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Biofuels Progress Report

Report on the progress made in the use of biofuels and other renewable fuels in the Member States of the European Union

{COM(2006) 845 final}

Review of economic and environmental data for the biofuels progress report

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1. INTRODUCTION

This staff working paper complements the biofuels progress report[1] in fulfilling the requirements of article 4.2 of the biofuels directive.[2] This states,

"By 31 December 2006 at the latest, and every two years thereafter, the Commission shall draw up an evaluation report for the European Parliament and for the Council on the progress made in the use of biofuels and other renewable fuels in the Member States.

This report shall cover at least the following:

(a) the cost-effectiveness of the measures taken by Member States in order to promote the use of biofuels and other renewable fuels;

(b) the economic aspects and the environmental impact of further increasing the share of biofuels and other renewable fuels;

(c) the life-cycle perspective of biofuels and other renewable fuels, with a view to indicating possible measures for the future promotion of those fuels that are climate and environmentally friendly, and that have the potential of becoming competitive and cost-efficient;

(d) the sustainability of crops used for the production of biofuels, particularly land use, degree of intensity of cultivation, crop rotation and use of pesticides;

(e) the assessment of the use of biofuels and other renewable fuels with respect to their differentiating effects on climate change and their impact on CO2 emissions reduction;

(f) a review of further more long-term options concerning energy efficiency measures in transport.

On the basis of this report, the Commission shall submit, where appropriate, proposals to the European Parliament and to the Council on the adaptation of the system of targets, as laid down in Article 3(1). If this report concludes that the indicative targets are not likely to be achieved for reasons that are unjustified and/or do not relate to new scientific evidence, these proposals shall address national targets, including possible mandatory targets, in the appropriate form."

The progress report concentrates on the political parts of the task – the evaluation of Member States' progress and the assessment of the need to adapt the system of targets. This staff working paper fulfils the technical parts of the task – items (a) to (f). Section 2 addresses item (a); sections 3 to 6 address items (b) and (d); section 7 addresses items (c) and (e); section 8 addresses item (f).

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[1] COM (2006) 845

[2] Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport, OJ L 123, 17.5.2003, p. 42.

The function of this paper is to support a report on progress up to 2006. Therefore, the data it presents relate to EU25 and do not cover the states that acceded to the Union in 2007 (Romania and Bulgaria). It can be pointed out, however, that these states have good potential to produce bioenergy[3]; their accession will therefore facilitate the development and implementation of Community biofuel policy.

Methodological conservatism

The literature contains widely divergent values for most of the relevant variables, resting on different methodological choices.[4] This working paper opts for choices that are intended to avoid overstating the case for biofuels. Examples of this methodological conservatism are in annex.

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3 For example, they each have 0.7 hectares of agricultural land per capita, compared to 0.4 in the EU25.

4 The main source used is the JRC/Concawe/EUCAR well-to-wheel study, referenced here as JEC (2006). The full reference is EUCAR, Concawe and European Commission Joint Research Centre (2006), Well-to-wheels analysis of future automotive fuels and powertrains in the European context, version 2b. The study is available on the internet at http://ies.jrc.cec.eu.int/wtw.html. Other sources consulted include Billins, P., Woods, J. and Tipper, R. (2005): Developing carbon and greenhouse gas assurance for bioethanol production in the UK; Confédération Générale des Planteurs de Betterave (CGB) (2003), La betterave en 2004; Conseil Général des Mines, Inspection générale des Finances and Conseil général du Génie rural des eaux et forêts (2005), Rapport sur l'optimisation du dispositif de soutien à la filière biocarburants; Delucchi, M. (2004): Conceptual and methodological issues in life cycle analyses of transportation fuels, report prepared for the U.S. Environmental Protection Office of Transportation and Air Quality; Elsayed, M.A., Matthews, R. and Mortimer, N.D. (2003): Carbon and energy balances for a range of biofuels options, Resources Research Unit, Sheffield Hallam University for Department of Trade and Industry; Energy research Centre of the Netherlands (ECN) (2003): Ligno cellulosic-ethanol: a second opinion; Farrell, A., R. Plevin, B. Turner, A. Jones, M. O'Hare and D. Kammen (2006): Ethanol can contribute to energy and environmental goals, Science 27th January 2006; Fernández, J., Professor of plant production, Polytechnic university of Madrid (2005): New energy crops for ethanol production in Mediterranean conditions, presentation to World biofuels conference, Seville, 17-19.5.5; HGCA (2005): Environmental impact of cereals and oilseed rape for food and biofuels in the UK; International Energy Agency (2004): Biofuels for transport – an international perspective; Jonassen, K. and B. Sandén (2004): Time and scale aspects in life cycle assessment of emerging technologies – case study on alternative transport fuels, Chalmers University of Technology, CPM-report 2004:6; Low Carbon Vehicle Partnership (2004): Well-to-wheel evaluation for production of ethanol from wheat; Macedo, I. (ed.), Sugar cane's energy - twelve studies on Brazilian sugar cane agribusiness and its sustainability; Patzek, T. (2003): Ethanol from corn: just how unsustainable is it?; Sancroft (2005): The Brazilian sugar industry – environmental and social impacts; Smeets, E., M. Junginger and A. Faaij (2005): Supportive study for the OECD on alternative developments in biofuel production across the world; TOTAL (2004): Evolution des carburants. Quel rôle pour les biocarburants ? Assemblée nationale Mars 2004; Turley, D., McKay, H. and Boatman, N. (2005): Environmental impacts of cereal and oilseed rape cropping in the UK and assessment of the potential impacts arising from cultivation for liquid biofuel production, HGCA Research review no. 54; Varela, M., Lago, C., Jungmeier, G. and Könighofer, K. (2005): Environmental and economic performance of biofuels, Volume I – Main report of the Viewls project; Yacobucci, B. (2004): Alternative transportation fuels and vehicles: energy, environment and development issues, Congressional Research Service report for Congress, updated 9th January 2004.

2. COST-EFFECTIVENESS OF THE MEASURES TAKEN BY THE MEMBER STATES

The Commission arranged for the PREMIA research project to review measures to promote biofuels in the Member States.[5] This study considered the measures taken by eight member states: Austria, Czech Republic, France, Germany, Poland, Spain, Sweden and the United Kingdom. Complemented with other data available to the Commission, it shows that the main measures that Member States have used to promote biofuels are:

- subsidies for energy crop growth;
- investment support;
- contributions to the capital cost of biofuel production facilities, often with support from the European Regional Development Fund and Rural Development Programme;
- loans and subsidies for biofuel production facilities and for filling stations;
- standards for distribution of biofuels;
- tax reductions or exemptions that are generally available;
- tax reductions or exemptions under quota systems (allowing selected companies to put a certain amount of biofuel on the market under reduced tax)
- biofuels obligations (under which fuel suppliers are required to include a given percentage of biofuels in the total amount of fuel they place on the national market);
- requirements for filling stations to sell biofuels (in high blends [or pure]);
- green public procurement of vehicles capable of running on high-blend or pure biofuels;
- demonstration projects and marketing;
- consumer incentives including free parking, no congestion charge.

