Biofuels and Climate Policy

By Gernot Klepper*

1. Introduction

There is a growing consensus that the emissions of greenhouse gases (GHG), especially CO_2 should be reduced as soon as possible. This essentially means that the consumption of fossil fuels needs to be reduced thus helping to mitigate climate change and to preserve scarce resources such as crude oil. The Fourth Assessment Report (FAR) of the IPCC shows growing evidence that activities to significantly reduce GHG emissions need to be taken within the next ten years if climate change is to be limited to an increase of average temperatures of about 2 degrees Celsius (IPCC 2007a). This reduction in the use of fossil fuels requires changes in energy use. Many studies undertaken (e.g. IEA 2005) indicate that a shift in the composition of energy consumption towards renewable energy sources together with improvements in the efficiency of end-energy use and advanced technologies in electricity production can achieve reductions of CO_2-emissions by 2050 in the order of 50 percent relative to the business as usual scenarios. The "Leitstudie" of the German Minister for the Environment (BMU 2007) investigates options that lead to even stronger reductions of Greenhouse gases (GHGs).

Among the different forms of renewable energy biofuels are one option that is particularly suited to replace fossil energy needs in the transport sector. They are therefore seen as a special option since the other renewable energy sources usually replace fossil fuels in the electricity generation or the provision of heat. The European Commission has decided to set specific targets for the consumption of biofuels in its "Renewable Energy Road Map" (Commission of the European Union 2007). Given the important role that biofuels seem to play in the policy arena and in the general public it is therefore interesting to take a closer look at the pros and cons of following the particular biofuel strategy that is developing in Germany and the European Union.

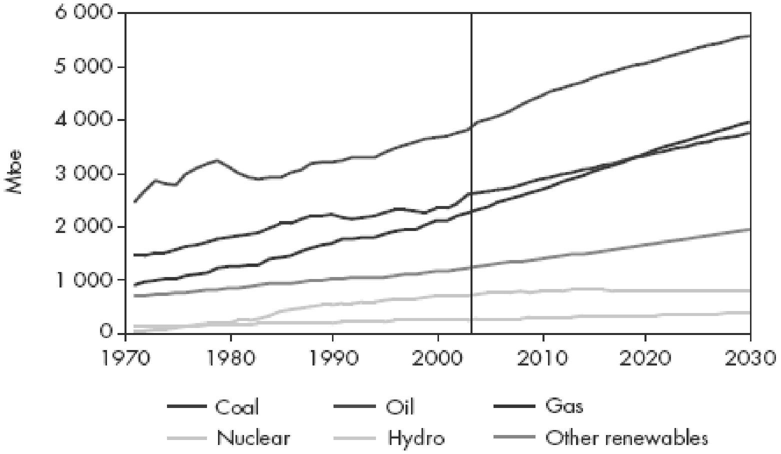
The paper addresses first the context in which the promotion of biofuels needs to be looked at. It then describes the European and international market development for biofuels and the government support that enables biofuel producers to compete with traditional fossil fuels. The potential GHG-savings from the use of biofuels are assessed and cost estimates for this particular climate policy are given.

* The Kiel Institute for the World Economy, Kiel, Germany.

The paper concludes with a discussion of policy options for the future support of the use of biomass for climate policies.

2. The Context for Assessing Biofuels as a Part of Climate Policy

There is general agreement in almost the whole research community concerned with energy and climate issues that the substitution of fossil fuels through renewable energy sources is inevitable in the long run. As the IPCC report (IPCC 2007a) has made clear a stabilization of the concentration GHGs in the atmosphere at around 500 ppmv requires a drastic reduction of emissions in the order of 80 percent by the end of the century. The reference scenario of the IEA (2005) for the primary energy use world wide as shown in Figure 1 clearly shows that the world is still far away from this goal and and achieving it would – among other things – require a much larger share of renewable energy sources in the energy mix than is envisaged in this scenario.



Source: IEA (2005) World Energy Outlook 2005 (reference scenario).

Figure 1: Primary Energy Use by Energy Source
Reference Scenario IEA World Energy Outlook 2005

The share of renewable energy in the German energy use is 6.4 percent of final energy use. Roughly two third comes from biomass, the rest from water and wind energy and to a small degree from solar and geothermal energy.[1] The production of energy from biomass is limited by the amount of land available within a country or – if international trade is included – by the world wide agricultural area. Currently

1 See BMU 2006.

the consumption of biofuels is concentrated on domestically produced fuels. This is to a significant degree determined by regulation and only partially by market forces.[2] Regardless whether biofuel consumption relies only on domestic production or on global sources the limiting factor for the expansion of its consumption is how much land should and will be dedicated for the production of biomass.

