RESOURCES FOR BIOETHANOL PRODUCTION

Roman[1)] M., Adriana Gog[2)], M. Chintoanu[1)], Gabriela Pitl[1)], E. Luca[2)], D.-F. Irimie[3)], N. Burnete[4)]

[1)]INCDO-INOE 2000, Research Institute for Analytical Instrumentation, 67 Donath, 400293-Cluj-Napoca, marius.roman@icia.ro

[2)]University of Agricultural Sciences and Veterinary Medicines, Manastur, str. nr 3-5, Cluj-Napoca, Romania

[3)]BABES-BLOYAI University, Mihail Kogalniceanu nr. 1, 400084 Cluj-Napoca, Romania

[4)]Technical University Cluj-Napoca, Constantin Daicoviciu nr 15, 400020 Cluj - Napoca, Romania

Abstract. *The paper presents an overview of the main renewable European resources used as raw materials in the bioethanol industry. Biofuels are a true alternative to conventional fuels, bioethanol is a well known and proven fuel with thousands of kilometers on his background. To ensure a durable and profitable development of biofuels market, it is important to setup cooperation actions with the aim to prepare sustainable development framework. This capacity building must involve all the EU countries, as this is in their common interest and knowledge transfer is essential for the integration in a global market.*

Keywords: biofuels, bioethanol, renewable energy, renewable resources

INTRODUCTION

Transport is a vital strategic sector for modern society. The EU transport sector accounts for more than 30 % of the total energy consumption in the Community; it is 98 % dependent on fossil fuel with a high share of imports and thus extremely vulnerable to any market disturbance. Concerning freight transport (growing at an annual average of 2.1 % for the EU 15 and 2.3 % for the new Member States), the road traffic will account for 77 % compared to 69 % in 2000, mainly at the expense of rail. Consequently the largest increase in fuel use for transport is expected to be for trucks. Regarding personal transport (growing at an annual average of 1.5 %), the use of aviation will double its share to 11 %, whereas private cars and motorcycles will present a market share of 76 % compared to 78 % in 2000 [1].

The growing transport sector is considered to be one of the main reasons for EU failing to meet the Kyoto targets. In the medium-term its contribution to the greenhouse gas (GHG) emissions is forecast to increase more rapidly respect to all other sectors of the economy. The main EU proposed strategies in order to reduce GHG transport emission are the substitution of fossil fuels with biodiesel and/or bioethanol and the binding target of 10 % renewable energy in transport petrol and diesel [2].

Due to the first oil crisis of 1973, Brazil decided to reduce its dependence on the import of mineral oil by establishing a National Alcohol Program to supply vehicles. This program started in 1975, using sugar cane as a feedstock. A second program stimulating the use of ethanol began in the USA in 1978, using mainly corn and to a much lesser extent sorghum as feedstock. In the USA, arguments for

subsidizing the production of bioethanol since 1978 have included energy security, supporting farm prices and incomes and improvement of air quality. Several Canadian provinces started out using 5–10% ethanol–gasoline mixtures in the 1980s.

At the current time bioethanol is used only into the cycle Otto engine and is able to substitute gasoline and traditional antiknock compounds (MTBE in particular).

Many research activities are aimed to adjust the bioethanol composition in order to use it into the cycle Diesel engine (for example through the addition of cetane improver) [3]. This choice is sustained by social, agronomical, technical and economic reasons. In particular the scenario for 2030 forecasts an increase of Diesel engine demand, an higher contribute of EU countries in bioethanol yield (approximately 4.4 tons/ha) rather than biodiesel yield (until 1.8 ton/ha), and higher reduction opportunities of bioethanol production cost than that of biodiesel.

So it is attended a significant increase of the bioethanol demand in the next decades. If Member States comply with the guidelines, the bioethanol market is estimated to grow to between 8 and 10 tons per year by 2010 and at 2030 almost 49.6 MTOE of bioethanol will be required [4]. Consequently the development of bioenergy chain is a strategic opportunity.