The study showed that different member states have focused on different fuels and/or blends, ranging from biodiesel, bioethanol to straight vegetable oil and biogas.[6]

Most of the measures taken by member states have imposed costs on government and to a smaller extent on vehicle manufacturers, consumers and fuel distributors. The costs incurred depend on the combination of measures taken to promote the use of biofuels and on the type of fuel promoted.

Member States have been able to expand the potential for producing feedstocks, particularly thanks to support from the Common Agricultural Policy. This provides the possibility of using set-aside land for food production as well as some specific aid for energy crops. This

5 PREMIA (2006): R&D, demonstration and incentive programmes effectiveness to facilitate and secure market introduction of alternative motor fuels

6 Each has different production costs. To quantify the cost of measures taken, the PREMIA study used JEC (2006).

aid originally covered 17 Member States; it is being extended to cover them all. The rural development policy also includes measures to support renewable energies.

For biofuel production, start-up costs are generally low. Investment, loans and research and development support measures were found to be the most cost-effective measures as financial support stops as the technology and the market matures. Measures which offer direct subsidies to manufacturers to cover the higher cost of biofuel production (as in Czech Republic) can be very expensive, but they ensure the creation of a mass of producers and long-term prospects for biofuel production.

Creating standards is a necessary first step for fuel distribution and market introduction. Its direct cost is limited to research funding.[7] The cost of other incentives varies from region to region and depends on the type of biofuel supported. Tax exemptions have been used in all the countries analysed to cover the extra costs to distributors. Tax exemptions were estimated to amount to a loss of tax income of €140 million/year in Sweden, €60-75 million/year in Spain, around €15-20 million/year in the Czech Republic and around €35 million/year in Poland. In most member states, market response stayed below expectations. In the UK, Austria and the Czech Republic tax reductions were not sufficient or too low compared to neighbour countries. In Germany, however, an increased tax reduction for biofuels in 1999 had a strong influence, because it went together with an increased tax for diesel fuel and rising oil prices. Although this policy cost the German government a loss of tax income of about €1000 million/year, it increased its income with the ecological tax reform on normal diesel and gasoline fuel (around €3500 million/year).

Germany has subsequently decided to phase out the tax reduction and replace it with a biofuels obligation. Other Member States have also recently decided to introduce biofuel obligations. As the biomass action plan[8] asserts, obligations place a responsibility for addressing the problem of excessive oil dependence on the sector where it originates – while implying only a negligible increase in the cost of fuel. Obligations give fuel supply companies an incentive to push down the cost of biofuels. For this reason, they can be expected to be more cost-efficient than tax exemptions. The extra costs arising from such measures are part of the fuel price and consumers pay the additional cost, although some costs occur due to administrative follow-up, such as biofuel certificates, penalties etc.

For markets to be penetrated, car manufacturers must be convinced to make vehicles compatible with biofuels. The disadvantage of high-blend fuels is that it requires more to convince the markets to change, although the costs of doing so are limited to research projects. Countries which have been successful in promoting biofuels cooperated with local car manufacturers to produce biofuel compatible vehicles. Green public procurement is an important tool to lead by example and does not incur significant costs. Costs of user incentives, such as an exemption from the congestion charge for eco-friendly vehicles in Stockholm or a 20% relief from company car taxation in Sweden, vary from case to case. The cost of the company car taxation reduction scheme in Sweden is estimated at around €0.5 million/ year.

The study concluded that overall, most of the costs associated with the promotion of the use of biofuels have been incurred by governments through tax reductions and exemptions.

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7 Indirectly, standards can reduce costs (by allowing product standardisation) or increase them (by keeping products that do not meet the standard, but are cheaper, out of the market).

8 COM(2005) 628 of 7.12.2005

However, when combined with other measures, such as obligations requiring fuel supply companies to place a given amount of biofuels on the market, targets can be achieved cost-effectively. The costs on manufacturers, distributors and consumers have been limited because of government incentives and the rising price of fossil fuels.

The question of the cost-effectiveness of tax exemptions as opposed to biofuel obligations was addressed by several responses to the public consultation exercise on the review of the biofuels directive. Many respondents felt that tax exemptions distort the market, so that feedstock is sold to Member States with the highest tax reductions. As tax exemptions are time restricted, they also do not provide long-term market certainty. Several respondents, including the Austrian, French, German and UK governments, felt however that a combination of obligations and tax exemptions during a transitional period is an acceptable way of promoting renewable technologies and increasing investment security.

3. SCENARIOS FOR THE ASSESSMENT OF ECONOMIC AND ENVIRONMENTAL IMPACTS

3.1. Scenarios

In order to assess the economic and environmental impact of increasing the share of biofuels, scenarios were developed for two possible shares of biofuel consumption in 2020: 7% or 14%.[9]

The European Simulation Model (ESIM), used by the Commission for agricultural commodity projections and policy simulations, was used to estimate the mix of biofuels likely to enter the market if a 7 or 14% share is achieved.[10] The main assumptions made were the following:

- The Common Agricultural Policy will develop as foreseen in the Commission's general projection of commodity market developments;
- The Commission's trade commitments will remain unchanged;
- It will remain possible to use set-aside land for bioenergy production;
- The Blair House agreement will limit the expansion of non-food oilseed production on set-aside land;[11]

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9 The volumes of biofuel consumption assumed in the two scenarios are 23.1 Mtoe and 43.1 Mtoe respectively. Assuming total petrol and diesel consumption of 312 Mtoe – as in the PRIMES "high RES + energy efficiency" scenario – these equate, in precise terms, to 7.4% and 13.8% respectively. The 7% share is derived from the estimate used in the PRIMES baseline of the market share that biofuels will achieve in 2020 if existing policies and measures in the Member States are maintained.

10 European Commission (2006): Prospects for agricultural markets and income 2006-2013, available on the internet at http://ec.europa.eu/agriculture/publi/caprep/prospects2006/index_en.htm. The document also includes methodological information.

11 The agreement with the US adopted by Council Decision n° 93/355/EEC (Blair House) provides for a limit on the production of oilsseds for non-food purposes on set-aside land. In order to meet this ceiling, Regulation (EC) n° 1973/2004 introduced a monitoring system to limit to 1 million tonnes of soya bean meal equivalent the quantities of by-products intended for human or animal consumption resulting from colza seed, rapeseed, sunflower and soya beans grown on land set aside and cultivated for non-food purposes.

- The energy crop premium of 45 €/ha for a maximum of 2 million ha will remain in place;

- As in the past decade, technical progress in European agriculture will be used mainly to reduce costs and fertiliser use per ton produced rather than to increase yields per hectare. Growth in yields per hectare will therefore average only 0.8% p.a.[12]

- The livestock sector will develop more slowly than in the past as population growth and the rate of increase of per capita meat consumption in Europe slow. This will increase the general availability of cereals;

- Higher demand for biofuel would mean more rapid development of second-generation biofuel technologies. Second-generation biofuels (BTL and cellulosic ethanol) will account for 20% of biofuels' contribution in the "7%" scenario, 37% in the "14%" scenario. The BTL will be made from farmed wood and straw, the ethanol will be made only from straw.

