DEPARTMENT OF AGRICULTURAL ECONOMICS AND ENGINEERING

UNIVERSITY OF BOLOGNA

"STUDY ON IMPLEMENTING THE ENERGY CROPS CAP MEASURES AND BIO-ENERGY MARKET"

Final Report

November 2006

This study has been financed by the Commission of the European Communities and produced by the Department of Agricultural Economics and Engineering of the University of Bologna.

The conclusions, recommendations and opinions presented in the report reflect the opinion of the consultant and not necessarily the opinion of the Commission

Bologna, November 2006

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GLOSSARY

Agricultural biomass
Solid biomass from agriculture. It includes dedicated energy crops as well as residues from agricultural activities (forestry and non-forestry).

Bio-fuels
Fuels produced from renewable resources. Liquid bio-fuels cover bio-ethanol (ethanol produced from biomass), bio-diesel (diesel produced from biomass or used fried oil), biomethanol, biodimethylether and bio-oil (a pyrolysis oil fuel produced from biomass).

Bio-gas
Bio-gas is a gas composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass. It comprises landfill gas, sewage sludge gas and other bio-gases such as bio-gas produced from the anaerobic fermentation of animal slurries and of wastes in abattoirs, breweries and agro-food industries.

Break even price
Given the crop i and the alternative land use j, the break even price of the crop i is the minimum price such that the gross margin of the crop i becomes higher than the gross margin associated to the alternative land use j.

Energy available for final consumption
Energy available for final consumption covers the energy put at the final users' disposal.

Final energy consumption
Final energy consumption covers energy supplied to the final consumer's door for all energy uses.

Gross inland consumption
Gross inland consumption represents the quantity of energy necessary to satisfy inland consumption of the geographical entity under consideration. It represents a measure of the energy inputs to the economy and it is calculated by adding total domestic energy production plus energy imports minus energy exports, plus net withdrawals from existing stocks.

Gross margin
The gross margin is the output (market) value from growing a particular arable crop plus any relevant crop specific, area-based support payments, less the variable costs associated with the production of the crop.

Input to autoproducers thermal power stations
Input to autoproducers thermal power stations consists of fuels transformed into electricity as well as the part of fuels used for the heat sold to third parties (Combined heat and power plants) by autoproducer thermal power stations. Autoproducer thermal power stations are defined as undertakings which generate electricity wholly or partly for their own use as an activity which supports their primary activity.

Input to conventional thermal power stations
Input to conventional thermal power stations covers fuel or geothermal heat transformed in conventional public utility power stations for the production of electricity and heat, as well as in autoproducer power stations for the generation of electricity and heat sold to third parties only. Public supply thermal power stations are defined as undertakings which generate electricity (and heat) for sale to third parties as their primary activity. They may be privately or publicly owned. Autoproducer thermal power stations are defined as undertakings which generate electricity wholly or partly for their own use as an activity which supports their primary activity.

Input to district heating plants
Input to district heating plants consists of fuels used in district heating plants. Delivered heat may be used for process or space heating purposes in any sector of economic activity including the residential sector.

Input to public thermal power stations
Input to public thermal power stations consists of fuels transformed into electricity and heat (if any) in public thermal power stations. Public supply thermal power stations are defined as undertakings which generate electricity (and heat) for sale to third parties as their primary activity. They may be privately or publicly owned.

Inter-crop choice
Choice among different crops.

Intra-crop choice
Choice between conventional and energy use of the same crop.

Primary production

Any kind of extraction of energy products from natural sources to a usable form is called primary production. Primary production takes place when the natural sources are exploited, for example in coal mines, crude oil fields, hydro power plants or fabrication of bio-fuels. Transformation of energy from one form to another, such as electricity or heat generation in thermal power plants, or coke production in coke ovens, is not primary production.

Solid biomass
Solid biomass is generally referred to as the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste (Directive 2001/77/EC).
However, the scope of this work concerns energy crops and agricultural residues only.
Reference is regularly made in the text regarding the use of either definition.

Transformation input
Transformation input covers all inputs into the transformation plants destined to be converted into derived products such as electricity and heat. For example wood is a transformation input when it is burnt in a combustor in order to generate electricity.

Variable costs
Seed, fertiliser, crop protection, machinery/contracting, other variable costs.

LIST OF ABBREVIATIONS

AEC	aid for energy crops
AP	area payment
bbl	barrel (oil)
BEP	break even price
BFBC	bubbling fluidised bed combustor
CAP	Common Agricultural Policy
CCGT	combined cycle gas turbine
CHP	combined heat and power
DAM	direct aid measure
EBB	European bio-diesel board
eBIO	European bio-ethanol fuel association
EC	European Commission
EQ	Evaluation Question
ETBE	ethil tertiary butyl ether
EU	European Union
EU-ETS	EU Emissions trading scheme
FAME	fatty acid methyl ester
FC	full cost
FI	feed-in tariff (scheme)
GHG	greenhouse gas/es
GM	gross margin
MS	Member State/s
NAP	national allocation plan (under the EU-ETS)
NExBTL	next generation biomass-to-liquid
NFSA	Non Food on Set Aside
NMS	New Member States
O&M	operation and maintenance
RDM	rural development measure
RE	renewable energy/ies
RES	renewable energy source/s
RES-E	electricity from renewable energy sources
RES-H	heating from renewable energy sources
RES-T	renewable energy sources for transport
RME	rapeseed methyl ester
SAPS	Single Area Payment Scheme
SRC	short rotation coppice
TGC	tradable green certificate
toe	tons of oil equivalent
VAT	value added tax

INTRODUCTION TO THE STUDY

1 CONTEXT OF THE STUDY

The present study is developed in the framework of the European Commission evaluation programme regarding all policy measures causing a budgetary expenditure, and meets as well the indication for a study on the aid for energy crops and bio-ethanol already scheduled by the EC-DG Agriculture.

The study – focusing on energy gained from biomass, which is object of both a market analysis and a policy impact analysis – appears to have a specially high interest, also considering the political and economical framework which it falls in.

The commitments of the European Union under the Kyoto-protocol on greenhouse gas emissions have put a new significance on the use of renewable energy sources, among which biomass is meant to play a relevant role. Moreover - also as a consequence of the recent evolution of some agricultural markets - the cultivation of energy crops as well as the development of bio-energy related activities as a complement to conventional agricultural ones, is now looked at as an opportunity for the primary sector, in terms of new market outlets and redeployment of production.

The Biomass Action Plan presented by the EC in December 2005, as well as the EC Communication about "An EU Strategy for Bio-fuels"[1] sets out precise actions to promote the production and the use of bio-fuels both in the EU and in the developing countries.

2 OBJECTIVES AND SCOPE OF THE STUDY

2.1 Objectives

The study provides an analysis of the EU bio-energy market, an evaluation of Energy crops CAP measures, including an assessment of the impacts concerned, as well as an outlook for future market development and policy recommendations.

The focus of the *market analysis* is on the sources of bio-energy (bio-ethanol, bio-diesel, bio-gas and direct burning of biomass), with also a look at the two other related markets within the supply chain, i.e. the market of agricultural biomass and the market of bio-energy for heating, transport and electricity. The main objectives of the market analysis in the framework of the study can be summed up in the following:

- to give a description of the market of the products concerned (bio-fuels as well as biomass and bio-energy uses).
- to determine the production costs for energy gained from biomass.
- to estimate the reduction in greenhouse gases emissions as well as the saving of fossil fuels which can be associated to the use of energy gained from biomass.

As for the *evaluation part* of the study, it is aimed at assessing the impact of the *direct aid measures* (decoupling, non food on set aside regime, aid for energy crops) and of the *rural development measures* on a number of variables concerning:

- cultivation of energy crops;
- income for farmers concerned;
- linkages with other EU and national measures regarding bio-energy;
- CO2 reduction and saving of fossil fuels;
- environmental effects at the level of primary production.

The assessment of the impacts on the above mentioned variables is related to the diverse objectives which the CAP measures feature, which are identified in the first part of the evaluation work.

Finally, the *outlook and recommendations part* of the study aims at outlining the future development of the EU market of energy from biomass, as well as providing advice concerning the EU policy for the sector, on the basis of the analyses and of the evaluation work carried out in the study.

[1] Commission of the European Communities, *Communication from the Commission – An EU Strategy for Bio-fuels,* 08-02-2006.

2.2 Scope of the study

2.2.1 Product coverage

The study covers – both for the market analysis and for the evaluation part – the main sources of bio-energy, namely: bio-ethanol, bio-diesel, bio-gas, direct burning of biomass.

As for the sources of biomass, all the crops cultivated for energy purposes are concerned (rape seed, soybean, sunflower seeds, sugar beet, maize, barley, rye, potatoes, wheat, willow, miscanthus, grass), as well as agricultural residues.

When relevant for the purpose of the study, also other additional sources of biomass are considered, among which animal waste, forestry and wood residues as well as thinning wood.

Finally, the bio-energy uses which are relevant for the study are electricity, transport and heat.

2.2.2 Geographical and time coverage

The study regards the EU territory. The evaluation of policy measures is limited to the EU-15 territory, because of the lack of information and of a relevant period for the assessment of impacts in the case of the New Member States.

As for the time coverage, the market analysis provides an evolution of the relevant markets in the EU, but is more focused on the present situation, while the evaluation part of the study covers the period between 1992 and today.

2.2.3 CAP measures coverage

The CAP measures to be covered in the evaluation include the Direct Aid Measures and Rural Development Measures specified below.

Direct aid measures	Rural development measures
- Decoupling - Aid for energy crops (AEC) - Non food on set aside regime (NFSA)	Chapter I: - on-farm investment in equipment for the use of biomass as energy source; - support for planting multi-annual biomass crops; Chapter VII: - investment in installation for first treatment of biomass (e.g. packaging); - investment in installation for the production of by-products (e.g. non refined plant oils); Chapter VIII: - non industrial processing and marketing of forestry products/afforestation; Chapter IX: - promoting the adaptation and development of rural areas.

Other relevant policy measures at national and EU level (tax exemption, tariffs, obligations regarding shares of renewable energies, etc.) are also considered as they have an influence on the economics and operations of the bio-energy supply chains.

Other non-CAP EU policies (in the fields of energy, environment, transport, employment, competition, research), which would normally fall outside the scope of the evaluation, are considered wherever relevant because of their interaction and possible synergies with the CAP measures listed above.

3 ORGANISATION OF THE REPORT

The report is structured in four main sections, according to the main topics dealt with.

- *Methodology*, containing a synthetic description of the general approach to the evaluation study (chapter 4).
- *Policy and regulatory framework*, containing a description of the CAP and non-CAP measures relevant for the study, as well as of their recent evolution (chapters 4-5).
- *Market analysis* (chapters 6 – 11).
- *Evaluation Questions*, containing the answers to the twelve evaluation questions and a general conclusion on the evaluation work (chapters 12-24).
- *Outlook and recommendations* (chapter 25).

The study is completed by a series of annexes containing details for methodology, data and information used in the framework of the market analysis and of the evaluation questions, as well as monographies for the nine regional case studies carried out in the framework of the evaluation.

METHODOLOGY

4 METHODOLOGY

Only the general approach to the evaluation study and the main typologies of data and information sources are synthetically described in the following paragraphs. An explanation of the operational methodology applied to address each specific issue is systematically given – together with a detailed description of the associated limitations and of data and information sources - in the part of the report where the issue is dealt with.

4.1 Market analysis

4.1.1 Demand analysis

The quantification of the annual demand of biomass, bio-energy sources and bio-energy for the sectors of electricity, heating and transport is carried out as follows:
1) As far as possible, through the analysis of the existing databases.
2) Where statistical data do not provide a satisfying comprehension of market demand at all the levels of the supply chain, by trying to infer the demand of biomass and bio-energy sources from the final demand of bio-energy.

A qualitative integration to the data collected according to points 1-2 above is made whenever opportune, by directly investigating the market operators and observers.

4.1.2 Supply analysis

The quantification of supply is carried out as far as possible through the analysis of the existing databases, integrated whenever opportune by non-systematic data and information coming from institutions, stakeholders, specialized bibliography and independent experts.

Supply analysis includes internal production as well as import and export flows from third countries to the EU and vice versa. The analysis of import and export is based on the official statistics as well as on qualitative information coming from stakeholders. As regards bio-fuels, an overview of the EU production capacity and of the location of the plants is also provided.

4.1.3 Pricing of bio-energy sources and of bio-energy

The methodology applied is sector-specific, and is therefore explained in detail at chapter 10. In general, both market-driven and regulated pricing mechanisms are investigated.

4.1.4 Analysis of the profitability and competitiveness of energy crops and bio-energy

The analysis is focused:

- On the quantification of production costs, revenues and margins associated with the cultivation of energy crops and with the production of bio-energy sources and bio-energy.
- On the comparison among the margins of the different energy crops cultivated in the EU, and between the prices of domestic and imported biomass.
- On the comparison among production costs of the different bio-energy sources and types of bio-energy, and between these and the costs of energy from traditional sources and other RES.

To the above purposes, two general approaches are followed, and integrated with each other when needed:

1. Elaboration of data and information sourced from the review of existing literature, from public and private institutions and from stakeholders.
2. Estimates based on assumptions validated by evidence coming from the case studies.

4.1.5 Assessment of effects on the reduction of CO_2 emissions and the saving of fossil fuels

The quantification of the potential for the abatement of CO_2 emissions associated to the switch from fossil fuel-based energy to bio-energy is limited to the consumption stage. A quantification of the switching costs and of the potential displacement of fossil fuels is also carried out.

4.1.6 Data coverage and sources

The data presented in the market analysis cover energy produced from biomass obtained from energy crops and agricultural residues. When the data collected also refer to sources of biomass which are out of the scope of the study, estimates have been carried out in order to isolate the share which is relevant for the study. Whenever this proved unfeasible, indication is given that the data also cover sources of biomass which fall outside the scope of the study.

As regards time coverage, an attempt was made to present the most updated data, as the markets under study are rapidly evolving. Time series are presented whenever possible, in order to show growth paths.

Main data and information sources include Eurostat databases, publications by the European Commission, Member States' reports to the European Commission, statistics reported by EurObserv'ER on bio-energy markets, as well as data and information from the European Commission, from international organisations and from stakeholders in the bio-energy sector. The large number of data sources may generate inconsistencies, due to differences in the definition of data aggregates. These inconsistencies have been regularly pointed out in the study.

4.2 Evaluation questions

4.2.1 The models of intervention logic

The definition of the models of intervention logic (MIL from now on) is the first fundamental step of the evaluation process.

The intervention logic can be defined as "a set of hypothetical cause and effect linkages that describe how an intervention is expected to attain its global objectives"[2]. In the framework of this study, three levels are considered in the definition of the relevant objectives:

- *specific objectives*: set in relation to the short-term results occurring at the level of direct beneficiaries of the measures;
- *intermediate objectives*: set in relation to the short to medium-term effects (or intermediate impacts) on both direct and indirect beneficiaries of the measures;
- *global objectives*: set in relation to longer term and more diffuse effects (or global impacts).

The sources employed for constructing the MILs are the following:

- the legal base of the intervention, i.e.: the EC Treaty; the Regulations and Directives covering the measures to be evaluated, as defined in § 2.2.3);
- supporting documents setting the objectives of EU policy in the fields which are to be deemed relevant in the framework of the study, namely agriculture, energy and environment.

4.2.2 Relevant issues, judgment criteria and indicators

The approach followed to provide an answer to each evaluation question is based on three key elements:

- Identification of the relevant issues posed by the evaluation question.
- Elaboration of the judgment criteria needed to address the relevant issues.
- Definition of the set of indicators associated to the judgment criteria.

A detailed description of the above elements is given at the beginning of the answer to each evaluation question (chapters 13-24).

[2] The reference source adopted to define the methodology for the drafting of the models of intervention logic is the guide by European Commission DG Budget – Evaluation unit "Evaluating EU activities: a practical guide for the Commission services" (DG Budget, 2004). The evaluation team chose to adhere as closely as possible to the guidelines set in the document.

4.2.3 Main aspects of the evaluation process

Three main aspects can be identified in the evaluation process.

The first is related to the *type of measures* under study (Direct Aid Measures, Rural Development Measures) and to their micro-economic mechanisms of action (see § 5.4).
Another aspect is related to the *kind of effects created by the measures*, which can be grouped as follows (in brackets the evaluation questions concerned):

a) effects on the volume of production of biomass, bio-energy sources or bio-energy (EQ 1, 3, 4, 5);
b) effects on the choice of a specific crop among the various alternatives[3] (EQ 6);
c) effects on the competitiveness of the production of bio-energy versus energy produced from other sources (EQ 2, 5 and 9);
d) effects on farmers' income, occupation and standards of living in rural areas (EQ 7 and 8);
e) environmental effects (EQ 11 and 12).

The third main aspect is related to the *kind of factors and mechanisms influencing the effects of the measures*, which can be grouped as follows:

a) *Measure specific factors*, which are related to the characteristics of the measure itself, to the way it is implemented, to the economic mechanisms it starts at farm level in order to orientate the farmers' decisions.
b) *Technical factors*, related to specific features of production processes.
c) *System factors*, related to the structure of the environment where the measures exert their influence: they are not intrinsic to the measures but they are able to influence their effects. System factors are of economic, institutional, social and cultural nature.

All the above factors can be considered *critical factors* inasmuch they facilitate (*promoting factors*) or hinder (*limiting factors*) the achievement of the effects which the measure is expected to cause.

The *critical factors analysis* is also aimed at studying (in brackets the evaluation questions concerned):

- the synergic effects of the measures under study (EQ 5);
- the role of the measures under study versus the role of non-CAP support measures at EU or Member State level (EQ 9);
- the effects stemming from system factors (EQ 10).

The critical factors analysis is based on the *system approach*, which tackles the issues under study in a "holistic" vision: given a phenomenon, all the factors which are supposed to exert an influence on it are theoretically considered at the same time, according to the mutual relations among the individual components which form the system. The adoption of the system approach requires outlining the main dimensions of the object of the analysis, according to:

- the type of factors involved: technical, economic, institutional, social, cultural;
- the relevant level of the analysis: farm/firm, sector (agricultural/industrial), system;
- if necessary, the time perspective: short, medium, long term.

4.2.4 Data and information sources

From a general standpoint, the data and information needed for the purposes of the evaluation process are sourced from the market analysis and the regional case studies.

Wherever needed or opportune, the evidence coming from the market analysis and the regional case studies is integrated with data and information provided by the European Commission, by international organisations, by stakeholders in the bio-energy sector and by independent experts, and/or by data and information retrieved in specialised bibliography.

The detail of the data and information sources is systematically given in the answers to each evaluation question, together with the limitations stemming from the type and quality of such data and information.

When – in absence of "actual" data – the evaluation process is based on estimates by the evaluation team, this is always pointed out, and indications are provided on the methodology used and on the assumptions made for the estimates, as well as on the associated limitations.

[3] Choice among the different kinds of energy crops; choice between energy crops and crops for food or feed use.

POLICY AND REGULATORY FRAMEWORK

5 SHORT DESCRIPTION OF THE CAP MEASURES UNDER STUDY

5.1 Historic and policy background of the measures

5.1.1 From the 1992 CAP reform to Agenda 2000

In 1991, the Commission, with Ray MacSharry as the Agriculture Commissioner, put forward proposals for the development and the future of the CAP in its Communication "The development and future of the Common Agricultural Policy – Follow-up to the reflections paper COM (91) 100 of 1 February 1991 – Proposals of the Commission" (COM (91) 258). This communication constituted the basis for a political agreement on the reform of the CAP, adopted by the Council on 21 May 1992, and for a formal approval of the reform on 30 June 1992.

The reform of 1992 marked a major change in the CAP and had as its principal elements:

- the cutback of agricultural prices to render them more competitive in the internal and world market;
- the compensation of farmers for loss of income.

Accompanying measures relating to the protection of the environment, to early retirement of farmers, and to the afforestation of rural areas were also introduced.

The reform of 1992 became operational with the start of the 1993-94 marketing year.

CAP measures which are relevant in the context of this study were introduced:

1) as far as Direct Aid Measures (DAMs) are concerned, with Council Regulation (EEC) No 1765/92 of 30 June 1992 establishing a support system for producers of certain arable crops[4];
2) as far as Rural Development Measures (RDMs) are concerned, with Council Regulation (EEC) No 2080/92 of 30 June 1992 instituting a Community aid scheme for forestry measures in agriculture[5].

In the framework of the CAP reform of 1992, the measures supporting agricultural biomass production for – among others – energy purposes (centred on biomass production on set aside land for non food uses[6] and on the afforestation of rural areas[7]) were mainly aimed at avoiding the formation of agricultural surpluses through the creation of new market outlets for agricultural products, the diversification of agricultural activities, and the reduction of excess production capacity through the reconversion of agricultural areas towards the cultivation of non-surplus crops. A manifest linkage with energy policy was not present.

In the following years, however, the evolution of the Community policy in the field of energy – in particular with the importance given to the promotion of renewable energy sources in the White Paper "An Energy Policy for the European Union" (COM(95) 682 of 13-12-1995) – came to interact with the efforts that were being made to adapt the CAP reform of 1992 to changing domestic and international conditions. Factors like the enlargement towards Central and Eastern Europe, the preparation of the single currency – which was causing budgetary constraints to the CAP - the increasing competitiveness of agricultural products from third countries and a new round of World Trade Organisation negotiations were indeed calling for further adaptation of the CAP.

In its Resolution of 8 June 1998 on renewable sources of energy, the Council noted the important contribution expected from biomass and stated that, consequently, Community policies on agriculture and waste management should take this into account. Meanwhile, the CAP reform process started in July 1997 within the framework of Agenda 2000 - a blueprint for the future of European Union policy, in view of the expected enlargement towards Central and Eastern Europe – was drawing to a close, with an agreement reached at the Berlin European Council in March 1999.

Agenda 2000 was at the time the most radical and comprehensive reform of the CAP since its inception, aimed at creating conditions for the development of a multi-functional, sustainable and competitive agriculture in the EU, and therefore covering all functions of the CAP: economic, environmental, rural.

Among others, the reform comprised measures for:

1) the reinforcement of the competitiveness of agricultural commodities in domestic and world markets;

[4] OJ L 181, 01-07-1992, p. 12.
[5] OJ L 215, 30-07-1992, p. 96.
[6] See Council Regulation (EEC) No 1765/92, art. 7(4), and Commission Regulation (EEC) No 334/93.
[7] See Council Regulation (EEC) No 2080/92.

2) the promotion of a fair standard of living for the farming community;
3) the creation of substitute jobs and other sources of income for farmers;
4) the formation of a new policy for rural development, which became the second pillar of the CAP;
5) the integration of a greater amount of environmental and structural considerations into the CAP.

The importance of promoting agricultural biomass as a renewable source of energy through specific CAP measures (that were again to be centred on biomass production on set aside land for non food uses, on one hand, and on the afforestation of rural areas within the framework of the new policy of rural development, on the other hand) was adequately considered in the framework of the reform process. In its Communication "Directions towards sustainable agriculture" of 27 January 1999 (COM (1999) 22), the Commission highlighted the importance of the contribution that agricultural biomass and bio-fuels as renewable energy sources could give to combating air and climate change and ozone depletion, and therefore called for their promotion through specific policy measures, provided that the environmental balance resulting from their production was positive.

Provisions aimed at promoting agricultural biomass production for energy purposes within the Agenda 2000 reform package were included:

- as far as DAMs are concerned, in Council Regulation (EC) No 1251/1999 of 17 May 1999 establishing a support system for producers of certain arable crops[8];
- as far as RDMs are concerned, in Council Regulation (EC) No 1257/1999 of 17 May 1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) and amending and repealing certain Regulations[9].

5.1.2 From Agenda 2000 to present

The need to assure the achievement of the objectives of the EU agricultural and rural development policy in an evolving domestic and international context is at the basis of the so-called Midterm Review (MTR) of the Agenda 2000. In its Communication "Mid-Term Review of the Common Agricultural Policy" (COM (2002) 394) the Commission tried to address the concerns expressed by EU citizens about the effectiveness of the CAP, focusing on the question of how to best support EU agriculture and rural areas and aiming at the improvement of coherence in CAP policy instruments. Substantial adjustments were proposed to achieve:

1) an enhanced competitiveness of EU agriculture;
2) a more market oriented and sustainable agriculture;
3) a strengthened rural development.

In relation with the developments of the EU policy in the fields of energy and environment, and of the obligations for the EU stemming from the signing of the Kyoto Protocol on the reduction of greenhouse gases, in COM (2002) 394 the Commission proposed to introduce measures *specifically* aimed at promoting the cultivation of energy crops, in relation with the positive impact they could have on both the reduction of CO_2 emissions and the saving of fossil fuels.

The MTR resulted in a radical reform of the CAP in June 2003, which altered the basis of direct aid to producers, progressively modulating and decoupling it from production. This decoupling, which began on 1 January 2005 for most Common Market Organisations (CMOs), separated grants received from production. The new system was intended to balance producers' income more effectively, through the so-called "single farm payment scheme". Farmers were free to decide what to produce while still receiving income aid. While Agenda 2000 increased compensation for farmers to make up their loss of revenue resulting from the progressive decrease of the level of price support, decoupling was intended to eliminate overproduction and thereby balance supply and demand, leaving farmers' incomes unaffected.

The reform allowed a transitional period for certain crops: each Member State had the possibility to choose to apply this period or not. A number of Common Market Organisations were also revised in the framework of the reform, namely the ones for milk, cereals, rice, durum wheat, dried fodder, starch potatoes and nuts.

It is worth noting that Council Regulation (EC) No 1782/2003 permitted Member States to opt - on the basis of the provisions of articles 64(2) and 66, and of articles from 100 to 110 - for a partial implementation of the reform as far as arable crops payments were concerned. Member States could retain up to 25 % of the component of national ceilings corresponding to the arable crops area payments listed in annex VI of the Regulation (area aid, grass silage payments, supplementary amounts, durum wheat supplement and special

[8] OJ L 160, 26-06-99, p. 1.
[9] OJ L 160, 26-06-99, p. 80.

aid), with the exception of compulsory set aside payment. In this case and within the limit of a fixed ceiling, the Member States concerned were to make, on a yearly basis, an additional payment to farmers producing arable crops[10] listed in Annex IX of the Regulation (cereals, oilseeds, protein crops, flax, hemp). In other words, the aforementioned provisions permitted to keep coupled to arable crops cultivation up to 25% of support to farmers: France and Spain chose to fully exploit this option, starting with 2006.

In the framework of the June 2003 reform, provisions aimed at promoting agricultural biomass production for energy purposes were included:

- as far as DAMs are concerned, in Council Regulation (EC) No 1782/2003 of 29 September 2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers and amending Regulations (EEC) No 2019/93, (EC) No 1452/2001, (EC) No 1453/2001, (EC) No 1454/2001, (EC) 1868/94, (EC) No 1251/1999, (EC) No 1254/1999, (EC) No 1673/2000, (EEC) No 2358/71 and (EC) No 2529/2001[11];
- as far as RDMs are concerned, in Council Regulation (EC) No 1783/2003 of 29 September 2003 amending Regulation (EC) No 1257/1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF)[12].

It is important to note that Council Regulation (EC) No 1782/2003 featured objectives and provisions *specifically* related to the promotion of the cultivation of energy crops (Whereas 41; Chapter 5).

It is also especially important to point out that, among the detailed rules to be adopted for the implementation of Council Regulation (EC) No 1782/2003, were also included those (see article 145(d)) relating to compliance with the Memorandum of Understanding on certain oilseeds between the European Economic Community and the United States of America within the framework of the GATT - - i.e. the so called "Blair House Agreement" - approved by Decision 93/355/EEC. The related implementing rule, Commission Regulation 1973/2004 of 29 October 2004[13], provided that "to guarantee conformity with point 7 of the Memorandum of understanding on certain oil seeds between the European Economic Community and the United States of America within the framework of the GATT" implementing rules were laid down "to reduce, where necessary, the quantity of by-products which may be produced for human or animal consumption if the total quantity of those by-products exceeds 1 million metric tonnes annually, expressed in soya bean meal equivalents" (see Commission Regulation 1973/2004, whereas 76 and art. 149). This limitation may obviously have an influence on the scale at which oilseed cultivation for energy purposes is practised in the EU.

In the framework of the enlargement process towards the Central and Eastern Europe Countries (CEECs), the EU offered the new Member States the option of operating a simplified system of direct payments – the Single Area Payment Scheme (SAPS). SAPS involved payment of a uniform amount per hectare of agricultural land. The level of the per hectare payment was calculated by dividing a national financial envelope by the utilised agricultural area of each new Member State. As is the case with the single farm payment, farmers in the new Member States that apply the SAPS system have no obligation to produce, but they must keep the land in good agricultural and environmental condition. SAPS is an option for three years (which can be extended for two years). Then the new Member States will have to opt for the scheme in force in the EU at the time. Eight out of the 10 new Member States have chosen to apply SAPS. Malta and Slovenia have opted for the CAP as applied in the EU-15.

As far as the new Member States are concerned, it must also be remembered that, on the basis of Council Regulation (EC) No 583/2004 of 22 March 2004[14] and of Council Decision 2004/281 of 22 March 2004[15], the

[10]CN Code – Description: 1001 10 00- Durum wheat; 1001 90 - Other wheat and meslin other than durum wheat; 1002 00 00 – Rye; 1003 00 – Barley; 1004 00 00 – Oats; 1005 – Maize; 1007 00 - Grain sorghum; 1008 - Buckwheat, millet and canary seed; other cereals; 0709 90 60 - Sweet corn; 1201 00 - Soya beans; ex 1205 00 - Rape seed; ex 1206 00 10 - Sunflower seed; 0713 10 - Peas; 0713 50 - Field beans; ex 1209 29 50 - Sweet lupins; ex 1204 00 Linseed - (Linum usitatissimum L.); ex 5301 10 00 - Flax, raw or retted, grown for fibre (Linum usitatissimum L.); ex 5302 10 00 - Hemp, raw or retted, grown for fibre (Cannabis sativa L.).

[11] OJ L 270, 21-10-2003, p. 1.

[12] OJ L 270, 21-10-2003, p. 70.

[13] OJ L 345, 20-11-2004, p. 1.

[14] Council Regulation (EC) No 583/2004 of 22 March 2004 amending Regulations (EC) No 1782/2003 establishing common rules for direct support schemes under the common agricultural policy and establishing certain support schemes for farmers, (EC) No 1786/2003 on the common organisation of the market in dried fodder and (EC) No 1257/1999 on support for rural development from the European Agricultural Guidance and Guarantee Fund (EAGGF) by reason of the accession of the Czech Republic, Estonia, Cyprus, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia to the European Union; OJ L 091, 30-03-2004 p.1.

[15] Council Decision of 22 March 2004 adapting the Act concerning the conditions of accession of the Czech Republic, the Republic of Estonia, the Republic of Cyprus, the Republic of Latvia, the Republic of Lithuania, the Republic of Hungary, the Republic of Malta, the

possibility of granting complementary national direct payments or aids was introduced for the new Member States. These payments or aids can be coupled.

The latest developments in the EU policy aimed at supporting the cultivation of energy crops result from the reform of the Common Market Organisation for sugar, which was agreed upon by the EU agriculture ministers on 24 November 2005. One of the aims of the reform, as provided for in Council Regulation (EC) No 318/2006 of 20 February 2006 on the common organisation of the markets in the sugar sector[16], is to enhance the market-orientation of the EU sugar sector: it is therefore deemed appropriate – in order to increase the outlets for the products in this sector – to support the cultivation of sugar beet, Jerusalem artichokes and chicory roots for purposes other than sugar production, including energy purposes.

5.2 Evolution of the measures over the evaluation period

5.2.1 Direct Aid Measures

The first CAP measures to promote the production of raw materials of agricultural origin not destined to food and feed use on set aside land were introduced with Council Regulation (EEC) No 2176/90 of 24 July 1990 amending Regulation (EEC) No 797/85 on improving the efficiency of agricultural structures[17]. Council Regulation (EEC) No 1765/92 featured analogous provisions at article 7(4). Commission Regulation (EEC) No 334/93 of 15 February 1993[18] laid down detailed implementing rules for the use of land set aside for the provision of such materials, entering in force with the start of the 1993/94 marketing year. The utilisation for energy purposes (directly or through their processing into bio-fuels) was among the permitted destinations for such materials.

Council Regulation (EEC) No 1765/92 was repealed with the end of marketing year 1999/2000 with the entry into force of Council Regulation (EC) No 1251/1999, which maintained provisions (at articles 1, 6 - and in particular 6(3) - and 11) aimed at promoting the production of raw materials of agricultural origin on set aside land destined, among others, to energy purposes. These provisions, applicable from the 2000/01 marketing years onwards, were integrated by detailed implementing rules defined by Commission Regulation (EC) No 2461/1999 of 19 November 1999[19].

In the marketing years from 1993/94 to 2003/04, no provisions *specifically* aimed at promoting the cultivation of energy crops were in place: the cultivation of such crops was permitted on set aside land, but no specific incentives were foreseen encouraging farmers to grow them instead of other non-food crops.

This situation changed with the start of marketing year 2004/05. Besides maintaining provisions aimed at promoting the production of raw materials of agricultural origin on set aside land destined, among others, to energy purposes (articles 55(b) and 107(3)), Council Regulation (EC) No 1782/2003 introduced new provisions *specifically* aimed at promoting the cultivation of energy crops, namely an "aid for energy crops" of 45 Euros per hectare within a maximum guaranteed area of 1.500.000 ha at EU level (Chapter 5). Commission Regulation (EC) No 1973/2004 of 29 October 2004[20] laid down detailed rules for the application of the Council Regulation (EC) NO 1782/2003 as regarded the "aid for energy crops" (Chapter 8) and the use of land set aside for the production of raw materials (Chapter 16), and applied to aid applications relating to marketing years or premium period starting from 1 January 2005.

Finally, by virtue of the political agreement on the reform of the sugar CMO reached by the EU agriculture ministers on 24/11/2005, from the 2006/07 campaign the following provisions apply:

- sugar beet, Jerusalem artichokes and chicory roots are now included in the list of the crops that can benefit from the "aid for energy crops";
- sugar beet, Jerusalem artichokes and chicory roots grown as a non-food crop on set aside land qualify for set aside payments.

Republic of Poland, the Republic of Slovenia and the Slovak Republic and the adjustments to the Treaties on which the European Union is founded, following the reform of the common agricultural policy - OJ L 093, 30-03-2004, p.1.

[16] OJ L 58, 28-02-2006, p. 1.

[17] OJ L 198 , 28-07-1990, p. 6.

[18] OJ L 38 , 16-02-1993 p. 12.

[19] OJ L 299, 20-11-99, p. 16.

[20] OJ L 345, 20-11-2004, p. 1.

5.2.2 Rural Development Measures

The start of an organic Community policy to promote the afforestation of rural areas - and therefore the production of raw materials that can also be used for energy purposes - stems from the orientations contained in COM (88) 255, which resulted in the entry in force of a set of combined Regulations in 1989. This policy was confirmed and reinforced in the framework of the 1992 CAP reform through the provisions of Council Regulation (EEC) No 2080/92.

With the start of an integrated Community policy for rural development in the framework of the Agenda 2000 reform package – and namely with the entry into force of Council Regulation (EC) No 1257/1999 of 17 May 1999 – Council Regulation (EEC) No 2080/92 was repealed, and the measures aimed at promoting the afforestation of rural areas became an integral part of rural development policy (Chapter VIII), together with a number of related provisions aimed at improving and rationalising the harvesting, processing and marketing of forestry products and at promoting new outlets for the use and marketing of forestry products. Also included were measures aimed:

- at supporting investments in agricultural holdings promoting the diversification of farm activities (article 4);
- at improving processing and marketing of agricultural products (Chapter VII);
- at promoting the adaptation and development of rural areas (Chapter IX – article 33), also through the diversification of agricultural activities and activities close to agriculture to provide multiple activities or alternative incomes.

A number of activities related with energy generation from agricultural biomass clearly fall within the scope of the aforementioned measures.

Council Regulation (EC) No 1783/2003 did not introduce significant changes in the measures above.

5.3 Main issues in the implementation of the measures

The most relevant difficulties encountered in the implementation of the measures under study were related to the aid for energy crops introduced by Council Regulation (EC) No 1782/2003 (chapter 5), in particular as far as the provisions of article 90 on the conditions for eligibility were concerned.

The first subparagraph of article 90 stated that "the aid shall be granted only in respect of areas whose production is covered by a contract between the farmer *and the processing industry*," (italics added) "except in case of processing undertaken by the farmer himself on the holding". This provision did not permit the application of areas for which a contract between a farmer and an intermediary between the farmer himself/herself and the processing industry ("collector") was signed, a situation which is instead common for a number of crops in many agricultural regions of the EU. The provision was therefore amended by Council Regulation No 319/2006 of 20 February 2006[21], at article 1(14), which replaced the subparagraph above with the following one: "The aid shall be granted only in respect of areas whose production is covered by a contract between the farmer and the processing industry *or by a contract between the farmer and the collector*," (italics added) "except in case of processing undertaken by the farmer himself/herself on the holding".

It is also worth noting that the provisions relating to the aid for energy crops do not apply for the new Member States that have opted for the Single Area Payment Scheme (SAPS). A recent proposal by the Commission[22], suggests the extension of the energy crop aid scheme to all Member States: in this respect, the Council foresees to extend the Maximum Guaranteed Area to 2 million ha.

Two more critical areas are worth mentioning:

- the growing of short rotation forestry for energy purposes, for which the Commission has highlighted the need of a different policy approach, "because farmers have to tie up land for several years and at least 4 years must pass before the first harvest"[23];
- the use of forestry products for energy purposes, which needs to be fostered through specific measures to be included in the forestry action plan to be adopted in 2006.

[21] OJ L 58, 28-02-2006, p. 32.
[22] Renewable energy: Commission proposes to extend energy crop aid scheme to all Member States, http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/1243&format=HTML&aged=0&language=EN&guiLanguage=en
[23] See COM(2005) 628 final "Biomass action plan", p. 13.

5.4 Intervention logic and microeconomic mechanisms of the measures under study

5.4.1 The intervention logic for the measures under study

The MIL presented in figure 5.1 is aimed at showing the relationships linking the measures under study - decoupling, non-food on set aside regime, aid for energy crops and rural development measures - with the specific objectives of each measure as well as with the global objectives of the CAP, the AGENDA 2000 and the recent CAP reform, and the global objectives of the EU policies in the fields of energy and environment (such as reducing CO2 emissions and saving fossil fuels by promoting renewable energy sources).

The microeconomics of the cause-effect linkages concerning the DAMs and the RDMs, as well as their functioning mechanisms, are described in more detail in figures 5.2 and 5.3, describing the way in which the measures reach their specific objectives.

Figure 5.1 - Overview of the intervention logic for DAM and RDM

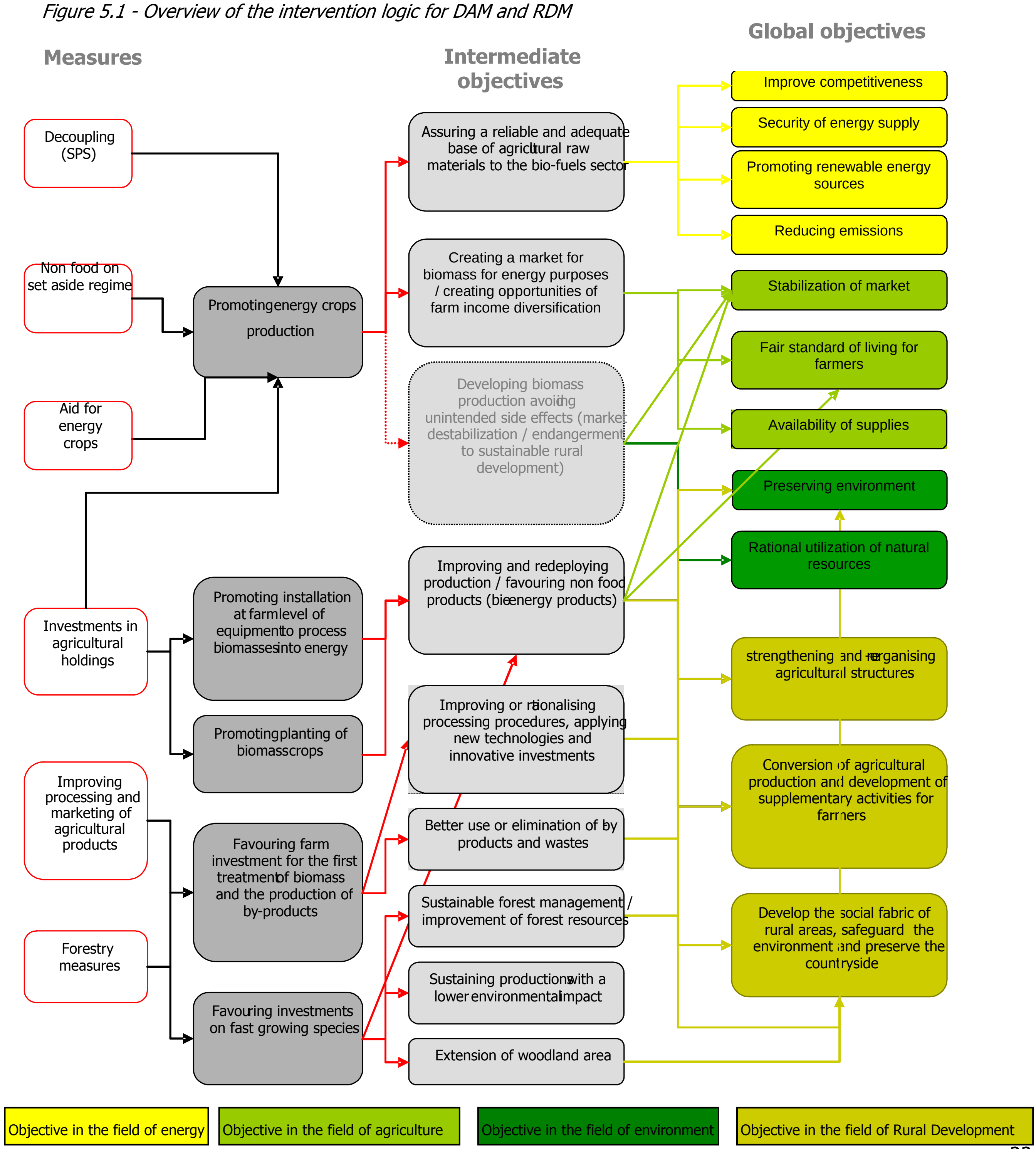


Figure 5.2 - Microeconomics and functioning mechanisms of Direct Aid Measures (DAMs)

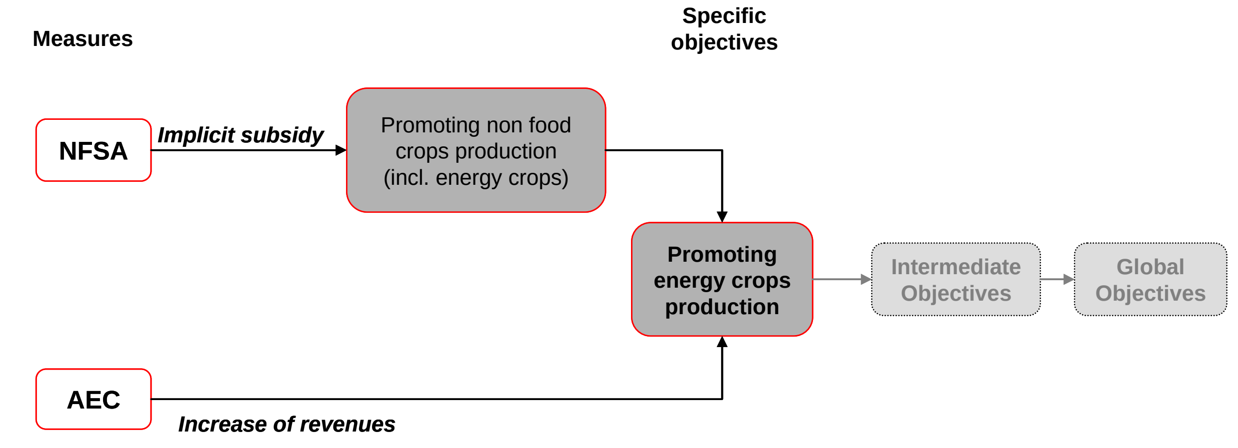
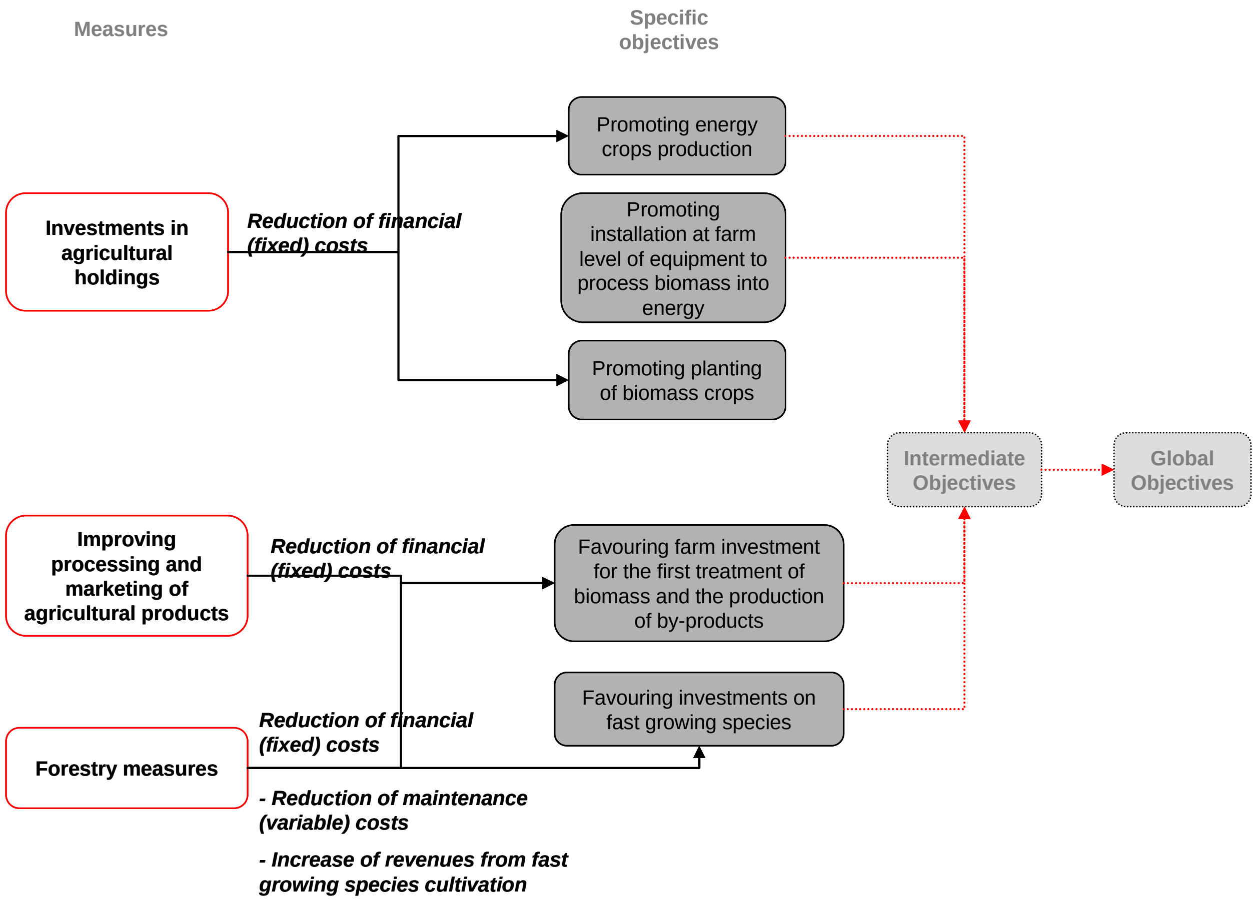


Figure 5.3 - Microeconomics and functioning mechanisms of Rural Development Measures (RDMs)



Functioning mechanism of the NFSA regime

The NFSA regime consists in the authorization to grow non food crops (including energy crops) on set aside land. Set aside payments are granted to the farmer irrespective of the fact that the land is cultivated with non food crops under the NFSA regime, or left fallow: hence they do not constitute an incentive to grow non food crops on set aside land[24].

The incentive to grow non food crops under the NFSA regime is given by the economic advantage granted by this option over leaving the land fallow. Such economic advantage constitutes an "implicit subsidy" to the cultivation of non food crops (including energy crops), and is given by two separate components:

1) An avoided cost, equal to the cost of land maintenance in the fallow set aside option, which the farmer must not bear in case he/she decides to grow non food crops on set aside land.
2) A component associated to the fact that on set aside land there are no feasible gainful alternatives to the cultivation of non food crops, as crops for food/feed use cannot be grown on such land. No opportunity cost is therefore associated to the choice of growing non food crops on set aside land, i.e. the land "comes for free".

Functioning mechanism of the AEC

The AEC promotes the cultivation of energy crops on non-set aside land by granting an additional revenue (45 Euros per hectare) to the farmers who choose to practise such activity in compliance with the obligations set for the eligibility for the measure.

Role of the arable crop area payments and of the SPS.

Differently from the NFSA regime and the AEC, both the arable crops area payments (in the pre-decoupling context) and the SPS (in the post-decoupling context) are not – by design - specifically aimed at promoting the cultivation of crops which can be destined to energy purposes, and *cannot* therefore *be considered as incentives to grow energy crops*.

Nevertheless, they play a *role in building a context which is favourable to the cultivation of energy crops on non-set aside land* in the following ways:

- The arable crops area payments were granted also to farmers growing for energy purposes crops which were eligible for them[25]: hence, by adding to market revenues, they contributed to cover operating expenses and to build up the margin of such crops.
- After the implementation of decoupling, aids coming from the SPS are not linked to crop cultivation anymore[26]: the SPS creates therefore a favourable context for the expansion of the cultivation of energy crops on non-set aside land inasmuch it allows the farmers to react freely – with respect to both the cultivated area and the type of crops – to favourable signals coming from the market of the biomass for energy purposes.

Functioning mechanisms of the Rural Development Measures.

The RDMs promote the implementation on the farm of a number of bio-energy related activities through two basic mechanisms:

- In the case of RDMs featuring an aid to investments, by reducing the financial (fixed) costs associated with such investments, thus helping their economic viability.
- In the case of RDMs granting an annual premium per hectare, such amount contributes to cover maintenance (variable) costs for the investment made or to grant an additional revenue aimed at covering the loss of income caused by the investment itself: in both cases, such premia help the economic viability of the investment.

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[24] The case of sugar beet cultivation under the NFSA regime is however peculiar, inasmuch - until the recent reform of the CMO for sugar - sugar beet grown on set aside land for non food uses could not benefit from set aside payments. Therefore, the choice of growing sugar beet on set aside land under the NFSA regime implied an *opportunity cost* for the farmer, i.e. the *renounce to the set aside payments*.

[25] The fact that some crops which can be destined to energy purposes (e.g. sugar beet, miscanthus, short rotation coppice) were not eligible for arable crops area payments might have – in theory at least - somewhat discouraged their cultivation (see evaluation question 6).

[26] It has to be remembered, however, that from 2006 onwards in Spain and France 25% of support concerning arable crop payments remains coupled.

6 POLICY AND LEGISLATIVE FRAMEWORK FOR BIO-ENERGY IN THE EU AND IN MEMBER STATES[27]

After the description of the relevant CAP measures provided above, here below a brief outline is given of the policy and legislative framework for the downstream activities, i.e. energy produced from renewable energy sources (RES), and in particular from "biomass"[28].

The first part of the chapter illustrates the relevant legislation and policy measures at EU level. These include both legislation and policies concerning the use of RES in general and legislation and policies targeted at specific sectors, namely electricity, transport and heating. The second section provides a brief description of the measures adopted by Member States (MS) to implement EU legislation and policies. Again, a distinction is made between the electricity, transport and heating sectors[29].

6.1 EU policy and legislative framework

The White Paper "Energy for the Future: Renewable Sources of Energy" (COM(97) 599 final) established the basis for the recent EU RES policy by setting an indicative objective of 12% for the contribution of RES to the EU gross inland electricity consumption (EU-15) to be achieved by 2010. To this end it requires Member States to encourage the increase of RES according to their own potential, and stresses the importance that they define national targets and strategies for contributing to the achievement of the EU objective. The White Paper suggests that a major share of the 12% target be covered by "biomass" – as it is defined, for instance, by Directive 2001/77/EC – and indicates the creation of "favourable financial conditions" among the priority actions to be undertaken for the promotion of RES.

The Green Paper "Towards a European Strategy for the Security of Energy Supply" (COM(2000) 769 final) confirms the key role of RES for diversification of energy sources and security of supply and stresses the importance of financial support measures for meeting the 12% target by 2010. It places particular emphasis on support to bio-fuels.

The Community guidelines on state aid for environmental protection (2001/C37/03) allow investment aid for RES up to 40% of eligible costs[30] as well as operating aid covering the difference between production costs for a given RES and the market price of the energy produced. Aids are justified for a limited time period and may be granted when they act as an incentive for firms to achieve levels of environmental protection higher than environmental standards, or when there is no Community standard and they are granted to firms for reducing pollution from their plants. Aids may vary according to the different kinds of energy and may be granted through a series of instruments, including market-based ones.

Directive 2003/96/EC allows for exemptions or reduced levels of taxation to be granted by MS to RES in order to promote the use of alternative energy and fuels, where such measures do not impede the proper functioning of the internal market and they do not bring about distortions of competition. Exemptions and reductions must be limited in time (maximum ten years). Directive 2003/96/EC makes specific reference to support to bio-fuels through total or partial exemptions, which may be granted provided that a series of conditions is fulfilled, i.e. avoidance of overcompensation and a six-year time limit for support.

The Biomass Action Plan (COM(2005) 628 final) sets out measures for promoting the development of biomass[31] through the introduction of market-based incentives and the removal of barriers for the development of the biomass and bio-fuels markets. The Action Plan indicates specific actions that the Commission will take regarding the use of energy from biomass in the heating, electricity and transport sectors, as well as providing cross-cutting measures concerning biomass supply, financing and research. The main actions include legislation on the use of RES (and of biomass in particular) in the heating and cooling sectors, the promotion of combined heat and power (CHP) generation through biomass, the assessment of current support systems for bio-fuels, the support to second-generation bio-fuels, and the creation of a bio-fuels technology platform.

[27] Differently from the scope of this study, legislation and policy measures described in this section refer to a broader definition of "biomass", including "the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste" (Directive 2001/77/EC; see also glossary).

[28] See footnote 27.

[29] The EU and national legislative and policy frameworks for bio-energy sources is described in more detail in Annexes A and B.

[30] It must be noted that exceptions apply to the 40% limit, see annex A.

[31] The definition of biomass that applies here is, once again, that of Directive 2001/77/EC, which is broader than the definition of biomass representing the focus of this study.

6.1.1 Specific policy and legislative measures for the electricity sector

With reference to the electricity sector, Directive 2001/77/EC requires Member States to set national indicative targets for the consumption of electricity produced from renewable energy sources (RES-E) by 2010, based on reference values identified in the Annex to the Directive. These objectives should lead to an overall target of 21% of gross electricity consumption covered by RES-E in the EU-25. In addition, Directive 2001/77/EC allows for direct and indirect mechanisms for the support of RES-E.

6.1.2 Specific policy and legislative measures for the heating sector

As far as the heating sector is concerned, no EU framework legislation has been set out to date for the promotion of RES. The European Parliament has recently acknowledged that clear framework conditions are needed such as those established by Directives 2001/77 for electricity and 2003/30 for transport, and has adopted a motion for a resolution requesting the Commission to submit by 31 July 2006 a legislative proposal on increasing the share of renewable energy for heating and cooling, following a series of recommendations provided by the Parliament itself (European Parliament final A6-0020/2006). The Commission's proposal should set a target for the share of RES in heating and cooling of at least 20% by 2020 as compared to the current share of approximately 10%. The Directive should then set the framework conditions for the establishment of national support schemes, with the ultimate objective of favouring market penetration of renewable energy technologies for the heating and cooling sector. The 20% target should be accompanied by legally binding targets at the Member States level.

Indirect support for the use of biomass – as defined for instance by Directive 2001/77/EC – could also come from Directive 2004/8/EC on the promotion of cogeneration in the internal energy market, which provides for support mechanisms and possibility of priority grid access for CHP generated electricity.

6.1.3 Specific policy and legislative measures for the transport sector

Following the White Paper "European Transport Policy for 2010: Time to Decide" (COM(2001) 370 final), which calls for EU dependence on oil in the transport sector to be reduced through the use of alternative fuels such as bio-fuels, Directive 2003/30/EC on the promotion of bio-fuels for transport requires Member States to set national indicative targets to ensure that a minimum share of bio-fuels and other renewable fuels is placed into their markets for subsequent use in the transport sector. To this end, the Directive provides reference values for the share of bio-fuels of 2% and 5.75%, in 2005 and 2010 respectively, measured on the basis of energy content, and calculated as a percentage of all petrol and diesel oil placed in the market. Member States may set targets lower than reference values, but they have to provide the Commission with adequate motivations.

The most recent initiative concerning bio-fuels is the EU strategy for bio-fuels (COM(2006) 34 final). Based on the Biomass Action Plan, the strategy for bio-fuels focuses on a wide range of policy actions, including the support to the demand as well as the production and distribution of bio-fuels and related feedstock, the capture of the environmental benefits that bio-fuels bring about, the enhancement of trading opportunities, the support to developing countries and to R&D[32].

Targets for RES as they are set or proposed under the aforementioned provisions are provided in Figure 6.1.

Figure 6.1 - Targets for RES

Sector	Measurement	Target 2010
Overall RES target	Percentage contribution to the EU gross inland energy consumption (EU-25)	12%
RES-E target	Percentage contribution to gross electricity consumption (EU-25)	21%
RES-T target	Percentage contribution of bio-fuels and other renewable fuels on the total quantity of fuels placed in the market (EU-25)	5.75% (2% in 2005, missed)
RES-H target	*Share of renewable energy used in heating and cooling (not specified further) (EU-25)*	*20% by 2020* *(proposed by Parliament)*

[32] See Annex A for a more detailed description of the measures proposed in the bio-fuel strategy.

6.2 Policy and legislative framework in the Member States

6.2.1 Electricity sector

Directive 2001/77 had to be transposed into national legislation by the Member States within 27 October 2003. New Member States were subject to the Directive's requirements since their accession in May 2004.

Measures taken by Member States to meet national targets may include direct and indirect support schemes for RES-E producers (including producers of biomass as it is defined, for instance, by Directive 2001/77/EC). These schemes are intended to fill the competitiveness gap between electricity generated from conventional sources and RES-E. They must not cause any prejudice to articles 87 and 88 of the EU Treaty on State Aid and must comply with the Community Guidelines on State aid for environmental protection.

Measures introduced by Member States to meet national indicative targets may be classified as follows.

- Feed-in tariffs – These are by far the most widespread policy measure among the MS. A feed-in tariff scheme consists in a fixed price that electricity companies, usually distributors, are obliged to pay for electricity from RES. This price is higher than the market price for electricity, the difference between the two representing either the higher cost of electricity generation from RES or the external (environmental) cost avoided by generating electricity from RES. The cost of the scheme is passed through to the final consumer by the way of a premium on the end-user electricity price. Tariffs are generally differentiated by technology in order to reflect the costs of different technologies. Since feed-in tariffs are usually set for periods extending over several years, they bring about high investment security. Nevertheless, feed-in tariffs may be criticised for low cost-effectiveness as well as for the risk of over-compensating RES-E producers with lower production costs, and that of over-compensating all producers in general if they are not adjusted according to the learning curve for RES-E generation. They can also be challenged under internal market principles because they are difficult to harmonise at the EU-level. Feed in tariffs are currently adopted by Cyprus, Estonia, Latvia, Lithuania, Luxembourg, The Netherlands, Portugal, Slovakia and Slovenia, while their use has recently terminated in Austria while it has been proposed in Malta. In France they are used in combination with tendering (see below). A few MS adopt a variant of the feed-in tariff scheme, in which a fixed-premium is paid on top of the electricity market price to RES-E producers. These are the Czech Republic, Denmark and Spain. In general, MS feed-in tariff schemes differ by time horizon and are sometimes used in combination with other instruments such as tax exemptions[33].
- Green certificates – Green certificates (hereinafter TGC, where T stands for "tradable") are market-based instruments which are used in combination with an obligation, usually on electricity suppliers, to deliver a specified share of RES-E (so-called quota obligation). All electricity – including 'green' electricity – is sold at the market price. TGC are issued by RES-E producers and must usually be purchased by electricity suppliers in order to meet their RES-E quota obligation. RES-E producers earn therefore the market price of electricity plus the price of TGC. The extra-cost of the system results in higher prices paid by final consumers. Certificates are transferable, i.e. obligated actors have the option of purchasing green certificates from RES-E producers (together with the supply of green electricity) or buying them on a market. The market is sometime organised in an official exchange or an over-the-counter (OTC). TGC should not have a pre-determined value, and their price should fully depend on demand and supply forces. In case an obligated actor does not meet its quota, non-compliance penalties usually apply. TGC have the advantages of cost-effectiveness and limited risk of over-funding. TGC would also work well in a single EU market. However, TGC schemes provide less investor security as compared to feed-in tariffs, and may hinder the development of technologies which could otherwise reveal profitable in the long term. Furthermore, since the incentive they give is equal for all RE technologies, lower-cost technologies are favoured as compared to most expensive ones. Finally, this type of schemes brings about high administrative costs. TGC are currently in use in Belgium, Italy, Poland, Sweden and the United Kingdom[34].
- Tendering – This is a market-based instrument that entails the state placing tenders for the supply of RES-E, and the lowest bidder winning the tender, therefore being able to supply the pre-determined amount of RES-E at the price of the bid. The extra-cost of RES-E is passed through to final consumers by the way of a specific levy. Tendering is an efficient instrument, but it does not provide constant support for RES-E and involves the risk for bids to be too low therefore preventing agreed projects to be implemented. Tendering has so far been used in France and Ireland only. However, France has recently opted for a scheme combining tendering with feed-in tariffs, and a similar change has been proposed in Ireland.

[33] Details regarding the feed-in tariff schemes implemented by the MS are provided in Annex B.
[34] Details regarding the TGC schemes implemented by the MS are provided in Annex B.

- Tax exemptions – This instrument is mostly used in combination with other tools. It represents the main instrument for the promotion of RES in Finland only. Tax exemption consists of partial or total exemptions, e.g. exemption for RES-E from the Climate Change Levy in the United Kingdom.

In conclusion, it must be noted that other instruments for the promotion of RES, such as investment grants, are not considered here because their analysis would fall beyond the scope of this study.

6.2.2 Transport sector

Directive 2003/30/EC had to be transposed into national legislation by the MS by 31 December 2004.

Measures introduced by Member States to meet their national targets may be classified as follows.

- Tax exemptions – These are the most popular policy measure adopted by Member States to promote bio-fuels. Tax exemptions and reductions for bio-fuels are regulated by Directive 2003/96/EC which allows MS to establish these measures – under certain strict conditions – for a maximum period of 6 consecutive years, without needing the unanimous approval by other Member States. While tax exemptions are supporting the development of a market for bio-fuels in many States (although many Member States have not met their national target for 2005, nor the EU target has been met), these also have a number of important drawbacks. They are usually costly instruments since they often result in over-compensation of lower-cost producers of bio-fuels. In addition, if tax exemptions are not granted under stable and multi-annual programs, they may not provide sufficient investor certainty. Tax exemptions may be granted to limited quantities of bio-fuels (so-called quota-based approach). In this case a process for selecting eligible projects must be set up, and this may result in arbitrary allocation of quotas as well as hinder competition (by favouring concentration) in the bio-fuel market. States that have opted for tax exemptions include Belgium, Denmark, Estonia, Finland, Hungary, Latvia, Luxembourg, Malta, The Netherlands, Poland, Slovakia, Spain and Sweden. A number of States use tax exemptions in combination with quota obligations (Austria, Lithuania, Slovenia, Germany and Czech Republic, where the introduction of bio-fuel obligations has been announced for 2007) and the UK (in this case the introduction of bio-fuels obligations has been proposed). Finally, four Member States grant tax exemptions to limited amounts of bio-fuel production, namely France, Ireland, Italy and Portugal. In Italy a bio-fuel obligation has been recently introduced[35].
- Bio-fuel obligations – This measure consists in requiring fuel suppliers to place a specified quota of bio-fuels in the market, generally calculated as a percentage of the total fuel they place in the market. This instrument is gaining increasing success among Member States. It may be used in combination with tradable certificates or tax exemptions and has the advantages of cost-efficiency (it gives incentive to lower the cost of bio-fuel production) and investor certainty (unlike state aids, they are not subject to time limits). It has been already noted that bio-fuel obligations are used in Austria, Italy, Lithuania, Slovenia, Germany and Czech Republic (where the introduction of bio-fuel obligations has been announced for 2007), while they have been proposed in the United Kingdom[36].

The EC has recently launched infringement proceedings against nine Member States (Denmark, Finland, Greece, Hungary, Ireland, Italy, Luxembourg, Poland, and the United Kingdom) for having set too low targets without providing adequate justification or for not having taken adequate action for the implementation of Directive 2003/30/EC. The legal action has then been continued against Finland and Italy, while the Commission is still assessing the positions of Denmark, Hungary, Luxembourg and the UK, and it has terminated action against Greece, Ireland and Poland.

6.2.3 Heating sector

Several Member States have established support mechanisms for the use of RES for heating (RES-H). However these initiatives lack continuity and – in most cases – only concern some RES-H technologies. In addition, they are sometimes carried out at the regional/local level only. Measures include information and education campaigns, mandatory utilisation of RES-H, demonstration projects, investment subsidies, etc. These sporadic interventions result in scarce investor security and in difficulties for the establishment of sustainable markets and industries for RES-H, with the exception of a few cases, such as those of Greece, Austria and Germany (European Parliament final A6-0020/2006).

A bill on climate change and sustainable energy has been recently voted by the House of Commons in the United Kingdom which should require – among other things – measures to promote the use of renewables for heating. The bill originally called for a renewable heat obligation similar to those set for RES-E, but this provision was revised and eliminated in order to provide more flexibility for actions to promote RES-H.

[35] Details regarding the tax exemption schemes implemented by the MS are provided in Annex B.
[36] Details regarding the bio-fuel obligation schemes implemented by the Member States are provided in Annex B.

MARKET ANALYSIS

7 THE EU MARKET FOR BIO-ENERGY

7.1 The bio-energy market

According to § 2.2, an analysis of the bio-energy market is provided below, focusing on the types of biomass, the bio-energy sources and the bio-energy final uses falling within the scope of the study.

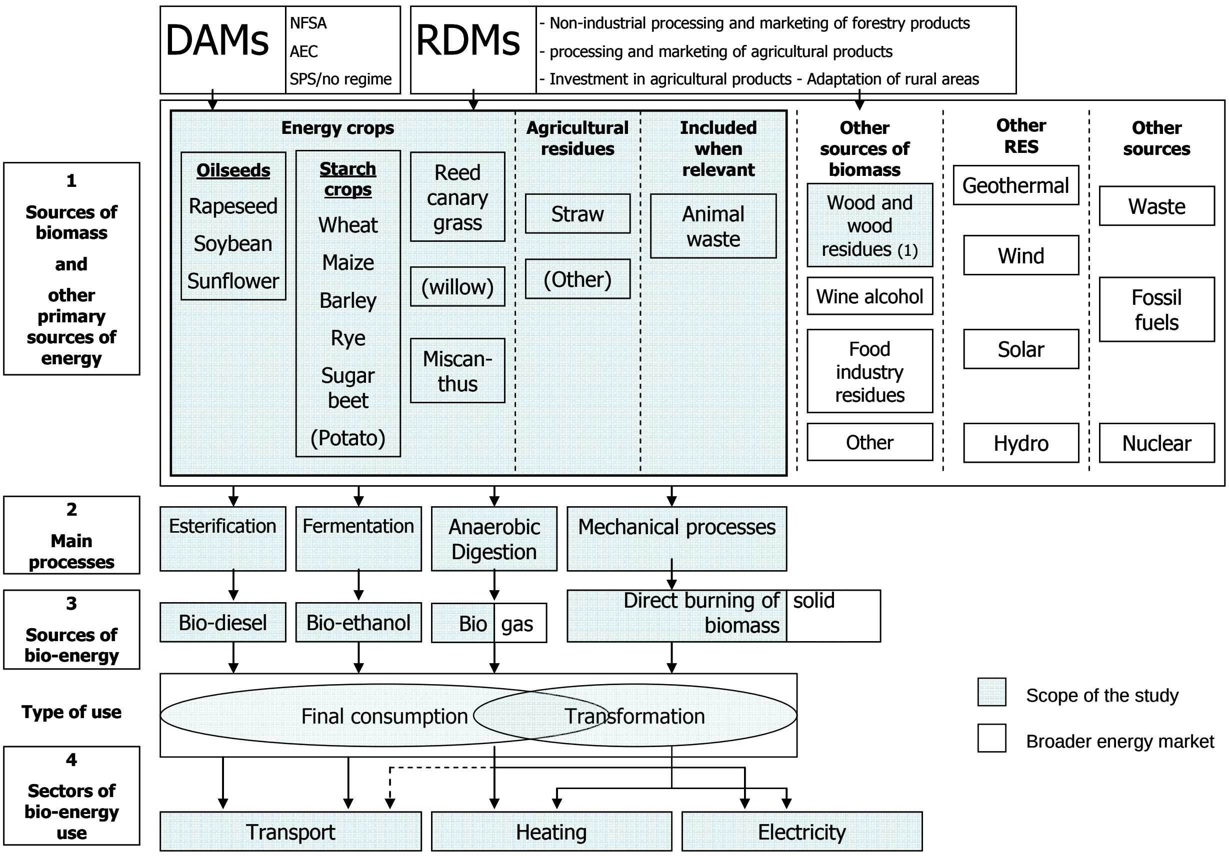
A scheme illustrating the whole bio-energy supply chain is provided in Figure 7.1, which will constitute a reference scheme for the descriptive part of the market analysis. Accordingly, four stages are identified in the scheme corresponding to the aspects on which the analysis is focused.