MATERIAL AND METHOD

Production and use of transport biofuels have a history of considerable length. The prototype of the Otto motor, which currently powers gasoline cars, was developed for burning ethanol and sponsored by a sugar factory. The FordModel T (Tin Lizzy) did run on ethanol. In the early twentieth century, ethanol-fuelled cars were praised because they experienced less wear and tear, were quieter and produced a less smoky exhaust than gasoline-fuelled cars Also in the early twentieth century, a significant part of train locomotives in Germany were powered by ethanol. In the same country, ethanol from potato starch was used in gasoline as an anti-knocking additive between 1925 and 1945. In the 1930s, ethanol produced from starch or sugar made something of a comeback as road transport fuel in the Midwestern states of the USA, because agricultural prices were very depressed. Also in the 1930s, the Brazilian government stimulated gasoline blends with 5% bioethanol.

As world production, bioethanol is the most important biofuel and it can be produced by a lot of crops containing carbohydrates. Therefore the choice of the raw material is strategic for the economic, energetic and water balances, in other words for the sustainability of the production process. The main crops are sugar cane in Brazil (14,3 million tons of bioethanol in 2006) and cereals in the United States (18.2 million tons of bioethanol in 2007, produced prevalently from corn), whereas in the EU the traditional crops are sugar beet and cereals (corn and wheat, prevalently) [5,6].

Sugar beet is largely used in the EU Member States. The three biggest producers are France, Germany and Poland. Due to the reform of the Common Market Organisation for sugar in 2006, the areas cultivated with sugar beet are

expected to decrease by 9 % in the EU-25 to million hectares. Germany are expected to reduce their cultivated areas by 2 % (i.e. 371,000 ha and 412,000 ha) and France by 15 % (i.e. 243,000 ha). Hungary is expected to reduce its areas by 34 % (i.e. 41,000 ha) and Italy by 20 % (i.e. 202,000 ha). The EU-25 production of sugar beet is therefore estimated at 121.8 million tons correspondent to a decrease of 6 % in comparison with 2005 production [7].

Corn can be grown in areas where the water availability is not a limiting factor. In the EU-27 areas cultivated with maize grain in 2006/2007 were 8,573,100 hectares and in 2007/2008 an increase of 2,27 % is expected (COPA-COGECA "EU-27 cereals area and production estimates in 2006/2007 and 2007/2008 marketing year", 2007).

Wheat can be grown in any region and very high yielding varieties albeit with poor flour quality could be worthwhile [8]. In 2006/2007 the EU-27 areas cultivated with wheat (soft and durum wheat) were 25,053,100 hectares. In 2008/2009 a light decrease is attended (-0.8 %) [9].

In order to satisfy the EU bioethanol scenario, cereals could play an important role, whereas sugar beet does not seem to have the same potentiality. Furthermore a large quantity of the bioethanol will be imported [10].

The current situation and its short-term prospect have to be reconsidered, because the "Proposal for a Directive of European Parliament and of the Council on the promotion of the use energy from renewable sources" introduces an innovative point of view, such as the environmental sustainability of the biofuel production [11]. The main sustainability criteria introduced for biofuels are: the greenhouse gas emissions saving from their use shall be at least 35 % and they shall not be made from raw material obtained from land with recognized high biodiversity value (forest undisturbed by significant human activity, areas designated for nature protection purposes, highly biodiverse grassland).

The traditional EU crops are penalized by energetic and water balances.

- Sugar beet: energy balance 1.1- 2.2 (without and with the by-products output, respectively); water demand 750 m^3/ton
- Corn: energy balance 1.0-2.5 (without and with the by-products output, respectively), water demand 500 m^3/ton. In fact using sugar beet the energy balance of the entire production process is 1.1-2.2 (without and with the by-products output, respectively) and the water requirement of the agricultural phase is 750 m^3/ton; using corn the energy balance of the entire production process is 1.0-1.1 (dry milling and wet milling plants, respectively), excluding the by-products output, and 2.2-2.5 (dry milling and wet milling plants, respectively), including them, and the water consumption for the agricultural phase is 500 m^3/ton.

Furthermore using the traditional crops the bioethanol production costs do not show significant reduction opportunities. In case of sugar beet utilisation, the bioethanol production cost is 1,200 €/t (energy equivalent) using sugar beet, in case of corn utilisation the bioethanol production cost is 1,000 €/t (energy equivalent)using corn.

In terms of world production, sugar cane plantations insure high yield, interesting energy content in the by-products and so widely positive energetic and

economic balances. But from an environmental sustainability point of view, sugar cane utilisation in bioethanol production shows some critical aspect because it determines significant environmental impacts caused by a decrease of biodiversity and an increment of de-forestation, soil erosion and ground water pollution. In order to preserve the ecosystems and reduce the oil consumption, the world bioethanol trade should be developed balancing the EU production and import of bioethanol and its raw materials.