- 15.5 Mtoe of straw (in terms of primary energy) is available for making second-generation biofuels;

- The ratio between biodiesel/BTL consumption and bioethanol consumption will be the same as that forecast for the ratio between diesel and petrol consumption in transport: that is, 55:45[13]. Second-generation biofuels will take the same share of the diesel market and the petrol market.

- Fuel quality constraints mean that the share of rape oil in biodiesel production will not be able to fall below 50%. The remainder is accounted for by soy and palm oil. The split between these is a function of their relative prices.

These assumptions are for illustrative purposes and do not prejudge the policy positions that the Commission may adopt in future.

To explore the effect of a higher share of imports, a third scenario was added: "14% - more imports" (as opposed to the "14% - more domestic" scenario derived from the assumptions above). For the purposes of this scenario, domestic production of first-generation biofuels was limited to the same level as in the 7% scenario; production of second-generation biofuels was limited to the amount that could be produced from straw; and the available straw was assigned to BTL production, since this would allow more biofuel to be produced. Unlike the other

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12 Among the reasons for this are the tight production standards established through the cross-compliance measure of the Common Agricultural Policy, including the water protection directives (Directive 91/676/EEC concerning the protection of waters against pollution caused by nitrates from agricultural sources and Directive 2006/11/EC on pollution caused by certain dangerous substances discharged in the aquatic environment of the Community), soil directive (Directive 86/278/EEC on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture), directives for the protection of biodiversity (Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds and Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild flora and fauna), and pesticides directive (Council Directive 91/414/EEC of 15 July 1991 concerning the placing of plant protection products on the market).

13 Source: PRIMES.

scenarios, this one is a purely theoretical construct. Its feasibility has not been assessed through modelling of the agricultural market.

The expected mix of biofuel consumption, based on these assumptions, is shown in table 1.

Table 1 Scenarios for biofuel use (Mtoe of biofuel)[14]

	7% share of biofuels	**14% - more domestic**	**14% - more imports**
domestic production			
biodiesel from rape	4.7	3.9	4.7
BTL from farmed wood	-	10.5	-
BTL from straw	2.5	0.5	7.5
ethanol from sugar beet	0.6	0.8	0.6
ethanol from wheat	5.6	11.2	5.6
ethanol from maize	1.3	1.5	1.3
cellulosic ethanol from straw	2.1	5.0	-
imports			
rape for biodiesel	2.4	2.6	2.6
palm for biodiesel	0.4	2.9	4.2
soy for biodiesel	2.6	3.2	4.6
ethanol from sugar cane	0.8	0.9	11.9
TOTAL	**23.1**	**43.1**	**43.1**
share of imports	*27%*	*22%*	*54%*
share of diesel replacers	*55%*	*55%*	*55%*
share of second-generation	*20%*	*37%*	*17%*

[14] The share of imports is a model outcome, given the assumptions made about trade agreements, for the 7% scenario and the "14% - more domestic" scenario. It is an assumption for the "14% - more import" scenario, which would require changes in trade agreements.
The most likely source of imports could be: rape oil from Ukraine and Russia; soy oil from Latin America; palm oil from Indonesia and Malaysia; sugar cane ethanol from Brazil or other tropical countries

3.2. Land use change

Table 2 shows how the scenarios affect expected EU25 arable land use in 2020.

Table 2 Estimated EU25 arable land use in 2020 (million hectares)[15]

	"no biofuel" scenario	**7% and 14% - more imports**	**14% - more domestic**
rape for biodiesel	0	2.7	2.6
cereals for bioethanol	0	4.6	8.3
sugar beet for bioethanol	0	0.3	0.5
farmed wood for BTL[16]	0	0	6.9
TOTAL LAND FOR BIOFUEL PRODUCTION	0	7.6	18.3
non-biofuel arable production	87.6	84.8	80.8
idle arable land (set-aside)	10.8	7.7	3.4
TOTAL ARABLE LAND	98.4	100.1	102.5

This modelling work suggests that for each additional 1 million hectares needed in the EU to produce raw material for biofuels, land use will change as follows:

- 370 000 hectares of arable land will be re-orientated from exports to domestic production;
- 400 000 hectares will be taken out of set-aside;
- 220 000 hectares of land that would otherwise have fallen into other uses will remain in arable use.[17]

Despite price increases for agricultural commodities, the intensity of agricultural production per hectare is not forecast to vary significantly between the scenarios. The main reason is that farmers are modelled as maximising profit, not yields. This leads to a careful scrutiny of the value of the inputs that can be used to increase yields, and an optimisation of their use.

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15 Source: 14% scenario: ESIM.
7% scenario: ESIM, adjusted to exclude use of farmed wood (since straw would be available, more cheaply, in sufficient quantities to supply the volume of second-generation biofuel production expected under this scenario). This adjustment was carried out on the assumption that land no longer required for biofuel production would be allocated between i) idle arable land, ii) arable land in active non-biofuel use and iii) non-arable land in the same proportions as are implied, in the ESIM results, for the shift between a 14% and a 7% share.
Finally, the same assumption was used to estimate the "no biofuel" scenario.

16 All the feedstock for cellulosic ethanol, and also for BTL in the 7% scenario, is assumed to come from straw that would otherwise be unused.

17 In a baseline scenario developed by the research organisation IIASA, arable land use was forecast to fall by about 7 million hectares between 2000 and 2020.

4. ECONOMIC IMPACT OF INCREASING THE SHARE OF BIOFUELS

The section looks into the following economic impacts:

– cost

– security of supply

– employment and GDP

– important price effects

– agricultural markets and rural economy

– development and external relations.

4.1. Costs

Base data for fuel costs were calculated from the JRC/EUCAR/CONCAWE well-to-wheel study (JEC (2006)). These data were adjusted as follows:

- The JEC cost estimates are for 2012. By 2020, cost improvements can be expected for second-generation biofuels. In their recent review of the literature, Hamelinck and Faaij (2006) forecast that in the long term (up to 2030) the cost of ligno-cellulosic ethanol production in the EU will fall by 50% and the cost of BTL production will fall by a little over 25%. It is assumed that this forecast of the rate of improvement is correct – but applied to investment and operating costs only - and that half the improvement will occur by 2020 in the scenarios with high second-generation use – with a lower rate of improvement in scenarios with lower use.

- The JEC cost estimates take into account the fact that increased consumption of biofuels will lead to increased demand for biofuel feedstocks, leading in turn to an increase in the price of these feedstocks and the cost of biofuels. However, they need adjusting to take into account the Commission's most recent estimates of future prices of agricultural commodities, and to take into account the fact that the biofuel shares under examination here (7% and 14%) are higher than the 5.75% share that the JEC study examined.