Primary (renewable) sources of biomass represent the input for bio-energy sources. The focus here is on energy crops and agricultural residues.

These sources are then converted through physico-chemical processes (e.g. esterification), bio-chemical processes (e.g. fermentation and anaerobic digestion) and mechanical processes (e.g. wood chipping and pelleting), in order to obtain bio-energy sources.

Finally, bio-energy sources are used either as transformation inputs or for final uses in the electricity, heating and transport sectors.

*Figure 7.1 - The scope of the study and the broader energy market**



* In brackets sources of biomass which have not been included because of lack of data and/or very rare use in the EU.
(1) Included when relevant

7.2 Outline of the market analysis

The market analysis is structured as follows.

An analysis of the supply is presented in chapter 8, starting from the supply of energy crops and agricultural residues. Subsequently, the supply of bio-energy sources is examined in three separate sub-sections dedicated, respectively, to solid biomass, bio-gas and liquid bio-fuels (the latter including bio-diesel and bio-ethanol); this section also includes an analysis of trade flows and – as far as bio-fuels are concerned – an overview of the EU processing capacity and plant location.

Chapter 9 provides an analysis of the recent development of EU demand of energy produced from biomass[37] in order to identify the size of this market as compared to the entire energy market. First, demand is described based on the different sources of bio-energy investigated and distinguishing demand for end use from that for transformation. Secondly, demand is analysed regarding the three sectors of energy use, namely electricity, heat and transport. In both parts the share of demand for bio-energy over total demand is highlighted.

Chapter 10 analyses the price of bio-energy in the MS and at international level, together with the price of energy sources different from (and substitute of) bio-energy, in particular fossil fuels. The analysis is structured according to the three sectors of energy use, i.e. electricity, heating and transport. A description of public intervention on price determination in the EU is also provided.

Chapter 11 focuses on costs and profitability of producing energy crops and bio-energy. First, the economics of biomass production at the farm level is analysed, and both EU internal and international competitiveness of different energy crops are investigated. Then, the costs and profitability of producing bio-energy from different biomass sources and via different technologies are assessed, the structure of the analysis being based again on the distinction of the three sectors of energy use.

Finally, in chapter 12 an estimate is made - limited to the utilisation stage - of the potential CO_2 savings from switching from fossil fuel-based energy to bio-energy, together with the associated costs. The potential for bio-energy sources to replace fossil fuels is also assessed.

[37] Estimates are made at this stage of the study in order to isolate and determine the actual demand for bio-energy obtained from agricultural sources (energy crops and agricultural waste).

8 SUPPLY ANALYSIS

Introduction

Objective and structure of the supply analysis

The supply analysis provided below separately analyses the supply for solid biomass – and specifically for the energy crops which constitute the main focus of the study - bio-gas and bio-fuels (mainly focusing on bio-ethanol and bio-diesel)[38]. The analysis refers to the scope of the study as clarified in chapter 2, and makes reference to the framework scheme presented in Figure 7.1.

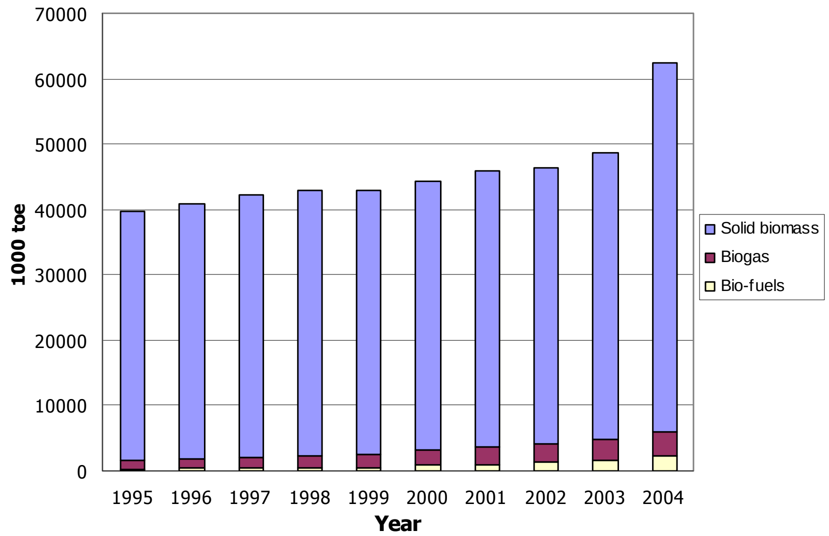
At the beginning of each chapter, the reference scheme is proposed highlighting, within it, the specific focus of the chapter itself (energy crops, solid biomass, bio-gas, etc.), with the aim to facilitate the reading path through the document as well as to show the position of the subject of each chapter in the wider framework of the study.

A brief overview of the bio-energy sources

Solid biomass – in their broad definition, i.e. including agricultural sources as well as forestry and food residues – accounts for about 90% of total bio-energy produced in the EU-25, while **bio-gas** – including gas recovered from landfills, sewage sludge and animal waste as well as gas produced from energy crops and agricultural waste – accounts for approximately 6%. The remaining 4% share is covered by **bio-fuels**[39].

Figure 8.1 shows a steady increase of the production of bio-energy sources since 1995, and a sharp increase in 2004[40]. Solid biomass increased by 48% in the analysed period. Much higher were the growth rates for bio-gas (294%) and bio-fuels production (944%), although increases in absolute terms for both total around 4.6 Mtoe versus the 18.2 Mtoe increase in solid biomass. The composition of bio-energy production has evolved from 96% solid biomass, 3% bio-gas and 1% bio-fuels in 1995 to the already-mentioned 90% solid biomass, 6% bio-gas and 4% bio-fuels in 2004. It is also interesting to mention the growth rates registered by the three sources of bio-energy in the last year (2004 towards 2003). This could give an idea of how fast supply is growing for the three typologies of sources. Solid biomass increased by 29%, as opposed to a 10% growth in bio-gas production and one of 54% in bio-fuels.

Figure 8.1 - Primary production of bio-energy sources in the EU-25 (1995-2004)



Source: DEIAGRA estimates on Eurostat and EurObserv'Er data

[38] See glossary for definitions of biomass, bio-gas, bio-fuels.
[39] Source: DEIAgra estimates on Eurostat and EurObserv'ER data.
[40] Please note that data are expressed in tons of oil equivalent (toe) in order to make figures comparable. The same unit is used when describing the supply of bio-gas , while tons are used for the supply of solid biomass and bio-fuels.

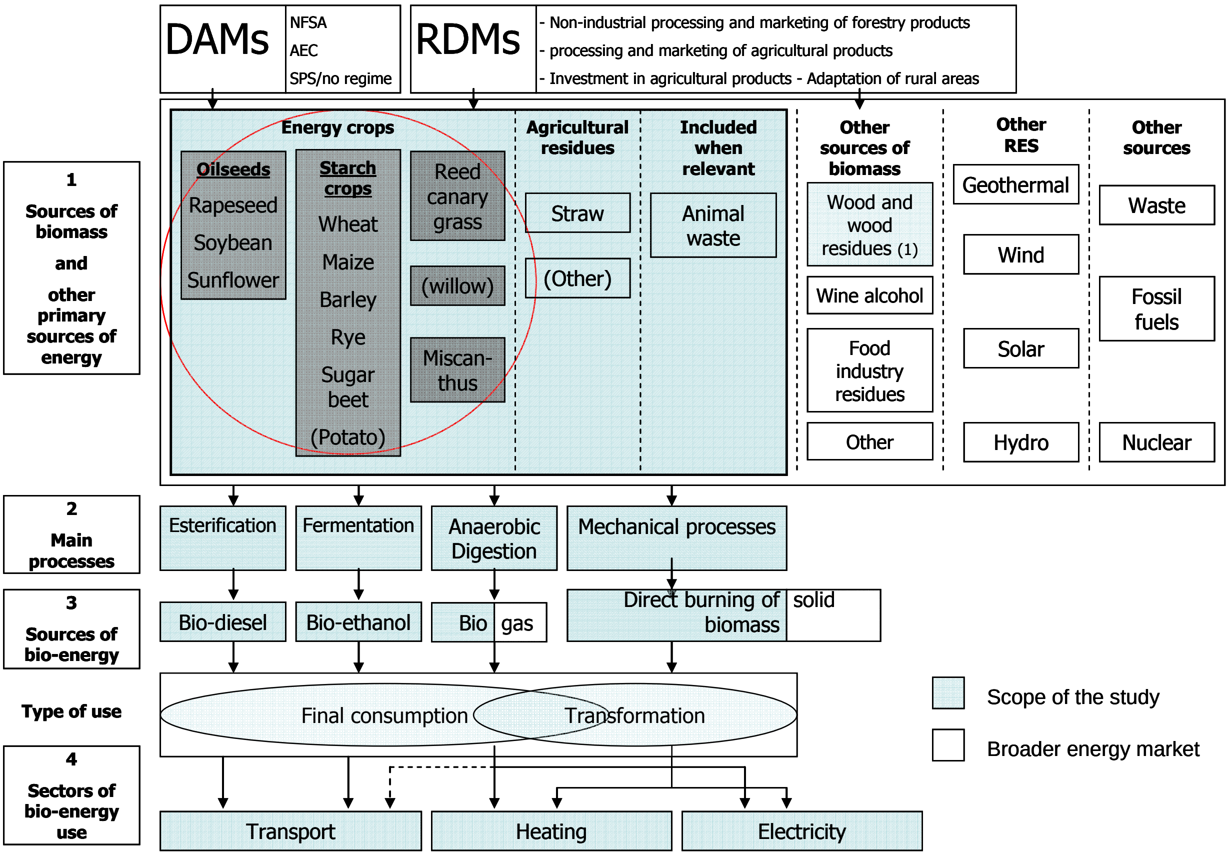
8.1 The supply of energy crops in the EU

The chapter focuses on the EU production of energy crops and provides an overview of the area under energy crops in the EU.

As highlighted in the reference scheme (Figure 8.2), the chapter focuses on:

- Oilseeds, and specifically rapeseed, soybean, sunflower;
- Starchy crops (wheat, maize, barley, rye, sugar beet, potatoes);
- Reed canary grass, willow and miscanthus

Figure 8.2 – Energy crops within the reference scheme



* In brackets sources of biomass which have not been included because of lack of data and/or very rare use in the EU.
(1) Included when relevant

8.1.1 The EU production of energy crops

8.1.1.1 Introduction

Before presenting the situation of the cultivation of energy crops in the EU and its recent evolution, it is essential to remind that *before the implementation of the decoupling*[41], the EU farmers could grow energy crops in three different regulatory situations:

- on set aside land (benefiting from the set aside payment[42])
- on non-set aside land, benefiting from both the arable crops area payment (if the energy crop considered is eligible for them) and the aid for energy crops (from 2004 onwards);
- on non-set aside land, benefiting from the arable crops area payment only (if the energy crop considered is eligible for them) or even without benefiting from them.

After the implementation of the decoupling, the regulatory situations where the EU farmers can grow energy crops are the following:

[41] See chapter 5 for details.
[42] With the exception of sugar beet until the 2006 reform of the CMO for sugar.

- on set aside land;
- on non-set aside land, benefiting from the aid for energy crops;
- on non-set aside land without benefiting from any specific payment.

As regards the New Member States (NMS), they distribute direct payments on an area basis in the framework of the SAPS. They can be authorised to pay additional national "top-ups", also for energy crops[43].

The following chapters describe the present situation and the recent evolution of areas and productions of energy crops, taking into account also the regulatory framework under which the cultivation is practised.

8.1.1.2 Overview of the area under energy crops in the EU

The total area under energy crops in the EU was around 1,6 million hectares in 2004 and is estimated in **2,5 million hectares in 2005**. As already cited (§ 8.1.1.1) energy crops in the EU can be cultivated under specific support regimes, i.e. the non food on set aside (NFSA) regime and the aid for energy crops (AEC), as well as without any specific support. The area under energy crops represents nearly 3% of the total arable land in the EU-25, while energy crop area under specific support schemes accounts for **1,5% of total arable land**.

Table 8.1 gives an overview of the distribution of energy crops in the EU among the three different regulatory situations (NFSA, AEC and without specific regime), referred to 2004 and 2005.

*Table 8.1 – Area under energy crops in the EU**

	EU25 (mio ha)			
	2004		2005	
NFSA	0,6	38%	*0,9*	35%
AEC	0,3	19%	0,6	23%
Without specific regime	0,7	44%	*1,0*	42%
TOTAL	**1,6**	**100%**	***2,5***	**100%**

**Italics font for estimates.*

Source: Working Document DG AGRI G1 (September 2005), "Bio-fuels in the EU – current situation". DEIAgra elaborations on other sources, see sources for table 7.2.

According to the above figures, a relevant role is played by the area under **NFSA**, which would cover in 2005 around **35%** of the total energy crops area. Around **23%** would be represented by the area under the **AEC**, while the remaining **42%** would be cultivated outside the two regimes.

Table 8.2 provides an estimate of the breakdown of the above areas among the MS.

Some preliminary considerations can be developed at this step, regarding:

- The high concentration of areas in a limited number of Member States. The sole Germany, France and United Kingdom cover more than 90% of the total EU-15 area.
- The crucial role played by Germany, where around 60% of the total energy crop area results to be concentrated.
- The quite relevant role played by the NMS, and specifically by Czech Republic and Poland, covering an area of 184.292 ha, around 7% of the total EU-25 area.

[43] In 2005 "top-ups" were paid in Hungary (arable energy crops: 27 €/ha; SRC: 205,79 €/ha - SRC is not eligible for SAPS) and in Poland (SRC, 55,46 €/ha).

Table 8.2 - Area under energy crops in the EU, by Member State and type of regime, 2005 (.000 ha)

Member States	TOTAL		AEC		NFSA		Without specific regime	
	Ha *(A)*	***% on EU-15*** *(B)*	Ha *(C)*	*% on EU-15* *(D)*	Ha *(E)*	*% on EU-15* *(F)*	Ha *(G)*	*% on EU-15* *(H)*
Belgique/België and Luxemburg	***7,56***	*0,3%*	2,59	*0,5%*	*4,07*	*0,5%*	*0,91*	*0,1%*
Denmark	***47,90***	*2,1%*	17,34	*3,1%*	*24,81*	*2,9%*	*5,75*	*0,6%*
Deutschland	***1.356,61***	*59,1%*	235,60	*42,6%*	*341,00*	*39,8%*	780,00	*88,1%*
Ellas	**-**	*0,0%*	-	*0,0%*	-	*0,0%*	-	*0,0%*
España	***39,45***	*1,7%*	25,61	*4,6%*	*9,11*	*1,1%*	*4,73*	*0,5%*
France	***572,61***	*24,9%*	135,40	*24,5%*	*376,21*	*43,9%*	61,00	*6,9%*
Ireland	***2,36***	*0,1%*	1,61	*0,3%*	*0,47*	*0,1%*	*0,28*	*0,0%*
Italia	***9,80***	*0,4%*	0,29	*0,1%*	*8,34*	*1,0%*	*1,18*	*0,1%*
Nederland	***1,29***	*0,1%*	0,05	*0,0%*	*1,09*	*0,1%*	*0,15*	*0,0%*
Österreich	***19,63***	*0,9%*	7,91	*1,4%*	*9,37*	*1,1%*	*2,36*	*0,3%*
Portugal	***0,09***	*0,0%*	0,08	*0,0%*	*0,00*	*0,0%*	*0,01*	*0,0%*
Suomi/ Finland	***9,44***	*0,4%*	8,31	*1,5%*	*0,00*	*0,0%*	*1,13*	*0,1%*
Sverige	***37,45***	*1,6%*	29,34	*5,3%*	*3,61*	*0,4%*	*4,49*	*0,5%*
United Kingdom	***191,17***	*8,3%*	88,59	*16,0%*	*79,58*	*9,3%*	23,00	*2,6%*
Total EU-15	***2.295,37***	*100,0%*	**552,72**	*100,0%*	***857,65***	*100,0%*	***885,00***	*100,0%*
Slovenija	***1,59***	*0,1%*	0,14	*0,0%*	*1,45*	*0,2%*	-	
Czech Republic**	***104,00***	*4,2%*	-		-		104,00	*9,9%*
Poland**	***60,20***	*2,4%*	3,67	*0,6%*	-		56,53	*5,4%*
Hungary	***18,50***	*0,7%*	18,50	*3,2%*	-		-	
Total EU-25	***2.479,66***	***100%***	**575,03**	***100%***	***859,10***	***100%***	**1.045,53**	*100,0%*
Percentage	***100%***		**23%**		**35%**		**42%**	

Italics font for estimates
** For Poland and Czech Republic data refer to areas benefiting from the "top-ups" and include only oilseed areas
(A) estimates
(C) Source: DG Agri - Unit D1: areas for which the aid has been paid (Communications of 31/07/2006), except for Ireland, Italy and UK, areas for which the aid has been claimed (definitive data 31/10/05). COPA-COGECA for Poland and Czech Republic.
(E) Total NFSA area estimated on the basis of the oilseeds NFSA area in 2005, assuming that NFSA area under oilseeds accounts for 95% of the total NFSA area
(G) For Poland and Czech Republic: COPA-COGECA. For Germany: FNR and German Farmers' Association. For France, Institute Français de l'Environment. For the UK: DEFRA, National Statistics.
Starting from the estimates for France and UK, it has been assumed that the area without specific regime accounts for about 12% of the total energy area in all the MS considered. Therefore, the estimate for the other MS has been obtained through the following expression: $(AEC + NFSA)x\,0{,}12/(1-0{,}12)$.

8.1.1.3 Energy crops under specific support regimes

As regards to the energy crops grown under the NFSA regime, table 8.3 shows the evolution of the total area under NFSA regime between 1999 and 2005, together with the indication areas dedicated to energy crop production. The total area seems not to vary significantly from year to year, being influenced above all by variations in the compulsory set aside rate.

Energy crop areas always represent over 96% of the total area under the NFSA regime. Around 92-96% of it is more or less constantly dedicated to oilseeds, and over 80% to the sole rapeseed, while cereals have usually covered around 5-6% in recent years.

Table 8.3 – Non food on set aside area, marketing years 1999/00 – 2004/05

	1999/00		2000/01		2001/02		2002/03		2003/04*		2004/05* (1)	
	.000 ha	%	.000 ha	%	.000 ha	%	.000 ha	%	.000 ha	%	.000 ha	%
Non-food on set-aside	924,5		918,1		867,0		942,5		900,0		576,5	
% on total set-aside area	*22,6%*		*23,6%*		*22,3%*		*22,7%*					
of which												
Energy generation	914,8	*99,0%*	883,4	*96,2%*	846,6	*97,6%*	908,0	*96,3%*	875,6	*97,3%*	560,9	*97,3%*
of which												
Oilseed	903,5	*98,8%*	815,5	*92,3%*	785,9	*92,8%*	856,3	*94,3%*	827,9	*94,6%*	507,6	*90,5%*
Cereals	1,4	*0,2%*	57,9	*6,6%*	51,3	*6,1%*	49,9	*5,5%*	47,2	*4,6%*	36,5	*6,5%*
Other	9,9	*1,1%*	10,0	*1,1%*	9,4	*1,1%*	1,8	*0,2%*	1,7	*0,9%*	16,8	*3,0%*

* Estimates
(1) Compulsory set aside rate at 5%
Source: Working Document DG AGRI G1 – Sept.2005, "Bio-fuels in the EU – current situation". DEIAgra estimates on DG AGRI G1 data

Table 8.4 also gives a breakdown by type of crop of energy crop area under the NFSA regime in 2005. The sole rapeseed area covers around 85% of the total NFSA area, followed by sunflower (4,8%), other oilseeds and cereals, the latter mainly represented by wheat (2%) and barley (2%) for bio-ethanol production. A small percentage of the total area is covered by sugar beet cultivated for energy purposes, whose presence is limited to France.

Table 8.4 – Energy crops under the NFSA regime in the EU-15, estimated areas and production, 2005 (.000 ha, .000t)

Type of crop	Area 2005	% on total	Estimated production
Rapeseed	731,618	85,2%	1.868,607
Sunflower	41,579	4,8%	75,479
Other oilseeds	15,078	1,8%	-
Oilseeds tot	**788,275**	***91,8%***	-
Wheat	17,251	2,0%	84,740
Barley	16,296	1,9%	16,174
Maize	13,108	1,5%	57,503
Rye	0,869	0,1%	1,431
Other cereals	1,015	0,1%	-
Cereals tot	**48,540**	***5,7%***	-
Sugar beet	5,261	0,6%	394,572
Willow	1,454	0,2%	
Short rotation coppice	1,379	0,2%	
Grass	1,053	0,1%	
Others	13,142	1,5%	
Others tot	22,288	***2,6%***	
Total	**859,103**	**100,0%**	

Source: DEIAGRA elaboration on DG-Agri Unit D1 data.
The estimates of production are based on the average yield and on the distribution of areas registered in 2005.

As regards to the AEC, in 2005 energy crop areas under this regime represented around 24% of the total energy crops area. Table 8.5 shows the distribution of these areas among the different member States, in 2004 and 2005.

The very high concentration of areas in a few States is evident. In 2005 Germany and France alone covered almost 70% of the total area. This percentage arises to almost 80% if also the United Kingdom is considered.

Table 8.5 – Areas under the AEC, by MS, 2004-2005

Member States	2004		2005	
	(.000) ha	*% on EU-15*	(.000) ha	*% on EU-15*
Belgique/België and Luxemburg	0,12	*0,0%*	2,59	*0,5%*
Denmark	4,45	*1,5%*	17,34	*3,1%*
Deutschland	109,30	*35,8%*	235,60	*42,6%*
Ellas	-		-	*0,0%*
España	6,70	*2,2%*	25,61	*4,6%*
France	130,03	*42,5%*	135,40	*24,5%*
Ireland	0,42	*0,1%*	1,61	*0,3%*
Italia	-		0,29	*0,1%*
Nederland	0,14	*0,0%*	0,05	*0,0%*
Österreich	3,50	*1,1%*	7,91	*1,4%*
Portugal	-		0,08	*0,0%*
Suomi/ Finland	3,48	*1,1%*	8,31	*1,5%*
Sverige	14,55	*4,8%*	29,34	*5,3%*
United Kingdom	32,93	*10,8%*	88,59	*16,0%*
Total EU-15	**305,62**	***100,0%***	**552,72**	***100,0%***

Source: DG Agri - Unit D1
For 2004, areas for which the aid has been paid (Communications of 31/07/2005).
For 2005, areas for which the aid has been paid (Communications of 31/07/2006)
Italics: for Ireland, Italy and UK, areas for which the aid has been claimed (definitive data 31/10/05).

A breakdown by type of crop of energy crop area under the AEC in 2005 is given in Table 8.6, together with an estimate of productions for the main crops. Also in this case, as for the NFSA areas, rapeseed covers by far and large the widest area, with around 79% of total, followed by rye (7,4%), maize (4%), short rotation forest trees, barley and wheat (2%).

Table 8.6 – AEC: estimated areas and production by type of crop in the EU-15, 2005 (.000 ha, .000 t)

	Area 2005		**Estimated production**
Type of crop	(.000 ha)	**%**	(.000 t)
Rapeseed	435,04	78,7%	1.518,34
Rye	40,53	7,3%	245,55
Maize	20,10	3,6%	180,45
Short rotation forest trees	16,39	3,0%	-
Barley	13,39	2,4%	47,17
Wheat	9,64	1,7%	57,74
Sunflower	9,22	1,7%	21,28
Grass	6,23	1,1%	-
Other cereals	1,81	0,3%	-
Oats	0,33	0,1%	1,62
Beans	0,04	0,0%	-
Other oilseeds	0,00	0,0%	-
Miscellaneous	0,00	0,0%	-
Soybeans	-	0,0%	-
Total	**552,72**	**100,0%**	

Source: DEIAGRA elaboration on DG-Agri Unit D1 data
The total area is obtained from areas for which the aid has been paid for each Member States (Communications of 31/07/2006), except for Ireland, Italy and UK, where data refer to areas for which the aid has been claimed (definitive data 31/10/05).
The distribution by type of crop is based on the distribution registered in 2004 (which takes into account the definitive data for UK, area for which the aid has been claimed: 32.927,84 ha)
The estimates of production are based on the average yields and on the distribution of areas registered in 2005.

Table 8.7 – AEC: areas and estimated production, by country and type of crop, 2004

Product / Country	Oilseeds				Cereals									
	Rapeseed		Sunflower		Wheat		Maize		Barley		Rye		Oats	
	Ha	t	Ha	t	Ha	t	Ha	t	Ha	t	Ha	t	Ha	t
Austria	739	2.528	272	732	-	-	3.003	27.987	-	-	-	-	-	-
Belgium	-	-	-	-	-	-	13	158	-	-	-	-	-	-
Denmark	4.850	18.624	-	-	-	-	-	-	-	-	-	-	-	-
France	124.209	428.520	4.545	10.817	1.208	7.795	-	-	-	-	-	-	-	-
Germany	80.236	315.327	8	19	466	3.326	8.124	71.407	290	1.903	21.459	130.683	164	839
Ireland	419	1.675	-	-	-	-	-	-	-	-	-	-	-	-
Luxembourg	-	-	-	-	-	-	133	1.637	-	-	-	-	-	-
Netherlands	143	428	-	-	-	-	-	-	-	-	-	-	-	-
Slovenija	292		-	-	-	-	-	-	-	-	-	-	-	-
Spain	-		348	365	406	1.437			6.223	20.847				
Suomi/ Finland	13	15	-	-	11	38	-	-	-	-	2	4	10	31
Sweden	117	318	-	-	3.314	19.785	-	-	858	3.698	1.267	7.007	10	41
UK	32.928	83.966												
Total	**243.945**	**851.401**	**5.172**	**11.932**	**5.404**	**32.379**	**11.273**	**101.189**	**7.371**	**26.448**	**22.727**	**137.693**	**184**	**911**

Souce: DEIAGRA elaboration on DG-Agri Unit D1 data
Malta 0 ha and UK 99.351 ha of total AEC area (area for which the aid has been claimed, provisional data 15/09/2005)

An overview of the relative importance of the main energy crops for the Member States in 2004 is given in Table 8.7 above, where an estimate of productions is also provided.

8.1.1.4 Energy crops outside specific regimes

An area of around 1 million hectares was estimated to be dedicated to energy crop production outside any specific support regime in 2005[44].

Here, a central role is played by **Germany**, where this area would reach around 780.000 ha. According to the German Agency for Renewable Sources (FNR), around 617.000 ha of rapeseed, 10.000 of sunflower, 18.000 of sugar beet and over 120.000 of other ethanol crops were cultivated outside specific regimes in 2005. Similar data are provided by the German Farmers' Association which estimates – for areas outside specific regimes - around 590.000 ha of rapeseed, 9.000 ha of sunflower, 65.000 ha of energy maize and over 120.000 additional hectares of ethanol crops (sugar beet, around 7.000 ha, and others).

According to the above figures, in Germany the total area under energy crops cultivated outside specific regimes would cover more or less the same area, or even a wider one (from 100% to 128%), than the energy crop areas under the NFSA regime and the AEC combined.

The role played by the areas outside specific regimes seems to be less relevant in almost all the other Member States, according to the few available data and to the related estimates.

In **France** for example, the available sources allow to estimate this surface in around 60.000 ha, representing around 11% of the total area under NFSA and AEC. Estimates for the United Kingdom lead to an area of around 23.000 ha, i.e. 16% of the total area under NFSA and AEC. All in all, a very high presence of areas outside specific regimes seems to be limited to the case of Germany. This situation is likely to be due mainly to the high bio-diesel processing capacity of this Member State.

A relevant role, in the case of areas outside specific regimes, is played by the NMS, and specifically by **Poland** and **Czech Republic**, where a total area of around 160.000 ha is estimated for 2005.

The aforementioned areas are likely to provide productions covering the difference between the global amount of biomass from energy crops which is processed in the EU plants, and the production obtained on energy crop areas under the NFSA regime and the AEC, net of the amount of biomass imported from third countries. At present, no reliable data are available regarding the volumes of imported biomass destined to be processed into bio-energy, thus making the estimate difficult. Nevertheless, our calculations aimed at estimating the "gap" for the main producing Member States (difference between the quantity of agricultural raw materials processed in the national plants and the quantity of products coming from energy crops grown under the NFSA regime and the AEC) generally confirm the above figures.

[44] Estimates regarding the energy crops area outside specific regimes are based on different sources as explained in notes to Table 8.2.

8.1.2 Import and export of energy crops in the EU

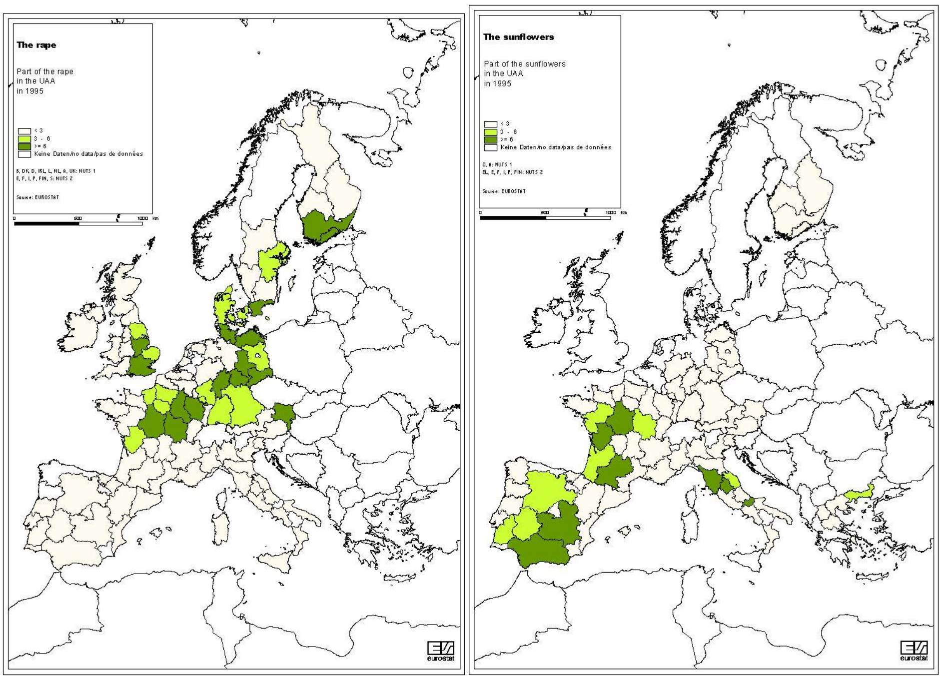
With respect to trade flows of energy crop products within and outside the EU, it must be noted that, generally speaking, statistics from most Member States do not provide specific data on the matter. Indeed the statistics always consider the whole trade flows of products, without any distinction according to their destination (food, processing into energy, other destinations).
For this reason the analysis of biomass import and export has been based on *i)* the official statistics recording the entire flows of the concerned products (rapeseed, sunflower seeds, wheat, etc.), and on *ii)* qualitative information coming from stakeholders as well as from the results of other parts of the study. Specifically, the elements which have been taken into account for *building* the analysis, include:

1. results coming from the comparison between primary production areas and areas where processing capacity is located;
2. information supplied by stakeholders in the bio-energy and in the food supply chains;
3. data regarding import and export flows of biomass (not specific for energy destination).

As for point 1, some considerations can be made after observing figure 8.3 and 8.4 as well as the maps representing the location of plants featured in § 8.4.3.1 and § 8.4.3.2 (see figure 8.14 and 8.15). It appears indeed that, both for bio-diesel and bio-ethanol, the processing capacity is either *i)* located within the main areas of primary production (see the case of bio-diesel in Northern Germany, or bio-ethanol plants in Northern France, where most EU plants are located) or *ii)* located close to important ports (see the case of all bio-diesel plants in Italy, or many plants both for bio-diesel and bio-ethanol in Spain). It can be assumed that a considerable share of processing plants mainly use, at present, imported raw materials. It is indeed the case of almost all the bio-diesel plants in Italy and of a considerable part of the Spanish ones.

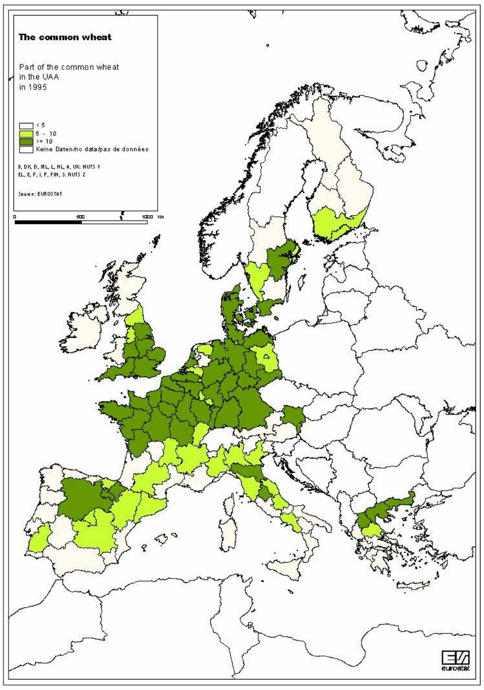
According to information collected from the stakeholders, the imported biomass is mainly sourced in other Member States, even though a low percentage also comes from third countries. Around 80% of the total quantity of rapeseed processed in the EU is produced in the EU itself, and this constitutes not less than 70% of the whole quantity of raw materials processed in the EU bio-diesel plants. No more than 5% of the total quantity of biomass for the production of bio-diesel would be represented by palm oil or other alternative raw materials, which are produced in third countries only.

Figure 8.3 – Rapeseed and sunflower vocated areas in the EU-15



Source: Eurostat

Figure 8.4 – Common wheat vocated areas in the EU-15



Source: Eurostat

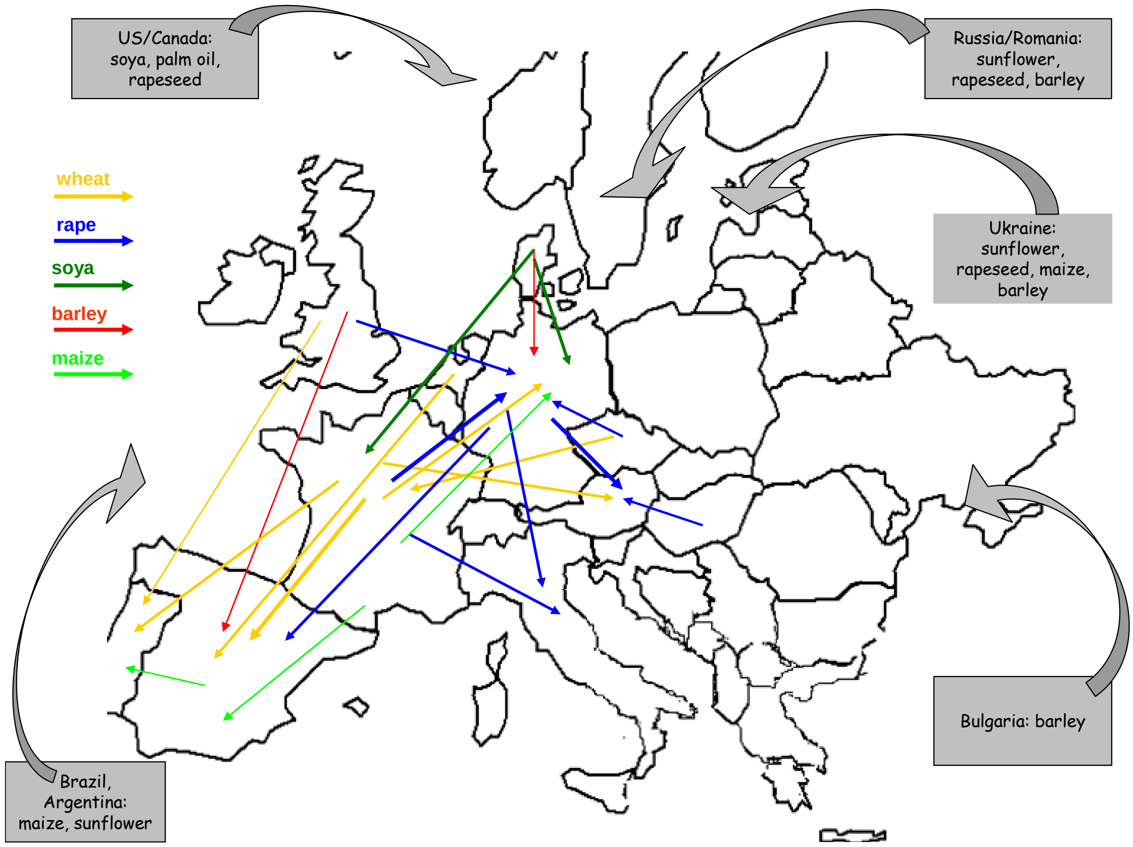
As regards the intra-EU trade, flows seem to concern above all rapeseed and, for lesser quantities, sunflower seeds, wheat and barley. Some quantities of rapeseed are likely to move from United Kingdom – where an important primary production is not used, at present, to feed any operating plant for bio-diesel - to Germany and France, as well as from Germany and France to Italy, Spain and Austria.

On the basis of a cross comparison between the import-export figures by type of crop and Member State[45], on one hand, and the location of processing plants, on the other, it may also be found that some relevant flows of cereals could move from France to Germany, Spain, the Netherlands, and from the United Kingdom to Central and Western Member States.

Also consistent flows of soya beans are registered from the Netherlands to Central Europe, mainly to Germany. It is plausible to suppose that the traded biomass in this case is coming from third countries to the Netherlands, and is then switched to other EU processing Member States.

[45] See also Annex E.

Figure 8.5 - Main biomass trade flows in Europe



Source: DEIAGRA elaboration on COMEXT data, direct interviews.

8.1.3 Main findings and conclusions

The main findings arising from the analysis of energy crop production in the EU can be summed up as follows.

- The EU total area under energy crops can be estimated in **2,5 mio hectares**. Within them, the dominant crop is by far represented by **rapeseed**, which accounts for around 80-85% of the total energy crop area. Low portions are covered by sunflower, maize, rye, wheat and sugar beet[46].
- A high concentration of these areas can be found in **Germany** (covering alone around 60% of the total EU-15 energy crops area), **France** (more than 25%), the United Kingdom (8%). Some relevant areas can be also found in Poland, Czech Republic, Sweden, Spain and Italy, most of these also showing remarkable growth rates.
- A relevant share of the total area under energy crops is located on **set aside areas** (around 35%) and **AEC areas** (around 23%), but the role played by cultivations **outside specific support regimes** is substantial (42%), particularly in Germany where this area would pass 700.000 ha[47].
- Generally speaking, areas dedicated to energy crops are expanding. However, the development of primary production results to be highly connected to that of processing capacity, having the analysis highlighted an overlapping of the main processing areas and of the main cultivation areas.
- Trade flows of agricultural raw materials for energy purposes seem to exist both within and outside the EU even though, generally speaking, the most part of such feedstocks is likely to come from the same areas where the processing activities are located. Import of raw materials from third countries mostly concern soya beans and some minor products, and normally account for a minor portion of the total quantity of biomass processed for energy purposes.

[46] Estimates by DEIAgra on EC-DG Agri and Euostat data for EU-15. COPA-COGECA for NMS. Other Sources for all Member States regarding the areas outside specific regimes of support, as specified in the previous paragraphs.

[47] See footnote 45.

Energy crops and related destinations*	
Oilseeds (rapeseed and sunflower)	→ 100% bio-diesel
Sugar beet	→ 100% bio-ethanol
Maize	→ 88% bio-gas → 2% direct burning → 10% bio-ethanol[1]
Wheat	→ 98% bio-ethanol → 2% direct burning
Other cereals	→ 98% bio-ethanol → 2% direct burning
Reed canary grass, willow, miscanthus	→ direct combustion
Straw and other agricultural residues[1]	→ direct combustion

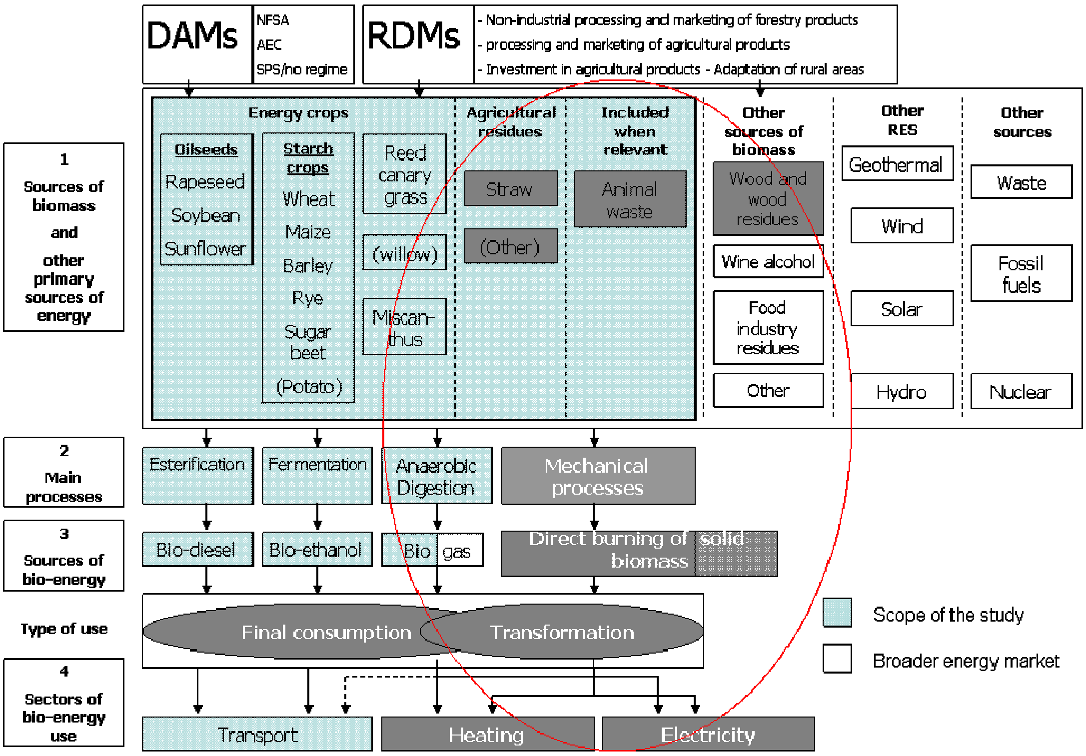
*Estimates[48]

[48] Estimates made on the basis of DG Agri Unit D1 data.
Estimates for bio-gas are based on data from Austria and Germany, where approximately 90% of the energy maize is destined to bio-gas production (elaborations on data from DG AGRI Unit D1, campaign 2002/03), and estimations regarding the Austrian and German share of the EU-15 energy maize production (around 98%). Estimates for direct burning are based on data from Austria and Germany. In Austria energy maize is destined to direct burning for 4-5% (elaborations on data from DG AGRI Unit D1, campaign 2002/03), and estimations regarding the Austrian share of EU-15 total energy maize production (around 23%). In Germany, energy wheat is destined to direct burning for 30-40%% (elaborations on data from DG AGRI Unit D1, campaign 2002/03), and the German share of the EU-15 total energy wheat production accounts for around 4%.
No quantitative estimates can be made for reed canary grass, willow, miscanthus and for straw and other agricultural residues: At present, R&D activities in the field of bio-ethanol focus on using lignocellulosic or woody materials as a feedstock. These include short rotation energy crops (for example willow, popular, miscanthus and eucalyptus), agricultural residues (e.g. straw and sugar cane bagasse), forest residues, waste woods, and municipal solid wastes (www.eubia.org).

8.2 The supply of solid biomass and the direct burning of solid biomass in the EU

As highlighted in the reference scheme (Figure 8.6), the solid biomass[49] other than energy crops falling into the scope of the study includes agricultural residues, animal waste, wood residues and thinning wood. Other sources of biomass, among which food industry residues, are considered when relevant.

Figure 8.6 – Solid biomass within the reference scheme



* In brackets sources of biomass which have not been included because of lack of data and/or very rare use in the EU.
(1) Included when relevant

8.2.1 The EU production of solid biomass different from energy crops

In 2004, the EU production of solid biomass was 69 Mtoe. On total biomass, the contribute coming from energy crops accounts for around 3%, while the remaining 97% is covered by wood and wood wastes (around 86%), municipal solid wastes and organic wastes (around 11%)[50]. Some examples of biomass sources are given in Table 8.9 below[51].

Table 8.8 - EU biomass production (2003)

	Mtoe	%
Wood direct from forest (increment and residues) Organic wastes, wood industry residues, agricultural and food processing residues, manure	67,0	97%
Energy crops from agriculture	2,0	3%
TOTAL	**69,0**	**100%**

Source: DEIAgra elaboration on data from Biomass Action Plan, COM (2005) 628 final, Annexe 2

[49] See glossary for definitions.
[50] See Biomass Action Plan, COM (2005) 628 final, Annexe 2.
[51] See chapter 9 for details regarding the use of biomass for energy purpose.

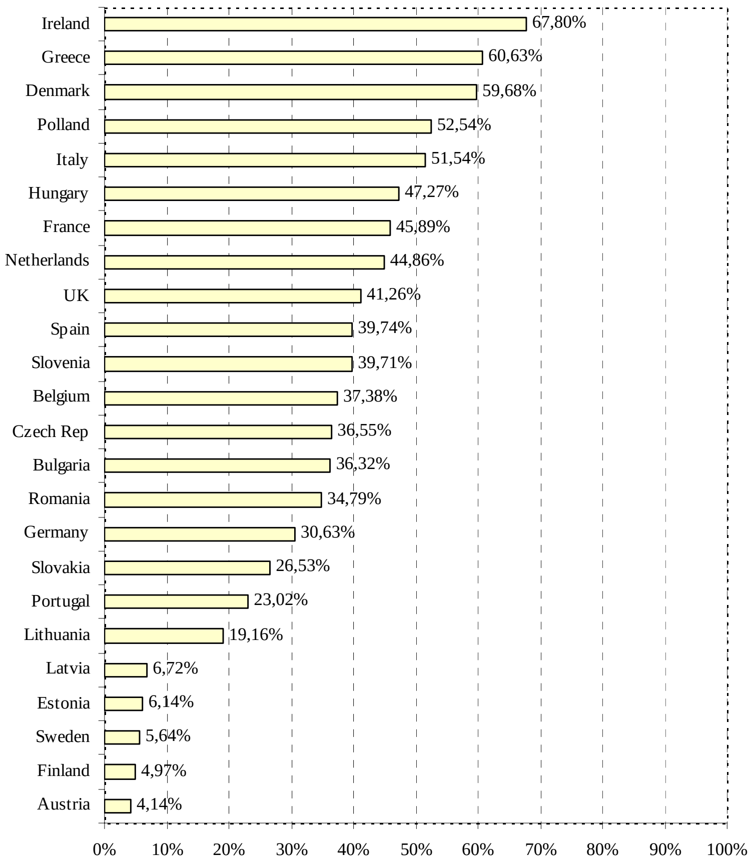
Table 8.9 - Main biomass sources excluding energy crops

Category	Examples
Residues	Wood from forestry thinning Wood felling residues Straw from cereals Other residues from food and industrial crops
By-products and wastes	Sawmill waste Manure Sewage sludge Organic fraction of municipal waste Used vegetable oils and fats

Source: European Commission, DG for Research – Sustainable Energy Systems "*Biomass – Green Energy for Europe*", 2005

The total amount of agricultural biomass resources varies greatly in the different Member States, and accounts for about 34% of the total biomass availability[52]. Figure 8.7 shows the percentage represented by agricultural biomass in the different Member States in 2000. In Finland and Sweden the most significant resource is wood. Short rotation coppice, energy grass and straw constitute a large part of biomass resources in Germany and Poland, straw being the most important. Fruit and herbaceous biomass fuels contribute considerably to biomass supply in Southern and Central Europe[53]. Waste from the pulp and paper industry (industrial black liquors) should be distinguished from the aforementioned resources, being an important bio-energy resource in some Member States, such as Finland and Sweden.

Figure 8.7 - Agricultural biomass resources in the total biomass availability



Source: DEIAGRA elaboration on data from *Nikolaou, A., Remrova, M., Jeliazkov, I.* (2003) "Biomass Availability in Europe". *Available Biomass (t/year), Available Energy Potential (PJ/year)*

[52] Nikolaou *et alii* (2003).
[53] Vesterinen, 2001. Fruit biomass does not include prune residues from fruit trees nor olives groves.

Not all the produced agricultural residues are used for energy purpose. In fact, focusing on the aggregate of wood energy in the broad sense of the term (wood waste, black liquors and solid agricultural crop residues), in 2004 around 55,4 Mtoe were processed into energy (with a growth of around 5,6% over 2003).

As highlighted by table 8.10, the main producing Member States are France, Sweden, Finland and Germany, where activity sectors linked to biomass are especially significant (slashing, furniture wood, building wood). In the Member States with the largest population, like France, Germany and Spain, the use of wood energy is especially localised in forestry regions.

table 8.10 - Primary energy production from wood energy in the EU (Mtoe)

Country	2003	2004	Growth %	Country	2003	2004	Growth %
France	9,002	9,180	*2,0%*	Czech Republic	0,895	1,007	*12,5%*
Sweden	7,927	8,260	*4,2%*	Greece	0,909	0,927	*2,0%*
Finland	6,903	7,232	*4,8%*	Hungary	0,777	0,805	*3,6%*
Germany	5,191	6,263	*20,7%*	Netherlands	0,561	0,720	*28,3%*
Spain	4,062	4,107	*1,1%*	Lithuania	0,672	0,697	*3,7%*
Poland	3,921	3,927	*0,2%*	Slovenia	0,422	0,422	*0,0%*
Austria	3,222	3,499	*8,6%*	Belgium	0,346	0,382	*10,4%*
Portugal	2,652	2,666	*0,5%*	Slovak Republik	0,300	0,303	*1,0%*
Latvia	1,240	1,300	*4,8%*	Estonia	0,150	0,150	*0,0%*
United Kingdom	1,084	1,231	*13,6%*	Ireland	0,145	0,144	*-0,7%*
Denmark	1,071	1,113	*3,9%*	Luxembourg	0,015	0,015	*0,0%*
Italy	1,015	1,083	*6,7%*	Cyprus	0,006	0,060	*900,0%*
				Malta	-	-	
Total EU 25					**52,488**	**55,493**	***5,7%***

Source: EuroBarometer, 2005

8.2.2 The direct burning of solid biomass

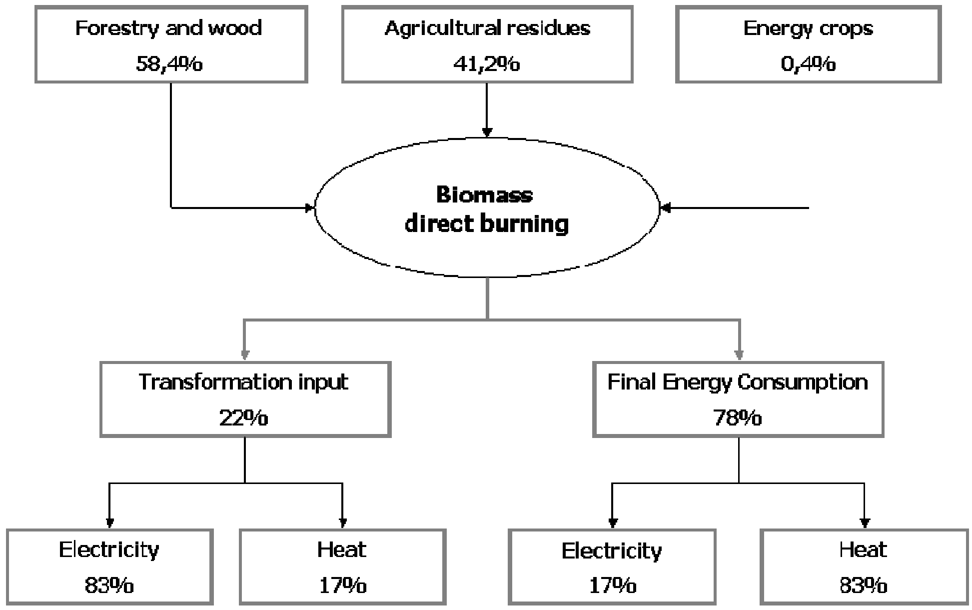
Direct burning of solid biomass consists in solid biomass transformation into electricity and heat. The EU production of solid biomass accounted for around 55 Mtoe in 2004. Being not relevant the share of solid biomass destined to outlets other than direct burning (i.e. pyrolisis and gasification), the overall production of solid biomass can be assumed as the total quantity of biomass destined to direct burning[54]. This overall quantity can be divided into two main categories:

- Final energy consumption, covering energy supplied to the final consumer's door for all energy uses; this share accounts for around 78%, i.e. around 43 Mtoe.
- Transformation input, covering all inputs into the transformation plants destined to be converted into derived products such as electricity and heat; this share accounts for around 22% on the total gross inland consumption, i.e. around 12 Mtoe.

Complete data and information regarding the final energy consumption are very difficult to be achieved, because of the high dispersion of domestic plants and the high difficult to control them and their functioning. However, figure 8.8 provides indications on the weight of different sources as well as various destinations of biomass for direct burning. Around 0,4% - almost 0,22 Mtoe in 2004 - of the total amount of solid biomass would be represented by energy crops[55]; around 58,4% would derive from forestry and wood; around 41,2% from agricultural residues[56].

[54] This assumption is supported by the existence of a limited number of plants using conversion processes different from direct burning. Furthermore, solid biomass is mainly demanded for final energy consumption (83,4% of the total solid biomass destined to direct burning), namely domestic heating, boilers and fireplaces (see § 9.1.1).
[55]Solid biomass for transformation input amounts to 12 Mtoe (22% of 55 Mtoe) so that the estimated share represented by energy crops (0,4%) amounts to 0,05 Mtoe.
[56] Source BTG 2004.

*Figure 8.8 – Direct burning of solid biomass**



*Estimates
Source: DEIAGRA elaborations on data BTG (2004), Eurostat and EurObserv'ER, "Wood energy barometer" (November, 2004), see § 9.1.1.

As regards to destinations, in the case of final energy consumption around 83,4% of the solid biomass is processed into heat, and around 16,6% is transformed into electricity (16,6%). Percentages are inverted in the case of transformation input (electricity 83%; heat 17%).

8.2.3 Brief overview of trade flows of solid biomass in the EU

The analysis of trade flows of solid biomass turns out to be very difficult due to the absence of specific data and information for the different categories of products. If some information is available regarding wood products, it does not refer specifically to biomass destined to energy production, thus impeding any reliable consideration on the topic.

Generally speaking, the available information regarding the **forestry sector**, shows that quite relevant quantities of wood residues, pellets and wood chips are currently traded in the EU (especially in the northern part), due to industrial and large scale uses (e.g. in district heating systems) of different forms of bio-fuels. A clear trend towards an increase in the trade of such materials has appeared in the last years. The reasons behind this can be found in the setting of EU targets for the use of RES (with bio-energy in a leading role) in several directives, as well as in the new Emission Trading System. The main traded forms of biomass are wood pellets and wood chips, but it should be considered – while studying trade flows – that these kinds of wood resources find also a use as raw materials (Alakangas, 2005).

In some Member States, there seems to be a growing interest in the international biomass trade, being trade able to provide biomass at lower prices.

Figure 8.9 presents the **estimated international biomass flows** (Alakangas, 2003). The largest volumes of biomass are traded from the Baltic Member States (Estonia, Latvia, Lithuania) to the Nordic Member States (especially Sweden and Denmark, but also Finland). In particular Sweden seems to be at present importing both from other Nordic Member States as well as from Canada. Sweden can also be considered as a future potential exporter. Some volumes are also traded from Finland to other Nordic Member States, and between neighbouring Member States in Central Europe, especially the Netherlands, Germany, Austria, Slovenia and Italy (Alakangas, 2003). Some biomass volumes are also traded from and to other continents. Italy is presently importing firewood from Northern Africa, while Germany exports some firewood to the Middle and Far East (Turkey, Arab Emirates, Japan and Hong Kong).

Figure 8.9 – Biomass trade in EU: wood, wood wastes and by-products

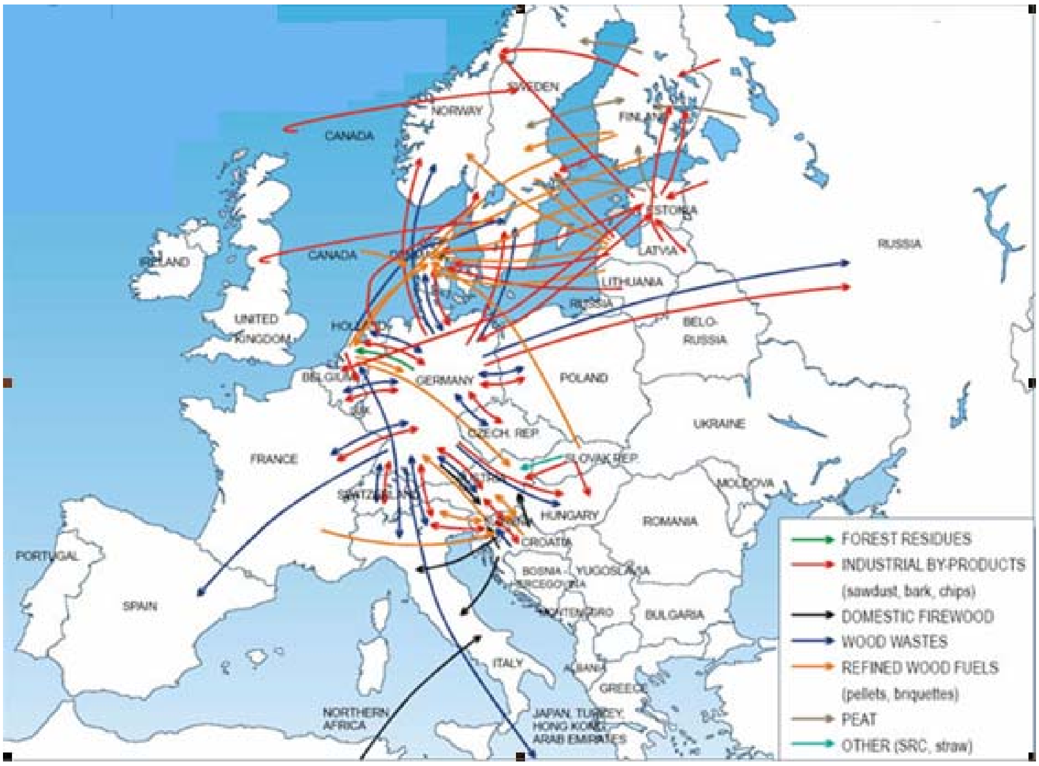


Figure 8.10 - EU biomass imports and export per country: wood and wood residues (2000)

	Import	Export
Austria	10,786 PJ (93% firewood from Germany and Croatia)	7,624 PJ (98% firewood)
Belgium	0,25 PJ firewood	0,09 PJ fuelwood
Denmark	0,7 PJ sawdust and wood pellets from the Baltic State and Canada	very low biomass export
Finland	12,3 PJ wood mainly from Russia	0,8 PJ wood pellets to Denmark, Sweden, NL
France	0,24 PJ	0,02 PJ
Germany	3,5 PJ (sawdust from Austria, Czech Rep., NL, Poland, Belgium, France, Italy, Denmark, Switzerland; chips from conifers from Belgium, Czech Rep., NL, Austria, France; firewood)	15 PJ (sawdust to Austria, NL, Poland, Belgium, France, Itlay, Denmark, Switzerland, Norway, Hungary, UK; chips from conifers to Belgium, Czech Rep., NL, Austria, France, Switzerland, Italy, Sweden, Norway, Denmark, UK, Russia, others; firewood - logs and chopped)
Greece	n.a.	n.a.
Ireland	0	0
Italy	5,6 PJ firewood from Croatia, Slovenia, Northern Africa	0
Netherlands	0,04 PJ	3 TJ wood briquettes and pellets to Denmark, Germany, Austria
Portugal	0	0,1 PJ
Spain	0,14 PJ	0,66 PJ
Sweden	25-32 PJ	0,24 PJ
United Kingdom	0,16 PJ	1,84 PJ fuelwood
Estonia	Minor imports of wood residues	4,7 PJ (wood fuel and wood residues)
Latvia		5,8 PJ (industrial wood chips, pellets, briquettes)
Lithuania		0,25 PJ
Czech Republic	0,7 PJ	4,4 PJ
Slovakia	0,23 PJ	1,2 PJ
Poland	0,03 PJ	0,83 PJ
Hungary	0,34 PJ	1,6 PJ
Slovenia	1,03 PJ	0,41 PJ

Source: Nikolaou, A., Remrova, M., Jeliazkov, I. (2003) "Biomass Availability in Europe".

Some detailed data – also including energy crop products – are available in the case of the Netherlands[57] and Finland[58].

[57] IEA Bio-energy task 40 – Country Report for the Netherlands (Junginger and Faaij, Utrecht University).

As for other solid biomass sources it must be noted that, according to some reliable sources[59], relevant quantities of **agricultural and industrial residues** to be processed into bio-energy usually arrive from Eastern Europe, Africa, Russia and South America. According to data coming from the port of Rotterdam and several biomass traders, **biomass pellets** would mainly originate from South Africa, North America (mainly Canada) and South America (e.g. Chile and Brazil), while agricultural residues are imported from Malaysia, Thailand and Mediterranean countries. The main ports for the import of biomass are currently the port of Rotterdam and Vlissingen, and to a lesser extent Amsterdam.

Figure 8.10 provides some information regarding the most relevant trade flows of wood and wood residues among the EU countries. The biggest volumes of biomass are clearly moved by northern countries – specifically Sweden and Finland – Austria and Germany.

8.2.4 Conclusions and main findings

The EU production of **solid biomass** was **69 Mtoe** in 2004. The contribute coming from **energy crops** accounts for around **3%** of total biomass, while the remaining **97%** is covered by **wood and wood wastes** (around 86%) and municipal **solid wastes and organic wastes** (around 11%)[60].

The total amount of **agricultural biomass** resources varies greatly in the different Member States and accounts for about **34%**[61] of the total biomass availability. In Finland and Sweden the most significant resource is wood. Short rotation coppice, energy grass and straw constitute a large part of biomass resources different from energy crops in Germany and Poland, straw being the most important. Fruit and herbaceous biomass fuels contribute considerably to biomass supply in Southern and Central Europe. Waste from the pulp and paper industry (industrial black liquors) is an important bio-energy source in some Member States, such as Finland and Sweden.

As regards to wood energy (wood waste, black liquors and solid agricultural crop residues), the production in the EU has been rapidly increasing during the last years, with a fast growth of the use of wood and wood by-products to produce electricity. The main producing Member States are France, Sweden, Finland and Germany.

The quantity of agricultural solid biomass destined to direct burning accounts for around 55 Mtoe at EU level in 2004. It is estimated that around 58,4% is represented by forestry and wood, 41,2% by agricultural residues and 0,4% by energy crops[62].

In 2004 solid biomass gross inland consumption was destined for 22% to transformation input and for the remaining 78% to final energy consumption. In the first case (transformation input) the main output of direct burning of solid biomass is electricity (83%) and only a lesser share is transformed into heat (17%). As for the final energy consumption instead, the main output is represented by heat (around 83%), and a lower share is transformed into electricity (17%)[63].

As regards the trade flows of solid biomass, increasing quantities of wood residues, pellets and wood chips are currently traded in the EU (especially in the Northern part). The largest volumes of biomass are traded from the Baltic to the Nordic Member States. Minor quantities are also traded from Finland to other Nordic Member States, and between neighbouring Member States in Central Europe. Some biomass volumes are also traded from and to other continents (firewood from Northern Africa, firewood exported to Middle and Far East, agricultural and industrial residues coming from Eastern Europe, Africa, Russia and South America).

[58] IEA Bio-energy – Business Forum on International Bio-energy Trade, 28-29 October 2004 – International Bio-energy Trade: Experience in Finland. See also Annex E.
[59] IEA Bio-energy task 40 – Country Report for the Netherlands (Junginger and Faaij, Utrecht University), see Annex E.
[60] Source: Biomass Action Plan, COM (2005).
[61] Nikolaou *et alii* (2003).
[62] Elaborations on data BTG (2004), Eurostat and EurObserv'ER.
[63] Source: BTG (2004).

8.3 The EU supply of bio-gas

8.3.1 Production data

Bio-gas production in the EU-25 increased almost threefold since 1995, reaching more than 4 million toe in 2004 and almost **5 million toe in 2005** (Table 8.11). Significant growth – particularly in the case of bio-gas produced for use in the electricity sector – is supported by the establishment of feed-in tariffs, TGC and similar schemes introduced in the framework of the European renewable energy policy. In addition, a major share of bio-gas is produced through recovery from landfills, a practice which is mainly driven by environmental reasons (GHG emission reduction).

With reference to the different sources of biomass from which bio-gas is produced, those concerned by this study - i.e. energy crops and agricultural residues - fall into the category "other" of Table 8.11, which also include other agricultural sources (e.g. manure) and municipal solid waste (the latter limited to the part which is processed in methanisation plants). The category "other" contributed to bio-gas production by 17% only in 2005, but this share increased over 2004 (when it was equal to about 13%).

The **United Kingdom** and **Germany** are by far the main producers of bio-gas (Table 8.11). The United Kingdom alone produced around 1,8 million toe in 2005, i.e. more than one third of the EU-25 production. United Kingdom's bio-gas mostly comes from landfills. Germany is very active in the production of bio-gas from agricultural biomass sources, where it represents more than 75% of total EU production. Denmark, Italy, the Netherlands and Spain are the other major players, but the largest share of production output comes from landfills also in these cases (EurObserv'ER Bio-gas Barometer June 2006). Sweden and the Netherlands represent two peculiar cases, for bio-gas is partly injected into the natural gas network (in the Netherlands) and partly used as a motor fuel (in Sweden). Finally, it is worth noting that the production of bio-gas is mostly concentrated in the EU-15 (97% of total production in 2005). Most of the remaining 3% is covered by Czech Republic and Poland, although the operation of a number of plants was started in other NMS, namely Slovenia, Slovak Republic and Hungary.

Table 8.11 - Production of bio-gas in the EU-25 (2004-2005)

	Production 2004 (1000 toe)				Production 2005 (1000 toe)***			
Member State	Landfill	Sewage sludge*	Other**	Total	Landfill	Sewage sludge*	Other**	Total
UK	1326.7	165.0		1491.7	1617.6	165.0		1782.6
Germany	573.2	369.8	351.7	1294.7	573.2	369.8	651.4	1594.4
Spain	219.1	52.4	23.6	295.1	236.5	56.8	23.2	316.5
France	127.0	77.0	3.0	207.0	129.0	77.0	3.0	209.0
Italy	297.7	0.3	37.5	335.5	334.1	0.4	42.0	376.5
Sweden	35.8	69.3		105.1	35.8	69.3		105.1
Netherlands	48.7	48.6	28.9	126.2	48.7	48.6	28.9	126.2
Denmark	13.8	19.8	55.6	89.2	14.3	20.5	57.5	92.3
Portugal			4.5	4.5			10.0	10.0
Czech Rep.	18.6	28.7	2.9	50.2	21.5	31.4	2.8	55.7
Belgium	56.3	9.7	7.8	73.8	56.3	9.7	7.8	73.8
Poland	21.5	23.9		45.4	25.1	25.3	0.3	50.7
Austria	11.8	19.1	14.5	45.4	11.8	19.1	14.5	45.4
Greece	20.5	15.5		36.0	20.5	15.5		36.0
Ireland	19.9	4.8	5.1	29.8	24.9	4.8	5.1	34.8
Finland	16.6	9.9		26.5	16.6	9.9		26.5
Slovenia	5.8	0.9		6.7	6.0	0.7		6.7
Luxembourg			5.0	5.0			6.7	6.7
Slovak Rep.		5.7	0.2	5.9		5.7	0.2	5.9
Hungary	0.7	2.6	0.2	3.5	0.8	2.9	0.2	3.9
EU-15	***2767.1***	***861.2***	***537.2***	***4165.5***	***3119.3***	***866.4***	***850.1***	***4835.8***
EU-10	***46.6***	***61.8***	***3.3***	***111.7***	***53.4***	***66.0***	***3.5***	***122.9***
EU-25	***2813.7***	***923.0***	***540.5***	***4277.2***	***3172.7***	***932.4***	***853.6***	***4958.7***

*Urban and industrial
**Decentralised agricultural plants, municipal solid waste methanisation plants, centralised co-digestion plants
***Eurobserv'Er estimations
Source: Eurobserv'Er 2006

Table 8.12 presents the evolution of bio-gas production in the United Kingdom over the period 2002-2005. According to estimates reported by EurObserv'ER, this has increased by almost 66% between 2002 and

2005 thanks to the increasing exploitation of landfills. Bio-gas produced in the United Kingdom is mostly used for electricity generation.

Table 8.12 - Production of bio-gas in the United Kingdom (2002-2005)

	2002	2003	2004	2005
Biogas production ('000 toe)	1076	1253	1491	1782.6*

*Eurobserv'Er estimations

Sources: Eurobserv'Er – Biogas Barometer June 2006, June 2005 and June 2004

While bio-gas production in the United Kingdom seems to grow at a steady pace, Germany has experienced a sharp growth between 2002 and 2003, with production level almost doubling, and a stabilisation between 2003 and 2004, followed by a further significant increase in 2005 (Table 8.13). According to EurObserv'ER, this might be due to hesitations by operators to invest in new capacity as a consequence of delays in adopting the national Renewable Energy Law.

