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**COMMISSION STAFF WORKING DOCUMENT**

**<u>Annex to the</u>**

**COMMUNICATION FROM THE COMMISSION**

**An EU Strategy for Biofuels**

**IMPACT ASSESSMENT**

{COM(2006) 34 final}

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**COMMISSION STAFF WORKING DOCUMENT**

**Impact assessment of the Communication on an EU strategy for biofuels**

## 1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

As the purpose of the Communication on an EU Strategy for Biofuels is to carry forward the biofuels component of the Biomass Action Plan (BAP), this Impact Assessment is based largely on the Impact Assessment work carried out for the BAP, with additional elements specifically related to biofuels.

The Impact Assessment work for the BAP started in December 2004. An External Expert Group, comprising a small team of bioenergy experts, was set up to advise the Commission team on the various strategies and alternatives. A meeting was held on 10 January 2005 and the group was invited to attend the External Stakeholder Group meeting on 4 March 2005.

In order to give stakeholders the opportunity to put forward their opinion and ideas on the Biomass Action Plan, an on-line public consultation was carried out. This was designed as a questionnaire asking for up to 3 recommendations for action needed at EU and national level to further accelerate the market development of bioenergy in the EU. The public consultation was open from 2 February to 31 March 2005. During that time 262 stakeholders responded to the questionnaire, 124 of them concerned with biofuels. The JRC Institute for Energy analysed the questionnaires and compiled a summary report, which was published on the EUROPA BAP webpage[1].

An external stakeholder meeting, attended by 64 participants, took place in Brussels on 4 March 2005[2]. The objectives of the BAP were presented and an extensive discussion took place between the stakeholders and the Commission's representatives. Relevant industry and consumer associations were invited from along the whole bioenergy process chains (from agriculture to the energy service), as well as members of the European national energy agencies' network (EnR), utilities, solid and liquid biofuel producers, technology providers, NGOs and Member State representatives.

In May–June 2005 the Commission services held several internal meetings to share information obtained from external consultations and to debate the options to be included in the BAP. In parallel, meetings were organised with the main stakeholders to accomplish the consultation process and to give as many of them as possible the opportunity to express their opinion. Meetings were also held with representatives of Member States (The Netherlands, Germany, United Kingdom) that have completed or are preparing national Biomass Action Plans.

In June 2005 the Commission College charged the Commissioners responsible to examine measures to encourage the production of biofuels and, if appropriate, present a proposal on these issues[3]. A Cabinet / Inter-service steering group was established on 7 July 2005 and

[1] http://europa.eu.int/comm/energy/res/biomass_action_plan/doc/results_questionnaire_esg.pdf.
[2] http://europa.eu.int/comm/energy/res/biomass_action_plan/doc/esg_meeting_minutes_v2.pdf.
[3] Minutes of the 1707th meeting of the Commission held in Brussels on Wednesday 22 June 2005.

chaired by the head of the Cabinet of Mrs. Fischer Boel. This steering group represented fourteen cabinets and thirteen services of the Commission. It held four meetings to prepare background material on the impact of the production and use of biofuels, and to discuss draft versions of the Communication. In order to identify critical areas where better coordination between policies is needed, several meetings were held with the services involved.

The issues were dealt with through six clusters, each involving from four to six Commission DGs, who contributed to the file in the form of specific elements for each topic (research, environment, global context, economic aspects, agriculture, regulatory and institutional aspects). This information was used as the basis for drawing up the Communication on the EU Strategy for Biofuels.

In the meantime, this technical information was drawn together in the standard format of an Impact Assessment, to accompany the Communication. In addition, information was taken from the Impact Assessment that accompanied the Biomass Action Plan, adopted by the Commission on 7 December 2005.

Owing to the complexity of the issues, and the need to represent them in a fair and balanced way, this Impact Assessment remains largely qualitative.

## 2. PROBLEM DEFINITION

### 2.1. Issues and underlying drivers

#### *2.1.1. Climate change*

Rising concentrations of greenhouse gases (GHG) in the earth's atmosphere are leading to potentially irreversible climate change. A shift in temperature zones caused by climate change could seriously affect biodiversity. Changes in precipitation and more irregular precipitation will mean that water resources in many regions are depleted. At the global level, climate change is expected to have a negative impact on agricultural production and worsen food security. Climate change, apart from having direct economic effects on already vulnerable livelihoods in terms of lost endowments and entitlements, is also likely to have major macro-economic implications. As far as Europe is concerned, Southern Europe and the European Arctic are considered to be the most vulnerable regions.

In the EU, transport is responsible for an estimated 21% of all greenhouse gas emissions that are contributing to global warming. Between 1990 and 2003, when greenhouse gas emissions in the EU saw an overall reduction, transport's share grew by about 24%[4]. The reduction of greenhouse gas emissions from transport, therefore, could contribute significantly to meeting the EU Kyoto targets.

#### *2.1.2. Insecurity of fuel supply*

Over the last year, the European citizen had to face price increases for transport fuels and other energy sources. The price of a barrel of oil approached the 60 US$ mark in March and exceeded 65 US$ in the summer of 2005. This increasing cost of energy had a strong impact on purchasing power.

[4] "Key GHG data –GHG Emission Data for 1990-2003", p. 69, UNFCCC 2005.

In the EU transport sector, 98% of the energy used comes from fossil oil. Known oil reserves are limited in quantity and restricted to a few world regions. New reserves exist, but will mostly be more difficult to exploit. Securing energy supplies for the future is therefore not only a question of reducing import dependency, but calls for a wide range of policy initiatives, including diversification of sources and technologies[5].

The central importance of energy policy in helping the EU meet the challenges of globalisation was confirmed by the Union's heads of state and government at the informal Hampton Court summit in October 2005.

### *2.1.3. Need for diversification in agriculture and rural economies*

The reform of the Common Agricultural Policy in June 2003 and the second reform package of April 2004 introduced major changes likely to have a significant impact on the economy across the whole rural territory of the Community in terms of agricultural production patterns, land management methods, employment and the wider social and economic conditions in rural areas. The reform of the sugar sector agreed in November 2005 adds to these challenges. With the reforms, EU farmers are more and more required to orientate their activities towards viable markets. New market opportunities are therefore of particular interest to the agricultural sector.

With over half the population of the EU-25 living in rural areas, which cover 90% of the EU's territory, rural development remains an important challenge. Behind the general picture which arises at EU-25 level, of rural regions having lower incomes, higher unemployment rates and a relatively higher dependency on the primary sector than urban regions, lies a wide diversity of situations in rural regions and areas, in and between Member States.

However, the economic weight of agriculture and forestry in terms of their contribution to GDP and employment has become smaller, even in predominantly rural regions. In 2003, the share of agricultural employment in total employment in these regions amounted to about 12% in the EU25. For many farmers and their families, agriculture is no longer the only source of income and, quite often, no longer the most important source.

The challenges to be addressed in rural areas can be summarised as follows:

- *Economic:* rural areas have incomes significantly below the average, an ageing working population, and a relatively greater dependency on the primary sector.

- *Social:* there is clear evidence of a higher than average rate of unemployment in rural areas. Low population density and depopulation in some areas may also increase the risk of problems like poor access to services, social exclusion and a narrower range of employment options.

- *Environmental:* the need to ensure that agriculture and forestry continue to make a positive contribution to the countryside and the wider environment.

[5] As emphasised in the Green Paper "Towards a European Strategy for the Security of Energy Supply" COM(2000) 769 final.

Developing the provision and innovative use of renewable energy sources can contribute to creating new outlets for agricultural products and forestry by-products, the provision of local services and the diversification of the rural economy.

### *2.1.4. Unemployment and the need to improve competitiveness in Europe*

The search for solutions to the problem of transport fuel supply and GHG emissions is closely linked with the need to address unemployment in the EU and improve competitiveness, by harnessing Europe's scientific and technological expertise and creativity.

Vehicle manufacturers are reluctant to invest the large sums necessary to market a new generation of cars more suited to the flexible use of biofuels, unless they can be sure of the future of the European market and the ongoing availability of biofuels. To optimise its performance, the industry requires an early understanding of what types of fuels will be available and developed in the future.

### *2.1.5. Developing countries affected by the sugar reform*

Developing countries face similar and even greater challenges with respect to transport energy: rising oil prices are badly affecting their balance of payments; reliance on imported fossil fuels implies vulnerability and they too are faced with the challenge of reducing greenhouse gas emissions. In those developing countries where sugar production may no longer be viable, following the reform of the EU sugar regime, alternatives are needed.

## 2.2 Development of the issues

The Biofuels Directive[6] set as "reference values" targets of a 2% market share for biofuels in 2005 and a 5.75% share in 2010. For the EU25 the target would require 18.6 mtoe of biofuels by 2010.

In 2000 biofuels contributed about 0.2% in energy terms of all fuels used in the EU. If Member States had achieved the national indicative targets they adopted under the Biofuel Directive, the contribution of biofuels would have reached 1.4% by 2005. Although the national targets are, on average, significantly lower than the reference value of 2% that the Directive laid down, some Member States have not met them.

Recent assessments have concluded that the 2010 indicative target set out in the Biofuel Directive is also unlikely to be achieved.

Although biofuels for transport have achieved a very limited market penetration, their cost has been reduced and their strategic importance augmented due to the hikes in the price of oil. And, looking beyond 2010, biofuels could have a bigger role to play if oil prices increase further, with a reformed agricultural policy, new technological breakthroughs and the challenge of imports from third countries.

Under Article 16 of the Energy Tax Directive[7], Member States may grant exemptions or reduced levels of taxation for biofuels. Under state aid rules, Member States have notified to

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[6] Directive 2003/30/EC of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport (OJ L 123, 17.5.2003).

[7] Council Directive 2003/96/EC of 27 October 2003 restructuring the Community framework for taxation of energy products and electricity (OJ L 283, 31.10.2003).

the Commission tax reductions in the order of €0.3 to €0.6 per litre of biofuel, which is the level deemed necessary to compensate for the higher production costs of biofuels compared with fossil fuels[8].

On the basis of the information submitted to the Commission, there are two main support systems:

– New measures in Austria, the Czech Republic and France are based on an obligation to the market to ensure that the appropriate volume of biofuels is used in the market by the oil companies.

– The most widely-used measure is still tax concessions, although some countries have announced a change to their policy. Germany, which currently has 100% tax relief on unlimited quantities, has announced that it will change to new measures based on obligations instead of tax policies. The UK, Netherlands and Slovenia have also announced that they will introduce obligations without tax relief.

In order to meet its climate change targets, as well as to contribute to security of supply and to foster the competitiveness of sustainable energy technologies in Europe, the Community has to proactively encourage the market uptake of alternative transport fuels, as part of a wider strategy of bioenergy production.

If the energy policy objectives of the Union are to be met, much more bioenergy will have to be brought into the market than at present. This was the conclusion of the Commission Communication "The share of renewable energy in the EU"[9] which specified that bioenergy should contribute an additional 74 mtoe by 2010 (EU 15 only) if the indicative target was to be achieved.

