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COMMISSION STAFF WORKING DOCUMENT

Annex to the

COMMUNICATION FROM THE COMMISSION

Biomass action plan

IMPACT ASSESSMENT

{COM(2005) 628 final}

TABLE OF CONTENTS

COMMISSION STAFF WORKING DOCUMENT

Impact assessment on the Communication on a Biomass Action Plan

Summary

In 2004, the Commission assessed the progress of renewable energy. It concluded that if the Union's target of a 12% renewable energy share in 2010 is to be achieved, the contribution of bio-energy will need to more than double.[1] For the EU-25 this means an increase in bio-energy use from 69 million tons of oil equivalent (mtoe) in 2002 to 149 mtoe. If the EU had to supply this level of bioenergy from its domestic resources alone, it has more than enough **potential** to do so. Since most regions of the world have higher potential, relative to their energy consumption, imports offer a valuable additional source of bioenergy. This increase is therefore technically achievable.[2]

This impact assessment asks what the economic and environmental effects of such an increase would be. It examines a "BAP" scenario under which the use of transport biofuels would increase by 18 mtoe per year; biomass use for heat generation would increase by 27 mtoe/yr; and biomass use for electricity generation would increase by 35 mtoe/yr.[3] It compares the cost and benefits of this scenario with the present-day situation.[4]

It reaches the following conclusions:

1) The increased use of bioenergy would deliver the following main benefits:

   i) **Diversification of the energy mix and increase of security of energy supply.** The share of fossil fuel use in the energy mix of the EU-25 would go down from 80% to 75%. The amount of imported crude oil would fall by 8%, with biofuels and biomass heating making the main contribution to this.

   ii) **Reductions in greenhouse gas emissions.** The reductions in greenhouse gas emissions would amount to 209 million tons CO_2–equivalent per year. Electricity generation and heat supply would contribute most to these reductions.

   iii) **Job creation and stabilisation of rural regions.** Some 250 000 to 300 000 additional jobs could be directly created inside the EU-25, most of them in rural areas. Biomass in electricity and biofuels in transport would create most of them. Further indirect employment effects may additionally take place.

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1 COM (2004) 366

2 see corresponding Communication on the Biomass Action Plan, COM(2005)xxx, annex 2

3 The Commission estimates that under this scenario, the 12% overall target would be achieved, as would the renewable energy targets laid down in the Directives on electricity from renewable energy sources (Directive 2001/77) and on biofuels (2003/34)

4 There is also a comparison with a scenario taking into account the gentle increase in bio-energy use that can be expected from existing policies and measures (the "BAU" or business as usual scenario).

2) Without internalising a monetary value of these benefits, the direct additional cost would be in the range of € 2.1 billion up to €16.6 billion per year, depending on the price level of fossil fuels.1 Biofuels in transport would account for the highest proportion of the costs, followed by biomass in electricity generation.

[1] The higher figure is based on the assumption of oil at €28/barrel and an exchange rate of €1=$1,25; the lower figure is based on the assumption of oil at €60/barrel and an exchange rate of €1=$1.

1. PROCEDURAL ISSUES AND CONSULTATION OF INTERESTED PARTIES

1.1. Organisation

1.1.1. Interservice Steering Group

One of the first actions was to invite 10 services to constitute the Inter-service Steering Group (ISG), of which 8 participated actively. Contacts with EIB were also established and information was requested on various issues related to financial support for bioenergy. Furthermore, and in order to identify critical areas where better coordination amongst the policies is needed so as to accelerate the deployment of bioenergy technologies, bilateral meetings were held with 10 services BAP.

1.1.2. BAP webpage

From January 2005 a BAP dedicated page on the EUROPA web-site[1] was established where all stakeholders could obtain basic information on the objectives of the BAP as well as analysis of questionnaires and other relative information.

1.2. Timing and procedure

Impact Assessment work was begun in December 2004. From January to April 2005 the main focus of work was launching an exhaustive consultation campaign in order to collect as much information as possible on bioenergy, and equally important, to obtain the opinion of associations, NGOs and representatives from Member States on the BAP objectives and alternative options. In May - June 2005 bilateral meetings with the other services were organised to share information obtained from external consultation and to debate about the options to be included in the BAP.

In parallel meetings were organised with main stakeholders to accomplish the consultation process and to give the opportunity to an as large as possible number of them to express their opinion. Reports and minutes of meetings were made available on the EUROPA BAP webpage[2].

The consultation process will be ongoing even after the completion of the Impact Assessment since this is considered as a recurring need in the policy development process.

1.3. Consultation and expertise

Although an extensive amount of information and expertise was available inside the Commission, it was nevertheless decided to expand as much as possible the information basis and expertise with outside sources; especially Member States' regions' representatives and market actors.

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1 http://www.europa.eu.int/comm/energy/res/biomass_action_plan/index_en.htm
2 http://europa.eu.int/comm/energy/res/biomass_action_plan/doc/esg_meeting_minutes_v2.pdf

1.3.1. External Expert Group

It was decided from the inception of the BAP planning that it would be valuable to establish a small team of recognised and reputed bioenergy experts to advice the DG TREN team on the various strategies and alternatives. The consultation was aiming to examine how *market barriers can be overcome* and eventually to *discuss alternative policy options*. The names of the experts are given in Annex 1. They were invited to contribute to the deliberations on a personal basis and not that of their organisations. A meeting was held on 10 January 2005 and the External Expert Group was invited to attend the External Stakeholder Group meeting on 4 March2005 (see point 1.3.3 below).

1.3.2. Public consultation

In order to give every stakeholder the opportunity to provide his/her opinion and ideas on the BAP, an on-line public consultation was carried out. This consultation was designed as a questionnaire asking for up to 3 recommendations for necessary action on EU and national level in order to further accelerate the European bioenergy market development. The questionnaire was located on the EUROPA BAP webpage and advertised through bioenergy associations and expert networks. The public consultation was open from 2 February 2005 until 31 March2005. During that time 262 stakeholders in total responded to the questionnaire, proposing 816 activities in total (out of that 650 activities referred to EU level). The JRC Institute for Energy analysed the questionnaire feedback and composed a summary report which was published on the EUROPA BAP webpage[1]

1.3.3. External Stakeholders Group Meeting (Significantly affected groups, associations, NGOs, M.S., Consultative Committee)

Since it was necessary to limit the number of participating stakeholders in the meeting it was decided to invite relevant industry and consumer associations from along the whole bioenergy process chains (from agriculture to the energy service), members of the European national energy agencies' network (EnR), utilities, solid and liquid biofuel producers, technology providers, NGOs, and representatives of Member States. The External Stakeholders Group meeting took place in Brussels on 4 March2005 and 64 stakeholders attended the meeting. The objectives of the BAP were presented and an extensive discussion took place between the stakeholders and the Commission's representatives.

Input from the stakeholders to the BAP was obtained via a dedicated questionnaire (other than the public consultation), which was distributed at the beginning of the meeting. It was analysed internally and published on the EUROPA BAP webpage.

1.3.4. Various meetings (Workshops, ad hoc)

<u>EnR Workshop:</u> A joint workshop was held on 4 May 2005 by DG TREN in cooperation with key representatives from the European national energy agencies network (EnR). Subject of the workshop were biomass policy and implementation related presentations by EnR members and subsequent discussions. Discussed topics included best practice policy instruments for stimulating biomass deployment and barriers to successful biomass business. The workshop was aiming at providing ISG members with the biomass-related operative experience of

1 http://europa.eu.int/comm/energy/res/biomass_action_plan/doc/results_questionnaire_esg.pdf

energy agencies from all over Europe and their particular recommendations regarding the EU Biomass Action Plan. From EnR 15 members took part.

REACT Workshop: The final meeting of this EU co-funded policy analysis and advice project REACT (Renewable Energy Action) was held on 25 February 2005 with a dedicated session devoted to recommending policies for the BAP. Biomass availability, permitting procedures, financing issues and market conditions were discussed and possible action on EU-level was recommended.

Research Experts Workshop: On 11 April 2005 two bioenergy experts presented research results on biomass resource availability in Germany and the EU, aspects of nature conservation, competition between biomass use for materials and for energy, limitations of land availability, future developments of agriculture in general and ecological farming in particular, and sustainability of biomass trade. The presentations were followed by open discussions with ISG members.

1.3.5. Meetings with Member States' representatives with completed or ongoing national Biomass Action Plans

The Netherlands: The government of the Netherlands has set targets for the production of renewable energy. In order to achieve these targets, the contribution from bioenergy must increase significantly and the Netherlands were the first to develop and publish a dedicated Biomass Action Plan. As in the case of the EU-level situation, in practice the realisation of bioenergy projects is confronted with a number of problems. The Dutch Action Plan aims to solve these problems through specific actions for the government and market parties. On 15 October 2004 representatives of the Dutch government came to Brussels to present this national Biomass Action Plan to DG TREN staff. A discussion of this programme and possible supplementary action on EU level took place.

Germany: On 22 April 2005 an informal discussion with members of the German_Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety, members of the German Federal Environmental Agency (UBA), and two bioenergy experts took place in Berlin. The ministry had recently finalised a three year study on sustainable bioenergy development in Germany until 2020.

United Kingdom: The UK Government launched a biomass task force in October 2004 which is in close contact with the industry. The main task of this group is to identify barriers to the development of bioenergy and make recommendations to the UK Government. The coordinator of this task group and a ministry representative visited DG TREN on 17 May 2005 and presented their activities.

1.3.6. Main Results of the Public Consultation

The main results of the external consultation process are summarised below. There are sufficient biomass resources available in the Union to meet the needs for the additional annual 80 mtoe without adverse effects on forest product industries and food production. Any shortcomings can be addressed by imports.

There are competitive, reliable and efficient European technologies to convert the biomass resources into electricity, heat or cooling and biofuels for transport. However, research, development and demonstration work on bioenergy supported by appropriate national and EC funds, has to be intensified in order to meet challenges for bioenergy to deliver considerably higher contributions after 2010.

European and international solid and liquid biofuels markets are at their initial stages and have to be developed further to commodity level. For their successful development, work on standards and norms has to be accelerated.

Bioenergy is in general more expensive than comparative fossil fuel energy. However, in some areas, such as household heating by pellets and industrial Combined Heat and Power (CHP) based on residues, bioenergy is already competitive.

There is an urgent need to start a consumer information campaign to better inform the European citizen about the benefits of bioenergy.

The essential problem that holds back the penetration of bioenergy in the energy markets is the lack of demand.

In general, a greater bioenergy market can be achieved effectively firstly, by full, proper and timely implementation of mainly newly adopted legislation and, secondly, by more targeted and further legislation, in order to overcome the shortcomings of the legal framework.

2. PROBLEM DEFINITION

What issue or problem is the policy/proposal expected to tackle; what would be the Community added value?

2.1. The problem

The Commission's Green Paper on Security of Energy Supply[1] forecasted that unless appropriate actions were taken, the EU dependency on oil, natural gas, coal imports would increase from the current level of 50% up to 70% due to the decline of EU oil, gas, and coal productions. Additionally the EU has committed itself to reducing the greenhouse gas emissions in accordance with the Kyoto Agreement. Renewable energy sources (RES), although having progressed rapidly in recent years, are still insufficiently used in the Union. Due to increases in global consumption and in spite of the various EU energy and environmental policies their overall contribution to the gross inland energy consumption remains practically static at about 6 %. The 1997 White Paper on Renewable Energy Sources[2] put as target for the Union to double the share of RES in the gross inland energy consumption to 12% by 2010.

Figure 1: The share of RES in the gross energy production for the period of 1990 to 2002 (the EU-25)

Figure 1 shows the share of RES in the gross energy production for the EU-25 in the period 1990 to 2003. Although RES grew since 1997 the share of RES stagnated mainly due to the increase of the overall energy consumption. The main observations are that the share of natural gas has increased at the expense of coal as has oil's share due to the continuously increasing demand for transport fuels, while the share of nuclear and renewables have not changed. Since 2001 several Directives for the promotion of RES have been adopted by the Parliament and the Council, namely on RES electricity[3], energy performance of buildings[4], biofuels for transport[5], taxation of energy products[6] and combined heat and power CHP[7], however, its impact on energy statistics are obviously not yet visible (last EUROSTAT statistics are for the year 2002-2003).

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1 Towards a European strategy for the security of energy supply COM(2000)769

2 White Paper for a Community Strategy and Action Plan "Energy for the future: Renewable Energy Sources of Energy" COMM(97)599 final

3 Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal market, (OJ L283/33, 27.10.2001)

4 Directive 2002/91/EC on energy performance of buildings (OJ L1/65, 4.1.2003)

5 Directive 2003/30/EC on the promotion of the use of biofuels or other renewable fuels for transport (OJ L123/42, 17.5.2003)

6 Directive 2003/96/EC for the taxation of energy products and electricity (OJ 283/51, 31.10.2003)

7 Directive 2004/8/EC on the promotion of cogeneration (OJ L52/50, 21.2.2004)

Figure 2: The share[1] of the various RES in 2002 in the EU-25

The actual share of the various renewable energy sources for the year 2002 is given in Figure 2 from which it is clear that bioenergy including energy from waste, is the main renewable energy source contributing to about 64% of the renewables share to the gross energy production for the EU-25. The contribution of 26.7% for hydro is almost exclusively based on large scale hydro plants for which the potential for further expansion in the Union is significantly limited. This share of bioenergy has not substantially changed over the years and has remained at about two thirds of all RES contribution over the period 1990 to 2002. The main difference is that over the last 5 years wind energy has achieved significant penetration in the electricity markets; however its contribution remains very small compared to that of bioenergy.