Table 8.13 - Production of bio-gas in Germany (2002-2005)

	2002	2003	2004	2005
Biogas production ('000 toe)	659	1229	1294.7	1594.4*

*Eurobserv'Er estimations

Sources: Eurobserv'Er – Biogas Barometer June 2006, June 2005 and June 2004

8.3.2 Import and export of bio-gas

No relevant trade exists with third countries nor within the EU. The bio-gas produced in EU farms in fact, is mostly destined to produce electricity and heat for self consumption. In some cases – Austria is an example – the excess bio-gas obtained from farm-based bio-gas plants is fed to the local gas network[64].

8.3.3 By-products

The production process of bio-gas (anaerobic digestion) generates two principal by-products:

- Acidogenic anaerobic digestate is a stable organic material comprised largely of lignin and chitin, but also of a variety of mineral components in a matrix of dead bacterial cells; some plastic may also be present. This resembles domestic compost and can be used as **compost** or to make low grade **building products** such as fibreboard.
- Methanogenic digestate is a liquid, which is rich in nutrients and can be an excellent **fertilizer** depending on the quality of the material being digested[65].

A less common by-product of anaerobic digestions are the **organic acids** (i.e. carboxylic acids).

Furthermore, bio-gas is made up of around 60% methane (CH4) and 40% carbon dioxide (CO2) and methane can be further refined to produce fuel related products such as methanol[66]

Finally, some potentially useful by-products originate from the anaerobic digestion. Fibre and liquid digestates can provide soil improvers and fertilisers, which have the potential to become cheaper than other increasingly expensive fertilisers. There is also some evidence that the digestates may suppress normal soil pathogen and parasite levels[67].

The most successful applications for digesters are associated to working as outlets for waste disposal, rather than as energy production units. Recent experimental works[68] on the digestion of food and meat wastes

[64] Walla and Schneeberger, 2003.

[65] If the digested materials include low levels of toxic heavy metals or synthetic organic materials such as pesticides or PCBs, the effect of digestion is to significantly concentrate such materials in the digester liquor. In such cases further treatment will be required in order to dispose of this liquid properly. In extreme cases, the disposal costs and the environmental risks posed by such materials can offset any environmental gains provided by the use of bio-gas. This is a significant risk when treating sewage from industrial plants.

[66] http://www.energy.ca.gov/pier/renewable/biomass/anaerobic_digestion .

[67] Information Sheet: Anaerobic Digestion, (2003) Warmer Bulletin, Issue 89 March.

[68] Work undertaken by East Harbour (East Harbour Management Services Ltd, "Availabilities and Costs of Renewable Sources of Energy for Generating Electricity and Heat", 2002)

indicate that the economics are improved significantly if the feedstock is based on waste which would otherwise generate a cost for its disposal.

Digesters have therefore a potential to add value through: *i)* converting hazardous wastes into useful fertilisers and *ii)* converting food processing by-products or waste into organic fertilisers.

Moreover, a successful operation of digesters calls for scale economies, which have a very significant effect on project economics. Indeed the clustering of organic waste producers is a strategy which may be used to provide a digester, or a cluster of digesters, with a substantial source of feedstock, and hence with scale economies.

8.3.4 Conclusion and main findings

The overall production of bio-gas in the EU was around 4,9 Mtoe in 2005 (4,8 in the EU-15)[69].

Bio-gas from the miscellaneous category of sources including energy crops and agricultural residues, represents around **17% of the total bio-gas** produced in the EU, while the largest share of production is obtained from landfills (64%), and the remaining share (19%) is processed from sewage sludge.

The main producers of bio-gas are the **United Kingdom and Germany**, the latter being responsible for over 75% of the EU production of bio-gas from agricultural biomass sources.

Finally, no significant trade of bio-gas exists either at EU or international level.

[69] EurObserv'ER 2006.

8.4 The supply of bio-fuels in the EU

The supply of bio-fuels in the EU is mostly composed of bio-diesel and bio-ethanol.

Bio-diesel is produced from vegetable oil, animal oil or recycled fats and oils through an esterification process. It takes the form of rapeseed methyl ester (RME), fatty acid methyl ester (FAME) or methyl ester from pure vegetable products (PME) and may be used in its pure form or blended with diesel oil.

Bio-ethanol is obtained from distilling the sugar contained in beets and cereals such as wheat, barley and corn, and can be used in its pure form or further processed in order to obtain ethil tertiary butyl ether (ETBE), made up of 50% ethanol and 50% isobutylene (a petrol derivative and a by-product of refinery processes).

Both bio-diesel and bio-ethanol are classified as **first-generation bio-fuels**. Other first-generation bio-fuels include pure vegetable oil and upgraded bio-gas, which have experienced significant diffusion in Germany and Sweden respectively[70].

Liquid bio-fuels are mostly produced from **energy crops and agricultural residues**. Specifically, bio-diesel produced in the EU is mainly obtained from rapeseed and sunflower seeds, while bio-ethanol produced in the EU is mainly obtained from sugar beet, wheat and barley. However, as far as bio-ethanol is concerned, a significant share of the EU production is obtained from wine alcohol originating from the distillation measure of the Common Market Organisation of wine. This share may be quantified in about 22% of the EU bio-ethanol production in 2005, which in turn corresponds to about 4% of the EU total bio-fuel production (expressed in tons) in the same year. However, the above mentioned share is subject to variation from year to year, depending on the amount of wine surpluses[71].

The so called **second-generation bio-fuels**, with superior fuel properties, are currently being assessed and developed, and should mainly employ **lignocellulosic feedstock**. To this end, pilot plants have been established in a number of Member States, and companies in the sector have announced investments for the development of such new sources of bio-energy[72]. The main second-generation bio-fuels are described in the table below. These fuels are not included in the study since they are only developed at the experimental level, hence supply is negligible and data scarcely available.

Table 8.14 – Second generation bio-fuels

Bio-fuel type	Specific name	Biomass feedstock
Bio-ethanol	Cellulosic bio-ethanol	Lignocellulosic material
Synthetic bio-fuels	Biomass-to-liquids (BTL) Fischer-Tropsch diesel Synthetic bio-diesel Bio-methanol Heavier (mixed) alcohols Bio-dimethilether (bio DME)	Lignocellulosic material
Bio-diesel (hybrid between 1st and 2nd generation)	Next generation biomass-to-liquid (NExBTL)	Vegetable oils and animal fat
Bio-gas	Synthetic natural gas (SNG)	Lignocellulosic material
Bio-hydrogen		Lignocellulosic material

Source: adapted from Bio-fuels Research Advisory Council 2006

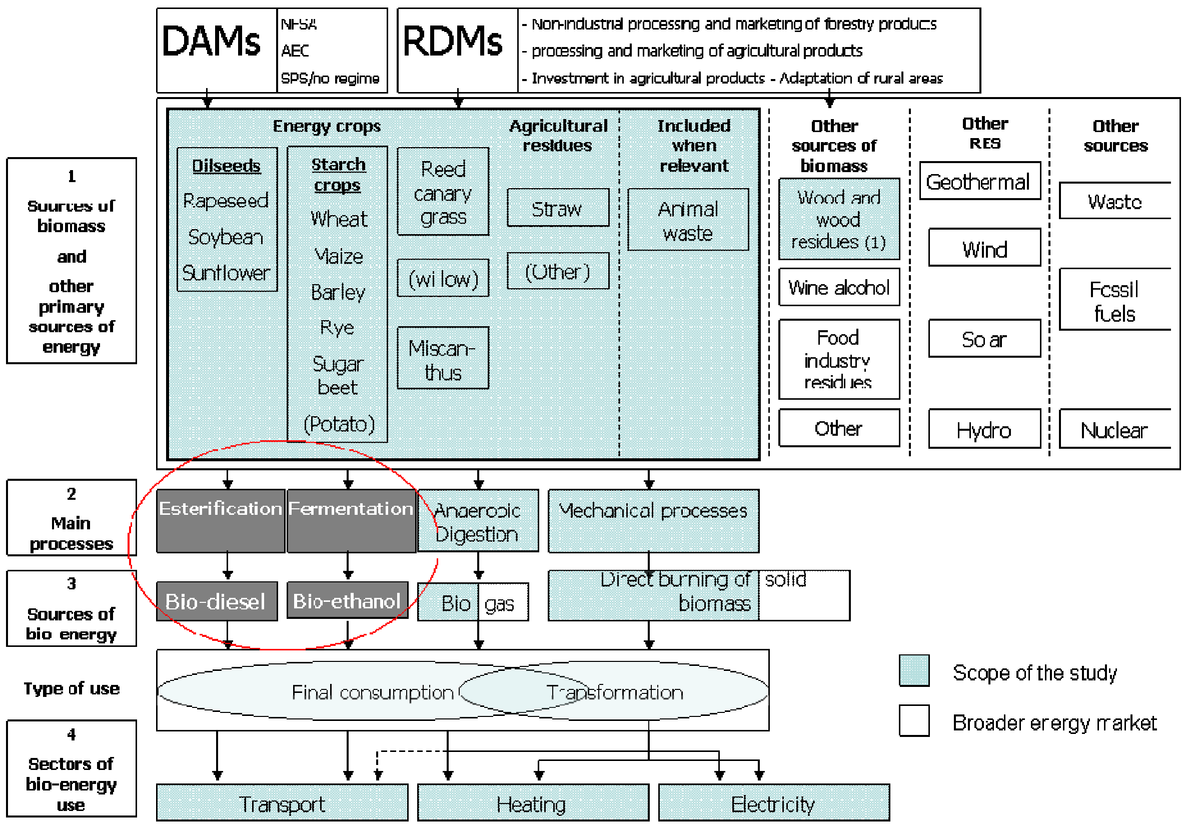
The scope of the analysis carried out in this section is illustrated in figure7.1 .

[70] For definitions of all the above-mentioned bio-fuels see COM(2006)34 final. Bio-fuels include liquid fuels such as bio-methanol, bio-ETBE, bio-MTBE, biomass-to-liquids and pure vegetable oils, as well as gaseous fuels such as bio-DME, bio-gas used as a transport fuel, and bio-hydrogen (for definitions see COM(2006)34 final).

[71] Fore more details regarding bio-fuel production from wine alcohol, see also § 8.4.

[72] See, for instance, Neste Oil and Total, which are to establish a bio-diesel plant using NExBTL technology (Neste Oil website, accessed May 2006).

Figure 8.11 - The supply of liquid bio-fuels



* In brackets sources of biomass which have not been included because of lack of data and/or very rare use in the EU.
(1) Included when relevant

8.4.1 The production of bio-fuels in the EU

The EU is the world's leading area for both production and consumption of bio-diesel, covering more than 90% of the global market, although several other Countries have recently launched important bio-diesel programmes. **Bio-diesel** accounts for **about 80% of bio-fuel supply** (measured in tons) in the EU.

Conversely, bio-ethanol is the most important bio-fuel at world level, with the EU covering about 10% of its supply. Referring to the EU market, **bio-ethanol** represents slightly more than **20% of total bio-fuel supply**.

EU bio-diesel production amounted to around 3,2 million tons (2,88 Mtoe) in 2005 (table 8.15Table 8.15). This figure represents a 65% increase as compared to the 2004 output (1,71 million tons) and a 112% increase as compared to 2003 (1,5 million ton[73]). Annual growth rates for previous years resulted much lower than the current one (always around 30-35%)[74].

As regards bio-ethanol, the EU production almost reached 0,73 million tons (0,47 Mtoe) in 2005[75], this figure representing a 73% increase as compared to 2004 and a 106% increase as compared to 2003[76].

Both bio-diesel and bio-ethanol markets are thus experiencing unprecedented growth. Such growth is likely to represent the result of the EU support policy for bio-fuels[77].

Table 8.15 - Production of bio-fuels in the EU-25 (2003-2005)

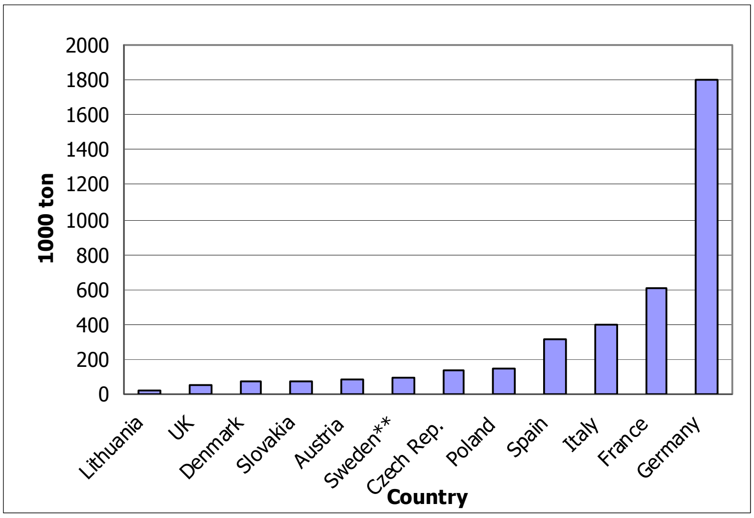
[73] Source for 2003 output is EurObserv'ER 2004 Bio-fuels Barometer.
[74] European Bio-diesel Board (EBB), EBB website, accessed May 2006. Figures include wine ethanol.
[75] This figure includes bio-ethanol obtained from wine alcohol, which amounts to 162.000 tons in 2005, and concerns four MS, namely Spain, Sweden, France and Finland (see table 8.16).
[76] European Bio-ethanol Fuel Association (eBIO), EurObserv'ER.
[77] In this respect, it is worth noting again that the deadline for transposition of Directive 2003/30 and subsequent introduction of support schemes for achieving bio-fuels targets was 31 December 2004.

	2003	2004	2005
Bio-diesel (1000 ton)	1504	1933	3184
Bio-ethanol (1000 ton)	351	419	762,4

Sources: EBB statistics, EurObserv'ER 2005 European Barometer of Renewable Energies, eBIO

With reference to Member States, Germany is by far the main producer of bio-fuels, with a production of 1,8 million tons in 2005 (Figure 8.12). Other important producers include France, Italy, Spain and Sweden, as well as two NMS, namely Czech Republic and Poland[78].

Figure 8.12 - Bio-fuels production in EU-25 MS (2005)



Sources: EBB and eBIO

Differently from the case of bio-gas, NMS seem to play a more important role in bio-fuels production, accounting all together for 10.5% of total EU-25 production. Czech Republic and Poland alone account for most of this share.

The separate analysis of the bio-diesel and bio-ethanol markets provides a clearer picture of the situation. Table 8.16 below, shows that the production in most EU countries is indeed limited to either bio-diesel or bio-ethanol in 2005. Exceptions in this context are represented by France (which is a leading producer for both bio-fuels), Germany (where new bio-ethanol capacity was installed and production reached a remarkably high level in 2005), and Spain (where bio-diesel output fast increased from 2003 to 2005). It is also interesting to note that many countries result to have started the production in 2005, especially among the NMS.

The **bio-diesel market** is clearly dominated by Germany, whose production represents 52% of EU-25 output, while France and Italy cover a further 28% share. As to the remaining share, NMS play an important role, Poland and the Czech Republic being among the leading producers and Slovakia featuring a sharp increase in output between 2004 and 2005. Finally, Spain and the United Kingdom achieved considerable production levels with very high growth rates in recent years.

Besides promoting the development of its bio-diesel market, Spain remains the leader for the production of **bio-ethanol**, with about 163.000 tons (0,1 Mtoe) in 2005 (240.000 tons when also wine alcohol is considered)[79]. France and Germany show similar production levels, but the latter experienced the sharpest

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[78] Figure 8.12 shows production levels of main producing MS only. Other Member States produce minor quantities of bio-fuels and most of them have only recently started the production of bio-fuels. More complete data are provided in table 8.16, where the production of bio-diesel and bio-ethanol are kept separate.

[79] A significant share of bio-ethanol produced in the EU is obtained from wine alcohol originating from the distillation measure of the CMO for wine. However, the volume of wine distillations, and consequently the volume of bio-ethanol produced from wine, results to vary markedly from year to year, being closely dependent on wine surpluses. Over the last 25 years an average amount of 26 million hectolitres of wine, i.e. 15% of production, has been distilled each year. However, the percentage has varied considerably in recent decades, reaching a maximum (25%) in the 1980s and a minimum (5%) in 1995/96. Since 2000, it has fluctuated around 10%.

growth, from 20.000 tons to 130.000 tons. These three Countries together cover almost 74% of EU-25 production. Significant volumes of bio-ethanol are also produced in Poland and Sweden, the latter being the main consumer in the EU.

Table 8.16 - Production of bio-diesel and bio-ethanol in EU MS (2004-2005)

	Biodiesel 2004 (1000 ton)	Biodiesel 2005 (1000 ton)	Bioethanol 2004 (1000 ton)	Bioethanol 2005 (1000 ton)
Germany	1035	1669	20	131.3
France	348	492	80.9	106.7 (114.7)
Italy	320	396	-	6.3
Spain	13	73	134.7 (202.4)	162.7 (241.2)
Poland	-	100	38.3	50.9
Czech Republic	60	133	-	-
Sweden	1.4	1	39.8 (56.5)	48.5 (121.8)
Austria	57	85	-	-
Slovakia	15	78	-	-
Denmark	70	71	-	-
UK	9	51	-	-
Hungary	-	-	-	27.8
Lithuania	5	7	-	6.3
Latvia	-	5	9.8	9.5
Slovenia	-	8	-	-
Estonia	-	7	-	-
Netherlands	n.a.	n.a.	11.1	6.3
Greece	-	3	-	-
Malta	-	2	-	-
Finland	n.a.	n.a.	-	7.9 (10.3)
Belgium	-	1	-	-
Portugal	-	1	-	-
Cyprus	-	1	-	-
EU-15	**1853.4**	**2843**	**286.5 (370.9)**	**469.7 (631.9)**
EU-10	**80**	**341**	**48.1**	**94.5**
EU-25	**1933.4**	**3184**	**334.6 (419)**	**564.2 (726.4)**

In brackets production levels including bio-ethanol from wine alcohol

Source: EBB, e-BIO and DG AGRI (the latter limited to bio-ethanol from wine alcohol)

As regards to the most important producing countries, table 8.17 shows Germany's output of bio-fuels in the last years, which consisted of bio-diesel only until 2003. This production has increased by 61% between 2004 and 2005, and by 370% since 2002. This can be mainly explained in terms of favourable legislation (tax exemption for pure bio-fuels with no exemption quotas) and low price for vegetable oils associated with high price for diesel fuel (EurObserv'ER 2004)[80].

As far as bio-ethanol is concerned, production was started in 2004 and increased strongly in 2005, reaching 130.000 tons. Germany is now the second largest producer of bio-ethanol and capacity is rising sharply.

The situation regarding wine distillation is however under evolution. Under the Common Organisation of the Wine Market (Council Regulation (EC) No 1493/1999), distillation is the main instrument of intervention on the established market mechanisms. The aim of distillation is to withdraw production surpluses from the market at a guaranteed minimum price. Nevertheless, some changes are likely to be introduced by the reform of the CMO for wine. According to COM(2006)319 final, *i)* market support measures in the form of distillation are not effective in terms of securing vine farmers' income and serve as a permanent outlet sustaining an unsaleable surplus and *ii)* crisis distillation, designed to tackle conjunctural surpluses, is used as a structural measure and now also covers "quality wines". Some alternative options of wine CMO reform have been identified (see COM(2006)319 final for details). For example, following option 2, all market measures, and in particular distillations, would be in general abolished. The termination of market management measures like support for by-product distillation and potable alcohol and dual-purpose grape distillation could have significant effects not only on the balance in the wine market (see COM(2006)319 final), but also – as regard the purposes of this study – on the production of bio-ethanol from wine.

[80] The new coalition Government has recently announced the replacement of existing tax-exemptions with an obligation to blend bio-fuels with fossil fuels. However, the marketing of pure bio-fuels should not be affected by such change (UFOP).

table 8.17 - Production of bio-fuels in Germany (2002-2005)

	2002	2003	2004	2005
Biodiesel (1000 ton)	450	715	1035	1669
Bioethanol (1000 ton)	0	0	20	131.3
Total biofuels (1000 ton)	450	715	1055	1800.3

Sources: EurObserv'ER - Biofuels Barometer June 2004; EBB; eBIO

As regards to **France**, here the production of bio-fuels has been supported since the early 1990s. Thanks to favourable legislation which granted substantial tax exemptions for bio-diesel, the Country was the EU largest producer of bio-diesel until 2001. Since then, production has slightly fallen (-5%) between 2002 and 2004, and recovered in 2005, reaching 492.000 tons (0,44 Mtoe, see table 8.18). A similar trend has concerned the bio-ethanol industry in the same period[81]. Such evolution is likely to depend on decisions concerning the so-called authorised quotas, as well as the recent evolution in the national legislation[82].

table 8.18 - Production of bio-fuels in France (2002-2005)

	2002	2003	2004	2005
Biodiesel (1000 ton)	366	357	348	492
Bioethanol (1000 ton)	90.5	82	81	106.7 (114.7)
Total biofuels (1000 ton)	456.5	439	429	598.7 (606.7)

In brackets production levels including bio-ethanol from wine alcohol

Sources: EurObserv'ER - Biofuels Barometer June 2004 and 2005 Barometer of Renewable Energies; EBB; eBIO

The production of bio-diesel in **Italy** has increased almost twofold in the interval 2002-2005, with a growth rate of 24% in 2005 with respect to the previous year (table 8.19). These results might be attributed to a three-year programme covering the period 2002-2004 which substantially increased production quotas, on which the Italian support system is based, similarly to the French one. The 2005 results are somewhat surprising, as the production quota was set at 200.000 tons. As to bio-ethanol, support will start in 2008 and a three-year bio-ethanol quota has been approved which exempts a maximum amount of 79.300 tons yearly, to be produced in Italy (EurObserv'ER). The Italian support to bio-ethanol may be explained by the fact that it can be produced using internal resources, while most vegetable oils used for bio-diesel production are imported. Bio-ethanol production started in 2005 with estimated 6.300 tons produced in Italian plants.

table 8.19- Production of bio-fuels in Italy (2002-2005)

	2002	2003	2004	2005
Biodiesel (1000 ton)	210	273	320	396
Bioethanol (1000 ton)	0	0	0	6.3
Total biofuels (1000 ton)	210	273	320	402.3

Sources: EurObserv'ER - Biofuels Barometer June 2004; EBB; eBIO

Spain leads the production of bio-ethanol in the EU and its production capacity is expanding. Output increased by 77% since 2002 and by 18% in 2005 as compared with the previous year. The development of the Spanish bio-ethanol market may be explained by favourable legislation (high tax exemptions for bio-ethanol). As far as bio-diesel is concerned, production started in 2003 and Spain became one of the leading

[81] It must be noted, however, that this is an estimate and not the actual production.
[82] Tax exemptions in the French system are indeed only granted to limited amounts of bio-fuels produced. In this respect, the French government announced in 2004 a considerable increase in authorised quotas, which should reach 800.000 tons by 2007 (480.000 for bio-diesel and 320.000 for bio-ethanol). In addition, a new tax on fuels (TGAP) was introduced by the 2005 Finance Law to support the bio-fuels market. Both these changes may explain the 2005 increase in bio-fuels production. As to future developments, in november 2005 the French government reviewed national objectives for bio-fuels by setting a target of 5.75% for 2008 (the same target had been formerly set for 2010), one of 7% for 2010 and one of 10% for 2015. Accordingly, a new call will be launched to producers in 2006 for additional production quotas of 1.1 million tons (Portail du Gouvernment – Premier Ministre, accessed May 2006).

producers in 2005 with 73.000 tons. Furthermore, significant investments are being made to increase capacity (see § 8.4.3).

table 8.20 - Production of bio-fuels in Spain (2002-2005)

	2002	2003	2004	2005
Biodiesel (1000 ton)	0	6	13	73
Bioethanol (1000 ton)	176.7	160	134.7 (202)	162.7 (241.2)
Total biofuels (1000 ton)	176.7	166	147.7 (215)	235.7 (314.2)

In brackets production levels including bio-ethanol from wine alcohol

Sources: EurObserv'ER - Biofuels Barometer June 2004 and 2005 Barometer of Renewable Energies; EBB; eBIO

No relevant export flows of bio-diesel and/or bio-ethanol from the EU to third countries have been observed in the analysis. This may be due to the fact that most EU Member States have only recently started bio-fuel production, and that their main objective is meeting national targets set in implementing Directive 2003/30/EC, rather than exploring opportunities for trading bio-fuels with third countries.

8.4.2 Bio-diesel and bio-ethanol imports

8.4.2.1 Bio-diesel

EU is at present the main world producer of bio-diesel, also featuring the highest demand. **Extra-EU trading of bio-diesel is thus very limited**, while a certain amount of trading is registered inside the EU among MS. Therefore, the bio-diesel market currently has a continental dimension. Nevertheless, imports from developing countries are expected to increase in the next future. Malaysia, Indonesia and Philippines represent some relevant examples in this respect, being leading producers of palm oil.

8.4.2.2 Bio-ethanol

The situation on the bio-ethanol market is rather different, since an **inter-continental market** is already in place for such bio-fuel. Some Member States import bio-ethanol from **Brazil**, the main world producing country[83].
The international market of bio-ethanol can be divided according to different levels of taxation on the product and different exporting countries. Import duties are defined by international agreements. Under the special drugs regime envisaged by Council Regulation (EC) 2501/2001, which was in force from the early nineties until repealed on 30 June 2005, exports from a number of countries (Bolivia, Colombia, Costa Rica, Ecuador, Guatemala, Honduras, Nicaragua, Panama, Peru, Pakistan, El Salvador and Venezuela) was qualified for duty-free access under code 2207. For some countries, defined as "most favoured nations" (MFNs), a custom duty of **19.2 euro/hl** applied on the overall volumes. On imports from other countries- mainly Russia and other former Soviet Union countries - custom duties reduced by 15% to 100% were imposed[84].

Thanks to its admission to the 100% custom duties exemption (due to the 1995 enlargement protocol with Sweden), in 2004 **Pakistan** was the major exporter to the EU-15. The new GSP[85] Regulation, which applies from 1 January 2006 to 31/12/2008, no longer envisages any tariff reduction for either denatured or undenatured alcohol under code 2207 (still classified as a sensitive product)[86]. The recent exclusion of

[83] This product is traded under code 2207, which covers both denatured and undenatured alcohol (CN 2207 20 and CN 2207 10 respectively). Both products can be used to produce bio-fuels, but is not possible to establish from trade data whether or not imported alcohol is used in the fuel ethanol sectors in the EU-25.
[84] The bio-ethanol import duties can be summed up in the following: Duty-free: 0 €/Hl; Reduced duty: 16,3 €/Hl; MFN: 19,2 €/Hl (source: COMEXT).
[85] Generalised System of Tariff Preferences, Council Regulation (EC) No 980/2005 of 27.06.2005.
[86] This Regulation puts in place a special incentive arrangement for sustainable development and good governance (the new GSP + incentive scheme) which was applied on a provisional basis since 1 July 2005, and which applies on a permanent basis from 1 January 2006 to 31 December 2008. This new incentive arrangement grants unlimited and duty free access (suspension of Common Customs Tariff duties) to denatured or undenatured alcohol under code 2207. It includes all the countries which already benefited from the previous drugs scheme, with the exception of Pakistan which is subject to the full MFN duty.

Pakistan from the list of countries having unlimited duty-free access to the EU market, will remove from the market one of the most competitive producers, even though, thanks to very low production costs, this country might continue to be able to export significant quantities of ethanol to the EU.
Brazil, the world's main producer, is included in the MFNs. Despite being one of the countries with higher levels of custom duties, Brazil has an important export activity to Europe[87].

With respect to the largest exporting countries:

a) over the 2002–2004 period, **Pakistan** was the largest duty-free exporter with an average of 501.745 hl, followed at a distance by Guatemala with 223.782 hl;
b) **Brazil** is the only country capable of exporting large quantities as MFN, with an average of 649.640 hl over the same period; the second MFN exporter - the USA – exported on average only 20.109 hl;
c) Ukraine accounts for the vast majority of imports at reduced duty, with an average of 107.711 hl over the 2002–04 period. Egypt was second with over 43.000 hl.

Table 8.21 reports the main exporting countries to the EU-15 in the last years.

Table 8.21 - EU-15 ethanol imports by country of origin in the 2002-2004 period (.000 Hl)

	2002	2003	2004
Pakistan	119	633	750
Brazil	54	57	547
Guatemala	48	367	256
Peru	6	92	194
Ukraine	73	106	111
Norway	67	92	108
Bolivia	90	223	95
Swaziland	77	93	87
Egypt	20	0	78
Zimbawe	138	159	66
South Africa	78	55	47
Ecuador	20	70	46
Argentina	2	0	40
total EU-15 imports	1252	2258	2579

Source: COMEXT

Data about exports to the EU-25 are available only at an aggregate level. It should be noted that the total imports of bio-ethanol to the NMS account for less than 20% of the total EU import from third countries.

Generally speaking, it can be assumed - differently from bio-diesel - that a global market for bio-ethanol does exist.

Figure 8.13 - Total imports of bio-ethanol in the EU-25

1000 hl	2002	2003	2004
Reduced duty	227	183	288
Duty-free	981	2028	1709
MFN	657	495	1125
TOTAL	1865	2705	3122

Source: COMEXT

8.4.3 Production capacity and geographical location of plants in the EU

8.4.3.1 Bio-diesel

Table 8.22 shows the evolution of bio-diesel production capacity in the 2003-2006 period for each Member State. Data highlight a fast growth between 2005 and 2006, when an increase of around 1,8 million ton was

[87] The relative weight of the duty represents around 64% of the production cost of bio-ethanol in Brazil (see chapter 11.2), and around 32% of the international price of bio-ethanol.

reported, likely to be due (in part at least) to measures for implementing Directive 2003/30/EC[88].

A remarkable growth was registered in Germany and Italy, where capacity more than doubled between 2004 and 2006, and in Spain and the United Kingdom, where much higher growth rates were achieved, so that these two Member States may now be considered among the leading producers of bio-diesel in the EU. As for France, capacity was relatively stable between 2003 and 2005, while it increased considerably in 2006, probably as a consequence of increases in authorised quotas in 2004 and 2005, which promoted new investments. Other Member States for which significant growth in capacity was registered include Poland, Czech Republic and Slovakia among the NMS as well as Austria, Denmark, Greece and Portugal among EU-15 Member States.

It is interesting to note that around 25% of the EU production capacity is currently unexploited (see also production data), even though some differences appear among the various countries. While the production potential seems to be well exploited in countries like Germany and France, the situation is at all different, for example, in Italy (around 48% of the installed capacity is exploited) and the United Kingdom (around 40%).

Table 8.22 - Bio-diesel production capacity in the EU (2003-2006)

	2003 (1000 ton)	2004 (1000 ton)	2005 (1000 ton)	2006 (1000 ton)
Germany	1025	1088	1903	2681
France	500	502	532	775
Italy	420	419	827	857
Spain		70	100	224
Poland	n.a.	n.a.	100	150
Czech Republic	140	140	188	203
Sweden	8	8	12	52
Austria	50	100	125	134
Slovakia		15	89	89
Denmark	40	44	81	81
UK	5	15	129	445
Lithuania		n.a.	10	10
Latvia			5	8
Slovenia			17	17
Estonia			10	20
Greece			35	75
Malta			2	3
Belgium			55	85
Portugal			6	146
Cyprus			2	2
Hungary			0	12
EU-15	2048	2246	3805	5555
EU-10	140*	155*	423	514
EU-25	2188	2401	4228	6069

*No data available for Poland and Lithuania

Sources: EurObserv'ER (2003 and 2004) and EBB (2005 and 2006)

Figure 8.14 also shows the present location of bio-diesel plants in the EU, pictured on the basis of a wide range of different sources[89]. Not surprisingly, a large number of plants is localised in Germany, where almost half of the EU capacity is located, even though a high number of small-sized plants actually operate in the country. The same situation occurs in Austria, while in other Member States plants have a higher average size (see, for instance, France and Italy).

A quite high concentration of plants can be also found in Spain and Portugal, as well as in Italy and United Kingdom, with quite a high number of plants located close to relevant ports, this being of some relevance in terms of relationship with the biomass production areas[90].

According to the available information, new investments have been carried out mainly on larger-sized plants in almost all the Member States. Such interesting development will be taken into account when focusing on cost competitiveness of bio-fuels.

[88] Different data sources could however be responsible of part of this evolution.

[89] A detailed table containing more information on the single plants is presented in Annex C.

[90] See also § 8.1.2.

Figure 8.14 – Geographical location of bio-diesel plants in the EU

8.4.3.2 Bio-ethanol

Table 8.23 shows the evolution of bio-ethanol production capacity in the EU in the 2003-2006 period, and also presents forecasts for 2007 and 2008. EU capacity increased almost fivefold between 2003 and 2006, reaching 1,8 million tons (1,1 Mtoe) in 2006. A major increase was achieved between 2005 and 2006, amounting to around 800.000 tons (0,5 Mtoe). Again, this is likely to be due (in part at least) to the implementation by MS of Directive 2003/30/EC. Around 90% of the EU global production capacity results to be localised in the EU-15.

Parallel to the growth of overall capacity – mainly verified in Germany, Spain and France - the number of producing Member States has increased, including Germany, Italy, Hungary, Lithuania and other minor producers.

Forecasts for 2007 and 2008 show further substantial growth of capacity, which is likely to reach 5,5 million tons overall, with an increasing role of NMS, which would account for more than 20% of the EU capacity. Massive investments are being carried out in France, which alone should account for more than 25% of the overall EU capacity in 2008. Germany and Spain would remain major producers, although planned investments are less substantial than those being carried out in other Member States, such as Hungary, the Netherlands, Belgium, Poland and the United Kingdom. New producing Member States in 2008 should include Belgium, the United Kingdom, Austria, Slovakia and Czech Republic, the latter re-entering the market after a few years when no relevant investments have been carried out.

It should be noted that the aforementioned increases in capacity will be probably associated in the short term with lower growth rates in actual production, due to start-up difficulties which may delay full operability of the new plants.

Table 8.23 - Bio-ethanol production capacity in the EU (2003-2008)

	2003 (1000 ton)	2004 (1000 ton)	2005 (1000 ton)	2006 (1000 ton)	2007 likely (1000 ton)	2008 likely (1000 ton)
Germany		196	476	576	576	706
France	103	142	142	499	1179	1499
Italy				33	33	33
Spain	180	257	257	415	515	615
Poland	n.a.	107	107	107	264	365
Czech Rep.	30				80	80
Sweden	54	55	55	55	55	175
Lithuania				25	25	25
Finland				10.3*	n.a.	n.a.
Austria					158	158
Slovakia					59	59
UK					55	253
Latvia				9.5*	6	6
Belgium					316	395
Netherlands		9	11	11	284	542
Hungary			28	37	63	593
EU-15	337	650	941	1599.3	3171	4376
EU-10	30	107	135	178.5	497	1128
EU-25	367**	757	1076	1777.8	3668	5504

**Due to lack of public data, figure refers to actual production in 2005. This has to be interpreted has a minimum capacity level.*

*** It does not include data regarding Poland, which is not available.*

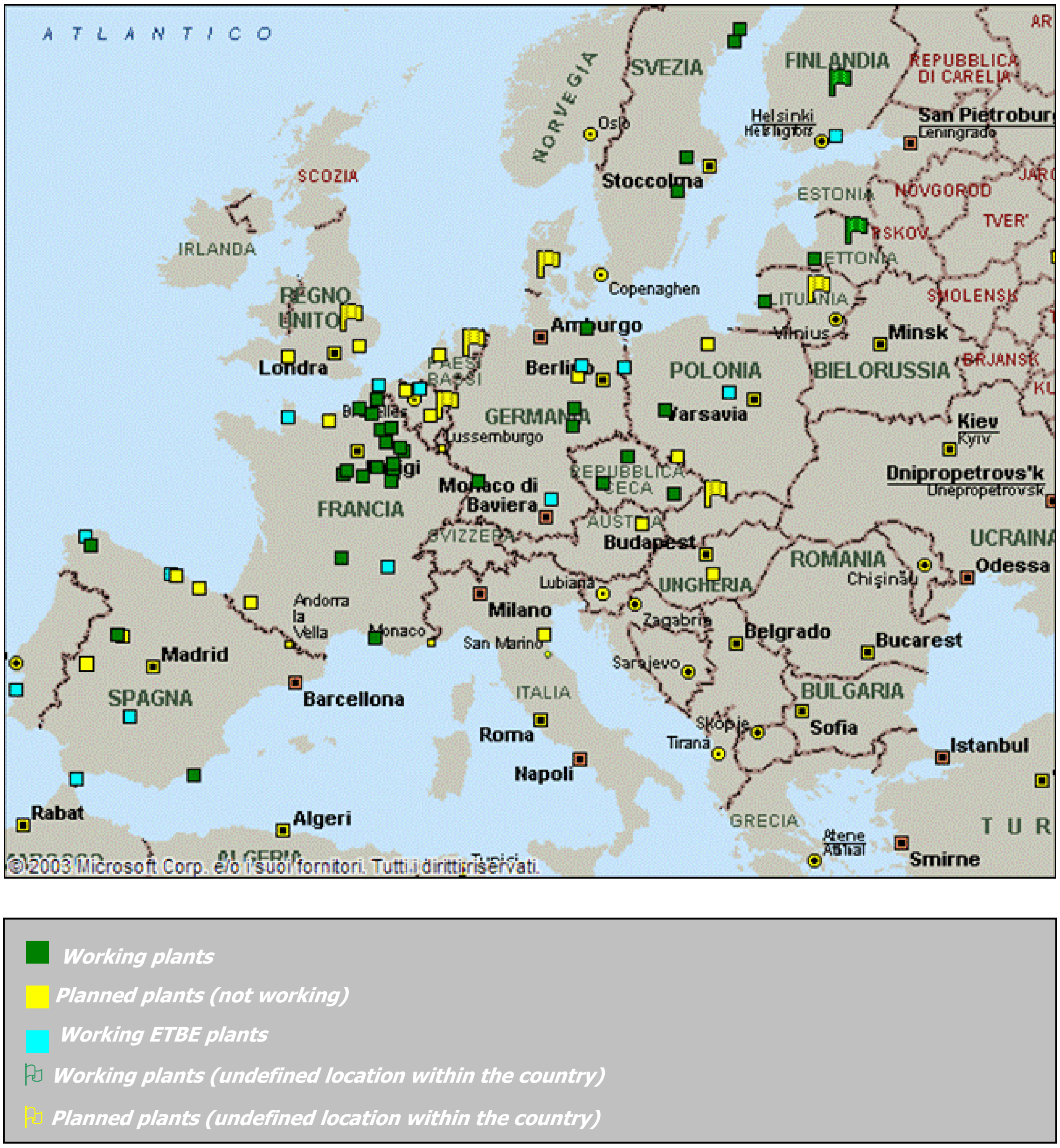
Sources: EurObserv'ER Biofuels Barometer June 2004 (2003 data); estimates by the DG AGRI of the European Commission; estimates on data collected by REF

Figure 8.15 shows the present location of bio-ethanol plants in the EU. A very high concentration of appears in France, especially in the Northern area of the country where most of the production capacity is installed. Nevertheless, it must be highlighted that a relevant number of plants here are small-sized, although recent investments concentrate on larger-sized installations. This also happens in other Member States, especially Belgium, Germany, Spain and the United Kingdom.

An analogous concentration of plants can also be found in Germany, Czech Republic and Sweden, while a relevant number of planned plants result to be concentrated in Spain, Denmark, Netherlands and the United Kingdom, as well as in the NMS (Hungary, Poland, Slovakia)[91].

[91] More detailed information, regarding the single plants production capacity as well as feedstocks used and new investments, is given in Annex C, even though the dataset here cannot be deemed as complete as in the case of bio-diesel. Nevertheless, sufficient coverage was achieved for Member States like France, Germany, Spain and Sweden.

Figure 8.15 – Geographical location of bio-ethanol plants in the EU



8.4.4 By-products from bio-diesel and bio-ethanol production

Some by-products derive from bio-diesel and bio-ethanol production processes, which have and are likely to have in future an economic relevance in the EU. Among these it can be cited: *i)* **oil cake** and **glycerine** for industrial use and **meals** for animal feeds, all obtained from the production of bio-diesel from rapeseed and sunflower; *ii)* **beet pulp**, obtained from the production of ethanol from sugar beet; *iii)* **DDG's**[92] **and CO_2**, obtained from the production of bio-ethanol from cereals. Some data are provided regarding the main by-products obtained from bio-fuel production in the different Member States (Figure 8.16).

[92] Distillers dried grains with solubles.

Figure 8.16 - By-products of the bio-fuels supply chain, for the different Member States

Austria	Oil cake	Rapeseed Cameline
	Rape meal (livestock feed)	Sunflower
	Glycerine (industrial use)	Rapeseed Sunflower
Belgium	Oil cake (livestock feed)	Rapeseed
	Glycerine (industrial use)	Rapeseed
Germany	Rape meal (livestock feed)	Rapeseed Sunflower
	Glycerine (industrial use)	Rapeseed Sunflower
Spain	DDG's	Barley
	CO2	Barley
	Meal	Rapeseed Sunflower
Finland	Oil cake	Rapeseed
	Rape meal	Rapeseed
France	Oil cake	Rapeseed High herucic rape Sunflower
	Glycerine (industrial use)	Rapeseed High herucic rape
	Soluble wheat	Wheat
Denmark	Oil cake	Rapeseed
Italy	Meal	Rapeseed Sunflower Maize
	Oil	Maize
	Glycerine (industrial use)	Rapeseed Sunflower
United Kingdom	Meal	Rapeseed High herucic rape
	Oil cake	Linseed Poppy seed

Source: DG AGRI, campaign "Non-food set aside" 2002-2003

Due to the high production of bio-diesel from rapeseed, **rapeseed meal** is now among the most diffused by-products, whose production has been highly increasing during the last years (around 29% from 2003 to 2005), resulting in its more widespread use as animal feed. In some Member States rapeseed meal is now also partially replacing corn gluten feed in animal feed rations[93].

As for the sunflower meal, its only use in the EU is as feed, but its demand is now expected to decline, given the lower crushing margins compared to rapeseed, the large availability of rapeseed meal caused by the development of the bio-fuels sector, and the decreasing compound feed production.

The EU balance sheets provided by Oil World for the period 2003-2006, show a continuous increase in both production and use of rapeseed meal during the last years, and a parallel decline in soybean meal overall demand (see Table 8.24).

Table 8.24 - Rapeseed meal and soybean meal EU-25 balance sheet (.000 t)

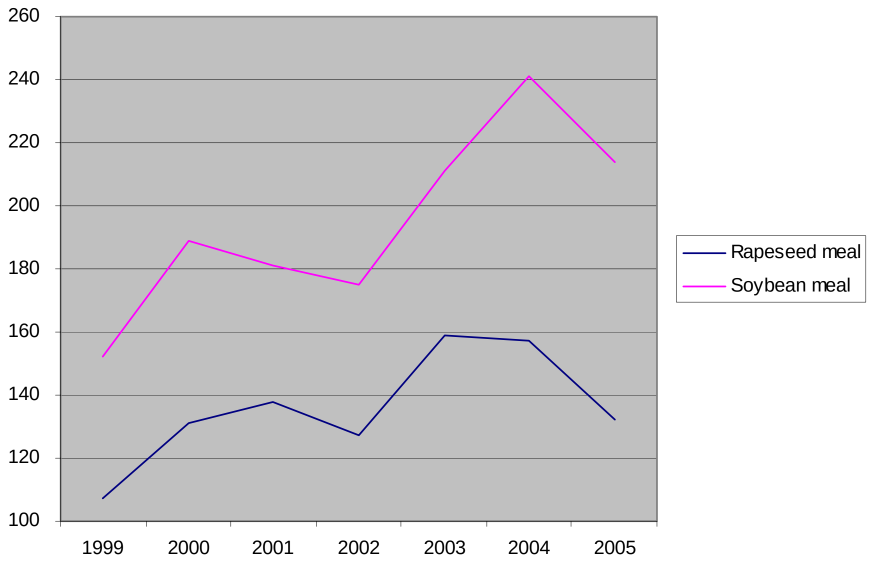
Oilmeals	Oct/Sept 01/02	Oct/Sept 02/03	Oct/Sept 03/04	Oct/Sept 04/05	Oct/Sept 05/06 (F)
Rapeseed meal					
Meal output	5.909	5.907	6.170	7.476	8.186
Imports	117	65	131	110	180
Exports	46	48	52	46	50
Demand	5.972	5.940	6.248	7.552	8.300
Output/Demand	*1,0013*	*0,9973*	*1,0002*	*0,9984*	*1,0019*
Soybean meal					
Meal output	13.877	12.883	10.931	11.118	10.246
Imports	20.591	21.361	23.032	23.037	23.650
Exports	346	358	426	510	640
Demand	34.107	33.879	33.539	33.643	33.250
Output/Demand	*1,0004*	*1,0002*	*0,9999*	*1,0001*	*1,0002*

Source: Oilworld, Rapeseed, Oil & Meal and Soybean, Oil & Meal, http://www.oilworld.biz

93 Source: Oil World, Rapeseed, Oil & Meal and Soybean, Oil & Meal, http://www.oilworld.biz.

As for prices, in both cases (rapeseed and soybean meal), after an increasing trend from 1999 to 2004, (+47% and +59% for rapeseed and soybean meal respectively), a decrease has been registered for both products between 2004 and 2005 (-16% and -11%). This recent trend in prices could be explained (in part at least) to the contemporaneous increase in the bio-diesel production.

Table 8.25 - Rapeseed meal and soybean meal prices



Source: *ISTA Mielke GmbH, OIL WORLD, The information provider for oilseeds, oils and meals.* *www.oilworld.biz*
Rape Meal, Hamburg, fob ex-mill (US-$ / T), Soya Pellets, Argentine, cif Rotterdam (US-$ / T)

Some more detailed information regarding the production and use of the main by-products during recent years, are provided by the analysis of the case studies (see box 8.1).

Box 8.1 – By-products from bio-diesel and bio-ethanol production: evidence from regional case studies

The main by-products obtained from the production of bio-diesel (Haute Normandie case study) are glycerine and oil cake. Glycerine is mainly used in the fields of cosmetics, pharmaceuticals and soap industries. More than 2.000 industrial applications (toothpaste, lipstick, etc.) exist to date for this co-product of bio-diesel production. The oil cake is a vegetable residue, rich in proteins, used in animal feeds, in particular for cattle breeding: its use improves the quality of milk and cheese. In 2008, the production of oil cake will reach two million tons, versus the present 1,3 million. France indeed imports 56 % of its vegetable protein requirements for the animal feeds, in particular in the form of soybean oil cake. A further co-product of the Diester production process is the raw oil, which is generally used in car engines.

Beet pulp constitutes the main by-product from the production of ethanol from sugar beet (Champagne Ardenne case study). Results derived from a review of studies indicate that profit for the sales of by-products can be as high as 247 €/ton ethanol. Only the starch component of the grain is converted to ethanol. The fibre, protein, minerals, carbon dioxide (CO_2) and vitamins remain. These components all have some economic value and it is important, for the overall economics of the production unit, to be able to capture such value. Grain-based ethanol plants traditionally produce two products in addition to ethanol: distillers' grains (either wet or dry) and CO_2. Distillers' grains are used as a high-protein feed in animal farming.

Bio-fuels (bio-diesel and bio-ethanol) production is associated with that of a number of by-products of commercial value, sold in various markets (Castilla y Leon case study). These include pulp and dried distiller's grains with solubles (DDGS) for the animal feed market, glycerine for the chemical and pharmaceutical industries and remains of woody plants, which can be used for cogeneration of energy (which may be utilized in the plant itself or sold on the electricity market). The main by-product which is obtained from the production of bio-diesel from sunflower is glycerine; flour for animal feeds and oils are also obtained as by-products, the latter being exported or utilized for the production of bio-diesel within Spain. The main by-product obtained from the production of bio-ethanol from cereals is DDG's.

The evolution of the by-products market (glycerine, DDGS) is an important factor to be considered. In the case of bio-ethanol, which features a relevant by-products' contribution to total revenues, the increasing number of processing plants in operation is leading to a ***surplus*** *of* ***glycerine,*** *with a correspondent price decrease. It might hence be that in the near future glycerine will turn into a problematic waste, whose recycling should be carefully considered.*

8.4.5 Conclusion and main findings

In 2005, the EU production amounted to around **2,88 million toe of bio-diesel** and around **467.200 toe of bio-ethanol**. These figures represent increases of 65% and 75% respectively as compared to the 2004 output. This substantial increase is very likely to be due (in part at least) to the implementation of Directive 2003/30/EC by the Member States, through the setting of national targets.

Bio-ethanol is mainly obtained from sugar beet/molasses (32%), starch (40%), wine alcohol (26%)[94] and other miscellaneous feedstock (2%)[95].

Bio-diesel is mainly obtained from rapeseed (84%), sunflower (13%), soybean (1%), and for a minor share also from palm oil (1%) and other feedstock (1%)[96].

The main producing Member States include **Germany, France and Italy** for **bio-diesel**, and **Spain, Germany and France** for **bio-ethanol**, with the NMS lagging behind, although their production levels are increasing rapidly.

Production capacity for both bio-fuels is remarkably increasing in many Member States, with several Member States entering the market right now. Around 6 million tons of bio-diesel and 1,7 million tons of bio-ethanol are foreseen to be produced in the EU-25 in 2006.

While no significant trade of bio-diesel exists between the EU and third Countries, the EU is a **net importer of bio-ethanol**, mainly from **Pakistan** (around 750.000 Hl in 2004, in condition of 100% custom duties exemption) and **Brazil** (around 547.000 Hl, with a custom duty of 19,2 €/Hl). More relevant trade flows occur within the EU.

As regards the main by-products of the bio-diesel and bio-ethanol production processes in the EU, these are oil cake, glycerine for industrial use, meals for animal feeds, beet pulp, DDG's[97] and CO_2. With respect to the by-products for animal feeds, a growing importance is gained by rapeseed meal production. The significant increase in rapeseed meal production (+29% from 2003 to 2004) resulted in a more widespread use in animal feeding and in a partial substitution of soybean meal and other feeds by rapeseed meal itself. Generally speaking, the evolution of the by-products market is an important factor to be considered. In the case of bio-ethanol, due to the relevant by-products' contribution to overall revenues, the increasing number of processing plants in operation is leading to a surplus of glycerine, with a correspondent price decrease for this important by-product.

Finally, it should be mentioned that **second-generation bio-fuels** are also being developed, albeit still at experimental level. These innovative bio-fuels should feature better fuel properties and lower production costs; most of them should be obtained from **lignocellulosic feedstock**.

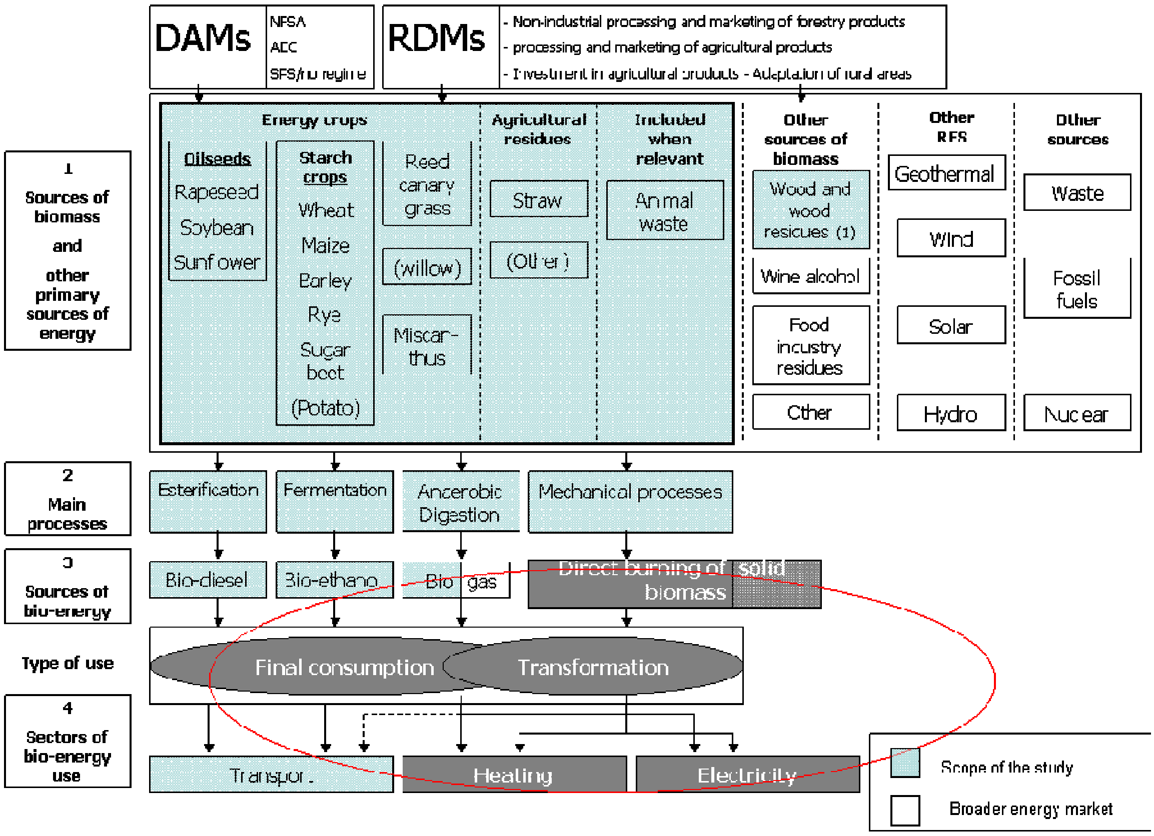
[94] A significant share of bio-ethanol in the EU is obtained from wine alcohol originating from the distillation measure of the CMO for wine. However, the volume of wine distillations, has varied markedly from year to year, being closely dependent on wine surpluses. However, some relevant changes regarding wine distillation are likely to be introduced by the reform of the CMO for wine (see § 8.4.1).
[95] UEPA, 2004.
[96] www.eubia.org, average data 2000-2004.
[97] Distillers dried grains with solubles.

9 DEMAND ANALYSIS

9.1 The EU demand by source of bio-energy

9.1.1 Demand of solid biomass for direct burning

Figure 9.1 – The demand of solid biomass within the reference scheme



* In brackets sources of biomass which have not been included because of lack of data and/or very rare use in the EU.
(1) Included when relevant

Gross inland **consumption of solid biomass** has grown rapidly in recent years, and in 2004 it accounted for around **55 Mtoe at EU level**.

Demand of solid biomass for transformation into electricity and heat (biomass direct burning) can be generated by electricity sellers (commercial activity), by electricity auto-consumers (industrial activity) or by final consumers (for example domestic heating).

In 2004 solid biomass gross inland consumption was destined for 22% to transformation input and for the remaining 78% to final energy consumption[98], but things are changing rapidly: less then 14% of the total biomass was destined to transformation input in 2000, and even a lower percentage (8%) during the 90s.

As a result the market demand for solid biomass is estimated - with the exclusion of the share burnt directly from final consumers and thus constituting a wholesale market - at 12 Mtoe in 2004, of which almost 0,05 Mtoe satisfied by energy crops[99].

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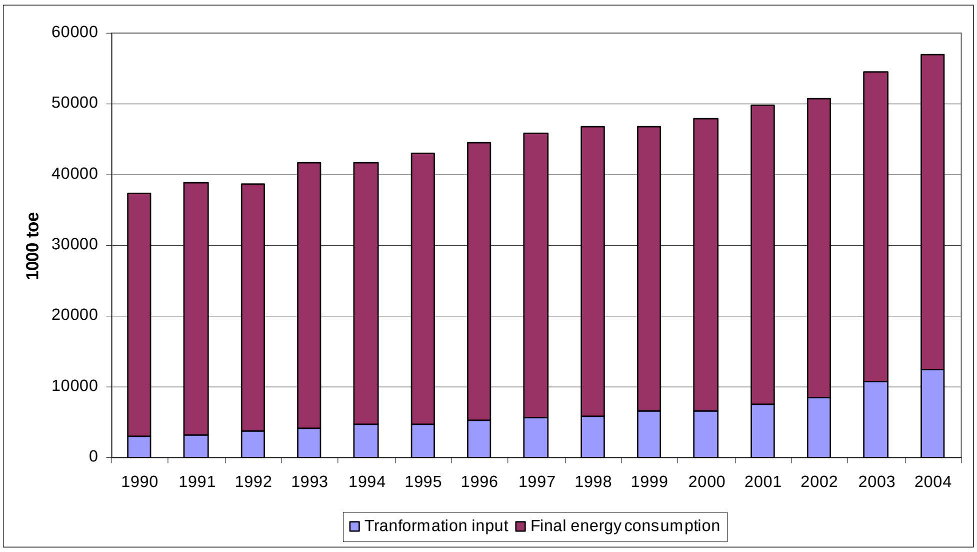
[98] Final energy consumption and transformation input are defined as follow:

- Final energy consumption covers energy supplied to the final consumer's door for all energy uses.
- Transformation input covers all inputs into the processing plants, destined to be converted into derived products such as electricity and heat.

[99]Demand of solid biomass for transformation input amounts to 12 Mtoe (22% of 55 Mtoe) so that the estimated share represented by energy crops (0,4%) amounts to 0,05 Mtoe.

Figure 9.2 - Evolution of gross inland consumption of solid biomass by destination (EU-25)

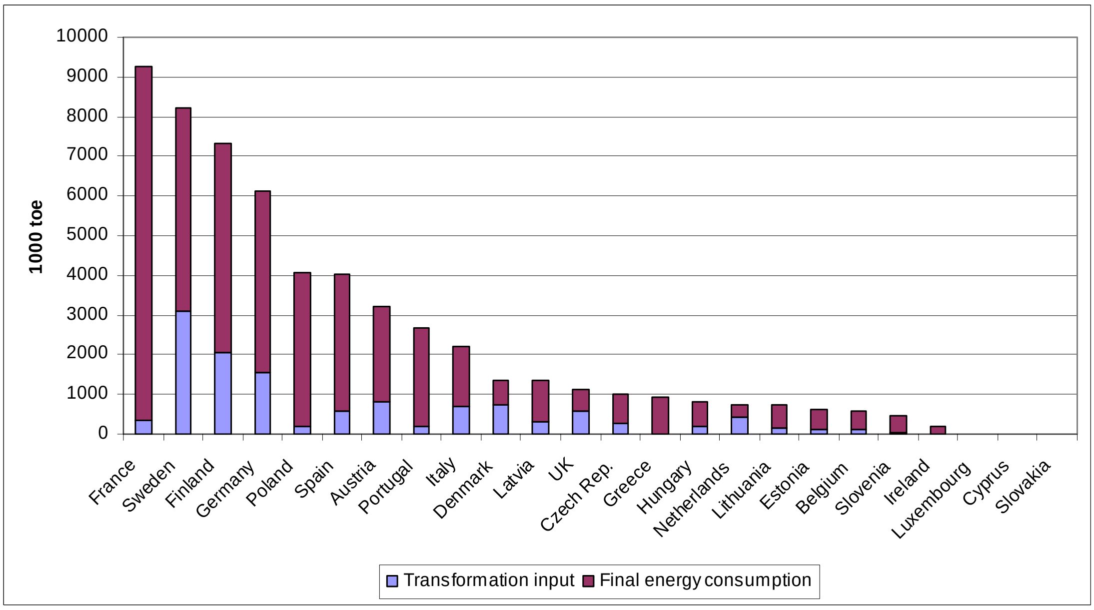


Source: Eurostat

France, Sweden, Finland and Germany are the main consumers of solid biomass, accounting together for around 54% of total EU demand. With respect to the type of biomass source, data show a high variability with respect to the EU average, even if the final energy consumption is always the main destination in the above four Member States: in France less then 4% of overall demand of solid biomass is destined to transformation input; in Sweden this share goes up to 38%. Some Member States, namely Greece, Portugal and especially Poland, use solid biomass almost exclusively for final energy consumption; for others, including the Netherlands, Denmark and the United Kingdom, this share is around 50%. The main consumers of solid biomass for transformation purposes are Sweden, Finland and Germany.

As regards the destinations of solid biomass as transformation input, around **83%** of solid biomass is burnt on average in the EU in **conventional thermal power stations** (electricity or combined heat and power), while the remaining share is destined to **district heating plants**. Relevant differences exist among the Member States also in this respect. Some Member States (e.g. Germany) destine all the biomass to conventional power stations, while in others (e.g. the Baltic States) the use in district heating plants is prevalent. In Sweden almost 25% of the demand is destined to district heating plants, in Finland less than 8%.

Figure 9.3 - Gross inland consumption of solid biomass, by Member State (2004)



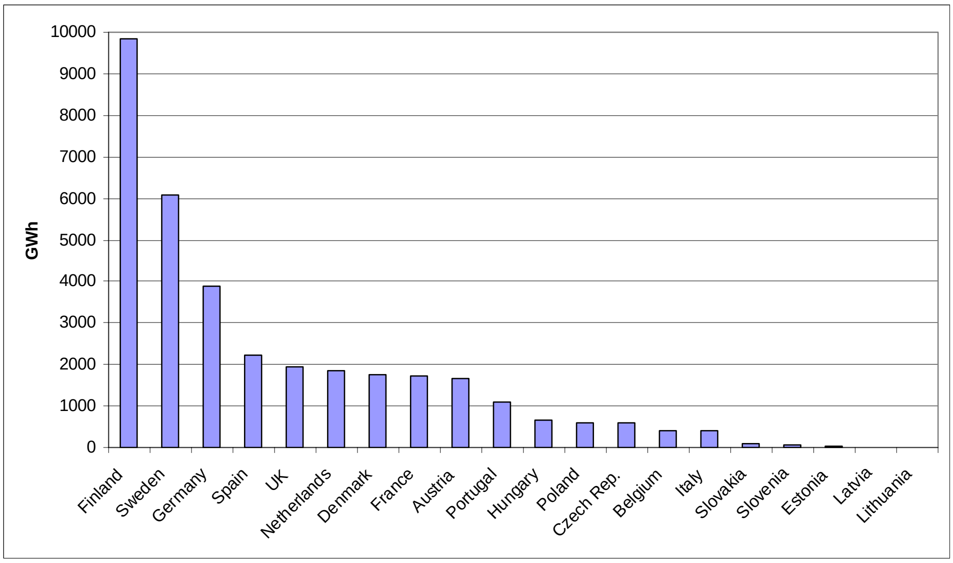
Source: Eurostat

9.1.1.1 Demand for electricity generation

As already cited, around 22% of the solid biomass burnt for energy purpose, is destined to transformation input, and around 83% of it is processed into electricity. Therefore, excluding the final energy consumption, around 10 Mtoe of solid biomass are processed into electricity.
In the period 2003-2004 the electricity generated using solid biomass increased by 23%, reaching 35.000 GWh (**3,01 Mtoe**), of which around 140 GWh (**0,012 Mtoe**) can be estimated to derive from energy crops.

As highlighted by the figure below, **Finland and Sweden** are the leading Member States in electricity production from solid biomass, accounting for 46% of the total biomass direct burning. These Member States have a relatively longer tradition in this field, and in fact their share is decreasing while other Member States become active in biomass direct burning, namely United Kingdom, Netherlands, Denmark and Hungary.

Figure 9.4 - Gross electricity generation from solid biomass, by Member State (2004)



Source: EurObserv'Er

9.1.1.2 Demand for heating purposes

As regards the demand of solid biomass for direct burning in heat production plants, it is difficult to get a consistent and comprehensive dataset. Table 9.1 provides a picture of the situation updated to 2004[100]. This is the most recent year for which adequate data are available.
It is particularly difficult to analyse the final demand of heat since most installations are used in domestic environments as heating apparatus.

Table 9.1 – Heating installation by type

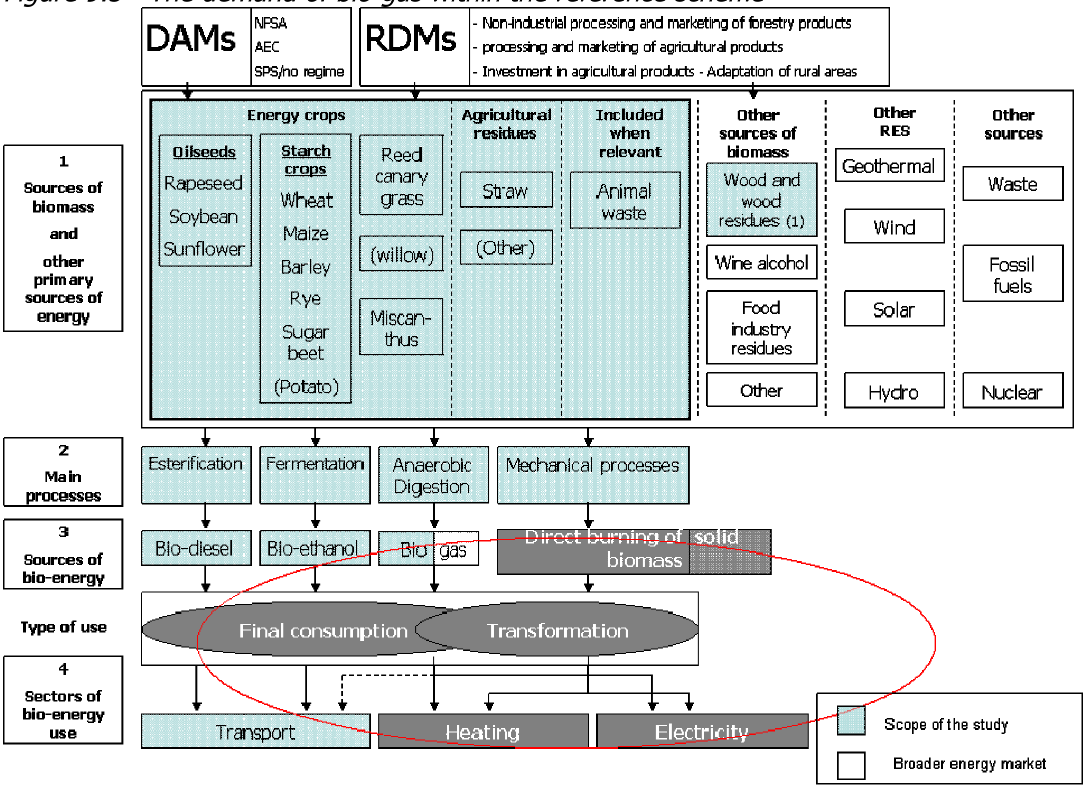
2004	Type of plant	MW e	MW th	n° installation
Finland	District heating	-	900	173
	CHP	3.403	16.040	237
Sweden	Heating apparatus	-	-	60.000
	CHP	-	3.192	100
France	Heating apparatus	-	-	5.000.000
	boiler plant	-	430	641
Germany	Heating apparatus	-	-	9.000.000
	District heating	-	5.000	1.100
	power plants	700	-	100
Austria	boiler plant	-	3.404	7.751
	power plants	379	-	155

Source: EurObserv'Er

[100] Data have been gathered from EurObserv'Er's annual reports on the bio-energy sectors.

9.1.2 Demand of bio-gas

Figure 9.5 - The demand of bio-gas within the reference scheme



* In brackets sources of biomass which have not been included because of lack of data and/or very rare use in the EU.
(1) Included when relevant

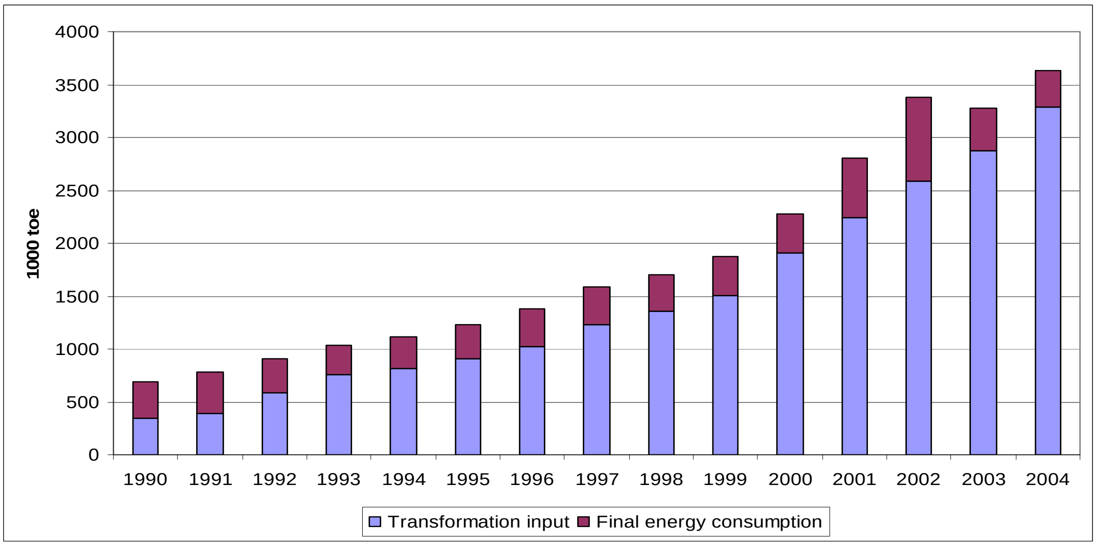
The demand of bio-gas sped up in the last years, growing sixfold in the period 1990-2004, with an average yearly increase of 13%. In 2004 the overall consumption of bio-gas was **3.7 Mtoe**. Assuming a share of energy crops and agricultural residues[101] over the total sources of 12.6% at EU level[102], the volume of bio-gas derived from sources falling into the scope of the work should amount to around 466 ktoe[103].