The promotion of biofuels needs to be seen in a competitive framework that goes beyond the fuel sector. The feedstock for all current biofuel technologies and for most so called second generation biofuels is biomass produced on agricultural soils. Figure 2 illustrates the many different uses of biomass. Whereas historically biomass has served nutritional needs and provided energy, its role as a provider of energy has diminished with the introduction of first coal, then oil and subsequently gas and nuclear energy. In this process agricultural activities have been reduced mainly to food production. This process was beneficial as the growing world population required increasing amounts of agricultural land to come under cultivation for food production. Now this process is moving back to a system with multiple demands for biomass. There is, first of all, the competition between producing bioenergy or producing food, the well-known debate on “fuels versus food”. There are also other biomass uses such as the non-energetic and non-food use of biomass as a raw material in industry.

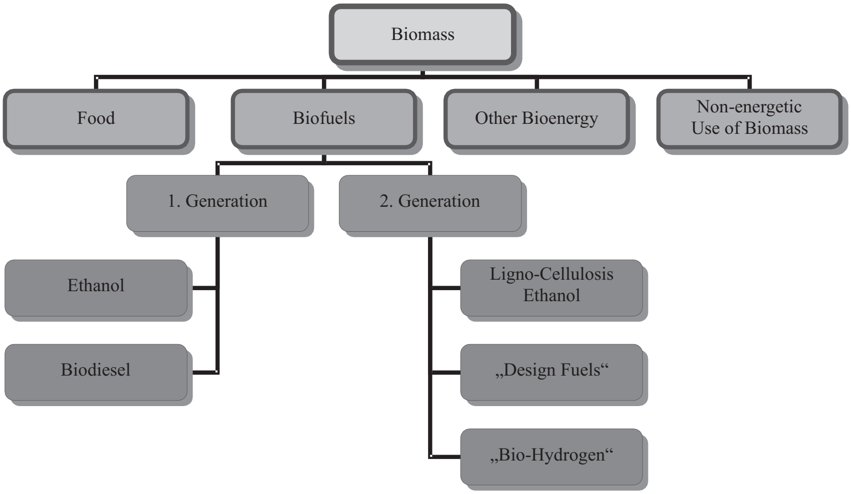


Figure 2: Competing Uses of Biomass

Even the bioenergy production from biomass is subject to competing uses. There is the question as to whether agricultural products c should go into the production of biofuels or into other energy uses such as the production of electricity or heat.

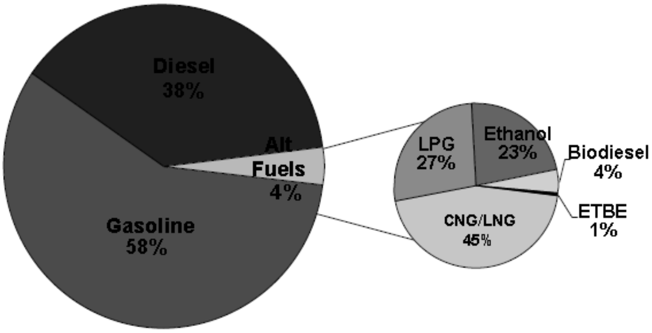
2 More on this in section 4.

Even within the biofuel uses the question is whether to promote Biodiesel or rather Bioethanol.

And this is still only a part of the multidimensional uses into which land can go. The preservation of biodiversity through protected areas, the set aside of natural land for tourist and recreational uses, and finally the destruction of fertile land for commercial non-agricultural uses such as roads, buildings etc. are all competing uses of scarce land resources. It is therefore indispensable that an evaluation of policy options in climate and energy policies involving biomass needs to take into account that these uses are competing with other valuable activities on scarce land resources.

3. The Market for Biofuels

There are different types of biofuels with rather different production technologies and different agricultural raw materials, usually called feedstocks. Yet, they are all part of a world market that is becoming increasingly globalized. The share of alternative fuel sources in the fuel market is still limited world wide to about 4 percent (Figure 3). Of those 4 percent less than a third actually consists of biofuels. The rest is composed of fuels based on natural gas which is not a renewable resource but is essentially another fossil fuel.



Source: Hart's World Refiring and Fuels Service, 2006.