## 2.3. Community Added Value

The general development of bioenergy over the last 15 years has seen the share of biomass as an energy source remain virtually constant at around 4%, although bioenergy use has grown significantly in absolute terms. This has demonstrated that national action alone is not sufficient to increase biomass use, in relation to growing energy consumption. This also holds for biofuels, in spite of the fact that there is general acceptance that renewable energy, including biofuels, should play a bigger role as an energy source.

In the context of its commitments on the reduction of greenhouse gases, the development of renewable energies is a clear political priority for the EU. Security of energy supply is also becoming increasingly important. There is now an established line of action at EU level in these fields.

In June 2001 the Commission's Communication "A sustainable Europe for a Better World: A European Union Strategy for Sustainable Development" was presented to the Gothenburg Council. In this, the Commission proposed that alternative fuels, including biofuels, should in future play a greater role.

8 The actual amount of tax concessions for biofuels depends primarily on their production costs compared with the production costs of fossil motor fuels and on the level of excise duty imposed on motor fuels.

9 Communication on the share of renewable energy in the EU, COM(2004) 366 final of 26.5.2004.

In November 2001 the Commission adopted a Communication[10] on alternative fuels for road transportation and on a set of measures to promote the use of biofuels. This was later transformed into a comprehensive Community framework for the promotion of biofuels, consisting of the Biofuels Directive and Article 16 of the Energy Tax Directive.

In the fiscal field, Member States were granted the possibility to use fiscal measures to promote biofuels, "thereby contributing to the better functioning of the internal market and affording Member States and economic operators a sufficient degree of legal certainty".

At the same time, the Biofuels Directive set indicative targets for biofuel use in the Member States. In the explanatory memorandum it was explained that "without coordinated decisions on fiscal, energy and environmental policies in this field and without clear prospects for the agricultural production and processing industry, it is doubtful whether biofuels will ever reach a substantial share of the total fuel consumption in the EU. Actions at Community level in the field of biofuels are therefore needed to create the basis for the investment required to promote sufficient quantities of biofuels".

The Biofuels Directive indicated that biofuels should have a 2% share of all fuels sold for transport purposes on Member States' markets by 31 December 2005 (calculated on the basis of energy content). An indicative target of 5.75% was set for the end of 2010.

Following on from the Commission Communication "The share of renewable energy in the EU"[11], in December 2005 the Commission adopted a Biomass Action Plan[12], which made it clear that the 2005 biofuels targets would not be met.

The current Communication takes up the issues concerning biofuels raised by the Biomass Action Plan and puts forward a strategic approach to Community policy in this area.

A specifically new area covered by the Communication is that of assisting developing countries to realise their biofuel potential. Any action in this respect would be carried out in the context of EU development policy, or through the accompanying measures for Sugar Protocol countries affected by the EU sugar reform and would take into account the need to ensure environmental protection in those countries.

## 3. OBJECTIVES

The central aim of this Communication is to encourage the development of a biofuel policy which will help address the problems outlined in section 2.1. This policy should therefore seek to diversify sources of energy supply and to reduce greenhouse gas emissions by the transport sector. It is expected to encourage new opportunities in rural areas and developing countries and contribute to the Lisbon Strategy, at an acceptable cost and with limited, if any, negative environmental consequences.

The Communication is intended as a contribution to the EU's overall approach to energy. The European Commission set out its ideas on security of energy supply in a Green Paper, and on energy cooperation with developing countries in a separate Communication. The recent Green Paper on Energy Efficiency proposes measures to boost energy efficiency.

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10 COM(2001) 547 final.
11 COM(2004) 366 final of 26.5.2004.
12 COM(2005) 628 final of 7.12.2005.

The Biofuels Directive of 2003 set out to promote the use of renewable fuels to partially replace diesel or petrol for transport purposes in each Member State, with a view to contributing to objectives such as meeting climate change commitments and environmentally friendly security of supply. It established reference targets for biofuels to be met by the end of 2005 and 2010. In accordance with the Biofuels Directive, the Commission will bring forward a report in 2006 on the Directive's implementation, with a view to a possible revision.

The Biomass Action Plan adopted by the Commission in December 2005 described various actions to encourage the use of biomass for renewable energy production. It includes a proposal for action to achieve an additional contribution of biofuels for transport applications. This objective was politically endorsed with the adoption of the Action Plan.

The Biomass Action Plan also announced that a separate Communication should carry forward the biofuel elements of the BAP early in 2006. This Impact Assessment therefore considers options to achieve three aims:

- To further promote biofuels in the EU and developing countries, ensure that their production and use is globally positive for the environment and that they contribute to the objectives of the Lisbon Strategy.
- To prepare for the large-scale use of biofuels by improving their cost-competitiveness through the optimised cultivation of dedicated feedstocks, research into "second generation" biofuels, and support for market penetration by scaling up demonstration projects and removing non-technical barriers.
- To explore the opportunities for developing countries – including those affected by the reform of the EU sugar regime – for the production of biofuel feedstocks and biofuels, and to set out the role the EU could play in supporting the development of sustainable biofuel production.

The specific operational objectives in the different policy fields are:

– Stimulate demand for biofuels
– Capture the environmental benefits
– Develop production and distribution of biofuels and remove technical barriers
– Expand supplies of feedstock
– Enhance trade opportunities
– Support developing countries
– Support research and development.

## 4. POLICY OPTIONS

In view of the issues and objectives discussed above, and against the background of policy measures already taken and announced, three approaches to the further development of biofuel policy were identified, grouping together different sets of measures.

The option 1 scenario ("business as usual") is based on the present policies and the evaluation of their implementation in the EU-25 until 2010, as already spelled out in the impact assessment for the Biomass Action Plan. However, the effects of implementing the BAP have not been taken into account for this Impact Assessment. Option 1 therefore models future development in the biofuels sector in the EU-25 based upon present policies with currently existing barriers and restrictions. Under this scenario the indicative target for biofuels in 2010 will not be met.

Options 2 and 3 both assume that **biofuel demand** will increase to meet the 2010 indicative targets. The instruments to achieve this may range from market-based approaches (e.g. voluntary agreements with the oil industry) to regulatory approaches (e.g. blending obligations). This debate on instruments will be held in the context of the forthcoming report on the Biofuels Directive and its possible revision. Concerning these key instruments to address biofuel demand, there is no difference assumed between options 2 and 3. However, option 2 includes some accompanying measures that are important for biofuel demand, for example the removal of technical barriers and the promotion of public procurement of clean vehicles. For the analytical purpose of this Impact Assessment, it is assumed that the market share of biofuels will increase to 5.75% in 2010 under both option 2 and 3.

There is also no difference between options 2 and 3 concerning **environmental safeguard instruments**. These may also range from market-based certification schemes to regulatory requirements. In the European Climate Change Programme, the Commission is already examining whether and how biofuels can contribute to an integrated approach to $CO_2$ reduction for light-duty vehicles. Whether and how to link policy measures to specific greenhouse gas benefits will be addressed in the context of the revision of the Biofuels Directive. For analytical purposes, both options assume that greenhouse gas monitoring and environmental standards for feedstock production will be established and that the Fuel Quality Directive will be revised.

Furthermore, both options include specific **research and development** actions to achieve reductions in production costs and to develop the efficiency of biofuels (e.g. bio-refineries, "second-generation" biofuels).

The main difference between options 2 and 3 is their approach towards the **supply** of biofuels and their feedstocks. This concerns the question of import tariffs for biofuels and their feedstocks, agricultural policy instruments, financial support for investment in biofuel production plants, and the approach to developing countries.

With regard to these questions, option 2 represents a market-based approach that continues to rely on existing regulatory instruments. Option 3 describes a deregulated approach, mainly based on phasing-out the existing tariffs for biofuels and their feedstocks and phasing-out existing agricultural instruments in favour of biofuels.

The three options considered have the following specific characteristics:

**Option 1 – "Business as usual"**

- Biofuels directive as it stands and implementation by Member States as known until today; targets will not be met.
- no greenhouse gas monitoring, and environmental standards for feedstock production as they stand (cross compliance and agri-environmental programmes)
- no special emphasis on investment aid by Structural or Rural Development funds
- energy crop premium and set-aside as they stand

- no progress in WTO negotiations and no bilateral trade concessions
- limited and ad hoc support measures to developing countries concerning biofuels; current market access conditions will be maintained
- no specific new RTD actions

**Option 2 – "Regulated market-based approach"**

- Take a balanced approach in trade negotiations as regards the needs of domestic producers and consumers and of EU trading partners (e.g. EU agricultural position tabled for the Doha Development Round), assess the possibility of separate nomenclature codes for biofuels, open biodiesel standard for (imported) vegetable oils
- Encourage use of energy crop premium, sugar beet made eligible for energy crop premium and set-aside payments
- Bring forward a Forestry Action Plan, review animal by-products legislation, waste framework regulation
- Encouragement of investment aid for biofuel projects by Structural and Rural Development funds, address industries concerning technical obstacles
- Develop coherent biofuels assistance package for developing countries, maintain favourable market access, facilitate biofuels platforms and regional action plans
- Address industries concerning technical obstacles to biofuel uptake on the market
- Encourage Member States to favour second-generation biofuels, e.g. by stimulating technical progress in biofuel production
- Encourage the Council and the European Parliament to give speedy approval to its recently adopted legislative proposal promoting public procurement of clean vehicles

**Option 3 – "Deregulated market-based approach"**

- Phase out tariff duties on biofuels and biofuel feedstocks by 2010 at the latest
- Phase out energy crop premium by 2010 , consider phasing-out set-aside obligations by 2010
- No special emphasis on investment aid for biofuel projects by Structural or Rural Development funds
- Time-limited and ad hoc support measures to developing countries concerning biofuels

## 5. ANALYSIS OF IMPACTS

### 5.1. General methodology

The proposed options, as outlined in chapter 4, should be seen as complete packages of measures. The evaluation of option 1 was carried out through a study[13] supported under the Altener programme. The option 2 and option 3 scenarios model the future development in the biofuels sector in the EU-25 based upon the assumption of achieving the 2010 targets in the EU-25. For the assessment presented here, the detailed information on biofuels has been extracted from the impact assessment for the Biomass Action Plan. The quantitative information presented here therefore corresponds to the information given in the BAP.

All scenarios presented model the reality in an abstract way. The Impact Assessment aims at identifying some global quantitative and qualitative impacts for the totality of biofuels to be brought on stream throughout the EU-25 Member States by 2010. That is why a detailed break-down into certain biofuel feedstocks, supply chains, and/or conversion technologies has not been carried out. Regional differences as regards biofuel types and availability as well as climatic conditions amongst the EU-25 Member States have not been treated separately either, although they may be crucial when analysing the environmental impact.

Additional liquid biofuel use is modelled as a mixture of biodiesel (56%) and bioethanol (44%) in accordance with the current ratio of diesel and petrol consumption in the EU-25. These assumptions may contribute to conservative cost calculations, as comparatively costly options (e.g. bioethanol) are considered with substantial shares in biomass growth.

The level of future global energy prices has a great influence on the results of the Impact Assessment. Prices have increased substantially since 2000. It must be pointed out that any future decrease or increase in oil prices will have a significant impact on the competitiveness of biofuels. Since estimating future trends in global energy prices will always be subject to high uncertainty, the Impact Assessment differentiated between two economic environments in 2010:

- a low global energy price environment with oil prices around €28/barrel. These prices correspond to the average level of the past ten years.