As for the demand of solid biomass, the demand of bio-gas for transformation into electricity and heat can derive from electricity sellers (commercial activity), from electricity auto-consumers (industrial activity) or from final consumers (for example domestic heating).

A main difference between the two market segments (i.e. bio-gas and solid biomass destined to electricity generation) is that most part of the demand of bio-gas derives from **input for transformation activities**. At EU level almost 88% of the gross inland consumption is destined to transformation input, while the remaining part (12%) is destined to final energy consumption. This situation is the result of a quite recent trend, being the demand of bio-gas highly depending on the demand of traditional gas for electricity and heat production, which grew rapidly over the past decade, thanks to the availability of new technologies such as the combined cycle gas turbines (CCGT). Thus, while the demand of bio-gas for final energy consumptions is relatively stable, the demand for transformation input has been growing at a yearly rate of 17% during the last decade.

[101] With reference to decentralized agricultural plants fed with energy crops and agricultural residues (which also include other agricultural sources like manure and animal waste), centralized co-digestion plants and municipal solid waste plants (the latter limited to the part which is processed into methanisation plants).
[102] Eurobserv'Er 2006
[103] Amount calculated as 12.6% of 3.7 Mtoe.

Figure 9.6 – Evolution of gross inland consumption of bio-gas by destination

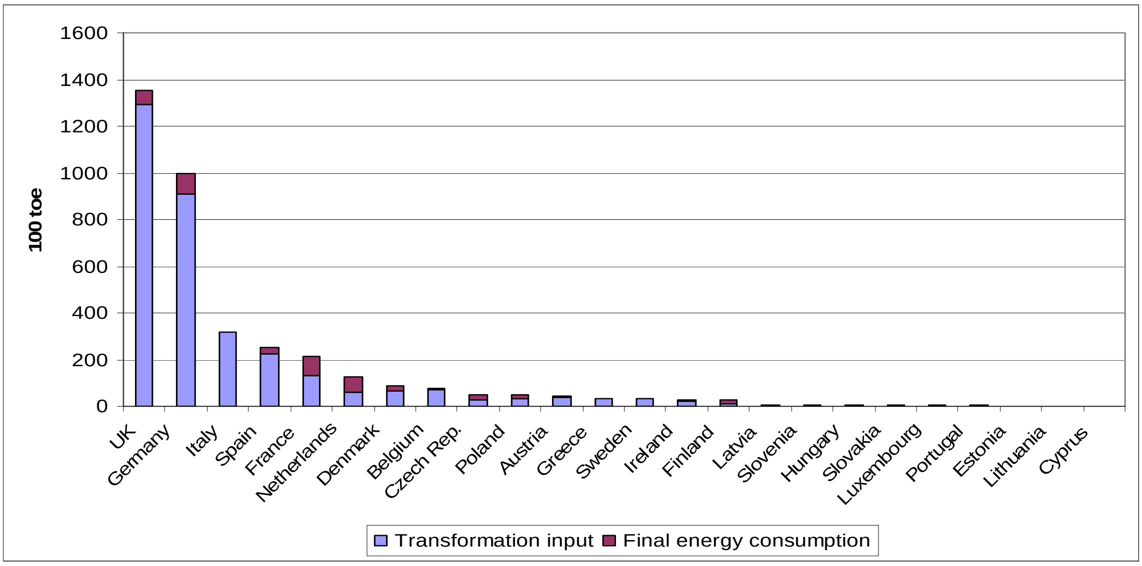


Source: Eurostat

At Member State level, **Germany and United Kingdom** are the main bio-gas consumers, concentrating around 63% of the total EU demand. With the exception of France and the Netherlands, a more relevant part of the bio-gas demand of the individual Member States is destined to transformation processes.

A relatively high correspondence can be identified between the main producing Member States and the main consuming ones, suggesting a very high rate of local consumption and the substantial absence of international trade for bio-gas.

Figure 9.7 - Bio-gas gross inland consumption in the EU, by Member State (2004)



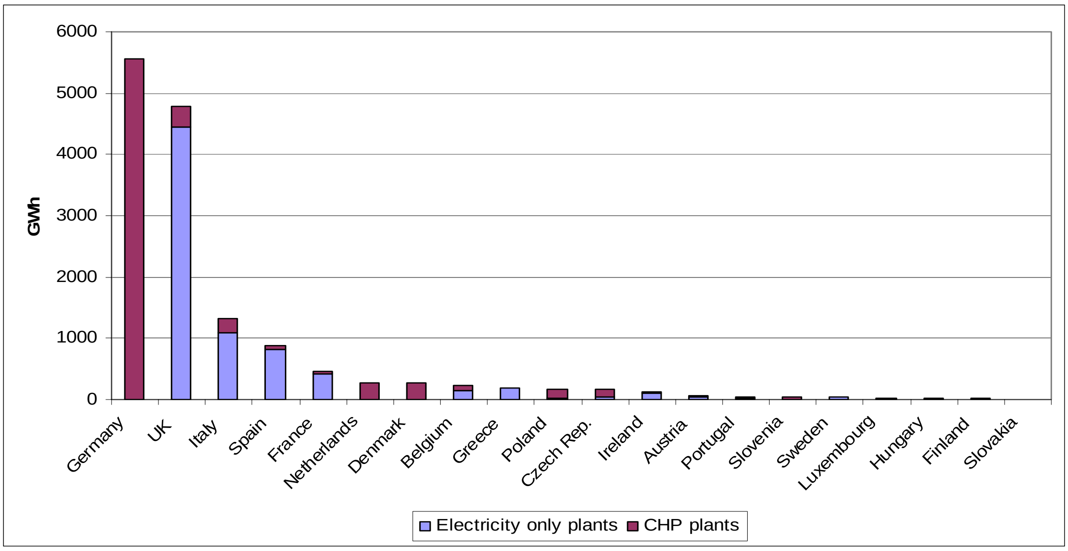
Source: Eurostat

9.1.2.1 Bio-gas demand for electricity generation

The EU demand of bio-gas for electricity production reached almost **3,7 Mtoe**, giving rise to an electricity production of around **1,3 Mtoe** (15.000 GWh) in 2005, with an increase of 15% over 2004, of which only **0,23 Mtoes** (2.700 GWh) are estimated to come from energy crops and agricultural residues falling within the scope of the work, the most part deriving indeed from landfill gas or sewage slurries.

At EU level, around half of the production is obtained in pure electricity generation plants, and half in CHP plants. As shown in Figure 9.8, Germany and the United Kingdom are the main producing Member States of electricity from bio-gas, but while German plants are mainly CHP plants, in the United Kingdom pure electricity generation plants predominate.

Figure 9.8 - Electricity production from bio-gas, by type of plant and by Member State (2005)

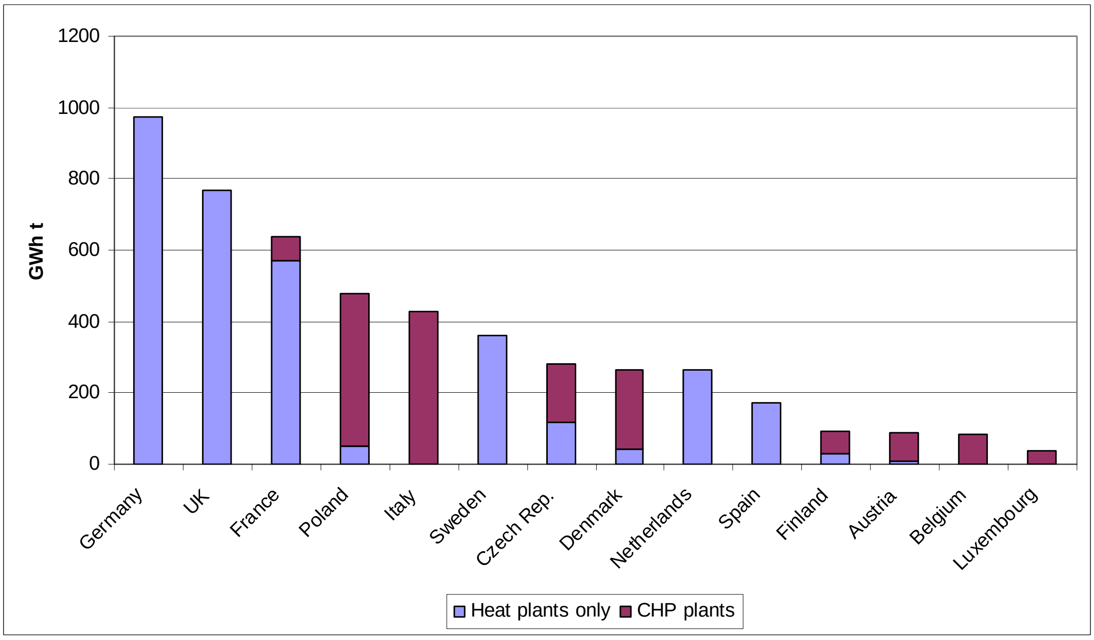


Source: EurObserv'Er

9.1.2.2 *Bio-gas demand for heating purposes*

The EU overall demand of bio-gas for heating purpose was 0,5 Mtoe in 2005. The correspondent heat production from bio-gas accounted for **4.931 GWh$_t$** (0,424 Mtoe) in the same year, the most part coming from heat only plants (68%) and the remaining from CHP plants.

Figure 9.9 - Heat production from bio-gas, by type of plant and by Member State (2005)

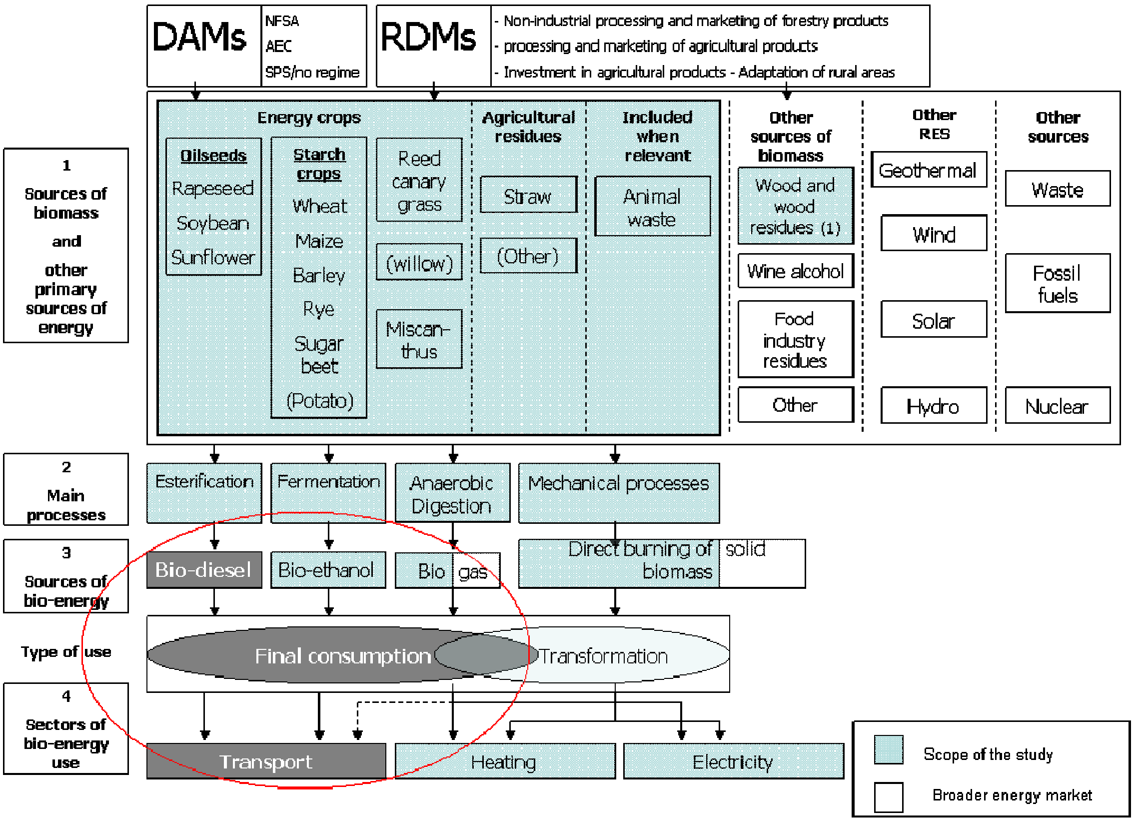


Source: EurObserv'Er

Germany is the main producing Member State, followed by the United Kingdom and France. Both in Germany and in the United Kingdom all heat is generated in dedicated plants, while in other Member States (e.g. Poland and Italy) most part is produced in CHP plants.

9.1.3 Demand of bio-diesel

Figure 9.10 - The demand of bio-diesel within the reference scheme



* In brackets sources of biomass which have not been included because of lack of data and/or very rare use in the EU.
(1) Included when relevant

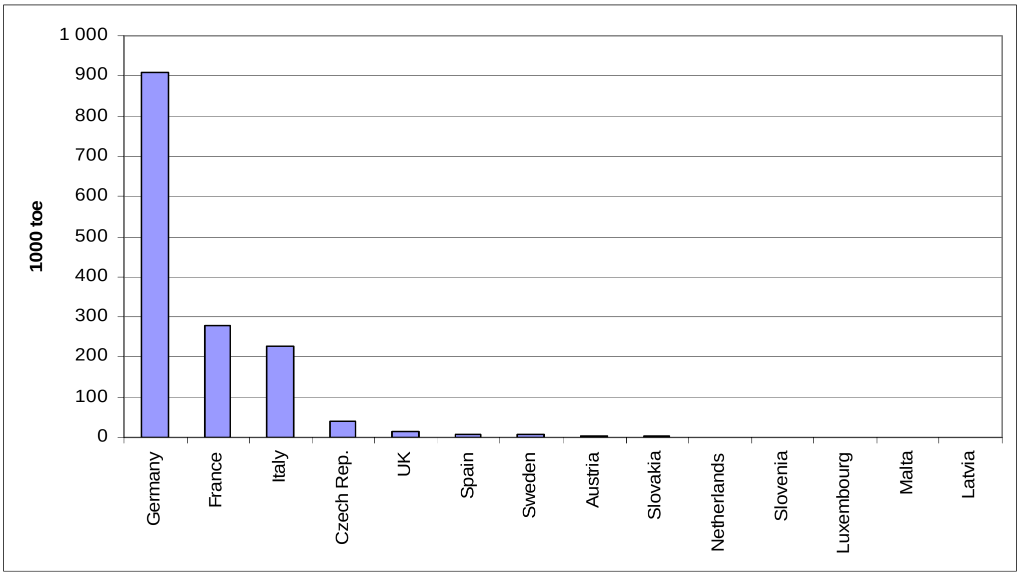
In 2004 bio-diesel consumption at EU level amounted to around **1,5 Mtoe**. Analysing the data provided by each Member State in accordance with Article 4(1) of Directive 2003/30/EC ("Bio-fuels directive"), a reliable picture of the current situation for bio-diesel consumption is shown, with reference to the most recent year for which data are available (2004).

The main consumer of bio-diesel is **Germany**. France, Italy and Czech Republic are responsible for a far lesser share of the total EU consumption, while in the remaining Member States consumption seems to be less important.

A high level of correspondence can be found between the main consuming and producing Member States in the EU-25. Germany, France and Italy produce (and demand) almost 90% of overall EU-25 bio-diesel volumes[104], this fact suggesting the prevalence of a local market dimension, and a negligible amount of international trade.

[104] See Table 7.18.

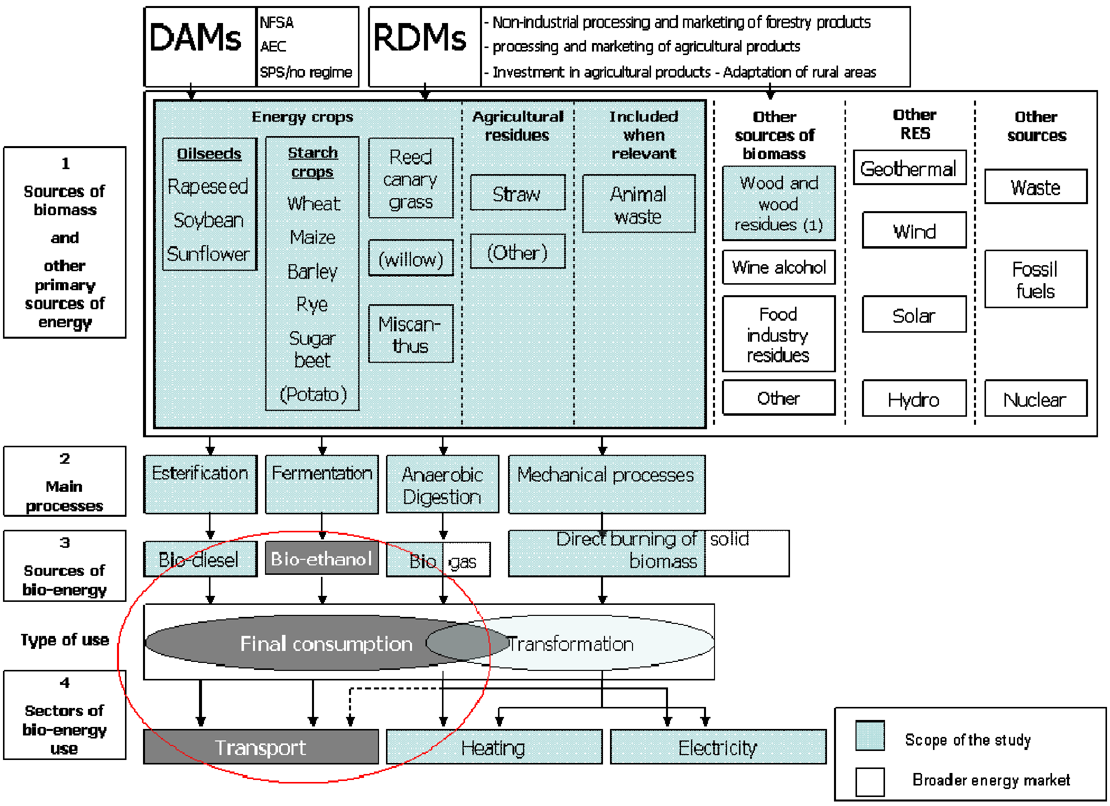
Figure 9.11 - Demand of bio-diesel at Member State level (2004)



Source: MS annual report and European Commission data

9.1.4 Demand of bio-ethanol

Figure 9.12 - The demand of bio-ethanol within the reference scheme

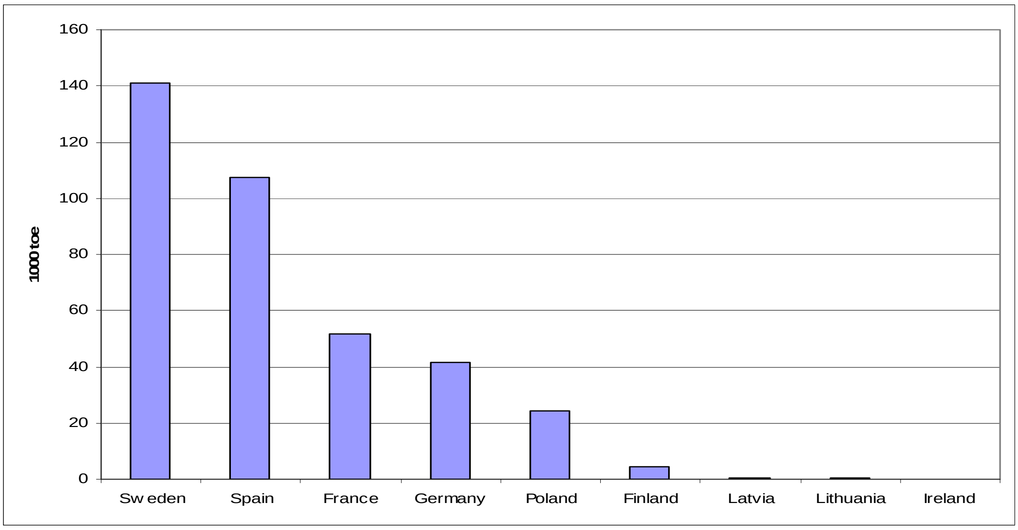


* In brackets sources of biomass which have not been included because of lack of data and/or very rare use in the EU.
(1) Included when relevant

In 2004, bio-ethanol consumption in the EU amounted to **0,371 Mtoe**. The analysis of the data provided by each Member State in accordance with Article 4(1) of Directive 2003/30/EC ("Bio-fuels directive") allows to picture in details the EU situation. The main consuming Member States are Sweden (38%) and Spain (29%);

far lesser volumes are consumed in France, Germany and Poland.

Figure 9.13 - Demand of bio-ethanol at Member State level (2004)



Source: MS annual report and European Commission data

Differently from bio-diesel, here the correspondence between the main producing and consuming Member States is less marked. The main producer is Spain followed by France[105], while the main consumer is by far Sweden. This confirms the existence of an international trade for bio-ethanol.

[105] See Table 8.16.

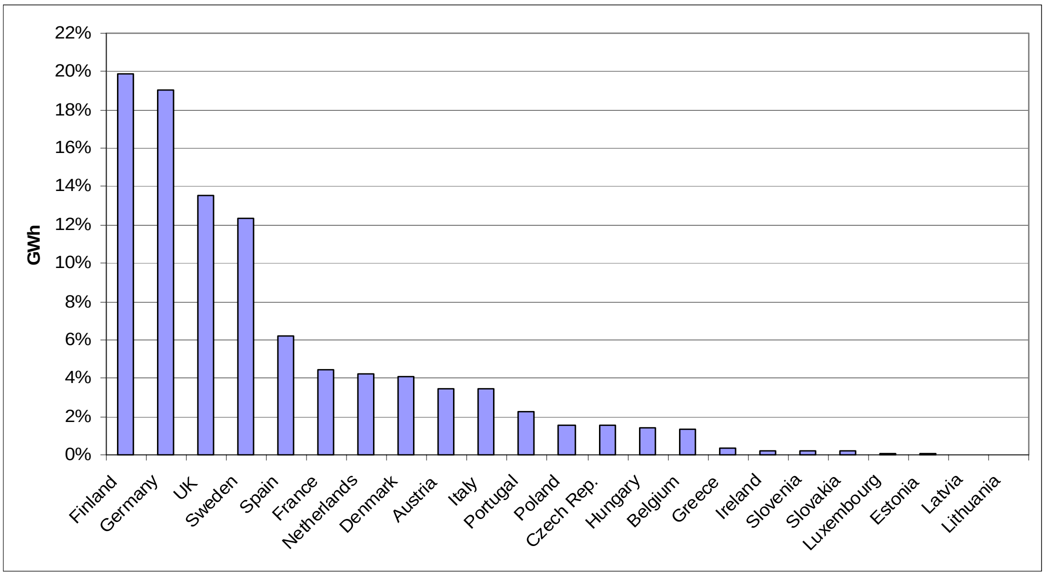
9.2 The EU demand by sector of energy use

A synthesis of the main findings deriving from the demand analysis is presented here below, differentiated by sector of energy use, namely electricity, heat and transport.

Electricity generation, by sources of bio-energy (bio-gas and solid biomass)

In 2005, the overall EU production of electricity from bio-energy sources was around **4,3 Mtoe** (50.000 Gwh). Almost **3,27 Mtoe** (38.000 GWh) are obtained from sources falling within the scope of the work. As highlighted by the figure below, Finland and Germany have the highest shares of production, with around 20% and 19% respectively.

Figure 9.14 - Member States' share in bio-electricity production, 2005



Source: EurObserv'Er

Heat production, by sources of bio-energy (bio-gas and solid biomass)

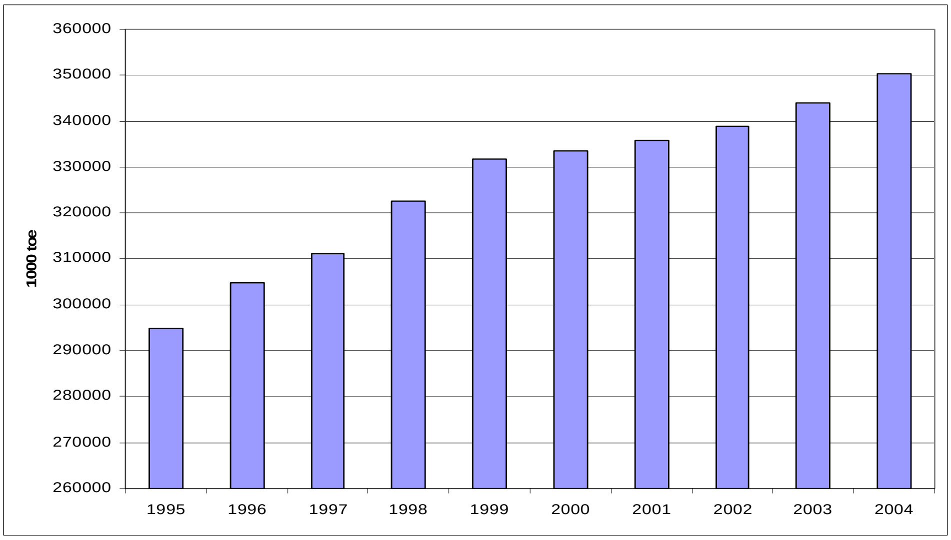
In 2005, the EU total heat production from bio-energy sources amounted to **0,427 Mtoe.** This data does not include heat production from solid biomass used directly in domestic heating apparatus, which generally are very numerous (for example, their total number in Germany is estimated at around 9 millions).

Transport uses, by sources of bio-energy (bio-diesel and bio-ethanol)

Energy consumption in the transport sector grew rapidly during the last decade, with a yearly growth rate of about 3% in the period 1995-1999, which decreased to 1% from 2000 onwards (figure 9.15).

In 2004, the global final energy consumption in the transport sector reached **350 Mtoe**, with around 28 Mtoe (i.e. about 8%) consumed in the NMS.

Figure 9.15 - Final energy consumption - transport (all fuels; EU-25)

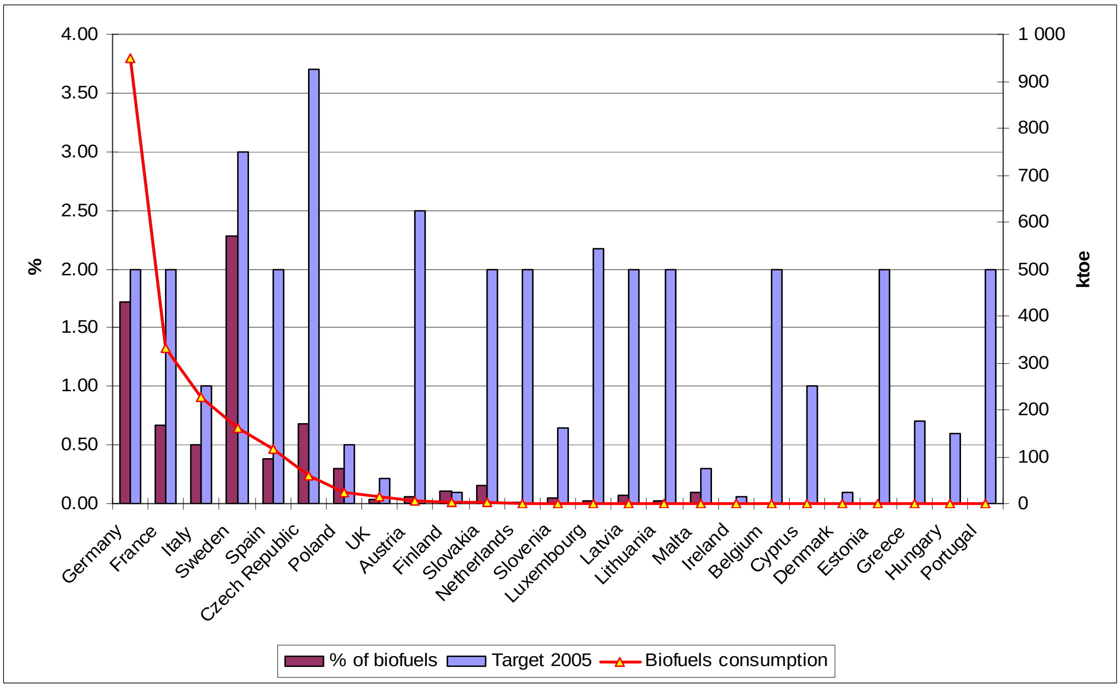


Source: Eurostat

Directive 2003/30/EC set a 2% target of utilization of bio-fuels at EU level, to be calculated on the energy content of the overall quantities of petrol and diesel oil for transport purposes placed on the market by 31 December 2005. As shown above, this target was not met, as almost all Member States reached percentages lower than the one set by the directive. However, on the basis of the declared target defined for each Member State, it is possible to calculate an implicit target at EU level (for 2005) of 1.4%, instead of 2%. This situation is due to the differences existing among Member States in the declared targets[106], some being aligned with the EU target and others not in line. A complete set of data for 2005 is not yet available. Figure 8.16 shows, for each Member State and referring to 2004:

- the overall consumption of bio-fuels,
- the actual percentage of bio-fuel over total traditional fuel consumption (petrol and diesel),
- the target for the year 2005.

Figure 9.16 - Bio-fuel consumption for transport in EU Member States (2004)



Source: DEIagra estimates on European Commission data

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106 See Annex A.

The EU-25 overall consumption of bio-diesel is 1.500 Ktoe in 2004, while the total consumption of bio-ethanol in the same year is 0,371 Mtoe.

Only 11 Member States show significant consumption volumes of bio-fuels. The main user is **Germany**, with a consumption of over 0,900 Mtoe in 2004; Sweden and Germany featured the best actual rates of consumption over total energy consumption in the transport sector (respectively 2,3% and 1,8%). Germany, Finland and Poland rates approximate the target, due to less demanding commitments (targets lower than 0.5%). Ireland consumption is limited to the uses for an experimental project. Twelve Member States still declare a zero-consumption of bio-fuels for transport.

Some Member States show a relevant consumption for only one typology of bio-fuels: the overall demand of Austria, Czech Republic and United Kingdom is satisfied by the sole bio-diesel, while Polish consumption only concerns bio-ethanol. However in many Member States a consumption of both bio-fuels (mainly bio-diesel but also bio-ethanol) is registered (France, Germany, Sweden and Spain). A peculiar situation can be found in Sweden, where the bio-energy sources used for transport also include bio-gas (11,2 ktoe in 2004). Sweden has indeed already 779 buses running on bio-gas, in addition to more than 4.500 cars fuelled with a mixture of petrol and bio-gas[107].

9.3 Conclusion and main findings

In recent years, an increase was registered for the EU gross inland consumption of bio-energy sources both for **solid biomass** - accounting for 57 Mtoe in 2004[108] - and for **bio-gas** (3,7 Mtoe in 2004[109]). A main difference between the two market segments is that the most part of the demand of **bio-gas** (88%) derives from **transformation activities**, while **direct burning** of solid biomass is mainly destined (78%) to **final energy consumption** (namely domestic heating, boilers and fireplaces). France, Sweden, Finland and Germany are major consumers of solid biomass, accounting alone for 54% of the total EU demand. Germany and the United Kingdom are the main bio-gas consuming Member States, concentrating around 63% of the total EU demand.

The main output of **solid biomass direct burning** is thus **heat** (around **68%** considering both transformation input and final energy consumption) with only a lesser share transformed into **electricity** (around **32%**). However, in the period 2003-2004 the electricity generated using solid biomass increased by 23%, reaching **3,01 Mtoe** for the sole transformation input: Finland and Sweden are the leading Member States in electricity generation from solid biomass, accounting for 46% of the total biomass direct burning.

On the other side most of the demand of **bio-gas** (about 75%) is destined to **electricity production**. At EU level half of the production derives from pure electricity generation plants, and half from CHP plants. The main producers of electricity from bio-gas in the EU are Germany and the United Kingdom.

With reference to the demand of **bio-fuels**, Directive 2003/30/EC set a **2% target** of utilization of bio-fuels at EU level, but – in 2004 - only 11 Member States showed significant consumption of bio-fuels. The main user in absolute terms is Germany, with a consumption of over 900 ktoe in 2004; Sweden and Germany show the best actual rate of bio-fuel consumption on the total energy consumption in the transport sector (respectively 2,3% and 1,8%). Finally, in some Member States consumption concerns solely bio-diesel or solely bio-ethanol.

Bio-diesel consumption at EU level amounted to around **1,500 Mtoe** in 2004, with Germany as the main bio-diesel consumer. In the same year, **bio-ethanol** consumption amounted to **0,371 Mtoe,** with the greatest volumes consumed in Sweden (38%) and Spain (29%); far lesser quantities were consumed in France, Germany and Finland.

[107] Source Eurobserv'Er 2006.
[108] BTG, 2004.
[109] EurObserv'ER 2006.

10 PRICING

10.1 Introduction

The following section aims at analysing the price of different types of bio-energy produced from biomass, and comparing it with the price level of other energy sources - fossil fuels in particular - both at EU and international level. A description of public intervention on price determination is included.

The analysis covers:

- Prices of electricity generated from direct burning of biomass or from bio-gas.
- Prices of heat generated from direct burning of biomass or from bio-gas.
- Prices of bio-fuels used for transport, namely bio-diesel and bio-ethanol.

Bio-energy and bio-energy sources - notably electricity and heat from biomass, but also bio-fuels - are seldom quoted in independent markets, with the exception of some countries. More often these products are used and traded as substitutes for the traditional energy sources (electricity, heat and fuel for transport). Their price is therefore determined or deeply influenced by two elements:

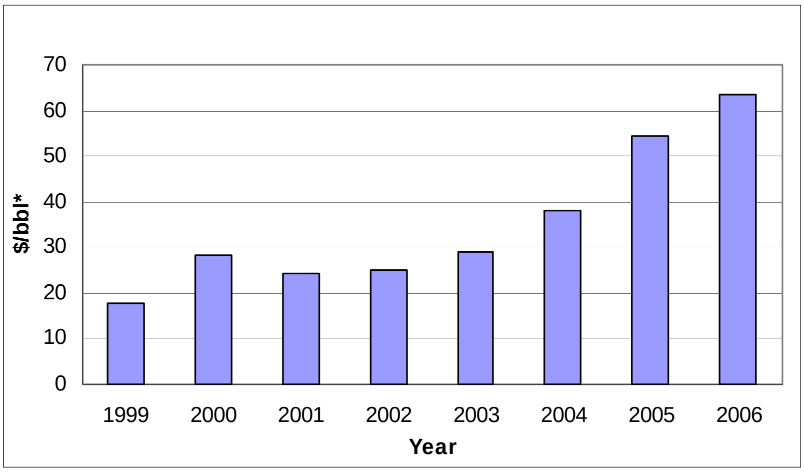
- the price of substitute products;
- the support policy.

In the following section both levels of support and prices of substitute products are analysed, with the aim of estimating possible revenues for bio-energy producers in the different Member States. This information, compared with cost levels, will be used to estimate the profitability of different bio-energy sources, in presence or in absence of a supporting policy (i.e. measures related to the RES production, different from the CAP measures under study)[110].

The price of traditional energy products is tightly linked to the international oil price. This is mainly due to contractual reasons. For example, electricity produced from oil products is nowadays a little percentage, being natural gas, coal and nuclear the main energy sources, but electricity prices continue to show high correlation with oil prices, as it happens for natural gas prices and other products.

International oil prices showed a trend of persistent growth in the last few years. In this phase, when bio-energy markets can be still considered very young, the evolution of the substitute's price is likely to influence the prices of bio-energy more than the supply/demand interactions.

Figure 10.1 – Brent Crude-Physical Del. Fob prices



*bbl=barrel
Sources: DEIAGRA estimates on Datastream and IPE data
2006: jan-apr

10.2 Electricity

In most Member States the price of electricity is determined by market forces. As already noted, a market for electricity from bio-energy sources does not exist, so usually electricity is traded regardless of the source.

[110] See chapter 4-5 and Annexes A and B.

However, electricity produced from RES (including bio-energy) is supported through a series of schemes that affect the price of electricity generated from such sources. In many cases different support levels are established according to the different energy sources.

We focus here on the price of electricity generated from bio-energy sources, and in particular from direct burning of solid biomass and from bio-gas[111].

10.2.1 Effects of national incentive schemes on prices of electricity produced from direct burning of biomass and from bio-gas

The achievement by the Member States of the indicative targets set by Directive 2001/77/EC brought about the need for introducing national support schemes for RES-E. We discussed the main advantages and drawbacks of these schemes in chapter 6, where we provided a brief description of the instruments implemented in each Member State. In particular, we noted that market-based instruments such as tradable green certificates (TGC) should have in theory higher cost-effectiveness than other instruments such as feed-in tariffs, an hypothesis that will be tested during the analysis.

The present analysis aims at investigating the effects of national incentive schemes on the prices of electricity generated from the direct burning of biomass and from bio-gas. To this purpose, estimates are provided concerning the support levels in each Member State. The two sectors of direct burning of solid biomass and of bio-gas are examined separately in order to take into account the existing differences in the support levels.

The main data source for this analysis is the Communication from the European Commission "The support of electricity from renewable energy sources (COM (2005) 627 final), which fulfils the requirement by article 4 of Directive 2001/77/EC for the Commission to report on "experience gained with the application [of Directive 2001/77/EC] and coexistence of the different [support] mechanisms" implemented by Member States[112]. Estimates of average support levels for electricity generated from bio-gas and from direct burning of solid biomass in the Member States are presented in table 10.1[113]. Data refer to the price at which a producer of bio-energy is able to sell its product. In the case of feed-in tariff schemes (FI), the only source of revenue is the tariff itself. In case of tradable green certificate schemes (TGC) the revenue earned by the seller is given by the market price of electricity plus the market price of the TGC. The data reported in table 10.1 include both sources of revenue. As to the other instruments, support level includes the electricity price plus premium for RES-E in the case of a premium feed-in tariff scheme (PFI), and estimates the total revenue in case of tendering procedures (TEN).

Support schemes vary not only with respect to the type of instrument that has been adopted (e.g. feed-in tariffs versus tradable green certificates) and to the support level within different instruments or the same type of instrument (e.g. higher versus lower feed-in tariffs), but they also vary according to the system's duration (e.g. 10 versus 20 years)[114]. Normalisation of support levels was therefore necessary in order to make data concerning different Member States comparable. Harmonisation was carried out by establishing a 15-year duration for support schemes and converting actual durations by using a 6.6% interest rate.

Belgium, Austria, Germany, the United Kingdom and Italy are the Member States with the highest support in terms of total revenue for electricity sales, both from bio-gas and from direct burning of solid biomass.

Contrary to theoretical expectations, the Member States with TGC generally have higher levels of support (with the exception of Sweden). This could be explained by the fact that despite the higher incentive to cost effectiveness provided by the TGC schemes, these schemes are characterized by uncertainty in final revenue, being both the price of electricity and TGC defined by market mechanisms. On the contrary, feed-in tariffs are set by the regulators for a certain period of time and their levels are usually not subject to revisions. The uncertainty linked to the TGC mechanism could result in a TGC price which includes a risk premium (not included instead in the feed-in tariffs), and so in higher support levels in general.

NMS generally show lower levels of support, with the exception of Czech Republic and Slovenia.

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[111] It is worth noting again that bio-fuels are only used in the transport sector.
[112] See Annex 3 of the Communication.
[113] Data in this part of the work are referred to forestry biomass. Since support schemes in the Member States barely are differentiated between different sources of biomass, they can be taken as the best possible approximation of the price of electricity produced from direct burning of energy crops.
[114] We have noted in chapter 6 that the duration of a support system has strong influence on the investors' decisions to add new capacity for bio-energy production, because it provides higher or lower stability for investments.

On average, support for electricity from bio-gas is slightly higher than support for electricity from direct burning of solid biomass.

Table 10.1 - Support levels for electricity from bio-gas and from direct burning of solid biomass (2003)

Support Levels for electricity from biogas in the EU-25 (2003)			**Support Levels for electricity from solid biomass in the EU-25 (2003)**		
Country	**Support**	**Support level (€/MWh)**	**Country**	**Support**	**Support level (€/MWh)**
Malta	-		Malta	-	
Poland	QO		Poland	QO	
Slovak Republic	FI	29,41	Slovak Republic	FI	28,42
Latvia	QO, FI*	49,41	Sweden	QO, TGC	42,86
Estonia	QO, FI	50,59	Estonia	QO, FI	50,53
Sweden	QO, TGC	54,73	Latvia	QO, FI	50,53
Finland	TE	54,74	France	FI, TEN	51,43
Lithuania	QO, FI	57,65	Finland	TE	55,71
France	FI, TEN	57,89	Lithuania	QO, FI	57,89
Cyprus	FI	63,52	Cyprus	FI	63,16
Hungary	FI	64,71	Hungary	FI**	64,21
Ireland	TEN	65,26	Ireland	TEN	65,71
Greece	FI	66,32	Greece	FI	68,57
Luxembourg	FI	69,47	Slovenia	FI**	69,47
Netherlands	FI	71,58	Czech Republic	FI, PFI**	70,53
Portugal	FI	72,63	Luxembourg	FI	71,43
Spain	FI, PFI	73,05	Denmark	PFI	72,86
Slovenia	FI	75,29	Netherlands	FI**	72,86
Czech Republic	FI, PFI	77,65	Portugal	FI	72,86
Denmark	PFI	82,11	Spain	FI, PFI	74,29
Belgium	QO, TGC	85,26	UK	QO, TGC**	82,86
Germany	FI	91,57	Belgium	QO, TGC**	85,71
Italy	QO, TGC	93,68	Italy	QO, TGC**	94,29
UK	QO, TGC	110,52	Austria	FI * **	107,14
Austria	FI*	126,32	Germany	FI	111,43
Average		71,45	Average		68,90
QO=Quota Obligation; FI=Feed-in; TGC=Trading Green Certificates; TE= Tax Exeption; TEN=Tendering, PFI=Premium Feed-in Tariffs.			*QO=Quota Obligation; FI=Feed-in; TGC=Trading Green Certificates; TE= Tax Exeption; TEN=Tendering, PFI=Premium Feed-in Tariffs.*		

*Support system now terminated
Source: COM(2005) 627 fina

*Support system now terminated
**Co-firing option

10.2.2 Prices of electricity produced from bio-energy sources versus average wholesale electricity prices

In this section prices of electricity produced from bio-energy sources are compared with average wholesale electricity prices.

Wholesale electricity markets developed in the EU as a consequence of electricity market liberalisation started with Directive 96/92/EC and revised with Directive 2003/54/EC. Prior to liberalisation, markets were organised in state-owned monopolies, usually vertically integrated, so that a wholesale market with average prices did not exist. In most Member States liberalised markets developed but, as showed by the recent inquiry of the DG Competition of the European Commission on the competitiveness of the energy sectors, liquid and actually competitive markets failed to develop in many Member States. Markets are often characterised by low liquidity, high concentration and market power by incumbent firms. Despite this, wholesale markets do exist in most Member States, and hence an estimate of the average wholesale price can be made.

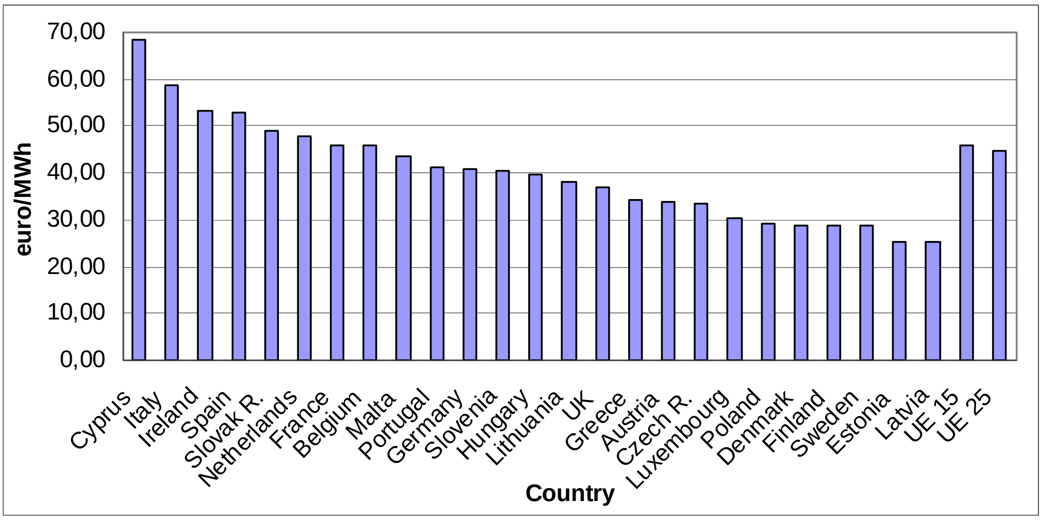
In some Member States electricity exchanges developed, which hourly quote the spot prices for electricity, with a daily schedule. Even if the liquidity of the exchanges is often very low, these quotations can be taken as reference values for average market prices. However, in most Member States the wholesale market is mainly made by over the counter contracts (OTC market), i.e. by bilaterally negotiated long term contracts.

The prices of such contracts are not publicly disclosed, and reports for the average electricity prices do not exist. In such cases the wholesale price is estimated adopting the following methodology.

- For Member States where an electricity exchange does exist, the average annual electricity price was used. Prices are calculated as the average of the hourly prices quoted on the day ahead spot markets. Such markets are: Austria (EXXA), France (Powernext), Germany (European Electricity Exchange EEX); Italy (Italian Power Exchange IPEX), Denmark, Finland, Sweden united in the same exchange (NordPool), Netherlands (Amsterdam Power Exchange APX), Poland (Polish Power Exchange PPX) and Spain (Omel).
- Eurostat statistics were used for large industrial consumers[115]. This final prices are on average 77% of the wholesale prices for the Member States which have an exchange[116].
- The wholesale price for the remaining Member States was thus estimated to be equal to 77% of the final prices paid by large industrial customers.

Results are reported in the figure below.

Figure 10.2 - Average wholesale electricity prices – 2005



Source: DEIAGRA estimates

It can be noted that average wholesale electricity prices vary among different Member States, from a maximum in Cyprus and Italy of around 60 Euros/MWh to a minimum of 25 Euros/MWh in Estonia and Latvia. Former East European Countries usually show lower prices, due to the high rate of production from coal on total and also thanks to a state policy of control on the price of energy sources, even if there are no significant differences between EU-15 and EU-25 average (around 45 Euros/MWh). Nordic Member States in fact also have relatively lower prices, thanks to the high rate of hydroelectric and nuclear production.

Wholesale electricity prices at international level also vary among different countries and different market organisations. Many countries did not liberalize the electricity market and so a reference price for the raw material does not exist. It happens even in many US states. Electricity prices in the USA aren't very different from EU average prices, for example the Pennsylvania, New Jersey and Maryland power market quoted a price of 58 $/MWh on average in 2005.

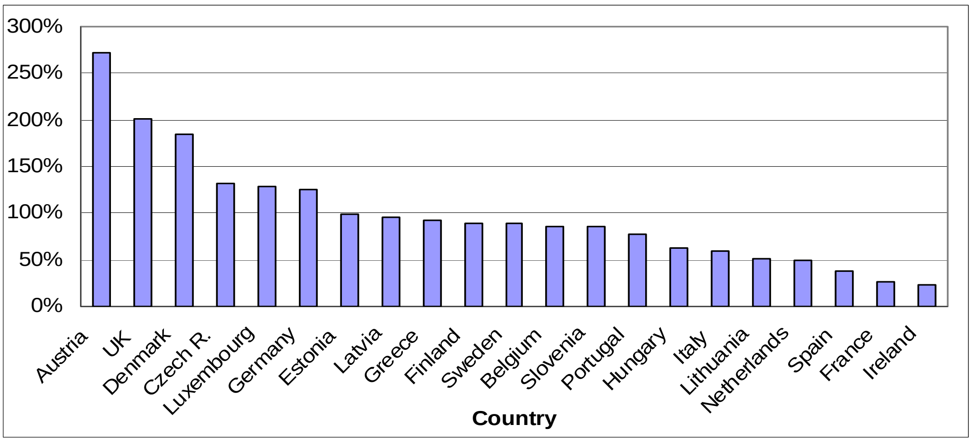
Figure 10.3 shows the percent difference between the supported price for electricity from bio-gas and wholesale electricity prices. Six countries, namely Austria, United Kingdom, Denmark, Czech Republic, Luxembourg and Germany, grant a price to electricity generated from bio-gas which is more than double the average wholesale price, while the average EU value is around 100%. Among these six Member States, the United Kingdom and Germany also feature high levels of production and consumption of bio-gas for electricity, as it may be expected considering that the supported price represents an incentive to increase

[115] Category industry Ii (where available, other category otherwise), including industrial consumers with a yearly consume of at least 70 GWh.

[116] Eurostat periodically reports electricity prices paid by final customers. Such prices are not comparable with wholesale prices; they constitute the revenue for an electricity producer and include the cost of the raw material (electricity) and also costs for transportation (network cost) and other costs (general system costs). Nevertheless, these prices are differentiated according to levels of yearly consumption; it can be assumed that prices referred to consumers with higher yearly consumption are more similar to the wholesale prices, being lower, for this type of users, both costs of transportation and general system costs.

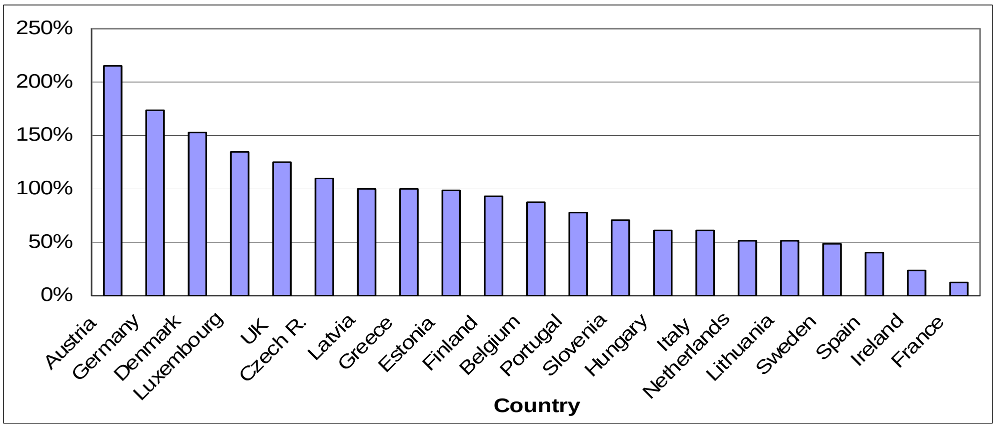
production. Conversely, the other four Member States do not feature high levels of production and consumption (at least in absolute terms) despite the high levels of support granted. Similar values apply for the electricity produced from direct burning of solid biomass, showed in Figure 10.4. Similarly to the previous case, Austria, Germany , Denmark, Luxembourg, United Kingdom and Czech Republic grant a price to electricity production from solid biomass which is more than twice the average wholesale price. In this case the average difference at EU level is slightly lower than 90%. In this case the highest levels of support do not correspond to the highest levels of electricity generation from solid biomass. In particular, Finland and Sweden are the main producers of electricity from solid biomass, despite a support level which is lower than the EU average (see also § 8.2).

Figure 10.3 - Percentage differential for bio-gas source – 2005



Source: DEIAGRA estimates

Figure 10.4 – Percentage differential for solid biomass source – 2005



Source: DEIAGRA estimates

10.3 Heating

10.3.1 Economic value of domestic heat generation from biomass

No information about regulation mechanisms concerning heat prices was found during the review of energy products legislation in the EU. In absence of price regulation mechanisms, heat prices are negotiated between parties. Moreover, statistics on this market do not exist.

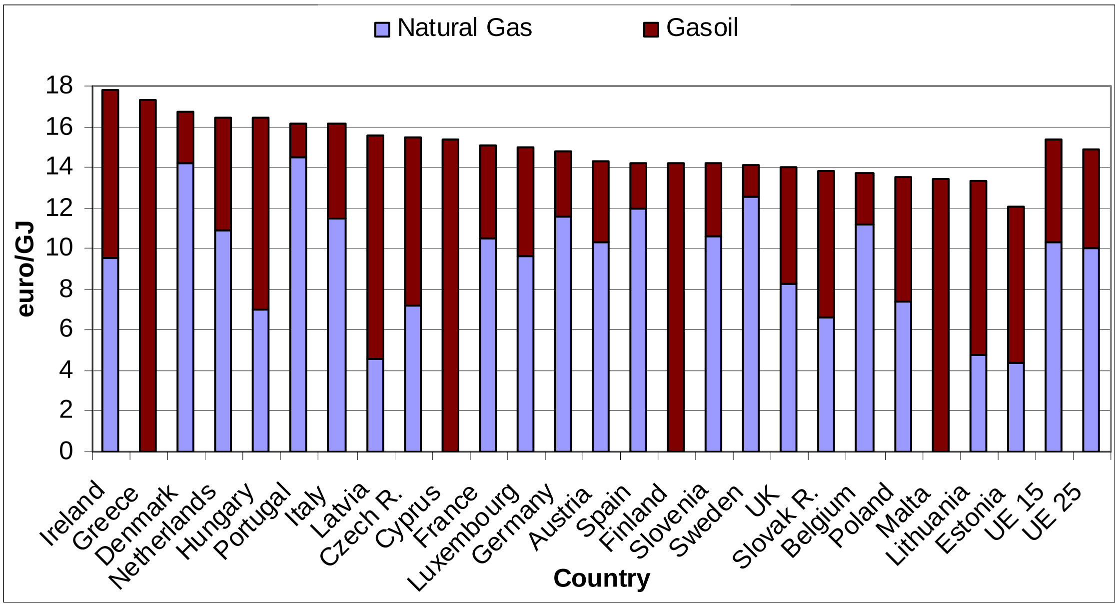
Since a market for heat produced from bio-energy sources does not exist yet, the price for such "product" can be associated with the price of its substitute products. In other words, producers of heat from bio-energy sources can sell their "products" only when their prices are lower than those of alternative products, i.e. heat from fossil fuels. Therefore, in this section we estimate the heat price for domestic heating from natural gas and from diesel oil. The methodology adopted is the following.

- Eurostat supplies the price for domestic uses of natural gas. The end user category used is the D3-b, that registers prices for average consumers (125 GJ/year), taxes excluded.
- Eurostat also supplies the price of diesel oil for domestic heating, taxes excluded.

- Once we have transformed the data in the same unit (Euros/GJ) we assume an average efficiency of a domestic boiler equal to 85%.
- The price of the fuel products multiplied for the average efficiency gives as a result the cost of the domestic heating from traditional sources.
- A producer of heat from bio-energy sources can sell its products only when their prices are lower than the cost of domestic heating from traditional sources.

The results of our analysis are reported in Figure 10.5. The range presented should be interpreted as a cap on prices that consumers of heat will accept in the bilateral negotiations.

Figure 10.5 - Maximum price of domestic heating from traditional sources – 2005



Source: DEIAGRA estimates on Eurostat data

Price of heating from diesel oil is always higher than from natural gas. Four Member States do not have a domestic distribution of natural gas: Greece, Cyprus, Finland and Malta. For these Member States only the data about heat from diesel oil are reported. Prices of heat from diesel oil vary from a maximum of almost 18 Euros/GJ for Ireland to a minimum of 12 Euros/GJ for Estonia.

Estonia also has the lower price for heat from gas (slightly over 4 Euros/GJ) but all the NMS present gas prices much lower than in the rest of the EU. The only Member State with a price comparable with those of the NMS is the United Kingdom (8 Euros/GJ); all the others have a price higher than 10 Euros/GJ, with a maximum of 14 Euros/GJ for Portugal.

10.4 Transport

Despite the fact that in some Member States fuel pumps exist at which final customers can buy directly bio-fuels (for example Germany, Spain and UK), more often bio-fuels are blended with traditional fuels. In any case the market is too tiny to have an independent quotation of such products, so the reference price at which bio-fuels producers can sell their products are still driven by the prices of fossil fuels, i.e. diesel (for bio-diesel) and petrol (for bio-ethanol). In this section we estimate such prices by taking into account national incentive schemes.

10.4.1 Effects of national incentive schemes on bio-fuel prices

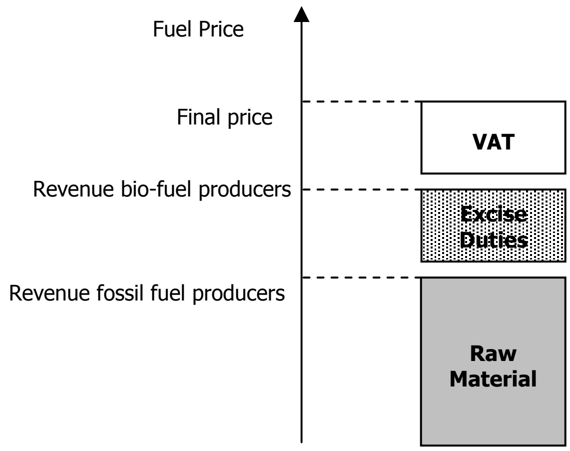
Following Directive 2003/30/EC, to meet the national targets of bio-fuel production many Member States adopted incentive schemes based on tax exemption for bio-fuel producers, pursuant to Directive 2003/96/EC. In chapter 8.4 it was underlined that in most Member States, as well as in the EU as a whole, targets concerning the share of bio-fuels in the transport sector have not been met. Here below we analyse the potential effect of support policies for bio-fuels on final prices, even for the Member States which actually do not feature any production or demand of bio-fuels. Such analysis will be useful in order to assess the market potential and competitiveness of bio-fuel production in each Member State (see chapter 11).

Final prices of traditional fuels can be considered as made up of three main components (Figure 10.6):

- Raw material
- Excise duties
- VAT

Revenue, for traditional fuel sellers, is represented by the component "raw material" of the final price (the bottom part of the bar in the figure). If producers of bio-fuels are granted excise duty exemption, they can be competitive by selling at a price equal to the raw material component plus the excise duty (the two lowest parts of the bar in Figure 10.6). Therefore, the main effect of a support scheme can be considered its capacity to allow bio-fuel sellers to set a higher price and thus receive a higher revenue than that received by sellers of fossil fuels. The difference between the two prices corresponds to the tax exemption granted.

Figure 10.6 - Final price of traditional fuels: components



In order to simplify the analysis, a full excise duty exemption is considered, since most Member States apply this support measure[117] . A few Member States either apply total exemptions to limited production quotas (e.g. France and Italy) or apply a partial exemption (e.g. Belgium and Latvia). However, since only a minor share of EU production is not granted full exemption, the above mentioned approximation seems to be reasonable.

Reference prices for bio-fuels were estimated on the basis of Eurostat data[118].

10.4.2 Bio-fuel prices versus prices of conventional transport fuels

Figure 10.7 reports the bio-ethanol prices (estimated from the petrol prices) in the Member States.

The highest price for petrol is registered in the Netherlands (almost 1.400 Euros/1.000lt) and the lowest in Latvia (slightly more than 800 Euros/1.000lt). Generally speaking, former Eastern Europe Member States show lower levels than Western Member States.

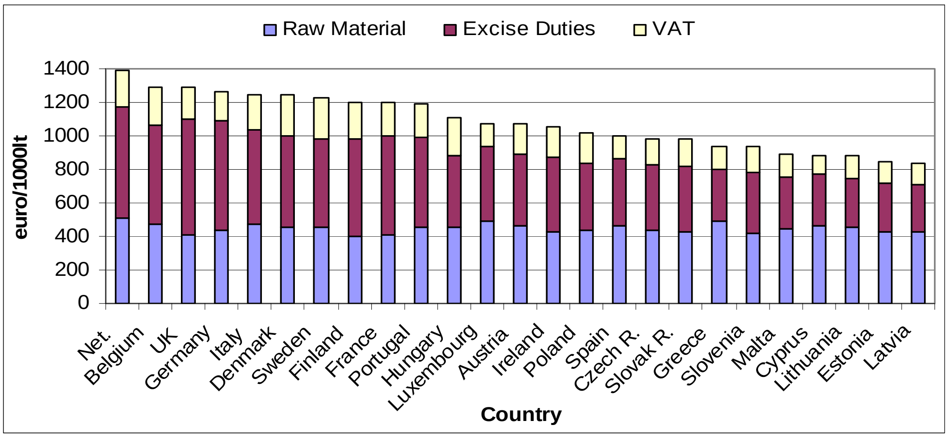
If VAT is excluded, the excise duties, representing the premium for bio-ethanol producers, account for 456 Euros/1.000lt (EU-25 average), with a peak of 685 Euros/1.000lt in the United Kingdom and a minimum of 275 Euros/1.000lt in Latvia. Excise duties are in fact very often set in terms of percentage on the raw material price. The average excise duty in the EU accounts for 41% of petrol raw material price, with maximums around 50% in the United Kingdom, Germany and France and lower values - slightly more than 30% - in former Eastern Europe Member States.

Figure 10.8 reports the same values for diesel oil and bio-diesel prices.

[117] See chapter 4 and Annexes A and B

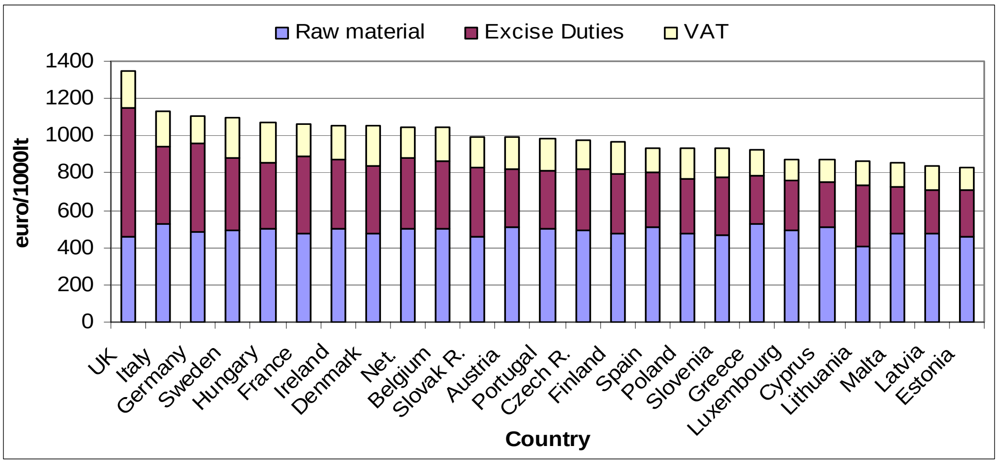
[118] Eurostat publishes the values of the "Premium unleaded petrol, 95 Ron" for "Automotive fuels at the pump" with all taxes (final price), without VAT and without all taxes: these were used to estimate bio-ethanol prices. Eurostat also publishes the values of the "Diesel Oil" for "Automotive fuels at the pump" with all taxes (final price), without VAT and without all taxes.

Figure 10.7 - Petrol and bio-ethanol prices - 2005



Source: DEIAGRA estimates on Eurostat data

Figure 10.8 - Diesel oil and bio-diesel prices - 2005



Source: DEIAGRA estimates on Eurostat data

Indeed similar values can be observed for diesel prices, with Western Member States featuring the highest final prices and former Eastern Europe ones (with the exception of Hungary) featuring lower prices. The United Kingdom is by far the Member State where diesel is most expensive, almost reaching 1.350 Euros/1.000lt, while Estonia features the cheapest price, i.e. approximately 830 Euros/1.000lt.

The very high price for diesel fuel in the United Kingdom is deeply influenced by the levels of the excise duty and other taxes, which are much higher than in any other Member States, amounting to 685 Euros/1.000lt versus a value of 470 in Germany, 413 in Italy, etc. The lowest value is featured by Latvia, where excise duty and other taxes amount to 235.6 Euros/1.000lt. In relative terms, excise duty and other taxes represent on average 34% of the final price for diesel, with peaks of 51% in the United Kingdom and 42% in Germany, and minimum levels of 28% in Latvia and Greece.

At the international level, prices of fuel for transport are considerably cheaper: in the USA the average price for petrol in 2005 was 611$/1.000lt (against an average of 1.082 Euros/1.000lt in the EU) and the average price for diesel oil was 634 $/1000lt (against 992 Euros/1.000lt in the EU). Most part of this gap can be explained by taxes: in the EU in fact taxes normally account for about 84% of the total price of petrol and diesel oil, with very few differences among the Member States, while in the USA taxes account for around 17% of the petrol price and around 19% in the case of diesel oil price.

10.5 Conclusion and main findings

As far as **electricity** is concerned, estimates on the level of support for electricity generated from bio-gas and from direct burning of solid biomass in the Member States show that tradable green certificate schemes generally provide a higher level of support than feed-in tariff schemes (with the notable exception of

Sweden). Support levels range from about **29 to 126 €/MWh** in the case of **biogas**, and from about **28 to 111 €/MWh** for **solid biomass**, with average support levels of 71 €/MWh and 69 €/MWh respectively.

Comparisons between supported prices obtained by sellers of **electricity from bio-gas**, on one hand, and electricity wholesale prices, on the other, show that the EU average level of supported price is 100% higher than the wholesale level. Moreover, in six Member States support results to be more than double than the EU average wholesale price. Among these are the two main producers of bio-gas, namely United Kingdom and Germany, and three other important players (Denmark, Czech Republic and Austria), although they do not rank among major producers.

As regards the comparison between supported prices obtained by sellers of **electricity from direct burning of biomass**, on one hand, and electricity wholesale prices on the other, the former is on average 36% higher than the latter.

However, no correspondence between support levels and production output may be observed in the case of electricity generated from direct burning of solid biomass, with the exception of Germany.

With reference to **heating**, data on prices of heat produced from natural gas and diesel oil have been presented in this section. Given the absence of support schemes based on EU legislation, these prices represent the maximum prices at which heat generated from bio-energy sources can be sold, in order to be competitive with heat generated from fossil fuels.

A similar exercise was conducted for bio-fuels for the **transport** sector, considering full excise duty exemption for liquid bio-fuels (bio-diesel and bio-ethanol). Accordingly, the maximum prices have been estimated at which bio-fuels for transport purposes can be sold in order to be competitive with fossil fuels.

11 COST AND PROFITABILITY OF ENERGY CROPS AND BIO-ENERGY

11.1 The economics of biomass production at the agricultural level: an assessment of profitability and competitiveness

The cost of biomass is an important element determining the cost of production of bio-energy (see § 11.1.2.1). Here below, an analysis is presented assessing:

- The **profitability of energy crops at farm level**. The analysis is based on the energy crops gross margins, per Member State and type of crop, calculated on the basis of average production costs and prices as well as additional revenues coming from DAMs. A comparison is provided among gross margins for the main energy crops in the main producing Member States[119], in order to define the framework for the farmers' cultivation choices in the context of both pre- and post decoupling[120].
- The **competitiveness of energy crop cultivation**, both at internal and international level. As for the internal competitiveness, the analysis is based on the estimated *break even price*, compared with the average market price per type of crop and Member State. As for the international competitiveness, an assessment is made by comparing prices registered on the EU market – for each relevant crop and Member State – and prices of imported products from the most important trade partners (for relevant crops and countries).

11.1.1 Profitability of energy crops at farm level

The objective of the profitability analysis is to compare the gross margins of the most relevant energy crops and identify the economic variables which influence the grower's cultivation choice.

For each Member State, a defined set of crops is considered, according to the relative importance - in terms of harvested area - of the different kinds of energy crops within the Member State itself.

Box 11.1 – Methodology for the analysis of profitability

The gross margin (GM) is a function of the following variables: yield, price, variable production costs and relevant coupled direct payments (which are different in the pre and post decoupling contexts)[121].

The analysis is based on some assumptions.

Assumption 1 *– The* ***yield of the energy crop*** *is assumed to be equal to the* ***yield of the conventional crop*** *(as suggested by evidence from case studies).*

Assumption 2 *– The* ***production cost of the energy crop*** *is assumed to be equal to the* ***production cost of the conventional crop****, within the same Member State (as suggested by evidence from case studies)*[122].

Assumption 3 *– Given the empirical evidence resulting from case studies, three cases were considered regarding price*[123]*:*

i) the price of the energy crop is assumed to be equal to the price of the conventional crop;
ii) the price differential between energy and conventional crop is assumed to be +10%;
iii) the price differential between energy and conventional crop is assumed to be -10%;

The profitability of the energy crop is analysed through the analytical framework described in table 11.1.

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119 By-products should be taken into account in the analysis of profitability of bio-energy. Like revenues coming from products, those deriving from by-products are determined by their *quantity* and *price*. Here, given the wide range of crops and the very different situations existing in the Member States, the influence of by-products on the profitability is taken into account only in a theoretical way. See also Caserta, G., Bartorelli, V., Mutinati, G. (1996), in bibliography.

120 See § 11.1.1.1 and 11.1.1.2 respectively. The analysis concerning the pre-decoupling context is referred to the year 2004.

121 As far as yields, prices, variable production costs and area payments are concerned, the source used is Graham Brookes, "European arable crop profit margins" (2004/05). These data relate to crops harvested in 2004. Following the author: *i)* whenever actual (or early harvest forecast) average yields and prices could not be used, estimates are used; *ii)* area support payment rates are those applicable to crops harvested in 2004 and marketed in 2004/05 marketing year; *iii)* costs of production data are derived from a variety of sources across the Member States covered. The main limitations of these data concern space and time dimensions; moreover, only an average performance for a crop is presented. Fixed costs are not considered, but only variable costs: *i)* direct variable costs (purchased seed, fertilizer, plant protection, etc.) and *ii)* indirect variable costs (machinery lease costs and contractors – harvest, irrigation, etc.).

122 Results from cases studies indeed confirmed in almost all cases (except for sugar beet) that the difference between the production cost of a certain kind of energy crop and that of the same kind of crop for food/feed uses is not relevant.