Figure 3: The Composition of World Fuel Consumption (2005)

There are currently two types of biofuels dominating the market: Bioethanol and Biodiesel. Bioethanol is produced from feedstocks such as sugar cane, corn, other grains, and sugar beet. Biodiesel is produced from vegetable oils, mostly rapeseed oil, palm and soy bean oil. The market for bioethanol with 45 mio. m^3 output is dominated by the Americas where the USA and Brazil dominate production. The EU contributes only 6 percent of the bioethanol (2.7 mil. m^3) to world markets of which France and Germany produce about 50 percent. The rest is more or less evenly divided among the other EU member states.

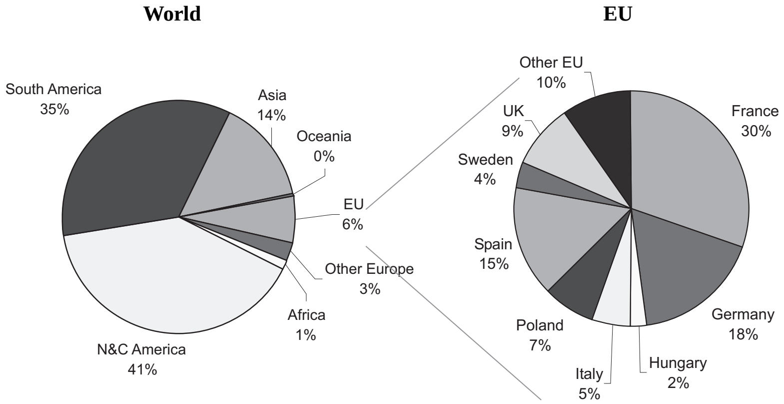
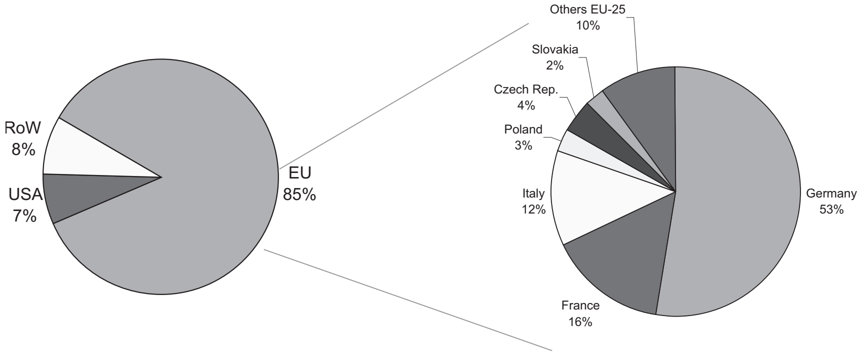


Figure 4: Ethanol Production by Region (2005)

Biodiesel production amounts to only 4.3 mil. m^3 and is dominated by the European Union, especially by Germany as Figure 5 shows. This is mainly due to the fact that Germany is one of the few countries that have for many years given tax incentives for diesel fuel resulting, compared to international averages, in a large share of diesel engines in the automobile fleet in Germany and some other European countries. Consequently, Germany's biodiesel production on the basis of rapeseed already requires almost the complete land area suitable for rapeseed production to be used.



Firgure 5: Biodiesel Production by Region (2005)

With very few exceptions the different biofuels are all not competitive against fossil fuels at current market prices. The only sidnificant exception is Brazil where bioethanol based on sugar cane as a feedstock is less costly that gasoline even without any price support or subsidies. European and North American bioethanol as well as biodiesel from Asia can not compete with fossil gasoline or diesel.

Therefore the current biofuel production in Europe, North America, and Asia is mainly driven by a whole set of government policies in support of biofuels.

4. Government Support for Biofuels

The largest markets for biofuels are Brazil, the USA, and the EU. Brazil that has promoted biofuels after the oil crises in the seventies, now has a completely open market without any governmental support measures. In the USA bioethanol is supported through a whole set of policies in the Farm Act such as tax refunds and through compulsory blending of bioethanol with fossil gasoline. In the EU, many governments support biofuels through a full or partial exemption from mineral oil taxes. These incentives are accompanied by compulsory blending requirements.