It should be noted, however, that there are two different approaches to calculating the contribution of different forms of energy. The first, known as the “classical approach”, gives the results described above. This approach has the disadvantage that when hydropower or wind power are used to generate electricity, their contribution to the primary energy balance is given less than half the weight that would be given to gas, coal or biomass if these generated the same quantity of electricity. The alternative approach, known as the “substitution approach”, rectifies this situation. However, it has the disadvantage that the weight given to hydropower and wind power is not fixed over time or space.

Under the substitution approach, the shares of the different renewable energy sources would be approximately as follows:

- hydropower 46%;
- wind power 7%;
- biomass and wastes 44%;
- others 3%.

If the energy policy objectives of the Union are to be met, much more bioenergy will have to be brought into the market than present. This was the conclusion of the Commission Communication “The share of renewable energy in the EU”[2] that proposed that a dedicated action plan for bioenergy was needed in order to achieve the 2010 RES targets. More specifically the Communication specified that bioenergy should contribute an additional 74 mtoe by 2010 (the EU-15) if the target was to be achieved.

Further more the communication proposed indicative sub-targets for bioenergy being:

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1 Chart does not apply the substitution method for wind and hydro power.

2 Communication on the share of renewable energy in the EU, COM(2004)366 final of 26.05.2004

The EU-15 contribution of bioenergy to 2010 targets in mtoe

mtoe	**Current (2002)**	**Future (2010)**	**Difference**
Electricity	20	52	32
Heat	42	66	24
Transport	1	19	18
TOTAL	64	138	74

However, the Communication of 2004 referred to figures concerning the EU-15 and the present IA concerns the EU-25, consequently the sub-targets for bioenergy have been adapted as follow:

The EU-25 contribution of bioenergy to 2010 targets in mtoe

mtoe	**Current (2002)**	**Future (2010)**	**Difference**
Electricity	20	55	35
Heat	48	75	27
Transport	1	19	18
TOTAL	69	149	80

The aim of this IA is to examine the impact of necessary market and legislative actions that have to be undertaken either at EU or national level in order to ensure that bioenergy will provide an additional 80 mtoe by 2010 so that the EU energy policy goals for RES can be reached.

What are the underlying drivers of the problem?

2.2. Six principal obstacles

Targeted actions on energy policies as well as market conditions need to be taken in order to overcome the prevailing five barriers that would provide the appropriate conditions for bioenergy to meet these objectives.

2.2.1. Reluctance among major energy and fuel suppliers, vehicle and boiler manufacturers

The energy markets are dominated by the major multinationals in the various sectors such as the oil companies and the utilities whose main aim is to maximise the shareholders' benefit. Although the majority of the multinationals have undertaken significant steps to improve their environmental accountability and performance, they still view the renewable energy sources with scepticism rather than as a business opportunity. Therefore they tend to look for the cheapest energy source rather than for the most reliable in terms of sustainability. This barrier places bioenergy at a disadvantage since it has to compete directly with fossil fuels and has costs that tend to be higher than those of fossil fuels.

2.2.2. Various levels of ambition among Member States

Although about half of the Member States have implemented the necessary policies and market support mechanisms to promote bioenergy in an effective and convincing approach, the other half are lagging behind. This factor appears to be the most important barrier to tackle since it is convincingly proven that whenever appropriate policies are implemented, the market reacts positively and develops the necessary structures and operational systems to deliver results in accordance with the policy requirements. Most successful examples are those policies related to biofuels for transport in Germany and Sweden, co-firing in the UK, biomass based heating for households in France and municipal solid waste incineration in the Netherlands. Another important issue is often the political uncertainty that is characteristic of Member States' support for renewable energy sources and relate to the duration as well as the level of financial support given. Examples are feed-in tariffs for renewable electricity and de-taxation for biofuels for transport.

However, Member States often have different attitudes for the same resource of market application and this can be a barrier in bioenergy deployment. For example the feed-in tariffs in Germany exclude co-firing of biomass with coal while the UK has implemented the Renewable Obligation Certificate for co-firing.

2.2.3. Cost: The role of technology

Biomass in general is still more costly compared to fossil fuels at today's market prices. There is a need to reduce costs and to maximise the net energy output from all technologies. Significant efforts are being undertaken by the industry to maximise the overall efficiency of bioenergy applications. Therefore technology development will continue to play an important role in promoting reliable and cost effective bioenergy applications.

Significant progress has been achieved on biomass procurement and conversion technologies over the last decade due to successful national and EU funded programmes such as the Research, Technology and Demonstration Framework Programmes (DG RTD) and several technologies can be considered commercial on specific fuel chains such as fluidized bed boilers for the residues of the pulp and paper industry and moving grade boilers for the incineration of Municipal Solid Waste (MSW). New fuel chains addressing more complex resources, new conversion routes such as gasification and pyrolysis, and new applications, are under development and this necessitates a continuous effort to increase reliability and reduce costs.

2.2.4. Lack of awareness among consumers

With rare exceptions the average European citizen is unaware of the benefits of bioenergy and even worse he/she is viewing bioenergy with some concern regarding pollutant emissions. The bioenergy community has failed to address this properly and the press often fails to recognise the importance of bioenergy, often failing to mention bioenergy at all in articles related to renewables. An encouraging sign lately is the change in attitude of some of the major NGOs, such as WWF, that take a pragmatic view and support certain bioenergy fuel chains and applications that are considered sustainable.

2.2.5. The fuel chain complexity

Bioenergy is the only renewable resource which cannot be harnessed free of charge such as wind, the solar light, running water and hot water from the earth. On the contrary, the delivery of a biomass fuel to a user entails a series of operations that are not only costly but also need to take place often over long periods of time such as planting, managing crops or forest, harvesting, transportation, size reduction, storage and pre-treatment - for solid biofuels - or chemical transformation - for liquid and gaseous biofuels. The duration of the whole cycle can be up to one year in the case of annual crops (such as rape seed) or up to several years or even decades in the case of forests.

This presents an enormous complexity and involves numerous stakeholders in the cycle and efforts are needed to streamline the various operations and provide confidence for a sustainable and reliable system for both the farmers and foresters who grow the resource and the users who will utilise the biomass fuels in their facilities. Guaranteeing the delivery of large quantities of solid biomass with specific quality and characteristics over long periods of time to large scale users such as utilities is still an area under development.

2.2.6. Slow market and trade development

For any new fuel to penetrate the existing energy markets it is necessary that the appropriate market tools need to be developed and implemented so that the fuel can become a tradable commodity. Such market tools are in particular quality standards, a specialised trading floor, dedicated transport and storage facilities and functional market distribution systems. With rare exceptions, most of these market tools do not exist for biomass fuels or are at the early stages of development. This hinders the efficient functioning of biomass fuels markets and need to be developed urgently.

The absence of such market tools also hinders the development of trade in biomass fuels either within the EU or with third countries. International trade of biomass fuels is already taking place and the EU imports wood chips from Canada, pellets from North-Western Russia and olive kernels from North Africa. However, the trade on biomass fuels need to be further developed in order to provide fuels at competitive prices whenever these cannot be procured at sufficient quantities within the EU.

Who is affected, in what ways and to what extent?

2.3. The challenge ahead: new business opportunities

The relative slow penetration of bioenergy affects the European Union, the Member States and the European enterprises and citizen in several ways.

Insufficient use of biomass resources for energy is an unnecessary burden in the way towards sustainable development EU and MS policies. Concerning businesses, new technologies to produce biomass feedstock materials and convert them into energy could help new market developments. This in particular will benefit both the production and consumption sides: farmers and foresters would have new markets for bioenergy products; waste treatment with energy recovery would be more efficient both economically and environmentally

The EU's oil and gas import dependency continues to increase due to the continuing decrease of indigenous energy production in the North Sea. Most Member States see an increased proportion of their GNP spent on fossil fuel imports, and the growth of their economies is being restricted by the oil price hike, with detrimental effects on industrial growth. The European citizen faces price increases at the pump as well as for heating fuel oil and feels the strong impact on his/her purchasing power due to the increasing cost of energyif quality of life is to be maintained.

At the same time farmers and foresters look to the future market value of their day-to-day products with uncertainty due to the reform of the Common Agricultural Policy (CAP) and, consequently, their own future with detrimental effects for the regional economy of the EU.

2.4. Insufficient Progress

The EU has taken measures to promote RES and their penetration in the energy markets, mainly the RES-electricity Directive, the Biofuels for Transport Directive and the accompanying Energy Taxation Directive. However, taken into account bioenergy trends, additional targeted measures would be needed to achieve the EU's energy policy and subsequent sustainable development targets, aims and objectives.

The RES-electricity Directive offered a dynamic environment for wind energy to penetrate the electricity market and significant progress has been achieved. However, for bioelectricity, the Directive has not created a dynamic environment due to the more complex structure of bioenergy compared to wind energy. The main problem for wind energy is to raise the capital to build the wind farm and to obtain the operating permits. After these elements have been obtained the wind farm can operate mostly on its own with occasional maintenance. This is practically the case for all RES renewables with the exception of bioenergy, for which in addition to the above elements a complex structure of supply and demand for biofuels (solid, liquid or gaseous) has to be established. This creates uncertainty for the utilities and the complex structure discourages utilities to invest in bioenergy since they would have to depend on third parties (relative new market structures) for the supply of their fuel.

On the other hand there is no Community framework for renewable heat and cooling yet, whereas bioheat, solar heat and geothermal heat face serious problems to penetrate the markets with rare exceptions where national policies have been instrumental in supporting specific areas of RES heat.[1]

Bioelectricity, bioheat ,and liquid biofuels need to achieve extremely high growth rates if EU policy aims and targets are to be met.

The Biofuels for Transport Directive is the most recent and already a significant progress has been achieved. In 2000 biofuels contributed to about 0.2% on energy basis of all fuels used in the EU. By 2003 this had been increased by a factor of 3. If Member States achieve the national indicative targets they have adopted under the Directive the contribution of biofuels on energy basis will reach 1.4% (see Communication, Annex 4) by 2005. However, it should be taken into account that these targets are, on average, significantly lower than the reference value of 2% that the Directive laid down; and that even so, some Member States may not meet their targets.

Although biofuels for transport have achieved this very limited market penetration, their strategic importance has been further augmented due to the hikes in the price of oil. And it becomes obvious that it is necessary to look beyond 2010 and consider the bigger role biofuels will have to play in an environment of high oil prices, an agricultural policy in further need of reform, new technological breakthroughs and the challenge of imports from third countries.

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1 Solar heating is promoted in Greece, Germany, some Austrian regions and the Netherlands; bioheat is promoted in Austria, Denmark, Finland, Germany and Sweden.

2.5. The Community Added Value

The development over the last 15 years, where the share of biomass as an energy source has remained virtually constant at around 4%, has however demonstrated that a few national actions alone is not sufficient to push biomass use significantly upwards. This in spite of the fact that virtually everybody agrees that renewable energy, including biomass, has to play a bigger role as an energy source.

A strong factor behind this lack of development is that biomass often carries a higher direct cost or inconvenience for those individuals or companies using the biomass, whereas the benefits, being it improved diversification of energy mix/ security of supply, reduced greenhouse gases emissions, improvement of the job creation and employment in rural areas, may induce a downward pressure on oil prices by the effects of oil products substitution. Concerning the specific case of biofuels, it has been demonstrated that they are likely to remain more expensive than petroleum based motor fuels, even at relatively high oil prices, and users (or governments in the countries where they are used) pay the difference. The economic benefit, over and above their reduced CO_2 emissions, is however broadly shared. In addition to the need for economic solidarity, it is unrealistic to expect that individual Member States are going to push biofuel use to higher levels unless they see comparable activity in other countries.

In the case of electricity, the need for EU action to increase the share of renewables has already been recognised in the 2001 Directive. The progressing liberalisation of the electricity market and increased competition between companies since then has only further stressed the need for a level playing field. Historically based differences between electricity generators in the different Member States is already a tough challenge in the liberalisation process. It is important that further developments will smooth the path rather than adding new boulders.

In the particular case of biomass in heat and cooling, the need for EU coordination is less obvious than in the sectors with strong intra EU competition. However, the advantage of creating a broader market rather than purely local, regional and national markets is obvious. Unless equipment and fuels will make the transition from the local level to a truly internal market (fuel quality specifications, emission standard for equipment) the use of biomass in heat is unlike to move from the present, far too modest, level where is has remained for decades.

Bioenergy is a renewable energy source with a huge untapped potential that, in addition to the general characteristics of renewable energy, can replace fossil fuels (solid biomass with coal, biogas with natural gas and liquid biofuels with diesel and petrol) and can thus make a direct contribution in substituting fossil fuels while improving the security of energy supplies for the EU. Considering the transport sector, and with the exception of hydrogen from electrolysis based on RES electricity (which is not expected to become commercially viable technology within the next decade), bioenergy is the only RES that can produce renewable transport fuels.

The following factors support Community action:

2.5.1. EU-action on climate change and the Carbon cycle

The growth of biomass is based on the process of photosynthesis, plants use carbon dioxide and store carbon in forests or carbon sinks. The carbon is released again as carbon dioxide when the biomass is used for energy production. Sustainable biomass production in principle closes the carbon dioxide circle and therefore contributes to the reduction of greenhouse gases emissions. Carbon can also be stored in materials such as construction wood for buildings thereby avoiding the use of energy intensive cement. Various products at the end of their useful commercial cycle (and after recycling), such as paper, are also used for energy recovery in municipal solid waste (MSW) incinerators or in dedicated installations and the emitted carbon dioxide enters again the carbon cycle. In the medium to long term when sequestration may become technically reliable and economically sustainable, bioenergy could provide the only means to remove carbon from the environment in co-firing or large scale biomass to energy applications where the carbon dioxide would be sequestered. Biomass supportive measures need to be coherent at EU-level if they want to play a role in the EU environmental policy on climate change.