- The JEC data take into account the impact on biofuel prices of changes in energy costs. Prices were calculated for two oil price assumptions: $48 and $70/barrel. In both cases, an exchange rate of €1:$1.20 was assumed.

- At present, EU cereal prices are above world market levels. In addition, the global fuel ethanol market is not fully competitive. Prices for imported ethanol appear to be a function of the price at which EU-produced ethanol is sold rather than of the cost of production. Two hypotheses for agricultural commodity prices were explored. Under the first (business-as-usual) hypothesis, the EU cereal market was assumed not to be exposed to increased international competition; the cost to the EU of imported ethanol was assumed to be 5% below the lowest production cost of domestically produced ethanol; the cost of biodiesel made from imported soy and palm oil was assumed to be 5% less than the lowest production cost of biodiesel from domestic feedstock; and the cost of biodiesel made from imported rape oil (currently uncompetitive with EU production) was assumed to be the same as that of biodiesel from domestic feedstock. Under the second (more competitive markets) hypothesis, EU cereal prices were assumed to be 15% lower than under the business-as-usual hypothesis, as part of world market opening under a World Trade Organisation agreement; the cost to the EU of imported ethanol was assumed to be cost-reflective[18]; and the cost of biodiesel made from imported soy or palm oil was assumed to lie 15% below that of biodiesel from domestic feedstock. As in the business-as-usual hypothesis, the cost of biodiesel from imported rape oil was assumed to be the same as that of biodiesel from domestic feedstock.

The results are shown in table 3.

[18] Macedo (2005) puts the cost of Brazilian sugar cane ethanol at about €330/toe (de Carvalho Macedo, I., Synthesis, in de Carvalho Macedo, I. (ed.) (2005), Sugar cane's energy). Smeets et al. (2005) suggest, however, that this price relies on the use of depreciated plant, and estimate that other tropical countries could produce sugar cane for €430-540/toe. According to CGB (2003), the transport cost of shipping Brazilian ethanol to Europe is about €120/toe. The total cost figure used here is (430+120) = €550/toe.

Table 3 Estimated fuel costs (cost in 2020, €2005/toe, mid-range estimates of the cost of the cheapest biofuel production technique, rounded to nearest €10)

A: oil at $48/barrel, business-as-usual for agricultural markets
B: oil at $48/barrel, more competitive agricultural markets
C: oil at $70/barrel, business-as-usual for agricultural markets
D: oil at $70/barrel, more competitive agricultural markets

	JEC values	**adjusted values: "7%" scenario**	**adjusted values: "14% - more domestic"**	**adjusted values: "14% - more import**
biodiesel from rape	700	A,B: 690 C,D: 720	A,B: 730 C,D: 760	A,B: 690 C,D: 720
biodiesel from imported palm/ soy oil	670	A: 650 B: 580 C: 690 D: 620	A: 690 B: 620 C: 730 D: 660	A: 650 B: 580 C: 690 D: 620
BTL from straw	n.a.[19]	A,B: 950 C,D: 1000	A,B: 890 C,D: 930	A,B: 950 C,D: 1000
BTL from farmed wood	1110	A,B: 1030 C,D: 1080	A,B: 960 C,D: 1010	n.a.
ethanol from sugar beet	680	A,B: 740 C,D: 800	A,B: 760 C,D: 820	A,B: 740 C,D: 800
ethanol from wheat	610	A: 730 B: 630 C: 810 D: 710	A: 780 B: 670 C: 850 D: 750	A: 730 B: 630 C: 810 D: 710
ethanol from imported sugar cane	580	A,C: 690 B,D: 550	A,C: 700 B,D: 550	A,C: 690 B,D: 550
cellulosic ethanol from straw	1030	A,B: 820 C,D: 840	A,B: 740 C,D: 770	n.a.
diesel and petrol	A,B: 400 C,D: 580			

Source: Commission service calculations from data in JEC (2006), adjusted as described above.

19 Not included in JEC (2006). Costs under 7% and 14% scenarios estimated by Commission services.

Based on these adjusted values, table 4 shows the estimated annual extra cost in 2020 of a 7% or 14% share of biofuels.

Table 4 Estimated extra annual cost in 2020 (€bn, €2005) compared to the cost of total reliance on oil-based fuels[20]

	7% scenario	**14% - more domestic**	**14% - more imports**
A: oil at $48/barrel, business-as-usual for agricultural markets	7.8	17.2	14.5
B: oil at $48/barrel, more competitive agricultural markets	6.8	15.3	11.5
C: oil at $70/barrel, business-as-usual for agricultural markets	4.7	11.4	8.1
D: oil at $70/barrel, more competitive agricultural markets	3.7	9.6	5.2

It can be seen how critically the cost of biofuel promotion depends on commodity prices. Most likely, the eventual price would lie somewhere between the extremes.

4.2. Security of supply

4.2.1. Introduction

In assessing security of energy supply it is useful to follow Jansen et al.[21] and distinguish between "long-term threats to the energy supply and delivery system of a region, notably sustained fuel supply disruptions, and attendant long run hedging approaches" and "supply disruptions of short duration that do not pose a long-term challenge to the regional energy system".

4.2.2. Short-term security of supply

Short term insecurity of supply manifests itself in imbalances between supply and demand. Governments keep oil stocks to guard against the negative effects of this. By replacing conventional fuels with biofuels, governments can reduce the amount of oil they need to stock to achieve a given level of protection. The Commission's Institute for Prospective Technological Studies (IPTS) estimated the maximum value of this reduction at 9.7 €cents/litre of biofuel consumption. Assuming that this represents a value over 5 years, the annual value of the short-term security of supply benefits of the "7%" scenario could then be estimated at a maximum of €0.5 bn; the equivalent figure for the "14%" scenarios would be €1.0 bn.

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[20] Maize ethanol assumed to cost the same as wheat ethanol.

[21] Jansen, J.C., W.G. van Arkel and M.G. Boots (2004), Designing indicators of long-term energy supply security, ECN-C—04-007

This estimate of short-term security of supply benefits does not take into account the possible need to carry security stocks of biofuels to address possible variations in biofuel feedstock production due, for example, to unfavourable weather conditions.

4.2.3. Long-term security of supply

Following Jansen et al. and the International Energy Agency[22], it seems appropriate to use diversity in energy supply as the measure of long-term security. The less diverse the energy sources relied on by a region, sector or industry, the more harm it will suffer if access to one of these sources is affected by a change in physical conditions or by war; the greater the risk of being held to ransom by an unscrupulous private or state monopolist or cartel; and the greater the harm if such a ransom attempt is made. The "7%" and "14%" scenarios would both do this, reducing annual petrol and diesel consumption by 23 Mtoe and 43 Mtoe respectively. It is expected that the growth in Europe's oil imports between 2005 and 2030 will be accounted for entirely by the Middle East and CIS regions[23]; it can be assumed that the oil consumption avoided as a result of biofuel promotion would equate to avoided imports from those regions. It is not obvious how to put a monetary value on the benefits of this.