Germany has started its political support for biofuels with a complete tax exemption for all biofuels. Given biofuel production costs of between € 0.50 and € 0.70 per litre, biofuels immediately became a very competitive product with its price advantage increasing even further the more oil prices were to increase in the future. Two reasons led to the policy change of reducing the tax exemption for some uses of biofuels and of abandoning it altogether for other uses. The European Union ruled overcompensation illegal, i.e., tax exemptions can not lead to a price of biofuels that is below fossil fuel prices at the gas station. Secondly, already in 2005 the tax exemption led to a fall in revenues from the mineral oil tax of about 1.3 bn € with the prospect of rising to more than 5 bn € if the objectives of the German biofuel initiative were to be met and the already planned investments in ethanol plants were to be realized.

Therefore the tax exemption was strongly modified. For the overall share of biofuels in the fuel consumption a quota system as proposed by the Commission of the EU has been introduced. The EU requests that member states reach a share of 5.75 percent of biofuels by the year 2010. In addition, a differentiated system of tax rates for the different types of biofuels was introduced. Table 1 shows that essentially those biofuels that are mixed to fossil fuels with a share of up to 5 percent, i.e., Ethanol (E5) and Biodiesel (B5), are now fully taxed. In contrast, second generation biofuels such as BtL or Lignocellulose and E85 or Biogas – which at the moment are only niche products – are still tax exempt.

It has already been mentioned that all biodiesel and bioethanol from European sources can not compete with fossil fuels at current market prices. It is only the tax exemption and the compulsory blending that bridges the gap between production costs for biofuels and fossil fuels. In addition, both for biodiesel and for bioethanol non-European suppliers can offer lower prices than European producers. Bioethanol from Brazil has production costs of 0.20 to 0.25 €/l, corn based bioethanol from the USA costs about 0.29 €/l whereas European producers have cost ranging from – in the best case – 0.35 €/l to 0.80 €/l. For biodiesel, the situation is not that clear since currently 85 percent of the biodiesel production takes place in Europe. However, subsidized imports from the USA enter the EU and the production of biodiesel on the basis of palm oil in Malaysia and Indonesia is expected to increase significantly in the next years. These potential exports will most likely have lower production costs than biodiesel based on rapeseed in Europe. This lack of competitiveness of European biofuels has not led to significant imports, simply because European biofuel markets are protected through several trade barriers.

Table 1

German Tax rates for Biofuels in € / litre

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
E85	0					Tax Free				
E5	0	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65	0.65
Ligno	0					Tax Free				
B100	0.09	0.09	0.15	0.21	0.27	0.33	0.45	0.45	0.45	0.45
B5	0.15	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47	0.47
SVO	0	0	0.10	0.18	0.26	0.33	0.45	0.45	0.45	0.45
BtL	0					Tax Free				
Biogas	0					Tax Free				

E85 = Fuel with 85% Ethanol, E5 = Fuel with 5 % Ethanol, Ligno = Biofuel from lignocellulose, B100 = pure Biodiesel, B5 = Diesel with 5 % Biodiesel, SVO = Straight Vegetable Oils, BtL = "Biomass to Liquid".

Source: Own compilation.

Imports of Ethanol face an import tariff with three different rates. 0.24 € / l for undenaturated Ethanol, 0.13 / l for denaturated and a value tariff of 6.5 percent for Ethanol as a "chemical product" are the different tariff rates. Most European countries require the use of undenaturated Ethanol in the biofuel sector although there is no reason for this requirement except for the fact that it has the highest tariff rate and makes sure that most imports are hardly competitive in European markets.[3]

In the biodiesel market non-tariff barriers provide most of the protection to foreign competition. The fuel quality regulations for biodiesel prohibit the use of biodiesel that has used palm oil or soybean oil as a feedstock. There are some not very convincing reasons to ban American and Asian biodiesel imports because of problems with using these biodiesel blends at low temperatures. In any case, such

3 This system has led to innovative activities such as "splash blending" where some gasoline is added to the Ethanol in order to turn it from an "undenaturated" into a "denaturated" product.

quality regulations – whether they are a non-tariff barrier intentionally introduced for protecting local markets or for reasons purely related to technical aspects – iareappreciated by European biodiesel suppliers.

The combination of partial or complete tax exemptions with mixing requirements and trade barriers have created a European market that is essentially isolated from the rest of the world and provides a profitable business for European farmers and biofuel producers. The price difference between foreign and European biofuels already makes clear that there is a welfare loss due to the impossibility of exploiting obvious comparative advantage from international trade in biofuels. In addition, there is the climate policy perspective of consuming biofuels. The GHGs saved from substituting gasoline and diesel through their biomass based counterparts differ significantly. The prospects for protecting the climate through the different biofuels therefore need to be considered.