2.5.2. EU-policies on rural development, agriculture and forestry

Due to its origin as a cultivated or grown resource, bioenergy has a direct relationship with agriculture and forestry. Therefore it creates positive impacts not only on security of energy supply, the environment and employment related to the generation of energy. In addition it has been good for the employment in agriculture and forestry, in particular in rural areas and also in new M.S. since it can provide new opportunities and outlets for the Common Agricultural Policy with the cultivation of energy crops, afforestation efforts and the proper management of forests with the extraction of thinnings and fellings. In order bioenergy crops and products to compete in the internal market, common guidelines or measures should be taken at EU-level that could thus help to increase the production of biomass for energy coherently across Europe

2.5.3. EU-level measures to support the local impact

Bioenergy development could have significant impacts on the regional, local and municipal environment, in addition to avoiding emissions from combustion of fossil fuels, as with all RES. The main characteristic of the biomass sector is its proximity to the local environment. Applications are often directly related to the citizen such as household heating with solid biomass (e.g. pellets), liquid biofuels for transport (e.g. ethanol 85 blend in fuel-flexible cars and 100% biodiesel in tractors) and recovery of energy from municipal waste streams (e.g. sewage sludge and municipal solid waste) that are generated continuously by society. However, local development does not mean ‘local’ or ‘niche’ market, on the contrary, only an EU-wide market (supported by dedicated tools such as standards, certificates, trading floor for biomass exchanges, etc.) will be able to afford bioenergy powered-services to local level.

2.5.4. EU framework to help industrial development and SMEs

The European industry is considered a world leader in several areas of bioenergy such as forest operations, boiler manufacturing, incineration technology, pollution abatement, power cycles, biogas production, district heating, biodiesel production, and in general technology and innovation. A further characteristic is that the majority of the organisations working in the area are SMEs and thus bioenergy has a direct effect in strengthening local economies and employment. However, such an industrial development will not happen rapidly if bioenergy markets remain national or local. Standardisation, certification, etc. at EU-level will be needed in order to provide more opportunities for business to European industry.

2.5.5. Differences on public support for energy

The Green paper "Towards a European strategy for the security of energy supply" drew attention to the opaque nature of State aid in the energy sector and recognised the need to draw up an inventory of all forms of State aid granted by the Member States to the various energy sectors. The Directive on renewable electricity in its Article 8 requests the Commission to identify and report in particular any discrimination between different energy sources. Work has been undertaken by Commission services to identify any measure that may be an aid to a sector and this beyond the strict concept of State aid as defined in Article 87 of the EC Treaty.

Public support to fossil fuels by M.S. could negatively influence the development of sustainable energy schemes and also the deployment of bioenergy if not done within an established and balanced EU-framework.

3. OBJECTIVES

3.1. How to manage the global energy situation

At global level, energy consumption is growing fast – by 15% over the decade 1990-2000 and is expected to grow even faster between 2000 and 2020. Fossil fuels (coal, gas and oil) account for about 80% of world energy consumption. Global consumption of fossil fuels grew in line with overall energy consumption during the 1990s. Fossil fuel use is expected to grow even faster than overall consumption in the period up to 2020. Fossil fuels offer many advantages. They are relatively cheap to extract, convenient to use and widely available. The infrastructure and logistics to deliver them in the energy markets is in place and well established. The industries that supply them are well organised and offer supplies in most parts of the world.

However, fossil fuels have two main disadvantages. Firstly, when they are burned, they emit pollutants with adverse effects on public health and the environment and greenhouse gases that are causing climate change. Secondly, countries without adequate reserves of fossil fuels – especially oil – are facing increasing risks to the security of their energy supplies. Import dependence and rising import ratios has lead to concern about the risk of interruption to or difficulties in supply. New increasing demand for oil and natural gas in emerging economies such as China and India will cause further strain in the supply chain and possibly costs of oil and natural gas. However, security of supply should not be conceived as merely a question of reducing import dependency and boosting domestic production. Security of supply calls for a wide range of policy initiatives aimed at, inter alia, diversification of sources and technologies and without ignoring the geopolitical context and its implications.

The price of a barrel of oil approached the 60 US$ mark in March and exceeded 65 US$ in the summer of 2005. For the first half of 2005 the price of oil did not fall below the 45 US$. This situation is a threat to the European Union's economy.

The European Commission has set out its ideas about how to tackle these problems in its Green Paper on security of energy supply and its Communication on Energy cooperation with the developing countries. The recent Green Paper on Energy Efficiency addresses the problem faced by the Union and proposes measures to be undertaken to boost energy efficiency.

3.2. How bioenergy can contribute to successfully implement EU energy policy

The contribution of bioenergy in the gross energy consumption for the EU-25 for 2002 is shown in Figure 3 (11) and it corresponds to 4.1% or 69.3 mtoe out of 1677 mtoe. This is more than double the contribution of hydropower and about 7 times more than the rest of RES (geothermal, solar and wind) combined. Details about bioenergy's contribution to the EU energy situation are given in Annex 2. As a substitute for fossil fuels, it improves the security of supply by boosting diversification of energy production. It also tackles climate change by reducing the greenhouse gases emissions. The case for renewable energy is strengthened by its effects in protecting air quality and creating new jobs and businesses – many of them in rural areas. The general and most important characteristics of bioenergy are summarised in Annex 3

Figure 3: the EU-25[1] Gross energy consumption and contribution of Bioenergy

The **general policy objectives** of the accompanying Communication to the European Parliament and the Council on the Biomass Action Plan are:

1) to diversify the energy mix and therefore to improve significantly the security of energy supply of the EU;

2) to reduce by a great extent the emissions of green house gases due to the bioenergy use;

3) to generate new employment, by proposing alternative crops for a dynamic European agriculture and thus to promote rural development, and at same time to strengthen the competitiveness of bioenergy European industry;

4) at a global level, to strengthen the sustainable development of the EU.

Its specific/operational objectives are:

1) to propose actions to be undertaken at national and EU level to ensure an additional annual contribution of 80 mtoe generated by bioenergy, distributed as 35 mtoe for bioelectricity, 27 mtoe for bioheat/cooling and 18 mtoe for biofuels for transport applications, using current technologies;

2) to pave the way for even bigger increases by 2020, adding new technologies to the mix.

These objectives constitute a very strong framework supporting the Lisbon and Sustainable Development Strategies of the the EU.

[1] Bulgaria and Romania: see section 5.1.3 of this Impact Assessment

4. POLICY OPTIONS

What are the possible options for meeting the objectives and tackling the problem?

The Consultation identified a set of policy options and measures (annex 4) that has to be implemented in order to meet the Community objectives for renewable energy in 2010. All of them have been grouped in a BAP scenario and compared to a "no further EU action" or BAU scenario.

The "No further EU action" would not achieve the policy objectives of the EU. The shortfall has been estimated equal to about 47 mtoe.

4.1. No further EU action (Scenario 1 – Business As Usual)

This scenario is based on the present policies and the evaluation of their implementation in the EU-25 until 2010. It implies a reinforced coordination of EU policies and the full implementation of EU legislation by Member States. Considered support schemes include

4.1.1. Electricity/CHP through the RES-E Directive

Four main supporting schemes are offered by the M.S. to the electricity suppliers/ consumers:

- The "feed-in tariff" which guarantees a minimum fixed electricity price paid to the energy supplier. This tool is currently used in 18 Member States and its biggest advantage lies in the long-term guarantee for receiving support.

- The RES-E "renewable obligation" or "quota obligation" where minimum shares of renewables are imposed on consumers, suppliers or producers. This instrument is now applied in 5 M.S. .

- The Fiscal incentives such as tax exemption of CO_2 or energy taxes. This instrument is also used by 6 M.S.

- The Tender scheme which is applied in only 2 M.S.

4.1.2. Heating – Cooling

There is currently no direct EU legislation in this area as it is the case for the two other bioenergy sub-sectors. The first EU wide promotion for heat is provided through the "Buildings Directive" (energy performance of the buildings, 2002/91/EC). This Directive provides the possibility for promoting selected renewable heating technologies but does not contain targets. In order to support the development of the heat market, M.S. have put into place policies and mechanisms based essentially on the investment incentives (17 M.S.) and on tax incentives (8 M.S).

4.1.3. Biofuels for transport

On the basis of the energy taxation Directive 2003/96/EC M.S. may de-tax up to 100% biofuels that are used for transport application. The excise tax varies in the range of € 310-650 per 1000 litre. Not all M.S. have submitted their national plans to the Commission yet. There are two main support systems:

- The most significant measure is the de-taxation one and some countries apply a quota system while Germany has unlimited de-taxation up to 100%.

- New measures in AT, CZ, FR and NL 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.

4.2. Evaluation of the Business As Usual scenario for the 3 bioenergy sectors

The evaluation of the BAU scenario was carried out through a study[1] supported by DG TREN under the Altener programme.

The main results are provided in the following table (based on the study and EUROSTAT data):

Scenario 1 - BAU - the EU-25

mtoe / TWh	**Current (2002)**	**Future (2010)**	**Difference**
Electricity*	48 TWh 20.6 mtoe	106 TWh 45.5 mtoe	58 TWh 24.9 mtoe
Heat	48.2	50.6	2.4 mtoe
Transport	0.5	6.5	6 mtoe
TOTAL	69.3	102.6	33.3 mtoe

* Net electric efficiency is 20% in 2002 and 2010

4.3. Evaluation of the Biomass Action Plan scenario for the 3 bioenergy sectors

In order to meet the EU targets by 2010 the following scenario has been established:

Scenario 2 - BAP – the EU-25

TWh/mtoe	**2002**	**Future (2010)**	**Difference**
Electricity*	48 TWh 20.6 mtoe	174 TWh 56 mtoe*****	126 TWh 35.4 mtoe
Heat	48.2 mtoe	74.8 mtoe	26.6 mtoe
Transport	0.5 mtoe	18.6	18.1
TOTAL	69.3	149.4	80.1

*** Net electric efficiency is 20% in 2002 and 27% in 2010 due to high co-firing share of additional capacities**

Starting from the BAU scenario, the additional progress needed towards meeting the 2010 targets can be summarised as follows:

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[1] 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

RES – E: In order to meet the target of 2010, additional annual 58 TWh/yr of electricity have to be generated from biomass.

RES – Heat: In order to meet the target of 2010, additional annual 24 mtoe of heat have to generated from biomass.

Transport Biofuels: In order to meet the target of 2010, additional annual 12 mtoe of liquid biofuel consumption have to be mobilised.

In order to mobilise these additional amounts of bioenergy use, additional measures have to be taken on all levels: EU, nationally, regionally and locally. Those measures focussing on EU-level action have been identified and combined to an effective package which is summarised in annex 4 to this Impact Assessment and in annex 1 to the corresponding Communication COM(2005)xxx.

The Commission's judgement is that these measures, taken together, will lead to a biomass energy contribution of about 150 mtoe, broken down as above, in 2010 or a little after.

In electricity, the Commission assumes that Member States will continue to be committed to achieving their national indicative targets under directive 2001/77 on electricity from renewable energy sources. For its part, the Commission will watch carefully over the implementation of the directive in order to ensure that full implementation of this important text is achieved. While energy sources such as solar, ocean and geothermal power will make some contribution to the achievement of these targets, the main contribution will have to come from three sources: hydropower, wind power and biomass. Hydropower makes the biggest contribution today, but scope for growth is limited. Wind power is growing fast, but even in an optimistic scenario wind power alone will not be able to ensure the achievement of national indicative targets in most Member States. This will only be able to happen with a significant increase in biomass use as set out above.

In transport, the increase in biomass use set out above equates to the achievement of the 5.75% objective defined in the biofuels directive. The Commission is required to assess in 2006 whether the EU is on track to achieve this objective. If the assessment concludes that this is not the case, the Commission intends to propose appropriate measures to put progress back on track, including mandatory national targets if appropriate, in line with the directive.

In heating, the action plan defines a number of steps in the field of legislation and standardisation which would accelerate the growth of biomass use. During 2006, as stated in the plan, the Commission will review these measures with a view to identifying the most cost-effective package consistent with achieving progress at the rate set out above. It should be underlined that in this sector the main issues are not, in fact, financial, since biomass heating is competitive with conventional heating in many situations.

Taken together, these measures will create a level of *demand* sufficient to lead to an increase in biomass use to the degree set out above. But this increase will only occur if the *supply* of biomass responds to this effective demand. The plan therefore outlines how the Commission is developing policies for agriculture, waste, forestry, animal by-products, and financial support for biomass energy in order to ensure that biomass supply and processing are in a position to respond to the extra demand that is manifesting itself. Finally, the plan outlines measures to remove technical obstacles which could act as a barrier between demand and supply. The Commission believes that without these reforms, the increase in effective demand for biomass in energy would not be fully translated into an increase in supply; and that with these reforms, biomass use will reach the levels set out above, in 2010 or shortly after.

5. ANALYSIS OF IMPACTS

This chapter tries to predict, across the policy options identified in chapter 4, the likely consequences – both intended and unintended - of each option.