- a high global energy price environment with oil prices around €60/barrel. These prices correspond to current peak price levels.

Considering the general uncertainties around these model assumptions and the very limited outlook of the Impact Assessment (2002–2010), all data are assumed to be for the same reference year. This means that there is no differentiation between costs based on 2002, 2005 or 2010 price levels. Similarly there is no gradual change assumed for specific emissions and external costs between 2002 and 2010.

All data should be understood as indicative but robust in their order of magnitude. They cannot be used to assess the impacts of individual installations, as specific local conditions may yield totally different results.

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[13] Ragwitz, M.; Schleich, J.; Huber, C.; Resch,G.; Faber, Th.; Voogt, M.; Coenraads, R.; Bodo, P. :"Analyses of the EU renewable energy sources evolution up to 2020" – FORRES 2020. Karlsruhe (Germany) April 2005

*5.1.1. Enlargement*

Bulgaria and Romania signed Accession Treaties on 25 April 2005 and will join the EU on 1 January 2007 or 2008. The accession of these countries could have an important impact on the implementation of the EU's biofuel policy Although it is not easy to identify the exact quantitative effects as no detailed biomass data are available for Bulgaria and Romania, it is apparent that both have substantial unused biomass resources.

In 2003, the total energy consumption of transport in Romania and Bulgaria was 4.3 mtoe and 2.3 mtoe respectively.

*5.1.2. Identification of most important impacts*

The following seven major impacts have been selected for consideration in this assessment:

- environmental impact: greenhouse gas emissions, feedstock cultivation, and through the use of biofuels
- impact on fuel supply: substitution of fossil fuel, diversification of sources, possible impact on the oil price
- impact on agricultural markets and land use
- direct and indirect impact on employment
- competitiveness, innovation and impact on other industries
- international effects
- cost of the policy options.

## 5.2 Environmental impact

There are environmental implications for all three options. Extending the use of biofuels can both reduce net greenhouse gas emissions and help to meet EU renewable energy targets. The cultivation of energy crops can also impact on biodiversity, soil and water resources. The positive and negative effects of biofuels on exhaust emissions must be carefully monitored.

*5.2.1. Impact on climate change*

The principal environmental benefit of biofuels, as compared with fossil fuels, is the reduction of greenhouse gas emissions through the "recycling" of carbon dioxide that is created when biofuels are consumed. While industry, buildings, electricity generators and agriculture are stabilising or cutting their emissions, the growth in emissions from transport is eating up many of the gains. The EU-15 Member States are committed to a combined 8% reduction of greenhouse gas emissions by 2008–12 under the Kyoto Protocol and most new Member States have individual targets. Biofuels can help these goals to be reached.

Life-cycle analyses consistently show that, compared with fossil fuels, the use of biofuels results in net reductions of carbon emissions. However, biofuels are not carbon neutral, since their production leads to greenhouse gas emissions, in particular from the cultivation of crops, the manufacture of fertilisers, fuel processing and distribution. The extent of carbon reduction and other environmental effects therefore varies widely according to the feedstock employed, the way the feedstock and the biofuels are produced, how they are transported and how far.

Most available studies indicate that the abatement costs of EU-produced biofuels are quite high compared with the current "carbon price". This means that EU-manufactured biofuels are currently not the most cost-effective way to reduce greenhouse gas emissions. The marginal abatement cost (carbon price) in the EU emissions trading scheme is about €20 per tonne of $CO_2$ avoided, while new biofuel technologies (second generation biofuels) are expected to have marginal abatement costs of between €40 and €100 per tonne of $CO_2$ avoided[14].

All relevant greenhouse gases such as $CO_2$, $CH_4$, $N_2O$ must be considered on the basis of the complete life-cycle and weighted according to their relative greenhouse potential. Results are expressed in $CO_2$-equivalent emissions.

According to common life cycle analysis practice, direct $CO_2$ emissions from biofuel combustion are not considered as relevant for climate change (due to the virtually closed carbon cycle of recent biomass growth and combustion). These $CO_2$ emissions are therefore not counted in the total greenhouse gas balance. All other greenhouse gas emissions in the life cycle of the biofuel system must be taken into account.

There are substantial divergences as to the method to be used for calculating the level of greenhouse gas savings from biofuels. A literature survey revealed the following total greenhouse gas (GHG) emissions for different fuel supply systems (table 5.2.1).

It seems clear that, under most production scenarios, the net greenhouse gas effect of biofuels is positive (only 3 of the 45 observations reported are negative). With ranges of uncertainty for all three fuel chains averaging 30–40 percentage points, nothing definitive can be said about the average amount of greenhouse gas savings, or about the ranking of the three fuels.

Some reasons can be given for the high degree of variation:

- most studies assume that some fossil energy is used to turn crops into biofuel. It is possible to power the process using other parts of the crop (as in Brazil) or some of the biofuel itself. This would improve the greenhouse gas balance but could increase the cost.
- as well as biofuel, by-products are produced, such as glycerine (from biodiesel production), lignin (from bioethanol production) and animal feed (from both processes). Studies differ in the way they attribute the greenhouse gases from the production process between the biofuel and the by-products. This substantially affects the results.
- $NO_2$ emissions are treated differently.

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14 RWI (2005): Questioning the Sustainability of Biodiesel, p. 21.

**Table 5.2.1: Reduction of greenhouse gas (GHG) emissions for biofuels from different European feedstocks as compared with fossil fuel emissions**

| source | bioethanol from sugar crops | bioethanol from grain | biodiesel from rape |
|---|---|---|---|
| VIEWLS – today[15] | 20–73% | minus 21% to plus 32% | 18–64% |
| VIEWLS – for 2010[16] | 35–72% | 16–64% | 7–74% |
| Sheffield Hallam[17] | 47–54% | 62–67% | 51–55% |
| Imperial College[18] | minus 11% to plus 63% | 5–68% | 48–80% |
| Concawe/Eucar/JRC[19] | 37–44% | minus 6% to plus 43% | 16–62% |
| PWC[20] | 40–60% | 40–70% | 50–70% |
| IEA[21] | 34–55% | 18–46% | 43–63% |
| ADEME[22] | 75% | 75% | 74% |

As already indicated in the Biomass Action Plan, greenhouse gas savings per unit of biomass are currently higher when using biomass in heat or electricity generation than in the transport sector. The relatively highest GHG savings are realised when biomass is used for electricity generation at high efficiencies e.g. in co-firing or combined heat and power installations and substituting primarily coal. New biofuel technologies currently under development should, however, help to increase the greenhouse gas benefits.

Some greenhouse gas savings would be achieved by **option 1** (business as usual), since some Member States have implemented biofuel support schemes. However, without greenhouse gas monitoring the precise quantities are extremely difficult to assess, since the actual saving depends on the production and processing method and can even be site-specific.

**Option 2** (regulated market based approach) assumes that biofuel use would increase in order to meet the indicative target in 2010. Greenhouse gas savings can be expected to triple compared with option 1. Although large differences between production and processing chains will continue to exist, a greenhouse gas monitoring system will help to identify and calculate the precise effects. If permanent grassland was ploughed up to produce biofuels, between 0.15

15 VIEWLS (2005): Environmental and Economic Performance of Biofuels.

16 VIEWLS (2005): Environmental and Economic Performance of Biofuels.

17 Sheffield Hallam University (aggregation of various work by Nigel Mortimer).

18 Imperial College, London (aggregation of various work by Ausilio Bauen/David Hart).

19 Concawe, Eucar, JRC Ispra: Well-to-Wheel analysis of future automotive fuels and power trains in the European context. 2005. http://ies.jrc.cec.eu.int/WTW.

20 Price Waterhouse Cooper (2005): Biofuels and other renewable fuels for transport. A study commissioned by the Federal Public Service of Public Health Food Chain Safety and Environment, Brussels, Belgium.

21 IEA (2004): Biofuels for Transport. An International Perspective.

22 ADEME/PWC/DIREME (2002): Bilans énergétiques et gaz de serre des filières de production de biocarburants. Rapport technique, version definitive, Novembre 2002.

and 1.75 t $CO_2$ per ha would be lost in the conversion from grassland to cropland[23]. However, new CAP cross compliance rules *de facto* exclude this possibility.

**Option 3** (deregulated market based approach) also assumes that the 2010 indicative target is met. Under this option large quantities of bioethanol would be imported due to their lower cost compared with current EU production. The use of bioethanol produced from sugar cane would give greater greenhouse gas savings. Brazilian production based on sugar cane reduces GHG emissions to 440 $kg_{CO2\text{-}eq}$/toe compared with petrol emissions of about 4 400 $kg_{CO2\text{-}eq}$/toe. However, additional production using for example virgin savannah could cancel out the GHG benefits for decades. Bioethanol produced from sugar cane in developing countries may be less GHG efficient than in Brazil, but without a monitoring system in place, this would be impossible to ascertain. Similar considerations apply to biodiesel, in particular produced from palm oil originating in South-East Asia and from soya grown in South America. Like option 2, this option provides for environmental monitoring, and the prospect of using flexible mechanisms such as the Kyoto Protocol's Clean Development mechanism could help minimise the potential negative effects.

### *5.2.2. Environmental Impact of feedstock cultivation*

To analyse the environmental impact of energy crops cultivation, the life-cycle approach needs to be complemented by a farming system approach, aiming to take account of possible changes in cropping patterns (e.g. rotation systems) and input use at the level of the whole farm, as well as of the effects of these changes on the overall ability of the farms concerned to provide environmental services. At the moment, however, no studies based on this type of approach are available.

Increases in input use per hectare and changes in land use, in particular the use of set-aside land, could have a negative environmental impact. Managing these risks, limiting any negative impacts and realising the possible advantages for the environment will be important for the overall acceptance of biofuels produced from energy crops[24]. Growing energy crops may on the other hand have environmental benefits, when fertiliser input is reduced to improve the starch content of cereals or when crop rotation systems are improved. The cultivation of energy crops may also contribute to the viability of farms that, with their land management practices and production methods, help to protect the environment (e.g. conservation of high nature-value farmed environments under threat, prevention of floods and landslides) and to maintain the countryside.

Apart from energy crops, a wide range of different feedstocks can be used to produce biofuels. These include wastes and residues and will in future include forest materials. Other, purpose-grown, sources should be rapidly developed in a sustainable and economical way. It should be noted that, if unused, forest residues are recycled naturally in the forest, so do not create a waste "problem", as might other types of residues. The use of wastes and residues for biofuels offers an environmental bonus compared with other means of disposal.

The main environmental impact from the cultivation of energy crops for biofuels relate to:

- Areas brought into production

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23 Estimates derived from an elaboration of the figures contained in Table 5-10 on p. 5.46 of the Reference Manual of the Revised IPCC Guidelines for National Greenhouse Gas Inventories (http://www.ipcc-nggip.iges.or.jp/public/gl/invs1.htm).