5. How Much Contribute Biofuels to Climate Protection?

The "Renewable Energy Roadmap" (Commission of the European Communities 2007) has set specific targets for biofuels. However, the argument for promoting the substitution of fossil fuels by the biofuels is not based on climate protection but only on energy security. Their contribution to climate protection did not seem to be worth mentioning. The German policies towards biofuels mention three objectives: energy security, mitigation of climate change, and support to rural areas. In fact, the question as to how much biofuels can contribute to the reduction of emissions of GHGs is discussed quite controversially. Proponents see it as a cornerstone of the move away from fossil energy sources towards renewable sources. Critics argue that biofuels are not as effective in substituting fossil fuels than other uses of renewable energy (Henke / Klepper / Schmitz 2004). They argue that biofuels are by no means free of fossil carbon since the production of the feedstock and the conversion of the agricultural feedstock into biofuels requires substantial inputs from fossil sources. Most important are the energy inputs for planting, harvesting, and transport as well as the use of chemical fertilizers. The conversion processes in most cases also use fossil energy sources such as oil, gas or even brown coal.

There are several ways in which the contribution of biofuels to climate protection can be assessed. A direct approach is to compare the GHG emissions from consuming fossil fuels with those of biofuels. As a result one can compute the amount of GHGs saved per litre of gasoline. A broader approach for assessing the role of biofuels takes into account the fact that biomass production is limited by the availability of land suitable for growing specific crops. The economically most valuable use of this limiting factor would need to be determined by evaluating not only the market value of different types of land uses but also the external effects. These externalities refer to climate protection but also to the preservation of biodiversity or the use of land for recreational purposes that may depend on intangible aspects such as landscape. However, such a comprehensive assessment of the social value of different types of land uses has so far not been done, not the least because such an evaluation would require a substantial interdisciplinary research effort. Nevertheless, a forward looking land use policy should be based on such a comprehensive assessment of the social value of land. Such assessments are not available but partial analyses of some of the externalities have been done and attempts to use those in regulating the uses of biomass are currently investigated. Until such assessments are implementable a direct and simple indicator for the contribution of biofuels to climate policy with respect to competing land uses consists of the amount of GHG emissions saved per unit of land in different uses.

The physical amount of GHG savings from biofuels – either per unit of land or per unit of fuel produced – also needs to be compared to the production costs of the different biofuels. With these production costs and the price of fossil fuels it is possible to compute the GHG abatement costs of biofuels. The GHG abatement costs are defined as the difference between the marginal costs of producing a certain biofuel and the corresponding costs of the comparable fossil fuel measured in energy equivalents.[4] Hence, GHG abatement costs are both depending on oil prices and on prices for agricultural products and the conversion costs. Rising oil prices will lower GHG abatement costs and rising feedstock prices for biofuels will increase them. This means that a move towards the "Second Generation biofuels" such as BtL that rely on byproducts from agricultural production or waste materials would automatically lower GHG abatement costs.

Table 2

Indicators for GHG Savings from Biofuels

	Biodiesel	Bioethanol (Grains)	Bioethanol (Sugar Beet)	Bioethanol (Sugar Cane)	BtL	Biogas
Gross Energy Savings[a)]	51	54	132	137	135	178
Net Energy Savings[a)]	38	30	88	116	118	113
GHG Savings[b)]	3.4	2.9	7.2	15.5	10	8
GHG Abatement Costs[c)]	154	252	290	–27	272	273

[a)] GJ / ha – [b)] tCO_2e / ha – [c)] € / tCO_2e.

Source: FNR (2006).

4 The conversion into energy equivalents is necessary since biofuels have a lower energy density such that the same amount of biofuel delivers a lower energy service than the corresponding fossil fuel. In fact, one litre of Biodiesel replaces 0.9 l of fossil diesel and one litre of Bioethanol replaces 0.65 l of gasoline.

Table 2 summarizes different indicators for the energy and GHG balances of different biofuels. The first column refers to Biodiesel as RME (rapeseed methyle ester) produced in Germany, the second to Bioethanol from grain, the third to Bioethanol with sugar beet as a feedstock, and the fourth one to Bioethanol from Brazil which uses sugar cane as a feedstock. Biomass to Liquid (BtL) is a second generation fuel still in the research face which uses as feedstock all kinds of biomass including biowaste. Finally Biogas refers to the production of gas with energy maize as a feedstock. Biogas is usually not turned into a car fuel but is used for heat and electricity production. It illustrates a different route of land use that also replaces fossil energy source although not for transportation.