123 Results from case studies pointed out that in almost all cases the difference between the price of energy crop and the price of the conventional crop ranges between -10% and +10%. Tables 1-21 in the Annexe H represent all the possible combinations of the three alternative price hypotheses.

Assumption 4 *– The strategic choice of the farmer depends on the gross margin of the crop (GM), and precisely he/she chooses the crop (energy or conventional) which implies the highest gross margin. Thus, his/her choice is influenced by yield, price, variable production costs of the specific crop and coupled payments (when differentiated by crop type).*

Assumption 5 *– The cultivation of non food crops on set aside land – for both energy and non-energy purposes – is allowed under the non food on set aside regime, as the only gainful alternative to leaving the land fallow. This provision can determine an economic advantage for the cultivation of non food crops on set aside land versus fallow set aside, i.e. an "implicit subsidy" to the cultivation of non food crops on set aside land: This "implicit subsidy" is given by two components:*

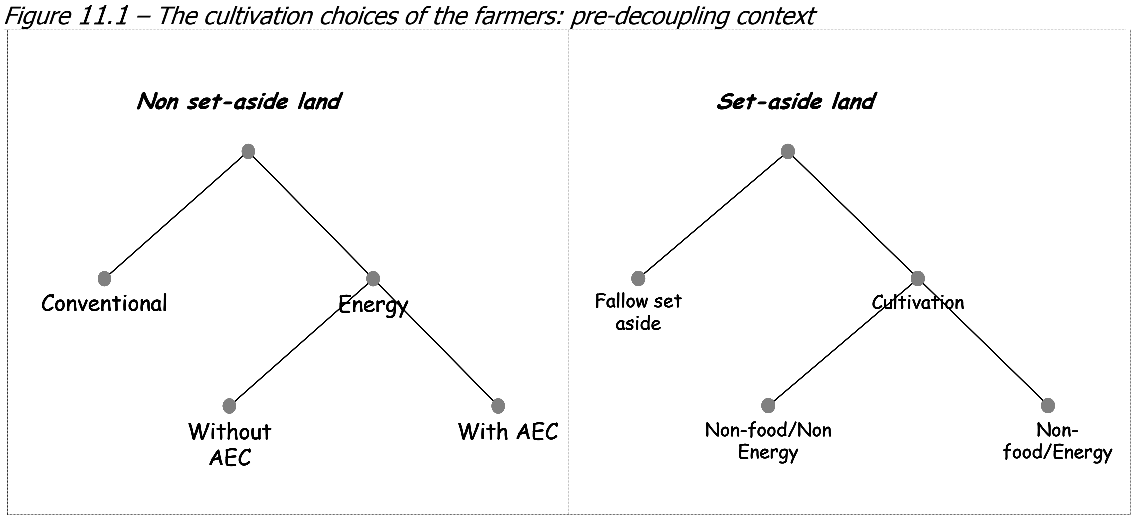
1. *An avoided cost, equal to the cost of land maintenance in the fallow set aside option, which the farmer must not bear in case he/she decides to grow non food crops on set aside.*
2. *A component associated to the fact that on set aside land there are no feasible gainful alternatives to the cultivation of non food crops, as crops for food/feed use cannot be grown on set aside land. No opportunity cost is therefore associated to the choice of growing non food crops on set aside land, i.e. such land "comes for free". The economic advantage stemming from this situation is however difficult to estimate, and therefore it has not been taken into account in the calculation of the implicit subsidy, which in the whole evaluation study is considered as given by the sole avoided cost of land maintenance.*

The "implicit subsidy" – as defined above - is entered in the calculation of the gross margin of non food crops grown on set aside land in all the analyses carried out for the evaluation study[124].

11.1.1.1 The pre-decoupling context

The set of cultivation choices for the farmer in the pre-decoupling context can be represented through the diagram at figure 11.1. It is important to point out that the delimitation between non-set aside land and set aside land is exogenously defined by the public authorities. Thus, the farmer faces two well defined and separated sets of choices.
Non-set aside land is eligible for AP, whereas set aside land is eligible for set aside payments (SAP).

Figure 11.1 – The cultivation choices of the farmers: pre-decoupling context



Source: DEIAGRA elaboration

Referring to the pre-decoupling context, table 11.1 shows the elements which constitute the farmer's gross margin in all the different cultivation options.

[124] It is also important to point out that such "implicit subsidy" is not an exclusive of energy crops grown on set aside land, but is instead an economic advantage inherent to all non food crops – both energy and non-energy ones – cultivated under the non food on set aside regime.

Table 11.1 - The Gross Margin in the different farmer's options: the pre-decoupling context

Use of the land	**Non-set aside land**			**Set aside land**		
Options	**Conventional**	**Energy without AEC**	**Energy with AEC**	**Non-Food Energy crops**	**Non-Food/Non Energy crops**	**Fallow set aside**
Crops eligible to AP	$GM = R - C + AP$	$GM = R - C + AP$	$GM_{AEC} = R - C + AP + AEC$	$GM = R + c - C$	$GM = R + c - C$	$GM' = -c$
Other energy crops (sugar beet, SRC, willow, etc.)	$GM = R - C$	$GM = R - C$	$GM_{AEC} = R - C + AEC$			
Variables	where, $R = py$ Gross margin per ha of the crop, which benefits only from the AP R Market revenues *p* Price at farm level *y* Average yield C operating expenses AP Area Payment	where, $R = py$ Gross margin per ha of the crop, which benefits only from the AP R Market revenues *p* Price at farm level *y* Average yield C operating expenses AP Area Payment	where, $R = py$ Gross margin per ha of the crop, which benefits from AP and AEC R Market revenues *p* Price at farm level *y* average yield C operating expenses AP area payment AEC aid for energy crops	where, $R = py$ Gross margin per ha of the non-food/energy crop R Market revenues *p* Price at farm level *y* average yield C operating expenses *c* "Implicit subsidy" = cost for the *land maintenance*	where, $R = py$ Gross margin per ha of the non-food/non-energy crop R Market revenues *p* Price at farm level *y* average yield C operating expenses *c* "Implicit subsidy" = cost for the *land maintenance*	where, $R = 0$ Gross margin per ha if the farmer does not cultivate any crop *c* cost for the *land maintenance*

Source: DEIAGRA elaborations

NB1: non-set aside land is eligible for AP, whereas set aside land is eligible for set aside area payment (SAP)

NB2: AP have an influence on the relative choice of the farmers only when the comparison is among crops which benefit from the payment and crops which do not, or when the comparison is between two crops which benefit from different amounts of the arable crops area payment.

SAP do not have any influence on the relative choice of cultivation by the farmers, since they receive the payment in any case.

NB3: On non-set aside land the gross margin for the sugar beet is given – before the COUNCIL REGULATION (EC) No 318/2006 of 20 February 2006 on the common organisation of the markets in the sugar sector – by the following expression: $GM = R - C$. After the Council Regulation 318/2006, the GM is given by $GM_{AEC} = R - C + AEC$. In the case of sugar beet cultivation on set aside land – before the COUNCIL REGULATION (EC) No 318/2006 of 20 February 2006 on the common organisation of the markets in the sugar sector – farmers had to renounce to set aside payments (SAP), and hence face an opportunity cost equal to the SAP: the gross margin is therefore given by the following expression: $GM = R - C - SAP + c$, where "c" is the "implicit subsidy" (see NB4 below).

NB4: The economic advantage of growing non-food crops on set aside land - "implicit subsidy" - is included in the calculation of the GM of non-food crops on set aside, and is assumed to be equal to the cost for the land maintenance.

A detailed analysis of the farmer's cultivation choices in each one of these options is given in Annex H. Here, some main elements should be pointed out.

1. Referring to **non-set aside land**, the gross margin of the crop is influenced by:

- the crop yield;
- the price of the product;
- the level of AP (when different from crop to crop);
- the AEC (in case the crop is grown with AEC);
- the variable costs connected to the cultivation of the crop.

As far as the *inter-crop choice* is concerned (farmer's choice among all the possible crops, for both food/feed and energy use), all these elements – by influencing the gross margins of the crops – influence the farmer's cultivation choices.

As far as the *intra-crop choice* is concerned (farmer's choice between the food/feed and the energy destination of a defined crop), basing on all the assumptions given in box 10.1[125], the elements determining differences in the gross margins, and therefore actually influencing the farmer's cultivation choices, can be identified in the sole:

- **price** of the product;
- **presence/absence of AEC**.

Generally speaking, the analysis developed for each Member State and for the most diffused crops, shows a determinant role played by the **price** of the product (see Annex H for details).

2. Referring to the cultivation on **set aside land**, the gross margin of the crop is influenced by:

- The crop **yield**;
- The **price** of the product;
- The **variable costs**;
- The ***implicit subsidy***, identified in the cost of land maintenance.

Being the *implicit subsidy* an avoided cost, independent from the type of crop cultivated on set aside land, the gross margin results to be actually depending only on price, yield and variable costs of the specific crop.

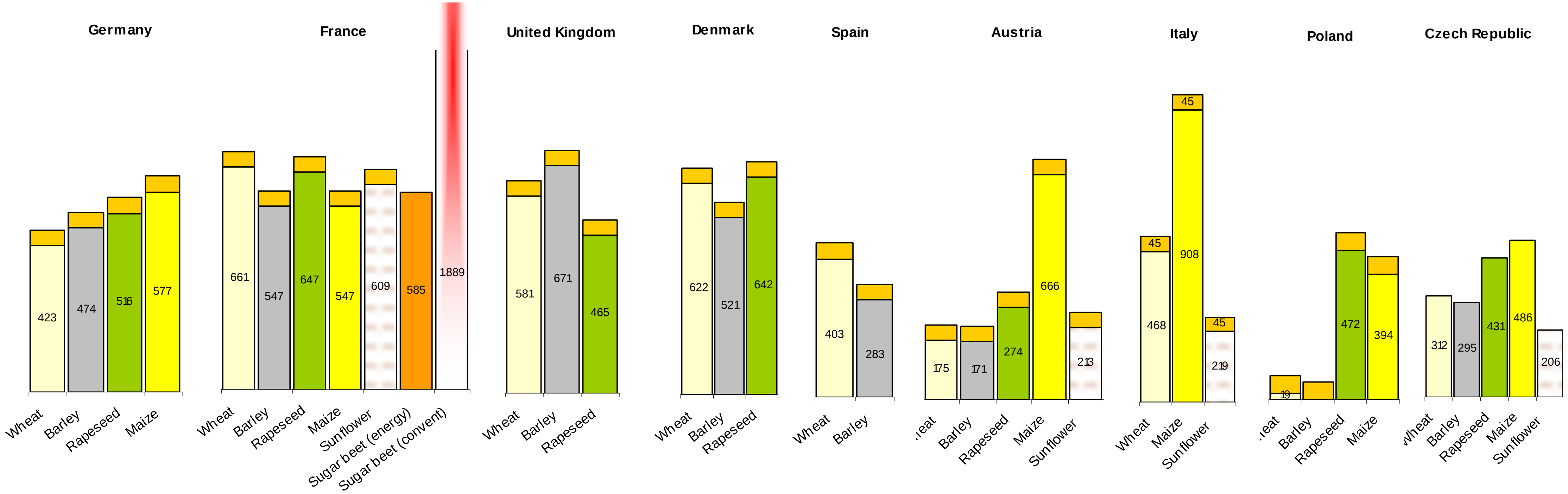
A compared analysis of actual gross margins, carried out for the main producing Member States and the most diffused crops[126], is pictured in Figure 11.2. The figure compares the crops margins with and without the AEC (or the national "top up" for Poland), highlighting both differences among crops in each Member State, and differences among Member States for the most important energy and non energy crops.

Generally speaking, quite high levels of margins characterise the main crops (soft wheat, barley, rapeseed and maize, both for energy and conventional use) in Germany, France, United Kingdom and Denmark, where indeed high levels of production are registered for almost all these crops (see also § 7.1). In these Member States, rapeseed, maize and soft wheat are always characterised by margins between around 400 and 700 euros/ha. The role of AEC in determining possible shifting from one crop to another, or from the conventional to the energy use, seems to be quite limited (AEC always represents from 7% to maximum 10% of the gross margin).

A different situation can be observed in Spain, Austria, Italy, Poland and Czech Republic. Here, with the exception of maize (in Austria and Italy, the latter however showing low levels of production for energy use) margins are normally lower, and the incidence of the AEC results to be generally higher (from 15 to 26% of the total gross margin).

[125] Invariability of yield and production cost for a defined crop in a defined country.
[126] The analysis was developed basing on the methodological assumptions given in Box 10.1.

Figure 11.2 – Gross margins of the main crops, per country (2004)



Source: DEIAgra elaboration on data from Graham Brookes, "European arable crop profit margins" (2004/05).

As far as the cultivation on set aside land is concerned, the cultivation options are limited to crops destined to energy (and more generally non food) use, and to the possibility to leave the land fallow. Here, theoretically, all crops showing gross margins higher than the (negative) level of the cost of land maintenance result to be economically convenient in comparison with fallow set aside.

Hence, if the level of gross margins is actually the only variable determining the farmer's cultivation choices, almost all the set aside land should be cultivated. The fact that – in reality – this does not happen in most Member States, highlights the presence of limiting factors other than margins[127].

11.1.1.2 The post-decoupling context

Referring to the post-decoupling context, the elements composing the gross margins in the different cultivation options are represented in table 11.2.

In this context, the AP does not exist anymore, and the farmer benefits from the SPS independently from the kinds of crop he/she chooses to grow, and even in absence of any cultivation. The AEC has an influence on the farmer's choice between energy and non-energy crops but does still not have any impact on the relative position of each energy crop in terms of profitability, as the amount of the AEC is the same for all the crops which are eligible for it.

The framework is valid in the case of complete decoupling, whereas it does not apply when payments are partially coupled. Indeed, according to Council Regulation (EC) No 1782/2003 (Chapter 5, Section 2, artt.64-69), Member States may maintain a proportion of product-specific direct aids in their existing form (known as "partial decoupling"), notably where they believe there may be disturbance to agricultural markets or abandonment of production by moving to the SPS. Member States may choose between several options, at national or regional level, but only under well-defined conditions and within clear limits[128]. The situation of the partially coupled support is also represented in table 11.2, as well as the specific case of energy crops non eligible to the partially coupled support.

As regards the cultivation of non food crops – for both energy and non-energy purposes - on set aside land in the post-decoupling context, the assumptions illustrated for the pre-decoupling context continue to be valid. In particular, the "implicit subsidy" to the cultivation of non food crops on set aside land is again factored in the calculation of the gross margin of such crops, as the alternative of leaving the land fallow continues to imply the bearing of the cost of land maintenance for the farmers who choose such an option: the choice of growing non food crops on set aside land keeps on benefiting from the economic advantage associated with the avoided cost of land maintenance.

Summarising, the main differences and similarities between the pre and the post-decoupling context are the following:

a) In the case of non set aside land:

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[127] For an analysis of the main limiting factors, see the answers to EQ 1 and EQ 10.

[128] See the Table below for an overview on the SPS implementation in different Member States.

Country and starting year	Regions	Model	What sectors remain coupled
Finland (2006)	Three regions based on reference yield	Dynamic hybrid moving to a flat rate model	Art.69 application: 2.1% of the ceiling for arable crops
France(2006)		Historic	Cereals 25%
Germany (2005)	Bundesländer (Berlin included in Brandenburg, Bremen in Lower Saxony and Hamburg in Schleswig- Holstein)	Dynamic hybrid moving to a flat rate model	
Greece (2006)	-	Historic	Art. 69 application: 10% of the ceiling for arable crops
Italy	-	Historic	Art. 69 for quality production: 8% of the ceiling for the arable sector
Portugal (2005)	-	Historic	Art. 69 for quality production: 1% of the ceiling for arable crops
Spain (2006)	-	Historic	Arable crops 25%

DEIAgra elaborations on the "Overview of the implementation CAP reform (first and second wave of the reform)", 19-04-2006, http://ec.europa.eu/agriculture/markets/sfp/ms_en.pdf

- in the case of full decoupling, the gross margin of the crops is no more influenced by the amount of the Arable Crop Area Payment;
- in the case of both full and partial decoupling, the AEC continues to influence the choice between energy and conventional destination of the crops (and to be neutral with respect to the choice among different kinds of crops eligible for it);
- in the case of partial decoupling, the partially coupled support influences the gross margin of the crops, in a way similar to the AP in the pre-decoupling context.

b) In the case of set aside land, the "implicit subsidy" continues to influence the profitability of non food (including energy) crops cultivation under the NFSA regime.

Table 11.2 - The Gross Margin in the different farmer's options: the post decoupling context

Use of the land	SPS					
	Non-set aside land			**Set aside land**		
Options	**Conventional**	**Energy without AEC**	**Energy with AEC**	**Non-Food Energy crops**	**Non-Food/Non Energy crops**	**Fallow set aside**
GM in the context of full decoupling	$GM = R - C$	$GM = R - C$	$GM_{AEC} = R - C + AEC$	$GM = R + c - C$	$GM = R + c - C$	$GM' = -c$
GM in the context of partially coupled arable crops payments, for crops eligible to the payment	$GM = R - C + APy$	$GM = R - C + APy$	$GM = R - C + APy + AEC$			
GM in the context of partially coupled arable crop payments, for crops non eligible to the payment	$GM = R - C$	$GM = R - C$	$GM_{AEC} = R - C + AEC$			
Variables	where, $R = py$ Gross margin per ha of the crop R Market revenues *p* Price at farm level *y* Average yield C operating expenses APy Partially coupled support	where, $R = py$ Gross margin per ha of the crop R Market revenues *p* Price at farm level *y* Average yield C operating expenses APy Partially coupled support	where, $R = py$ Gross margin per ha of the crop, which benefits from AEC R Market revenues *p* price *y* average yield C operating expenses AEC aid for energy crops APy Partially coupled support	where, $R = py$ Gross margin per ha of the non-food/energy crop R Market revenues *p* price at farm level *y* average yield C operating expenses *c* "Implicit subsidy" = cost for the *land maintenance*	where, $R = py$ Gross margin per ha of the non-food/non-energy crop R Market revenues *p* price at farm level *y* average yield C operating expenses *c* "Implicit subsidy" = cost for the *land maintenance*	where, $R = 0$ Gross margin per ha if the farmer does not cultivate any crop *c* operating expenses, cost for the *land maintenance*

Source: DEIAGRA elaborations
NB1: This framework is valid in the case of complete decoupling, whereas it does not apply in the cases of France and Spain, where the payments are partially coupled.
NB2: Compared to Table 10.1, in this analysis, the AP does not exist anymore and the farmer benefits from the SPS independently from the kinds of crop he/she chooses to grow, and even in absence of any cultivation. The AEC has an influence on the farmer's choice between energy and non-energy crops.
NB3 *y* represents the percentage of coupled arable crops area payments, for crops eligible to the payment.
NB4 The economic advantage of growing non-food crops on set aside land - "implicit subsidy" - is included in the calculation of the GM of non-food crops on set aside, and is assumed to be equal to the cost of land maintenance.

11.1.2 The competitiveness of energy crops production

11.1.2.1 Internal competitiveness: the break even price analysis

The objective of the break-even price analysis is to define the minimum level of price over which the cultivation of a defined crop becomes economically convenient in comparison to its best alternative.

The analysis is carried out separately for the pre- and the post-decoupling context, in the cases of *i)* non-set aside land[129] and *ii)* set aside land[130]. Referring to the pre-decoupling context, the distinction between crops which were eligible and non eligible for AP has been taken into account[131].

11.1.2.1.1 The pre-decoupling context

As far as the *intra-crop choice* is concerned (choice between energy and conventional use of the same crop), the break-even price analysis allows defining the minimum price such that the energy destination of the crop becomes more convenient than the conventional use. Here, the presence of the AEC, by granting an additional revenue to the farmer, makes the break even price of the energy crop lower in comparison with the conventional crop[132]. In other words, in presence of AEC, a lower price level of the product would be sufficient to make the energy use of the crop more convenient than the conventional one.

As for the *inter-crop choice*, the break-even price (BEP) analysis aims at identifying the minimum price level where a defined energy crop becomes more convenient than the best alternative - energy or conventional - crop[133]. Consequently, substitution phenomena among different crops are analysed, referring to three different situations:

a) Cultivation of the crop on non-set aside lands without applying for the AEC.
b) Cultivation on non-set aside lands applying for the AEC. In this case, the best alternative choice can be 1) a conventional crop or 2) an energy crop[134]. As the AEC does not differentiate according to the type of energy crop, if the best alternative crop is an energy crop, the BEP such that the considered crop becomes more profitable than the best one is equal to the BEP without AEC.
c) Cultivation on set aside land under the NFSA regime. In this case, the analysis individuates the minimum price level for a defined energy crop, over which the crop becomes convenient with respect to another non-food (energy or non-energy) crop and/or with respect to fallow set aside.

The analysis of the scenarios a) and b) above also considers the following cases:

- both the analysed crop and its best alternative are eligible for AP;
- neither the analysed crop nor its best alternative are eligible for AP;
- the analysed crop is eligible for AP, whereas its best alternative is not;
- the analysed crop is not eligible for AP, whereas its best alternative is eligible for AP.

The analysis of the three different situations above (a, b, c) is carried out at Member State level, and a comparison is made between the level of the BEP in the three cases and the actual price registered in the Member State under study[135]. Generally speaking, if the BEP of a certain crop in a certain Member State is higher than the maximum actual price of the same crop, this means that such crop is on average not competitive with respect to the best alternative crop in that Member State. It is important to point out

[129] Where the set of alternatives includes conventional crops, energy crops without AEC, energy crops with AEC.
[130] Where the set of alternatives includes non-food energy crops, non-food/non-energy crops, fallow set aside.
[131] Another important element which has to be taken into account is the price differential between energy and conventional crop. Given the number of cases which have to be considered, in order to simplify the analysis, we consider only the case in which the price of the energy crop is equal to the price of the conventional one.
[132] See the data "BEP F/E" in the Tables 22-27 in the Annex H.
[133] Graham and Downing (1995), for example, use an equation to estimate the biomass break-even price (BEP), given the assumption that farmers will convert their land to biomass production for energy use when the profit received equals or exceeds current profits from growing conventional crops. Compared with this analysis, we take also into account *i)* any relevant crop specific area-based support payments (AP) and *ii)* the DAM which promote the cultivation of energy crops (AEC or NFSA regime).
[134] See Table 1 in Annex I for a detailed description of the cases considered. As for the comparison among the three mentioned situations, it has to be pointed out that only the comparison between the scenarios a) and b) (cultivation on non-set aside land, without and with AEC respectively) is economically justified, whereas the comparison between these two scenarios and the third one is meaningless, as none of the crops for food/feed use included in the set of alternatives for the scenarios a) and b) can be included in the set for the scenario c): crops for food/feed use cannot indeed be grown on set aside land.
[135] See Tables 22-26 in the Annex H.

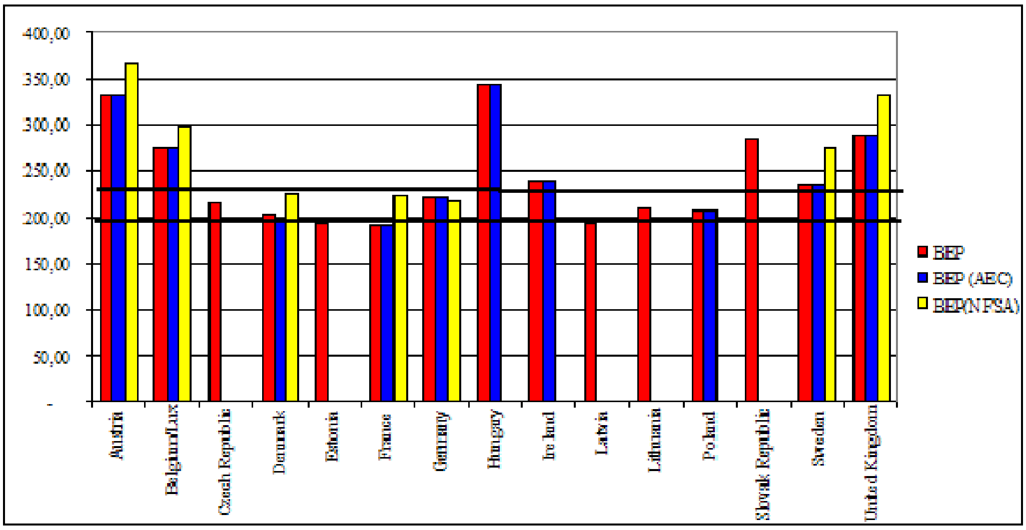
that a crop which is not competitive without the support granted by the AEC or the NFSA regime might become on average competitive if it is cultivated with the support granted by one of the two measures.

In general the AEC has the effect to increase the competitiveness of a crop, but this is sometimes not the case. Indeed if the best alternative choice is represented by an energy crop, the AEC has no effect on the BEP[136].

As regards instead the effect of the NFSA regime, the improvement of the competitiveness of a crop (i.e. the relative position of the BEP compared to the actual price) depends on the relative importance of factors which act simultaneously on the formation of the gross margin: variable production costs, yields and price[137].

To make an example, in Denmark, the **energy rapeseed** results to be competitive with respect to the best alternative crop only in the scenario b), i.e. in the case of cultivation on non-set aside land applying for the AEC[138]. Energy rapeseed represents indeed around 90% of the total area under energy crops in the country, whereas in Austria, Sweden and United Kingdom the rapeseed results to be not competitive with respect to the best alternative crop in all the cases considered. In these countries indeed, the relative weight of rapeseed on the total energy area is much lower (from 41 to 46%). In Germany, the competitive position of rapeseed is quite good, the BEP in the three scenarios being close to the actual price[139]. The large area destined to rapeseed for energy use in the country confirms this situation. In the case of France, the energy rapeseed results to be competitive with its best alternative both with and without the AEC, as well as in the case of cultivation on set aside land[140].

Figure 11.3 - BEP analysis: rapeseed



Source: DEIAGRA elaborations on Graham Brookes, "European arable crop profit margins" (2004/05). Values in euros.

NB1 The black rows in each figure represent the minimum and the maximum actual price levels for the crop within the set of Member States under study.

NB2 See expressions (A3)-(A5) for a detailed analytical explanation of the possible relations between the BEP in the cases of: non-set aside land without AEC and non-set aside land with AEC.

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136 See equations (A3)-(A5) of Annex I for a detailed and analytical explanation of this result.

137 It is important to remind that in this specific case the best choice - within the set of alternatives which applies on set aside land - can be a non-food energy crop, a non-food/non-energy crop or fallow set aside.

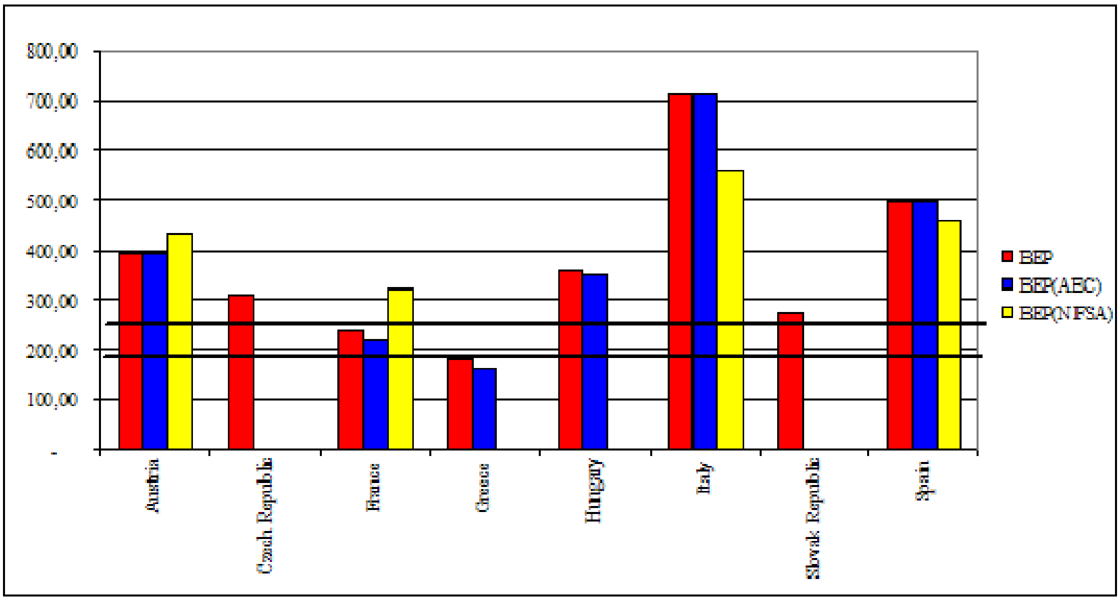
138 The best alternative choice to energy rapeseed (cultivated on non set aside land without AEC) is conventional rapeseed, whereas the best alternative choice to energy rapeseed (cultivated on non set aside land with AEC) is energy soft wheat. Energy rapeseed cultivated on set aside land (case *iii*) results not to be competitive with respect to the best alternative (soft wheat on set aside land).

139 In this case the AEC does not have any influence on the BEP in the scenarios a) and b), because the best alternative choice (silage maize) is also an energy crop. The AEC does not have therefore any effect in the "inter-crop" choice in this case.

140 It is important to underline that in this analysis, the cultivation of sugar beet for conventional use was excluded from the comparisons among gross margins. It was considered in fact that its inclusion among the possible cultivation options would have completely altered the results. The gross margin of this crop is indeed very high if compared with all the other crops included in the analysis, but the actual possibility to cultivate sugar beet for food use is limited by the presence of sugar production quotas. Generally speaking, this is a limit of the break-even price analysis. From a theoretically point of view, the break-even price analysis would take into account the best alternative choice in terms of gross margin. However, for agronomical factors or environmental constraints or whatever reason, some crops cannot be grown on all the areas. This implies that the theoretical best alternative might be different from the actual best alternative, whose definition has to take into account the aforementioned constraints and factors.

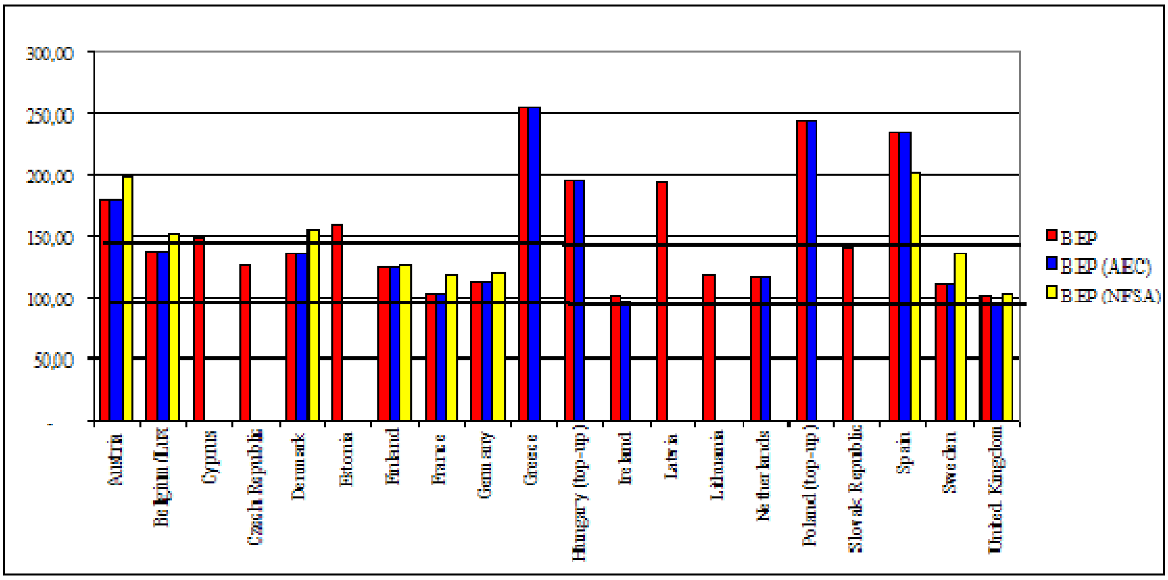
As regards **energy sunflower**, it results not to be competitive with respect to the best alternative crop in most Member States, even with the support of the AEC or under the NFSA regime. Under the NFSA regime, the difference between the actual price and the level of the BEP is quite relevant (except for France), although this crop represents in some cases a quite important percentage of the total energy area (in particular in Italy and Spain).

Figure 11.4 - BEP analysis: sunflower



Source: DEIAGRA elaborations on Graham Brookes, "European arable crop profit margins" (2004/05). Values in euros.

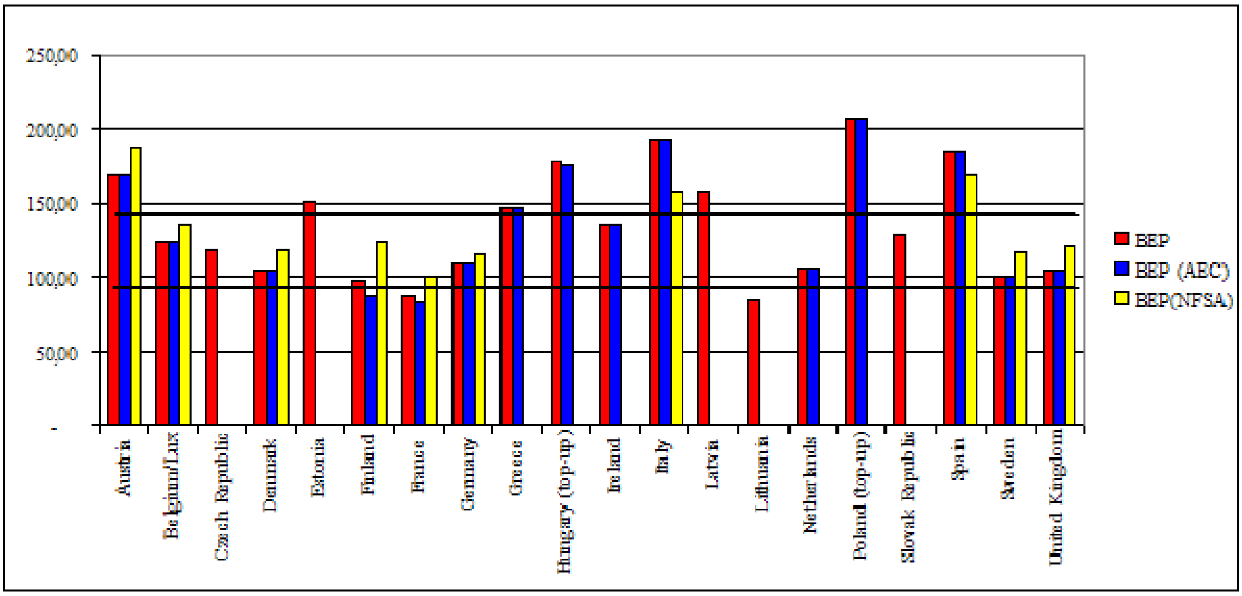
Figure 11.5 - BEP analysis: barley



Source: DEIAGRA elaborations on Graham Brookes, "European arable crop profit margins" (2004/05) . Values in euros.

In almost all the Member States considered, **energy barley** is not competitive in most Member States with respect to the best alternative crop if the lowest price level is considered. However in the United Kingdom, Ireland, France, Germany, Finland and Sweden it rapidly becomes competitive as soon as slightly higher prices are considered. The NFSA regime has an important influence on the competitiveness of the crop in Spain - where it represents a quite important portion of the total energy area (53%) - and also in the United Kingdom, Germany, France, Finland and Sweden.

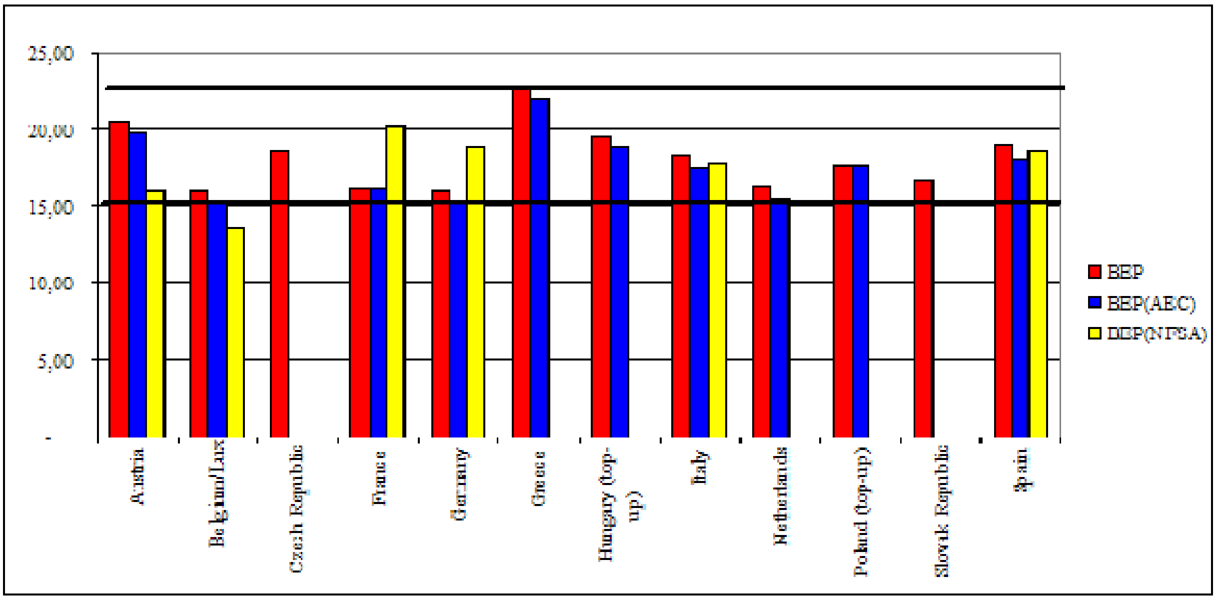
Figure 11.6 - BEP analysis: soft wheat



Source: DEIAGRA elaborations on Graham Brookes, "European arable crop profit margins" (2004/05) . Values in euros.

Energy soft wheat is competitive with respect to the best alternative crop in France, Finland and Sweden (where it accounts for about the 27% of the total energy area). In some cases, the AEC improves the competitive position of soft wheat (see for example the case of Finland and France).

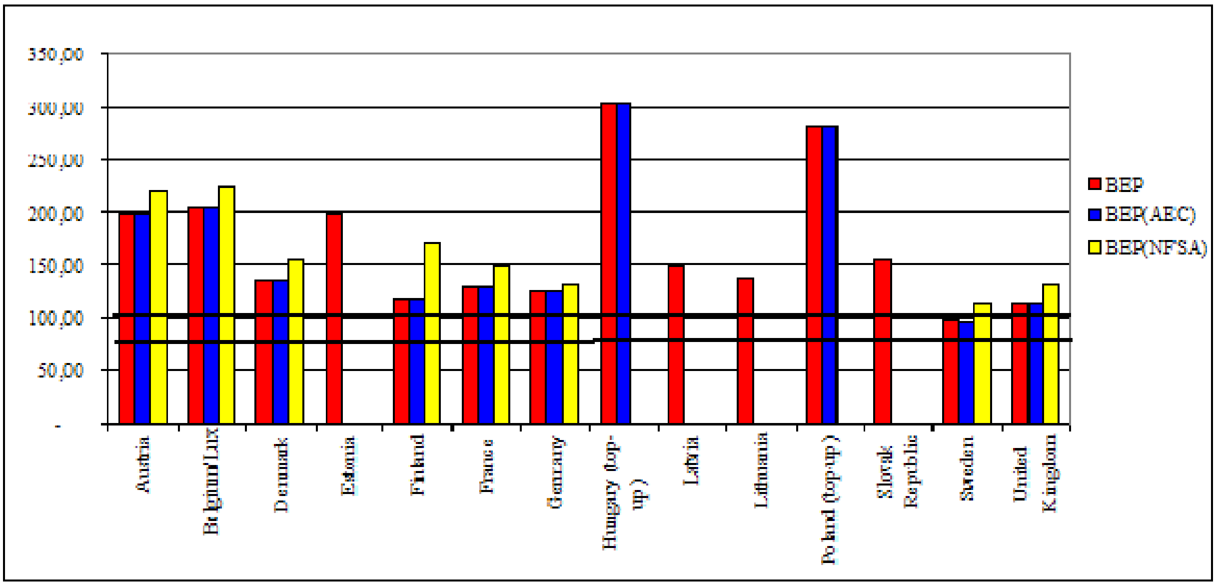
Figure 11.7 - BEP analysis: maize



Source: DEIAGRA elaborations on Graham Brookes, "European arable crop profit margins" (2004/05) . Values in euros.

In Belgium, Italy and Spain, **energy maize** is on average competitive with respect to the best alternative crop. In Italy, it represents about 43% of the total energy area. In the Netherlands, Austria and Germany it becomes competitive only with the support granted by the AEC. In Austria, in particular, the AEC has a positive impact on the competitiveness of maize, which represents about 36% of the total energy area. The role of the NFSA regime in making energy maize competitive is particularly relevant in Italy, Spain, Austria and Belgium.

Figure 11.8 - BEP analysis: rye



Source: DEIAGRA elaborations on Graham Brookes, "European arable crop profit margins" (2004/05) . Values in euros.

Rye is relevant for energy use only in Germany, where it represents about the 7% of the total energy area. Indeed according to the competitiveness analysis, in almost all the Member States considered energy rye is not competitive with respect to the best alternative crop (in Sweden it becomes competitive only with the support granted by the AEC).

11.1.2.1.2 The post-decoupling context

The BEP analysis in the post – decoupling context is developed here from a theoretical standpoint, highlighting the main differences of this new framework in comparison with pre-decoupling[141].

As regards the *intra-crop choice*, no differences exist with respect to the situation mentioned for the pre-decoupling. Also in this case in fact, the AEC has the effect to lower the break even price, i.e. the minimum level of price over which the farmer switches from the conventional to the energy use of the crop.

As for the *inter-crop choice*, the three different situations which applied in the case of the pre-decoupling context, are still valid, and precisely: *a)* cultivation on non-set aside land without AEC, *b)* cultivation on non-set aside land with AEC and *c)* cultivation on set aside land.

In the first two situations, i.e. on **non-set aside land**, the only difference in comparison to the pre-decoupling context, is constituted by the absence of the AP (and the presence of the SPS, which is not dependent from the type of crop). In this situation, in comparison with the previous context, we can observe an improvement of the competitiveness (reduction of the BEP) of those crops which, in the pre-decoupling context, had a level of the AP lower than the alternatives (this difference does not exist any more in absence of the AP).

Moreover, in the post-decoupling context, the competitiveness of those crops which - in the pre-decoupling context - were not eligible to AP, results to be improved, since also in this case the difference in competitiveness which was due to the AP does not exist any more.

Finally, as far as the partially coupled support for arable crops is concerned, it still plays a role in influencing the relative competitive position of the eligible crops, even though to an extent lower than that of the pre-decoupling context. Crops which are not eligible for the partially coupled support continue nevertheless to suffer of a disadvantage position in comparison to the eligible ones.

[141] See paragraph 11.1.1.2 for an analysis of the profitability of energy crops at farm level and for an investigation of the farmers' cultivation choices in the post-decoupling context.

Finally, in the case of cultivation on **set aside land**, no substantial differences exist in comparison with the pre-decoupling context.

11.1.2.2 The international competitiveness

The objective is here to make an assessment of the international competitiveness of the EU energy crops towards the most relevant third countries.

Box 11.2 – Brief description of general methodology

For each Member State which is a relevant importer of energy crops from third countries, the first trade partner in terms of volume has been defined.

On the basis of Eurostat data (COMEXT database - average data 2003-05), the main importing Member States have been identified for each product, as well as the most important non-EU exporters selling biomass to them. Results from this analysis are summed up in Figure 11.9, where also an analysis of prices is presented.

Given a defined Member State, a defined crop import quantity from the partner, and the corresponding import value[142], the implicit import price of the crop from that country is defined. Such implicit import price has then been compared to the domestic price of the same energy crop in the importing Member State [143], assuming that the price differential between the energy and the conventional crop is equal to zero.

Given the internal price and the implicit importing price, if the ratio between the internal and the implicit importing price is > 1, then the importing Member State would result not competitive for that crop compared to the exporter, whereas if this ratio is < 1, the importing Member State would be more competitive for that crop than the exporter.

Figure 11.9 illustrates the results of the analysis of international competitiveness, based on internal and implicit import prices. The weakest competitive positions concern barley, rye and maize.

Specifically, internal price of barley in Cyprus and Greece is not competitive compared to the importing price from Syria, Ukraine, Russia (for Cyprus) and Ukraine, Bulgaria and Russia (for Greece).

Spain results not to be competitive as far as barley and maize are concerned. In particular, barley in Spain is not competitive compared to the barley imported from Turkey (24% of the total barley quantity imported by Spain). Maize in Spain is not competitive compared to the maize imported from Ukraine (7% of the total maize quantity imported by Spain). Rye in Germany is not competitive compared to the rye imported from Russia (20% of the total rye quantity imported by Germany).

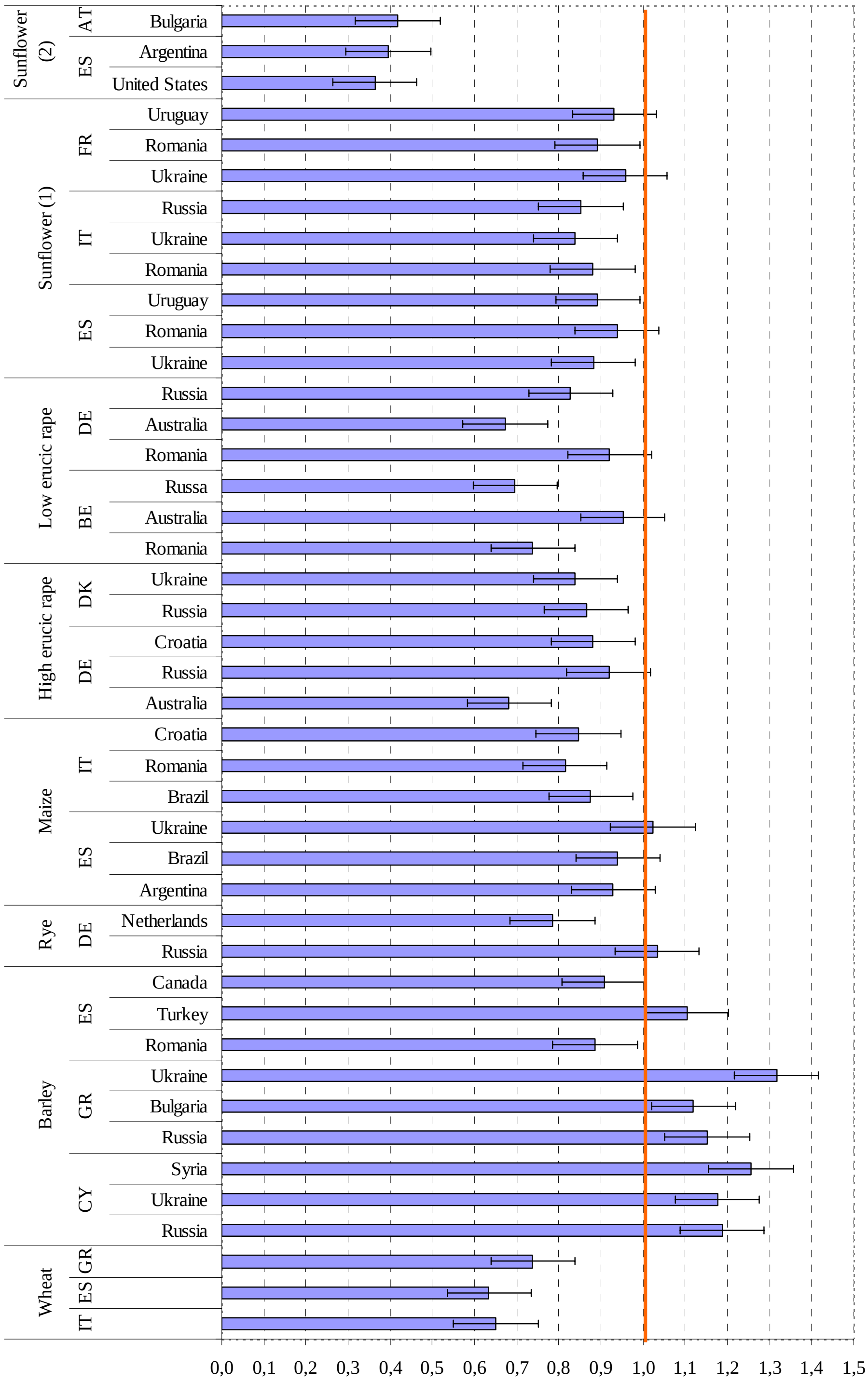
As regards the cases where the internal energy crop price is 10% higher than the conventional crop price, some potentially weak competitive positions emerge[144]. For example, the competitive position of sunflower[145] in France is potentially menaced by sunflower imported from Uruguay and Ukraine, whereas the competitive position of sunflower in Spain is potentially menaced by sunflower imported from Romania.

As far as rapeseed is concerned, the competitive position of rapeseed in Germany results to be potentially menaced by rapeseed imported from Romania[146] and Russia[147], whereas the competitive position of rapeseed in Belgium is potentially menaced by rapeseed imported from Australia.

As far as maize is concerned, the competitive position of maize in Spain is potentially menaced not only by maize imported from Ukraine, but also by maize imported from Brazil and Argentina. The competitive position of rye in Germany is potentially menaced by rye imported from Russia.

[142] Eurostat data 2005.
[143] Following Eurostat data (2005), the statistical value, which is used for the trade data, is the value calculated at national frontiers. It is a FOB value (free on board), for exports and dispatches, or CIF (cost, insurance, freight) for imports and arrivals.
[144] Given a variation of plus/minus 10% for the energy crop price compared to the conventional crop price, we define a tolerance interval of 0,1 for the ratio, in order to identify not only the weak/strong competitive positions, but also the potentially weak/strong competitive positions. In the cases we refer to, the ratio is higher at least by 0,1.
[145] Whether or not broken.
[146] Low erucic rape.
[147] High erucic rape.

Figure 11.9 - The international competitiveness: a comparative analysis



(1) whether or not broken, (2) whether or not shelled

Source: DEIAGRA elaboration on Eurostat data (2005) and Brookes (2005).

11.1.3 Main findings of the assessment of profitability and competitiveness of energy crops

Referring to the **pre-decoupling context**, in the case of **non set-aside land without AEC**, the only competitiveness factor is the **market price** of the crop, together with the AP in those cases where the AP is differentiated from one crop to another. Thus the energy crop is competitive if and only if it is characterized by the highest price (compared to both conventional and energy alternatives).

In the case of **non set aside land with AEC**, the AEC **favours the switching** from the conventional to the energy use of a crop, **but does not assure that the energy crop is the most profitable alternative for the grower**, within the whole set of choices. In fact, there could be other (conventional) crops, which are more profitable. Furthermore, as the AEC does not differentiate among different energy crops, its introduction does not change the relative competitive position of each energy crop compared to the situation of absence of AEC.

As regards **set-aside land**, firstly the possibility to cultivate crops on set aside land allows to save the cost of land maintenance, which therefore represents a positive component of the gross margin of the crop. Secondly, the reduction of the range of cultivation alternatives, reduces the opportunity cost for the grower. These two elements constitute the "implicit subsidy", inherent to the possibility to grow non food crops on set-aside land, which constitutes an important component of the gross margin and thus influences the grower's choice.

In the context of **post-decoupling** the AP does not exist any more in the case of full decoupling and the grower benefits from the SPS independently from the types of crops he/she chooses, and even in absence of any cultivation. In the case of partially decoupling, the cultivation choice of the grower depends also on the relative importance of the amount of the partially coupled support for each type of crop.

As far as the **levels of gross margins** are concerned, generally speaking, and referring to the pre-decoupling context, quite high levels of margins characterise the main crops (soft wheat, barley, rapeseed and maize, both for energy and conventional use) in Germany, France, United Kingdom and Denmark, where indeed high levels of production are registered for almost all these crops. In these countries, rapeseed, maize and soft wheat are always characterised by margins between around 400 and 700 euros/ha, and the AEC always represents from 7% to maximum 10% of the gross margin.

The situation is rather different in other Member States, such as Spain, Austria, Italy, Poland and Czech Republic, where – with the exception of maize in Austria and Italy - margins are normally lower, and the incidence of AEC is more important (from 15 to 26% of the total gross margin).

As regards the main findings emerging from the **analysis of internal competitiveness** (break even price analysis), they show that the support granted by the AEC generally implies a reduction in the level of BEP, through an increase of the extra-market revenues for the farmer. Consequently it determines an increase in the competitiveness of the energy crops within the farmer's set of choices[148]. Nevertheless, this contribution results to be very limited in most cases, a situation which is also confirmed by the results coming from the analysis of margins (the contribution of AEC to the competitiveness of the crop through its influence on the gross margin is in most cases lower than 10% of the gross margin itself).

In the case of the NFSA regime, the improvement of the competitiveness of a crop depends on the relative importance of factors which act simultaneously on the formation of the gross margin: variable production costs, yields and price.

In the post-decoupling context, in the case of full decoupling the absence of the AP has in some cases modified the level of the break even price; specifically, if the AP were differentiated by type of crop, their absence might favour the competitiveness of the crops which featured the lowest levels of the AP. Such an outcome is less evident in the case of partially coupled support for arable crops.

Finally, the **analysis of the international competitiveness** has highlighted the favourable competitive position of some Member States for certain crops (e.g. Germany for rapeseed, Italy for maize and sunflower), whereas other Member States result not to be competitive (Greece and Spain for barley,

[148] The only cases where the decrease of BEP thanks to the granting of the AEC does not occur are the ones where the best alternative is represented by an energy crop. See § 11.1.2.1.1 for details.

Germany for rye, etc) and some others are potentially menaced by imported energy crops. The level of international competitiveness is likely to affect the level of imports.

Moreover, it was found that the supporting measures (AEC and the NFSA regime), which have an impact on the profitability and competitiveness of the energy crops, are likely to have an important role also in determining their international competitiveness.

11.2 Cost and profitability of bio-energy

This section focuses on cost and profitability of bio-energy obtained from energy crops and agricultural residues as well as on comparing the aforementioned costs with those of other RES and non-RES. In the case of bio-fuels, these analyses and comparisons are carried out both at EU and at international level. Differently, the analysis is limited to the EU level in the case of electricity and heat, due to their nature of network commodities, for which exchanges with third countries are scarce and limited to neighbouring states.

The method used for the cost and profitability analysis is the following. The full cost is calculated for each examined technology. The full cost is defined here as **the level of remuneration that covers both variable and fixed costs given an investment cost, a lifetime, and a given discount rate**[149].

Profitability is then assessed by comparing the **calculated full production costs** with **energy prices** both in case **support schemes** are in place and in case of **absence of any support**. The energy prices used in this section are those reported in chapter 10.

Similar to the previous sections, the analysis is carried out by separately considering the three energy use sectors, namely electricity, heat and transport.

11.2.1 Electricity

Biomass[150] sources can be converted into electricity following three different routes.

First, solid biomass may **be directly burnt**: combustion may take place in dedicated plants or in plants where other fuels are also burnt, with co-firing with fossil fuels being also an option. Besides electricity, heat can also be produced through direct burning.

Second, **thermo-chemical conversion** processes at high temperature may take place, such as gasification and pyrolysis, which convert solid biomass into gaseous or liquid fuel. Besides use in the electricity sector, these fuels may be also used in the heating and transport sectors. As far as energy crops and agricultural residues are concerned, gasification and pyrolysis are still only developed at experimental level, while they are more frequently used for producing energy from coal and wood.

Third, electricity may be obtained from **bio-chemical processes** such as anaerobic digestion, which take place at lower temperatures than in the previous case. Again, this process' output (bio-gas) may also be used in the heating sector.

In this section a profitability analysis is carried out concerning electricity generation from bio-energy sources that originate from energy crops and agricultural residues. In particular, the focus is on solid biomass obtained from two different energy crops – miscanthus and reed canary grass – and an agricultural residue – straw –, as well as on bio-gas obtained from silage maize[151].

To this end, the following combinations of technologies and feedstock are examined:

- Bubbling Fluidised Bed Combustor (BFBC) plant fuelled with either miscanthus, reed canary grass or straw.
- Farm bio-gas plant where co-digestion of slurry and manure (70%) with silage maize (30%) provides bio-gas for electricity.

These technologies and processes – in combination with the selected feedstock – were selected on the basis of existing literature[152] as well as on the findings of the case studies carried out for the study. With reference to the combustion technology chosen, a fluidised bed combustor(FBC) represents an established technology that provides high fuel flexibility (EUBIA website 2006)[153]. As to co-digestion for bio-gas

[149] See annex F where a more detailed description of the full cost model is presented.
[150] Biomass is here referred to in broad terms (see glossary). However, it is worth noting again that this work only focuses on energy crops and agricultural residues.
[151] These are the feedstocks for which applications exist in the EU (e.g. reed canary grass in Finland and straw in the UK) and/or studies have been carried out and are present in the literature (see for instance JRC IES 2005).
[152] See for example Platts, *Power in Europe*, Issue 473, April 10, 2006, and Walla and Schneeberger (2003).
[153] Fluidised bed combustors are furnaces where the fuel is placed and burnt in a hot bed of granular material such as sand. Two types of FBC are currently available, namely bubbling (or stationary) fluidised bed combustors (BFBC) – which have been selected for this analysis – and circulating fluidised bed combustors (CFBC).

production, this is a more likely option as opposed to digestion of maize silage only, thanks to the availability and the low cost of animal slurry and manure (see Walla and Schneeberger 2003).

The main assumptions concerning the technical and economic parameters of the investigated technologies are reported in table 11.3 below.

Table 11.3– Assumptions concerning the selected technologies

	BFBC	Biogas plant
Investment costs (euro/kW)	2550	3515
Lifetime (years)	15	15
Discount rate (pre-tax)	0.07	0.07
Load factor* (%)	80	80
O&M costs (euro/kW/year)**	60	70
efficiency (%)	30	29

*The load factor is referred to as the number of hours a plant works at full capacity (see annex F)

**O&M costs generally include expenses for labour and administration, maintenance and energy. They are assumed to be 100% fixed costs in this study.

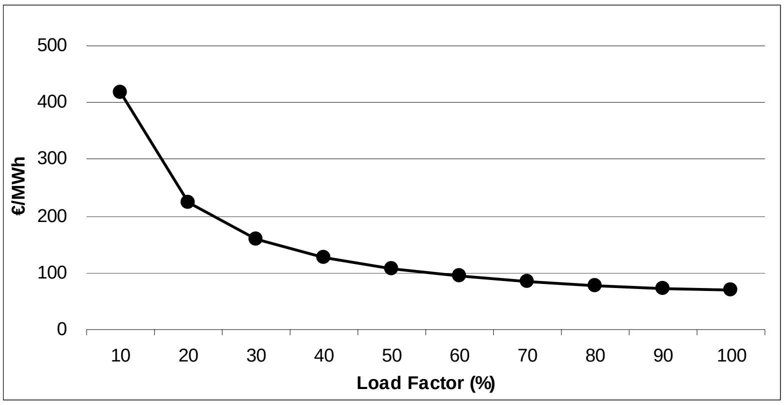
The above parameters are used together with fuel costs for estimating the full cost of electricity generated from the selected combinations technology/feedstock, which are then compared with the estimated full cost of electricity generated from wood-based bio-energy, from alternative RES, waste and fossil fuels. Data concerning production costs for these sources were gathered from existing literature too, as well as taken from REF's forecasting model "El-fo"[154].

11.2.1.1 Full cost analysis

Before illustrating the results of cost comparisons, it is worth noting that assumptions concerning the load factor are of critical importance for the results of the analysis. The load factor both depends on technical elements - such as the hours of planned maintenance needed to correctly run the plant and the probability of unplanned outages – and on economic aspects – such as fuel availability. With reference to the energy sources on which this work focuses (energy crops and agricultural residues) we assume full availability of the selected types of feedstock (miscanhtus, reed canary grass, straw and maize silage) and about 1.800 hour/year of maintenance and unplanned outages, resulting in a load factor of 80%.

Figure 11.10 illustrates the variability of the full cost of electricity as a consequence of variations in the load factor, in the case of a BFBC plant fuelled with straw.

Figure 11.10 - Full cost variability according to the load factor



Another critical variable for the profitability analysis of bio-energy fuelled power plants is the variable cost of the fuel[155]. Once the plant's efficiency has been taken into account, the variable cost of the fuel represents by far the largest share of the plant's variable costs. Fuel costs were selected here based on the main findings of the first part of the market analysis and of the case studies carried out for this study.

[154] "El-fo" is an electricity dispatching model developed by REF which is used to forecast market structure trends (including costs, prices, market shares, etc.), based on a comprehensive database of Italian thermo-electrical power plants. See also Platt's *Power in Europe* no. 473/2006 and Walla and Schneeberger (2003) for production costs.

[155] The word "fuel" is here referred to as the input to the transformation process for electricity generation, therefore including solid biomass inputs, and in particular those analysed in this study.

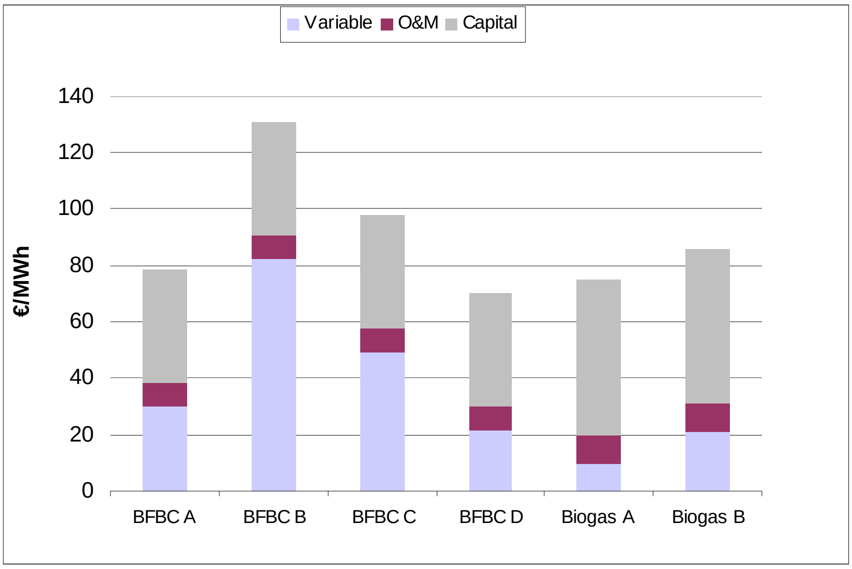
In the case of straw, the available data sources show a large variability of prices across Europe, so that the minimum and the maximum price were selected with the aim of providing a range of the full costs of electricity generated from this source of biomass in the EU. The same has been done for silage maize with reference to on-farm bio-gas plants. Assumptions concerning fuel costs are presented in table 11.4, together with the associated combinations technology/feedstock[156].

Table 11.4 – Analysed technologies, inputs and prices

Code	Description
BFBC A	BFBC plant; minimum straw price (43.5 €/t)
BFBC B	BFBC plant; maximum straw price (120 €/t)
BFBC C	BFBC plant; miscanthus (73.12 €/t)
BFBC D	BFBC plant; reed canary grass (31.9 €/t)
Biogas A	Biogas plant; minimum maize silage price (15.5 €/t)
Biogas B	Biogas plant; maximum maize silage price (33 €/t)
BFBC E	BFBC plant; wood (12.33 €/MWh)
Gasification	Gasification plant; wood (12.33 €/MWh)
Wind A	Wind on-shore
Wind B	Wind off-shore
PV	Photovoltaic
BFBC waste	BFBC plant; waste
CCGT	Combined-cycle gas turbine; natural gas
PF coal	Pulverised fuel; coal

Cost comparisons showed in figures 11.11-11.13 provide separate indication of variable costs, and of operation and maintenance (O&M) and capital costs (both fixed costs)[157].

Figure 11.11 - Full cost of electricity from agricultural biomass



Source: DEIAgra estimates

Due to the low cost of fuel, electricity generated from direct burning of reed canary grass (BFBC D in the figure) appears to be the cheapest option among those considered (see figure 11.11). In general, the combustion in the BFBC plants brings about lower capital costs – due to lower investment costs than in the case of digestion in a bio-gas plant – therefore making full costs rather sensitive to feedstock prices. Besides high capital costs, in the case of digestion in a bio-gas plant the low share of full cost covered by feedstock (variable) costs may be explained by the assumption of co-digestion of silage maize with animal

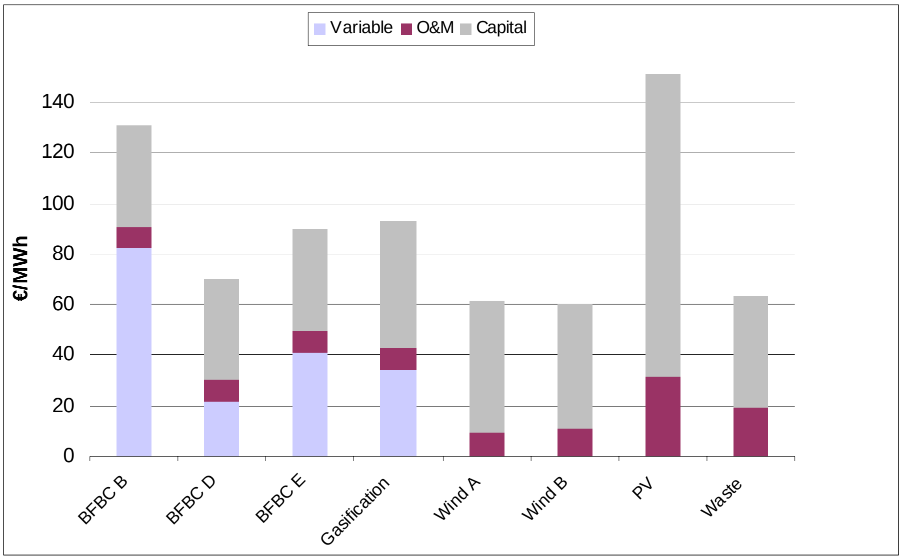
[156] Further details on the aforementioned assumptions are provided in annex G, together with those concerning electricity generated from the direct burning and gasification of wood, as well as other RES and fossil fuels.
[157] In fact, O&M costs of power plants usually have both fixed and variable components, the former mainly consisting of plant operating labor, and the latter being mainly made up of replacement and repair of system components and the use of consumables (e.g. water). However, for the sake of simplicity O&M costs are considered as fixed costs in this analysis, since variable O&M costs only account for a low share of total O&M costs (see for instance Synapse Energy Economics, 2004, and Ciemat, 2005).

slurry and manure, since the latter input is provided without any cost (it is produced in the farm where the bio-gas plant operates).

The minimum and maximum full costs estimated and reported in figure 11.11 are then selected in order to define a cost range for electricity produced from the energy crops and agricultural residues considered in this analysis. The minimum cost selected is that of BFBC direct burning of reed canary grass (BFBC D), while the maximum cost selected is that of BFBC direct burning of straw, assuming the maximum straw price (120 €/t). The defined range is compared with the full costs of electricity from woody bio-energy sources, other RES and waste (Figure 11.12).

Electricity generation from energy crops and agricultural residues is in all cases more expensive than electricity from wind, which represents the cheapest option despite its high investment costs. However, if the cheapest feedstock is chosen, the gap between electricity from agricultural biomass and cheaper alternatives narrows. With reference to other biomass sources than those on which this study focuses, e.g. wood, this does not seem to be the cheapest option neither in the case of direct burning in a BFBC plant nor in the more expensive gasification plant.

Figure 11.12 - Full cost of electricity generated from the selected crops vs other RES

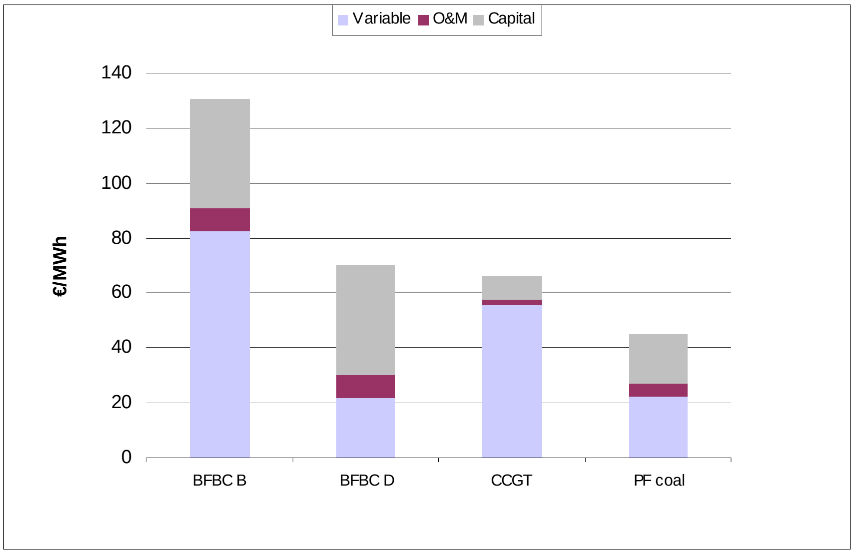


Source: DEIAgra estimates

As a last exercise, the identified cost range BFBC D – BFBC B is compared to the full costs of power generation from fossil fuels (see figure 11.13).

Fossil fuel-based electricity generation is still the least expensive option, but the cheapest crops might become competitive in case of increases in natural gas prices. In addition, it must be noted that the CO_2 costs are not considered in estimating the full costs concerning fossil fuels. This kind of analysis will be carried out in chapter 12.