24 The options to achieve this will be discussed in the appropriate context.

- biodiversity could suffer from the loss of habitats provided by set
- aside, which has come to play an important environmental role in many areas.
- loss of biodiversity if land in NATURA 2000 areas, in areas characterised as High Nature Value, or permanent grassland is used to produce energy crops. However, EU cross compliance standards under the 2003 CAP reform *de facto* exclude the possibility of converting permanent grassland into land for other agricultural use. Moreover, as agricultural production in NATURA 2000 areas is regulated by public authorities, its use for energy crops can be limited.
- soil quality could suffer, particularly if land which has been under grass or set
- aside and is susceptible to erosion is used.

• Change in crops cultivated for biofuels

- water quantity, with potential impacts on biodiversity, salinisation, etc. This could be particularly true of fast
- growing species which need large amounts of water, e.g. short
- rotation coppice.
- the introduction of energy crops can allow a move away from monoculture or the improvement of rotation systems with, for example, a possible shift of land under sugar beet to land for cereals production (reduced danger of erosion, less input of chemicals).

• Change in use of chemical inputs

- soil and water quality and biodiversity are all affected by the use of chemical inputs. The general use of chemicals could go up on the overall crop area if the increased demand for agicultural biomass cannot be met otherwise, in particular in the short to medium term.
- cereals grown specifically for energy content may use less fertiliser and pesticides[25] than those grown for food or feed.

• Avoiding agricultural land abandonment

- in certain regions energy crops can contribute to maintaining agricultural land in production, which may help prevent floods and landslides, or the conservation of important semi
- natural habitats.

Preliminary results of an EEA study suggest "that there is sufficient biomass potential in the EU-25 to support ambitious renewable energy targets in an environmentally responsible way"[26]. The EEA study draws attention in particular to the need to protect sensitive areas and

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[25] HGCA (2005): Environmental impact of cereals and oilseed rape for food and biofuels in the UK.

[26] European Environment Agency, Briefing 2/2005 "How much biomass can Europe use without harming the environment".

maintain a minimum amount of set-aside for biodiversity goals. It does not itself look at the local environmental effects of cropping practices, but points to the importance of safeguards in this area so as to ensure that the net environmental balance is positive.

Some of these environmental pressures are similar to those exerted by current cropping practices on non-biofuels, but may be exacerbated if biofuel production expands. Potential for the most negative additional environmental impact concerns the possible additional use of 3 mio ha of set-aside land, the use of water (in cases where the biofuel/biomass crops chosen require significant water inputs); and the use of pesticides to the extent that farmers may take less care to keep use to a strict minimum if residue testing is not carried out, as it is for food crops.

The challenge is to avoid the risk that the environmental gains produced through $CO_2$ savings are outweighed by negative environmental impacts at the more local level. Public acceptance of a biofuels policy is less likely if it is perceived as adding to environmental pressures, rather than reducing them.

The information presented above leads to the conclusion that the choice of biofuel crops and the intensity and management practices under which they are grown will influence their potential impact on soil, water and biodiversity in particular. This helps in assessing the different options from an environmental point of view.

**Option 1** (business as usual) can be assumed to have no significant additional environmental impact as there is only a limited increase in energy crops.

**Option 2** and option 3 both propose a monitoring scheme for environmental standards. Taking measures in relation to energy crops and to where they can be grown, as proposed under these options, seems to be the best way to meet the environmental challenges.

**Option 3**, which would result in higher imports and lower domestic production, could reduce greenhouse gas emissions at a lower cost than option 2. However, growing demand for biofuel feedstocks is likely to seriously increase environmental pressures in some producer countries outside the EU. Specific examples are large scale expansion of sugar cane (Brazilian savannah), palm oil (South East Asian rainforest) and soya (Brazilian rainforest). Increasing demand for palm oil (currently in particular for food production) is already contributing to the clearance of large tracts of rainforest in Malaysia and Indonesia. Although this option assumes monitoring schemes will be put in place, they might be more difficult to implement in non-EU countries than in the EU.

#### *5.2.3. Environmental Impact of using biofuels*

In the case of all three options, the environmental effects of biofuels in use have to be monitored. Due to high vehicle emission standards in the EU, the impact of currently available biofuels on exhaust emissions is regarded as rather small. But they should contain few impurities and, because of their oxygen content, are expected to lead to more complete combustion and lower pollutant emissions. This can be particularly important in countries with lower emission standards than the EU.

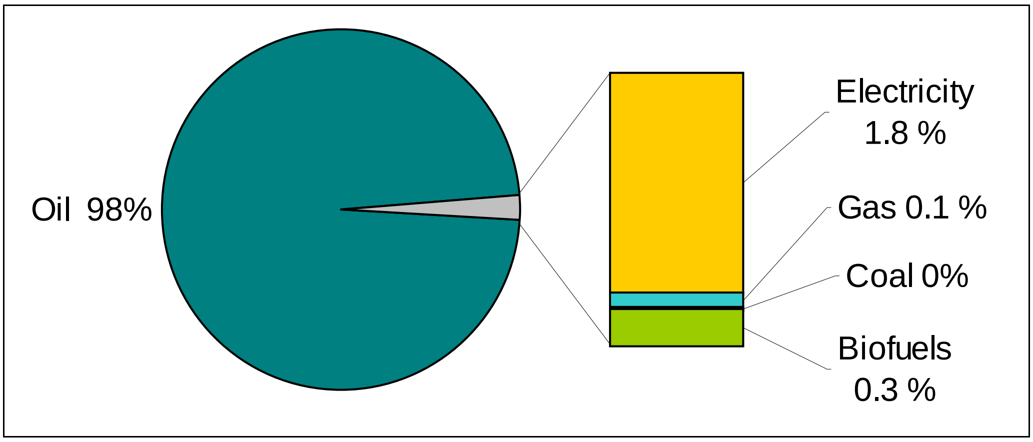
Under EU conditions, ethanol appears to consistently reduce particulate matter (PM) emissions but for other regulated pollutants results are less consistent. If the EU Fuel Quality Directive did not set limits on vapour pressure, a specific difficulty would relate to volatile organic compounds (VOC) from ethanol blends, while a specific benefit would result from the low vapour pressure of ETBE. The Commission is currently examining the impact of increasing the limit for VOC emissions.

For biodiesel, carbon monoxide emissions are reduced but for particulate matter, nitrogen oxides and hydrocarbons results are less consistent, with either positive, negative or negligible effects recorded. Synthetic diesel is expected to lead to lower pollutant emissions because of its good characteristics and the fact that it does not contain sulphur or aromatics.

### 5.3. Impact on fuel supply

In the EU transport sector fossil oil is the main energy source with a 98% contribution to all transport fuels. In 2002 alternative motor fuels contributed 2% and biofuels only 0.3%[27]. However, during the last years the contribution of biofuels has increased due to the implementation of the biofuels directive in several Member States.

**Figure 5.3: Energy sources for the EU transport sector 2002**




Because of its almost complete dependency on fossil oil, transport accounts for more than half the fossil oil used in the EU and this share is increasing. Growing demand in the transport sector is the main reason for the growth in overall EU oil consumption.

During the last five years the dollar price of oil has tripled. Although exchange rate movements cushioned the effect, Europe has still seen oil prices more than double[28].

Over the next twenty to thirty years EU fossil oil production is expected to decline, while transport demand is likely to continue to grow. World oil demand is also expected to show strong growth. The global distribution of known fossil oil reserves will leave the Middle East OPEC members as the main suppliers for this increased demand, although the accelerated exploitation of Canadian and Venezuelan tar sands could provide up to 3% of world fossil oil production by 2010[29].

Apart from fossil based LPG (liquid petroleum gas) and CNG (compressed natural gas), liquid biofuels are currently one of the few possible substitutes for fossil oil based transport fuel. They can easily be put on the market now and provide immediate greenhouse gas reductions. In contrast to fossil oil reserves, which are concentrated in a relatively small number of

27 Currently, 80% of EU biofuel consumption in the transport sector is biodiesel, 20% bioethanol.
28 The euro buys about 40% more dollars now than in 2001.
29 “Alternative Fuels: An Energy Technology Perspective”, IEA/CERT (2005)17.

geographical regions, the raw material for biofuels can be produced nearly anywhere on earth. Thus, increasing the share of biofuels in EU transport fuels could help to broaden the range of EU energy suppliers.

### *5.3.1. Substitution of fossil fuels*

As a basis for this analysis, the impact assessment of the Biomass Action Plan assumed that every 1.0 mtoe biofuel is produced with a fossil primary energy input of 0.66 mtoe on average. It substitutes 1.3 mtoe of crude oil when used as transport fuel. This value (1.3 mtoe) comprises the energy value of the petrol and diesel fuel as well as all losses of crude primary energy in the whole petrol and diesel process chains. However, these averages conceal large variations concerning the different fuels and production technologies. Other studies have used different substitution coefficients[30].

In 2002, liquid biofuels replaced about 0.65 mtoe of crude oil in the transport sector. Taking into account the energy consumption to produce biofuels, the net energy saving can be estimated at 0.45 mtoe in that year.

For imported biofuels it has been assumed that no additional fossil fuels will be consumed inside the EU. For the calculation of the fossil fuel substitution potential it has further been assumed that 30% of the biofuels will be imported under options 1 and 2 and that the import share will be 85% under option 3. Based on these assumptions the following indicative fossil fuel energy can be substituted in the year 2010 (Table 5.3.1):

**Table 5.3.1: Fossil fuel substitution potential for 2010**

| mtoe/year | Situation 2002 | Option 1 | Option 2 | Option 3 |
|---|---|---|---|---|
| Liquid biofuels | 0.5 | 6.5 | 18.6 | 18.6 |
| **Direct substitution of crude oil in mtoe/year** | | | | |
| Crude oil substitution | 0.65 | 8.45 | 24.2 | 24.2 |
| Change compared to 2002 | | 7.8 | 23.5 | 23.5 |
| **Fossil primary energy input for biofuels production in mtoe/year** | | | | |
| Energy input | – 0.2 | – 3.0 | – 8.6 | – 1.9 |
| Change compared to 2002 | | – 2.8 | – 8.4 | – 1.7 |
| **Fossil energy substitution balance in mtoe/year** | | | | |
| Net fossil energy substitution | 0.45 | 5.45 | 15.65 | 22.3 |
| Change compared to 2002 | | 5.0 | 15.2 | 21.8 |

**Option 1** (business as usual) would save some 7.8 mtoe of crude oil in 2010 compared with 2002. However, the production of biofuels consumes some fossil energy. Thus the net saving of option 1 would be around 5 mtoe compared to 2002.

**Option 2** (regulated market based approach) would allow some 23.5 mtoe of crude oil to be saved compared with 2002. Under this option about 8.4 mtoe per year would be used to

30 e.g. JRC Ispra (op.cit).

produce the biofuels, thus the net energy substitution would be around 15 mtoe in 2010. This equals 2.3% of the EU's crude oil consumption and 3.1% of all crude oil imports into the EU-25 (490 mtoe/yr crude oil imports in 2002[31]).

**Option 3** (deregulated market based approach) relies mainly on imported biofuels, of which Brazilian bioethanol currently has a better energy balance compared with EU produced biofuels. The potential for energy saving is therefore higher than for option 2 – the net substitution is estimated here to be about 22 mtoe or 3.4% of the gross EU consumption of crude oil and 4.5% of all crude oil imports.