4.3. Employment and GDP

4.3.1. Methodology and results

Using results from the ESIM model (see section 3.1) and process chain data drawn from JEC (2006), IPTS used input-output analysis to estimate the GDP and employment effects of the 7% scenario and the 14% (more domestic) scenario.[24] The following assumptions were made:

- The oil price would be $48/barrel, with a business-as-usual hypothesis for the competitiveness of agricultural markets.
- The extra cost of biofuels will be met through tax exemptions. These will be recollected from private consumers through an increase in general taxation, causing a reduction in the disposable income of consumers.
- The global biofuel market will grow. This will create technology export opportunities for EU companies. Their share of global investment will be a function of the size of the domestic market for the technology in question.
- Changes in demand for crude oil (caused by increased biofuel consumption) will affect its price.[25]

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22 International Energy Agency (2004): Energy security and climate change policy interactions – an assessment framework

23 In 2000, Europe's oil imports stood at 9 million barrels per day (mbpd): 2 from Africa, 3 from the Middle East and 4 from Russia and the CIS. By 2030, imports are expected to grow to 14 mbpd – with the Middle East accounting for 80% of the increase, and Russia/CIS for the other 20%. (International Energy Agency (2004): World Energy Outlook, 2004.) Data relate to OECD Europe.

24 It should be noted that the input-output analyses are based on a comparative statics approach and should be interpreted as "what if" scenarios with no time label; they should not be interpreted as directly representative of a hypothetical year 2020.

25 According to economic theory, changes in demand for a commodity affect its price. This is true both in competitive markets and in monopolistic markets. In the former, the effect of demand changes is a function of the cost of production. In the latter, it is taken to be an inverse function of the price elasticity

It should also be noted that while the ESIM results quoted elsewhere in this paper assume that all the feedstock for second-generation biofuels will be domestically produced, the input-output exercise was conducted on the assumption that 15% of the raw material will consist of imported wood products.

On these assumptions, it is estimated that the "7%" scenario would lead to an employment increase of 105 000 jobs in the EU, while the 14% scenario would lead to an employment increase of 144 000 jobs. (Increases of 190 000 in agriculture, 46 000 in biofuel production and distribution and 14 000 in the food industry would be offset by reductions of 35 000 in services, 21 000 in the conventional fuel sector, 16 000 in transport, 14 000 in the energy sector and 22 000 in other industrial sectors.)

On the same assumptions, it is estimated that the "7%" scenario would lead to a 0.12% increase in EU GDP, while the "14%" scenario would lead to a 0.23% increase.

The results could be expected to be more positive if the extra cost of biofuels was less – for example, with a higher oil price or more competitive agricultural markets.

If the assumptions were changed to make the volume of EU biofuel technology exports independent of the volume of EU biofuel consumption, the employment effect would fall to 77 000 and 111 000 in the 7% and 14% scenarios respectively. If the assumptions were changed to make the price of oil be something that is unaffected by changes in demand for oil, they would fall to 13 000 and minus 32 000 respectively.

4.3.2. Price effects taken into account in the above analysis

The replacement of conventional fuels with biofuels will lead to increased demand for the raw materials used; increased supply of biofuel by-products (animal feed and glycerine); and reduced demand for oil.

Changes in demand and supply affect prices. The replacement of biofuels with conventional fuels can be expected to lead to higher prices for the raw materials used to make biofuels, and lower prices for meat (as a result of lower feed costs), glycerine and oil.

The scale of these price effects can be estimated using elasticities derived from empirical research. These effects are taken into account in the biofuel costs and input-output modelling reported above. Some of the most important effects from the agricultural market modelling of the 7% and 14% (more domestic) scenarios are summarised in table 5.

Table 5 Important price effects of biofuel promotion[26]

commodity	**Average price**	**Price change relative to 2006 average**

of demand. The oil market is neither fully competitive nor fully monopolistic. It can best be described as oligopolistic. Economic theory is less well equipped to model oligopolistic markets. For the purposes of this exercise, the view was taken that prices in oil markets are closer to the price that a profit-maximising monopolist would set, than to the cost-reflective price that would be observed in a free market. It was therefore assumed that the rate of price change that could be expected is comparable to those that would be observed if the market was monopolistic. In the light of this, and taking into account data on the low price elasticity of oil consumption, it was assumed that reduced demand for oil would lead to its price falling by 1.5% (under the 7% scenario) and 3% (under the 14% scenario).

26 Relative to scenario with no biofuel consumption. Wholesale prices, 2020, EU, €2006.

	2006 (€/t)			
		no biofuel use	**7% scenario**	**14% (more domestic) scenario**
common wheat	124	114 (-8%)	123 (-1%)	131 (+6%)
rape meal	109	158 (+45%)	69 (-37%)	63 (-42%)
rape oil	654	332 (-49%)	672 (+3%)	737 (+13%)
soy meal	170	202 (+19%)	119 (-30%)	104 (-39%)
soy oil	484	330 (-32%)	693 (+43%)	745 (+54%)
wood	no expected price effect[27]			
oil	change relative to no biofuel use:		-1.5%	-3%
glycerine	no expected price effect[28]			

Source for 2006: Oil World (for rape and soy); European Commission (for wheat)

Source for 2020: ESIM results except oil price effect estimated by Commission services on the basis of elasticities from Cooper (2003). [29]

In relation to the most dramatic price effects – for vegetable oil – it should be noted that the price levels expected in the "7%" scenario are comparable with those prevailing today. Under the "14%" scenario, prices would be a little higher than today; under the "no biofuel" scenario they would be a good deal lower.

The promotion of biofuels can have a negative effect on other industries that use the same raw materials, as competition drives up prices. Parts of the food industry, chemical industry and forest based industries are the most likely to be affected. The data above suggest that while such effects can be expected, their scale will not be dramatic, under any of the scenarios, relative to the prices in force today. While some industries face increasing costs as a result of biofuel promotion, others (those that use biofuel by-products such as rape meal, soy meal and glycerine) will benefit from cost reductions.

All the above price effects are fully taken into account in the employment and GDP effects reported in the previous sub-section.

4.4. Agricultural markets and rural economy

Biofuels offer potential economic benefits for EU agricultural markets and rural economy. 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

27 Increase in demand is fully met by i) straw; ii) farmed wood from new plantations. Thus no effect on existing wood users is expected.

28 There has already been a very large price drop for glycerine, almost to zero, as a result of biofuel promotion.

29 Cooper, J.C.B (2003): Price elasticity of demand for crude oil: estimates for 23 countries, OPEC Review, Vol. 27(1), March 2003, pp. 1-8.

viable markets. New market opportunities are therefore of particular interest to the agricultural sector.