The largest energy yield that one can get from a hectare of agricultural land is not through biofuels but in the form of Biogas as the first row of Table 2 shows. Sugar beet and sugar cane have high hectare yields resulting in a high gross energy output of Bioethanol whereas grains and rapeseed by far do not provide a comparable energy content. Since gross energy yields do not take into account that the production of the biofuels requires inputs of fossil fuels the appropriate measure for the fossil energy savings from biofuels is the net energy yield where the fossil energy inputs are subtracted from the energy content of the biofuel.

The highest net energy yield of existing production activities comes from Brazilian Bioethenol.[5] European Biodiesel and Bioethanol net energy yields are much lower since they require substantive inputs of fossil energy. A comparison of the Biodiesel and the German Bioethanol gross and net yields indicates that between 25 and 40 percent of the energy content in the biofuels has been used as fossil fuels in the production of the biofuels. These fossil energy inputs occur both in the production of the feedstock as well as in the conversion process. They are more pronounced in the production of rapeseed, grains and sugar beet than in the production of sugar cane or biogas. In the latter, the conversion processes use very little to almost no fossil energy and the energy requirements of the feedstocks are also of less importance.

Under a global perspective in which there is an increasing shortage of land available for food and bioenergy production it would not be reasonable to produce biofuels in Germany if they lack competitiveness when compared to, for example, Brazilian Bioethanol. If the policy objective is to substitute fossil fuels by energy sources from biomass in general the best choice in Europe would be biogas as it brings about the highest net energy yield per hectare. Finally, under a purely national perspective of supporting the production of biofuels the choice between Diesel, Bioethanol from grain and Bioethanol based on sugar beet goes clearly in favour of sugar beet based Bioethanol. Such a national or European orientation is debateable, yet the revealed preference of European decision makers as it is evi-

[5] BtL and Biogas are in a similar range but the former is currently not available on an industrial scale and the latter is not a substitute for fossil transport fuels.

dent from the high tariff barriers for biofuels is clear. They prefer national or at most European but not global solutions.

Turning from energy savings to the savings of GHGs which is the main issue when one is concerned with climate policy, the GHG savings on a hectare of land are again largest in Brazil. Bioethanol from sugar cane saves 15.5 tCO_2e / ha compared to 2.9 tCO_2e / ha for grain based Ethanol and up to 7.2 tCO_2e / ha for Ethanol from sugar beet with Biodiesel being in the middle. Even biogas is not competitive with respect to Brazilian Ethanol.

Even though land as a scarce resource is an important determinant for the availability of biofuels and the competition between agricultural products for food and fuels, abatement costs are an equally important factor for an efficient use of alternative renewable energy resources. The different biofuels have quite divergent abatement costs. GHG-Abatement costs are defined as the additional costs that are incurred if a certain amount of fossil fuel is replaced by a biofuel. In this calculation included is the fact that biofuels have a different energy density, i.e., a specific quantity of biofuel does not replace the same quantity of fossil fuel. One litre of Bioethanol, for example, replaces roughly 0.65 litres of fossil fuel. In other words the fossil fuels have a higher energy density and thus a higher energy service per unit of fuel.

The GHG-Abatement costs for the different fossil fuels vary drastically. Biodiesel costs somewhat more than 150 € / tCO_2e. Reducing GHG-emissions through the substitution of Bioethanol from grain and sugar beet already cost 250 and 290 € / tCO_2e. Biogas and BtL are similarly expensive. In contrast, Brazilian Bioethanol has negative abatement costs. This is due to the fact that Bioethanol in Brazil today is – even without subsidies – less expensive than fossil gasoline such that it is profitable to use Bioethanol instead of traditional gasoline.

The abatement costs of biofuels heavily depend on the price of gasoline. Whereas the figures in Table 2 are based on simulations with a crude oil price of 50 $ / barrel, at todays prices the abatement costs would also be lower. [illegible]e roughly 80 $ / barrel of oil even European biofuels can become competitive vis-avis gasoline. However, the relative competitive position of the different biofuels in terms of their abatement costs will not change under different oil prices. European biofuels will remain much more costly than foreign alternative products such as Bioethanol from Brazil or Biodiesel produced from Palmoil.