With the savings possible under options 2 and 3, and in addition to crude oil savings due to other biomass use for energy as well as savings announced in the energy efficiency green paper, the EU25 would be substantially less dependent on fossil oil. However, option 3 implies the import of large quantities of biofuels while option 2 partially replaces fossil oil by domestic biofuel production.

#### *5.3.2. Impact on the oil price*

It is too soon to judge whether the currently tight oil market is a temporary phenomenon, or whether it might not be the beginning of "the end of oil", as world energy demand continues to grow and supplies of fossil oil become increasingly scarce and expensive. The latter scenario, in which oil prices would be high by historical standards, and possibly rising, would reduce the cost of supporting biofuels. Moreover, as an additional source of supply, biofuels could help to reduce the risk of temporary supply disruptions, although the main mechanism for this would remain buffer stocks.

Evidence shows that biofuel prices tend to fluctuate in line with petrol and diesel prices. Biofuels produced from energy crops may add a new source of price volatility by yield variations, although a global market should be able to balance biofuel and feedstock supply. However, in a tight market, some analysts expect that even small increases in fuel supply (i.e. biofuels) would significantly reduce the gap between production capacity and oil demand and would thus have significant beneficial effects on oil prices.

Although the EU biofuel targets for 2010 (options 2 and 3) would represent only some 0.4% of world oil demand (option 1 would represent even less) in a tight fuel market even small increases in fuel supply could have significant beneficial effects on oil prices. However, various countries are planning a rapid expansion of biofuel production. Some studies suggest that a tenfold global increase by 2020 would be feasible, based on sugar cane alone[32].

### 5.4 Impact on agricultural markets

The implications of the different options for cereals, sugar and oilseed markets up to 2010 were assessed by the Commission with the economic model used for commodity projections and policy simulations. In order to analyse the impact of increasing biofuel demand on agricultural markets three illustrative scenarios, which are just a few of the many possible, were constructed. They are not intended as a forecast of the future, but describe what might happen under a specific set of assumptions and circumstances. The three scenarios are based

31 see EUROSTAT (op. cit)
32 "Biofuels for transport. An international perspective", IEA/OECD, Paris, 2004.

on a set of common assumptions regarding macro-economic conditions, the agricultural and trade environment and the developments of international markets[33].

The **option 1** scenario assumes that biofuel production would remain limited to 2004 production capacities. The impact of biofuel demand on feedstock markets would remain marginal with a very limited impact on feedstock prices and land use. The general market outlook for cereals and oilseeds would remain moderately optimistic. This scenario serves as the baseline reference for options 2 and 3.

Options 2 and 3 assume specifically that:

– until 2010 the main biofuel feedstocks would remain cereals, sugarbeet or sugar cane, and oilseeds, as well as vegetable oils. Second generation biofuel feedstocks would only play an increasing role after 2010;

– 56% of the biofuel demand would be biodiesel and 44% bioethanol, consistent with the EU diesel and petrol consumption in 2002;

– biodiesel production would be possible from rapeseed and sunflower seed, as well as from soybean and palm oil.

The two alternative scenarios vary in two sets of assumptions defining the economic environment:

– option 2: additional imports of cereals and bioethanol, as well as oilseeds, vegetable oil and biodiesel would be possible under current MFN tariffs;

– option 3: all tariffs on biofuels and biofuel feedstocks would be phased out, set-aside obligations and the energy crop premium would be phased out as well.

Under the assumptions made for production costs, agricultural prices and trade regimes, options 2 and 3 show that the EU has a large potential for biofuel production, with different levels of domestic feedstock use.

The simulation for **Option 2** shows that about half of the projected biofuel demand of the EU-25 in 2010 would be served by domestically grown feedstocks, driven notably by price increases for cereals (6% to 11%) and oilseeds (5% to 15%). The share of domestic feedstock production would be significantly higher for bioethanol than for biodiesel, reflecting the different levels of import tariffs on feedstocks.

Biofuel demand in the EU would be served by increasing feedstock production, a shift in domestic use, lower exports and higher imports of feedstock. The increasing demand for biofuel feedstock would lead to price increases.

- *Increasing production* of feedstocks would be reached by expanding cereal and oilseed production by 4.1 million hectares. This would represent around 4% of the total arable land of the EU25. The additional production of cereals and oilseeds would contribute 21% to the biofuel demand. The use of sugar beet in the most productive regions could contribute an

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[33] For a detailed description of the assumption, a summary of the results of option 1 and reference to the tool see European Commission "Prospects for Agricultural Markets and Incomes 2005-2012", July 2005.

additional 4% to meeting biofuel demand, representing about 250 000 ha. In total 25% of biofuel needs in 2010 could be served by increasing production of EU feedstocks.

- *A shift in domestic demand* due to the increase of feedstock prices, in particular for cereals, would decrease use for animal feed and non-energy industrial purposes in favour of biofuels. This shift would satisfy a further 11% of the EU biofuel demand.

- Favourable domestic market conditions would lead to a *replacement of exports* in favour of domestic biofuel use. This concerns primarily cereals, vegetable oils and, to a very limited extent, also oilseeds. In the option 2 scenario, 17% of domestic biofuel needs could be met in this way.

- The balance between EU consumption and production would be met by *increasing imports*. Under the chosen scenario, the increase would be much lower for bioethanol feedstocks than for biodiesel feedstocks.

- While substantial quantities of high quality animal feed will be produced as by-products, additional imports of animal feed might be needed to replace the domestic feedstocks now destined for processing into biofuels.

Under this option 2 scenario, a total of 8.25 mio hectares will be used for biofuel production in the EU, in addition to the biofuels and feedstock material imported. The additional demand for cereals is likely to save export subsidies and to reduce the need for market intervention, which would reduce budget expenditure.

**Option 3** results in 27% of EU biofuel demand being served domestically, mainly due to increasing oilseed production caused by higher oilseed prices (5% to 12%). With the phasing out of tariffs on biofuels and their feedstocks, cereal prices decline (–15% to –20%) due to the substantial increase in imports. Nevertheless bioethanol produced from cereals and sugarbeet would remain uncompetitive compared with imported bioethanol. All bioethanol used in the EU would be imported.

- *Increasing production* of feedstock would be reached by expanding oilseed production by 2.3 million hectares. This would represent around 2% of the total arable land of the EU25. The additional production of oilseeds would contribute 16% to the biofuel demand. Despite the decline in prices, sugar beet and cereals as feedstock for bioethanol production in the EU would not be competitive as compared to imported bioethanol.

- *A shift in domestic demand* due to the increase of oilseed feedstock prices, in particular rapeseed and rapeseed oil, would dampen the food and other industrial use. This shift would satisfy a further 4% of the EU biofuel demand.

- Favourable domestic market conditions would lead to a *replacement of vegetable oil exports* in favour of domestic biofuel use. This would satisfy approximately 8% of domestic biofuel demand.

- The biofuel balance would be met by *increasing imports*. Under the chosen scenario, imports would satisfy the entire demand for bioethanol in the EU and roughly half of the biodiesel demand.

The policy options chosen for this scenario would cause public intervention stocks of cereals to increase by roughly 18 mio t annually as 2 mio ha of former set aside land would enter cereals production after the abolition of set aside and substantial imports of cereals would substitute domestic production. Under option 3 about 3.5 mio ha would be used for producing feedstocks for biodiesel. Mainly because of the expansion of oilseed production, total land use would increase by 4 mio ha. In summary, option 3 would lead to significant structural imbalances on the cereals market, with negative effects on farm income and farm employment.

Although cereals, sugar and oil crops will continue to be important biomass resources, the use of lignocellulosic biomass is expected to become essential in the longer term. Ligno-cellulosic materials include feedstocks such as short rotation coppice, wood and forest residues, straw and other agricultural residues. These feedstocks will significantly contribute to the supply of biomass available for conversion and will help to reduce costs. First pilot or demonstration-scale facilities have been established recently, but much more work is needed to assess technical and economic viability.

## 5.5. Employment Effects

In principle, biofuels can have a positive economic impact, locally and regionally, in developed and, probably even more, in developing countries. Employment opportunities are mainly linked to biofuel processing and the provision of agricultural and forestry feedstocks. This is particularly important for rural areas, where other options may be limited. However, since biofuels are still more expensive than fossil fuels, additional cost or public spending might have an impact on the overall economy. When estimating the net employment effects of the different options a distinction will be made between direct employment effects and indirect ones which are triggered, for example, by changes in the productivity of the economy, redistribution of income and the export potential of new technologies.

### *5.5.1. Direct employment effects*

Direct employment relates to feedstock production, processing and logistics, as well as biofuel processing. These jobs are mainly in rural areas. When deciding where to locate a new biofuel plant, transport costs will be a decisive factor. These will be lower if the plant is close to feedstock supplies, markets for by-products (e.g. cattle feed markets) and, if possible, near to existing storage and grain procurement infrastructure, all of which implies in or close to rural areas. Plants have also been set up close to import facilities, often alongside oil refineries. Most jobs in the biofuels industry are therefore likely to be either in rural areas or at existing refinery sites. The number of jobs created directly by biofuel production will very much depend on the size of the plant; smaller plants have higher labour input per tonne of biofuel than larger plants, which can be expected to be more efficient.

For the Biomass Action Plan the direct employment effects were calculated by applying a factor of 8 100 full time jobs for the production of 1 mtoe biofuels (without considering imports). This document also concluded that, relatively, the highest direct employment effects are realised when biomass is used for biofuel production and the lowest effect is realised when biomass is used for heat generation.

As the use of biomass for biofuels offers new markets for agricultural and forestry products and residues, there could also be an impact on employment in these sectors. In the EU, agricultural jobs associated with biofuels will quite likely not be new jobs, but the effect could rather be to mitigate the trend of declining agricultural employment. The labour input is generally higher when biofuel production is based on annual energy crops (for the EU mainly cereals, sugar beet, oilseeds) rather than on perennial crops (e.g. short rotation coppice). A study based on UK conditions expects that 2–5 farming jobs could be sustained or created for each 1000 tonnes of biofuels produced[34].

Under the assumptions made for the Biomass Action Plan, **option 1** would result in direct employment effects of 34 000 full time jobs per year for the EU-25 in 2010.

Studies[35] [36] [37] for Europe indicate that in 2010 the direct employment effects of a scenario corresponding to **option 2** could be more than 100 000 jobs[38] in the EU. This means that the regulated market approach has the potential to create an additional 67 000 jobs (direct employment) for the EU-25 in 2010, as compared with option 1. Most of these additional jobs would be created in rural regions.

However, different studies give widely different figures[39] and new jobs in the biofuel sector might replace traditional fossil fuel employment although only on a small scale because, unlike biofuels, fossil fuels create little employment in Europe. One recent study[40] estimates that conventional diesel and petrol require 5 and 6 jobs per billion passenger-km respectively. Comparable figures for biodiesel from vegetable oil are 186 – 623 and for bioethanol from wheat 161 – 371, with the higher figures representing organic cultivation.