5.1. General Methodology

5.1.1. Two scenarios

The proposed actions, as outlined in chapter 4, should be seen as a complete package. That is why this Impact Assessment is limited to the comparison of two options for action. These two alternatives are:

- Scenario 1 "Business as Usual (BAU)": This scenario models the future development in the bioenergy sector in the EU-25 based upon present policies with currently existing barriers and restrictions. Future policies, which have already been decided upon, but have not yet been implemented, are also considered. No single BAP-related new action is assumed to be implemented in this scenario.

- Scenario 2 "Biomass Action Plan (BAP)": This scenario models the future development in the bioenergy sector in the EU-25 based upon the assumption of delivering the expected contribution to achieve the White Paper targets in the EU-25.

Starting from the year 2002 these two scenarios assume the following development in the liquid biofuels, bio-electricity, and bio-heating sectors in the EU-25 until 2010 (Table 1).

	Liquid biofuel use in mtoe/yr	Electricity generation from biomass (incl. CHP) in TWh_{el}/yr	Heat generation from biomass (incl. CHP) in $mtoe_{th}$/yr
Absolute figures			
Situation in 2002[1] [2]	0.5	48	48.2 [3]
BAU-scenario in 2010[4]	6.5	106	50.6
BAP-scenario in 2010[5]	18.6	174 [6]	74.8 [7]

1 Ragwitz, M. et al.: FORRES 2020 (op.cit)

2 EUROSTAT statistics, http://epp.eurostat.cec.eu.int

3 Calculated on the basis of the following assumptions: 47.8 mtoe total heat generation from biomass in the EU-25 in 2001 (see Ragwitz, M. et al.: FORRES 2020 (op.cit))); linear market growth until 50.6 mtoe in 2010 (BAU); 48.2 mtoe total heat generation from biomass in EU-25 in 2002

4 Ragwitz, M. et al.: FORRES 2020 (op.cit)

5 COM(2004) 366 final: "The Share of Renewable Energy in the EU"

6 Calculated on the basis of the following assumptions: 162 TWh/yr electricity generation from biomass in the EU-15 in 2010 = 27% of targeted electricity generation from RES in the EU-15 in 2010 (22.1% of 2 678 TWh/yr); 174 TWh/yr electricity generation from biomass in the EU-25 in 2010 = 27% of targeted electricity generation from RES in the EU-25 in 2010 (21.0% of 3 018 TWh/yr); in both cases total electricity generation was used as EUROSTAT statistical data for 2002; see EUROSTAT (op. cit)

7 Calculated on the basis of the following assumptions: 42.2 (66) mtoe/yr heat generation from biomass in the EU-15 in 2001 (2010); 47.8 (74.8) mtoe/yr heat generation from biomass in the EU-25 in 2001 (2010); in both cases total heat generation in 2001 was used from FORRES 2020 study; see EUROSTAT (op. cit)

Relative figures			
BAU-scenario in 2010 as compared to 2002	+ 6.0	+ 58	+ 2.4
BAP-scenario in 2010 as compared to 2002	+ 18.1	+ 126	+ 26.6
Difference BAP-BAU	+ 12.1	+ 68	+ 22.2

Table 1: Development in the liquid biofuels, bioelectricity, and bio-heating sectors in the EU-25 until 2010, divided by scenario BAP and BAU

These figures correspond to an additional biomass fuel use as outlined in chapters 4.2 and 4.3)[1].

5.1.2. Identification of most Important Impacts

The following five impacts have been selected for consideration in this Impact Assessment:

- Diversification of the energy mix/ security of supply;
- Greenhouse gas emissions;
- Direct employment effects;
- Indirect employment effects;
- Cost for the society.

All impacts have been calculated as net change compared with an identical energy supply based on conventional energy systems. They have been calculated separately for both scenarios. All quantified impacts refer to the EU-25 and the year 2010.

The Impact Assessment does not cover a potential downward effect on oil prices from reduced demand as a result of the use of biofuels in transport.

5.1.3. Enlargement

Bulgaria and Romania signed the Accession Treaty on 25 April 2005, and will joint the EU on 1 January 2007 or 2008.

The Impact Assessment focuses on the EU-25 as no similarly detailed biomass data were available on Bulgaria and Romania. The quantitative effect of this, as regards the identified impacts, is assumed to be small as primary energy consumption in Bulgaria and Romania (19 and 36 mtoe/yr, respectively, as compared to 1 677 mtoe/yr in the EU-25[2]) and the use of renewable energy in these states (0.83 and 3.75 mtoe/yr, respectively, as compared to 95 mtoe/yr in the EU-25[3]) are relatively small.

[1] Conversion factors: 1 mtoe = 1 million tonnes of oil equivalent = 41.868 PJ = 41.868 x 1015 J = 11.63 TWh; 1 GWh = 3.6 TJ = 3.6 x 1012 J; 1 TWh = 3.6 PJ = 3.6 x 1015 J; 1 kWh = 3.6 MJ

[2] EUROSTAT (op. cit)

[3] EUROSTAT (op. cit)

Qualitatively, however, Bulgaria and Romania are of high importance for bioenergy and they will play an important role during the implementation of the Biomass Action Plan. Both Accession States have a significant district heating sector and offer substantial potentials of unused biomass resources.

5.1.4. General Assumptions

Both scenarios, BAU and BAP, model the reality in an abstract way. They subdivide the complex bioenergy market into the three sectors "liquid biofuels", "bio-electricity" and "bio-heat" because different quantitative impacts can be expected from these sectors. Electricity produced from combined heat-and-power (CHP) installations is included in the "bio-electricity" category. Heat co-produced in CHP stations is included in "bio-heat".

The Impact Assessment aims at identifying global quantitative and qualitative impacts for the totality of all bioenergy installations to be brought on stream within these three sectors throughout all the EU-25 Member States by 2010. That is why a detailed break-down into certain biomass feed-stocks, supply chains, and/or conversion technologies within the three biomass sectors has not been carried out. Regional differences as regards biomass types and availability as well as climatic conditions amongst the EU-25 Member States have not been treated separately either.

Considering that the three sectors mentioned comprise very different technologies, the following indicative energy system mixtures have been assumed: Additional liquid biofuel use is modelled as a mixture of biodiesel (56%) and bio-ethanol (44%, with 16% stemming from sugar beet and 28% from wheat) in accordance with the current ratio of diesel and petrol consumption in the EU-25. Additional bio-electricity generation is modelled as a mixture of biomass co-firing in fossil-fuel based power and CHP installations on the one hand (50%) and stand-alone biomass CHP installations of all sizes including biogas on the other (50%). Additional bioheat generation is assumed to be partly based on modern small scale installations like pellet and wood chip fired central heating boilers or co-generated heat from small scale CHP-plants (together 50%), and partly to be based on medium to large scale installations like co-generated heat from larger CHP-plants, district heating, and industrial heating applications (together 50%). These assumptions may contribute to conservative cost calculations, as comparatively costly options (e.g. bioethanol, small scale CHP) are considered with substantial shares in biomass growth.

Biomass and biofuel imports from outside the EU-25 have been taken into consideration although recent studies identified sufficient available biomass resources in the EU-25 to meet 2010 White Paper targets[1]. In this Impact Assessment it is assumed that in 2030 30% of all liquid biofuels used in the EU-25 are imported. Additionally, 15% of all biomass to be used in electricity and 10% of all biomass to be used for heat supply are supposedly imported. The higher import share for liquid biofuels is justified by the easier integration of liquid biofuels in existing transport logistics.

The level of future global energy prices has a great influence on the results of the Impact Assessment. In the past, prices 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:

[1] EUROSTAT (op. cit)

- A low global energy price environment with oil prices ranging at 35 US$/barrel (= 28 €/barrel at 1.25 US$/€; 4.9 €/GJ). Coal and natural gas prices also tend to be low: coal import prices range at 35 €/tonne (1.3 €/GJ), natural gas import prices at 2.5 €/GJ. These prices correspond to the average level of the past ten years [1].

- A high global energy price environment with oil prices ranging at 60 US$/barrel (= 60 €/barrel at 1.0 US$/€; 10.4 €/GJ). Here coal import prices reach 60 €/tonne (2.2 €/GJ) and natural gas import prices 5.0 €/GJ. These prices correspond to current peak price levels.

- A third scenario with very high oil prices of 90$/barrel (75€/barrel at present exchange rate of 1.20 US$/€) was not calculated as it would not deliver substantially different results. Plant oil based biodiesel breaks even with petroleum based diesel at 75€/barrel crude oil. Bioethanol produced in Europe on the basis of European crops are likely to require an oil price of 90 €/barrel (110 $/barrel at present exchange rate) to break even.

Considering the general uncertainties arising from these model assumptions and the very limited outlook of the Impact Assessment (2002-2010), all data are assumed to be of virtually the same reference year. This means that there is no differentiation carried out 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 order of magnitude. They cannot be used to assess the impacts of individual installations as certain local conditions may yield totally different results.

5.2. Diversification of the Energy Mix/ Security of Supply

The use of biomass based energy carriers contributes to the diversification of the energy mix used in Europe. In addition to that, biomass can be considered a domestic resource. With this characteristic bioenergy positively contributes to the security of energy supply for Europe.[2]

5.2.1. Detailed Methodology

This chapter determines the net fossil and nuclear primary energy substitution potential for both scenarios as a quantitative indicator for their contribution to a diversification of the energy mix and security of supply. Results are expressed in energy units (mtoe) of substituted fossil and nuclear primary energy.

Considering the very high import dependency of the EU-25 on crude oil (77% in 2002[3]), the substitution potential of this primary energy resource is determined separately as far as the major substitution potentials are concerned (transport and heating sector). The consumption of all other fossil and nuclear primary energy resources as well as minor mineral oil substitution potentials are summarised as a "fossil and nuclear primary energy mix". Here the import

[1] see EUROSTAT (op. cit)

[2] European Commission: Towards a European Strategy for the Security of Supply. Green Paper, Brussels, 2001

[3] see EUROSTAT (op. cit)

dependency can be assumed as an average value of all the EU-25 fossil and nuclear energy imports (48% in 2002[1]).

Consumption of fossil and nuclear primary energy for the production of imported liquid biofuels is assumed to be zero inside the EU-25. The influence of imports on electricity and heat generation from biomass has been neglected due to the substantially lower level of fossil and nuclear primary energy consumption in these life cycles and due to the lower import rates.

5.2.2. Data Base

A literature survey revealed the following net fossil and nuclear primary energy substitution potentials for different bioenergy supply systems (Table 2; based on references [2] [3]). It is assumed that the share of substituted nuclear energy is negligible in comparison to the share of substituted fossil primary energy. The reason for that is that the operation of nuclear power plants is usually continuously taking place at base load, regardless of any load changes in the medium or peak load. That is why in this Impact Assessment any substitution potential of fossil and nuclear primary energy will be assumed to be primarily a fossil primary energy carrier substitution potential.

	Fossil PE substitution potentials in mtoe PE/ mtoe biofuel use	Fossil PE substitution potentials in mtoe PE/ mtoe biomass use for electricity	Fossil PE substitution potentials in mtoe PE/ mtoe biomass use for heating
Crude oil *	1.3	-	0.45
Fossil primary energy mix* (import rate in %)	Biodiesel (56%) -0.55 Bioethanol (44%) -0.8 Mix (100%) -0.66 30% -0.46 **	Mix (100%) 0.90	Mix (100%) 0.50
Total	0.84 **	0.90	0.95

Table 2: Fossil primary energy (PE) substitution potentials for different uses of bioenergy

* *Negative values refer to a consumption of fossil primary energy, positive values refer to a saving of fossil primary energy*

** *Import of liquid biofuels is considered (fossil PE consumption for biofuel production takes place outside the EU-25)*

Logic check: The values at the bottom row of table 2 can be compared with each other because they refer to the same amounts of energy (1 toe). It should be noted, however, that the value for biofuels does not refer to 1 toe biomass input but to 1toe liquid biofuel. Furthermore this value does not account for any energy consumption caused by biofuel production outside

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[1] see EUROSTAT (op. cit)

[2] 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

[3] Heinz, A.; Kaltschmitt, M.; Hofbauer, H.: Use of energetic and non-energetic resources in energy systems (in German). UWSF Z Umweltchem Oekotox 2004 (OnlineFirst)

the EU-25. That is why it appears higher than usually expected. That is why the hierarchy of specific fossil primary energy savings as shown in table 2 is reasonable. Stationary bioenergy applications can be realised with lower fossil primary energy consumption than biofuels.

Table 2 indicates that every 1.0 mtoe biofuel is being produced with a fossil and nuclear 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.

Bioelectricity is by 90% less based on fossil and nuclear primary energy resources than electricity produced from a fossil and nuclear fuels mix (with a very high coal share due to the co-firing assumptions).

Heat from biomass consumes 95% less fossil and nuclear primary energy than heat generation from fossil fuels). Considering that a large scale replacement of natural gas based heating installations with biomass fired boilers does not make sense from an environmental end economic point of view, we assume a high share of bioheat to replace heat generation from mineral oil products (and coal). This is consistent with our assumption made in chapter 5.5.2 on external costs; requesting that a substantial increase in the use of bioheat shall not lead to a net increase in pollutant emissions. This assumption does not affect the total fossil and nuclear primary energy substitution potentials.