Efficient abatement of greenhouse gases is achieved if the least costly options for reducing these gases are chosen. The ranges of abatement costs of European biofuels are significantly higher than many other abatement options. The carbon prices in the European Emission Trading Scheme (ETS) are around 25 € / tCO_2 for the second commitment period. Emissions reduction certificates under the Kyoto-Protocol sell at even lower prices. Alternative measures such as energy savings in energy end use activities are estimated to be almost costless or in some cases even negative. Other technologies such as photovoltaics are so expensive that they are only efficiently applicable in specific circumstances.

The quantities of fossil fuels that can be replaced by biofuels is strongly limited if the biofuels are to be produced within the EU. The “Renewable Energy Roadmap” of the EU sets a target of 10 percent for biofuels in the overall fuel consumption. This would according to a report (DLG 2007) require to devote about 50 percent of the agricultural land in the EU-15 to the production of feedstock for biofuels. The situation in the USA is similar where about 30 percent would be needed to meet a 10 percent target. Only Brazil for Ethanol and in part Malaysia and Indonesia for Biodiesel have sufficient land areas suitable for biofuel production. Given the world wide demand even these areas would not be able to satisfy more than a small proportion of fuel demand world-wide.

In addition, there is doubt whether these supplies can really be supplied on a sustainable basis without threatening other environmental resources. Especially the supplies from Asia and from Brazil have been criticized for indirectly threatening climate protection and for destroying scarce environmental resources. The illegal logging in primary rainforests in Indonesia and the draining of peatlands for Palmoil production may lead to such high emissions of GHGs that the savings from biofuels are more than eaten up. The expansion of areas devoted to sugar cane in Brazil are believed to push the previous agricultural activities such as cattle raising and soy bean production more towards the tropical rainforests. It is argued that – although indirectly – the Ethanol production is responsible for the destruction of the Amazon forest. If biofuels are produced under such conditions they compromise the attempts to use biofuels for climate protection. Hence appropriate measures need to be introduced to preserve the credibility of the GHG-savings that are achieved under proper and sustainable agricultural practices. In addition, expanding the production of biofuels beyond already existing land areas which are used so far for food production needs to be monitored carefully in order not to undermine other land use objectives such as the preservation of biological diversity.

6. Policy Options for Biofuel and Bioenergy Policies

As described above, biofuels in Europe rely on a sophisticated system of support ranging from trade protection through tariffs to tax incentives and mixing requirements. The current policy mix encourages national solutions which are more costly than global solutions. It also does not take into account criteria for an efficient use of scarce land resources and the sustainability of biofuel strategies. The efficient allocation of scarce land resources would require to put those activities in place that provide the highest social benefit, i.e., not the highest profits based on market prices but also the benefits from protecting the climate or from protecting biological diversity.

In terms of climate protection those options of bioenergy production should then be chosen that have the lowest CO_2-abatement costs. If one looks only at the biofuel production locally it would favour Biodiesel over Bioethanol. If instead other uses of Biomass for energy production were also included options such as the direct conversion of biomass into heat and power may yield higher fossil energy savings at lower cost.[6] In the case of Biogas the abatement costs could be significantly lowered if the biogas plants could produce biogas together with heat that can be used in the neighbourhood.

The current system of mixing requirements for biofuels and of price support for Biogas and other biomass based energy production does not provide the appropriate incentives for a socially efficient allocation of land resources. The objective of reducing GHG-emissions through the use of Biomass should use mechanisms that provide signals to farmers such that the best climate policy is automatically chosen. This would require a rethinking of support measures by moving away from the ad hoc regulation of different Bioenergy activities towards an integrated climate policy with respect to Bioenergy. Such a unifying system should be based on the GHG-savings that a particular activity provides.

If the GHG-savings are the measuring rod for support, those activities with the highest savings would receive the highest support whereas those with low savings would be supported less. A possible solution would be a certification system in which the GHG-balance for a particular plant all along the supply chain is assessed. The GHG-savings could then be traded in an emission trading scheme such as the ETS or even the ETS itself. This would, however, require the inclusion of all energy related activities such as transport and small incineration activities into the ETS. Such a system in effect internalizes in an efficient way the GHG-savings that arise from the use of biomass for energy production and thus avoids the differential treatment of different land use activities with respect Bioenergy.

Such a carbon accounting logic for determining the best energy production from Biomass would first of all mean that many of the adhoc support policies for different biofuels could be abandoned. This would also include a revision of the mixing directive of the EU. But since it is in direct conflict with another EU requirement, namely the reduction of the carbon content of fuels by one percent per year, a reform of the biofuel policies of the EU will be necessary in any case.