On the other hand, a different "bottom-up" methodology has been applied to assess the direct employment effects in the agricultural sector and in processing and blending of biofuels, explicitly taking into account limits in available additional arable land and direct crowding-out effects and arrives at estimates of up to 22 000 full time jobs[41]. Some analysts further argue that the option of eliminating the set-aside obligation under **option 3** would have a similar positive effect on employment in agriculture as option 2, because potential additional employment is linked to an expanded land use and in both cases the area currently set-aside would be reused. However, such a scenario with a lifted set-aside obligation and perhaps a further lowered price support might accelerate structural change,

The results on agricultural markets (section 5.4) suggest that option 2 is clearly more positive for agricultural employment than option 3. Structural imbalances on the cereals market, due to the phasing-out of tariffs on biofuels and their feedstocks under option 3, would result in a sharp decline in agricultural income and employment.

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34 "The Impacts of Creating a Domestic UK Bioethanol Industry," report by ADAS Consulting Ltd, ECOFYS UK Ltd and ECOFYS bv.

35 European Renewable Energy Council: Renewable Energy in Europe.

36 Price Waterhouse Coopers (PWC): Evaluation of the externalities and economic, social and environmental effects of the biodiesel production chain in France. Paris 2003.

37 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit.).

38 This figure assumes that 70-90% of the biofuels are produced in the EU. "Impact Assessment of the Communicaton on a Biomass Action Plan", p. 36. The analysis provided in section 5.4 estimates that half of the feedstocks for the total EU biofuel consumption would be domestically produced and the other half would be imported.

39 In terms of direct employment, biofuels are typically 50-100 times as employment intensive in the EU as fossil fuel alternatives according to U. Fritsche "Bioenergy 2030: a vision for Germany (and the EU)". Öko-Institut, presentation to international biomass conference 2005.

40 U. Fritsche, op. cit.

41 This estimate is based on data from: "Datensammlung Betriebsplanung 2004/05", KTBL (Kuratorium für Technik und Bauwesen in der Landwirtschaft); "The impacts of creating a domestic bioethanol industry", East of England development Authority; "Best case studies on biodiesel plants in Europe", Austrian Biofuels Institute; "Ethanol production costs: a worldwide survey", F.O. Lichts; "Homegrown for the Homeland", US Renewable Fuels Association.

Option 3 would have similar direct employment effects for the EU as option 1, outside the agricultural sector. Since most biofuels, namely bioethanol, are imported with this option, the creation of direct employment in the bioethanol production chain will be mainly outside the EU. In a static model, some analysts have calculated that the withdrawal of the set-aside obligation might have a similar positive effect on employment as the scenario set out under option 2. However, this model does not take into account the effects on agricultural markets and prices if obligatory set-aside was abolished (see chapter 5.4). Other modelling results tend to indicate that agricultural labour efficiency would have to improve in order to cope with the decline of cereal prices, though the increase in oilseed prices should offset some of the negative effects.

A study estimates that if the EU target for renewable energy in the European Union is met in 2010 there will be a growth in net employment in the biofuels sector of 424 000 jobs[42].

### *5.5.2. Indirect employment effects*

Associated with high economic costs, an increased biofuel use could indirectly have a negative impact on the overall economic and employment situation, due to the higher cost of transport fuels for society. The calculations are complex however. From the standpoint of sustainable development and global approaches to integrating the external costs of fossil fuel use, a strategic approach to developing biofuels might be more favourable for job creation in the long run, than to relying almost completely on fossil fuels. New job opportunities could also arise from technology export.

When estimating indirect or “second-round” employment effects two approaches are frequently used:

- a partial analysis that often suffers from the major shortcoming that it neglects that a policy has to be financed and that the money spent could have been spent on other measures;
- a macroeconomic analysis that avoids these shortcomings but may suffer from a lack of disaggregation and works with simplified assumptions, e.g. that a regulated sector functions like the average economy.

(1) The first group of studies takes into account positive indirect employment effects such as jobs created as a result of expenditure related to biofuel use (technology purchase, diesel consumption during transport etc.). They often rate indirect effects at similar orders of magnitude as the direct effects[43] [44]. However, these models do not consider alternative policies, e.g. to save energy, which could also have positive employment effects.

Other employment effects may be caused by increased purchasing power. Studies available concerning renewable resources have rated these induced job effects at up to 30% of direct and indirect employment effects[45]. However, these studies ignore the source of the increased purchasing power, which may come from reduced purchasing power in other parts of the economy.

42 European Renewable Energy Council (op. cit.).
43 Institute for Applied Ecology: Bioenergy – New Growth for Germany.
44 European Renewable Energy Council: Renewable Energy in Europe.
45 European Renewable Energy Council: Renewable Energy in Europe.

Positive employment effects caused by future exports of biofuel technologies and services are often referred to. Ambitious biofuels targets for the EU-25 would cause fundamental investments in new technologies. This would give the related European industries the possibility of gaining more and earlier expertise in new bioenergy technologies than their global competitors. This could well pay off for Europe in the medium to long term. The effect could be less relevant for first generation technologies, but could become increasingly important as second generation technologies come on stream.

(2) A macroeconomic approach allows the interdependencies of different economic sectors and activities to be shown. Thus, the consequences for employment of higher fuel prices can be modelled. Depending on the money available some households may cut their expenditure in other areas or save less. This may in turn have a negative effect on employment both inside and outside the EU-25 (e.g. through the reduced consumption of imported electronic consumer articles).

The quantification of all these indirect effects for the EU-25 is a highly complicated issue and commentators are substantially divided on the extent of the potential indirect employment effect. Some point to the multiplier opportunities which could double the size of the direct effect. Others argue that jobs in the biofuel sector will replace other jobs, and the net employment effect will be zero. Against this background, the QUEST model was used to run a first simulation of option 2. The results pointed to a range of net employment effects between minus 40 000 to plus 15 000 jobs, depending on how wages and unemployment payments (the reservation wage) react to higher energy prices.

Option 3 could be expected to show a smaller impact due to the mitigating effects of less expensive imported biofuels. This preliminary assessment does not take into account the expected significant loss of employment in agriculture, as compared with options 1 and 2.

### 5.6 Competitiveness, innovation and impact on other industries

Compared with petrol and diesel based on fossil fuels, bioethanol and biodiesel produced in Europe are more costly, even at today’s oil price levels. It has been estimated that bioethanol produced under current conditions in Europe would only become competitive with oil prices of about €90 per barrel, while biodiesel would break even at oil prices of about €60 per barrel. These estimates are on the basis of current feedstock and by-product prices.

The QUEST simulation referred to in section 5.5.2 above provides an estimate of the aggregate effects on economic activity. At current oil prices (that is, close to the “high oil price” variants above), these simulations estimate that option 2 would give rise to a long-run fall in GDP of slightly over 0.1%, equivalent to about €12.5 billion in today’s prices. Declines of a similar size in private consumption and real wages are also projected. Adverse impacts of the option 3 scenario would be about one-third of these amounts.

To achieve a substantial reduction in biofuel production costs in the EU, research and technological development is crucial on two main fronts: optimised production of raw material and development of advanced conversion technologies. In parallel, long-term market based policy mechanisms could help achieve economies of scale and stimulate investment in “second generation” technologies which could be more cost effective.

In the longer term, bio-refineries have the potential to improve the cost competitiveness of biofuels by producing an optimum combination of fuels, products, and industrial heat and power, from each biomass feedstock. Their development requires a high degree of innovation and investment and is expected to boost rural economies and to contribute to industrial growth.

Encouraging the use of currently available biofuels could be a useful intermediate step to prepare the EU economy for other, more efficient alternatives in the transport sector which are not yet mature. For example, one major ethanol producer (Abengoa) is constructing a pilot plant for the production of second-generation ethanol on the same site as an existing first-generation plant. The advantage is that the converted sugars from the cellulosic raw materials share much of the processing plant with those from the traditional raw materials. Investments in production and feedstock provision must therefore take into account that new technologies are emerging. A forward-looking biofuel strategy should pave the way for further innovation, supported by research activities, and move towards a sustainable and innovative transport policy.

With the aim of developing a common European vision on biofuels research, the Biofuels Research Advisory Council (BIOFRAC) was established in mid-2005. It brings together representatives of the major European biofuels stakeholders, including the agricultural and forestry sectors, food industry, biofuels industry, oil companies and fuel distributors, car manufacturers and research institutes. BIOFRAC's work is the preparatory step to the launching of the European Biofuel Technology Platform.

The European Biofuels Technology Platform is expected to develop and implement a Strategic Research Agenda towards a common European vision for biofuels, addressing co-operation between EU and national programmes as well as international collaboration. Biofuel related activities also feature in other technology platforms such as "White Biotechnology" "Plants for the future", "Forest-based Sector" and "Road Transport".

The development of options 2 and 3 could have an impact on a number of industrial sectors, as described in the following section.

*Oil industry*: Shifting fuel supply to biofuels would entail the crowding out of the processing and distribution of petrol and diesel, estimated at about 18 mtoe. This could result in a lowering of oil company profit margins and have a potential impact on employment.

*The automotive industry* also has a clear interest in competitiveness and innovation. The CARS21 High Level Group carried out an analysis of a range of alternative fuels that could contribute to reducing $CO_2$ emissions from the road transport sector. It was concluded that by the year 2010, $CO_2$ avoidance could be in the range of 20–30 Mt/year provided that current indicative Community targets are met.

The Group's conclusions support the increased use of biofuels in the EU and identify second generation biofuels as being particularly promising. The Group recommends that their development should be given substantial support. Their report also concludes that further policy developments should take into account and reflect the differing climate change benefits of different biofuel technologies and production processes.

The automotive industry has indicated that blending up to 10% of biofuels with conventional diesel and petrol could be discussed without major problems in terms of vehicle technology, although discussions should also include component suppliers regarding warranties. For blends above 10% it is important that potential effects on existing and future vehicles are carefully assessed.

*Food industry*: Increased demand for agricultural raw materials which are also used in the food industry might result in increased competition and increased prices for these commodities. This could affect the competitiveness of some sub-sectors of the food industry, such as the spirits or oil consuming industry (e.g. mayonnaise, mustard, sauces, margarine production). With increased demand for biodiesel use, rapeseed prices are now quite high compared with recent years. Climatic and agronomic conditions limit the possible increase in rapeseed production in the EU. This might have an effect on feedstock prices (see section 5.4) and prices for processed food products.

*Chemical industry*: Ethanol can be produced either from an agricultural origin (i.e. fermented) or synthetically from petroleum but the end-product is exactly the same. Synthetic alcohol is an important chemical product which can be used directly as a solvent but is also an intermediate in chemical manufacturing. Its production accounts for approximately 25% of total ethanol production in the EU, i.e. 600 million litres per year.

There are three main markets for ethanol: for use in drinks, the fuel market and the market for industrial uses (cosmetics, detergents, inks, household cleaners, etc.). In Europe, synthetic ethanol can only be used for industrial purposes. It is excluded from the potable market and it makes economically no sense to produce fuel ethanol from oil since petrol can be directly produced instead.

There is a risk that bioethanol benefiting from tax relief and destined for the fuel market could end up on the market for industrial uses where it will directly compete with unsubsidised synthetic alcohol. This risk of fraud could increase in the future with increased use of bioethanol in the fuel sector. Additional controls in the synthetic ethanol user industries might therefore be needed to avoid distortive effects for the producers of synthetic ethanol.