If the current policy framework does not change, the quantities of domestic production depicted in the "14% (more domestic)" scenario should be seen as the most that can be achieved under sustainable conditions at EU25 level. (At EU27 level, the accession of Romania and Bulgaria adds significant production potential.) Further liberalisation of markets following a successful conclusion to the current WTO round, or measures to increase the fluidity of regional cereal markets in the EU, could significantly enhance the availability and competitiveness of cereals for first-generation (grain) and second-generation (straw and whole plant) bioethanol production. The removal of the Blair House restrictions on oilseed production on set-aside land would further increase production potential.

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.

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.

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.

4.5. Development and external relations

In adopting the biomass action plan[30] and the biofuels strategy[31,] the Commission opted for a balanced approach to biofuel trade. Under this approach, both domestic producers and importers should benefit from a growing EU market for biofuels. The opportunity to sell biofuels or biofuel raw materials into the EU market could provide a valuable opportunity for trading partners. It could help resolve regional or global trade negotiations, and could offer specific benefits to developing countries, including some of those affected by the reform of the EU sugar regime. Growing biofuels demand will likely lead to a rise in the price of agricultural products – although only a small one, even in the 14% scenario.

In terms of development benefits, for countries which have appropriate natural resources, and develop efficient supply chains, the expansion of biofuels markets opens new opportunities in

30 Biomass action plan, COM (2005) 628
31 An EU strategy for biofuels, COM (2006) 34

terms of economic and social development in the generally poorer rural areas (including employment creation, diversification of and value addition to agricultural activities, and rural access to energy). Certain countries with small domestic markets and relatively low costs will develop only if the world market offers possibilities for economies of scale.

Growing biofuels demand will likely lead to a rise in prices of agricultural products. This should further benefit farmers and rural communities, although it could be detrimental to the poorer populations. However, it should be underlined that 70% of the world's poor are also rural, and can hence also be among the beneficiary group of rising agricultural prices. Nevertheless, maximising such potentially positive impacts, as well as minimising the risks for net food consumers, requires the concerned countries to establish appropriate policies to promote food security, as well as an equitable sharing of the benefits of biofuels development. The latter should also take into account the risk of displacement of more vulnerable communities due to the rise in the value of land.

5. ENVIRONMENTAL IMPACT OF INCREASING THE SHARE OF BIOFUELS

This section looks into the following environmental impacts:

– greenhouse gas emissions

– sustainability of crops used for the production of biofuels

– sustainability of oil production.

5.1. Greenhouse gas emissions

Base data for greenhouse gas emissions were calculated from the revised version of the JRC/EUCAR/CONCAWE well-to-wheel study (JEC (2006)). Emissions values associated with the cheapest production techniques were used. These data were adjusted as follows:

- JRC (the Commission's Joint Research Centre, co-author of the JEC study) updated the study's data on biodiesel from rape and cellulosic ethanol from straw, and calculated new data for biodiesel from palm and soy.

- Electricity, heat and diesel are used as inputs in the production of biofuels. In JEC (2006) the emission profile of the electricity used is assumed to correspond to the average EU mix in 2005. The heat used (in the cheapest production techniques) is generally derived from fossil fuel. The diesel used is assumed to be entirely fossil. By contrast, the Commission's strategic energy review[32] proposes that the Community should aim, for 2020, at a 20% share of renewable energy (compared to 6.5% in 2005). This will lead to an improvement in the average emissions impact of electricity, heat and diesel. The JEC data for EU-produced biofuels were adjusted in accordance with an estimate of this improvement.

Table 6 shows the resulting values.

[32] COM (2007) 1

Table 6 Estimated greenhouse gas emissions from transport fuels, EU (mid-range estimates of the cost of the cheapest biofuel production techniques) – well-to-wheel analysis of individual fuels[33]

	greenhouse gas emissions ($tCO2_{eq}$/toe)	**expected saving 2020 (%)**
diesel	*(3.65)*	
biodiesel from rape	1.79	51%
biodiesel from soy	2.60	29%
biodiesel from palm	1.73	53%
BTL from straw	n.a.	n.a.
BTL from farmed wood	0.27	93%
petrol	*(3.62)*	
ethanol from sugar beet	2.17	40%
ethanol from wheat	1.85	49%
ethanol from sugar cane	0.41	89%
cellulosic ethanol from straw	0.33	91%

Based on these values, the greenhouse gas impact of increasing the share of biofuels can be estimated at an annual saving of 48 $MtCO_{2eq}$ in 2020 with a 7% biofuel share, 101 $MtCO_{2eq}$ with a 14% share (more domestic) and 103 $MtCO_{2eq}$ with a 14% share (more imports).[34]

The JEC data do not take into account the effect of land use change, notably changes in soil and plant carbon stocks. This can be positive (as it would be, for example, if sugar cane plantations replaced degraded pasture land), largely neutral (where biofuel demand leads to higher yields from areas that are already cultivated) or severely negative (for example, if soybean cultivation replaced rain forest). In the absence of a global land use model, it has not been possible to estimate the greenhouse gas effect effect of the land use changes likely to be associated with these scenarios.

5.2. Sustainability of crops used for the production of biofuels

Production of raw materials for 1st generation biofuels

The Commission assessed the impacts of increased production of first generation biofuels on the environment. The environmental impact of biofuels crop production will depend to a larger extent on the farmland areas used, the crops cultivated and the farming practices used. However, a wide range of climatic, physical (topography, soils), and economic conditions determine the spatial distribution of crops across the EU, which makes the assessment difficult.

[33] Equivalent saving figures for first-generation biofuels in 2005 are 34% for sugar beet ethanol, 46% from wheat ethanol and 50% for rape biodiesel.

[34] Calculations of Commission services based on the values in table 5. Maize ethanol assumed to have the same emissions as wheat ethanol. BTL from straw assumed to have the same emissions as BTL from farmed wood.

The assessment found, in summary, that the recent increase in production of biofuel crops[35] did not result in major land use changes or significant environmental impacts, as the diversion of crops from existing food and fodder markets to biofuel crops production did not lead to different farming practices.

However, a significant expansion and a change of crops patterns of the current arable land area to meet any increased biofuels market demand can be expected. In this perspective, an expanded biofuels production could lead to significant environmental pressures if most of the crops production shifted towards cropping systems which exert greater environmental pressure, such as increased water use, and if energy crops mostly expanded into current set-aside areas[36].

The main results of the assessment are the following.

– The most significant impacts on farm practices and the environment could occur if energy crops mostly expand into current set-aside areas.

– Several scenarios of changes in land use patterns driven by an expansion of biofuels were assessed. Overall, it can be concluded that a deployment of biofuels crops may lead to a decrease in input use in a given cropping system if they replace high input crops and their introduction leads to wider crop rotations more advantageous from a wider environmental perspective. The opposite can also occur. For instance, increased maize cultivation could lead to local environmental pressures, and in particular to higher water use, which will be undesirable in areas where water is a critical agronomical constraint. Cereals and sunflower have a generally good environmental profile. Oilseed rape's performance depends critically on the management of nutrients and plant protection products. Sugar beet is evaluated as more environmentally risky than cereals and oilseeds, but it is expected that its cultivation is maintained only in the most agronomical suited areas. However, the overall environmental impact of these different crops will eventually depend on the whole rotation patterns, at farm and landscape level.