This proposed reform would not constitute a policy directly geared at the fuel sector but would provide equal opportunities for all energy sources from Biomass. This implicitly assumes that fossil fuels, i.e., oil, are good to perfect substitutes with other oil uses such as heating[7], an assumption that is difficult to refute. It would therefore make no difference whether crude oil is saved in the transport sector or in the heating activities. In terms of climate protection those land uses should be preferred that provide GHG-savings at the lowest abatement costs.

The current focus on local supplies of biofuels also poses a serious efficiency problem and thus a policy problem. The local biofuels are more expensive and less

6 See for example Henke / Klepper / Schmitz (2004)

7 Oil is practically irrelevant for electricity production in Germany and most of Europe.

climate friendly than foreign supplies, e.g. from Brazil. The comparative advantage for biofuels is not in Europe for mainly climatic reasons that lead to lower yields per hectare, but also because of the higher cost of production and, not the least, because of the lower CO_2-savings of the biofuels. This poses a direct conflict between an efficient climate policy and the support of agriculture in Europe. From a climate policy perspective the biofuel as well as the bioenergy strategy should be internationally oriented thus exploiting the best options for GHG-savings. An opening of biofuel markets to international competition would result in an immediate loss of competitiveness of European biofuels, but it would also pose a threat of uncontrolled imports of biofuels that may not be as climate friendly as other supplies that are properly produced.

Controlling the imports of biofuels that provide no real GHG-savings can be overcome by an appropriate certification scheme that assess both the sustainability and the GHG-savings for biofuels from a particular foreign or local supplier. Such certification schemes are in planning in several European countries and their introduction could strongly ease the opening of European biofuel markets.

The conflict between agricultural support and climate policies may seem to look unsolvable in the short run. In the long run this problem is likely to be resolved by market forces. The demand for food products, especially meat, is growing with rising incomes in many countries with large populations. This is accompanied by an increasing demand for feedstocks in the biofuel production as well as an increased use of biomass for electricity and heat. World markets have already responded with prices for grain and oil products that are increasing fast and that have broken a trend of falling prices which has persisted for many years.

On the one hand, this provides higher income opportunities for farmers. On the other hand it also raises feedstock prices for biofuels thus making biofuel production relatively less profitable than food production. Hence, the world-wide trend towards higher grain and vegetable oil prices will change the relative profitability of European farming activities. In other words, even in a market without trade barriers Europeans farmers are unlikely to loose. Instead they might move back towards food production and let the comparative advantage of other countries in the production of biofuels be realized.

In summary, a move towards a system that provides support to energy from biomass based on GHG-savings would provide more rationality to land use control. A particularly efficient way would be to link bioenergy production with the European emission Trading Scheme (ETS) through an international certification of biomass. The opening of biofuel markets could not only exploit unused comparative advantage in cost terms, it could also exploit higher GHG-savings from foreign supplies. The increasing scarcity of agricultural areas that will become even more pronounced with climate change will raise agricultural prices such that income from agricultural activities is likely to increase and the profitability of bioenergy production in Europe will diminish.

References

BP (2006): “Statistical Review of World Energy”. London

Bundesminster für Umwelt, Naturschutz und Reaktorsicherheit (BMU) (2007): “Leitstudie 2007 – Ausbaustrategie Erneuerbare Energien.” Berlin.

Commission of the European Communities (2007): “Renewable Energy Roadmap – Renewable Energies in the 21st Century: Building a More Sustainable Future,” COM(2006) 848 final, Brussels.

Henke, J. M. / *Klepper,* G. / *Schmitz,* N. (2004) Tax exemption for biofuels in Germany: Is bio-ethanol really an option for climate policy? Energy.

International Energy Agency (2005): “World Energy Outlook 2005,” OECD / IEA Paris.

– (2006): “Energy Technology Perspectives 2006,” OECD / IEA Paris.

IPCC (2007a): “Climate Change 2007 – Impacts, Adaptation, and Vulnerability – Summary for Policy Makers,” http: // www.ipcc.ch / SPM13apr07.pdf.

– (2007b): “Climate Change 2007 – Mitigation of Climate Change – Summary for Policy Makers,” http: // www.ipcc.ch / SPM040507.pdf.

Fachagentur für nachwachsende Rohstoffe (FNR) ed. (2006): “Biokraftstoffe – Eine vergleichende Analyse,” Gülzow.