*Forest-based industry*: With second generation biofuels, a sharp increase in the use of wood could have a strong impact on the competitiveness of forest-based industries. If wood prices should rise to levels which make the sector’s production within the Community significantly more costly and possibly unprofitable, investments might be diverted to third countries. Already today, with negligible use of forest material for biofuel production, leading EU pulp and paper producers are allocating large investment resources to South America and Asia.

The Biomass Action Plan correctly states that EU forests are expanding, and that about 35% of their wood production is going uncut[46]. However, this figure takes no account of national and regional variations, which are considerable. For instance, only four Member States (Finland, France, Germany and Sweden) account for about half of the total EU forest growing stock (standing volume of wood). In addition, the resources in Finland and Sweden are already used to a very high degree; Finland is now importing 25% of its usage of wood and Sweden 10%, mainly from Russia.

## 5.7 International effects

Increased use of biofuels in the EU will be accompanied by an increased external demand for biofuels and their feedstocks, which is likely to have various effects on developing countries. The different economic, social and environmental effects, their scale and whether they can be

[46] Most of the uncut wood is not cut because: (a) it is environmentally sustainable and desirable to leave it uncut, and/or (b) it is too expensive to harvest (being too remote or dispersed) and transport over large distances and/or (c) it is of inappropriate tree species, quality and/or dimensions.

counted as positive or negative, will depend on the local situation, and requires case-specific investigations that go beyond the scope of this impact assessment. For this reason only a qualitative analysis is provided here.

The effects of other possible interventions with respect to biofuels in developing countries are not covered. For instance, the small scale production of oils from biomass can also be used locally to replace fossil diesel in generators and small scale electricity generation.

*5.7.1. Economic effects*

- *Employment and growth:* biofuel production can contribute to maintaining employment and creating new jobs in rural areas, thereby diversifying income sources and providing a counterweight to rural-urban migration. Employment can be created both on existing farms (use of crop residues, diversification) and in new production areas. Conversion plants are also sources of employment. Where investments take place and employment is created, a positive effect on economic growth will result.

- Effects on the *national budget*: the effect on the national budget depends on the balance between government income and expenditure related to transport fuels. Whereas fossil fuels are often taxed, biofuel production usually needs incentives (direct investment, loans, subsidies, tax credits), as the production of biofuels is not (yet) competitive in most developing countries compared with the price of (often imported) fossil fuels. Further increases in world oil prices and reductions in biofuel production costs would increasingly lead to the balance changing in favour of the production and use of biofuels.

- Where *Government investments* are required for biofuel production and use, funds may be diverted from other investments (e.g. education, transport infrastructure) with specific effects on growth, income and employment. The net effects require case-specific determination.

- Effect on *balance of payments*: where biofuels can be produced locally, they are likely to reduce the fossil oil import bill and improve the balance of payments. Moreover, where production can take place for export markets, a further positive effect on the balance of payments will be achieved.

- Energy *security*: diversifying energy sources reduces vulnerability and by relying on local resources the dependence on imported fuels is reduced.

*5.7.2. Environmental effects*

- Pressure on *sensitive ecosystems* with effects on *biodiversity*: large scale expansion of feedstock production will have effects on land use. Whereas in some cases expansion may take place on neglected or abandoned agricultural land, in other cases pressure will be on sensitive and valuable ecosystems like rainforests, savannah or wetlands. Development of plantations in rainforest areas destroys the ecosystem and its qualities in terms of greenhouse gas absorption, water circulation etc. It also affects biodiversity in the area by reducing habitats and compartmentalising the remaining forest area through the creation of transport infrastructure networks. In addition, there are substantial $CO_2$ losses if grassland is ploughed up or forests cleared. These losses can be expected to outweigh $CO_2$ gains from biofuels for many years.

- *Soil fertility*: effects on soil fertility depend on production method and fertiliser use, as for any crop. If good practices are used biofuel feedstock production can maintain or even improve soil fertility, including on marginal land, but in other cases the nutrient balance or soil structure may be undermined.

- *Pesticide use*: biofuel feedstocks, particularly those grown in plantations, require pest management, but the extent to which pesticides damage human health and have unwanted effects on biodiversity will depend on the genetic qualities of the feedstock, as well as on the type, intensity and scale of pest management applied.

- Effects on *water*: different feedstocks have different requirements with respect to water use and may require irrigation or the use of relatively large amounts of water in situations of water scarcity. Water pollution can be caused by biofuel production, e.g. by untreated palm oil mill effluent or over-use of chemicals polluting groundwater and/or rivers.

- *Climate change mitigation*: where forest or agricultural productivity is increased, $CO_2$ emissions can be negative, as more $CO_2$ is taken up and converted to biomass. However, this has to be weighed against the $CO_2$ released (often by fossil fuels) during feedstock production, harvesting, transportation and conversion.

- *Atmospheric pollution*: using biofuels may result in lower emissions of air pollutants compared with the use of fossil fuels (sulphur oxides, carbon monoxide, heavy metals) as well as pollutants contributing to photochemical smog. This can be important for heavily congested cities in the developing world. On the other hand, forest fires to clear land for plantations have become a frequent source of haze in Southeast Asia, contributing to health problems.

- Increased *soil erosion* and *sedimentation* in rivers can be caused directly by the clearance of inland forest cover, or indirectly by the destruction of coastal mangrove forests. This may lead to problems in local transport on the river, as well as additional dredging costs.

#### *5.7.3. Social effects*

- *Competition with food or fodder crop* production: when biofuels are promoted as agricultural produce, they may compete with food crops for land, labour and capital. At present, however, there is little understanding whether this competition will actually arise[47]. Similarly, effects may take place with respect to animal feed (e.g. in using cotton seed for oil or for fodder) but the degree to which this will occur is uncertain.

- A global increase in the use of agricultural raw products for biofuels could result in higher *food prices*, which would hit the poor in developing countries.

- *Pressure on vulnerable communities*: where large scale expansion of agricultural production takes place, new land is cleared and/or land hitherto considered marginal increases in value. In both cases, pressure may increase on small and marginal communities to move away or to drastically adapt their lifestyles.

- *Social cohesion*: many rural areas in the developing world suffer from migration of labour to urban and industrialised regions, with often negative consequences for investments in

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47 Global Bioenergy Partnership, White paper. Oct. 2005.

farming, in land and for the cohesion of communities. By providing a new land-based opportunity, feedstock production can counter the trend and by including a wide range of local stakeholders it can create regional social and economic multiplier effects.

**The example of Brazil**

Brazil has become the world's largest producer and consumer of ethanol, thanks to the targeted subsidies under the Proalcool programme, but these subsidies (for producers and consumers) have triggered even larger benefits in terms of import savings. In economic terms, investments in agriculture and industry for the production of transport ethanol in the period 1975–89 have been estimated at close to US$ 5 billion, which has triggered import savings worth over US$ 52 billion (for 1975–2002). This apparently highly-favourable rate of return does not take operating costs into account and is related to the high productivity of Brazilian agriculture and industry and to the scale of operations achieved[48].

The employment effects in Brazil have been very positive. In 2004, the sugar cane sector was responsible for 700 000 jobs and for 3.5 million indirect jobs. The ratio of jobs created per unit of energy produced is higher than in other energy sectors, while it also compares favourably with most other industries in terms of jobs generated per unit of investment[49]. Though wage levels in the sugarcane sector are not high, they are comparatively higher than other rural sectors, while labour laws were generally better enforced in large-scale sugar plantations than elsewhere.

However; agricultural expansion in Brazil is causing deforestation in the Amazon basin at a speed of tens of thousands of hectares per month. Forest clearance is mainly related to soybean production, predominantly as a food product for export to China, as well as cattle-ranching, also mainly for export. It could, however, also potentially be used for biodiesel production.

Biofuels have proved effective in reducing atmospheric pollution. Ambient lead concentrations in Sao Paolo Metropolitan Region have dropped from 1.4 g/m3 in 1978 to less than 0.1 g/m3 in 1991 as a result of the Brazilian ethanol programme. In addition, carbon monoxide (CO) emissions were drastically reduced from over 50 g/km to less than 5.8 g/km in 1995.

Although a database on economic, social and environmental effects on developing countries of biofuels expansion is lacking, there are sufficient indications to conclude that increased demand for biofuels in Europe will have various general effects on developing countries. First, it will imply an initial supply response from currently efficient producers of ethanol (Brazil) and biodiesel (Malaysia, Indonesia), while a number of other countries could also develop export potential, but at a more limited scale. Second, there will be positive effects on employment in the exporting countries, directly creating up to several hundreds of thousands jobs. Third, there will be increasing pressures on eco-sensitive areas, notably rainforests, where several millions of hectares could be transformed into plantations.

**Option 3**, which relies mainly on imports, will have the biggest impact. The impact of **option 2**, which encourages the development of the EU's domestic biofuel industry in a balance approach with import, will be lower and linked with an environmental monitoring system. The effect will be minimal in the case of **option 1** (business as usual).

48 Goldemberg et al. (2003). Ethanol learning curve – the Brazilian experience', Biomass and Bioenergy, Vol. 26/3, pp. 301-304.

49 UNCTAD, Biofuels – Advantages and Trade Barriers. February 2005.

It should be noted that these effects are likely to occur regardless of EU policy towards biofuels, as increased demand from elsewhere (China, Japan) will have similar effects. However, EU demand will add to and magnify these effects.

A more specific assessment requires further research and a clear country-specific differentiation to be made with respect to products and feedstocks. The Global Energy Partnership could be a useful platform to facilitate and coordinate such work.

The main general negative effect of biofuel feedstock expansion will be the increased pressure on rainforests. Several initiatives have been taken to better channel and control such expansion and thereby mitigate the most serious effects. With respect to palm oil production, the Roundtable on Sustainable Palm Oil (RPSO)[50], an initiative by WWF, producers, traders and NGOs, has recently announced the adoption of a set of criteria for the responsible production of palm oil, which would allow palm oil production without affecting the sustainability of tropical forests and endangered species. Success will depend on widespread participation by producers and on consumer behaviour. Support for this and similar initiatives would help mitigate the negative impact of the expansion of biofuel production around the world.

Concerning the potential of sugar protocol countries to diversify into the production of bioethanol, the successful development of biofuels requires a sufficiently large scale of operation, appropriate policies and a conducive environment for investments and market development, based on well-researched economic and environmental realities. If developing countries are to benefit from the prospects that exist, international assistance will be required in terms of transfer of technology, investments in processing and marketing and policy development.

## 5.8 Cost of the policy and overall assessment

The previous sections discussed the different impacts of the three options. The question here is their cost to society. Considering the general uncertainty concerning the development of oil prices, all illustrative scenarios on costs presented here are based on current oil and biofuel prices, as explained in section 5.1. The assumptions on the additional cost for biofuels are summarised in table 5.8.1.