– As regards permanent grasslands, their conversion into arable land is severely limited by environmental constraints fixed under cross compliance.

– While potential additional pressures of biofuel crops production may occur as a result of the incentives to transform some high nature value farmland areas or temporary pastures (fodder crops) into arable land, biofuel crop production might help improve the overall profitability of farm business, contributing to the maintenance of farming in areas where this might be useful from an economic, social and environmental perspective.

– The assessment also considered the potential future evolution of biofuels cropping. Some studies suggest that there may be some scope to reduce environmental pressure if adapted biofuels crops varieties, different from those used for food, are developed. The use of species dedicated to energy purposes, and therefore managed for their energy content and not for their nutrient value, could provide opportunities for lower input requirements and

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35 Biofuel crop production increased from using around 1% of EU25 arable land in 2003 to about 3% of arable land in 2005

36 Set-aside refers to the removal of farmland from production, usually with the overall aim of reducing the production of arable crops, in particular cereals. Farmers producing a significant amount of arable crops are required to 'set aside' a proportion of their land as a condition for receiving support payments. The current percentage is 10 % of the eligible land to the single farm payment.

extensive cropping systems (e.g., double cropping). It has also to be considered that, at current grain prices and in light of future uncertainty over returns, farmers may not seek to maximise yields but to maximise profit. To be profitable, biofuels crops need lower levels of input costs than conventional crops.

– Safeguards in the form of existing environmental legislation, such as the nitrates directive and, in particular, the cross-compliance obligations applicable from 2005 to all direct payments to EU farmers and from 2007 applicable to Rural Development measures, (under CAP) are in place to ensure that farmers undertake practices to reduce the risk of adverse impacts on the environment. Under the cross-compliance requirement, Members States must ensure that set-aside areas are managed in order to protect the environment.

Production of raw materials for second-generation biofuels

The use of agricultural by-products (like straw), ligno-cellulosic crops (like miscanthus or short rotation coppice), and forest biomass to produce second-generation biofuels are expected to deliver significant advantages:

- **Agricultural and forestry by-products**: As by-products are not produced specifically for use as a biofuels resource, the diversion of their use to biofuels does not generally increase environmental pressures. However, these materials play important agri-environmental functions that should be taken into account for determining the quantities available for biofuels (for instance, leaving straw in the soils after harvest is a good agricultural practice for protecting soils against erosion and maintaining productivity). This has been taken into account in designing the scenarios described in section 3.1.

- **Ligno-cellulose perennial crops**: Perennial energy cropping systems can deliver significant advantages compared to conventional food and fodder crops. These crops (trees or grasses), can improve soil quality in a variety of ways, such as increasing soil coverage (after several years of growth) and organic matter, reducing soil disturbance ad soil erosion risks. Plantations of certain tree species can reduce evaporative water losses and improve soil moisture conditions to allow for cropping on previously degraded lands. Perennial crops may also need reduced applications of fertilisers, pesticides, energy, and lower water inputs.

  The spreading out of perennial grasses and short rotation forestry can also further promote crop diversification and add to regional landscape and habitat diversity. However, better insights into how biodiversity can be affected by large scale expansion of short rotation coppice on farmland is needed. Increasing demand for biofuels may also create new uses for the less profitable extensive agriculture and in such way help preventing land abandonment and loss of valuable open habitats.

Production of raw materials in third countries

There is significant scope to increase third-country production of sugar cane, soy bean/oil, palm oil, rape seed/oil, wood products and other biofuel feedstocks – or biofuels made from these raw materials. However, depending on the production process and on the land used for this purpose, this can be an environmentally friendly process and contribute positively to climate change mitigation, or the opposite.

Particular risk is associated with the conversion to agriculture of land presently harbouring high-biodiversity natural environments (wetlands, native forests, and others), in areas where such ecosystems exist and where there could be rapid and uncontrolled development of biofuel feedstock production. There has been clear evidence of this phenomenon, albeit related above all to demand in the food and feed markets, in some major soy bean[37] and oil palm production areas.[38] As in the EU, third countries usually have environmental legislation, but this may not always be optimal or well enforced. Finding solutions to these issues poses formidable challenges.

5.3. Sustainability of production of petroleum-based fuels

Greater biofuel consumption will mean less consumption of oil products. This means that some of the environmental impacts of oil exploration, production and transport will be avoided.

An overview of these impacts is given in O'Rourke and Connolly (2003).[39] Having cited data on oil spills from tankers and pipelines, these authors argue that "the physical alteration of environments from exploration, drilling, and extraction can be greater than from a large oil spill. Major impacts include deforestation, ecosystem destruction, chemical contamination of land and water, long-term harm to animal populations (particularly migratory birds and marine mammals), human health and safety risks for neighbouring communities and oil industry workers, and displacement of indigenous communities".

The data cited include an indication that the European Union is particularly affected by oil spills. Among 982 oil spills that occurred since 1960 in the 11 worst hot spots for tanker oil spills, 34% were in the seas around Europe – even though Europe accounts for only 21% of global oil consumption.

The evidence given by O'Rourke and Connolly remains anecdotal rather than comprehensive. It does not make it possible to estimate how the environmental effect of oil production would vary with volume.

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37 See for example Morton, D., R. DeFries, Y. Shimabukuro, L. Anderson, E. Arai, F. Espirito-Santo, R. Freitas and J. Morisette (2006): Cropland expansion changes deforestation dynamics in the southern Brazilian Amazon, PNAS, September 26th 2006, vol. 103, no. 39, pp 14637-14641.

38 Similar concerns have been voiced that deforestation in the Amazon basin, related to the expansion of arable cultivation, could be linked to pressure on land availability caused by the expansion elsewhere in Brazil of sugar cane cultivation for ethanol. However, sugar cane expansion in Brazil appears, in fact, to be in general a well managed process that avoids such effects – even if the present state of knowledge does not permit the exclusion of the hypothesis that other crops have, on some occasions, been displaced to forested regions.

39 O'Rourke, D. and S. Connolly (2003): Just oil? The distribution of environmental and social impacts of oil production and consumption, Annual Review of Environment and Resources, 28, pp 587 – 617.

6. SUMMARY OF IMPACTS

The quantified impacts described in sections 4 and 5 are summarised in table 7.

Table 7 Promotion of biofuels – summary of quantified impacts (annual, 2020)

	"7%" scenario	**14% (more domestic) scenario**	**14% (more import)**
extra cost (relative to complete reliance on oil-based fuels)	€3.7 – €7.8 bn	€9.6 – €17.2 bn	€5.2 – €14.5 bn
short-term security of supply (maximum)	€0.5 bn	€1.0 bn	€1.0 bn
long-term security of supply – reduced imports of oil from Middle East and CIS	23 Mtoe	43 Mtoe	43 Mtoe
employment in EU	up to 105 000 jobs	up to 144 000 jobs	less favourable than the "more domestic" scenario
GDP	up to +0.12%	up to +0.23%	less favourable than the "more domestic" scenario
greenhouse gas emissions	-48 $MtCO_{2eq}$	-101 $MtCO_{2eq}$	-103 $MtCO_{2eq}$

7. PROMOTION OF FUELS THAT ARE CLIMATE AND ENVIRONMENTALLY FRIENDLY

The preceding sections analysed how a 7% and 14% share of biofuels might be achieved if cost were the driving factor in the choice of biofuels.

