set-up in the early seventies - nota bene before the first oil crisis - ambitious programme called PROALCOOL: Ethanol is produced from sugar cane at - compared to the situation in Europe - low costs and a high percentage of vehicles since run on 100 % ethanol (with adapted engines). Additionally ethanol is mixed at a rate of 22 % to mineral oil based gasoline. There was a great effort from the car manufacturers to adapt the vehicle park to these new fuels.

Similarly, in the USA a mixture of 10 % ethanol (mainly from corn) with gasoline - called GASOHOL - is used. This programme is strongly promoted under the US-Clean Air Act.

In Europe, the situation is quite inhomogeneous. While the EU-Directive no. 85/536 of 5 December 1985 allows for an incorporation of 5 % ethanol or up to 15 % ETBE into gasoline, only France has set-up the necessary legislation and industrial framework for the market introduction of ETBE fuels. In Spain, Sweden and the Netherlands, tax incentives for pilot projects exist. Table 3.1 shows the actual situation. In Sweden, 15 % of ethanol are added to gasoline, similar to the US-gasohol, in France 8 to 15 % of ETBE in gasoline is used, similarly Spain and the Netherlands too will use up to 15 % ETBE.

Table 3.1: Tax situation for Ethanol fuels /10/

	Mineral oil tax on gasoline EURO/l	**Mineral oil tax on ethanol EURO/l**
France	0.584	0.086
Sweden	0.513	none
Spain	0.363	none
Netherlands	0.569	ca. 0.267 - 0.343

The actual production capacity in France is 227,000 t/a of ETBE, the production in 1996 was 122,000t, in 1997

191,000 t and estimated for 1998 at 220,000 t. The base material is sugar beet (70 %) and wheat (30 %) /10/.

In Spain, a 80,000 t/a ethanol plant is under construction near Cartagena, using barley as feed. Ethanol will be transformed into ETBE (185,000 t/a) in existing MTBE installations.

Sweden has an experimental 10,000 t/a plant for ethanol which is mixed at a rate of 15 % to gasoline. In the Netherlands a 24,000 t/a ethanol production unit is in the planning phase.

4. BIOFUELS AND THE ENVIRONMENT

Despite the ongoing discussions on pros and cons of replacing fossil fuels by biofuels, the following facts are proven and commonly accepted:

- all known improvements in energy conservation and/or more rational use of energy apply to biofuels as well as to fossil fuels,
- all above discussed biofuels have demonstrated that they can be introduced into the existing technical and logistical environment of engine fuels supply and use with no or only minor adaptations of the latter.
- In Europe biofuels may technically achieve a market potential which is small - e.g. 5 to 15 % - compared to fossil fuels, at least in the coming two decades,
- detailed eco-balances have shown, that biofuel production needs less fossil energy than the replaced fossil fuel. The balance is defined by the product of total fossil energy input for mineral oil based fuel to total fossil input for the renewable fuel scenario including by-products:
  - for ethanol fuels this balance is 1.10 to 1.20 /11/
  - for biodiesel the balance is 2.7 /12/,
- biofuels reduce the emission of greenhouse gases
  - ETBE compared to MTBE by 19 % /11/,
  - ETBE compared to gasoline by 10 % /11/,
  - biodiesel compared to fossil diesel by ca. 70 % /12/,
- biofuels have the potential to reduce tail-pipe emissions
  - gasoline with 15 % ETBE compared to straight gasoline /10/

reduction of hydrocarbons (HC):	3 - 11 %
reduction of carbonmonoxyde (CO):	11 - 17 %
reduction of aromatise (C_6H_6):	17 - 20 %

  - biodiesel (100 %) compared to fossil diesel on engines without catalyst /13/

reduction of hydrocarbons (HC):	20 - 40 %
reduction of particulates:	0 - 40 %
nitrogen oxide:	-15 - +5 %

- production costs of biofuels are 2 to 3-fold higher than mineral oil fuels and need substantial incentives if they have to compete on the free market,
- tax incentives (no or reduced mineral oil tax) show a cash-return rate of 60 to 70 %, through reduced imports and additional tax income from new industrial activities /10/, /12/,
- biofuel industry has the potential to create new jobs and initiates technological export.

The European Commission and Parliament /6/ as well as most of the member states have expressed their intention to promote biofuels on the intermediate and long range. Some of the institutional and legal framework has been set-up. Nevertheless, the needs of biofuels industry and of the final users at this moment are not completely covered.

It is urgently needed that

- agriculture is enabled to produce the necessary feed materials under economic attractive conditions,
- biofuel manufacturers get the necessary security on supply of feed material at known prices, licenses for their production and access to the market,
- users of biofuels obtain security with respect to taxation and secure supply.

We hope that the European Commission, the European Parliament and the national governments will take appropriate action in the very near future.

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