Figure 11.13 - Full cost of electricity generated from the selected crops vs fossil fuels

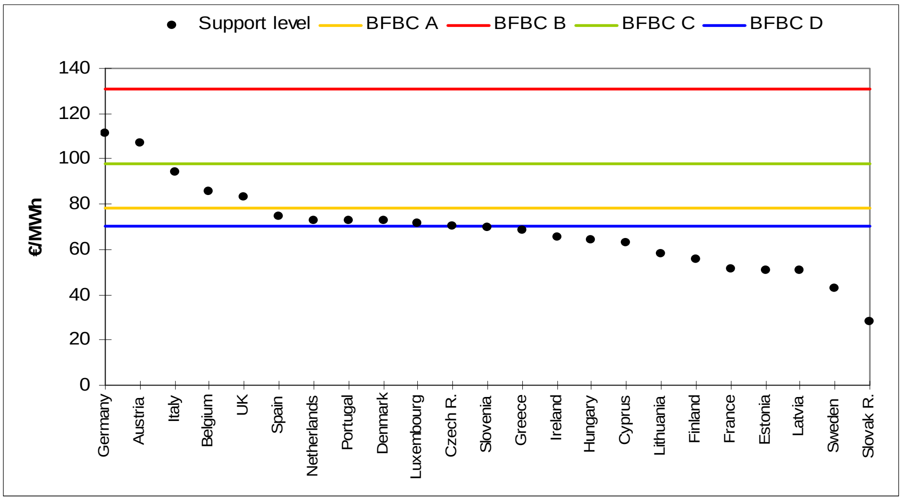


Source: DEIAgra estimates

11.2.1.2 Profitability analysis

The analysis has been carried out by comparing the full costs estimated through our model and reported in figure 11.11 with electricity wholesale prices and support levels for electricity produced from bio-energy sources. Comparisons with wholesale electricity prices showed that these are in all cases much lower than the estimated full costs. Therefore, in figure 11.14 and figure 11.15 we showed support levels only[158]. Results are presented through two different charts since support levels for direct burning of solid biomass and for bio-gas differ. The support levels are represented in the two figures through dotted lines, while estimated full costs regarding the sources of biomass investigated are represented through horizontal lines.

Figure 11.14 - Full costs of the selected combinations vs support levels - solid biomass

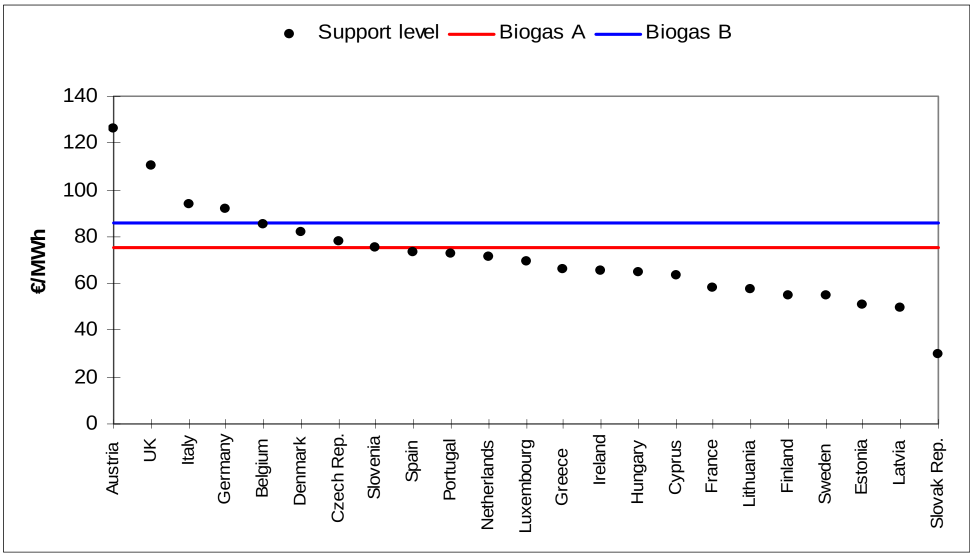


Source: DEIAgra estimates

Figure 11.14 shows that direct burning of reed canary grass in a BFBC plant represents a competitive option in a significant number of Member States. Similar results are obtained for the option BFBC A, although support levels in some Member States seem to be slightly insufficient in this case. Finally, direct burning of miscanthus (BFBC C) is competitive in two Member States, namely Germany and Austria.

158 Support levels are taken from chapter 10.

Figure 11.15 - Full costs of the selected combinations vs support levels – bio-gas



Source: DEIAgra estimates

With reference to bio-gas, Figure 11.14 shows that only four Member States, namely Austria, the United Kingdom, Italy and Germany, grant a support level which is sufficient for making electricity from agricultural bio-gas competitive, if the maximum silage maize price is assumed. Not surprisingly, all these Member States are major bio-gas producers, with the exception of Austria, which is nevertheless an important player (see chapter 8.3). The number of Member States where support is sufficient for granting the profitability of agricultural bio-gas production increases to eight in the case of minimum silage maize price. Once again a certain correspondence with production data may be observed (see chapter 8.3). Two Member States where support levels appear to be rather low, namely France and Sweden, feature significant output levels. In the case of Sweden low support may be attributed to low wholesale electricity prices, which determine the level of support together with the price of green certificates.

11.2.1.3 Potential developments

An increase in the number of installations – especially dedicated ones – which process energy crops and agricultural residues into electricity could bring about considerable learning economies and hence reductions in processing costs (especially in investment and O&M costs).

In addition, the development of location studies could help in guaranteeing an adequate availability of feedstock in proximity of power plants, therefore allowing for an increase in plant load factors and hence for a reduction of full costs.

11.2.2 Heating

Biomass-based heat generation[159] is carried out through the same processes as for electricity, i.e. direct burning, gasification and anaerobic digestion.

In this section a profitability analysis is carried out concerning heat generation from energy crops and agricultural residues, focusing on the following technologies and types of feedstock:

- Boiler fuelled with either miscanthus, reed canary grass or straw.
- Gasifier which converts the above inputs in heat.

These technologies and types of feedstock were selected on the basis of the studied literature[160] as well as of the findings of the case studies carried out for the study. In particular, a boiler represents a typical appliance for heat generation, while gasification can represent an interesting option for biomass-based heat generation, although commercial implementation is still problematic (EUBIA website 2006).

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[159] Biomass is here referred to in broad terms (see glossary). However, it is worth noting again that this work only focuses on energy crops and agricultural residues.

[160]See for instance Riva (2004) and Ambiente Italia (2003).

The main assumptions concerning the technical and economic parameters of the investigated technologies are reported in table 11.5.

Table 11.5– Assumptions concerning the selected technologies

	Boiler	Gasifier
Investment costs (euro/kW)	210	930
Lifetime (years)	14	20
Discount rate (pre-tax)	0.07	0.07
Load factor (%)	0.17	0.23
O&M costs (euro/kW/year)	17	17
efficiency (%)	0.85	0.8

The above parameters are used together with fuel costs for estimating the full cost of heat generated from the selected combinations technology/feedstock, which are then compared with the estimated full cost of heat produced from pellets and natural gas. Data concerning production costs for these sources were gathered from existing literature too[161], as well as taken from REF's forecasting model "El-fo".

11.2.2.1 Full cost analysis

Cost comparisons are showed in figure 11.16 and 11.17 which provide separate representation of variable costs, and operation and maintenance (O&M) and capital costs (both fixed costs)[162]. Fuel costs are the same used for electricity, therefore referring to the main findings of the first part of the market analysis and of the case studies carried out for the study.

Assumptions concerning fuel costs are presented in table 11.6, together with the associated combinations technology/feedstock[163].

Table 11.6 – Analysed technologies, inputs and prices

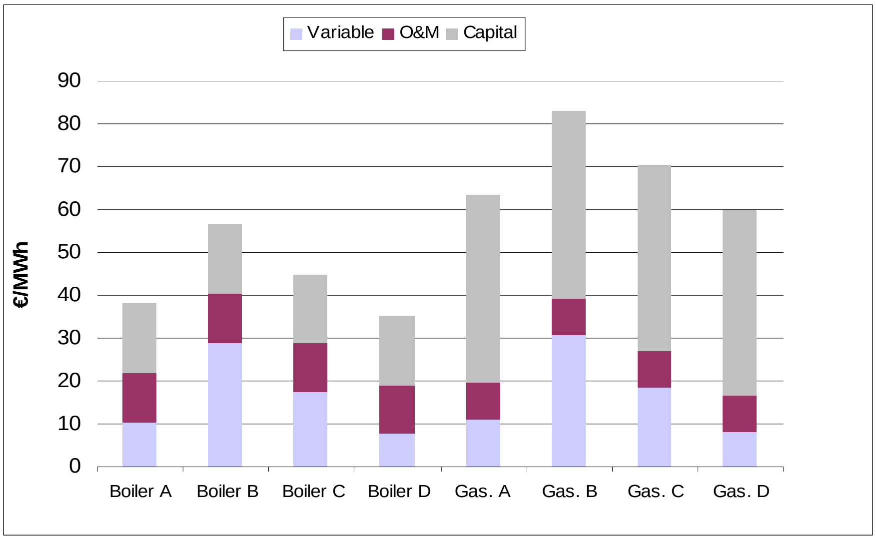
Code	Description
Boiler A	Boiler; minimum straw price (43.5 €/t)
Boiler B	Boiler; maximum straw price (120 €/t)
Boiler C	Boiler; miscanthus (73.12 €/t)
Boiler D	Boiler; reed canary grass (31.9 €/t)
Boiler E	Boiler; pellet (175 €/t)
Boiler F	Boiler; natural gas (27.8 €/MWh)
Gas. A	Gasifier plant; minimum straw price (43.5 €/t)
Gas. B	Gasifier plant; maximum straw price (120 €/t)
Gas. C	Gasifier plant; miscanthus (73.12 €/t)
Gas. D	Gasifier plant; reed canary grass (31.9 €/t)
Gas. E	Gasifier plant; wood (12.33 €/MWh)

[161] See for instance Riva, 2004, and Ambiente Italia, 2003.

[162] Similar to the case of electricity, O&M costs of heating plants usually have both fixed and variable components, the former mainly consisting of plant operating labor, and the latter being mainly made up of replacement and repair of system components and the use of consumables (e.g. water). However, for the sake of simplicity O&M costs are considered as fixed costs in this analysis, since variable O&M costs only account for a low share of total O&M costs (see for instance Synapse Energy Economics, 2004, and Ciemat, 2005).

[163] Further details concerning the aforementioned assumptions are provided in annex G, together with those concerning heat generated from direct burning of pellets and natural gas, as well as gasification of wood.

Figure 11.16 - Full cost of heat generated from agricultural biomass



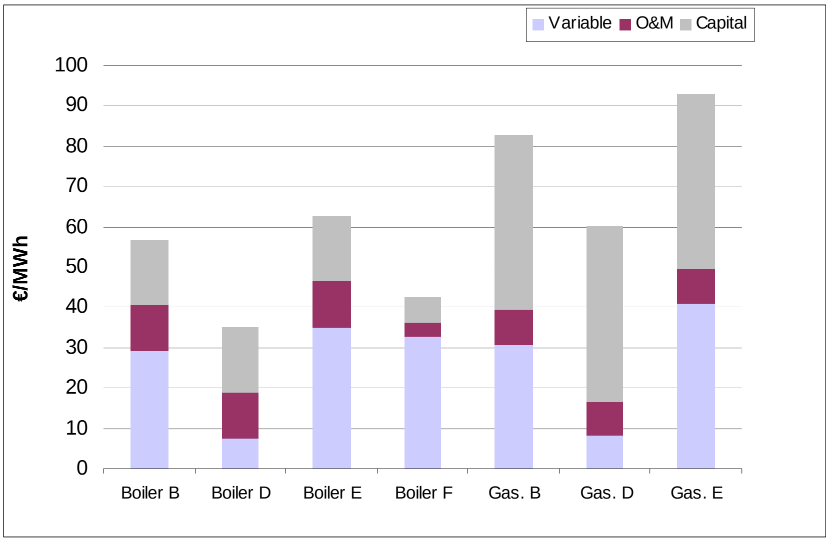
Source: DEIAgra estimates

Figure 11.16 shows that direct burning of the four sources of biomass considered in a boiler is cheaper than gasification. This is also true in the case of maximum feedstock price (column Boiler B). The main reason for such a result is the high investment cost of gasification in the case analysed. Due to the low cost of fuel and the lower investment costs, heat produced from direct burning of reed canary grass appears to be the cheapest option (Boiler D in the figure).

The minimum and maximum full costs estimated and reported in Figure 11.16 for each considered technology were selected in order to define a cost range for heat produced from the four sources of biomass analysed. The minimum costs again concern the use of reed canary grass (Boiler D and Gas. D), while the maximum costs concern the use of straw, assuming the maximum straw price of 120 €/t (Boiler B and Gas. B). The defined range is compared with the full costs of heat from direct burning of pellets and natural gas, as well as wood gasification (figure 11.17).

The cheapest option among those reported in figure 11.17 is direct burning of reed canary grass. This appears to be even cheaper than a natural gas fuelled boiler, whose capital and O&M costs are very low. Clearly, this is due to high natural gas prices. High feedstock prices also bring about higher costs for direct burning of pellets. With reference to gasification, all values in the cost range for agricultural biomass are lower than the full cost of gasifying wood.

Figure 11.17 - Full cost of heat generated from selected crops vs other sources

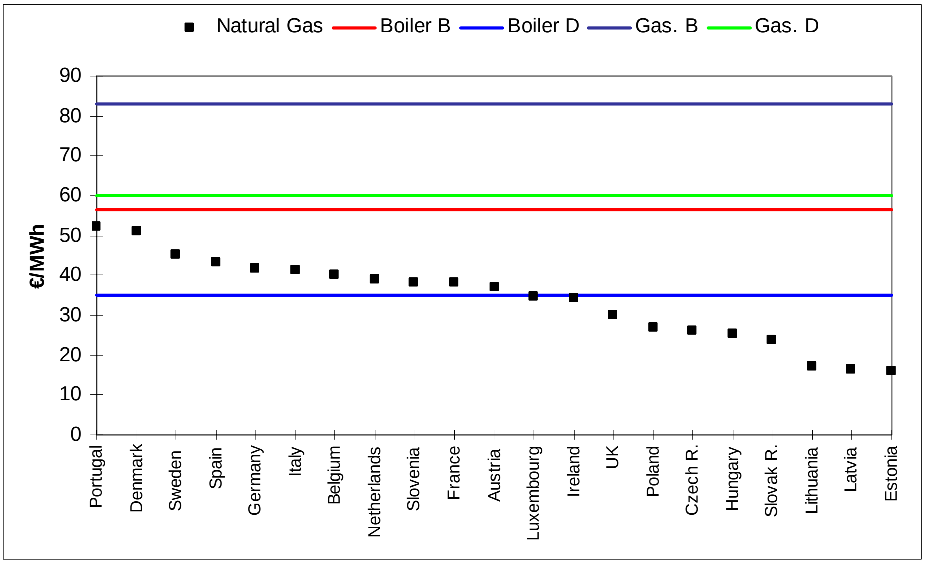


Source: DEIAgra estimates

11.2.2.2 Profitability analysis

The profitability analysis is carried out for the different Member States by comparing the full costs estimated and reported in figure 11.16 and figure 11.17Figure 11.17 with the price of natural gas and diesel oil respectively. Such prices are taken from chapter 10 of this report. Results are shown in the figures 11.18 and 11.19.

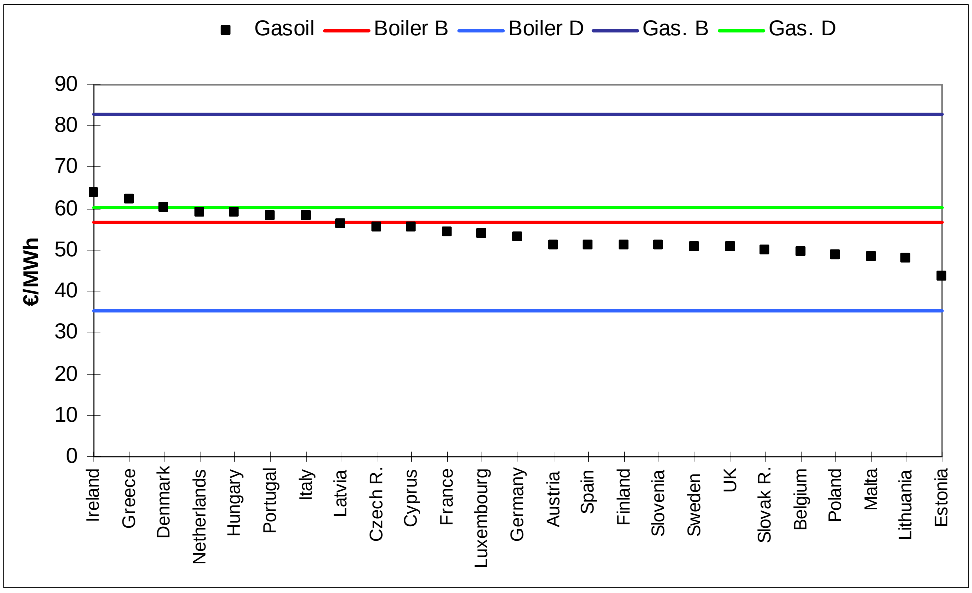
Figure 11.18 - Full costs of the selected combinations vs natural gas prices



Source: DEIAgra estimates

The heat generated from the bio-energy sources considered is not competitive with heat generated from natural gas. This is probably due to the absence of specific support schemes for heat from renewable energy sources. The direct burning of reed canary grass in a boiler seems to represent an exception. In particular, in 13 Member States this option may successfully compete with natural gas.

Figure 11.19 - Full costs of the selected combinations vs diesel oil prices



Source: DEIAgra estimates

Due to higher diesel oil prices, heat generated from direct burning of the four sources of biomass considered seems to be competitive in several Member States. In particular, in the case of minimum feedstock prices the estimated full cost is lower than diesel oil prices in all EU Member States. In addition, in the case of maximum feedstock prices, the full cost is lower than diesel oil prices in seven Member States, and it shows similar values than diesel oil prices in further six Member States.

11.2.2.3 Potential developments

Support schemes for heat produced from RES in general, and bio-energy sources in particular, are likely to be currently in place only in a few Member States, at the national or local level. The introduction of national support schemes as a consequence of EU legislation, similar to those introduced for the electricity sector, may help further development of the use of energy crops and agricultural residues as feedstock in the heating sector.

11.2.3 Transport

In this section the profitability of bio-diesel and bio-ethanol production in the Member States is assessed, and the costs of producing these bio-fuels in the EU are compared with production costs in other major producing countries.

In chapter 11.2.3.1 production costs in the EU are estimated for bio-diesel obtained from rapeseed and sunflower oil, and these are compared with production costs of bio-diesel obtained from soybean oil in the USA. Subsequently, the estimated costs at the EU level are compared with raw material prices for diesel, and with subsidised prices, assuming that full tax exemption is in place. This exercise is aimed at assessing the competitiveness of bio-diesel in the case of absence of support and in the case of support through fuel tax exemption.

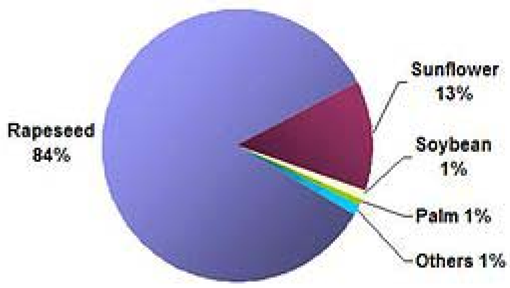
In § 11.2.3.2 production costs in the EU are estimated for bio-ethanol obtained from sugar beet, wheat, barley and straw, and these are compared with production costs of bio-ethanol obtained from sugar cane in Brazil and from corn in the USA. Subsequently, similar to the case of bio-diesel, the estimated costs for the EU are compared with raw material prices of petrol as well as with subsidised prices, assuming that full tax exemption is in place, in order to assess the competitiveness of bio-ethanol in absence of support and where fuel tax exemption is instead granted.

11.2.3.1 Bio-diesel

Bio-diesel is obtained through esterification of vegetable oil extracted from oil crops or waste oils (e.g. used cooking oil), and is generally used as a transport fuel. The vegetable oil extracted from oil crops may also be used as a transport fuel without undergoing the esterification process.

Feedstock for bio-diesel production include rapeseed and sunflower in the EU (figure 11.20) - where most of the world's bio-diesel production takes place (around 90% of world's production) - and soybean oil in the USA, another major producer, although it features much lower production volumes than the EU. By-products of bio-diesel production include straw (which can be used as a source of energy or ploughed in the soil), oil cake – which may be used as cattle feed – and crude glycerine, which is used for example in the cosmetics sector.

Figure 11.20 – Types of feedstock for bio-diesel production in the EU



Source: EUBIA website (accessed June 2006)

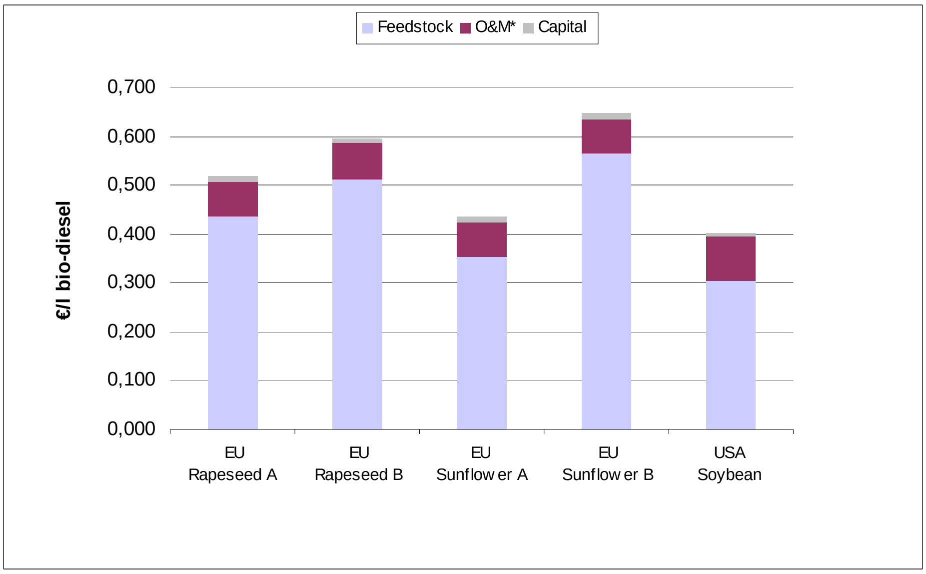
Data about bio-diesel production costs in the EU and in the USA are shown in figure 11.21. These data were gathered from the studied literature, mainly from a study of the Joint Research Centre (JRC) of the

European Commission (IPTS 2002a)[164]. Capital costs are estimated in the JRC study on the basis of the assumption of investment costs of 100,000 €/1000 t/year, of a 10% discount rate and of a plant life time of 15 years. Besides capital costs, other fixed costs include O&M costs and income from the sale of by-products[165]. Conversely, feedstock price constitutes the variable cost of bio-diesel production. Feedstock prices were selected from the case studies carried out for the study. In the case of both rapeseed and sunflower seeds, there seems to be significant price variability in the EU. Thus, a minimum and a maximum price have been selected and used in the analysis[166]. The investigated options, including feedstock and feedstock prices, are illustrated in table 11.7.

Table 11.7 – The investigated options

Code	Description
EU Rapeseed A	EU - Bio-diesel from rapeseed - price 195 €/t
EU Rapeseed B	EU - Bio-diesel from rapeseed - price 230 €/t
EU Sunflower A	EU - Bio-diesel from sunflower - price 160 €/t
EU Sunflower B	EU - Bio-diesel from sunflower - price 257 €/t
USA Soybean	USA - Bio-diesel from soybean

Figure 11.21 - Full cost of bio-diesel production in the EU



*Includes revenues from the sale of by-products.
Source: DEIAgra estimates on data from IPTS (2002a) and Informa Economics (2006)

The cost analysis shows that a major share of the full cost for bio-diesel is made up of feedstock costs. In all cases such costs account for more than 80% of the full cost, meaning that the analysis' results are strongly influenced by assumptions on prices. In addition, the major weight of feedstock costs implies that incremental improvement in existing technologies leading to a decrease in fixed costs could only influence the full cost of production to a limited extent[167].

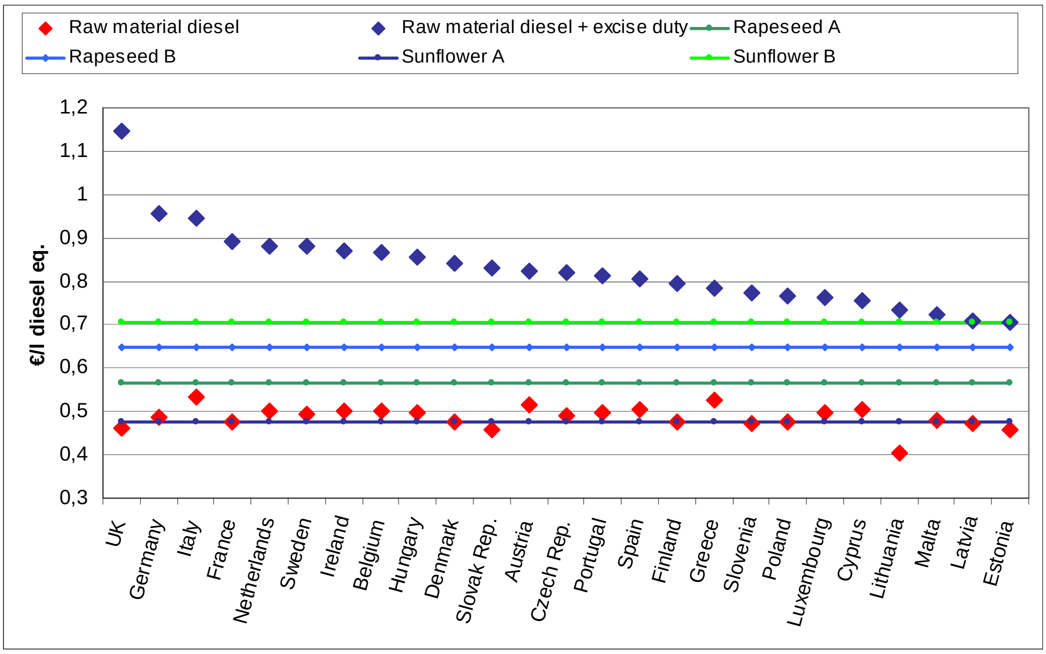
A further remark may be done concerning the fact that a large increase in bio-diesel production across the EU is likely to bring about a decrease in by-product prices, with subsequent decrease of the associated revenues[168](OECD 2005).

[164] Other data sources include the European Biomass Industry Association (EUBIA website accessed June 2006), a study by the OECD (2005) and one by Informa Economics (2006).
[165] It is worth noting again that O&M costs include expenses for labour and administration, maintenance, energy and chemicals. They are assumed to be 100% fixed in this study. By-products include oil cake and glycerine. Income from the sale of by-products is considered from now on a fixes negative component of the production cost.
[166] See also annex G
[167] Since bio-diesel production technologies are rather mature, radical cost improvements cannot be expected (see also IEA 2004).
[168] These revenues currently represent more than 10% of the full cost (see Annex G).

As far as the EU/USA comparison is concerned, US costs seem to be significantly lower than costs in the EU, although it must be noted that the comparison is carried out among production costs of bio-diesel obtained from different feedstocks.

The estimated full costs for bio-diesel production in the EU have then been compared with the costs of the competing fuel, i.e. conventional diesel, in order to assess whether full exemption from the excise duty effectively supports bio-diesel production. To this end, figure 11.22 shows the raw material price of conventional diesel in each Member State (red dots) and the raw material price of diesel plus the excise duty (blue dots)[169]. Bio-diesel production costs for the investigated options are also shown in the figure (horizontal lines)[170].

Figure 11.22 - Competitiveness of bio-diesel production in the EU with and without support



Source: DEIAgra estimates on data from Eurostat. IPTS (2002a) and Informa Economics (2006)

First of all, it must be noted that in absence of support at national level only bio-diesel obtained from sunflower would be competitive in most Member States, albeit only if minimum sunflower price is considered. This is particularly clear in the case of a few Member States – notably Austria, Greece and Italy – where the diesel raw material price is very high. In addition, bio-diesel obtained from rapeseed is almost competitive in these Member States, if minimum rapeseed price is considered. If full tax exemptions are also taken into account, it can be noted that a sufficient level of support appears to be in place in all Member States, with particularly high levels in the United Kingdom, Italy and Germany. The effects of the level of support on the competitiveness of the bio-energy source are confirmed by the distribution of the bio-diesel production among the different Member States. In fact, United Kingdom, Germany, Italy and France represent in total about 82% of the EU-25 bio-diesel production in 2005. At the upper limit of the cost range (pale green and blue horizontal lines, corresponding to maximum prices for sunflower and rapeseed respectively), barely sufficient support seems to be granted by Member States like Latvia and Estonia.

11.2.3.2 Bio-ethanol

Bio-ethanol is obtained from fermentation of the sugar fraction contained in sugar plants or starchy crops and subsequent distillation. It is used directly as a transport fuel - often in blends with petrol - or transformed into ETBE.

[169] These prices are reported in chapter 10; the source is Eurostat.
[170] Full costs have been converted into full costs per litre of diesel equivalent using a fuel consumption substitution ratio bio-diesel/diesel of 1.088 (IPTS 2002a).

Feedstock for bio-ethanol production in the EU include sugar beet and wheat, with barley being also used to a wide extent in Spain. The main feedstock used in Brazil – the world's leading producer – is sugar cane, while corn is used in the USA, the second largest producer. Bio-ethanol from ligno-cellulosic feedstock such as straw, grass and wood, is currently being studied since it seems to have the potential for significant cost reductions. By-products of bio-ethanol production include dried distillers grains solids (DDGS) in the case of wheat, beet pulp in the case of sugar beet, corn stover in the case of corn and a fibrous residue called bagasse in the case of sugar cane.

Data about bio-ethanol production costs in the EU and in the major world producers (Brazil and USA) are shown in figure 11.23. Such data were collected from the studied literature, mainly from a study carried out by the Joint Research Centre of the European Commission[171]. Capital costs are estimated on the basis of the assumption of investment costs of 100,000 €/1000 t/year, of a discount rate of 10% and of a plant lifetime of 15 years. Similar to the case of bio-diesel, fixed factors include capital and O&M costs and revenues from the sale of by-products, while feedstock prices determine variable costs. Such prices have been again taken from the case studies carried out for this study as well as from other available sources. In the case of wheat and sugar beet, a minimum and a maximum price have been considered, since there seems to be significant price variability among Member States[172]. The investigated options are shown in table 11.8.

Table 11.8 – The investigated options

Code	Description
EU Sugar beet A	EU - Bio-ethanol from sugar beet - price 11 €/t
EU Sugar beet B	EU - Bio-ethanol from sugar beet - price 26 €/t
EU Wheat A	EU - Bio-ethanol from wheat - price 95 €/t
EU Wheat B	EU - Bio-ethanol from wheat - price 111 €/t
EU Barley	EU - Bio-ethanol from barley - price 104€/t
EU Straw	EU - Bio-ethanol from straw - price 204 €/1000 l bio-ethanol
Brazil sugar cane	Brazil - Bio-ethanol from sugar cane
USA corn	USA - Bio-ethanol from corn

Two prices of sugar beet for ethanol production have been considered. The lower price is equal to the price of "C" (out-of-quota) sugar beet destined to this specific purpose in France (the Member State where the use of sugar beet for bio-ethanol production is most significant). As this price is too low to be deemed appealing for a substantial part of the EU sugar beet farmers (indeed it can be so deemed only by the most efficient ones), a higher price has also been considered, which falls somehow halfway between the price of in-quota sugar beets destined to sugar production in France and the aforementioned lower price. The higher price can be deemed appealing – in theory at least - for a greater portion of the EU sugar beet farmers.

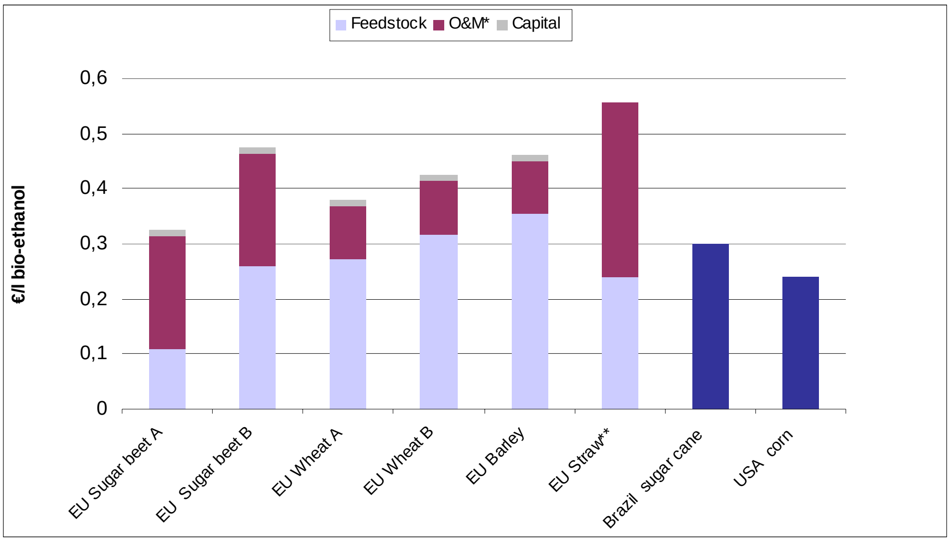
The cost analysis shows that a major share of the full cost for bio-ethanol in the EU is determined by feedstock costs, with the notable exceptions of bio-ethanol from sugar beet (at the minimum price of 11 €/t) and from ligno-cellulosic feedstock (straw in the analysis). In the former case, this is due to the low price considered for sugar beet and to the very low commercial value of by-products (sugar beet pulp). If a sugar beet price of 26 €/t is considered, most of the full cost is determined by the feedstock price. In the case of straw, processing costs – including capital and O&M costs – are still high because production of bio-ethanol from such feedstock is still carried out at experimental level.

In all other cases the analysis is rather sensitive to assumptions regarding feedstock prices. Moreover, similar to the case of bio-diesel, incremental improvement in existing technologies would only influence full costs to a limited extent.

With reference to the cost comparison with World leading producers, i.e. Brazil and the USA, production costs in the EU seem to be significantly higher. This may be attributed to lower processing costs in these countries[173], as well as to the different feedstock considered.

[171] IPTS 2002b. Other data sources include (OECD 2005) and (IEA 2004).
[172] See annex G.
[173] See annex G.

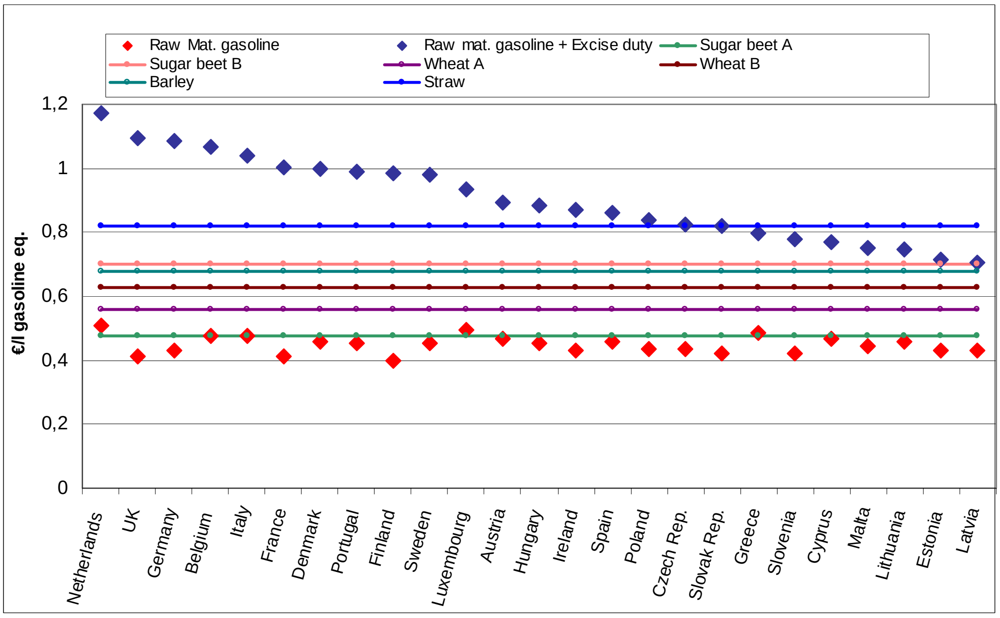
Figure 11.23 - Full cost of bio-ethanol production in the EU



*Includes revenues from the sale of by-products
**O&M costs in the case of straw should be treated as processing costs, thus including capital costs
Source: DEIAgra estimates on IPTS (2002b) and OECD (2005) data

The estimated full costs for bio-ethanol production in the EU have then been compared with the prices of the competing fuel, i.e. petrol, in order to assess whether full exemption from the excise duty effectively supports bio-ethanol production. Results are illustrated in figure 11.24, showing the raw material price of petrol in each Member State (red dots) and the raw material price of petrol plus the excise duty (blue dots)[174]. Bio-ethanol production costs are represented by horizontal lines[175].

Figure 11.24 - Competitiveness of bio-ethanol production in the EU with and without support



Source: DEIAgra estimates on data from Eurostat, and IPTS (2002b)

[174] These prices are reported in chapter 10; source: Eurostat.
[175] Full costs have been converted into full costs per liter of petrol equivalent using a fuel consumption substitution ratio bio-ethanol/petrol of 1.472 (IPTS 2002b).

Bio-ethanol produced from sugar beet appears to be competitive[176] – in theory at least - in some Member States even in the absence of government support. This is true in Member States where petrol prices are particularly high (the Netherlands, Belgium, Italy, Luxembourg, Greece). In the same Member States, the gap between bio-ethanol obtained from wheat and petrol raw material is rather narrow, if minimum wheat prices are considered. In all other cases, support is needed for bio-ethanol to be competitive. In the case of full tax exemption, support is sufficient in all the Member States, with particularly high levels of support in the Netherlands, the United Kingdom, Germany, Belgium, Italy and France. The consequences of the level of support on the competitiveness of the bio-energy source are quite confirmed by the distribution of the bio-ethanol production among the different Member States. In fact, Netherlands, the United Kingdom, Germany, Belgium, Italy and France represent in total about 43% of the EU-25 bio-ethanol production in 2005. The only partial exception in this sense is represented by bio-ethanol obtained from ligno-cellulosic feedstock, whose current high processing costs limit its competitiveness.

As for Spain, which is at present the main bio-ethanol producer in the EU, a specific reasoning must be done. In this case in fact, the high volume of production has to be mainly attributed to the fact that the duty exemption is not limited to a certain amount of production (differently from France, Italy, Portugal, Ireland).

11.3 Main findings from the analysis of cost and profitability of bio-energy

With reference to the **electricity sector**, in general the direct burning of solid agricultural biomass in a fluidised bed combustor seems to be a cheaper option than the burning of bio-gas obtained from co-digestion of silage maize and manure, due to the lower capital costs. Electricity generated from energy crops and agricultural residues is in some cases cheaper than electricity generated from other bio-energy sources, depending on the feedstock price. Comparison with other RES shows that electricity obtained from wind energy is in all cases cheaper than electricity obtained from agricultural bio-energy sources. Similarly, electricity produced without support from energy crops and agricultural residues is generally more expensive than electricity obtained from the burning of fossil fuels. In case support measures implemented by Member States pursuing Directive 2001/77/EC are considered, electricity from energy crops and agricultural residues is competitive with other sources for a significant number of Member States. These usually correspond to the main producers of electricity from bio-energy sources.

With reference to the **heating sector**, heat generated from energy crops and agricultural residues through direct combustion in boilers shows in some cases similar costs than heat generated from other biomass and from fossil fuels, strictly depending however on feedstock prices. In particular the profitability analysis carried out against natural gas and diesel oil prices has shown that bio-energy-based heat is seldom competitive with heat obtained from natural gas, while it can be competitive with heat generated from diesel oil in a higher number of cases.

Finally, as far as the **transport sector** is concerned, both bio-diesel and bio-ethanol produced in the EU are seldom competitive with fossil fuels in the absence of support measures. Conversely, if support in terms of excise duty exemptions is granted, both bio-fuels may be placed on the market at competitive prices in most Member States. Finally, bio-fuel production costs in the EU are higher than those registered in other major producing countries, such as Brazil and the USA.

[176] It has however to be pointed out that the lower price of sugar beet is assumed as equal to the price of "C" (out-of-quota) sugar beet destined to this specific purpose in France (the Member State where the use of sugar beet for bio-ethanol production is most significant). As this price is too low to be deemed appealing for a substantial part of the EU sugar beet farmers (indeed it can be so deemed only by the most efficient ones), an higher price has also been considered, which falls somehow halfway between the price of in-quota sugar beets destined to sugar production in France and the aforementioned lower price. The higher price can be deemed appealing – in theory at least - for a greater portion of the EU sugar beet farmers.

12 ASSESSMENT OF THE EFFECTS OF BIO-ENERGY USE ON THE REDUCTION OF CO_2 EMISSIONS AND THE SAVING OF FOSSIL FUELS

The reduction of greenhouse gas (GHG) emissions is one of the main objectives at which policies for the development of bio-energy sources in the EU aim. In fact, bio-energy sources are targeted at **partially replacing fossil fuels** in the electricity, heating and transport sectors, which are responsible for a major share of **GHG emissions**. The aim of this section is to analyse the **potential** and the **cost of reducing CO_2 emissions** – which by far represent the largest share of GHG emissions – through the development of different sources and uses of bio-energy, as well as to assess bio-energy **potential for replacing fossil fuels**.

The analysis focuses on the stage at which bio-energy is consumed, therefore not including the production of primary energy sources (sources of biomass), their processing into bio-energy and transportation of either sources of biomass or bio-energy.

In fact, while the consumption of bio-energy may be considered as carbon neutral[177], the whole production process for obtaining bio-energy normally generates GHG emissions, mainly depending on how much fossil fuel energy is required in the process itself. In particular, in the case of bio-energy obtained from energy crops and agricultural residues, most GHG emissions originate from the growing and harvesting of crops and the processing of feedstock into bio-energy, while in most cases only minor emissions originate from the transportation of feedstock and of final products and from other phases[178].

With a few notable exceptions – especially in the case of bio-fuels – scientists agree on the positive impact of bio-energy use (as opposed to fossil fuel use) in terms of GHG emissions. Moreover, they expect greater opportunities for emission abatement from second-generation bio-fuels (see for instance World Watch Institute 2006 on bio-fuels for transportation). However, the estimates on the possible reduction of CO_2 emissions vary widely, depending on the assumptions made about the boundaries of the system, the values of key parameters and their weight in the analysis. For instance, opinions are divided about which stages of energy crops' lyfe cycle and about what types of GHG have to be included in the analysis. Besides this, different hypotheses on the changes in land use, on the use of fertilizers and on the level of irrigation required to grow energy crops are of crucial importance for assessing the effects caused at the feedstock production stage, while assumptions on conversion efficiency, on the consumption of fossil fuels and on the use of co-products are paramount for the processing stage. Finally, the results of the analyses are space-dependent, since climate and land productivity – which affect energy crop yields – vary from one area (or country) to another. In the case of bio-fuels for transport, these differences make for studies with a wide range of diverging results, some showing significant reduction of GHG emissions – especially in contexts such as Brazil, where energy crop yields are very high – while others conclude on limited opportunities to cut such emissions, or even suggest that increases in GHG emissions are possible (World Watch Institute 2006).

Since this analysis only focuses on the consumption stage, it is not possible to draw from it definitive conclusions on the total balance of CO_2 emissions. Nevertheless this analysis can provide some indications on the "upper limit" of the reduction of CO_2 emissions and of the saving of fossil fuels which can be achieved through the use of bio-energy.

The methodology used for analysing the potential and the cost for the reduction of GHG emissions through the development of bio-energy use is the following:

- to estimate the potential **saving of fossil fuels and reduction of CO_2 emissions** from the switch from fossil fuels to the different bio-energy sources in the three sectors under study - electricity, heating and transport - using average CO_2 emission rates;
- to estimate the **cost of switching** from the different fossil fuels to the different bio-energy sources, according to the methodology of the full cost adopted in § 11.2;

[177] The term carbon neutral is used here to indicate that exactly the same amount of CO_2 that is absorbed by the plants through photosynthesis is released as a consequence of combustion of bio-energy sources obtained from such plants.

[178] GHG emissions from transporting feedstock and bio-energy sources depend on the distance between the place where they are produced and the place where they are processed into bio-energy, as well as on the distance between the places where production and consumption of bio-energy take place. These distances are usually short, as shown in the previous analysis where the geographic dimension of bio-energy markets was described (see chapter 8.4).

- limited to **electricity** sector, to estimate the **potential saving in terms of emission allowances** according to the EU ETS scheme (Directive 2003/87/EC) and the consequences in terms of money saved.

The sources used in the analysis are a database by REF, European Commission's and Member States' documentation pursuant to Directive 2003/87/EC, and direct interviews with environmental NGOs[179].

12.1 Saving of fossil fuels and reduction of CO_2 emissions: actual and potential

12.1.1 Electricity

The traditional fossil fuel sources for electricity production are:

- coal-fuelled steam plants (coal),
- combined cycle gas turbines (CCGT),
- oil-fuelled steam plants (oil).

The standard emission rates for these technologies - in terms of grCO_2/kWh of electricity produced, and referred to the utilisation phase only (combustion of the fuels in order to generate electricity) - are the following:

- 375 grCO_2/kWh for CCGT;
- 910 grCO_2/kWh for coal;
- 700 grCO_2/kWh for oil.

Average standard emission rates are estimated by analysing Member States' National Allocation Plans pursuant to Directive 2003/87/EC[180]

In the year 2004, about 46 TWh of electricity were produced from biomass in the EU-25. In particular 35 TWh were generated through direct burning of biomass, while the remaining 11 TWh were generated from bio-gas[181].

12.1.1.1 Saving of fossil fuels

In order to estimate the saving of fossil fuels it would be necessary to know which power plants have been substituted by the bio-energy-fuelled power plants. For the sake of simplicity it is assumed here that all the electricity produced from bio-energy in the EU-25 is the consequence of switching from either fossil fuel-based electricity, or nuclear electricity, to biomass-based electricity, therefore excluding potential switching from other RES-E to biomass-based electricity. As a consequence, the estimated impact on CO_2 emissions represents the **maximum CO_2 emission abatement** assuming switching from non-renewable energy sources only. Such impact would certainly be lower should a switching from RES be also assumed. With reference to the individual sources from which the switching takes place, it is assumed that the share of switching for each source is proportional to the share of electricity it generates, i.e. that the switching takes place for 39% from nuclear energy, for 32% from coal, for 24% from natural gas and for 5% from oil[182].

Consequently, overall displacement of fossil fuels may be quantified in **6,73 Mtoe**, assuming efficiency rates for coal-fuelled power plants, oil-fuelled power plants and CCGT equal to 30%, 35% and 50% respectively[183]. Overall displacement is made up as follows:

- 4,19 Mtoe coal, which correspond to 4,38 Mt of coal equivalent[184].
- 0,62 Mtoe oil.
- 1,92 Mtoe natural gas, which correspond to 2,23 billion cubic metre natural gas[185]

The steps of the calculation are reported in table 12.1.

[179] Such as WWF Italia.
[180] http://ec.europa.eu/environment/climat/emission_plans.htm
[181] EurObserv'Er; see also § 9.1.
[182] These percentages are based on IEA estimates of electricity generation by source in the EU-15 for the year 2004 (IEA 2005).
[183] These efficiencies are considered as representative of the most common power plants at EU level according to interviews with European power market experts at REF.
[184] This figure is based on international average calorific values.
[185] This figure is based on international average calorific values.

Table 12.1 – Estimated fuel saving from electricity produced from bio-energy

		Coal	Oil	Gas	Nuclear	Total
A	% of electricity production by source	32%	5%	24%	39%	100%
B	Estimated displacement by fuel (GWh)*	14 604	2 530	11 170	17 733	46 037
C	Power Plants Efficiency	30%	35%	50%		
D=B*C	Avoided consumption of fuel (GWh)	48 680	7 228	22 340		78 248
E=D*a	Avoided consumption of fuel (MToe)	4.2	0.6	1.9		6.7
F=E*b	Avoided consumption of fuel	4.4 (tons of coal equivalent)	0.6 (toe)	2.23 (billion cubic metre)		
a = 0.000086 (conversion factor)						
b = international average calorific vales						

Source: DEIAgra estimates based on IEA estimates (2005)

12.1.1.2 Reduction of CO_2 emissions

CO_2 emission reductions may be quantified in slightly more than **19 Mt CO_2**, assuming emission factors for coal, oil and natural gas equal to 910 g CO_2/kWh, 700 g CO_2/kWh, and 375 g CO_2/kWh respectively. These reductions are made up as follows:

- 13,29 Mt coal.
- 1,77 Mt oil.
- 4,19 Mt natural gas.

No emission reduction is obtained from a switch from nuclear power to bio-electricity, since electricity generation from nuclear energy is CO_2-free. However, according to the above-mentioned assumptions, such switch would amount to almost 18 GWh electricity.

The steps of the calculation are reported in table 12.2.

Table 12.2 – Estimated reduction of CO_2 emissions from electricity produced from bio-energy

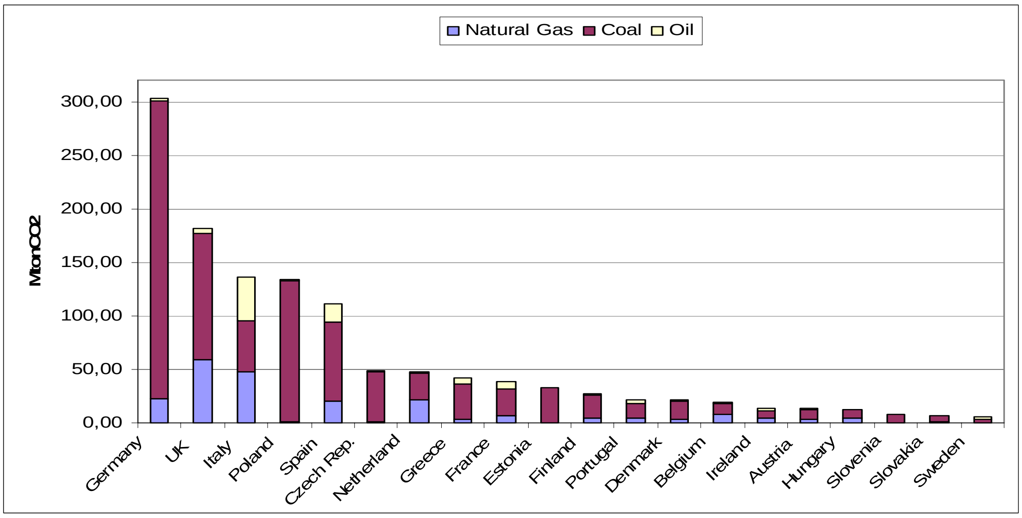
		Coal	Oil	Gas	Nuclear	Total
A	% of electricity production by source	32%	5%	24%	39%	100%
B	Estimated displacement by fuel (GWh)*	14 604	2 530	11 170	17 733	46 037
C	CO2 emissions rates gCO2/kWh	910	700	375	0	
D=B*C	Avoided CO2 emissions (Mt)	13	2	4	0	19

Source: DEIAgra estimates based on IEA estimates (2005)

At EU-25 level **CO_2 emission from electricity production** amounted in 2004 to **1.230 Mton** of which 223 Mton from natural gas sources, 910 Mton from coal, 94 Mton from oil.

Figure 12.1 reports the detail by Member State. At present electricity production from bio-energy sources allows to save around **1,5%** of overall CO_2 emissions caused by electricity generation. Theoretically speaking if all the fossil fuel-based electricity production could be switched to bio-energy-based production the maximum reduction of CO_2 emissions could equal the overall amount. The main limiting factors to such an outcome are the availability of energy crops and obvious economical, technological, environmental and social limitations. It is also worth noting again that the above conclusion is based on the assumption that limits the analysis to the consumption stage. In fact, producing biomass and processing it into bio-energy sources and bio-energy usually generates additional CO_2 emissions (see the introduction to this chapter).

Figure 12.1 – CO2 emission from electricity generation (2004)



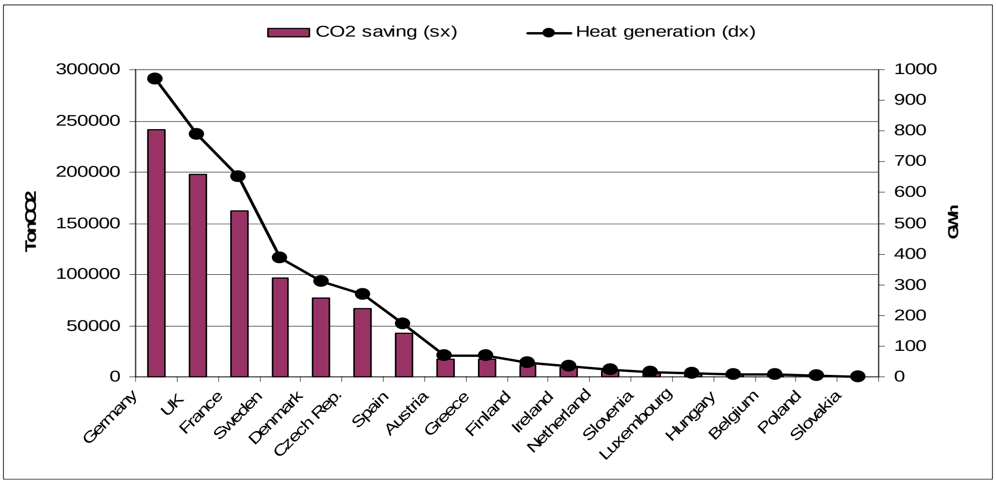
Source: DEIAgra estimates on Eurostat and IEA data

12.1.2 Heat

The CO_2 emission rate for a standard boiler for heat production with an efficiency of 80% is 250 grCO_2/kWh. The analysis carried out in this paragraph is based on this standard technology for sake of simplicity [186]. The analysis is thus limited by such assumption, but usually the efficiency of boilers does not show substantial deviations from the above standard value, and is generally very high.

In 2004 at EU-25 level **3,8 TWh** (EurObserv'Er) of **heat from biogas** were produced. Assuming that the alternative source was a boiler fuelled with natural gas, the **fossil fuel saving** amounted to **0,4 Mtoe** of natural gas and the maximum (see introduction to this chapter) **reduction of CO_2 emissions** was **0,96 Mton**, obtained by multiplying the production for the average emission rate. Figure 12.2 reports the details of the above estimate for each Member State.

Figure 12.2 - Heat generation from bio-gas and potential reduction of CO_2 emissions (2004)



Source: DEIAgra estimates

These data do not include **heat production from solid biomass used directly in domestic heating apparatus**, which are generally very numerous but for which an estimate is not possible. For example, the estimated number of these apparatus is about 9 million in Germany only.

[186] The assumptions on standard efficiency and emission rate are based on interviews with environmental experts.

12.1.3 Transport

12.1.3.1 Saving of fossil fuels

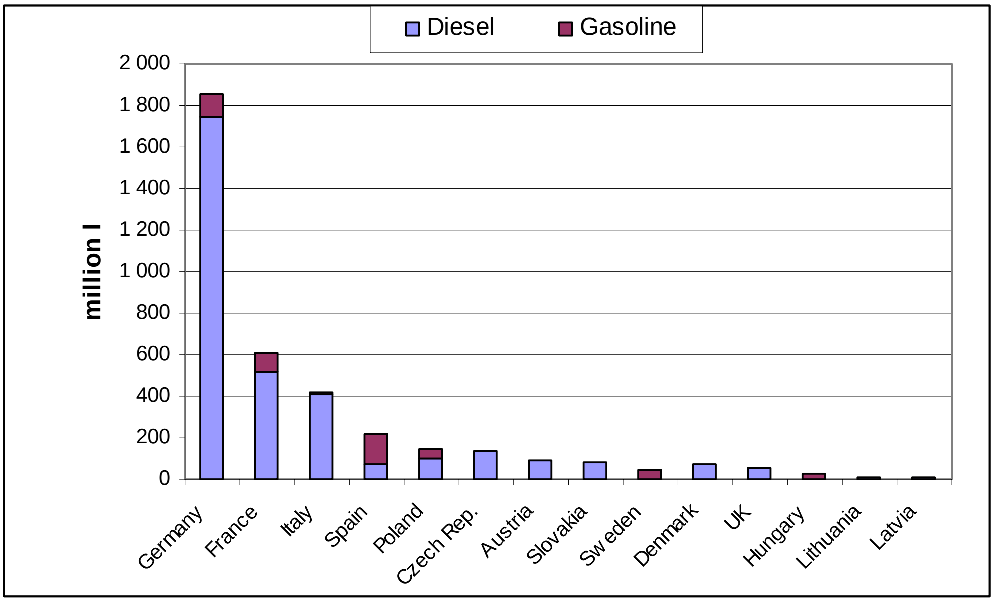
The conversion factors between bio-fuels and fossil fuels in terms of energetic values are:

- 1,472 litres of bio-ethanol are equivalent to one litre of petrol (IPTS 2002b);
- 1,088 litres of bio-diesel are equivalent to one litre of diesel (IPTS 2002a).

Overall, around 3,2 Mt (2,88 toe) of bio-diesel and 0,73 Mt (0,47 toe) of bio-ethanol were produced in the EU in 2005 for use in the transport sector[187]. This is equal to 3,6 billion litres of bio-diesel and 0,91 billion litres of bio-ethanol. By dividing these values for the conversion factors, approximately 3,3 billion litres of diesel and 0,62 billion litres of petrol are displaced by bio-diesel and bio-ethanol respectively, equal to **3,1 and 0,50 Mtoe[188]**.

Figure 12.3 reports the contribution to the saving of fossil fuels from a selection of Member States[189]. The main contribution comes from Germany, with a saving of 1.612 million litres of diesel and 94 million litres of petrol.

Figure 12.3 – Saving of fossil fuels from the use of bio-fuels (2004)



Source: DEIAgra estimates on Eurostat and IEA data

12.1.3.2 Reduction of CO_2 emissions

The average emission rates for the fossil fuels used in the transport sector are the following (source EPA 2005):

- 640 grCO_2/litre for petrol;
- 734 grCO_2/litre for diesel.

By multiplying the saved volumes of fossil fuels by the average emission rates, the total maximum **reduction of CO_2 emissions from the use of bio-fuels** can be estimated in **2,82 Mton for 2005, of which 2,4 Mton from bio-diesel[190]**.

It is worth noting again that **only the utilisation phase is taken into account in this analysis**, i.e. the stage at which fossil fuels and bio-fuels are burnt for transport use. A more thorough analysis would focus on the whole fossil fuels and bio-fuels life cycles, including exploration and extraction of oil, transport and refining, storage, distribution and retail and vehicle fuelling - in the former case - and crops growing and

[187] The figure concerning bio-ethanol includes 0,17 Mt of bio-ethanol obtained from the distillation of wine alcohol, as a consequence of the distillation measure of the Common Market Organisation of wine.

[188] If the bio-ethanol from wine alcohol is not taken into account, the EU-25 production amounts to 0,56 Mt, i.e. 0,71 billion litres and it displaces 0,49 billion litres of petrol, i.e. 0,40 Mtoe.

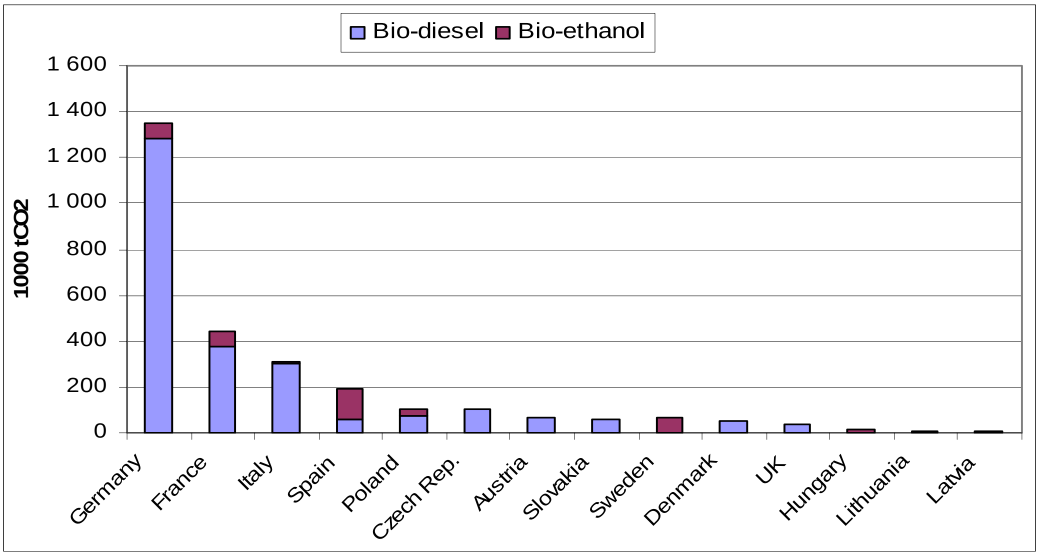
[189] The figures presented in figure 11.3 do not include petrol saving from bio-ethanol obtained from wine alcohol.

[190] If bio-ethanol from wine alcohol is not considered, the maximum reduction of CO_2 emissions amounts to 2,75 Mt.

harvesting, transportation and processing into bio-fuels, storage, distribution and retail, as well as vehicle fuelling - in the latter case. However, such life-cycle approach – on which scientists' opinions and study results differ widely in several cases (see introduction to this chapter) – falls outside the scope of this study.

Figure 12.4 reports the contribution to the maximum reduction of CO_2 emissions by a selection of Member States. The main contribution comes from Germany with a saving of 1,35 Mton $CO_{2,}$ of which 1,28 Mton from bio-diesel.

Figure 12.4 – Reduction of CO2 emissions from the use of bio-fuels (2004)



Source: DEIAgra estimates on Eurostat and IEA data

Since the use of bio-fuels accounts for 0,63% of total energy consumption in the transport sector at EU level, the potential for further reduction of CO_2 emissions is theoretically very high. The actual potential depends on the availability of **energy crops and processing plants**. We estimate below the potential reduction induced by the targets of the Directive 2003/30/EC. The estimate was made by assuming a yearly 2% growth rate of total fuel consumption in the transport sector with respect to 2004 values and the average emission rates previously cited:

- 2005 target reached (2%): overall **6 MtonCO_2 reduction**, with an additional reduction of 3,6-5,6 MtonCO_2 with respect to 2004 values;
- 2010 target reached (5.75%): overall **17,5 MtonCO_2 reduction**, with an additional reduction of 15,1-17 MtonCO_2 with respect to 2004 values;

The ranges are computed assuming a 100% contribution of bio-ethanol in reaching the targets for the higher values, and a 100% contribution of bio-diesel in reaching the targets for the lower values. In fact, diesel has a higher CO_2 emission rate than petrol but also a higher calorific value: hence burning a litre of diesel emits more CO_2 than burning a litre of petrol, on one hand, but it emits lower CO_2 with respect to the energy provided compared to petrol, on the other hand.

The steps of the calculation are reported in the table 12.3.

Table 12.3 – Estimated reduction of CO2 emissions from the reaching of the targets set for bio-fuels

			Gasoiline	Diesel	Total
A	Overall consumptions (Billion Litre)	2005	468	412	880
		2010	473	416	889
B	Target	2005	2%	2%	2%
		2010	5.75%	5.75%	5.75%
C = A*B	Fuel Saving	2005	9	8	18
		2010	27	24	51
D	Emission rate (grCO2/litre)		640	734	
E=C*D	CO2 Saving (MTonCO2)	2005	6	6	12
		2010	17	18	35

Source: DEIAgra estimates

12.2 The cost of the reduction of CO_2 emissions

12.2.1 Electricity

On the basis of the analyses carried out in chapter 11, it is estimated here below the cost of reducing CO_2 emissions from electricity generation by comparing the full cost of electricity from fossil fuels with that of electricity generated from different sources of bio-energy.

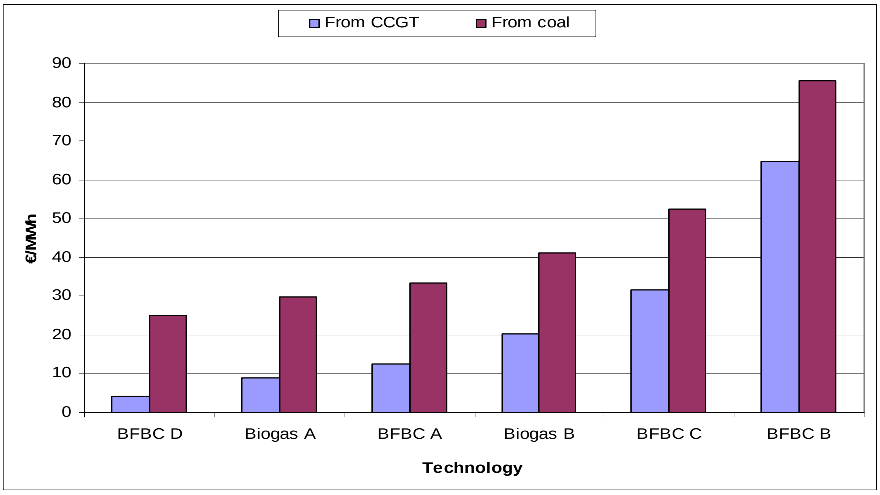
In order to simplify the analysis we identify some standard technologies that represent the whole range of costs for the technologies available at present.

Table 12.4 – Analysed technologies, inputs and prices

Code	Description
BFBC A	BFBC plant; minimum straw price (43.5 €/t)
BFBC B	BFBC plant; maximum straw price (120 €/t)
BFBC C	BFBC plant; miscanthus (73.12 €/t)
BFBC D	BFBC plant; reed canary grass (31.9 €/t)
Biogas A	Biogas plant; minimum maize silage price (15.5 €/t)
Biogas B	Biogas plant; maximum maize silage price (33 €/t)
CCGT	Combined-cycle gas turbine; natural gas
PF coal	Pulverised fuel; coal

The results of the comparison are reported in figure 12.5. Switching from CCGT to biomass-based production on average increases the full cost of electricity generation by 24 Euros/MWh, with a high variance ranging from 4 to 65 Euros/MWh. Switching from coal is more expensive - since the coal technology is cheaper - and costs on average 45 Euros/MWh.

Figure 12.5 - Full cost increase in switching from fossil fuel to biomass-based electricity



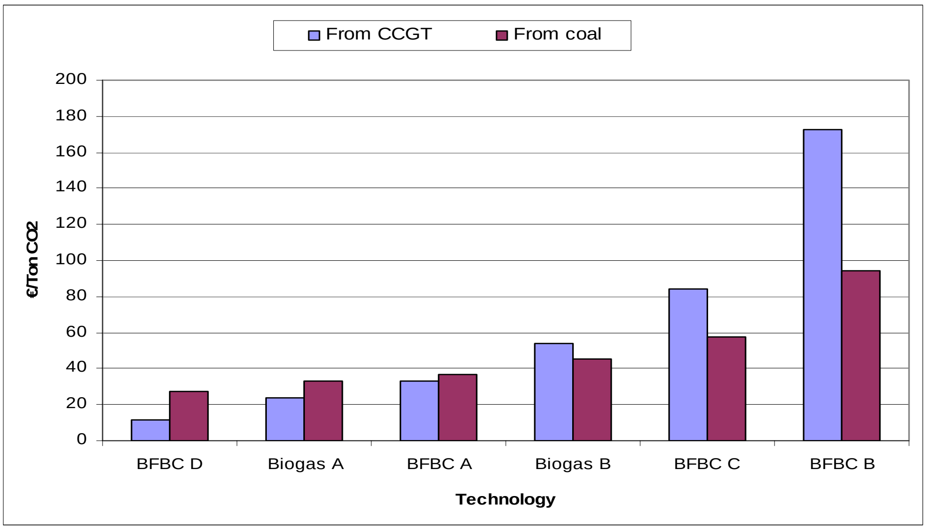
Source: DEIAgra estimates

Dividing these values by the average emission rates, the cost expressed in Euros/Ton CO_2 is obtained. The results are presented in Figure 12.6: **on average, saving a Ton CO_2 costs 63 Euros in the case of CCGT and 48 Euros in the case of coal plants**. In fact switching from coal plants allows to save more CO_2 per MWh.

This first conclusion does not take into account the effects of Directive 2003/87/EC establishing a scheme for **greenhouse gas emission allowance trading** (EU ETS) within the Community. The scheme includes all EU power plants fuelled with fossil fuels with an installed capacity greater than 20 MW. The scheme requires such plants to surrender an allowance for each ton of CO_2 emitted. Allowances are allocated by Member States according to national allocation plans (NAP), but in case of shortage or excess of allowances with respect to actual emissions they can be traded on the international market. This implies that in the balance of switching from a fossil fuel to a biomass-based production, the additional revenue in terms of EU ETS allowances saved should also be computed.