It suggests that the economic and environmental impacts would be globally positive.

However, there can be substantial variation in the environmental impact of producing each type of biofuel.

The main sources of variation are the following:

a) <u>Greenhouse gas impacts of using inappropriate land</u>

Some land types – notably wetland – carry quantities of stored carbon so large that the use of this land to produce raw material even for second-generation biofuels could never be considered to give a positive greenhouse gas balance.

b) <u>Biodiversity impact of using inappropriate land</u>

Some land types – notably tropical forest – shelter such diversity of life that the use of this land to produce raw material for biofuel, while it might give a positive greenhouse gas balance, could never be considered to give a positive environmental balance overall.

c) Fuel choice in the production of first-generation ethanol

According to the data in JEC (2006), the use of lignite as process fuel for the production of first-generation ethanol would give a negative greenhouse gas balance. The same would be true of coal (but not of other fossil fuels).

The renewable energy roadmap[40] proposes a system of incentives/support for biofuels. This could be designed to create disincentives to the practices outlined above – while ensuring that security of supply aspects are also taken into account.

According to the data in JEC (2006), the use of biomass as process fuel in producing first-generation biofuels, or the use of these biofuels' by-products for energy generation rather than as animal feed, can improve the rate of greenhouse gas savings by 15-20%. The increasing availability of by-products and the limited growth of animal production in the EU25 will make significant quantities available for use in this way, and these practices will be further encouraged by the incentives for the use of renewable energy in heating which would be necessary to achieve the 20% share of renewable energy in 2020 proposed in the Strategic Energy Review.

8. OTHER OPTIONS FOR ENERGY EFFICIENCY IN TRANSPORT

The Commission has assessed the potential contribution of energy saving measures in transport in the impact assessments for the action plan on energy efficiency[41] and the forthcoming communication on CO_2 and cars. Estimates, derived from these impact assessments, of the potential for reducing oil use in transport are shown in table 8.

40 COM (2006) 848
41 Action Plan for Energy Efficiency: Realising the Potential, COM (2006) 545

Table 8 Estimates of the potential for reducing oil use in transport (Mtoe, annual, in 2020)

	Potential for savings (Mtoe)	**Cost of savings (€/toe)**
Estimates from impact assessment for action plan on energy efficiency		
measures to make driving costs more km-dependent	3 to 15	
limitation of maximum speed, acceleration or power-to-weight ratio of new cars and trucks	11	
fuel efficient tyres and measures for fuel efficient tyre pressure	15	
fuel price increases	22	
maximum emission standards for new cars plus more stringent voluntary agreement for the fuel efficiency of new cars and lorries after 2008/2009	28	
Estimates from impact assessment for forthcoming communication on CO_2 and cars		
fuel efficient mobile air conditioning systems	1	36
low rolling resistance tyres	2	4
tyre pressure monitoring systems	3	-273
low friction lubricants	4	284
reducing fuel consumption in light commercial vehicles	5	557
reducing fuel consumption in passenger cars	20	71 to 505
Estimates from the present staff working paper		
promotion of biofuels	43	120 to 399

It can be seen that biofuels are the measure with the greatest potential to reduce oil use in transport. Moreover, they are the only measure on the list that decreases transport's oil dependence (the other measures reduce oil use in quantitative terms, but leave the percentage share of oil in transport energy consumption more or less untouched. Other fuels, like hydrogen (including bio-hydrogen) will in future also have the potential to do this – but, as suggested in the communication towards a European strategic energy technology plan[42], this potential will certainly not be realised by 2020.

The list includes small-scale measures that are cheap. It includes one large-scale measure (fuel price increases) that is financially cheap – but politically challenging, given the high levels of fuel taxation already applied to road transport in Europe. And it includes two measures that are expensive but capable of large-scale effects: reducing fuel consumption in passenger cars, and biofuels. It is clear that any attempt to achieve large-scale reductions in oil consumption (and greenhouse gas emissions) in transport will need to rely heavily on these two measures.

[42] COM (2007) XX

Annex : Examples of methodological conservatism in assessment of impacts

costs

- Marginal data are used. This means that cheaper biofuel raw materials with limited availability are not taken into account, and that the limited market for valuable industrial uses of glycerine is not taken into account.

- Scale economies and technology learning are not assumed for first-generation biofuels.

greenhouse gas emissions

- It is assumed that the rate of greenhouse gas emissions from agricultural production processes will not fall.

- The use of marginal data means that biofuel raw materials with lower emissions and limited availability are not taken account, and that the limited market for industrial uses of glycerine (which give high greenhouse gas savings) is not taken into account.

- The carbon stock effects of oil exploration, production and long-distance transport are not taken into account.

- The effect of oil production on N_2O emissions from soil is not taken into account.

biofuel types

- In the absence of market experience and performance data, no account is taken of the potentially better-performing biofuels expected to come on the market in 2007 (BTL from vegetable oils and biobutanol)

production potential

- The significant potential of Romania and Bulgaria is not taken into account in estimating domestic production.

- It is assumed that biofuel crops will only be grown on arable land. The possibility of producing energy crops (such as grasses) on permanent grassland has not been taken into account.

fuel efficiency

- Some authorities claim that vehicles use biofuels more efficiently than conventional fuels, permitting them to drive more km for the same quantity (measured in energy content) of fuel. For example, according to the International Energy Agency, "Biodiesel contains only about 90% as much energy as diesel fuel, but its high cetane number and lubricity lead to efficiencies just a few percentage points below that of diesel."[43]. Hamelinck and Faaij (2006) state, by contrast, that the efficiency benefits of biodiesel are "so small that they will not be reckoned with"; but they claim that "Alcohols may have a higher efficiency in

[43] International Energy Agency (2006): Energy technology perspectives – scenarios and strategies to 2050

spark-ignition [vehicles] than gasoline, if the vehicles are adapted to profit from the slightly higher octane number".[44]

- Other studies give a different view. For example, the Commission's Joint Research Centre, with EUCAR and CONCAWE (research bodies affiliated to the vehicle and oil industries), tested 10 ethanol blends in 7 cars and found no statistically significant relationship between fuel consumption (measured in energy content) and ethanol content.

- In this report, it is assumed that biofuels carry no efficiency bonus.

Against this, it should be noted that the method used for the valuation of short-term security of supply is designed to give a maximum, not a minimum estimate.

[44] Hamelinck, C. and A. Faaij (2006), Outlook for advanced biofuels, Energy Policy 34 (2006), pp 3268-3283