5.2.3. Results

Based on the basic scenario data assumptions (section 5.1.1) on the one hand and the specific input data from the preceding section on the other, the following indicative finite primary energy substitution potentials are calculated for the year 2010 (Table 3):

	Due to additional liquid biofuel use in mtoe/yr	**Due to additional bio-electricity generation in mtoe/yr**	**Due to additional heat generation from biomass in mtoe/yr**	**Total**
Crude oil substitution potential in mtoe/yr				
Scenario BAU	7.8	0	1.4	9.2
Scenario BAP	23.5	0	15.0	38.5
Additional fossil primary energy substitution potential in mtoe/yr				
Scenario BAU	-2.8	16.6	1.5	15.4
Scenario BAP	-8.4	36.1	16.6	44.4
Total fossil primary energy substitution potential in mtoe/yr				
Scenario BAU	5.0	16.6	2.9	24.5
Scenario BAP	15.2	36.1	31.6	82.9
Difference BAP-BAU	10.1	19.5	28.7	54.8

Table 3: Fossil primary energy substitution potentials for the year 2010, divided by scenario BAP and BAU

In summary the two scenarios end up with indicative fossil primary energy savings of 25 mtoe/yr (BAU) and 83 mtoe/yr (BAP) respectively in 2010. Looking at crude oil substitution only, the two scenarios end up with net savings of 15 mtoe/yr (BAU) and 44 mtoe/yr (BAP) respectively in 2010. This means that the full delivery of the expected biomass contribution to achieve the White Paper targets in the EU-25 would cause an additional 55 mtoe/yr fossil primary energy substitution potential (as compared to the BAU scenario). Out of that 29 mtoe/yr would be crude oil.

Compared to 2002, the BAP scenario would reduce the European consumption of crude oil by 39 mtoe/yr. This equals 7.8 % of all crude oil imports into the EU-25 (490 mtoe/yr crude oil imports in 2002[1]). Adding this to the additional crude oil savings announced in the energy efficiency green paper[2], the EU-25 would be substantially less dependent on oil imports.

In 2002 the EU-25 consumed 1 677 mtoe of primary energy out of which 1 334 mtoe were of fossil origin. The total European import rate of primary energy carriers was 48% (virtually exceptionally due to 789 mtoe/yr of imported fossil energy carriers). The crude oil consumption of the EU-25 was 638 mtoe/yr at an import dependency of 77%. Relating these statistical data[3] to the substitution potentials as summarised in table 3, the following conclusions can be drawn:

- A realisation of the BAP scenario (83 mtoe/yr of substituted fossil primary energy) would reduce the share of fossil fuel use in the energy mix of the EU-25 from 80 % to 75 %. This equals an increase of the share of renewable energy within the primary energy mix of the EU-25 by 5 percentage points.

- If the substitution of fossil primary energy carriers would reduce both, domestic and imported energy carriers proportionally, a realisation of the BAP scenario would reduce the European import dependency on primary energy carriers from 48% to 44% (amount of total fossil primary energy imports being reduced from 789 mtoe/yr to 740 mtoe/yr). If the substitution of fossil primary energy carriers would solely reduce imports, the European import dependency on primary energy carriers would go down from 48% to 42% (amount of total fossil primary energy imports being reduced from 789 mtoe/yr to 706 mtoe/yr).

- A similar conclusion can be drawn for crude oil substitution. Assuming that the substitution of crude oil inside the EU-25 (39 mtoe/yr) would primarily reduce crude oil imports, a realisation of the BAP scenario would reduce the import share of crude oil into the EU-25 from 77% to 71% (amount of total crude oil import being reduced from 491 mtoe/yr to 452 mtoe/yr).

5.3 Greenhouse Gas Emissions

A second impact which is a key driver for an increased use of bioenergy is climate change. Biomass has got the potential to substantially reduce greenhouse gas (GHG) emissions and thus to contribute to European GHG reduction targets.

In the past substantial GHG reductions have been achieved by fuel switching to gas and from one-off effects of structural changes away from more pollutant sectors to less emitting ones in several Member States. In future it may turn out to be harder to realise further GHG reductions.

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[1] see EUROSTAT (op. cit)
[2] European Commission: Doing more with less. Green Paper on energy efficiency. Brussels, 2005
[3] see EUROSTAT (op. cit)

5.3.1. Detailed Methodology

This chapter determines the net differential greenhouse gas emissions for both scenarios. For each scenario, the net differential greenhouse gas emissions result from subtracting the total greenhouse gas emissions of the additional bioenergy use in 2010 from the total greenhouse gas emissions of an identical additional energy supply based on conventional energy systems (identical in terms of energy service provided). For both, biomass and fossil fuel based energy systems, the total greenhouse gas emissions are calculated as total life-cycle greenhouse gas emissions of energy systems. All relevant greenhouse gases such as CO_2, CH_4, N_2O are considered and weighed according to their relative greenhouse potential. Results are expressed in CO_2-equivalent emissions.

According to common life cycle analysis practice, direct CO_2-emission from biomass and biofuel combustion is not considered as relevant for climate change (due to the virtually closed carbon cycle of recent biomass growth and combustion). That is why this CO_2-emission is not accounted for in the total greenhouse gas balance. All other greenhouse gas emissions in the life cycle of the bioenergy systems are certainly fully accounted for.

The greenhouse gas balance is calculated on a global base and not referring to savings inside the EU-25, only climate change is a global concern. Considering that most GHG savings take place where otherwise fossil fuels would be burned, it can be assumed that virtually all GHG savings quantified here take place in the EU-25.

Any changes in global greenhouse gas balances due to the use of imported biomass have been neglected. This is a conservative approach as in other parts of the world energy crops may grow with higher yields and less additional energy input. Additionally, all GHG emissions caused by crop production and processing outside the EU-25 are fully taken into consideration and reduce the net reductions. These yields a conservative result for the GHG savings in Europe.

5.3.2. Data Base

A literature survey revealed the following total greenhouse gas (GHG) emissions for different energy supply systems (Table 4; based on references [1] [2] [3] [4] [5] [6] [7] [8]). The only figures that were utilised in the Impact assessment are the differential values in the bottom row of this table.

	GHG-emissions of transport fuels in kg_{CO2-eq}/toe	**GHG-emissions of electricity generation in g_{CO2-eq}/kWh_{el}**	**GHG-emissions of heat generation in g_{CO2-eq}/kWh_{th}**

[1] JRC Ispra: Well-to-Wheel (op. cit)

[2] Dones, R.; Heck, Th.; Bauer, Chr.; Hirschberg, St.; Bickel, P.; Preiss, Ph.: ExternE-Pol Externalities of Energy: Extension of Accounting Framework and Policy Applications. Belgium, 2005 (www.externe.info)

[3] Institute for Applied Ecology (Oeko-Institut): Bioenergy – New Growth for Germany. Darmstadt, Berlin, Freiburg, 2004; see also full report (in German) under http://www.oeko.de/service/bio/

[4] Kaelber, St.; Leible, L.; Kappler, G.; Lange, S.; Nieke, E.; Proplesch, P.; Wintzer, D.; Fuerniss, B.: Renewable transportation fuels, electricity or heat from wood and straw – a system analytical evaluation. Bioenergy in Wood Industry 2005, Book of Proceedings, Finland

[5] VIEWLS (2005): Environmental and Economic Performance of Biofuels

[6] Licht, F.O. : Ethanol Production Costs a World Wide Survey. 2003

[7] Licht, F.O.: World Ethanol and Biofuels Report. 10.5.2005

[8] JRC: Techno-economic Analysis of Bio-Alcohol Production in the EU. 2002

Bioenergy-based energy supply	Biodiesel (56%): 1 538 Bioethanol (44%): 1 930 * Mix (100%): 1 710	Mix (100%): 60	Mix (100%): 35
Conventional energy supply	Diesel (56%): 3 495 Petrol (44%): 4 427Mix (100%): 3 905	Mix (100%): 750	Mix (100%): 300
Difference bio fossil	-2 195	-690	-265

Table 4: Total greenhouse gas (GHG) emissions[1] for different energy supply systems

* *Imported bioethanol reduces GHG emissions by 90% as compared to petrol. Bioethanol value without imports: 2 568 kgCO2-eq/toe*

Logic check: The values at the bottom row of table 4 cannot be directly compared with each other because they refer to different amounts of energy (toe, kWh electricity, kWh heat). Relating all figures to 1 mtoe biomass input they yield about: -1 688 t_{CO2-eq}/mtoe biomass input (biofuels); -2 167 to -2 560 t_{CO2-eq}/mtoe biomass input (bioelectricity at 27-35% el. efficiency); -2 466 t_{CO2-eq}/mtoe biomass input (bioheat). This hierarchy of specific GHG savings is reasonable. The relatively highest GHG savings are realised when 1 mtoe biomass is used for electricity generation at high efficiencies e.g. in co-firing or CHP installations and substituting – as assumed here – primarily coal.

5.3.3. Results

Based on the basic scenario data assumptions (section 5.1.1) on the one hand side and the specific input data from the preceding section on the other, the following indicative net differential GHG emissions are calculated for the year 2010 (Table 5):

	Due to additional liquid biofuel use in million t_{CO2-eq}/yr	**Due to additional bio-electricity generation in million t_{CO2-eq}/yr**	**Due to additional heat generation from biomass in million t_{CO2-eq}/yr**	**Total**
Scenario BAU	-13.2	-40.0	-7.4	-61
Scenario BAP	-39.7	-86.9	-82.0	-209
Difference BAP-BAU	-26.6	-46.9	-74.6	-148

Table 5: Net differential GHG emissions are calculated for the year 2010, divided by scenario BAP and BAU

Table 5 indicates that the two scenarios end up with total reduced GHG emissions in 2010 of -61 million t_{CO2-eq}/yr (BAU) and -209 million t_{CO2-eq}/yr (BAP) respectively. This means that

[1] These values represent total life-cycle greenhouse gas (GHG) emissions, including all GHG emissions which occur during biomass and fossil fuel production, processing, transport, distribution and utilisation.

the full delivery of the expected biomass contribution to achieve the White Paper targets in the EU-25 would cause an additional reduction of GHG emissions by -148 million t_{CO2-eq}/yr in 2010 (as compared to the BAU scenario).

A recent IEA study which assessed the effects of the EU-25 meeting its RES targets for 2010 ended up with a biomass-related GHG reduction of -178 million t_{CO2-eq}/yr in 2010[1]. This value has to be compared with the BAP-scenario result (-209 million t_{CO2-eq}/yr). The difference (15%) is likely to be caused by different assumptions made for the electricity sector. This Impact Assessment assumes 50% of the additional bio-electricity to be produced in co-firing installations, primarily in coal fired power plants (see section 5.1.4). Such installations have specific greenhouse gas emissions (GHG) of 800 to 1 000 gCO_2-eq per generated kWh of electricity[2]. The other 50% derive from distributed bio-electricity installations which indirectly (via the electric grid) substitute electricity generation in conventional medium and peak load installations. These installations are primarily based on hard coal and natural gas use with specific GHG emissions in the order of 400-800 gCO_2-eq/kWh [3]. With this background, we assumed the average specific GHG emissions of electricity generation from substituted conventional energy systems to be 750 gCO_2-eq/kWh (see table 4). The cited IEA study does not disclose its assumptions on substituted electricity generation. It could be assumed that the IEA study has utilised the average specific GHG emissions of the whole European power plant mix (covering all base, medium, and peak load installations and all fuels incl. nuclear and renewables). In this case they would have calculated with specific GHG emissions for power generation of only 422 gCO_2-eq/kWh on average[4]. Using this value instead of 750 gCO_2-eq/kWh would have yielded GHG reductions of -167 million t_{CO2-eq}/yr for the BAP scenario in 2010. The relative difference to the IEA study results would thus be reduced to -6% (down from +15%). We consider this as a confirmation of our calculations. However, this Impact Assessment does not allow for the use of this low specific GHG emissions for conventional power generation (422 gCO_2-eq/kWh), because the assumptions made here about the structure of future bio-electricity installations would directly cause a significantly higher substitution of coal-based power generation.

5.4. Direct Employment Effects

A third key driver for bioenergy is its particular potential to directly generate new employment opportunities. These additional direct employment effects would primarily be caused in rural regions. In consequence, bioenergy has got the potential of economically stabilising rural regions and thus positively contributing to European cohesion.

5.4.1. Detailed Methodology

This chapter determines the direct full time employment (FTE) effects of an increased bioenergy use in the EU-25 in 2010 for both scenarios. For each scenario, the direct FTE effect is a summarised value for the whole life-cycles of biomass use. Calculations refer to the year 2010.

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1 International Energy Agency (IEA): Renewable Energy in Europe - Building Markets and Capacity. London, 2004

2 Dones, R. et al.: ExternE-Pol (op. cit)

3 Dones, R. et al.: ExternE-Pol (op. cit)

4 Greenhouse gas emissions data: European Environment Agency; Energy data: EUROSTAT (op. cit)

The direct employment effects comprise all direct employment effects of biomass production, processing, logistics as well as all direct employment effects of the operation of bioenergy installations. These direct effects mostly take place in rural regions.

It is assumed that imported biomass does not cause any direct employment effects inside the EU-25. This is a conservative assumption, as European workforce would still be needed to transport imported biomass e.g. from the harbours to the (rural) bioenergy installations or refineries and to process the biomass there.

It is important to note that this calculation is limited to direct employment effects of bioenergy use only. Neither indirect employment effects (e.g. caused by purchases within the bioenergy process chains or by the crowding out of competing energy systems), nor macro-economically induced employment effects (e.g. caused by changed purchasing powers) have been considered here. These effects are discussed in sub-chapter 5.5.