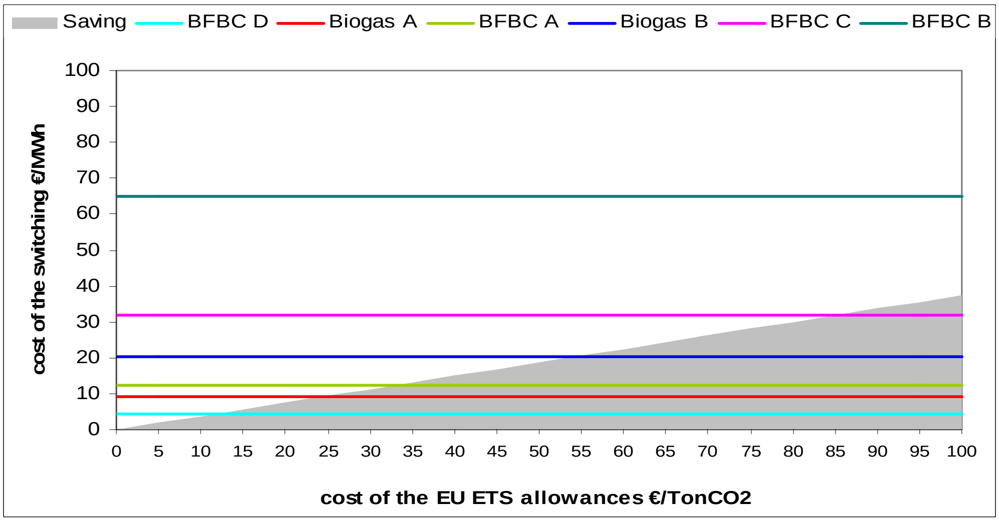
The price of the allowances on the international market was around **20 Euros/Ton CO_2** for the first period (the market started in March 2005), but the price is highly volatile and unpredictable, since actual level of demand and supply of allowances are not known and very difficult to estimate, depending on national regulations, firms behaviour and other unpredictable aspects (such as the weather conditions for electricity generation).

Figure 12.6 – Cost per Ton CO2 saved in switching from fossil fuel to biomass-based electricity



Source: DEIAgra estimates

Figure 12.7 - Balance of CO2 emission reduction by switching from CCGT to biomass-based electricity



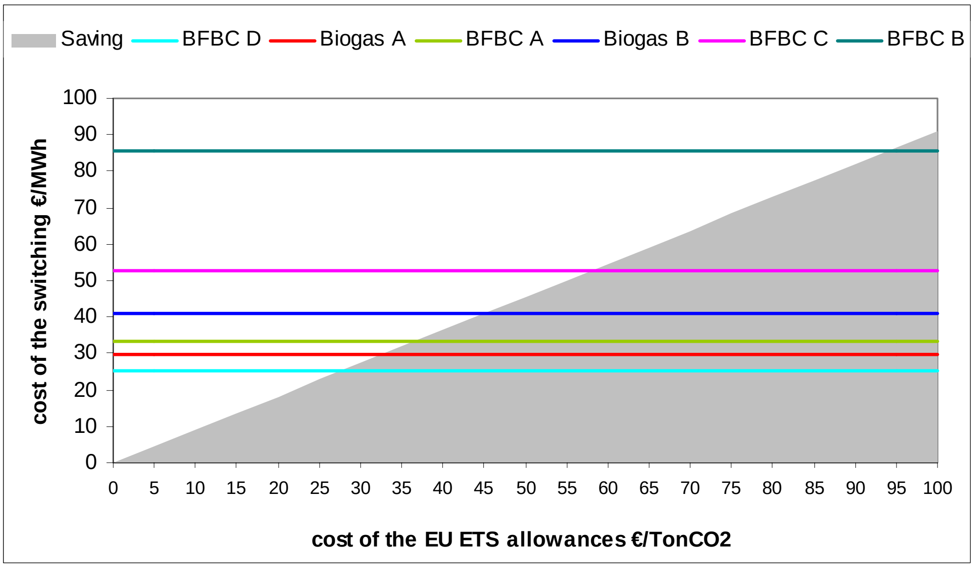
Source: DEIAgra estimates

Figure 12.7 and figure 12.8 report the balance of costs and revenues in switching to biomass-based electricity from CCGT and coal respectively. The differences in these costs depend on the differences between the full cost of the different technologies as shown in figure 12.5 and 12.6. The revenue depends on:

- the CO_2 saved in switching (greater amount for coal than for CCGT);
- the cost of the EU ETS allowances on the international market; since such price is highly unpredictable, we took it as a variable, letting it vary **from 0 to 100 Euros/Ton CO_2**.

It can be seen from the graphs that the presence of the EU ETS alone would impede the switching to be profitable - this being the case when revenues (grey area) are higher than costs (coloured lines) - exception made for high allowances prices. For allowances price at 20 Euros/MWh only the case of switching from gas to the cheapest biomass technology (BFBC D) would be profitable, while for the switching from coal to be profitable the allowance price should increase to about 28 Euros/Ton CO_2.

Figure 12.8 – Balance of CO2 emission reduction by switching from coal to biomass-based electricity



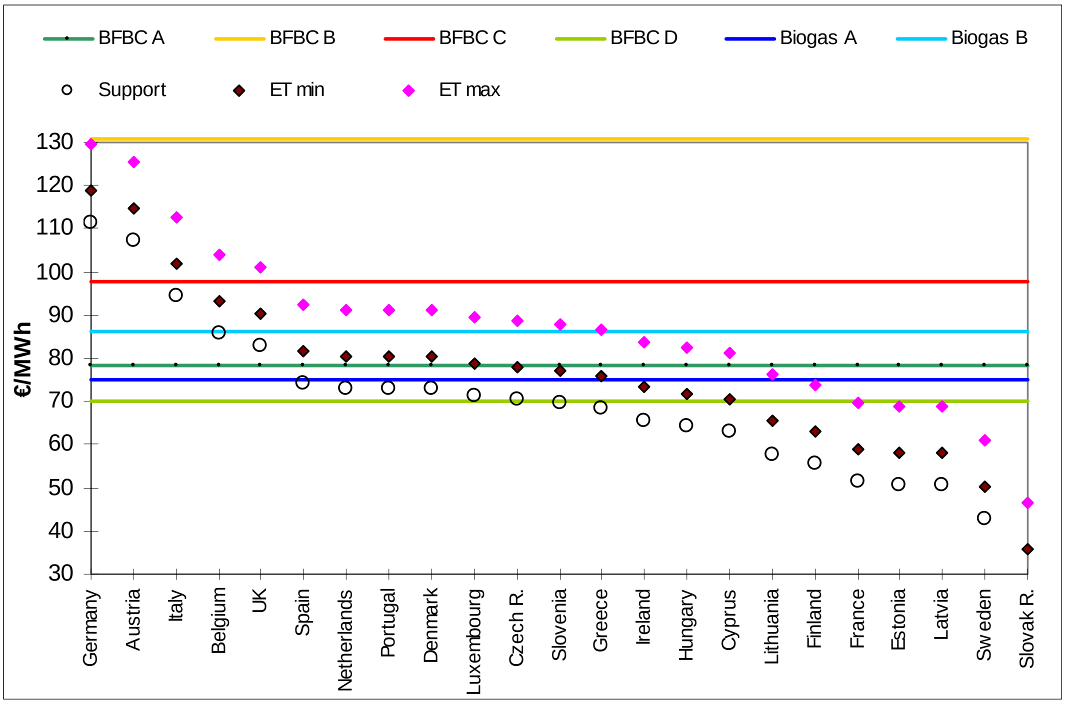
Source: DEIAgra estimates

However, the effects of the EU ETS on the profitability of switching to biomass-based electricity should be considered in combination with those generated by **support schemes** pursuant Directive 2001/77/EC, which was already assessed in § 11.2.

Figure 11.9 illustrates the profitability of the six selected biomass-based technology/feedstock combinations for the production of electricity, when the effects of the EU ETS are considered in addition to the effects of support schemes for electricity produced from RES.

Horizontal lines show once again the full costs of the selected combinations technology/feedstock for the production of biomass-based electricity. The data series "Support" identifies the support level for electricity produced from RES as estimated and analysed in § 10.2 and 11.2. The series "ET min" reports the estimated support level if the effects of the EU ETS are taken into account, in the case of switching from natural gas (CCGT) to bio-energy sources. Such switching would generate a surplus of ET allowances (EUA) for the installation concerned, which would in turn imply additional revenues for the installation itself. The EUA price assumed for the analysis is 20 Euros/Ton CO_2. Similar to "ET min", the series "ET max" reports the estimated support level considering the EU ETS in the case of switching from coal to bio-energy sources. This support level would be higher than that for switching from CCGT, since the savings of CO_2 and EUA would be higher in the case of switching from coal. The assumed EUA price is 20 Euros/Ton CO_2.

Figure 12.9 – Profitability of electricity from biomass considering the effects of the EU ETS



Source: DEIAgra estimates

It can be observed from the figure above that **if the additional incentive provided by the EU ETS is taken into account, the competitiveness of electricity generated from bio-energy sources increases significantly**. For example, when a switch takes place from gas to bio-energy sources, the three combinations "BFBC D", "Bio-gas A" and "BFBC A" appear to be competitive in at least 10 Member States, while in the case of switching from coal the above mentioned combinations – together with "Bio-gas B" – appear to be competitive in most Member States.

So for example, a producer of "Bio-gas B" in the United Kingdom, with an electricity production cost of 86 Euros/MWh (light blue line in the figure), could sell its electricity on the market, including the revenue granted by the United Kingdom's policies for renewable sources, at 82,86 Euros/MWh (series "Support"), thus resulting unprofitable. Suppose now that the producer is a firm which owns also traditional fuelled power plants. If - when producing a MWh of electricity from bio-gas - such firm reduces its production of 1 MWh from a CCGT plant, according to the Emission Trading scheme it could save the associated CO_2 allowances and thus sell them on the international market. Assuming a price of allowances of 20 Euros/MWh, the total revenue for electricity plus the sale of allowances could be 90,36 Euros/MWh (series "ET min"). Now the production results to be profitable. Furthermore, if the switching is made from a coal plant then, by saving more CO_2 allowances, the total revenue increases to 101 Euros/MWh, with a higher profit for the firm.

12.2.2 Heat

On the basis of the analyses carried out in chapter 11, we estimate the cost of reducing CO_2 emissions from heat production by comparing the full cost of heat produced through standard boilers fuelled with natural gas with the full cost of heat produced through boilers fuelled with biomass.

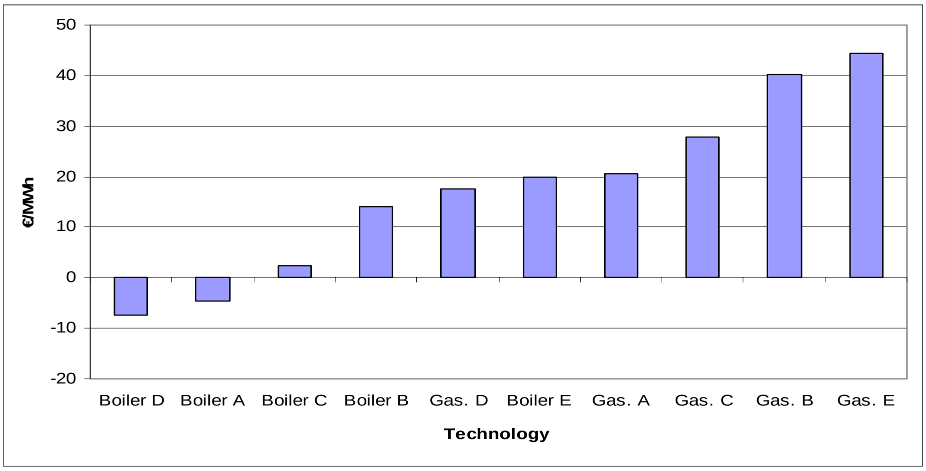
For sake of simplicity we identify some standard technologies which can represent the whole range of costs for the available technologies.

Table 12.5 – Analysed technologies, inputs and prices

Code	Description
Boiler A	Boiler; minimum straw price (43.5 €/t)
Boiler B	Boiler; maximum straw price (120 €/t)
Boiler C	Boiler; miscanthus (73.12 €/t)
Boiler D	Boiler; reed canary grass (31.9 €/t)
Boiler E	Boiler; pellet (175 €/t)
Boiler F	Boiler; natural gas (27.8 €/MWh)
Gas. A	Gasification plant; minimum straw price (43.5 €/t)
Gas. B	Gasification plant; maximum straw price (120 €/t)
Gas. C	Gasification plant; miscanthus (73.12 €/t)
Gas. D	Gasification plant; reed canary grass (31.9 €/t)
Gas. E	Gasification plant; pellet (175 €/t)

Results from the comparison are reported in figure 12.10. Boilers fuelled with biomass of type D and A are cheaper than a natural gas boiler. On average, the cost increase in the case of switching from a boiler fuelled with natural gas ("boiler F") to a boiler fuelled with agricultural biomass is almost 5 Euros/MWh, while switching to a gasification plant costs 30 Euros/MWh more.

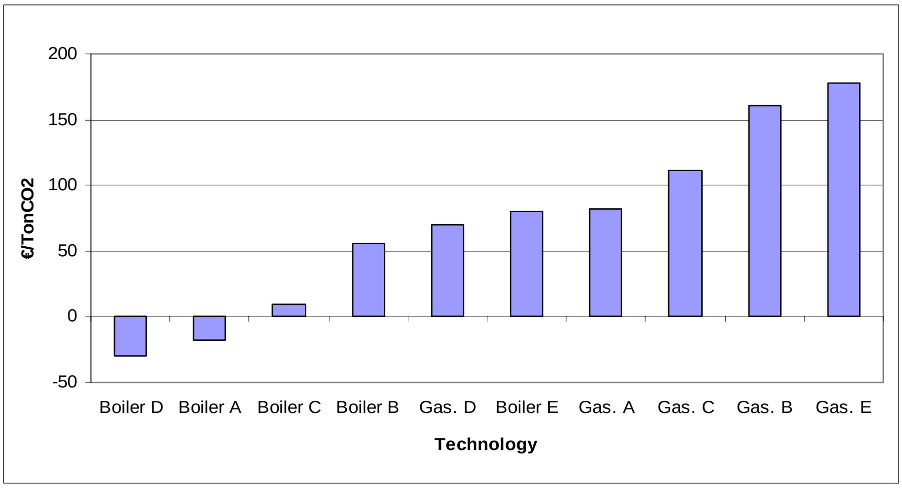
Figure 12.10 - Full cost increase in switching from a natural gas boiler to biomass-based heat generation



Source: DEIAgra estimates

By dividing the above values by the average emission rate of the standard boiler (0,25 Ton CO_2/MWh) it is possible to estimate the cost in terms of **Euros per Ton CO_2** saved. Results are reported in figure 12.11. In this case the average cost increase is about 19,5 Euros/Ton CO_2 in the case of switching to a biomass-fuelled boiler and 120,5 Euros/Ton CO_2 in the case of switching to a biomass-fuelled gasifier.

Figure 12.11 - Cost of each Ton of CO2 saved in switching from a natural gas boiler to biomass-based heat generation



Source: DEIAgra estimates

12.2.3 Transport

In order to estimate the cost of switching from fossil fuels to bio-fuels in the transport sector we consider the average EU raw material prices (as analysed in § 10.4) as a proxy of production costs. Such prices in fact do not show high variability across the EU, and so they are considered to be representative of the average production cost of diesel and petrol. The prices are equal to 0,45 Euros/lt for petrol and 0,46 Euros/lt for diesel.

The cost of switching from fossil fuels to bio-fuels is then estimated as the difference between the above average production cost of diesel and petrol and the full cost of producing bio-ethanol and bio-diesel with different types of agricultural biomass.

The results of the comparisons are shown in figures 11.12 and 11.13 for bio-ethanol and bio-diesel respectively.

On average, **switching from petrol to bio-ethanol costs 0,2 Euros/lt**, while **switching from diesel to bio-diesel is cheaper with 0,11 Euros/lt**; however the variability around the average is higher in the first case, with even a case in which the switching represents a cost saving (cheaper sunflower).

Figure 11.12: Full cost increase in switching from gasoline to bioethanol

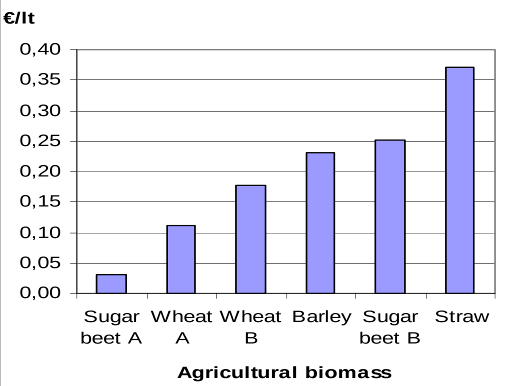
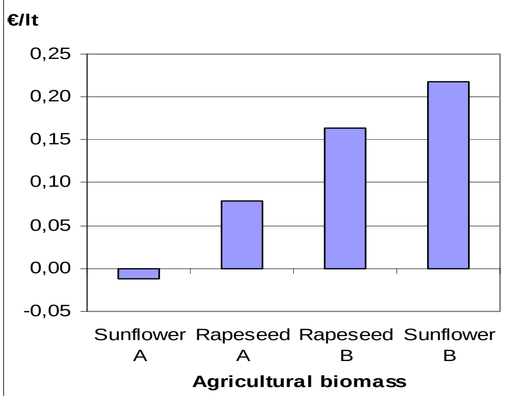


Figure 11.13: Full cost increase in switching from diesel to biodiesel



Source: DEIAgra estimates

By dividing the above values by the average emission rate of petrol and diesel respectively (640 gr CO_2/lt and 734 gr CO_2/lt) the cost increase for each Ton of CO_2 saved can be estimated. Results are reported in Figures 11.14 and 11.15. In this case the average cost increase of switching from petrol to bio-ethanol is 305 Euros/Ton CO_2, while that of switching from diesel to bio-diesel is 153 Euros/Ton CO_2.

Figure 11.14: Cost increase for Ton CO2 saved in switching from gasoline to bioethanol

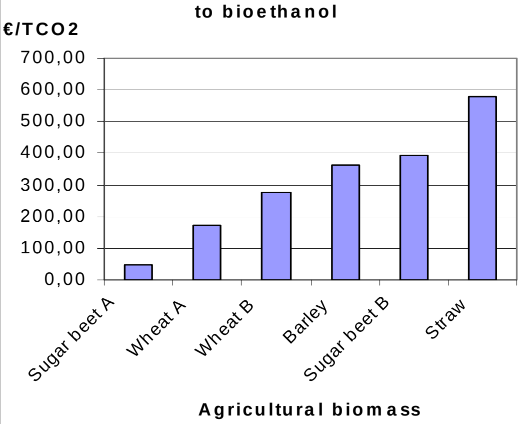
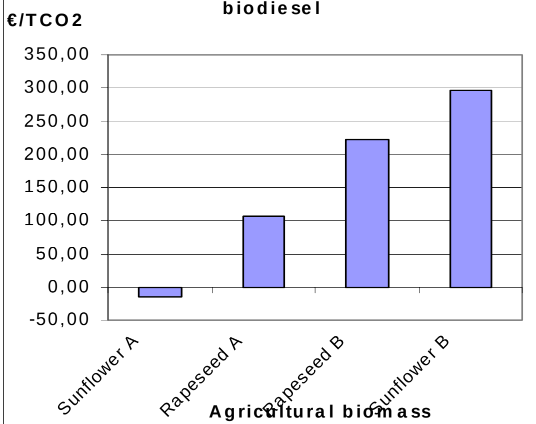


Figure 11.15: Cost increase for Ton CO2 saved in switching from diesel to biodiesel



Source: DEIAgra estimates

12.3 Main findings

The **saving of fossil fuels** from bio-energy use in 2004 is estimated at **6,73 Mtoe** for the **electricity** sector, **0,4 Mtoe** for the **heat** sector and **3,6 Mtoe** for the **transport** sector (**3,1 Mtoe** from **bio-diesel, 0,5 Mtoe** from **bio-ethanol** production), for a total of slightly less than **11 Mtoe**.

The correspondent maximum reduction of CO_2 emissions - taking into account the average emission rate of the different fossil fuels saved - amounts to a total of **23 Mton CO_2**, of which 83% from the electricity sector, 4% from the heat sector, 11% from bio-diesel, and 2% from bio-ethanol. The above figure represents the maximum reduction of CO_2 emissions since **this analysis focuses on the sole stage at which bio-energy is consumed**, therefore not including the production of biomass, its processing into bio-energy sources and bio-energy and the transportation of biomass, bio-energy sources and bio-energy. In fact, while the consumption of bio-energy may be considered as carbon neutral, the whole production process for obtaining bio-energy normally generates GHG emissions, especially in the stages at which energy crops are grown, harvested and processed into bio-energy sources and bio-energy, and mainly depending on how much fossil fuel energy is required for these operations. As a debate is ongoing on these issues in the scientific community, and as an agreed methodology for a life-cycle approach has not yet emerged, the evaluation team chose to focus on the sole stage of consumption.

Electricity plants fuelled by bio-energy sources result more costly than traditional coal and gas fuelled power plants. On average, the **abatement of a ton of CO_2 costs 63 Euros** if a switching occurs from CCGT[191] plants to bio-energy fuelled plants, and **48 Euros** if a switching takes place from coal plants to bio-energy fuelled plants.

The support provided by the **EU emission trading scheme** alone appears to be insufficient to guarantee profitability for bio-energy fuelled power plants at current allowance prices. If the support from national schemes for promoting RES is also taken into account, profitability is reached in a significant number of Member States. The exact measure of profitability depends on the price of CO_2 allowances on the international market, which is highly volatile and unpredictable.

Not in all cases **heat** plants fuelled with bio-energy sources result more expensive than traditional heat plants fuelled with fossil fuels. **Boilers fuelled with straw and reed canary grass** result to be cheaper than a standard natural gas boiler. In this case the saving of one Ton of CO_2 corresponds to a **cost saving of 24 Euros** on average. **However, taking into account all the technologies analysed, saving one Ton of CO_2 generally implies an additional cost**.

As regards **transport**, additional costs are associated to the switching from fossil fuels to bio-diesel and bio-ethanol, with the exception of bio-diesel obtained from sunflowers, which results however to be cheaper than diesel under the sole minimum sunflower price assumption. In particular, the **cost increase for each ton of CO_2 saved** varies from **–16 Euros (cost saving) to +300 Euros for bio-diesel**, and from **+47 Euros to almost +600 Euros for bio-ethanol**.

In conclusion, although this analysis identifies some promising combinations of feedstock and technology that may bring about a reduction in CO_2 emissions while being able to compete with fossil fuel-based energy on economic grounds, the limitations affecting the assessment – which is based on the restrictive assumption of a focus on the sole consumption stage – make it desirable to develop an agreed methodology for assessing the environmental impacts of bio-energy in a life-cycle perspective. This would permit a more comprehensive evaluation of CO_2 abatement opportunities and costs for different bio-energy sources.

[191] Combined cycle gas turbine fuelled by natural gas.

13 MAIN FEATURES OF THE BIO-ENERGY MARKET

As regards **electricity** (see § 9.2), in 2005 electricity produced from solid biomass represented around 1,43% of the total EU final consumption of electricity (of which 41,6% covered by energy crops and agricultural residues), while electricity generated from bio-gas represented around 0,5% (of which around 15% covered by energy crops and agricultural residues).

As regards **heat** (see § 9.2), the share of energy gained from the direct burning of solid biomass represented around 2% (excluding domestic apparatus[192]) of the total heat demand, of which around 0,4% derived from energy crops (0,01% of the total heat demand). The share of energy gained from biogas, accounts for around 0,6% of the total heat demand.

As regards **transport** (see § 9.2), bio-ethanol and bio-diesel combined represented around 1% of the EU global demand of fuels in 2005. Among them, bio-diesel production accounted for around 1,6% of the total diesel consumption, and bio-ethanol for around 0,4% of the total consumption of petrol. These fuels are mostly produced from energy crops and agricultural residues. However, as far as bio-ethanol is concerned, a share of around 22% was obtained from wine alcohol in 2005 (representing around 5% of the total EU bio-fuel production). This situation may be subject to change in relation to the reform process of the CMO for wine (see § 8.4.1).

The largest share of **bio-gas** production (2005) is obtained from landfills (64%) and around 19% from sewage sludge; the share obtained from energy crops and agricultural residues falls into the remaining 17% (also including municipal solid waste and manure, see § 8.3).

Total production of **solid biomass** in the EU is about 69 Mtoe, of which around 2 Mtoe obtained from energy crops.

The EU **production** of bio-energy and bio-energy sources has been **rapidly increasing** during the last years. From 1995 to 2005, it was registered an increase of around 48% in the use of solid biomass for energy purpose; in the same period the production of bio-gas almost tripled and that of bio-fuels increased almost tenfold (see § 8.4). The installed **processing capacity**, growing rapidly, is at present largely **under-exploited**[193]. Plants are mainly located in areas where the **supply** of biomass is guaranteed by local production or close import terminals (see § 8.4.3).

As regards the **agricultural level**, the EU total area under energy crop covered around 2,4 million ha in 2005. Around 90% of it was concentrated in Germany, France and the United Kingdom (see § 8.1). The very major share of this area was destined to **oilseeds** and rapeseed in particular (respectively 91% and 85% of the total area under energy crops), while cereals and starchy crops totally covered around 7-8% of the total.

As for their **destination**, oilseeds are almost exclusively destined to the production of bio-diesel, and sugar beet to that of bio-ethanol. Cereals are partially used for the production of bio-ethanol, and for a minor share destined to bio-gas, with the exception of maize, which has a large use as feedstock for the anaerobic digestion. Various products, among which also willow, miscanthus, grass and agricultural residues are also used for the direct burning.

Production of energy crops in the EU during recent years has been **increasing** (from slightly less than 1,2 million ha in 2003 to about 2,4 million ha in 2005[194]). Referring to 2005, around 60% of the total area destined to energy crops in the EU was cultivated under the AEC regime (24%, i.e. about 560.000 ha) and NFSA regime (35%, i.e. about 835.000 ha). The remaining 40% (around 1 million ha) was cultivated outside specific support regimes, and was mainly concentrated in Germany and, for a lesser share, in France.

Besides biomass imports from third countries[195], a quite relevant amount of **intra-EU trade** exists, transferring raw materials from agricultural productive areas and from import terminals towards the main processing facilities. As regards bio-ethanol, in 2004 around 2,5 million Hl were **imported from third countries** (mainly Brazil; the import tariff is at present set at 19,2 €/Hl, equal to around 32% of the average bio-ethanol price).

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[192] An estimate of the portion associated to such apparatus is unfeasible, given their very high number and their varying technical features (see 9.2).

[193] According to the Market Analysis, around 25% of the EU bio-diesel production capacity is currently unexploited.

[194] Source: DEIAGRA estimates on data from DG Agri - Unit D1; DG Agri – Unit G1; DG Agri – Unit G2; COPA-COGECA; FNR and German Farmers' Association; Institut Francais de l'Environment; DEFRA.

[195] The EU is importing mainly rapeseed and, for lower quantities, soybeans and other minor products (palm oil, others).

13.1 Cost and profitability of bio-energy sources

As regards the **electricity sector**, electricity generated from energy crops and agricultural residues is generally more expensive than electricity obtained from the burning of fossil fuels. When additional support by Member States pursuing Directive 2001/77/EC is considered, electricity from energy crops and agricultural residues becomes competitive with the other sources in a significant number of Member States, usually corresponding to the main producers of electricity from bio-energy sources. The direct burning of solid agricultural biomass in a fluidised bed combustor seems to be a cheaper option than the burning of bio-gas obtained from co-digestion of silage maize and manure, due to the lower capital costs. Electricity generated from energy crops and agricultural residues is in some cases cheaper than electricity generated from other bio-energy sources, depending however on the feedstock price. Nevertheless, comparison with other renewable energy sources shows that electricity generated from wind is in all cases cheaper than electricity obtained from agricultural bio-energy sources.

With reference to the **heating sector**, heat generated from energy crops and agricultural residues through direct combustion in boilers shows in some cases costs similar to heat generated from other biomass and from fossil fuels, strictly depending however on feedstock prices. In particular the profitability analysis carried out against natural gas and diesel oil prices has shown that bio-energy-based heat is seldom competitive with heat obtained from natural gas, while it can be competitive with heat generated from diesel oil in a higher number of cases.

Finally, as far as the **transport sector** is concerned, both bio-diesel and bio-ethanol produced in the EU are seldom competitive in terms of production costs with fossil fuels. Bio-fuel production costs in the EU are higher than those registered in other major producing countries, such as Brazil and the USA.

13.2 Potential savings of fossil fuels and abatement of CO_2 emissions

The **saving of fossil fuels** from bio-energy use in 2004 is estimated at **6,73 Mtoe** for the **electricity** sector, **0,4 Mtoe** for the **heat** sector and **3,6 Mtoe** for the **transport** sector (**3,1 Mtoe** from **bio-diesel, 0,5 Mtoe** from **bio-ethanol** production), for a total of slightly less than **11 Mtoe**.

The correspondent maximum reduction of CO_2 emissions - taking into account the average emission rate of the different fossil fuels saved - amounts to a total of **23 Mton CO_2**, of which 83% from the electricity sector, 4% from the heat sector, 11% from bio-diesel, and 2% from bio-ethanol. The above figure represents the maximum reduction of CO_2 emissions since **this analysis focuses on the sole stage at which bio-energy is consumed**, therefore not including the production of biomass, its processing into bio-energy sources and bio-energy and the transportation of biomass, bio-energy sources and bio-energy.

Taking into account all the technologies analysed, saving one Ton of CO_2 generally implies an additional cost. On average, the additional costs for the **abatement of a ton of CO_2** in **electricity** generation is **48-63 Euros** (depending on both the conventional technology substituted and the bio-energy based technology replacing it), while in **transport** it goes from **47 to 600 Euros** (depending on the type of conventional fuel replaced and on the bio-fuels production technology used). In some specific cases, however (e.g. where boilers fuelled with straw and reed canary grass replace a standard natural gas boiler for heat generation) saving one Ton of CO_2 can imply a cost saving of 16-24 Euros.

EVALUATION QUESTIONS

14 EVALUATION QUESTION 1

"To what extent have the direct aid measures individually and/or in combination with one another been an incentive to the farmer to introduce the cultivation or increase the quantity of crops cultivated for energy use? Identify the leading crops and in particular, limiting factors to an increase in production".

The **relevant issues** to tackle in the framework of EQ 1 are the following:

1) Identification of the leading energy crops.
2) To assess whether and to what extent the support provided through direct aid measures (cause) has modified EU farmers' behaviour, inducing them to start or to expand the cultivation of energy crops (effect).
3) To identify the promoting and limiting factors that may influence positively or negatively the cause-effect relation at point 2) above.

The **methodology** for answering the question is summarised below.

Judgment criteria, indicators and information sources

Judgment Criteria (JC)	Indicators (IND)	Information sources
Direct Aid Measures constitute a *potential incentive* to the farmer to introduce or increase the cultivation of energy crops only if: **JC 1:** their contribution is decisive to achieve a positive margin => comparison between the margins with and without the support of the DAMs or **JC 2:** their contribution is decisive to reverse a situation where growing an energy crop without applying for the Direct Aid Measure would imply an opportunity cost for the farmer => comparison between the margins of energy crops, with and without the support of the DAMs, and the margins of the most common alternatives	**IND 1)** Market revenues per hectare **IND 2)** Operating expenses per hectare **IND 3)** Support per hectare granted by the Direct Aid Measures	**Market revenues per hectare and operating expenses per hectare**: DEIAGRA elaborations on data from: bibliography; organisations and individual operators interviewed in the regional case studies; technical literature **Support per hectare granted by the Direct Aid Measures**: relevant EU regulations; DEIAGRA elaborations on data from: bibliography; organisations and individual operators interviewed in the regional case studies; technical literature
JC 3: Direct Aid Measures constitute an *actual incentive* to EU farmers to introduce or increase the cultivation of energy crops only if the status of potential incentive is associated with an increase of the area under energy crops, also taking into account the role played by promoting and limiting factors	**IND 3.1)** Area cultivated with energy crops under the Direct Aid Measures **IND 3.2)** Area cultivated with energy crops under no specific support regime	**Area cultivated with energy crops under the Direct Aid Measures**: European Commission – DG-Agriculture **Area cultivated with energy crops under no specific support regime**: DEIAGRA estimates on the basis of data and information by European Commission – DG-Agriculture; agricultural and industry organisations at EU and Member State level

14.1 Identification of the leading energy crops

The dynamics of the areas under energy crops in the EU over the evaluation period, broken down by relevant measure and by main typologies of crops, are reported in Table 14.1 below[196].

As regards the **energy crop area under the non food on set aside (NFSA) regime**, the following facts are noteworthy:

- After a steep increase in the three year period 1993-1995, from 1996 onwards energy crop area under NFSA approximately followed the evolution in the rate of compulsory set aside (see also Figure 14.1): in most of the years when such rate was equal to 10%, energy crop area under NFSA regime has floated around the 900.000 ha mark.
- Energy crops are undoubtedly the most common non food crops under NFSA: over the 1999-2002 period, when the rate of compulsory set aside was kept constantly equal to 10%, energy crops represented on average over 97% of total non food crop area on set aside (see Table 14.2). Over the same period, energy crops covered more than 22% of the total area under compulsory set aside in the EU.
- At least 90% of the energy crop area under NFSA has been dedicated to oilseeds over the entire evaluation period (Table 14.1). Most of this area has been cultivated with rapeseed (see Table 14.3)[197]. Sunflower ranked second in 2005 (see § 8.1.1.3 in the market analysis).
- Non-oilseed energy crops have represented less than 10% of total energy crop area under NFSA over the evaluation period. Cereals and sugar beet are the most important non-oilseed energy crops grown on set aside land (see Table 14.2 and § 8.1.1.3 in the market analysis).

In 2004, the aid for energy crops (AEC) was introduced. The expansion of **energy crop area under AEC** has been remarkable, with a growth of 83% in 2005 over the previous year. Such area has contributed to boost the total area under energy crops in the EU (see also Figure 14.2). At least 78% of the energy crop area under AEC has been dedicated to oilseeds, a percentage lower than that observed under the NFSA regime. Indeed, while the most important crop under AEC in 2005 was by far rapeseed (like in the case of NFSA), rye ranked second, even though at a long distance (see § 8.1.1.3).

It should be noted that, according to our estimates, a substantial area in the EU has been destined to the **cultivation of energy crops outside the aforementioned regimes**. The expansion of such area has indeed been remarkable over the last three years: in 2005 it represented more than 40% of the total estimated area under energy crops in the EU. According to our estimates (see § 8.1.1.4), most of this area is dedicated to rapeseed.

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[196] Table 14.1 is mostly based on data and information reported in § 8.1.1 and in annex D of the market analysis, to which the reader should refer for further details, and for a more exhaustive explanation of the methodology and assumptions used in the estimates carried out by the evaluation team.

[197] The figures in Table 14.3 are indeed referred to non food oilseeds under NFSA regime for both energy and non-energy purposes. However, as energy crops cover the near-totality of the area under non food crops on set aside (more than 97% on average in the 1999-2002 period, see Table 14.2), such data can be deemed representative of the most common kinds of oilseeds grown for energy use on set aside land.

Table 14.1 - Areas under energy crops in the EU, 1993-2005 (1.000 ha)

Geographical area	Items	Year													Var (%)	
		1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06		
EU-12 / EU-15 / EU-25	**% of compulsory set aside**	**15%**	**15%**	**12%**	**10%**	**5%**	**5%**	**10%**	**10%**	**10%**	**10%**	**10%**	**5%**	**10%**	**n.s.**	
EU-12 / EU-15 / EU-25	**Areas under non food on set aside regime (total) (1)**	***235,0***	***687,7***	***1.016,5***	***654,0***	***382,6***	***405,6***	**913,9**	**883,3**	**846,7**	**908,1**	***875,6***	***560,9***	***835,7***	**-8,6%**	**2005 on 1999**
EU-12 / EU-15 / EU-25	Areas under non food on set aside regime (oilseeds) (1a)	*219,8*	*657,6*	*969,8*	*642,0*	*382,3*	*403,7*	903,5	815,5	785,9	856,3	*827,9*	*507,6*	*793,9*	-12,1%	2005 on 1999
EU-12 / EU-15 / EU-25	Areas under non food on set aside regime (excl. oilseeds) (1a)	*15,2*	*30,2*	*46,7*	*12,0*	*0,3*	*1,9*	10,4	67,8	60,8	51,8	*47,7*	*53,3*	*41,8*	301,8%	2005 on 1999
EU-12 / EU-15 / EU-25	**Areas under aid for energy crops (total)**												**305,6**	**561,3**	**83,7%**	**2005 on 2004**
EU-12 / EU-15 / EU-25	Areas under aid for energy crops (oilseeds) (2)												*238,7*	*449,8*	88,5%	2005 on 2004
EU-12 / EU-15 / EU-25	Areas under aid for energy crops (excl. oilseeds) (2)												*66,9*	*111,5*	66,6%	2005 on 2004
EU-12 / EU-15 / EU-25	**Areas under other regimes / no specific regime (3)**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	***300,0***	***700,0***	***1.048,7***	**249,6%**	**2005 on 2003**
EU-12 / EU-15 / EU-25	**TOTAL (areas under non food on set aside regime (1) + areas under aid for energy crops (2))**	***235,0***	***687,7***	***1.016,5***	***654,0***	***382,6***	***405,6***	**913,9**	**883,3**	**846,7**	**908,1**	***875,6***	***866,5***	***1.397,0***	**59,5%**	**2005 on 2003**
EU-12 / EU-15 / EU-25	**GRAND TOTAL (areas under energy crops)**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	**n.a.**	***1.175,6***	***1.566,5***	***2.445,7***	**108,0%**	**2005 on 2003**

Source: DEIAGRA elaboration on:
years 1993-1998: DEIAGRA estimate on the basis of data from DGVI/C2 (total non food crops on set aside), assuming that the % of energy crops on set aside in the 1993-1998 period was equal to the average one (97,27%) in the 1999-2002 period (see table 1bis)
years 1999-2002: data from Working Document DG Agri G1 "Biofuels in the EU - Current situation" - September 2005;
years 2003 and 2004, areas under non food on set aside regime: DEIAGRA estimate on the basis of DG AGRI G1 and DG AGRI D1 data
year 2005, areas under non food on set aside regime: DEIAGRA estimate on the basis of the oilseeds NFSA area in 2005 (data from the Member States collected by DG AGRI: see table 8), assuming that oilseeds NFSA accounted for 95% of the total NFSA area, and that the % of energy crops on set aside in 2005 was equal to the average one (97,27%) in the 1999-2002 period (see table 1bis).
year 2004, areas under aid for energy crops: areas for which the aid has actually been paid, data from the Member States collected by the Commission DG AGRI D1- consolidated figures
year 2005, areas under aid for energy crops: areas for which the aid has been claimed, definitive data from the Member States collected by the Commission DG AGRI D1
Notes:
Figures in *italics*- ***italics*** are estimated
(1) energy crops only (non food crops grown on set aside for uses other than energy excluded)
(1a) 1993-1998: areas per type of crop are estimated on the basis of data from DGVI/C2 (total non food crops on set aside), assuming that the % of energy crops on set aside in the 1993-1998 period was equal to the average one (97,27%) in the 1999-2002 period (see table 1bis); 2005: areas per type of crop are estimated assuming that oilseeds NFSA accounted for 95% of the total NFSA area, and that the % of energy crops on set aside in 2005 was equal to the average one (97,27%) in the 1999-2002 period (see table 1bis).
(2) 2004: areas per type of crop for UK estimated; 2005: areas per type of crop are estimated on the basis of the distribution registered in 2004
(3) 2003: estimates from Working Document DG Agri G1 "Biofuels in the EU - Current situation" - September 2005; 2004 and 2005: DEIAGRA estimates on data from: DG Agri - Unit D1; COPA-COGECA (Poland and Czech Republic); FNR and German Farmers' Association (Germany); Institut Francais de l'Environment (France); DEFRA (United Kingdom).
n.s. = non significant
n.a. = not available

Table 14.2 - Importance of energy crops grown under the NFSA regime on compulsory set aside land, 1999/2002

Items	Years				Avg. 1999-2002
	1999/00	2000/01	2001/02	2002/03	
Compulsory set aside rate	10%	10%	10%	10%	**10%**
1) Set aside area (1.000 ha)	4.097,1	3.888,3	3.895,0	4.161,0	**4.010,4**
2) of which non food crops on set aside (1.000 ha)	924,5	918,1	867,0	942,0	**912,9**
3) of which energy crops on set aside (1.000 ha)	913,9	883,3	846,7	908,1	**888,0**
3a) of which oilseeds (1.000 ha)	903,5	815,5	785,9	856,3	**840,3**
3b) of which cereals (1.000 ha)	1,4	57,9	51,3	49,9	**40,1**
3c) of which other crops (1.000 ha)	9,0	10,0	9,4	1,8	**7,6**
Importance of 3) on 1) (%)	22,31%	22,72%	21,74%	21,82%	**22,14%**
Importance of 3) on 2) (%)	98,85%	96,21%	97,66%	96,40%	**97,27%**
Importance of 3a) on 3) (%)	98,86%	92,32%	92,82%	94,30%	**94,63%**
Importance of 3b) on 3) (%)	0,15%	6,55%	6,06%	5,49%	**4,52%**
Importance of 3c) on 3) (%)	0,98%	1,13%	1,11%	0,20%	**0,85%**

Source: DEIAGRA elaboration on data from Working Document DG Agri G1 "Bio-fuels in the EU - Current situation" - September 2005

Table 14.3 - Oilseeds: areas under non food on set aside regime (energy crops + non-energy crops) in the EU-15, 1995-2005 (1000ha)

Items	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	2001/02	2002/03	2003/04	2004/05	2005/06	Var %
Rapeseed: areas under NFSA regime (1.000ha)	825,9	571,5	311,0	338,8	895,2	714,8	685,5	721,7	777,4	472,2	796,2	-3,6%
Sunflower: areas under NFSA regime (1.000ha)	143,5	88,5	81,8	58,3	57,0	48,0	114,2	66,2	85,8	55,8	73,4	-48,8%
Total oilseeds: areas under NFSA regime (1.000ha)	969,4	660,0	392,8	397,1	952,2	762,8	799,7	787,9	863,2	528,0	869,6	-10,3%

Source: DEIAGRA elaborations on estimated data from DG AGRI G2 -outlook

In the agricultural reality of the EU, different kinds of crops are technically suited to the production of biomass for energy purposes, through the processes being relevant for this study. However, the evidence presented above[198] show that, over the evaluation period, the biggest share of agricultural areas under energy crops was destined to **oilseeds for bio-diesel production**, with **rapeseed** as the leading energy crop. Other energy crops – **cereals** and **sugar beet** in particular - have quite limited overall importance at EU level, but are indeed relevant for energy uses other than bio-diesel production (i.e. production of bio-ethanol; production of bio-gas; direct combustion of biomass) and/or if considered at national or regional level.

Summarising, the leading energy crops grown with the support of the DAMs under study in the EU are those identified in Table 14.4 below[199].

Table 14.4 - Leading energy crops under specific regimes (NFSA + AEC) in the EU, 2005

Regime	Leading energy crops	Sources of bioenergy	Member States where the situation applies
Non food on set aside regime (NFSA)	1) Rapeseed	Biodiesel	Germany, France, Denmark, Austria, Belgium, Luxembourg, The Netherlands, Ireland (rapeseed = most important energy crop under NFSA regime)
	2) Sunflower	Biodiesel	Italy (sunflower = most important energy crop under NFSA regime)
Aid for energy crops (AEC)	1) Rapeseed	Biodiesel	France, Germany, Denmark, Ireland, The Netherlands (rapeseed = most important energy crop under AEC)
	2) Rye	Bio-ethanol / direct combustion	Germany (rye = 2nd most important energy crop under AEC)
No specific regime	1) Rapeseed	Biodiesel	Germany

[198] See also the market analysis, § 8.1.1 and annex D.

[199] For a more detailed and comprehensive description of the importance of the various kinds of energy crops in the different regimes, please refer to § 8.1.1 and annex D of the market analysis, to the answer to the evaluation question 6 and related annexes, and to the case study monographs.

Source: DEIAGRA estimates on data from DG AGRI D1 (NFSA and AEC), DG AGRI G1, COPA-COGECA, FNR, German Farmers' Association, Institut Francais de l'Environment - French Institute of the Environment and DEFRA (no specific regime).

However, substantial areas (well over 100.000 ha) under non-oilseed crops for energy use - especially starchy crops for bio-ethanol production (cereals, potatoes) and maize for bio-gas production - are grown outside specific regimes, mostly in Germany (see in this respect § 8.1.1.4 in the market analysis).

14.2 Support provided through DAMs as a potential incentive to the farmer to introduce or increase the cultivation of energy crops

To assess whether the support provided through the relevant DAMs constitutes a potential incentive to the farmer to introduce or increase the cultivation of energy crops, a study of the economics of energy crop cultivation is needed, allowing to distinguish the market-related factors from the policy-related ones (and specifically from the action of the measures under study). An explanation of the micro-economic mechanisms of impact of the measures under study is provided in § 5.4. A synthetic description is provided below.

Micro-economic mechanisms of impact of the measures under study

Total revenues per hectare of a specific kind of energy crop can be broken down into two main components:

1) *Market revenues (basically determined by the yield per hectare of the crop and by the price of the biomass);*
2) *Revenues generated by the relevant DAMs ("DAM revenues"), which can be further divided in two sub-components:*
    a) *A "generic" component[200] which is not specifically linked to the destination of the crop to energy purposes, and which does not constitute, by design, an incentive to promote the cultivation of energy crops.*
    b) *A "specific" component, tied to the destination of the crop to energy purposes, which constitutes the real policy incentive to grow energy crops instead of crops for food, feed and other non-food purposes. This component is represented by the aid for energy crops (AEC).*

Under the NFSA regime, set aside payments are granted to the farmer irrespective of the land being cultivated with non food crops (for energy uses or for other non food uses) or left fallow: hence, set aside payments do not constitute an incentive to grow energy crops (or crops for other non food uses) on set aside land[201]. The cultivation of non food crops on set aside land benefits however from an economic advantage (the avoided cost of land maintenance) over fallow set aside: such advantage constitutes a component of the "implicit subsidy" to the cultivation of non food crops on set aside land, the other component stemming from the fact that on set aside land there are no feasible gainful alternatives to the cultivation of non food crops, i.e. the land "comes for free" (see also § 5.4 and § 11.1.1).

To assess the role of each DAM as *a potential* incentive to the farmer to introduce or increase the cultivation of energy crops, economic analyses[202] were carried out to measure the contribution of the support granted by the DAM under study in:

1) achieving a positive gross margin for the energy crops;
2) reversing a situation where growing an energy crop without applying for the DAM under study would have implied an opportunity cost for the farmer.

The rationale behind such economic analyses is synthetically described below, making a distinction between the pre- and post-decoupling contexts.

Direct aid measures as potential incentives to the cultivation of energy crops

Before the implementation of decoupling

Given the "generic" nature of aids coming from area payments, the comparisons which are decisive to assess the importance of DAMs as *a potential* incentive for the farmers to choose to grow energy crops are those involving the AEC.

The area payments did not constitute, by design, an instrument aimed at promoting the cultivation of energy crops, and cannot therefore be considered a potential incentive in this respect[203].

[200] Area payments for arable crops (before the implementation of decoupling) or the aids coming from the SPS and the remaining coupled payments for arable crops (after the implementation of decoupling) form this "generic" component.
[201] The case of sugar beet cultivation for energy purposes on set aside land is however peculiar, inasmuch - until the recent reform of the CMO for sugar - sugar beet grown under the NFSA regime could not benefit from set aside payments.
[202] Please refer to tables from A.1.10 to A.1.23 in the annex to this evaluation question for the details of the analyses, which were based on the most recent available data (generally falling within the 2003-2005 period).

Equally, the NFSA regime was not conceived – and did not operate - as an instrument to promote the cultivation of energy crops on set aside land[204]. However, through the authorisation to grow energy crops on set aside land without having to renounce to set aside payments[205], the NFSA regime has contributed in creating a favourable environment for an expansion in the area under energy crops in the EU.

After the implementation of decoupling

After the implementation of decoupling, aids coming from the SPS are not linked with crop cultivation anymore, and therefore cannot constitute, by design, a tool aimed at directly promoting the cultivation of energy crops. The same can be said of the payments that have remained coupled (in France and Spain)[206]. Nevertheless, the SPS contributes indirectly to create an environment which is favourable to the development of energy crops: as income support for farmers is no longer linked to the quantity and type of crop, farmers are now free to respond to favourable demand dynamics in the markets of biomass for energy purposes.

As regards the NFSA regime, the market margin and the "implicit subsidy" still are the relevant items for the analysis, as the AEC continues not to be applicable to energy crops grown on set aside land.

In the light of the above considerations, the analysis has to be focused first on the role of the AEC as a *potential* incentive to introduce/increase energy crop cultivation, as the AEC is - both before and after the implementation of decoupling - the only DAM designed to grant additional support (i.e. differential benefits) only to the farmers that choose to grow energy crops. Then an assessment of the role of the NFSA regime as a potential incentive to introduce/increase energy crop cultivation has to be carried out.

Limitations of the analysis and validity of the results

1) *The economic analysis was carried out at regional level, on the basis of data collected in the framework of the regional case studies*[207].

This choice limited the possibility to extend the validity of the results of the analysis to broader geographical areas, i.e. to "generalise" its main findings[208].

As a partial remedy, a number of situations were chosen which might be deemed representative - from a qualitative if not a quantitative (statistical) standpoint - of the most significant bio-energy supply chains to be found in the EU, i.e. the ones identified at § 14.1 above, as far as both the kinds of energy crops and the types of bio-energy sources were concerned.

All the data on the economics of energy crops featured in these paragraphs are actual data retrieved in the framework of the case studies, not estimated ones, and are all referred to the situation existing before the implementation of the decoupling. Such data were obtained through interviews to the stakeholders: while relevant efforts were made in order to ensure the maximum possible reliability and comparability of such data, however the results have to be taken with due care. Another limitation stems from the fact that the analyses are referred to a specific year since no time series of actual data on the economics of energy crops were found.

[203] Indeed the level of the support granted through area payments did not increase if the farmer chose to grow energy crops instead of crops destined to food, feed or non-food uses other than energy purposes. Nevertheless, a substantial – albeit non–specific - support was provided through area payments to the energy crops which were eligible for them (the most common ones, actually), as such payments supplemented market revenues in covering the operating expenses for their cultivation and in creating their margin. It has to be noted however that a number of energy crops was not eligible for area payments: sugar beet, short rotation coppice, miscanthus, reed canary grass, etc. This situation might have influenced the farmers' choices, favouring some kinds of energy crops over other kinds (see in this respect the answer to the evaluation question 6).

[204] Indeed the NFSA regime did not provide differential benefits to farmers if they chose to grow energy crops instead of non-food crops destined to other uses, or instead of leaving the land fallow. However, the NFSA regime had an indirect "specialisation effect" inasmuch it limited the set of possible alternatives to the cultivation of energy crops on set aside land (crops for food and feed use cannot indeed be grown on such land).

[205] With the only exception of sugar beet, which could not benefit from set aside payments before the reform of the CMO for sugar.

[206] Indeed the support granted through the remaining coupled payments does not increase if the farmer chooses to grow energy crops instead of crops destined to food, feed or non-food uses other than energy purposes.

[207] The reasons behind this choice were basically the following:

1) As no specific data on the economics of energy crops were available through FADN, a systematic analysis at Member State level based on data retrieved from a single, ample and methodologically coherent database was unfeasible.
2) Being forced to base the analysis on data from heterogeneous, "spot" sources, it was deemed prudent to limit the geographical scope of the analysis to the specific area where data were retrieved.

[208] The use to this purpose of the data on the profitability of energy crops at Member State level which appear in § 11.1.1 would not be correct. Such data are estimated, through a number of undifferentiated assumptions, from figures concerning the economics of conventional (non-energy) crops: the data used here are instead elaborations of actual data concerning the economics of energy crops, which are referred to specific techno-economic contexts.

The data on the margins for the conventional crops are referred to the Member States which the regions under study belong to and retrieved from bibliography[209]. Consequently, the limitations to the methodology used by the author affect these calculations[210].

As far as the analysis based on the opportunity costs is concerned, this has been carried out taking the most common conventional crop (for food or feed use) in the regions under study as the alternative to the energy crop. This simplified approach was chosen to analyse a situation which could be relevant for the highest possible number of farmers in those regions, as not all the theoretically possible alternative crops are actually suited to all the farms. Moreover, this choice permitted to keep the complexity of the analysis (i.e. the number of comparisons to be made) within manageable limits. Obviously this solution does not permit to investigate on specific situations where farmers can choose among a higher number of feasible alternatives.

It is also to remind that throughout the whole study the component of the "implicit subsidy" stemming from the fact that on set aside land there are no feasible gainful alternatives to the cultivation of non food crops was not factored in the calculations, as its estimate proved too difficult. Hence in the whole evaluation study the "implicit subsidy" is considered as given by the sole avoided cost of land maintenance on set aside land.

Finally, the estimate of the cost of land maintenance on set aside land was made assuming for all the Member States the use of a standard technique[211]. This resulted in a land maintenance cost of 100 Euros per hectare. The strongest assumptions in such estimate are those concerning the adoption of average values for the hourly cost of labour and for the cost of fuel, as variations in the actual values among the different Member States can be non-negligible. In modern mechanized agriculture, the adoption of a standard technique and of standard labour and fuel requirements is instead plausible, especially in the case of rather commonplace operations as harrowing and mowing. The non-differentiation at regional level of the cost of land maintenance constitutes indeed a limitation of the analysis[212].

14.2.1 The role of the AEC as a potential incentive

To assess the role of the AEC as a potential incentive, two types of analyses are needed:

- when the choice is between two different uses – energy versus non-energy - of the same crop, i.e. in the case of an **"intra-crop" choice**, a comparison between the support granted by the AEC and the market margin is needed;
- when the choice is between a certain kind of energy crop and another kind of crop for non-energy use, i.e. in the case of an **"inter-crop" choice**, the opportunity costs associated with the cultivation of the former – both with and without the support granted by the AEC – in alternative to the latter must be compared.

A detailed illustration of the rationale of the two analyses follows.

In the case of **"intra crop" choice**, the crucial indicator for a *potential* incentive was identified in the one *comparing AEC with the "market margin (DAM revenues excluded)"*, i.e. the margin resulting from the combined action of the market forces and natural variability in crop productivity. As the variations in this margin are outside the farmers' control, every type of support which is independent from the forces that cause the variations in the margin, and especially all the types of support based on the granting of a constant additional revenue, are usually appreciated by farmers who can benefit from an increase in their

[209] Data are the same featured in the market analysis (§ 11.1.1), based on a set of data - yields, prices, variable production costs and area payments - retrieved from Graham Brookes, "European arable crop profit margins" (2004/05), and relating to crops harvested in the latter half of 2004. Following the author, the sources of information and the methodology are the following: i) whenever actual (or early harvest forecast) average yields and prices could not be used, estimates are used, ii) area support payment rates are those applicable to crops harvested in 2004 and marketed in 2004/05 marketing year (full payment rates are used, except for the cases of penalties for overshooting base areas that may apply) and iii) costs of production data are derived from a variety of sources across the Member States covered. As the majority of these costs data are derived from surveys that relate to earlier years (2002 and 2003), they have been extrapolated by the author to 2004.

[210] According to the methodology used by the author, some relevant limitations of these data have to be identified. First, only an average performance for each crop is presented. Second, the data relate to one year, whereas yields and prices vary from year to year, as well as other factors which have an influence on the margin (different incidence of pests and diseases, soil type, weather and management, labour skills/expertise, etc). Third, the data relate to average arable crop area payments, whereas differences across regions exist in reality (especially in the larger EU Member States).

[211] Two harrowings and a mowing, with the use of a 100 hp tractor (which implies labour requirements of 4 hours per hectare). A fuel consumption of 150g/hp/hour was assumed (total fuel consumption per hectare equal to 60 kilos). An average hourly cost of labour of 11 Euros and a fuel cost of 0,7 Euros/kilo were assumed. The associated costs for lubricants and maintenance of the equipment were estimated at 14 Euros.

[212] The evaluation team felt however that the added value for the study deriving from an in-depth, Member State-specific, *ad hoc* analysis of the cost of land maintenance on set aside would have been quite limited in comparison with the work burden required. For instance, by assuming an hourly cost of labour of 9,5 Euros and a fuel cost of 0,6 Euros/kilo (i.e. significantly different values from the ones adopted by the evaluation team, obviously remaining within plausible values), the cost of land maintenance would be of (9,5 X 4 + 60 X 0,6 + 14) = 88 Euros, just slightly more than 10% lower of the estimated one.

revenues and also from a sort of "insurance" against the vagaries of the margin. In the case of AEC, the cultivation of energy crops is conditional for the farmer to achieve such benefits, and there lies the ability of AEC in acting as a *potential* incentive for the farmers. The higher is the AEC in comparison with market margin, the more important is the role of AEC in "hedging" farmers against the variations of this margin, and consequently the clearer its function of *potential* incentive to introduce/increase energy crop cultivation in their holdings.

When the market margin is tight, the role of the AEC as a *potential* incentive for energy crop cultivation is important; when the above margin is negative, the role of the AEC from this standpoint is decisive. On the other hand, the role of the AEC cannot be deemed important when the margin resulting from the sole market forces is high.

In the case of **"inter crop" choice**, an assessment of the role of the AEC as a *potential* incentive for energy crop cultivation can be done only taking into account the *opportunity cost of cultivating an energy crop* - with and without the support of AEC - *instead of a crop for food or feed use*. The opportunity cost is given by the difference in the total unit margins of the crops (energy vs. alternative). If the support granted through the AEC can reverse a situation where growing an energy crop without applying for the AEC would imply an opportunity cost (i.e. whenever the energy crop becomes more profitable than the alternative as a result of the granting of the AEC), then the role of the AEC as a potential incentive can be deemed decisive also as far as "inter crop" choice is concerned.

The essential data for the analysis and its results[213] - i.e. the values assumed by the crucial indicators - are illustrated in table 14.5 and table 14.6.

Table 14.5 - Economics of energy crops cultivation under AEC: importance of AEC for some representative situations at regional level, 2004

Regions	Type of activity	Market revenues (Euros/ha)	Operating expenses (Euros/ha)	Market margin (DAM revenues excluded) (Euros/ha)	Aid for energy crops (Euros/ha)	AEC / Market margin (%)
AT21 - Kärnten	Maize cultivation for energy use (biogas production)	935,00	620,00	315,00	45,00	14,3%
DE9 - Niedersachsen	Rapeseed cultivation for energy use (biodiesel production)	812,00	525,00	287,00	45,00	15,7%
	Maize cultivation for energy use (biogas production)	870,00	790,00	80,00	45,00	56,3%
ES41 - Castilla y León	Sunflower cultivation for energy use (biodiesel production) - dry culture	160,00	160,00	0,00	45,00	margin is zero
	Sunflower cultivation for energy use (biodiesel production) - irrigated culture	496,00	370,00	126,00	45,00	35,7%
	Barley cultivation for energy use (bio-ethanol production) - dry culture	282,00	303,00	-21,00	45,00	margin is negative
	Barley cultivation for energy use (bio-ethanol production) - irrigated culture	456,00	514,00	-58,00	45,00	margin is negative
Oulu Region (Finland)	Reed canary grass cultivation for energy use (direct burning in power plants)	210,00	237,00	-27,00	45,00	margin is negative
FR21 - Champagne-Ardenne	Common wheat cultivation for energy use (bio-ethanol production)	760,00	500,00	260,00	45,00	17,3%
FR23 - Haute-Normandie	Rapeseed cultivation for energy use (biodiesel production)	805,00	530,00	275,00	45,00	16,4%

Source: DEIAGRA elaboration on data from regional case studies

[213] The analysis is referred to the situations that applied before the implementation of decoupling, as no adequate sets of data on the economics of energy crops were retrieved for years 2005 and 2006. It has to be noted, however, that the comparisons featured in Table 14.6 below would be valid (provided that price levels and yields do not vary) also for the cultivation of energy crops after the decoupling, as the market margin is considered in these comparisons.

Table 14.6 - Economics of energy crops cultivation under AEC: opportunity costs associated with the cultivation of energy crops for some representative situations at regional level, 2004

Regions	Type of activity (energy crops)	1) Total unit margin, AEC included (Euros/ha)	2) Total unit margin, AEC excluded (Euros/ha)	Alternative activity (most common conventional crop in the region)	3) Total unit margin (Euros/ha)	4) Unit opportunity cost, AEC excluded = (2)-(3) (Euros/ha)	5) Unit opportunity cost, AEC included = (1)-(3) (Euros/ha)
AT21 - Kärnten	Maize cultivation for energy use (biogas production)	692,00	647,00	Grain maize	477,00	170,0	215,00
DE9 - Niedersachsen	Rapeseed cultivation for energy use (biodiesel production)	667,00	622,00	Common wheat	422,74	199,3	244,26
	Maize cultivation for energy use (biogas production)	460,00	415,00	Common wheat	422,74	-7,7	37,26
ES41 - Castilla y León	Sunflower cultivation for energy use (biodiesel production) - dry culture	223,00	178,00	Barley	283,20	-105,2	-60,20
	Sunflower cultivation for energy use (biodiesel production) - irrigated culture	349,00	304,00	Barley	283,20	20,8	65,80
	Barley cultivation for energy use (bio-ethanol production) - dry culture	202,00	157,00	Barley	283,20	-126,2	-81,20
	Barley cultivation for energy use (bio-ethanol production) - irrigated culture	165,00	120,00	Barley	283,20	-163,2	-118,20
Oulu Region (Finland)	Reed canary grass cultivation for energy use (direct burning in power plants)	18,00	-27,00	Barley	266,10	-293,1	-248,10
FR21 - Champagne-Ardenne	Common wheat cultivation for energy use (bio-ethanol production)	690,00	645,00	Common wheat	661,10	-16,1	28,90
FR23 - Haute-Normandie	Rapeseed cultivation for energy use (biodiesel production)	716,00	671,00	Common wheat	661,10	9,9	54,90

Source: DEIAGRA elaboration on data from regional case studies (1, 2) and Graham Brookes, "European arable crop profit margins" (2004/05) (3)
Items 1, 2 and 3: total unit margin = market margin + area payment (+ AEC in column 1)
Note: the data source used did not permit to differentiate dry and irrigated culture in the calculation of the total unit margin for the alternative activity – conventional barley – in the cases concerning the Castilla y Leon region. It is however plausible that – similarly to energy barley – conventional barley achieves a higher margin in irrigated culture (the additional margin in the case of energy barley is about 40 Euros/ha). This implies that opportunity costs might be lower than the ones estimated above in case of dry culture, and higher than the ones estimated above in the case of irrigated culture.

In the light of the results illustrated in table 14.5 above, in the case of **"intra crop" choice** the role of the AEC as a *potential* policy incentive to the farmer to introduce or increase the cultivation of energy crops was deemed:

- *Decisive* for three out of four situations studied in Castilla y Leon and for the situation studied in Finland, that were all characterised by negative or extremely tight (near-zero) market margins for the energy crops under study.
- *Important* in the cases of maize cultivation for energy use (bio-gas production) in Niedersachsen and of irrigated sunflower cultivation for energy use (bio-diesel production) in Castilla y Leon, as the AEC is equal to 35-50% of the market margin.
- *Significant* for the remaining situations, as the AEC represents anyway 14-17% of market margin.

In the case of **"inter crop" choice**, the analysis of the opportunity costs (see

Table 14.6 above) highlighted that the role of the AEC could be deemed decisive in the case of energy maize cultivation in Niedersachsen versus the cultivation of conventional common wheat. In some cases, being the most common conventional crop the same as the energy crop under study (barley in Castilla y Leon; common wheat in Champagne-Ardenne), we cannot speak of a proper "inter crop" choice. Nevertheless, in the case of common wheat grown for bio-ethanol production in Champagne-Ardenne, the role of the AEC is equally decisive in reversing a situation where – in comparison with the cultivation of conventional common wheat – the choice to grow energy wheat without AEC would have implied an opportunity cost for the farmer. Moreover, the role of the AEC is important – although not decisive – also with reference to the cultivation of both rapeseed for bio-diesel production in Haute Normandie and irrigated sunflower for bio-diesel production in Castilla y Leon: in these cases the support granted through the AEC indeed made the advantage of such energy crops over the most common conventional crops less tight.

14.2.2 The role of the NFSA regime as a potential incentive

As regards the economic analysis of the role of NFSA regime as a potential incentive to introduce/increase energy crop cultivation on set aside land, it is interesting to compare the level of the "implicit subsidy" with the market margins of energy crops grown on set aside land, though it has to be remembered that the "implicit subsidy" is a potential incentive which is not specific to energy crops, as all non food crops grown on set aside land benefit from it. However, as in practice most non food crops grown on set aside land are destined to energy purposes (see in this respect § 8.1.1.3 of the market analysis), this analysis can however give useful indications. It is important to remember that the "implicit subsidy" differs from the AEC as it does not constitute an additional monetary revenue, but it is an economic advantage over an alternative use of set aside land, i.e. fallow set aside[214].

The results[215] of the aforementioned analysis are illustrated in table 14.7 below.

The "total margin" of the energy crops grown on set aside (last column in table 14.7 below) is not a purely monetary value (differently from, for instance, the "total margin" of energy crops grown under the AEC regime), but combines a non-monetary economic component - the "implicit subsidy" (which is an avoided cost) - with a properly monetary one, the market margin. Such "total margin" measures the total economic advantage of the cultivation of non food crops over fallow set aside.

Table 14.7 - Economics of energy crops cultivation under NFSA: "implicit subsidy" versus market margins of energy crops on set aside land in some representative situations at regional level, 2004

Regions	Type of activity	Market margin ("implicity subsidy" excluded) (Euros/ha)	"Implicit subsidy" (Euros/ha)	Implicit subsidy / Market margin (%)	Total margin ("implicit subsidy" included) (Euros/ha)
DE9 - Niedersachsen	Rapeseed cultivation for energy use (biodiesel production)	287,00	100,00	34,8%	387,0
	Maize cultivation for energy use (biogas production)	80,00	100,00	125,0%	180,0
ES41 - Castilla y León	Sunflower cultivation for energy use (biodiesel production) - dry culture	0,00	100,00	margin is zero	100,0
	Sunflower cultivation for energy use (biodiesel production) - irrigated culture	126,00	100,00	79,4%	226,0
	Barley cultivation for energy use (bio-ethanol production) - dry culture	-21,00	100,00	margin is negative	79,0
	Barley cultivation for energy use (bio-ethanol production) - irrigated culture	-58,00	100,00	margin is negative	42,0
FR21 - Champagne-Ardenne	Common wheat cultivation for energy use (bio-ethanol production)	260,00	100,00	38,5%	360,0
FR23 - Haute-Normandie	Rapeseed cultivation for energy use (biodiesel production)	275,00	100,00	36,4%	375,0

Source: DEIAGRA elaboration on data from regional case studies

[214] The "implicit subsidy" is the reason behind the cultivation on set aside land of non food crops with negative market margins: if the absolute value of the market margin is less than the cost of land maintenance, the cultivation of the non food crop is more convenient than leaving the land fallow, as the economic loss associated with the former option is lower than the expenses to be incurred in the latter one.

[215] The analysis is referred to the situations that applied before the implementation of decoupling, as no adequate sets of data on the economics of energy crops were retrieved for years 2005 and 2006. It has to be noted, however, that the relevant items to assess the role of the NFSA regime as an incentive to introduce/increase energy crop cultivation on set aside land before the implementation of decoupling – i.e. the market margin and the "implicit subsidy" – continue to be the relevant ones also in the post decoupling context.

From table 14.7 above, it can be seen that the "implicit subsidy" had an important role as an incentive in three out of four situations studied in Castilla y Leon, where the market margin of the energy crop was zero or negative.

Finally, it has to be reminded that the "implicit subsidy" features also a second component, stemming from the fact that on set aside land there are no feasible gainful alternatives to the cultivation of non food crops, i.e. the land "comes for free" (see also § 5.4 and § 11.1.1). Though not factored in the above calculations due to difficulties in its estimate, this second component is nevertheless to be deemed relevant, especially where highly profitable crops for food/feed use can be grown on non-set aside land: in these cases the opportunity costs associated to the cultivation of energy crops - which are avoided on set aside land, as food/feed crops cannot be grown there – are higher.

14.3 Support provided through DAMs as an actual incentive to the farmer to introduce or increase the cultivation of energy crops

The identification of a number of relevant situations where the DAMs under study, and the AEC in a special way, represent for EU farmers a ***potential*** incentive to grow energy crops does not imply that the actual dynamics of the areas under energy crops are governed by the evolution of these measures. To assess the role of the DAMs as ***actual*** incentives to farmers to introduce or expand the cultivation of energy crops two further analyses are needed:

1) The study of the actual dynamics of agricultural areas under energy crops that fall within the scope of the relevant measures, in order to:
   - verify the existence of favourable dynamics for these areas;
   - put in relation the actual dynamics for these areas with the crucial changes in the design of the system targeted at promoting the cultivation of energy crops through the direct aid measures.
2) The study of the influence of factors other than the DAMs that could have caused favourable/unfavourable dynamics in the area under energy crops (acting in the latter case as limiting factors to its increase).

This paragraph reports the results of the analysis at point 1) above, while the following paragraph reports the results of the analysis at point 2).

From the figures illustrated in table 14.1 above, from the figure 14.1 and figure 14.2 below and from Table 14.8 below[216], the following relevant phenomena emerge at EU-15 level, as far as the dynamics of the area under energy crops in the evaluation period are concerned.