RESULTS AND DISCUSSION

Concerning economic aspects, at the current time just an estimate of bioethanol EU production cost is available, correspondent to 250-300 €/ton, if all by-products are exploited In the EU bioethanol market feedstock cost is the major limiting factor with prices ranging from US$ 0.74 per litre (i.e. nearly 600 €/ton) from wheat to US$ 0.85 per litre (i.e. nearly 700 €/ton) from sugar beet compared to US$ 0.21 litre in Brazil. Ethanol production from food crops (e.g. maize and cereals) is far from competitive when compared to gasoline and diesel prices. Therefore in the short run the tendency is avoiding any strategy of large scale implementation until feedstock costs can be reduced significantly [10].

Bioethanol production from sweet sorghum shows some socio-economic benefits, due to the low distance required (45-50 km) between the agricultural enterprises (biomass suppliers) and the transformation plant. This is caused by the high content in water (65-80 %w/w) and sugar (10-20 %w/w) of the sweet sorghum harvested biomass, that thus can not brave long transport. Consequently the plant size is in the range 10,000-50,000 tons/y as capacity. In order to feed the plant continuously all year around, the more sustainable solution is ensiling, borrowed from the animal feed conservation; the alternative dehydratation of the sugar juice (from 15-16 °Brix to 60 °Brix), required to stop the microbial spontaneous fermentation, takes too much energy.

The main socio-economic benefit for the farmers are their direct participation to the bioethanol chain, the diversification of the agricultural yield (not only food, but also energy), the increase of the added value of the agricultural products and, finally, the improvement of the life style in rural areas.

In contrast with the actual situation, the development of this bioethanol chain acknowledges the EU indication about the decentralisation of energy production. In fact at the current time the EU bioethanol market is controlled by big industrial groups and large agricultural cooperatives of the sugar and alcohol industries, so that sugar and alcohol production industries are the principal actors of the bioethanol sector. The current market concentration depends on several reasons; among these trade and information barriers occur. In fact some studies have indicated that investment may be deemed too risky until markets show long-term stability and growth. Options to fully develop bioethanol include long-term contracts for biomass at prices that ensure economic return for the local investor (55 % of bioethanol production cost depends on biomass prices) [12]. Unstable markets make it difficult for small and medium enterprises to sign long-term, high-volume contracts as this is seen as too risky. Due to the small volumes, the biomass trade is basically 100 %

bilateral, i.e. direct agreements between buyer and seller. In addition excise duties represent a significant barrier influencing the competitiveness of the production. In fact biofuel market is not like any other market because its development is intimately linked to its total or partial exemption from the tax on oil products [13]. The information barriers regard the benefits of sustainable biomass energy, new crops technologies, e.g. sugar crops, and by-products market are still largely unknown to many stakeholders such as small-medium enterprises, farmers, policy makers, NGOs and the general public. The development of networks among plant producers and entrepreneurs are also needed.

CONCLUSIONS

Considering the current situation and the forecast short-medium term scenario, it is strategic to improve the economic, energetic and water balances of the production process and thus many efforts are finalized to test new crops, cultivable in the EU countries, rich in carbohydrates and in able to fulfil the criteria for environmental sustainability.

There are several reasons why bioethanol is considered relevant technology by both developing and industrialized countries. They include energy security, environmental concerns, foreign exchange savings, and socioeconomic issues related to the rural sector. Due to its environmental merits, the share of biofuel in the automotive fuel market will grow fast in the next decade. The advantages of biofuels are the following: ***(a)*** they are easily available from common biomass sources; ***(b)*** caırbon dioxide cycle occurs in combustion, ***(c)*** they are very environmentally friendly, and ***(d)*** they are biodegradable and contribute to sustainability.

The main sustainability criteria for biofuels, introduced by the "Proposal for a Directive of European Parliament and of the Council on the promotion of the use energy from renewable sources [14], are: the greenhouse gas emissions saving from their use shall be at least 35 % and they shall not be made from raw material obtained from land with recognized high biodiversity value (forest undisturbed by significant human activity, areas designated for nature protection purposes, highly bio-diverse grassland).

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