5.4.2. Data Base

A literature survey revealed the following direct full time employment (FTE) effects for different bioenergy supply systems (Table 6; based on references [1] [2] [3] [4]).

Few expert studies disclose direct FTE effects of bioenergy systems separately. Often they only present the sum of direct and some indirect (usually only those being caused by purchases within the life-cycles) FTE effects. In general, results vary substantially depending on the assumptions made:

- Biofuels for transport: The sum of direct and indirect FTE effects are reported to be 16 000 to 26 000 FTE/mtoe[5], 4 300 to 14 520 FTE/mtoe[6], and 6 300 to 10 500 FTE/mtoe[7]. One study identifies 18% of these job effects to be indirectly caused by agricultural inputs, 54% to be directly caused by plant cultivation and storage, and 28% to be caused by biofuel production and transport (without distinguishing between direct and indirect effects) [8]. According to this study, direct effects contribute largely to the total job effects of biofuels. Another study presents the opposite and calculates direct job effects of biofuels to be only in the order of 30% out of the sum of direct and indirect effects [9]. Our assumption is the direct creation of 8 100 FTE effects due to the production of biofuels (without consideration of imports).

- Bioelectricity: One study calculates the sum of direct and indirect FTE effects of bio-electricity in the range of 100 to 5 700 FTE/TWh of electricity, depending on the scale of the installation and the share of energy crops used. The contribution of direct effects to this

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1 COM (2001) 547 provisional version, on alternative fuels for road transportation and on a set of measures to promote the use of biofuels
2 IEA: Renewable Energy in Europe (op. cit)
3 Price Waterhouse Coopers (PWC): Evaluation of the externalities and economic, social and environmental effects of the biodiesel production chain in France. Paris, 2003
4 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
5 COM (2001) 547 provisional version (op. cit)
6 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
7 PWC: Evaluation of the externalities of biodiesel (op. cit)
8 PWC: Evaluation of the externalities of biodiesel (op. cit)
9 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)

figure is presented as 70% on average [1]. This yields direct FTE effects of 70 to 4 000 FTE/TWh. Another study calculates the direct effects of bio-electricity in the range of 13 to 52 FTE/PJ fuel use which equals 173 to 693 FTE/TWh [2]. Our assumption is the direct creation of 900 FTE effects for power generation from biomass. This value is assumed to be a robust average value for all types of biomass fuels and scales of installations. Imports are not considered yet in this value.

- Bioheat: The references used are the same as for bio-electricity. One study calculates the sum of direct and indirect FTE effects of bioheat installations in the range of 300 to 1 700 FTE/TWh of produced heat. Again, this value largely depends on the scale of the installation and the share of energy crops used. The contribution of direct effects to this figure is documented to be some 25% on average[3]. This yields direct FTE effects of about 75 to 425 FTE/TWh for bioheat. Another study calculates the direct effects of bioheat as 52 to 134 FTE/PJ fuel use. This equals 235 to 605 FTE/TWh[4]. Our assumption is the direct creation of 245 FTE effects for heat supply from biomass.

	Direct FTE effects of transport fuels in FTE/mtoe	Direct FTE effects of electricity generation in FTE/TWh_{el}	Direct FTE effects of heat generation in FTE/TWh_{th}
Bioenergy-based energy supply (import rate in %)	Mix (100%): 8 100 30% 5 670 *	Mix (100%): 900 15% 765 *	Mix (100%): 245 10% 220 *

Table 6: Direct full time employment (FTE) effects for different bioenergy supply systems

*: All direct FTE effects have been reduced by the rates of imported biomass fuels

Logic check: The values at the bottom row of table 6 cannot be directly compared with each other because they refer to different amounts of energy (mtoe, TWh electricity, TWh heat). Relating all figures to 1 mtoe biomass input they yield some 4 362 direct FTE/mtoe biomass input (biofuels); 2 722 direct FTE/mtoe biomass input (bioelectricity); 2 050 direct FTE/mtoe biomass input (bioheat). This hierarchy of direct job effects is reasonable. The relatively highest direct FTE effects are realised when 1 mtoe biomass is used for biofuel production. Here the highest share of energy crops is utilised. The lowest direct FTE effect is realised when biomass is used for heat generation because here the use of energy crops is lowest and the operation of residential heating installations (through residents) is not considered as an employment effect.

5.4.3. Results

Based on the basic scenario assumption (section 5.1.1) on the one hand and the specific input data from the preceding section on the other, the following indicative direct full time employment (FTE) effects have been calculated for the EU-25 in the year 2010 (Table 7).

	Due to additional liquid biofuel	**Due to additional bio-electricity generation in**	**Due to additional heat generation from biomass in**	**Total**

1 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
2 IEA: Renewable Energy in Europe (op. cit)
3 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
4 IEA: Renewable Energy in Europe (op. cit)

	use in FTE/yr	FTE/yr	FTE/yr	
Direct employment effects in rural regions of the EU-25				
Scenario BAU	34 020	44 370	6 150	84 540
Scenario BAP	102 627	96 390	68 158	267 175
Difference BAP-BAU	68 607	52 020	62 008	182 635

Table 7: Direct full time employment (FTE) effects of an increased use of bioenergy for the EU-25 in 2010, divided by scenario BAP and BAU

The two scenarios end up with indicative direct full time employment effects of 85 000 FTE/yr (BAU) and 267 000 FTE/yr (BAP) respectively for the EU-25 in 2010. This means that the full delivery of the expected biomass contribution to achieve the White Paper targets would cause an additional direct employment effect of 183 000 jobs for the EU-25 in 2010 (as compared to the BAU scenario). Most of these additional job opportunities would be created in rural regions.

5.4.4. Summary

This calculation of direct employment effects for the BAP scenario can be summarised as follows:

1) For the purpose of this Impact Assessment, direct employment effects of bioenergy use are defined as those employment effects which are directly caused by biomass production, processing, logistics as well as operation of bioenergy installations. This does neither include indirect employment effects (e.g. caused by purchases within the bioenergy process chains or by the crowding out of competing energy systems), nor macro-economically induced employment effects (e.g. caused by changed purchasing powers).

2) The starting point of direct employment effects calculation is the extra biomass consumption in 2010 as compared to 2002. For the BAP scenario, this means an extra 18.1 mtoe/yr of transport biofuels, an extra of 35.4 mtoe/yr biomass use for electricity generation, and an extra of 33.3 mtoe/yr biomass use for heat supply (i.e. an extra 26.6 mtoe/yr heat from biomass).

3) The next step is the quantification of the direct job creation (in full time employment FTE effects) per mtoe of biofuels and biomass fuel use. One study directly presents such figures. These are 623 to 2 498 FTE/mtoe (173 to 693 FTE/TWh at 31% el. efficiency)[1] for bio-electricity and 698 to 3 954 FTE/mtoe (75 to 425 FTE/TWh at 80% efficiency)[2] for bioheat. The other data available to us only give total full time employment (FTE) effects combining direct and indirect effects. These are 4 300 to 26 000 FTE/mtoe[3] [4] [5] for liquid biofuels, 356 to 20 285 FTE/mtoe (100 to 5 700

[1] IEA: Renewable Energy in Europe (op. cit)

[2] IEA: Renewable Energy in Europe (op. cit)

[3] COM (2001) 547 provisional version, on alternative fuels for road transportation and on a set of measures to promote the use of biofuels

[4] Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)

[5] PWC: Evaluation of the externalities of biodiesel (op. cit)

FTE/TWh) for bio-electricity[1], and 2 791 to 15 817 FTE/mtoe (300 to 1 700 FTE/TWh) for bioheat [2]. The large differences in job effects are caused by the different scales of biomass installations and the different biomass fuels assumed. The more energy crops are use and the smaller the installation, the higher the direct employment effects (and the higher the internal cost).

4) Some available studies indicate average break-downs between direct and indirect job effects. These give direct-to-total ratios of 30 to 80% for transport biofuels[3] [4], and 25% to 94% for bio-electricity and bioheat [5] [6]. We use middle range values of 54% for transport fuels, and 60% for both, bio-electricity and bioheat.

5) In the light of these data indicative middle range estimates for direct job effects where taken as follows: 8 100 FTE/mtoe for liquid biofuels (54% out of 15 000 FTE/mtoe), 3 203 FTE/mtoe (60% of 5 338 FTE/mtoe) for bio-electricity and 2 278 FTE/mtoe (60% of 3 796 FTE/mtoe) for bioheat. These figures assume a 100% biomass production inside the EU-25.

6) To comply with the rest of this Impact Assessment it has been assumed that only 70% of transport biofuels have been produced inside the EU-25, 85% of biomass for electricity generation and 90% of biomass for heating purpose. The direct employment figures were reduced proportionally assuming that imported biofuels do not have any direct employment effects inside the EU-25 at all. The result of this process are 5 670 FTE/mtoe for liquid biofuels (70% of 8 100 FTE/mtoe), 2 722 FTE/mtoe (85% of 3 203 FTE/mtoe) for bio-electricity and 2 050 FTE/mtoe (90% of 2 278 FTE/mtoe) for bioheat. These figures account for biomass imports.

7) The direct employment effects of an increased bioenergy use inside the EU-25 has therefore been estimated as follows:

	Liquid biofuel use	Bio-electricity generation	Heat generation from biomass
Additional biofuels and biomass fuel use in mtoe/yr in the EU-25 in the year 2010 (BAP scenario)	18.1	35.4	33.3
Direct full time employment effects in FTE/mtoe biofuels and biomass fuel use	5 670	2 722	2 050
Direct full time employment effects in the EU-25 in the year 2010 (BAP scenario) *[row A x B]*	102 627	96 390	68 158
Total [sum of the direct full time employment effects of liquid biofuels, bio-electricity	267 175		

1 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
2 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
3 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
4 PWC: Evaluation of the externalities of biodiesel (op. cit)
5 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
6 PWC: Evaluation of the externalities of biodiesel (op. cit)

and bioheat]	

8) Taking into consideration the various assumptions made in this calculation and the inherent uncertainties, the total direct job creation due to an increased use of biomass in the EU-25 in 2010 may be some 250 000 to 300 000 FTE/yr in total (BAP scenario).

5.5. Indirect Employment Effects

The key message of the previous sub-chapter is that an increased use of biomass would have substantial direct employment effects for the EU-25. Many of these would take place in rural regions.

Indirect employment effects (which may primarily take place outside rural regions) have not been quantified in chapter 5.4. These indirect effects comprise:

- Positive indirect employment effects such as jobs created as a result of expenditures related to biomass use (technology purchase, diesel consumption during transports, etc.). They are usually rated at similar orders of magnitude as the direct effects[1] [2].

- Negative indirect employment effects caused by the substitution of competing conventional energy systems. These negative effects, however, appear to be smaller than the sum of direct and indirect positive employment effects of bioenergy systems. Detailed process chain analyses indicate that biofuels are typically 50-100 times as employment intensive in the EU as fossil fuel alternatives; biomass electricity 10-20 times as employment intensive; biomass heating twice as employment intensive.[3]

- Positive employment effects caused by increased exports of biomass products and services in future. Ambitious bioenergy 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 and references on new bioenergy technologies than their global competitors. This could well pay off for Europe in the medium to long term.

- Negative employment effects due to higher fuel, heat, and electricity prices. Higher energy prices may eventually rather hit private consumers. Depending on the actually available monies some households may as a consequence cut their expenditures in other areas. This may in consequence cause negative employment effects both, inside and outside the EU-25 (e.g. through the reduced consumption of imported electronic consumer articles).

- Induced employment effects caused by changes of purchasing power. Net increased employment effects may increase the purchasing power inside EU-25 and by that means induce further positive employment effects. Some studies rate these induced job effects at up to 30% of direct and indirect employment effects [4].

The quantification of all these indirect employment effects for the EU-25 is a highly complicated issue. No generally accepted methodology exists for this task.

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1 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
2 IEA: Renewable Energy in Europe (op. cit)
3 Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)
4 IEA: Renewable Energy in Europe (op. cit)

Process-chain based models (as it has been applied in sub-chapter 5.4) are very precise as regards direct and indirect effects of specific products and services. This is particularly important if novel processes (such as bioenergy systems) are assessed as they are differing from standard products of conventional sectors of the economy. The methodological problem is, however, that such process-chain based models usually neglect macro-economic effects. In order to compensate for that, additional calculation steps have to be carried out which account for (positive or negative) macro-economic effects.

Alternatively, comprehensive macro-economic models may be utilised. Price Waterhouse Coopers has developed such a simulation tool (ASTRA model). This model is a system dynamics models which is composed of 8 modules (population, macro-economy, regional economy, foreign trades, transport, environment, vehicle fleet for transport and welfare indicators). The ASTRA model presently covers the EU-25 countries and is differentiated into 25 economic sectors. The particular strength of this model is its very high precision as regards macro-economic interrelations. A particular challenge for macro-economic models is, however, to correctly model the specific direct and indirect effects of new processes.

Due to this lack of a generally accepted methodology, commentators are substantially divided on the extend of indirect employment effects.

Some point to the multipliers opportunities which could imply double the size of the direct effect. The following two studies with reference to the EU-25 are exemplarily cited:

- The employment effect of electricity generated from renewable energy sources in the EU-25 has been calculated with the ASTRA model in 2005. In this calculation reduced consumption behaviours due to increased product prices have been accounted for. The results indicate an additional employment effect of 775 000 full time employment effects by 2010 (as compared to 2001). The study does not disclose the employment effects per renewable energy source and thus the bioelectricity share has to be estimated. Bio-electricity delivers 40% of all additional RES-electricity in this calculation and may consequently account for some 40% of the calculated employment effects (=310 000 FTE)[1].