**Table 5.8.1: Fuel cost (in € per tonne of oil equivalent) excluding taxes, subsidies, external cost and benefits**

| | **Conventional fuels** | | **Biofuels** | **Difference** | |
|---|---|---|---|---|---|
| | **low oil price** | **high oil price** | | **low oil price** | **high oil price** |
| | € / toe | € / toe | € / toe | € / toe | € / toe |
| **Diesel / Biodiesel** | 329 | 563 | 750 | 421 | 187 |
| **Petrol / Bioethanol *** | 311 | 545 | 680 – 900 | 369 – 589 | 135 – 355 |
| **Mix (56% Diesel, 44% Petrol)** | 321 | 555 | 720 – 816 | 399 – 458 | 165 – 224 |

* lower range corresponds to cif import price, higher range to current price of EU production

50 See www.sustainable-palmoil.org.

The actual magnitude of additional internal cost is very much depending on the future development of global energy prices. The higher the global energy prices, the lower the additional internal cost. Prices have increased substantially since 2000. Since estimating future trends in global energy prices will always be subject to high uncertainty, the Impact Assessment differentiated between two economic environments in 2010:

- a low global energy price environment with oil prices around €28/barrel. These prices correspond to the average level of the past ten years[51];
- a high global energy price environment with oil prices around €60/barrel. These prices correspond to current peak price levels.

Based on these assumptions, the following indicative (and incomplete) additional cost for the EU-25 have been calculated for the year 2010 (Table 5.8.2). Indirect effects, e.g. from changes in food prices, have not been included. On the other hand, it is important to note that the monetary values of external effects such as diversification of the energy mix, security of supply, stabilisation of rural areas through direct job creation, and possible positive indirect employment effects are not included in this calculation.

Table 5.8.2 indicates that the net additional internal cost range from €1.35 to 2.75 billion/yr for option 1, from €4.06 to 8.29 billion/yr for option 2 and from €2.48 to 6.72 billion/yr for option 3. As indicated in the Biomass Action Plan, an average cost of €6 billion per year can be assumed for option 2, the average cost of option 3 would be around €4.5 billion per year.

**Table 5.8.2: Additional cost of different opitons for EU25 in 2010**

| | **Option 1** | | **Option 2** | | **Option 3** | |
|---|---|---|---|---|---|---|
| | **low oil price** | **high oil price** | **low oil price** | **high oil price** | **low oil price** | **high oil price** |
| | € billion | € billion | € billion | € billion | € billion | € billion |
| **Additional internal cost** | 2.75 | 1.35 | 8.29 | 4.06 | 6.72 | 2.48 |
| **Difference compared with option 1** | – | – | 5.54 | 2.71 | 3.97 | 1.13 |

Relating this to the gross diesel and petrol consumption in the EU-25 (288 mtoe = 334 billion litres in 2002[52]) yields an average increase of transport fuel cost of 1.2 to 2.5 cents per litre in order to finance the additional biofuel use under option 2.

Concerning the fiscal cost for Member States, tax exemptions at present penetration rates of biofuels have only a limited budgetary impact (option 1). An increase in market penetration as assumed for options 2 and 3 might increase the budgetary burden, if Member States continue to rely on tax exemptions. However, this debate will be held in the context of the possible revision of the Biofuels Directive.

The IEA/OECD has summarised the discussion about costs as follows:

"While increased crop demand may trigger an increase in crop prices, as well as in other related markets, there are also important potential "macro" benefits from increasing the

[51] see EUROSTAT (op. cit).
[52] see EUROSTAT (op. cit).

domestic production of biofuels. … Biofuels production in developing countries can also have a positive impact on agricultural employment and rural development, particularly when conversion facilities are smaller-scale and are located near crop sources in rural districts. In Brazil for example, it is estimated that 700 000 jobs have been created in rural areas to support the additional sugar cane and bioethanol industry. The development of multi-product "biorefineries" could further spur the development of related secondary industries.

In addition to employment benefits, domestic biofuels production enhances the security of national energy supply and improves the balance of trade, since many countries spend large percentages of their foreign currency reserves on oil imports.

The potential economic benefits from developing biofuels must be weighed against the costs of producing the biofuels, and the negative economic impact these higher costs have on government budgets and economic growth. Such effects must be carefully assessed before the broader macroeconomic benefits are used as justification for biofuels production."[53].

The cost of the different options has anyway to be weighed against the benefits of the policy objectives spelled out earlier. The monetary value of the benefits related to biofuels, such as reduced greenhouse gas emissions, an enhanced diversification of the energy mix and security of supply, direct job creation in rural areas, have not been quantified here. In the absence of these data, it is not possible to make a definitive assessment whether or not the cost of the different options are (over-) compensated by the monetary value of these benefits.

## 6. COMPARING THE OPTIONS

The different options are compared by their impact on the EU-25 by 2010. Table 6.1 summarises the effects in a qualitative way – compared with the situation in 2002.

**Table 6.1: Comparing the options**

| | **Option 1** | **Option 2** | **Option 3** |
|---|---|---|---|
| **Environmental impact** | | | |
| Greenhouse gas savings | low | high | higher |
| Impact from cultivation of feedstock (EU) | no change | to be monitored | to be monitored |
| **Security of fuel supply** | | | |
| | low | diversification of sources (domestic and imports) | diversification of sources (mainly from imports) |
| **Impact on agriculture and rural areas** | | | |
| Use of agricultural land<br>EU<br>third countries | <br>no change<br>no change | <br>increase<br>limited increase | <br>limited increase<br>larger increase |
| agricultural employment<br>EU<br>third countries | <br>reduced as per trend<br>no influence | <br>positive<br>limited positive effect | <br>negative<br>positive effect |
| **Employment effects (non-agricultural)** | | | |
| Direct | limited positive | positive | limited positive |

53 IEA: Biofuels for transport: an international perspective, 2004.

| | | | |
|---|---|---|---|
| Indirect | negligible | unclear | unclear |
| **Other economic effects** | | | |
| competitiveness | negligible | unclear | unclear |
| innovation | negligible | positive | positive |
| **International effects** | | | |
| Economic | no change | unclear | unclear |
| Environmental | no change | moderate additional land use, environmental monitoring system | higher additional land use, environmental monitoring system |
| Social / political | no change | to be assessed case by case | to be assessed case by case |

## 7. MONITORING AND ASSESSMENT

Monitoring and assessing the economic, social and environmental effects of EU public policies has become a standard element of the political process.

Most EU legislative acts taken in the fields of Renewable Energy Sources and other relevant legislation related to the biofuels sector introduce the monitoring of their implementation by Member States, and their impact and effectiveness at EU level in order to propose, if needed, further action or reorientation of the measures.

Many of the actions in the Biofuels Strategy need to be developed by Member States or by other public authorities which are even closer to the citizen. Considerable experience in monitoring exists in the Commission services and in the Member States. Hence, there is scope for cooperation, sharing of information, improvement of core indicators and the enhancement of analytical tools used for monitoring and assessing policies. Existing statistical systems in the fields of the environment, agriculture, energy, micro- and macro-economics need to be adapted to provide sufficient information in this context.

Environmental monitoring of biofuel production needs to cover the whole range of potential impacts and benefits for the $CO_2$ balance, transport emissions, soil and water resources, as well as biodiversity. Data on energy crops and conversion pathways allows the $CO_2$ balance of biofuel production to be calculated.

A system for monitoring progress and the impact of biofuel production needs to allow an assessment to be made of progress towards meeting renewable energy targets, as well as provide information on the impact of biofuel production and use. The basis for reporting on progress should be a common framework for monitoring and assessment, to be established in cooperation with Member States. The existing reporting methodology used for biofuels in transport Directives would form the foundations of an improved monitoring and assessment system. These should be supported by thematic studies and analysis at Community level, covering the whole spectrum of issues, i.e. environment, agriculture, energy, economic and welfare effects

## ANNEX: Measures proposed

**Stimulate demand for biofuels**

- Bring forward a report in 2006 in view of a possible revision of the Biofuels Directive. This report will *inter alia* address the issues of setting national targets for market share of biofuels, using biofuels obligations and ensuring sustainable production.
- Encourage Member States to give favourable treatment to second-generation biofuels in biofuels obligations.
- Encourag the Council and the European Parliament to give speedy approval to its recently adopted legislative proposal to promote public procurement of clean and efficient vehicles, including those using high blends of biofuels.

**Capture the environmental benefits**

- Examine how biofuel use can count towards the $CO_2$ emission reduction targets for car fleets.
- Explore and, where appropriate, propose measures to ensure optimal greenhouse gas benefits from biofuels.
- work to ensure the sustainability of biofuel feedstock cultivation in the EU and third countries.
- Examine the issues of limits on the content of ethanol, ether and other oxygenates in petrol; limits on the vapour content of petrol; and limits on the biodiesel content of diesel.

**Develop production and distribution of biofuels**

- Encourage Member States and regions to take into account the benefits of biofuels and other bioenergy when preparing their national reference frameworks and operational plans under cohesion policy and rural development policy.
- Propose setting up a specific ad hoc group to consider biomass including biofuels opportunities within national rural development programmes.
- Ask the relevant industries to explain the technical justification for practices that act as barriers to the introduction of biofuels and monitor the behaviour of these industries to ensure that there is no discrimination against biofuels.

**Expand supplies of feedstock**

- Make sugar production for bioethanol eligible for both the non-food regime on set-aside land and the energy crop premium.
- Assess the opportunities for additonal processing of cereals from existing intervention stocks into biofuels, to contribute to reducing the amount of cereals exported with refunds.
- Assess the implementation of the energy crop scheme by the end of 2006.
- Monitor the impact of biofuel demand on commodity and by-product prices, their availability for competing industries and the impact on food supply and prices, in the EU and in developing countries.

- Finance a campaign to inform farmers and forest holders about the properties of energy crops and the opportunities they offer.
- Bring forward a Forestry Action Plan, in which the energy use of forest material will play an important part.
- Review how animal by-products legislation could be amended in order to facilitate the authorisation and approval of alternative processes for the production of biofuels.
- Implement the mechanism proposed to clarify standards for the secondary use of waste materials.

**Enhance trade opportunities**

- Assess the advantages, disadvantages and legal implications of putting forward a proposal for separate nomenclature codes for biofuels.
- Maintain market access conditions for imported bioethanol that are no less favourable than those provided by the trade agreements currently in force, maintain in particular a comparable level of preferential access for ACP countries and take into account the problem of preference erosion.
- Pursue a balanced approach in ongoing and future trade negotiations with ethanol-producing countries and regions – The EU will respect the interests of both domestic producers and EU trading partners, in the context of the rising demand for biofuels.
- Propose amendments to the "biodiesel standard" to facilitate the use of a wider range of vegetable oils for biodiesel production, and allow ethanol to replace methanol in biodiesel production.

**Support developing countries**

- Ensure that accompanying measures for Sugar Protocol countries affected by the EU sugar reform can be used to support the development of bioethanol production.
- Develop a coherent Biofuels Assistance Package that can be used in developing countries which have a potential for biofuels.
- Examine how the EU can best assist the development of national biofuel platforms and regional biofuel action plans which are environmentally and economically sustainable.

**Support research and development**

- In the 7$^{th}$ Framework Programme continue to support the development of biofuels and strengthening the competitiveness of the biofuel industry.
- Give a high priority to research into the "bio-refinery" concept – finding valuable uses for all parts of the plant – and into second generation biofuels.
- Continue to encourage the development of an industry-led "Biofuel technology platform" and mobilise other relevant technology platforms.
- Support the implementation of the Strategic Research Agendas prepared by these technology platforms.