- A recent study of the IEA assessed the employment effects of the EU-25 meeting its renewable energy targets for 2010. This study ended up with a biomass-related additional employment effects of 762 000 FTE/yr (424 000 out of that due to biofuels) in 2010[2].

Others argue that jobs in bio-energy will replace other jobs, and the net employment effect will be zero.

With this background, a generally accepted calculation of the indirect employment effects for the BAP and the BAU scenario could not be undertaken within this Impact Assessment.

Another conclusion is that there is substantial need to scrutinise employment effects of bioenergy use further and to develop generally accepted methodologies for their quantification.

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[1] European Commission: Final Report, Contract: Lot 1, reference TREN/A1/17-2003, Contribution study to the Impact Assessment Analyses on Social and Economic Aspects of RES-E for the Future Communication on the Financing of Sustainable Energies. Brussels, August 2005

[2] IEA: Renewable Energy in Europe (op. cit)

5.6. Cost for the Society

The previous sub-chapters quantified substantial positive impacts of an increased use of bioenergy in the EU-25. The question now is at what cost for the society these benefits could be realised.

5.6.1. Detailed Methodology

This chapter aims at the determination of the net differential cost for the society of the EU-25 in 2010 for both scenarios.

In a first step, for each scenario, the net differential internal cost is calculated. It results from subtracting the total internal cost for the additional bioenergy use in 2010 from the total internal cost of an identical additional energy supply based on conventional energy systems (identical in terms of energy service provided). For both, biomass and fossil fuel based energy systems, the total internal cost is calculated as total life-time cost of whole energy systems.

Import of solid biomass is considered to take place at the same cost as domestic biomass supply. This is a conservative approach as any import of biomass fuels would only take place if the total cost of import is less than the total cost of domestic supply. Liquid biofuels are treated differently due to their higher import rate. Here it is assumed that imported biofuels are 15% cheaper than domestically produced ones.

In a second step, the monetary values of all major external effects such as cost and savings caused by greenhouse gas (GHG) emissions, non-GHG emissions, enhancement of diversification of energy mix and security of supply, stabilisation of rural areas through direct job effects, and possible positive indirect employment effects need to be included into the calculation in order to end up with net differential cost for the society. This however, turns out to be impossible as no generally accepted methodologies exist for the internalisation of many of these benefits. That is why in the discussion of the cost calculation this should duly be noticed.

It is important to note that the total cost for the society is not identical with the business cost of an individual project. Both types of cost should not be mixed up when interpreting the results of this chapter. Furthermore, all calculations pursued here are rather indicative due to the numerous assumptions made.

5.6.2. Data Base

A literature survey revealed the following total life-time cost (excluding taxes, subventions, and external cost, and monetary benefits -> "total internal cost") for different energy supply systems (Table 8; based on references [1] [2] [3] [4] [1] [2] [3] [4] [5] [6]). The only figures that were utilised in the Impact Assessment are the differential values at the bottom row of this table.

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[1] Institute for Applied Ecology: Bioenergy – New Growth for Germany (op. cit)

[2] Jungmeier, G.; Spitzer, J.: Costs of Greenhouse Gas Reduction with Bioenergy in Austria. 12th European Conference on, Biomass for Energy, Industry and Climate Protection, 17-21 June 2002, Amsterdam

[3] International Energy Agency: Renewables for Power Generation. 2003

[4] Kaelber, St. et a.: Leible: A system analytical evaluation (op. cit)

As regards the differential internal cost of liquid biofuels on the one hand side and petrol and diesel on the other, JRC Ispra recently calculated 503-514 €/toe (25 €/bbl), and 290-308 (50€/bbl) for biodiesel and bioethanol production in Europe[7]. An extrapolation of their results to 60 €/barrel yields additional internal cost of some 216 €/toe. These values have to be compared with 495 €/toe (at 25 €/barrel) and 261 €/toe (at 60 €/bbl), respectively – the values of table 8 without consideration of cheap biofuels imports. Apparently both Impact Assessment and this recent JRC study, are well in-line with each other.

	Total internal cost of transport fuels in €/toe	**Total internal cost of electricity generation in Ct/kWh$_{el}$**	**Total internal cost of heat generation in Ct/kWh$_{th}$**
Bioenergy-based energy supply (import rate in %)**	Biodiesel (56%): 750 Bioethanol (44%): 900 Mix (100%): 816 30% 779	Co-firing (50%): 6.0 CHP incl. biogas (50%): 11.0 Mix (100%): 8.5***	Small scale (50%): 8.5 Medium to large scale (50%) 4.0 Mix (100%): 6.3***
**Conventional energy supply * ** **	Diesel (56%): 329-563 Petrol (44%): 311-545 Mix (100%): 321-555	Mix (100%): 5.0-7.0	Small scale (50%) 7.5-11.0 Medium to large scale (50%) 2.5-4.0 Mix (100%): 5.0-7.5
Difference **low energy prices** **high energy prices**	 458 224	 3.5 1.5	 1.3 -1.3

Table 8: Total internal cost (excluding taxes, subventions, external cost and benefits) for different energy supply systems

* Lower value for low energy price environment, higher price for high energy price environment

** Newly built energy installations are regarded with their full costs; Costs depending on world fuel prices

*** Assumed to be independent of the import rate

Logic check: The values at the bottom row of table 8 cannot be directly compared with each other because they refer to different amounts of energy (toe, kWh electricity, kWh heat). Relating all figures of high energy prices (in brackets: low energy prices) to 1 toe biomass input they yield: 172(352) €/toe biomass input (biofuels); 52(122) €/toe biomass input (bioelectricity); -114(114) €/toe biomass input (bioheat). This hierarchy of total internal costs is reasonable. The relatively highest internal cost is caused when 1 mtoe biomass is used for

1 Kavalov, B.; Peteves, S.D.: Bioheat Applications in the European Union – An analysis and perspective for 2010. JRC Petten, 2004
2 VIEWLS (op. cit)
3 Licht, F.O.: Ethanol Production Costs (op. cit)
4 Licht, F.O.: World Ethanol and Biofuels Report (op. cit)
5 JRC : Techno-economic Analysis of Bio-Alcohol (op. cit)
6 Werner, S.; Broden, A.: Prices in European District Heating Systems. 9th International Symposium on District Heating and Cooling, Helsinki August 30-31, 2004
7 JRC Ispra: Well-to-Wheel (op. cit)

biofuel production. If biomass is used for stationary applications, the internal differential cost is lower. This is particularly true for bioheat applications.

Energy supply systems also cause external costs which is usually paid for by the society and not by the operator of the energy installation. External cost caused by gaseous emissions comprise the following categories:

- cost of greenhouse gas emission abatement which is rated here at 19 €/tonne CO_2-equivalent (GHG-effects);

- cost of medical treatment for people who are suffering from diseases after having continuously inhaled gaseous emissions from an energy installation;

- monetary losses due to reduced agricultural yields, damage on buildings, and other effects (non-GHG effects).

The comprehensive European ExternE project[1] calculated external cost categories for different energy supply systems as summarised in table 9. The only figures which were utilised in the Impact Assessment are the differential values at the bottom row of this table.

	External cost of transport fuels in €/toe	**External cost of electricity generation in Ct/kWh$_{el}$**	**External cost of heat generation in Ct/kWh$_{th}$**
Bioenergy-based energy supply **GHG-only** **non-GHG only**	 - -	 Mix (100 %): 0.1 1.2	 Mix (100 %): 0.07 0.30
Conventional energy supply **GHG-only** **non-GHG only**	 - -	 Mix (100 %): 1.4 1.4	 Mix (100 %): 0.57 0.30
Difference **GHG-only** **non-GHG only**	 -36* 0*	 -1.3 -0.2	 -0.5 -0.0

Table 9: External cost caused by greenhouse gas (GHG) emissions and non-GHG emissions for different energy supply systems

**: no data available; the difference is solely calculated on the base of differing greenhouse gas emissions (see GHG balance in section 5.4) at CO_2 costs of 19 €/t (same base as other ExternE data)*

The non-GHG related external cost of bioenergy systems (particularly those of bio-heat installations) in table 9 is at the most as high as their conventional energy mix counterparts. This deliberate choice derives from the obligation that any increase in bioenergy use shall by no means increase the total amount of pollutant emissions as compared to the substituted energy system. The emission of particulate matter PM2.5 plays an important role in this context and in several EU Member States biomass installations are contributing significantly to the total emission of this harmful substance. In the framework of this Impact Assessment it has not been possible to assess quantitatively the impact on PM2.5 emission of an increase of biomass burning. According to the data gathered in the framework of the preparation of the

[1] Dones, R. et al.: ExternE-Pol (op. cit)

Thematic Strategy on air pollution adopted in September 2005 by the Commission[1], this impact could be significant[2] notably in terms of public health. It is therefore essential to develop new initiatives to reduce PM emission from these installations both at EU level (through the EUp Directive) and at M.S. level. This does not mean, however, that biomass installations shall reach low emission levels of modern natural gas boilers. What is needed is any avoidance of higher pollutant emissions on average, taking into account the higher specific emissions of other substituted fuels such as heating oil, heavy oil, and coal (see assumptions made in chapter 5.2.2).

The monetary value of other external effects such as enhanced diversification of the energy mix and security of supply, stabilisation of rural areas through direct job creation, and possible positive indirect employment effects have not been quantified here as no generally accepted methodology could be identified.

Even without internalisation of these benefits, tables 8 and 9 indicate that biomass co-firing is on average less costly for the society than electricity generation from fossil fuels. With rising global energy prices the cost difference between biomass co-firing and conventional energy supply grows further; from 0.5 up to 2.5 Ct/kWh cost advantage over fossil power generation under the conditions examined here.

The same is true for heat supply from biomass. Here the internal cost of bioenergy is of the same order of magnitude as heat supply from conventional fuels. High fossil fuel prices and internalisation of GHG-reductions would yield cost savings of up to 1.8 Ct/kWh in favour of biomass.

5.6.3. Results

Based on the basic scenario assumptions (section 5.1.1) on the one hand and on the specific input data from the preceding section on the other, the following indicative (and incomplete) net differential cost for the society of the EU-25 has been calculated for the year 2010 (Table 10). 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.

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.

Table 10 indicates that the net additional internal cost for the society range from 1.9 to 5.1 billion €/yr (BAU) and 2.1 to 16.6 billion €/yr (BAP) respectively in 2010. This means that the full delivery of the expected biomass contribution to achieve the White Paper targets in the EU-25 would cause differential internal cost of 0.2 to 11.5 billion €/yr for the EU-25 society in 2010.

Assuming fossil fuel prices about 10% lower than today's, the additional internal cost of the BAP scenario can be estimated at €9 billion per year (mean value of 2.1 and 16.6 billion €/yr).

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[1] http://europa.eu.int/comm/environment/air/cafe/index.htm

[2] Without additional action, in 2020 it is expected that about 40% of primary particulate matter of small size (PM 2.5) could originate from biomass burning in small scale combustion installations.

Out of that €6 billion would be caused by transport biofuels and €3 billion by biomass in electricity generation (biomass in heating is often cost-competitive).

The internal cost has to be compared with monetary savings. Reduced non-GHG emissions account for savings of -0.12 billion € (BAU) and -0.25 billion € (BAP), respectively. Reduced GHG savings account for savings of -1.1 billion € (BAU) and -3.9 billion € (BAP), respectively. The monetary values of the other biomass-caused benefits such as an enhanced diversification of the energy mix and security of supply, stabilisation of rural areas through direct job creation and possible positive indirect employment effects have not been quantified here. In a total balance they ought to be subtracted from the internal cost, too.

	Due to additional liquid biofuel use in billion €/yr	Due to additional bio-electricity generation in billion €/yr	Due to additional heat generation from biomass in billion €/yr	Total
Net differential internal cost				
Scenario BAU low energy prices high energy prices	2.75 1.35	2.03 0.87	0.35 -0.35	5.1 1.9
Scenario BAP low energy prices high energy prices	8.29 4.06	4.41 1.89	3.87 -3.87	16.6 2.1
Net differential external cost (caused by GHG emissions only)				
Scenario BAU	-0.22	-0.76	-0.14	-1.1
Scenario BAP	-0.65	-1.65	-1.56	-3.9
Net differential external cost (caused by non-GHG emissions only)				
Scenario BAU	0	-0.12	0	-0.12
Scenario BAP	0	-0.25	0	-0.25
Monetary value of increased diversification of the energy mix and increased security of supply: not included				
Monetary value of stabilisation of rural areas through direct job effects: not included				
Monetary value of possible positive indirect job effects: not included				
Net differential cost for the society (internal + external cost but excluding the monetary value of other benefits)				
Scenario BAU low energy prices high energy prices	2.53 1.13	1.15 -0.01	0.21 -0.35	3.9 0.8
Scenario BAP low energy prices high energy prices	7.64 3.41	2.51 -0.01	2.31 -5.42	12.5 -2.0
Difference BAP-BAU low energy prices high energy prices	5.11 2.28	1.35 -0.01	2.10 -5.08	8.6 -2.8

Table 10: Net differential cost for the society of the EU-25 in 2010 excluding the internalisation of monetary values of several benefits, divided by scenario BAP and BAU

A sector-specific analysis of the results provides the following conclusions (without internalisation of any benefits):

- The additional internal cost for the society which solely emerges from electricity generation from biomass has been quantified as 1.9 to 4.4 billion €/yr in 2010 (BAP-scenario). Relating this to the gross electricity consumption in the EU-25 (3 018 TWh in 2002[1]) yields an average increase of electricity cost of 0.06 to 0.15 Ct/kWh in order to finance the additional bio-electricity generation.

- The additional internal cost for the society which solely emerges from increased liquid biofuel use has been quantified as 4.1 to 8.3 billion €/yr in 2010 (BAP-scenario). Relating this to the gross diesel and petrol consumption in the EU-25 (288 mtoe = 334 billion litres in 2002[2]) yields an average increase of transport fuel cost of 1.2 to 2.5 Ct/l in order to finance the additional biofuel use.

These increased internal cost of an increased use of bioenergy could well be (over-) compensated by the monetary value of its benefits (diversification of the energy mix and security of supply; greenhouse gas reduction; direct employment effects particularly in rural regions). The final judgement about the total cost for the society of an increased use of biomass is thus a political one, not a scientific one.

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[1] see EUROSTAT (op. cit)
[2] see EUROSTAT (op. cit)

6. COMPARING THE OPTIONS

The two scenarios, BAU and BAP, are compared to each other regarding their impact on the EU-25 by 2010. The two scenarios differ substantially: the BAP scenario assumes biomass to fully deliver the expected contribution to achieve the White Paper targets in the EU-25. The BAU scenario fails to meet this target.

This difference of the two scenarios translates unto the following figures:

In the BAP scenario, the biofuel use (for transport applications) grows three times faster than in the BAU scenario (18.1 mtoe/yr instead of 6.0 mtoe/yr in 2010);

In the BAP scenario, the electricity generation from biomass (incl. CHP) grows twice faster than in the BAU scenario (126 TWh/yr instead of 58 TWh/yr in 2010);

In the BAP scenario, the heat production from biomass (incl. CHP) grows ten times faster than in the BAU scenario (26.6 mtoe/yr instead of 2.4 mtoe/yr in 2010).

Possible impacts of a realisation of the BAP and the BAU scenario on the EU-25 have been quantified in the previous sub-chapters. The following qualitative conclusions can be drawn:

Increased use of bioenergy would substitute fossil energy carriers in Europe and thus diversify the energy mix and reduce the import dependency of the EU-25 further. The BAP scenario would reduce European consumption of finite primary energy carriers to a three times larger extend than the business as usual scenario (BAU). In the BAP scenario, biofuel use would contribute most to a reduction of oil consumption (and imports) whereas electricity and heat generation from biomass would contribute most to a total reduction of finite primary energy consumption inside the EU-25.

An increased use of bioenergy would reduce greenhouse gas emissions substantially. The BAP scenario would yield three times more greenhouse gas reductions than the business as usual scenario (BAU). In the BAP scenario, electricity and heat generation from biomass contribute most to climate protection.

An increased use of bioenergy would generate significant direct employment opportunities, mostly in rural regions of the EU-25. The BAP scenario would generate three times more of such direct employment opportunities than a business as usual scenario. In the BAP scenario, biofuel use and electricity generation from biomass would contribute most to direct job creation.

An increased use of bioenergy would additionally cause indirect employment effects. Commentators are divided on the assessment of this effect. Some point to multipliers or export opportunities which could imply double the size of the direct effect. Others argue that jobs in bio-energy will replace other jobs, and the net employment effect will be zero.

An increased use of bioenergy would cause increased internal cost. Their extend would largely depend on the global price levels for conventional energy carriers. The higher the global energy prices, the lower the additional internal cost for bioenergy. The BAP scenario would cause up to three times higher internal cost than the business as usual scenario (BAU).

In the BAP scenario, biofuels would contribute most to the internal cost, followed by bio-electricity.

These increased internal costs of an increased use of bioenergy could well be (over-) compensated by the monetary value of its benefits (diversification of the energy mix and security of supply; greenhouse gas reduction; direct employment effects particularly in rural regions). The final judgement about the total cost for the society of an increased use of biomass is thus a political one, not a scientific one.

7. MONITORING AND EVALUATION

What are the core indicators of progress towards meeting the objectives?

Core indicators Monitoring and Evaluation arrangements

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

In addition, many of the actions in the Biomass Action Plan need to be developed by Member States or by other authorities which are even closer to the citizen. Considerable experience exists in EUROSTAT and many Member Sates and hence there is scope for cooperation, sharing of information and further improvement of the core indicators that are used for energy purposes.

The common set of indicators would allow aggregation of outputs, results and impacts at EU level and thus assist in monitoring progress.

The basis for reporting on progress should be based on a common framework for monitoring and evaluation to be established in cooperation with Member States. The existing reporting methodology used for the RES electricity and biofuels for transport Directives would form the foundations of an improved monitoring and evaluation system. The evaluation should be continuous and cover *ex-ante*, mid-term and *ex-post* evaluation actions. These should be supported by thematic studies and synthesis evaluations at Community level.

ANNEX 1

BAP External Expert Group

Members

Name	**Country**	**Organisation**
Maurice Dohy	France	ADEME
Sven-Olov Ericson	Sweden	Ministry of Industry, Employment and Communications
Carlos Alberto Fernandez	Spain	IDAE
Birger Kerckow	Germany	FNR
Kees Kwant	The Netherlands	SENTER/NOVEM
Christian Rakos	Austria	EVA
Yves Schenkel	Belgium	CRA-W & ValBiom
Bjorn Telenius	Sweden	STEM

ANNEX 2

The role of Bioenergy in the EU energy mix

In Figure A.2.1 the total RES contribution is compared to that of fossil fuels and nuclear

Figure A.2.1 : the EU-25 Gross energy consumption in 2002

Although the percentage contribution of RES has remained unchanged since 1997, their actual contribution has increased by about 25 mtoe between 1990 and 2002 as shown, in figure A2.2. From this figure it is clear that their main increase is due to

Figure A.2.2: Renewables gross energy consumption for the EU-25

bioenergy which increased by about 30 mtoe over the same period of time; while geothermal has remained static, hydro has decreased and although wind has achieved important breakthroughs its contribution still remains very small overall.

The annual growth of all RES for the EU-25 is given in Figure A5.3 which shows that in 2002 bioenergy use grew by about 2.5 mtoe. The data also indicate that the annual growth of bioenergy has been increasing steadily since 2000 and by 2005 it must have exceeded 3mtoe. Hydro power varies significantly but this can be due to climatic conditions and in 2002 it achieved a growth of 1.5 mtoe while wind achieved a growth of 0.5 mtoe.

Data: EUROSTAT

Figure A.2.3: The annual growth rate of RES

Figure A2.4 shows that the most significant resource of bioenergy is wood and wood waste which accounts for about 80%. This is followed by waste which provides about 9mtoe and then by biogas that shows a small but steady increase. Biofuels for transport applications still contribute little but their contribution has increased rapidly in 2004 and 2005 (not shown in Figure A.2.4) thanks to the implementation of the biofuels for transport Directive in several Member States that undertook the appropriate fiscal and market measures. Their contribution is expected to increase rapidly.

Figure A.2.4: Gross energy consumption per type of biomass

The contribution of bioenergy for the three sectors of the energy market, electricity, heat and transport, for the EU-25 and for the year 2002 is given in figure A5.5. Renewable electricity contributed about 13% to the gross electricity production in the Union with about 77 % provided by large scale hydro followed by bioenergy with about 12.5 %. Wind energy contributed about 9.5 % and geothermal about 1%.

Figure A.2.5: Bioenergy's contribution in the energy market

In the heat sector renewables contributed 6.6 % with almost 97 % of this contribution generated by solid biofuels. The balance was provided by geothermal and solar with about 1.5 % each. In the transport sector oil is the main resource with 98 % contribution to all transport fuels. Alternative motor fuels contributed 2 % and biofuels for transport only 0.2. However, since 2002 the contribution of biofuels has increased due to the implementation of the biofuels Directive in several Member States and if the EU targets will be met, by 2010 it will have reached close to 6 %.

ANNEX 3

General characteristics of Bioenergy

Biomass is the only renewable energy source (RES) which does not suffer from problems with intermittency and can provide energy to be used for heat/cold, electricity and transport potentially from the same installation.

Biomass in the form of biofuels (solid, liquid or gaseous) is the only RES that can replace directly fossil fuels (solid, liquid and gaseous), either fully or in blends of various percentages. In the latter case often there is no need for equipment modifications. When combining co-utilisation with fossil fuels and subsequent carbon sequestration, bioenergy offers the unique option to withdraw carbon from the environment. The same may apply to carbon sinks.

Biomass is the only RES that usually cannot be used instantly and for free; it necessitates logistic chains including activities such as planting, growing, harvesting, pre-treatment (storage and drying) and upgrading to a fuel, and finally mechanical, thermo-chemical or biological conversion to power, heat/cold, or biofuels for transport. Therefore, biomass fuels (with the exception of untreated municipal waste) always have an associated cost that has to be carried by the final user.

Biomass has the advantage in comparison to other RES that it can be stored over long periods of time. On the other hand most biomass fuels have the disadvantage in comparison to fossil fuels of the relative low energy density (energy content per unit volume or unit mass), leading to relative high transport cost.

In contrast to all other RES, biomass and biofuels can be traded at local, national and international markets. Although international trade in biomass fuels (solid or liquid) is still at its infancy, it is expected that it will play a major role for the development of a limited based bio-economy.

Biomass resources cover a wide range of products, by-products and waste streams from forestry, agriculture (including animal husbandry), downstream agro-forestry industries, as well as municipal and industrial waste streams. A summarising definition that has been adopted by the EU legislation is: "…the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substrates), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste…". It is therefore impossible to generalise costs and efficiencies of "bioenergy".

In addition to energy policy, bioenergy cuts across several other policies, such as agricultural and forestry, environment, employment, trade and market, tax policies, regional development et al.

Since land availability is limited there may come a point in the future that biomass for energy will have to compete with food, materials, bio-chemicals and carbon sinks. This point in time, however, is expected beyond 2020. If international trade in biomass fuels will become effective in the meantime, this point in time may even be beyond 2050.

Environmental concerns must also be addressed whenever biomass is produced for either food, products, or biomass fuels. This has to be done within an overall systems approach and in comparison to other alternatives.

ANNEX 4

Summary of key measures

Biomass for heating and electricity

The Commission will:

- Work towards a proposal for Community legislation in 2006 to encourage the use of renewable energy, including biomass, for heating and cooling;

- Examine how the directive on energy performance of buildings could be amended to increase incentives for the use of renewable energy;

- Study how to improve the performance of household biomass boilers and reduce pollution, with a view to setting requirements in the framework of the eco-design directive;

- Encourage district heating scheme owners to modernise them and convert them to biomass fuel;

- Encourage Member States that apply a reduced VAT rate to gas and electricity to apply such a rate to district heating too;

- Pay close attention to the implementation of the directive on electricity from renewable energy sources;

- Encourage Member States to harness the potential of all cost-effective forms of biomass electricity generation;

- Encourage Member States to take into account, in their support systems, the fact that in combined heat and power plants biomass can provide heat and electricity at the same time.

Transport biofuels

The Commission will:

- Bring forward a report in 2006 in view of a possible revision of the biofuels directive. This report will address the issues of:

    - setting national targets for the share of biofuels;

    - using biofuels obligations on fuel suppliers;

    - ensuring, through certification schemes, that the biofuels used to meet the targets satisfy minimum sustainability requirements.

- Encourage Member States to give favourable treatment to second-generation biofuels in biofuels obligations.

- Bring forward a legislative proposal promoting public procurement of clean and efficient vehicles, including those using high blends of biofuels.

- Examine how biofuel use can count towards the CO_2 emission reduction targets for car fleets.

- Pursue a balanced approach in ongoing free trade agreement negotiations with ethanol-producing countries/regions. The EU must respect the interests of domestic producers and EU trading partners, within the context of rising demand for biofuels.

- Propose amendments to the "biodiesel standard" to facilitate the use of a wider range of oils, including imported oils, to produce biodiesel, and allow ethanol to replace methanol in biodiesel production.

- Assess the impact of options to address 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.

- 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.

- Support developing countries by helping them to produce biofuels and by maintaining market access conditions that are no less favourable than those provided by the trade agreements currently in force.

- Bring forward a communication dealing specifically with biofuels early in 2006.

Cross-cutting issues

The Commission will:

- Assess the implementation of the energy crop scheme.

- 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 energy use of forest material will play an important part.

- Review the impact of the energy use of wood and wood residues on forest based industries.

- Consider how the waste framework legislation could be amended to facilitate the use of clean wastes as fuel.

- Review how the animal by-products legislation could be amended in order to facilitate the authorisation and approval of alternative processes for the production of biogas and other biofuels

- Encourage the European Committee for Standardisation to speed up work on standards for the quality of biomass fuels.

- Explore how to develop a European spot market in pellets and chips.

- Encourage Member States to establish national biomass action plans.
- Encourage Member States and regions to ensure that the benefits of biomass are taken into account when preparing their national reference frameworks and operational plans under the cohesion policy and the rural development policy.

Research

The Commission will:

- Continue to encourage the development of an industry-led "Biofuel technology platform".
- Consider how best to take forward research into the optimisation of agricultural and woody crops for energy purposes, and biomass to energy conversion processes.
- Give a high priority to research into the "bio-refinery" concept, finding valuable uses for all parts of the plant.
- Give a high priority to research into second-generation biofuels, with an aim of improving their efficiency and cost-effectiveness; a substantial increase in Community funding is expected.