1) After the initial three year expansion phase (1993-1995), from 1996 onwards whenever the dynamics of energy crop cultivation under the NFSA regime have featured substantial variations, these have appeared to follow somehow (figure 14.1) the variations in the rate of compulsory set aside, although often showing less than proportional decreases; in the periods when the rate of compulsory set aside was left unchanged at 10%, energy crops area under NFSA regime has tended to remain fairly stable, floating around the 900.000 ha mark.
2) The introduction of the AEC in 2004 counterbalanced the effects on total area under energy crops of the switch in the rate of compulsory set aside (from 10% to 5%) in the same year, and resulted in a substantial boost to total area under energy crops in 2005 (see Figure 14.2), when the rate of compulsory set aside was returned to its previous level (10%). AEC area showed three-digit growth rates over 2004 in nearly all the Member States where the measure was implemented also in 2005 (see Table 14.8).
3) Areas where energy crops are grown outside AEC or NFSA regime have been really substantial in recent years, having reached around 1 million ha in 2005 (see Table 14.1 above). The extremely large expanse of such areas poses some issues which are relevant when assessing the role of the DAMs in promoting the cultivation of energy crops. These issues are basically the following two:
   - In certain cases the cultivation of energy crops has been, and still is, economically attractive even without the support granted by AEC, or outside the NFSA regime: the analysis at § 14.2 indeed showed that in some cases market margins are substantial (see Table 14.5), and moreover most of these crops have been eligible for the support granted through arable crops payments and then the

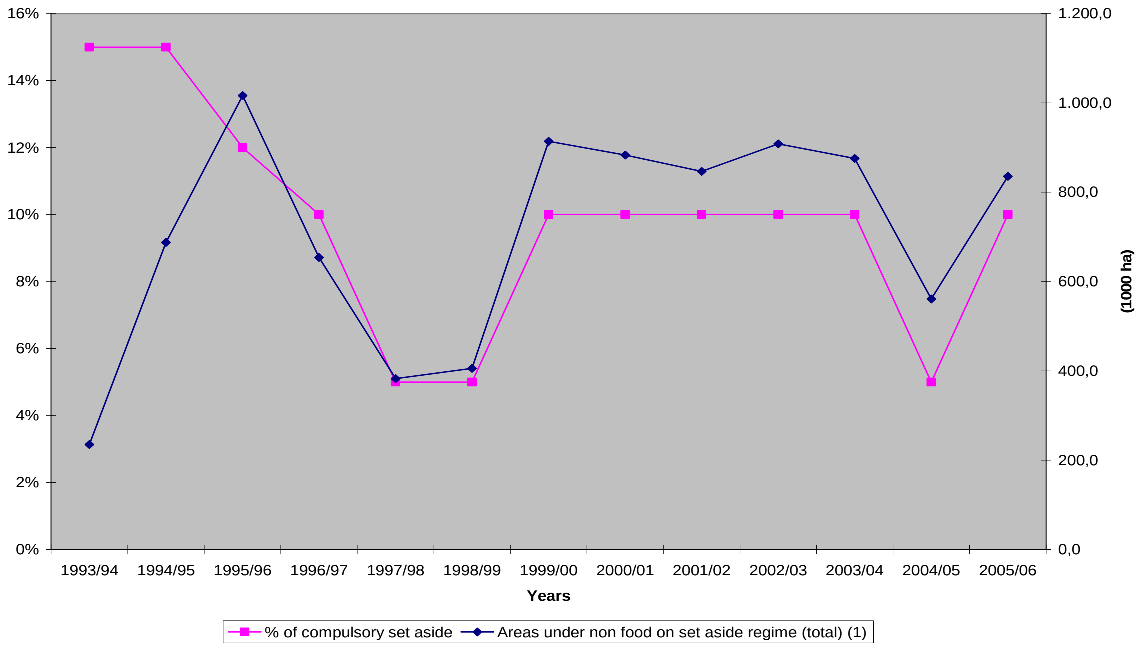
[216] Further evidence in this respect is illustrated in detail in § 8.1.1 and annex D of the market analysis, and also in the case study monographs.

SPS. Furthermore, in the post decoupling context farmers can react freely to favourable market signals (increase in prices caused by an expanding demand for biomass for energy purposes), expanding the area under the most profitable energy crops.

- The AEC maximum guaranteed area (1.500.000 hectares) has been far from being saturated in the first two years of implementation of the measure (2004 and 2005), while areas under energy crops not benefiting from AEC or NFSA regime have reached around 1 million ha in 2005: can the two phenomena be somehow related? In other words, do some farmers find the AEC not so attractive? If yes, why?

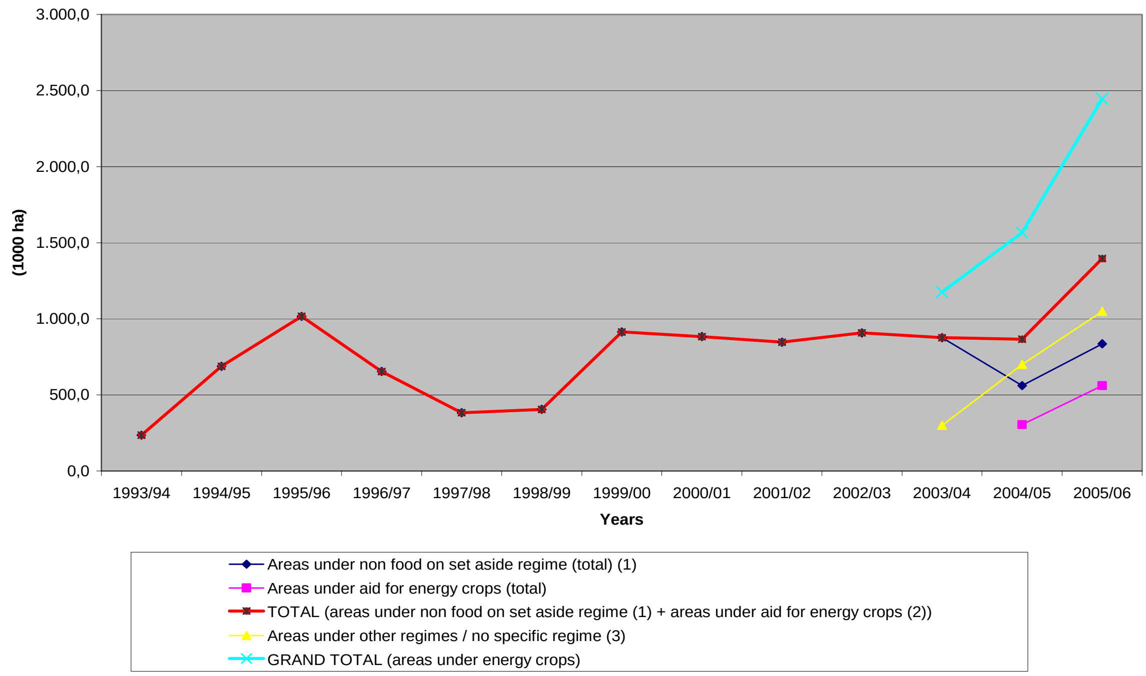
These issues will be addressed, among other ones, at § 14.4 below.

Figure 14.1– Evolution of compulsory rate of set aside and of the area under energy crops under non food on set aside regime in the EU, 1993-2005.



(1) energy crops only (non food crops grown on set aside for uses other than energy excluded)

Figure 14.2 – Evolution of the area under energy crops in the EU by type of regime, 1993-2005



(1) energy crops only (non food crops grown on set aside for uses other than energy excluded)
(2) 2004: areas for which the aid has actually has actually been paid; 2005: areas for which the aid has been claimed, definitive data.
(3) 2003: estimates from Working Document DG Agri G1 "Bio-fuels in the EU - Current situation" - September 2005; 2004 and 2005: DEIAGRA estimates on data from: DG Agri - Unit D1; COPA-COGECA (Poland and Czech Republic); FNR and German Farmers' Association (Germany); Institut Francais de l'Environment (France); DEFRA (United Kingdom).

Table 14.8 - Areas under aid for energy crops in the EU-15, 2004-2005 (ha)

Member States	2004	2005	Var %
Belgique/België and Luxembourg	120,6	2.644,2	2092,2%
Danmark	4.450,4	17.445,1	292,0%
Deutschland	109.300,8	237.704,5	117,5%
España	6.705,0	27.321,4	307,5%
France	130.034,0	135.822,7	4,5%
Ireland	418,8	1.613,1	285,2%
Italia		285,4	n.s.
Nederland	138,6	320,5	131,2%
Österreich	3.498,0	8.130,2	132,4%
Portugal		77,5	n.s.
Suomi/ Finland	3.475,3	10.300,4	196,4%
Sverige	14.547,3	31.075,9	113,6%
United Kingdom	32.927,8	88.589,9	169,0%
Total	**305.616,6**	**561.330,6**	**83,7%**

Source: DEIAGRA elaboration of:
2004: areas for which the aid has actually been paid, data from the Member States collected by the Commission DG AGRI D1-consolidated figures
2005: areas for which the aid has been claimed, definitive data from the Member States collected by the Commission DG AGRI D1
Note:
Aid for energy crops maximum guaranteed area = 1.500.000 hectares (R. 1782/2003 - article 89)

Besides the issues at point 3) above, the dynamics registered in the areas under energy crops in the 2003-2005 period[217] suggest that, among the DAMs under study, the AEC constituted an additional *actual* incentive to the introduction/expansion of energy crops in the EU in the most recent part of the evaluation period. It is also interesting to note that substantial increases in the energy crop area under the AEC occurred in Spain and Finland, as it was seen at § 14.2 that the role of AEC as a *potential* policy incentive to the cultivation of energy crops was deemed decisive in a number of representative situations in these two Member States (in the Castilla y Leon and Oulu regions respectively).

The remarkable expansion in the energy crop area under the NFSA regime which occurred at the beginning of the evaluation period (1993-1995), and the linkage between its dynamics and the rate of compulsory set aside from 1996 onwards, suggest that also this measure had its role as an *actual* incentive to the introduction/expansion of energy crops in the EU, or at least as an incentive to maintain the cultivation of such crops. This conclusion is consistent with the findings of the "Evaluation of the impact of community measures concerning set aside" carried out for the EU Commission in 2002, with respect to the role of the set aside regime in determining the evolution of non food crops: "within favourable contexts, the implementation of set aside has been determinant for the development of (non food) crops"[218].

14.4 Promoting and limiting factors to an increase in production

A number of relevant factors – other than the DAMs under study - likely to have a positive (*promoting factors*) or negative (*limiting factors*) effect on the dynamics of the areas under energy crops benefiting from DAM support, were individuated in the framework of the regional case studies[219]. For a better clarity in the exposition, promoting and limiting factors are here divided into two broad categories (whose boundaries are sometimes difficult to trace):

- *Technical factors*, which comprise all the factors concerning cultivation techniques, agronomical conditions, technical features of the various kinds of biomass destined to energy purposes, etc.

[217] Besides the expansion that occurred in the areas not covered by specific regimes, the areas under AEC have grown remarkably (see Table 14.1 and Table 14.8 above) while the areas under NFSA regime have failed to do so (see Table 14.1).
[218] Original wording in French of the synthetic answer: "Dans les contextes favorables, la mise en place du gel a été déterminante pour le développement de ces cultures" ("Evaluation of the impact of community measures concerning set aside", chapter 4, § 30 http://ec.europa.eu/agriculture/eval/reports/gel/chap4.pdf).
[219] See also case study monographs, in the annexes.

- *Non-technical factors*, which comprise all the factors concerning the economics and organisation of production at the various levels of the bio-energy supply chain, private and public regulation mechanisms (institutional factors), socio-cultural environment, etc. In studying this broad group of factors, a particular attention has been given to those concerning the administrative aspects of the implementation of the measures under study (description in underlined types in the lists below).

Another reason behind the above classification is that while it is difficult or even impossible for policy makers to intervene on technical factors (as defined above), non-technical factors (as defined above) constitute the traditional target of public policies.

A picture of the most relevant promoting and limiting factors identified in the framework of the regional case studies, is very synthetically outlined in this paragraph; only the factors concerning the administrative aspects of the implementation of the measures under study are treated in more detail[220].

The main ***promoting factors*** identified in the framework of the regional case studies are cited in the table below:

Promoting factors			
Technical factors		**Non-technical factors**	
Factor	**Energy crops and/or region where the relevance of the factor was assessed**	**Factor**	**Energy crops and/or region where the relevance of the factor was assessed**
Consolidated production techniques, very similar to those for crops for food and feed use	Rapeseed in Niedersachsen, Haute Normandie, Eastern England; Sunflower in Castilla y Leon and Tuscany; Maize for bio-gas production in Niedersachsen and Carinthia; Wheat for bio-ethanol production in Champagne Ardenne; Barley for bio-ethanol production in Castilla y Leon; Reed canary grass in Oulu region	Increasing demand for biomass for energy purposes, with the associated increase in prices	Niedersachsen; Champagne Ardenne; Haute Normandie; Carinthia; Oulu region
Availability of varieties more suited to energy use	Rapeseed for bio-diesel production in Niedersachsen	Diversification of farming activities	Niedersachsen; Castilla y Leon; Champagne Ardenne; Haute Normandie; Eastern England; Oulu region; Carinthia
Positive agronomical effects	Rapeseed for bio-diesel production and maize for bio-gas production in Niedersachsen; Sunflower for bio-diesel production in Castilla y Leon	Institutional environment favourable to bio-energy	Niedersachsen; Champagne Ardenne; Haute Normandie; Eastern England; Carinthia; Oulu region
Possibility of using the by-products of the bio-energy supply chain in agriculture, as fertilizers, feed, etc.	Maize for bio-gas production in Niedersachsen and Carinthia; Rapeseed for bio-diesel production in Niedersachsen and Haute Normandie; Sugar beet for bio-ethanol production in Champagne Ardenne	Favourable attitude of the resident population towards the cultivation of energy crops	Niedersachsen; Champagne Ardenne; Haute Normandie; Oulu region
		Self-esteem for farmers as agents contributing to the reduction of pollution and to the country's energy supplies	Haute Normandie; Castilla y Leon

Two further sets of promoting factors may have played a relevant role at regional and Member State level in the expansion of the areas under energy crops, and especially of those grown outside specific regimes:

- the granting of additional support through public policies at Member State level and/or through non-CAP measures at EU level (see EQ 9);

[220] Please refer to section V (Regional case studies) for a full description of the promoting and limiting factors that were found to be relevant in each specific region.

- favourable contextual ("system") factors other than the ones listed above (see EQ 10).

The main *limiting factors* that were identified in the framework of the regional case studies are cited in the table below:

Limiting factors			
Technical factors		**Non-technical factors**	
Factor	**Registered for**	**Factor**	**Registered for**
Agronomical constraints (crop rotation issues, absence of specific varieties, etc.)	Rapeseed in Niedersachsen; Castilla y Leon; reed canary grass in Finland	Poor profitability of energy crops in comparison with the possible alternatives	Castilla y Leon; sunflower for bio-diesel production in Tuscany
Production techniques still in a semi-experimental phase	Miscanthus and short rotation coppice in Eastern England	Insufficient demand for biomass due to limited presence of processing plants at a reasonable distance from the producing areas	Niedersachsen; Castilla y Leon; Oulu region
		Insufficient demand for certain sources of biomass due to the abundance of more technically suited and/or cheaper alternative sources	miscanthus and short rotation coppice in Eastern England
		Unfavourable situations in the market of the type of bio-fuel obtained by some energy crops	wheat and sugar beet for bio-ethanol production in Champagne Ardenne
		Unfavourable attitude of the resident population towards some kinds of processing plants operating within the bio-energy supply chain	Niedersachsen; Eastern England

Moreover, two other limiting factors are to be taken into account, and precisely:

- Obligation for farmers to renounce to the possibility to decide freely among the different possible uses of the crops (food; feed; non food uses including energy) only at the moment of harvesting them, on the basis of their different profitability. If farmers want to benefit from support granted through AEC, the destination of the crops to energy uses is pre-defined, and the possibility of selling them at a better price for food or feed use is precluded. This situation was found to be of particular relevance in the case of maize for bio-gas production in Carinthia: farmers preferred not to apply for the AEC when they decided to grow maize for bio-gas production in order to remain free to decide the destination of the silage maize they grew at the moment of harvest, or even after. It must be kept in mind that the AEC does not have a decisive role as incentive in the case of the cultivation of maize for bio-gas in Carinthia, as the market margin is quite high.
- In Niedersachsen it was found that the artificial shortage of land available for food and feed production induced by the set aside regime had negative impacts on the cultivation of energy crops on non-set aside land. Moreover, the administrative burden – especially as far as control procedures were concerned - imposed on farmers that applied for the cultivation of energy crops under the NFSA regime appeared to act as a disincentive for some of them.

Finally, a very important limiting factor at EU level is constituted by the obligations stemming from the "Blair House Agreement".

Table 14.9 - Importance of the Blair House obligations as a limiting factor for oilseeds cultivation under the NFSA regime in the EU

Items	Years	
	2005	2006
Compulsory set aside rate	10%	10%
Oilseeds area under the NFSA regime in the EU (ha)	816.148	833.521
1) Resulting quantity of by-products destined to human or animal consumption, expressed in soya meal equivalent (tons)	852.663	908.109
2) Maximum quantity of by-products destined to human or animal consumption, expressed in soya meal equivalent, that can be produced in compliance with the Blair House obligations (tons)	1.000.000	1.000.000
% of 2) filled by 1)	85,3%	90,8%

Source: DEIAGRA elaboration of data communicated by Member States to DG-AGRI

From Table 14.9 above it can be seen that, as the area under oilseeds on set aside gets closer to the 900.000 ha mark, the quantity of by-products destined to human or animal consumption resulting from such crops gets closer to the limit set by the Blair House obligations[221].

The Blair House obligations act therefore as a limit to the area that can be destined in the EU to the cultivation of oilseeds for non food - and hence energy - purposes under the NFSA regime.

It is important to note how the energy oilseed area cultivated on set aside land crossed the 900.000 ha mark in 1995 (see Table 14.1), i.e. just in the third year of implementation of the NFSA regime.

14.5 Judgment

Leading energy crops

Oilseeds, and **rapeseed** in particular, have been the **leading energy crops grown in the EU under the AEC and NFSA regime** over the evaluation period: at least 78% of total area under AEC and at least 90% or total area under the NFSA regime have been cultivated with oilseeds since the introduction of the measures.

Role of the AEC as an incentive

Since its introduction in 2004, the role of the **AEC** as an incentive to the farmer to introduce the cultivation of or to increase the area under energy crops was found to be **decisive[222] in the following situations:**

1) As far as the choice between two different uses – energy versus non-energy - of the same crop is concerned, the AEC plays a decisive role **where market margins for the energy crops are negative or tight**: this was the case in four out of ten representative situations studied in six regions (two regions are concerned).
2) As far as the choice between a certain kind of energy crop and another kind of crop for non-energy use is concerned, **whenever the support granted by the AEC is decisive in making an energy crop more profitable than the most common alternative (non energy) crop**: this was the case in two out of ten representative situations studied in six regions (two regions are concerned).

The area under the AEC in the EU indeed increased by 83% between 2004 and 2005. Increases in the 200-300% range were recorded in Spain and Finland, i.e. where most of the representative situations featuring a decisive role of the AEC were noticed. It is anyway worth noting that the maximum guaranteed area for the AEC (1,5 million ha) was not reached in the EU in the 2004-2005 period.

It has however to be underlined that **promoting factors other than the support granted by the AEC** also have played an important role, especially where the market margins for the energy crops are high: this is proved by the existence of a substantial area on non set aside land (around 1 million ha in 2005, mostly concentrated in Germany) which is cultivated with energy crops outside specific regimes. The granting of **additional support through public policies at Member State level and/or through non-CAP**

[221] This happens also because of the clear prevalence of rapeseed over sunflower on set aside: the conversion factor into soya meal equivalent is indeed higher for rapeseed than for sunflower.

[222] The role of one of the measures under study is deemed "decisive" in this respect when we can reasonably be sure that, in absence of the support granted by the measure, no cultivation of energy crops would have taken place.

measures at EU level (see EQ 9), and other **favourable "system" factors** (see EQ 10) have been among the most important promoting factors.

The withdrawal by the farmer of the possibility to decide freely among alternative destinations (food, feed, energy) for the crops, up to the moment of harvesting them or even after, which is associated with the eligibility for the AEC, is an administrative aspect in its implementation which was found to constitute a limiting factor for the diffusion of the AEC among farmers: this was however true in a very specific situation, where the AEC did not constitute a decisive[223] incentive for the cultivation of energy crops.

Role of the NFSA regime as an incentive

Thanks to the economic advantage - equal to the avoided cost of land maintenance (around 100 Euros/ha) - that it grants over fallow set aside, and to the fact that on set aside land there are no feasible gainful alternatives to the cultivation of non food crops, the **NFSA regime** has been an **effective incentive** to the farmer to introduce, maintain and increase the cultivation of energy crops especially **where market margins for the energy crops are negative or tight**: this was the case in three out of eight representative situations studied at regional level.

The area under the NFSA regime indeed increased from 235.000 ha to over 1 million ha between 1993 and 1995. From 1996 onwards, the evolution of the energy crop area under NFSA regime has followed the variations in the **rate of compulsory set aside**, which constitutes an intrinsic limit of this measure. The extent of such area has also been constrained by the **Blair House obligations**, which constitute a relevant **limiting factor** to an increase of the set aside area under oilseeds. Indeed an oilseed area under the NFSA regime of more than 900.000 ha would imply a high possibility of overshoot with respect to the plafond of 1 million tons of by-products for human or animal consumption set by such obligations. It has however to be pointed out that such overshoot never occurred over the entire evaluation period. The crossing of the 900.000 ha mark in 1995, i.e. just in the third year of implementation of the NFSA regime, constitutes on the other hand further proof of the effectiveness of the regime as an incentive.

Limiting factors

The **limiting factors to an increase in production** identified are of both technical and non-technical nature. Some of them are measure-specific (the limitations stemming from the Blair House commitments, which concern the sole energy crops grown under the NFSA regime, are the most important), while others have a generalized impact: price levels (insufficient demand for biomass due to limited presence of processing plants at a reasonable distance from the producing areas) and agronomical constraints, which negatively influence the profitability and the feasibility of the crops.

[223] See previous note.

15 EVALUATION QUESTION 2

"Have the direct aid measures contributed to achieve a price level for crops cultivated for energy use allowing these crops and sources of bio-energy gained from these crops to be competitive to other energy sources?"

The relevant issues to tackle in the framework of EQ 2 are the following:

1) To assess whether and to what extent the support provided through direct aid measures (cause) has exerted an influence on the price paid by the processing industry for the raw materials obtained by the sources of biomass under study(effect).
2) If the cause-effect relation mentioned at point 1) above is verified, to assess whether and to what extent the above mentioned influence (cause) has in turn resulted in an influence on the unit cost of a bio-energy unit (effect).
3) If the cause-effect relation mentioned at point 2) above is verified, to assess whether the direct aid measures have contributed to improve the competitiveness of bio-energy sources versus the other energy sources.

The **methodology** for answering the question is summarised below.

Judgment criteria, indicators and information sources

Judgment Criteria (JC)	Indicators (IND)	Information sources
JC 1: comparison between the unit costs of generation for bio-energy (with and without the support of DAMs) and the unit costs of energy generation from other sources	**IND 1.1)** Full unit cost of generation for bio-energy with DAM support **IND 1.2)** Estimated full unit cost of generation for bio-energy without DAM support **IND 1.3)** Full unit cost of generation of energy from the main other sources	**Full unit cost of generation for bio-energy with DAM support; estimated full unit cost of generation for bio-energy without DAM support; full unit cost of generation of energy from the main other sources**: DEIAGRA elaborations on data from: organisations and individual operators interviewed in the regional case studies; technical literature

15.1 Effect of the support granted through DAMs on the biomass price

The AEC and NFSA regime can have an effect on the price of biomass destined to energy purposes through the two following mechanisms:

a) **directly**, through the additional revenues they grant. These additional revenues may limit somehow the amount of revenue that the farmer should get from the market through the price of the various types of biomass for energy uses;
b) **indirectly**, by means of their effects on the supply of biomass, which stem from their capacity to promote the cultivation of energy crops, and hence the production of biomass for energy purposes. Such effects on price would clearly derive from the increases in the supplied quantity of biomass - relative to market demand - which the measures are able to cause by promoting the cultivation of energy crops.

The direct effects at point a) above can be estimated through a counterfactual analysis (i.e. a comparison with a hypothetical situation in which no support is granted by the DAM under study) by making some assumptions about the level of supply to be reached, about the behaviour of farmers and about their expectations as regards the level of profitability of energy crops.

To estimate the indirect effects at point b) above, it should be estimated the price increase that would be caused by an hypothetical absence on the market of the supplied quantities of biomass produced from energy crops under the DAM under study (counterfactual analysis). Such indirect effects are difficult and risky to estimate, even in the hypothesis of demand invariance: indeed the void left by the biomass for energy purposes produced with the support of a specific DAM could be filled, totally or in part, by biomass produced with the support of another DAM, and/or by biomass produced under no specific regime, and/or by feedstock imported from third countries. The reliability of such an estimate would be seriously limited by the strong assumptions – on the evolution of both biomass demand and biomass supply from alternative sources - that would be needed to carry it out.

The evaluation team chose therefore to focus on the estimate of the direct effects only.

15.1.1 Aid for energy crops (AEC)

According to the economic rationale of the AEC, the support it grants constitutes an additional revenue to the farmer growing energy crops: this additional revenue limits somehow the amount of revenue that the farmer "needs" to get from the market through the price of the various types of biomass for energy uses, in order to maintain a gross margin high enough to constitute an incentive to grow energy crops. It is therefore reasonable to think that the prices of biomass for energy uses would need to be higher without the support granted through the AEC.

To assess the direct effect of the AEC on the price of biomass, a counterfactual analysis has to be carried out, through a comparison with an hypothetical situation in which no support is granted through the AEC.

15.1.2 Non food on set aside regime (NFSA)

In the case of the NFSA regime, the mechanisms through which such regime can have an effect on the price of biomass are quite complex, and this because:

- no additional revenue is specifically associated with the cultivation of energy crops on set aside land;
- the NFSA regime promotes the cultivation of non food crops (both energy and non-energy ones) on set aside land simply by authorizing such activity: this authorization generates an "implicit subsidy" for the cultivation of non food crops versus fallow set aside.

As the "implicit subsidy" is inherent to the authorization to grow non food crops on set aside, the farmers cease to benefit from it only when such authorization is denied. Moreover the "implicit subsidy", unlike the AEC, is not a monetary entity, and it cannot be considered an additional revenue associated with the cultivation of non food crops in absolute terms, but only in comparison with the only other alternative use of set aside land (i.e. leaving such land fallow).

Therefore, as regards the authorization to grow non food crops (for both energy and non-energy purposes) on set aside land, the effects on price are of the indirect type (effects on the supplied quantities), not the direct one[224].

As the "implicit subsidy" constitutes an incentive to grow energy crops (in general, non food crops) on set aside land, it contributes to **foster the total supply of biomass for energy purposes**: should the cultivation of energy crops not be permitted on set aside land, the supplied volumes might be lower and – with the present demand levels – the **price of biomass for energy purposes might be higher**. The measure of such indirect effects on price through the supplied volumes is however extremely difficult and risky to estimate, for the reasons already cited at § 15.1: hence the evaluation team chose to limit the analysis of the effects of the NFSA regime on biomass price to qualitative considerations, which are developed hereunder.

Another indirect effect on price of the authorization to grow non food crops on set aside land is associated with the fact that, should this authorization be denied, the cultivation of energy crops could take place only on non-set aside land. As the number of more profitable alternatives to energy crops is much higher on non-set aside land than on set aside land (where the most common alternative use is leaving the land fallow, which is a non-gainful alternative), the biomass price needed to produce on non-set aside land an additional quantity of biomass, equal to that produced under the NFSA regime, might be higher.

Whenever the cultivation of an energy crop on set aside land is the only feasible alternative to fallow set aside, the farmer could accept – in theory at last - any price level which makes such activity more economically attractive than leaving the land fallow. Table 15.1 shows - for the cases and regions studied more in-depth - the levels of the **break even prices[225] of energy crops versus fallow set aside**, and the spreads between them and the actual prices paid for energy crops, which are indeed substantial. Such a situation indeed:

- confirms that the NFSA regime constitutes an effective incentive to the farmer to grow non food crops (including energy ones) on set aside land: the price actually paid for biomass is much higher than the

[224] The only situation in which the absence of the "implicit subsidy" can be hypothesized is clearly represented by a situation where the farmers are not authorized to grow non food crops on set aside land: this obviously would imply that no biomass production could take place on such land, and thus in such situation there would be no biomass produced on set aside land to sell, and therefore no biomass price to be paid for it.

[225] See also the market analysis, § 11.1.2.1, for an explanation of the concept of break even price and for a practical application of it in the assessment of the profitability of energy crops on both set aside and non-set aside land.

one theoretically needed to make non food crop cultivation more profitable than fallow set-aside, i.e. the actual economic advantage for the farmer is substantial;

- suggests that under the NFSA regime biomass prices much lower than the actual ones might be – in theory at least - equally appealing to farmers, as the most common alternative to non food crops cultivation is a non-gainful one, i.e. leaving the land fallow.

Table 15.1 - NFSA regime: break even prices of energy crops versus fallow set aside

Regions	Energy crops (final product)	1) Yield (t/ha)	2) Actual price (€/t)	3) = 1 x 2 = Market revenues (€/ha)	4) Operating expenses (€/ha)	5) = 3 - 4 = Market margin (€/ha)	6) Gross margin - fallow set aside	7) =(4 + 6)/1 = Break even price of energy crops versus fallow set aside	8) = 7 / 2 = break even price vs. actual price (%)
DE9 - Niedersachsen	Rapeseed (biodiesel)	4,00	203,00	812,00	525,00	287,00	-100,00	106,25	52,3%
	Silage Maize (biogas)	45,15	19,27	869,90	790,05	79,85	-100,00	15,28	79,3%
ES41 - Castilla y León	Sunflower (biodiesel) - dry culture	1,00	160,00	160,00	160,00	0,00	-100,00	60,00	37,5%
	Barley (bio-ethanol) - dry culture	2,72	104,00	282,56	303,00	-20,44	-100,00	74,72	71,8%
	Wheat (bio-ethanol)- dry culture	2,98	111,00	330,88	237,90	92,98	-100,00	46,26	41,7%
FR21 - Champagne-Ardenne	Common wheat (bio-ethanol)	8,00	95,00	760,00	500,00	260,00	-100,00	50,00	52,6%
FR23 - Haute-Normandie	Rapeseed (biodiesel)	3,50	230,00	805,00	530,00	275,00	-100,00	122,86	53,4%

Source: DEIAGRA elaboration on data from regional case studies

Note: 6) For details on the estimate of the gross margin of fallow set aside, and for the associated limitations, please refer to § 5.4, 11.1.1, 14.2.2.

However, no evidence was retrieved from case studies suggesting that such potential of the NFSA regime to achieve cheaper prices for biomass produced on set aside land has actually been exploited. The reasons behind this are to be found in the following:

1) Such potential can be exploited only when leaving the land fallow is the only alternative to the cultivation of an energy crop on set aside land: if non food crops for uses other than energy are feasible, the potential ceases to exist.
2) Even in the situations at point 1) above, for the potential to be exploited all the buyers would have to coordinate in offering the farmers prices just slightly higher than the break even level. Such a situation is unlikely to occur in practice, and would anyway constitute an anticompetitive conduct.
3) Even where the conditions at point 1) and 2) above are satisfied, it cannot be taken for granted that all the farmers would be willing to grow energy crops on set aside land with price levels for biomass which would make such activity just slightly more attractive than fallow set aside, given the very different technical difficulty of the two activities and the higher risk associated with the former[226].

In conclusion, the most relevant **indirect effects of the NFSA regime on the price of biomass for energy purposes** are associated to its ability in fostering the total supply of biomass for energy purposes (indirect effects on biomass price caused by an increase of supplied volumes).

15.1.3 Estimate of the direct effects of the AEC on biomass price

The big issue about the estimate of the direct effects of the AEC on biomass price lies mainly in determining the measure of the price increases which would be needed in its absence in order to maintain the same supply level achieved in presence of it. To this purpose, some behavioural assumptions concerning the farmer need to be made: from such assumptions stem the main limitations of the analysis, discussed in the box below.

Limitations of the analysis and validity of the results

To estimate the price levels that would be needed without the AEC to maintain a constant supply level, it is assumed that farmers would consider attractive a gross margin at least equal to the one granted in presence of the AEC, i.e. a condition of margin invariance*. This behavioural assumption is not the only possible one, but it is reasonable: if farmers*

[226] In such situations it is reasonable to think that some farmers would prefer to leave the set aside land fallow, and lose some money, in order to avoid the complications and the risks associated with the cultivation of an energy crop.

*grew energy crops to a certain extent when the "old" margin was achieved, they would continue to grow them to the same extent when the "new" margin (with all the revenue granted by the AEC now assured by higher biomass price levels) is at least equal to the "old" one, provided that all the other relevant factors – in particular the gross margins of the alternative crops - do not vary (*coeteris paribus *assumption).*

An economic analysis on the margins of the different kinds of energy crops was carried out at regional level, on the basis of data collected in the framework of the regional case studies[227]. This choice obviously limited the possibility to extend the validity of the results of the analysis to broader geographical areas, i.e. to "generalize" its main findings. As a partial remedy to this limitation, the evaluation team tried to picture a number of situations that could be deemed representative - from a qualitative if not a quantitative (statistical) standpoint - of the most significant bio-energy supply chains to be found in the EU.

The estimated price in absence of the AEC is the one needed to fully compensate, given the yield levels of the various kinds of energy crops, the loss of the revenues granted by the AEC.

The level of the "new" estimated price is such that, multiplied for the yield, it equals the sum of the market revenues with the "old" price and of the aid granted by the AEC. The formula used for the estimate is derived from the equation below:

(Actual price in presence of the support granted by the AEC) X (yield) + (amount of the aid granted by the AEC) = (Estimated price in absence of the support granted by the AEC) X (yield)

and is therefore the following:

(Estimated price in absence of the support granted by the AEC) = [(Actual price in presence of the support granted by the AEC) X (yield) + (amount of the aid granted by the AEC)] / (yield)

The actual prices paid for biomass in presence of the support granted by the AEC, and the estimated prices that would have to be paid to fully compensate its absence are reported in Table 15.2 below.

Table 15.2 - Direct effect of the AEC on biomass prices in the hypothesis of margin invariance

Regions	Crop cultivation for energy use (and final product)	1) Actual price paid in presence of the AEC	2) Estimated price to be paid to compensate the absence of AEC support (gross margin invariance)	(2) - (1)	(2) - (1) / (1) (%)
AT21 - Kärnten	Silage maize (biogas)	17,00	17,82	0,82	4,8%
DE9 - Niedersachsen	Rapeseed (biodiesel)	203,00	214,25	11,25	5,5%
	Silage Maize (biogas)	19,27	20,26	1,00	5,2%
ES41 - Castilla y León	Sunflower (biodiesel) - dry	160,00	205,00	45,00	28,1%
	Barley (bio-ethanol) - dry	104,00	120,56	16,56	15,9%
	Wheat (bio-ethanol)- dry	111,00	126,10	15,10	13,6%
FI193 - Oulu Region (Finland)	Reed canary grass*	30,00	36,43	6,43	21,4%
FR21 - Champagne-Ardenne	Common wheat (bio-ethanol)	95,00	100,63	5,63	5,9%
FR23 - Haute-Normandie	Rapeseed (biodiesel)	230,00	242,86	12,86	5,6%

* (direct burning in power plants)
Source: DEIAGRA elaboration on data from regional case studies

From the data in Table 15.2 above it can be seen that, in the hypothesis of *margin invariance*, the increase in prices that would be needed to fully compensate the absence of the AEC is relatively limited, albeit with the exception of the cases where the AEC constitutes a significant part of the gross margin (the three situations considered for the Castilla y Leon region, and the one considered for Oulu region).

15.1.4 The case of sugar beet cultivation for energy purposes

The case of sugar beet cultivation for energy purposes represented a peculiarity over the most part of the evaluation period. Indeed, until the reform of the sugar CMO at the end of 2005, sugar beet grown for

[227] See the answer to the Evaluation Question 1, and specifically the box on the limitations of the analysis.

energy purposes on non-set aside land was not eligible for the AEC, and the same crop grown for non food purposes (including energy) on set aside land could not benefit from the set aside payments.

The above peculiarities may have influenced the prices paid for sugar beet grown for energy purposes, as it is plausible that the additional revenue granted by the AEC (in the case of cultivation on non-set aside land) or the removal of the opportunity cost given by the renounce to the set aside payments (in the case of cultivation on set aside land) would have made it possible for the farmers to deem lower prices as attractive.

It is anyway evident that, with respect to sugar beet cultivation for energy purposes before the reform of the sugar CMO, the above peculiarities made it impossible for the AEC and the NFSA regime to contribute directly[228] to the achievement of a price level allowing such crop, and the source of bio-energy gained from it (bio-ethanol) to be competitive to other energy sources.

Finally, the changes introduced with the reform of the sugar CMO[229] have indeed the potential to contribute to the achievement of a price level for such crop allowing it, and bio-ethanol produced from it, to become more competitive to other energy sources. However, no evidence in this respect was retrieved in the regional case studies, probably also because of the very short time passed since the implementation of the reform of the sugar CMO.

15.1.5 Indirect effects of the AEC and of the NFSA regime on biomass price

As previously underlined, the indirect contribution of each of the measures under study - through their effects on the supply of biomass for energy purposes - is extremely difficult and risky to estimate.

Generally speaking, if the combined effect of the AEC and of the NFSA regime on the supply of biomass for energy purposes is considered, it is reasonable to think that a related indirect effect on biomass price exists, given the fact that a substantial part of such biomass is produced under the AEC or NFSA regime[230]. However, this energy crop area under support represents, at present, quite a small portion (around 1,5%) of the total EU arable land, and only a limited amount of the total production of cereals and, to a lesser extent, of oilseeds is currently used for bio-fuels. Moreover, in the EQ 1 the AEC was found to be not always decisive for farmers to choose to grow energy crops. Therefore, it can be assumed that the indirect effects of DAMs on price of energy crops through the volume of production is quite limited.

Finally, as the extent of the area under energy crops grown without specific regime has become more and more substantial in recent years, also the indirect effect on biomass prices of the increasing additional supply of feedstock for energy purposes coming from areas outside specific regimes has to be deemed non negligible.

15.2 Effect of the support granted through the DAMs on the competitiveness of bio-energy

To assess the effect of the support granted through the DAMs under study on the competitiveness of bio-energy in the various relevant uses (transport, electricity, heating), first it is necessary to estimate the effect on the full cost of an energy unit which the higher prices (that would be needed in absence of the support granted through such DAMs) would have (counterfactual analysis, i.e. comparison with an hypothetical situation where no support is granted through the DAMs under study). This done, a comparison with a benchmark, i.e. the full cost of an energy unit produced in a supply chain whose economics are surely not influenced by the measures under study[231], has to be carried out.

Limitations of the analysis and validity of the results

The limitations of the analysis stem directly from the limitations that were highlighted in the previous paragraph with respect to the assessment of the effects of the measures under study on the price of biomass. In particular, the choice to focus on the estimate of direct effects only, practically limited the analysis to an assessment of the effects of the sole AEC, as the NFSA regime was found to have an influence on the price of biomass in an indirect way only.

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[228] The indirect effects on price of the NFSA regime described at § 15.1.2 may have indeed concerned also sugar beet grown for energy purposes on set aside land, as they are not related to the granting of set aside payments.

[229] Sugar beet grown for energy purposes on non-set aside land has become eligible for the AEC, and non food sugar beet grown on set aside land can benefit from set aside payments.

[230] See in this respect the answer to evaluation question 1.

[231] Bio-diesel production from soybean in the USA was chosen as a benchmark as it is surely not influenced by the measures under study, being carried out in a third country. Bio-ethanol production from sugar beet in France was chosen as a benchmark as, until the reform of the CMO for sugar, sugar beet was not eligible for the AEC. In the case of electricity and heat generation, two of the most common technologies based on the use of fossil fuels were chosen as benchmarks.

Further limitations derive from the fact that the prices in absence of the AEC were estimated on the basis of data collected in the framework of the regional case studies (see the box at § 15.1.3).

Another important limitation stems from the fact that the estimates of the effects of the AEC on the full cost of an energy unit were made coeteris paribus*, i.e. assuming that among all the factors that determine the full cost of an energy unit, only the price of biomass might vary. In fact a possibility exists that increases in the full cost of an energy unit caused by the higher biomass prices that would be needed in absence of the support granted through the AEC might be counterbalanced – in part at least – by savings achieved through more efficient processing technologies, through a decrease in the prices of inputs other than biomass, etc.* ***The adopted methodology might therefore lead to overestimate the effects of the AEC on the full cost of an energy unit.***

The estimates of the effects of the AEC on the full cost of an energy unit have been made using the same methodology used to estimate the full cost of an energy unit in the framework of the market analysis[232], using the biomass prices (actual and estimated) reported in Table 15.2 above. The results of these estimates – as far as the production of bio-diesel and bio-ethanol, the generation of electricity and the use of bio-energy for heating are concerned - are illustrated in the tables below[233].

As regards the analyses concerning bio-diesel and bio-ethanol, it should be noted that the need to have a single benchmark for each analysis made it impossible to choose the raw material diesel and petrol costs as benchmarks, since such costs vary significantly in the different Member States (see § 11.2.3, and the use of an average value in the EU would have had very limited practical meaning from an economic standpoint. An in-depth analysis of the cost competitiveness of bio-diesel and bio-ethanol (including the benchmark cases analysed here) with respect to fossil fuels was carried out for all the Member States at § 11.2.3 and in EQ 9 (§ 22.3.3). It is anyway important to remind here that only under very peculiar conditions (especially concerning the price of the biomass used as feedstock) bio-diesel and bio-ethanol become competitive in the EU with raw material diesel or petrol in terms of unit full production cost.

Table 15.3 – Estimated unit full cost of bio-diesel, with and without AEC

Type of biomass used as feedstock	Region where the biomass is sourced	1) Actual price paid for biomass in presence of DAMs (Euros/t)	A) Unit full cost of biodiesel with 1) (Euros/litre diesel equivalent)	2) Estimated price to be paid to compensate the absence of AEC support (Euros/t)	B) Unit full cost of biodiesel with 2) (Euros/litre diesel equivalent)	C) Benchmark - Unit full cost of biodiesel from soybean (USA) (Euros/litre diesel equivalent)	Cost disadvantage / advantage over the benchmark	
							Actual price (A - C)/C (%)	Estimated price (B - C)/C (%)
Rapeseed	Niedersachsen	203,00	0,584	214,25	0,611	0,438	33%	39%
Rapeseed	Haute-Normandie	230,00	0,649	242,86	0,681	0,438	48%	55%
Sunflower (from dry culture)	Castilla y leon	160,00	0,474	205,00	0,582	0,438	8%	33%

Source: DEIAGRA elaboration on data from the regional case studies

Table 15.4 – Estimated unit full cost of bio-ethanol, with and without AEC

Type of biomass used as feedstock	Region where the biomass is sourced	1) Actual price paid for biomass in presence of DAMs (Euros/t)	A) Unit full cost of bio-ethanol with 1) (Euros/litre gasoline equivalent)	2) Estimated price to be paid to compensate the absence of AEC support (Euros/t)	B) Unit full cost of bio-ethanol with 2) (Euros/litre gasoline equivalent)	C) Benchmark - Unit full cost of bio-ethanol from sugarbeet (France) (Euros/litre gasoline equivalent)	Cost disadvantage / advantage over the benchmark	
							Actual price (A - C)/C (%)	Estimated price (B - C)/C (%)
Wheat	Champagne-Ardenne	95,00	0,559	100,63	0,583	0,478	17%	22%
Wheat (from dry culture)	Castilla y Leon	111,00	0,626	126,10	0,690	0,478	31%	44%
Barley (from dry culture)	Castilla y Leon	104,00	0,679	120,56	0,762	0,478	42%	59%

Source: DEIAGRA elaboration on data from the regional case studies
Note: Benchmark is estimated for a sugar beet price of 11 Euros per ton ("C" beet price for France).

232 See § 11.2 and annexes F and G of the market analysis for a description of this methodology and of its limitations.
233 For a more detailed illustration of these estimates, see tables A.2.1-A.2.10 in the annex to this chapter.

Table 15.5 – Estimated unit full cost of electricity, with and without AEC

Power station fed by (type of plant)	Type of biomass used as feedstock	Region where the biomass is sourced	1) Actual price paid for biomass in presence of DAMs (Euros/t)	A) Unit full cost of an energy unit with 1) (Euros/MWh)	2) Estimated price to be paid to compensate the absence of AEC support (Euros/t)	B) Unit full cost of an energy unit with 2) (Euros/MWh)	C) Benchmark - Unit full cost of an energy unit from pulverised fuel - coal (Euros/MWh)	Cost disadvantage / advantage over the benchmark	
								Actual price (A - C)/C (%)	Estimated price (B - C)/C (%)
BFBC plant	Reed canary grass	Oulu region	30,00	68,84	36,43	73,19	45,07	53%	62%
Biogas plant (co-digestion: 30% biomass 70% slurry)	Silage maize	Carinthia	17,00	75,04	17,82	75,52	45,07	66%	68%
Biogas plant (co-digestion: 30% biomass 70% slurry)	Silage maize	Niedersachsen	19,27	76,36	20,26	76,94	45,07	69%	71%

Source: DEIAGRA elaboration on data from the regional case studies

Table 15.6 – Estimated unit full cost of heating, with and without AEC

Type of heat generation plant	Type of biomass used as feedstock	Region where the biomass is sourced	1) Actual price paid for biomass in presence of DAMs (Euros/t)	A) Unit full cost of an energy unit with 1) (Euros/MWh)	2) Estimated price to be paid to compensate the absence of AEC support (Euros/t)	B) Unit full cost of an energy unit with 2) (Euros/MWh)	C) Benchmark - Unit full cost of an energy unit - boiler fueled by natural gas (Euros/MWh)	Cost disadvantage / advantage over the benchmark	
								Actual price (A - C)/C (%)	Estimated price (B - C)/C (%)
Boiler	Reed canary grass	Oulu region	30,00	34,71	36,43	36,25	42,59	-18%	-15%
Gasifier	Reed canary grass	Oulu region	30,00	59,63	36,43	61,26	42,59	40%	44%

Source: DEIAGRA elaboration on data from the regional case studies

The estimates illustrated above show that the effect of the AEC on the competitiveness of the bio-energy sources deriving from the energy crops under study, through its effect on biomass prices, can sometimes be relevant, under the assumptions made for the estimates (see both the above boxes on the limitations).

The absence of the support granted by the AEC would cause relevant shifts in the cost advantage/disadvantage over the benchmark especially in the following situations, where the price increases needed to compensate fully the absence of the AEC are falling within the 15-30% range:

1) In the case of bio-diesel production from sunflower (dry culture) in the Castilla y Leon region, the absence of the AEC would make the unit full cost 33% higher than the benchmark (instead of just 8%).
2) In the case of bio-ethanol production from barley and wheat (dry culture) in the Castilla y Leon region, the absence of the AEC would make the unit full cost respectively 44% and 59% higher than the benchmark (instead of 31% and 42%).
3) In the case of electricity generation from reed canary grass in the Oulu region, the absence of the AEC would make the unit full cost of an energy unit 62% higher than the benchmark (instead of 53%).

It is worth reminding that in the EQ 1 the AEC was found to be of decisive importance as an incentive to introduce or expand the cultivation of energy crops in all the above situations.

However, it should be recalled that the adopted methodology might overestimate the effect of the AEC on the competitiveness of bio-energy sources, as it assumes the invariance of the other factors determining the unit full cost of a bio-energy unit (processing technology, cost of inputs other than biomass, etc.).

Moreover, in the situations studied other than the ones highlighted at point 1, 2, and 3 above, the shifts in the cost advantage/disadvantage over the benchmark which would be caused by the absence of the AEC are indeed rather modest.

A more extensive analysis of the competitiveness of bio-energy sources (in presence of the support granted by the DAMs under study) to other energy sources (both renewable and non renewable ones) is carried out in the market analysis[234]. This analysis shows that in the current situation bio-energy generated with the sole support of DAMs is almost always less competitive than energy generated from conventional sources[235].

[234] See § 11.2.
[235] It has also to be underlined in this respect that the benchmarks considered here in the cases of bio-diesel and bio-ethanol are competitive with diesel oil and petrol in terms of full unit cost only in some Member States (see § 11.2).

Indeed, from Table 15.3, Table 15.4, Table 15.5 and Table 15.6 above it can be seen that only in one case out of the eleven considered, i.e. heat generation in a boiler fed with reed canary grass in Oulu region, there is a significant cost advantage over the benchmark, both with and without the support of the AEC (unit full cost of an energy unit respectively 18% and 15% lower). In the other ten cases, more or less relevant cost disadvantages appear, both in presence and in absence of the AEC.

15.3 Judgment

The **NFSA regime can have only indirect effects on biomass price**, by means of its effect on the supply of biomass for energy purposes: such effects are however very difficult and risky to quantify. The following qualitative considerations can nevertheless be made on the issue:

- Should the cultivation of energy crops not be permitted on set aside land, the supplied volumes might be lower and – with the present demand levels – the price of biomass for energy purposes might be higher.
- As the number of more profitable alternatives to energy crops is much higher on non-set aside land than on set aside land, the biomass price needed to produce on non-set aside land an additional quantity of biomass, equal to that produced under the NFSA regime, might be higher.
- Whenever the cultivation of an energy crop on set aside land is the only feasible alternative to fallow set aside, the farmer could accept – in theory at last - any price level which makes energy crops cultivation more profitable than leaving the land fallow: hence prices might be much lower than the ones actually paid. However, no evidence emerged from the case studies suggesting that such potential of the NFSA regime to achieve cheaper biomass prices has actually been exploited.

Besides having indirect effects on biomass price (for which the above considerations apply), **the AEC has** instead **also direct effects – which can be estimated - on the price of biomass**, which were found to be relevant in four out of the nine representative situations studied. Indeed, biomass price increases in absence of the support provided by the AEC were estimated to be in the 15-30% range (in the hypothesis of invariance of the margin of the energy crops concerned). These relevant effects in the price of biomass resulted in relevant effects on the cost competitiveness - with respect to an adequate benchmark - of the sources of bio-energy gained by the energy crops concerned in three out of the eleven representative situations studied.

However, **only in one case out of the eleven considered** (heat generation in a boiler fed with reed canary grass) **a significant cost advantage over the benchmark was estimated**, both with and without the support of the AEC (the full cost of an energy unit was respectively 18% and 15% lower than that of the benchmark). In the other ten cases, more or less relevant cost disadvantages with respect to the benchmark appeared, both in presence and in absence of the AEC. Moreover, we must underline that the adopted methodology might overestimate the effect of the AEC on the competitiveness of bio-energy sources, as it assumes the invariance of the other factors that determine the unit full cost of a bio-energy unit (processing technology, cost of inputs other than biomass, etc.).

On the basis of the evidence presented, we judge therefore that:

- The **AEC** can have direct effects on biomass prices, which were however found to be **too limited to contribute significantly to achieve a price level for crops cultivated for energy use allowing these crops and sources of bio-energy gained from these crops to be competitive to other energy sources**.
- As regards the **NFSA regime**, its effects on price are only indirect ones, whose extent could not be quantified. However, the qualitative considerations developed suggested that the **contribution** of the measure **has probably been very modest**.

Further confirmation of the above judgments, with particular respect to the role of the CAP measures versus the role of additional support granted at Member State level, is given by the judgment to EQ 9.

16 EVALUATION QUESTION 3

"To what extent have the direct aid measures individually and/or in combination with one another contributed to an increase in the volume of bio-energy production? Identify the leading bio-energy sources and in particular, possible limiting factors to an increase in the volume of production"

The relevant issues to tackle in the framework of EQ 3 are the following:

1) The identification of the leading bio-energy sources.
2) To assess whether and to what extent the support provided through direct aid measures (cause) has modified EU bio-energy producers' behaviour, through the cause-effect relation previously illustrated for the evaluation question 2, inducing them to increase the volume of bio-energy they produce (effect).
3) To identify the limiting factors that may influence negatively the cause-effect relation at point 2) above.

The **methodology** for answering the question is summarised below.

Judgment criteria, indicators and information sources

Judgment Criteria (JC)	Indicators (IND)	Information sources
JC 1: comparison between the unit costs of generation for bio-energy (with and without the support of DAMs) and the unit costs of energy generation from other sources	**IND 1.1)** Full unit cost of generation for bio-energy with DAM support **IND 1.2)** Estimated full unit cost of generation for bio-energy without DAM support **IND 1.3)** Full unit cost of generation of energy from the main other sources	**Full unit cost of generation for bio-energy with DAM support; estimated full unit cost of generation for bio-energy without DAM support; full unit cost of generation of energy from the main other sources**: DEIAGRA elaborations on data from: organisations and individual operators interviewed in the regional case studies; technical literature
JC 2 : Direct Aid Measures constitute an *actual incentive* to EU bio-energy producers to increase the volume of production only if the competitiveness of bio-energy produced with the support of the DAMs (see EQ 2) is associated with an increase in the volume of production, also taking into account the role played by promoting and limiting factors	**IND 2.1)** Volume of bio-energy production	**Volume of bio-energy production**: DEIAGRA estimates on data from EBB statistics, EurObserv'ER 2005 European Barometer of Renewable Energies, eBIO, DG-Agriculture

16.1 Identification of the leading bio-energy sources

The data and information illustrated in the framework of the market analysis[236] and in the answer to the evaluation questions 1 and 2 permit to identify the leading bio-energy sources that are relevant for this question, i.e. those bio-energy sources whose supply chain economics are significantly influenced by the DAMs under study, through their effect on the economics of energy crop cultivation.

The aforementioned leading bio-energy sources, in decreasing order of importance, are identified in the following (in parentheses the reasons behind the choice):

- **bio-diesel** (the most important bio-fuel produced in the EU, mostly from dedicated energy crops – oilseeds, and rapeseed in particular – that are the leading energy crops grown both under the NFSA regime and the AEC);
- **bio-ethanol** (the second most important bio-fuel produced in the EU, for a good part from dedicated energy crops – cereals – which constitute the second most important group of energy crops grown both under the NFSA regime and the AEC).

Though solid biomass is very important as a source of bio-energy at EU level, the share of it which is obtained from dedicated energy crops benefiting from the support of the DAMs under study is extremely limited. The same considerations can be made for bio-gas[237].

[236] See § 8.

[237] See market analysis, § 8.1.3.

16.2 Effect of the support granted through DAMs on the volume of bio-energy production

The AEC and the NFSA regime can promote an increase in the volume of bio-energy production by acting on one of the many factors that have relevance in the economics of the bio-fuel industry: the cost of the biomass used as feedstock. The mechanism of impact of the AEC and NFSA regimes in this respect is centred on the achievement of price levels for the biomass obtained from energy crops grown with their support allowing the sources of bio-energy produced from such biomass to be competitive to other energy sources. In the answer to the EQ 2, it was highlighted that such effects of the AEC and the NFSA regime on biomass price can be of both direct and indirect type[238].

Being targeted at the agricultural level of the bio-energy supply chain, neither the AEC nor the NFSA regime have the ability to promote an increase in the volume of production of bio-fuels by acting on the demand dynamics of such products. The drivers behind favourable dynamics in the markets of bio-fuels are therefore outside the influence of the AEC and the NFSA regime, and are instead mostly associated with the existence of an institutional framework at EU and Member State level which is targeted at promoting the substitution of fossil fuels with bio-fuels[239].

The evidence gathered in EQ 2 shows that the biomass price levels – i.e. the unit cost of biomass for bio-fuel producers - reached in presence of the support granted by the AEC and the NFSA regime, are in most cases unable, alone, to make bio-fuels competitive to fossil fuels.

In the answer to the EQ 2, it was seen that the biomass price levels – i.e. the unit cost of biomass for bio-fuel producers - which have been reached in presence of the support granted by the AEC and the NFSA regime have proved in most cases to be unable, alone, to make bio-fuels competitive to fossil fuels.

Bio-diesel and bio-ethanol become competitive in comparison with, respectively, conventional diesel oil and petrol mostly through the granting of additional, non-CAP related support at EU or Member State level (mainly under the form of tax exemptions), as the competitiveness analysis carried out at § 11.2.3 of the market analysis, the answer to the evaluation question 9 and the evidence coming from the case studies (see box below) show. Such additional support is therefore a decisive factor in fostering the dynamics of the supply of both bio-diesel and bio-ethanol, whose volumes of production greatly increased in the EU in the last years (see Table 16.1 below).

Table 16.1: Dynamics in the volume of production of bio-fuels in the EU-25 (2003-2005)

	2003	2004	2005
Bio-diesel (1.000 ton)	1504	1933	3184
Bio-ethanol (1.000 ton)	351	419	722

Sources: DEIAGRA estimates on data from EBB statistics, EurObserv'ER 2006 European Barometer of Renewable Energies, eBIO, DG-Agriculture (bio-ethanol from wine alcohol)

Evidence of the importance of non-CAP support at EU and Member State level coming from the case studies

Many stakeholders interviewed in the framework of the regional case studies cited the support provided at EU and Member State level and targeted at the processing level of the bio-fuel supply chains as a decisive factor for the development of the bio-fuel industry in their countries.

The most notable examples are to be found in France (for both bio-diesel and bio-ethanol) and Germany (especially for bio-diesel).

In France, the development of the bio-diesel and bio-ethanol industry was promoted by the national government since both with measures targeted at promoting the expansion of the installed production capacity and with tax exemptions (concerning both excise taxes and the general tax on polluting activities) granted to bio-fuels.

In Germany, the tax exemptions granted to bio-fuels since 2004 triggered an investment boom especially in the bio-diesel industry.

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[238] The AEC and NFSA regime can have an effect on the price of biomass destined to energy purposes through the two following mechanisms:

- Directly, through the additional revenues they grant. These additional revenues may limit somehow the amount of revenue that the farmer should get from the market through the price of the various types of biomass for energy uses.
- Indirectly, by means of their effects on the supply of biomass, which stem from their capacity to promote the cultivation of energy crops, and hence the production of biomass for energy purposes. Such effects on price would derive from the increases in the supplied quantity of biomass - relative to market demand - which the measures are able to cause by promoting the cultivation of energy crops.

[239] See in this respect § 6 and the answer to the evaluation question 9.

The AEC and the NFSA regime are therefore just one of the factors behind such a positive dynamics in the supply of the two kinds of bio-fuel, and not the decisive one. The introduction of the AEC in 2004 may have contributed to favour, through the increase in the supply of biomass for energy purposes it promoted (see also EQ 1), and consequently through the indirect effect on biomass prices it may have caused, the remarkable increase in the supply of bio-fuels that occurred between 2003 and 2005: however, as the supply of both bio-fuels has practically doubled over this three year period, the introduction of the AEC alone is unable to explain by itself an increase of this magnitude.

It must also be noted that the expansion of the energy crop area under no specific regime played a more important role over the 2003-2005 period, in comparison with AEC, in increasing the supply of biomass for energy purposes (see EQ 1).

As regards the 1993-2003 period, the following considerations can be made:

1) The NFSA regime was the only specific support measure in place over such period.
2) The measure could contribute to an increase in the volume of bio-fuels only through its indirect effects on biomass price levels, whose extent is however very difficult to quantify (see EQ 2).
3) The portion of the overall quantity of feedstock destined to bio-diesel and bio-ethanol production represented by biomass produced under the NFSA regime was more important, as the AEC (and the associated biomass production) was not yet in place, and also because the quantity of biomass produced outside specific regimes probably was less substantial in the 1993-2003 period than in the 2003-2005 period.
4) As a consequence of the above facts, it is plausible that the indirect effects of the NFSA regime on biomass price levels were more important before 2003 – albeit to an extent which cannot be quantified: hence the measure may have played a more important role in promoting an increase in the supply of bio-fuels in the 1993-2003 period. However, it must be kept in mind that the considerations previously developed on the importance of the role of other factors - and of the additional support granted at Member State level in particular (see EQ 9) – for the 2003-2005 period are valid also for the 1993-2003 period.

In conclusion, the **DAMs under study, individually and/or in combination with one another, cannot be deemed to have played a decisive role in promoting the remarkable increase in the supply of bio-fuels that occurred between 2003 and 2005**. A more important role - albeit to an extent which cannot be quantified - may have been played by the NFSA regime before 2003; nevertheless it is plausible that such role was not a decisive one.

16.3 Limiting factors to an increase in the volume of bio-energy production

The limiting factors to an increase in the volume of bio-energy production exert their influence in a direct or indirect way.

The limiting factors identified in the EQ 1 have an indirect effect on the volume of bio-energy production, inasmuch they limit the quantity of biomass for energy purposes from dedicated crops which is obtained in the EU and made available to processors; it has however to be noted that this limitation can be overcome – in theory at least – by importing biomass for energy purposes from third countries[240].

Among the limiting factors likely to have a direct adverse effect on the volume of EU bio-energy production, the following ones – identified in the framework of the market analysis and of the regional case studies – appear to be the most noteworthy[241]:

- Possibility of importing from third countries substantial quantities of bio-fuels at cheaper prices than the ones that apply for the same EU products (in the case of bio-ethanol).
- Difficulties and delays in the implementation at Member State level of the measures aimed at promoting the substitution of fossil fuels with bio-fuels.

[240] See also market analysis, § 8.
[241] In some specific situations analysed in the framework of the regional case studies (notably in the case of bio-ethanol in France and Spain), the unfavourable attitude by the oil industry and automotive industry lobbies towards the substitution of fossil fuels with bio-fuels also emerged as a limiting factor. However this appears to be a factor of lesser importance, especially considering that norms are already in place at Member State level that make this substitution mandatory and set precise substitution levels to be achieved in the future.

16.4 Judgment

The **leading bio-energy sources** relevant for this question are identified in the ones whose supply chain economics are significantly influenced by the NFSA regime and the AEC, through their effect on the economics of energy crop cultivation: **bio-diesel** and **bio-ethanol**.

Being targeted at the agricultural level of the bio-energy supply chain, the AEC and the NFSA regime have the potential ability to promote an increase in the volume of production of bio-energy only by reducing the cost of the biomass used as feedstock.

The evidence gathered in EQ 2 shows that the **biomass price levels** – i.e. the unit cost of biomass for bio-fuel producers - **reached in presence of the support granted by the AEC and the NFSA regime**, are in most cases **unable, alone, to make bio-fuels competitive to fossil fuels**. Moreover, as the supply of both bio-fuels in the EU has practically doubled between 2003 and 2005, the increase in the supply of feedstock for bio-diesel and bio-ethanol production which has followed the introduction of the AEC in 2004 is unable to explain by itself an increase of this magnitude. It has also to be taken into account that no increase in the supply of feedstock for both bio-fuels were achieved on the area under the NFSA regime in the same period, and that the most remarkable increases must instead be attributed to energy crops grown outside specific regimes (see in this respect EQ 1).

Factors other than the measures under study, and especially **the additional, non-CAP related support granted to the production of bio-fuels at Member State level** (mainly under the form of tax exemptions), are **decisive in fostering the dynamics of the supply of bio-diesel and bio-ethanol** (see EQ 9).

We judge therefore that **the NFSA regime and the AEC, individually and/or in combination with one another, cannot have played a decisive role** in promoting the remarkable increase in the supply of bio-fuels that occurred over the evaluation period.

The competition of bio-ethanol imported from third countries and the difficulties and delays in the implementation at Member State level of the measures aimed at promoting the substitution of fossil fuels with bio-fuels are the most notable **limiting factors** identified as having a direct adverse effect on the volume of EU bio-energy production. Also the limiting factors to an increase in the production of energy crops that were identified in the answer to the EQ 1 can have an indirect adverse effect on the volume of bio-energy production, inasmuch they limit the quantity of biomass for energy purposes from dedicated crops which is obtained in the EU and made available to processors.

17 EVALUATION QUESTION 4

"Have the rural development measures concerned been implemented as foreseen by the programmes? To what extent did the projects contribute to an increase in the volume of production of bio-energy? Identify the leading bio-energy sources and the most effective rural development measures to promote them as well as the limiting factors. Identify measures financed by other Structural funds (in particular ERDF) leading to the production of bio-energy and the synergies with the financial rural development measures".

The relevant issues to tackle in the framework of EQ 4 are the following:
1) To identify the leading bio-energy sources.
2) To assess whether and to what extent the rural development measures have been implemented according to the foreseen objectives.
3) To assess whether the implementation of the rural development measures (cause) has influenced – directly or indirectly – the bio-energy producers' behaviour (farmers and processors), determining an increase in the volume of production of bio-energy (effect)
4) To identify the limiting factors that may influence negatively the cause-effect relation at point 3) above.
5) To identify the relevant "measures financed by other Structural funds leading to the production of bio-energy".
6) To identify synergies between the rural development measures and the measures at point 5) above which can foster bio-energy production.

The elaboration of the **methodology** for answering the question was deeply influenced by the very limited amount of data and information available, as well as by the quality of such data and information: in some cases only plausible or purely logical considerations could be made with respect to the relevant issues listed above.

Quantitative indicators were used only for the analyses synthetically described below. The answer to the remaining issues was based on eminently qualitative considerations.

Judgment criteria, indicators and information sources

Judgment Criteria (JC)	Indicators (IND)	Information sources
JC 1: actual implementation of the relevant RDMs versus target levels foreseen by the RDPs	**IND 1.1)** actual (area, production etc.) / target level for (area, production, etc.)	Rural development plans (RDPs)
JC 2 : Importance of the beneficiaries of the relevant RDMs on the total number of farmers	**IND 2.1)** number of beneficiaries ./ total number of farmers	**Number of beneficiaries**: institutions responsible for the implementation of the RDPs at Member State or regional level **Total number of farmers**: EUROSTAT

Limitations of the analysis and validity of the results

The most serious limitation of the analysis stems from the fact that – due to the absence of systematic data – it is mostly based on non-systematic data and information, retrieved from heterogeneous sources (institutions in charge of the implementation of the measures at Member State and regional level; independent experts; literature)[242]*.*

In fact, the systems currently in use by the Paying Agencies for collecting and storing information regarding the implementation of the RDMs normally do not allow the kind of queries which would be needed for answering to this evaluation question.

As for the available literature, only a small amount of "spot" information was found on the techno-economic features of the projects funded by the relevant RDMs. This greatly limited the possibility to tackle many of the relevant issues posed by the evaluation question: cause-effect relation between the granting of support through RDMs and the dynamics in the

[242] It was tried to retrieve data on the implementation of the relevant RDMs at the responsible institutions at Member State and/or regional level (mostly paying agencies). Nevertheless, as in most cases no systematic and separate recording is carried out of "bio-energy related" rural development projects, to provide a measure of the degree of implementation of the relevant RDMs (with respect to payments made, number of beneficiaries, type of projects funded and – where relevant – agricultural area concerned) the contacted institutions should have carried out a "project by project" search of the relevant ones. Such search proved to be unfeasible, especially over a short time span. As a consequence, only a very limited use of quantitative indicators had to be made.

volume of bio-energy production; associated limiting factors; synergies with measures financed by other Structural funds.

17.1 The leading bio-energy sources

Basing on the findings of the market analysis (see § 8), neither bio-diesel nor bio-ethanol can be considered among the leading bio-energy sources concerned by the RDMs, due to the large-scale industrial technologies through which they are generally produced in the EU. The related production processes are unsuitable to be implemented at an adequate scale in the near-totality of the EU farms (with the partial exception of non-refined vegetable oil production for energy purposes).

According to the findings of the market analysis and the regional case studies, and also to the additional collected literature, the bio-energy sources most suited to on-farm production are therefore bio-gas and direct burning of solid biomass[243].

With respect to the direct burning of biomass, it has to be remembered that a number of the relevant RDMs also promote on-farm production of solid biomass through the support they grant to the planting of multi-annual crops (see § 5 in this respect).

17.2 The implementation of the relevant RDMs

With respect to the assessment concerning the implementation of the relevant RDMs (see § 5 for their detailed description), three different but complementary levels of analysis can be identified, centred on the following judgment criteria:

1) The presence in the Rural Development Plans (RDPs) elaborated at Member State or regional level of measures specifically and exclusively aimed at promoting the implementation at farm level of bio-energy related projects.
2) The degree at which the targets foreseen by the Rural Development Plans for the measures at point 1) above have been achieved.
3) The share represented by the farms which benefited from the support of the relevant RDMs on the total number of farms in the Member State or region under study.

17.2.1 Measures in the RDPs specifically aimed at promoting the implementation at farm level of bio-energy related projects

The inclusion in the RDPs of measures specifically and exclusively aimed at promoting the implementation at farm level of bio-energy related projects constitutes the first criterion to assess whether and to what extent the relevant RDMs have been implemented according to the foreseen objectives. Indeed such inclusion proves that a special attention was given by the Member State or region which elaborated the RDP to the implementation at farm level of bio-energy related activities. Where such activities can benefit only from the support granted by non-specific measures, they actually compete with other non-bio-energy related activities for the support granted by such measures, and hence may be – in theory at last – less effectively promoted.

On the basis of the information retrieved in the regional case studies, at a number of institutions responsible for the implementation of the RDPs (mostly paying agencies) and in the additional literature studied, it emerged that while in some Member States or regions the RDPs indeed have included at least one of the aforementioned specific measures over the 2000-2006 programming period, in other Member States or regions – probably the majority[244] – this has not happened.

Within the first group of cases, the England Rural Development Plan represents a significant example, described in details in the box below.

Information from literature and bibliography also demonstrate that specific measures result to have been implemented in some regions in Italy (Lombardia, Friuli Venezia Giulia and Lazio), supporting investments concerning production, harvesting, post-harvest handling and transport, and processing of forestry biomass for energy purposes[245]. In 2005, the region of Emilia Romagna granted, through specific measures, the

[243] See in this respect: Spinelli R. and Magagnotti N. (2006), Berruto R., Bechis S., Busato P., Piccarolo P. (2006); Candolo G. (2006), in bibliography.
[244] As previously underlined in the box on limitations, the picture drawn on the matter on the basis of the information provided by the institutions responsible for the implementation of the RDPs in the EU is very far from being complete.
[245] See in this respect APAT, 2003, in bibliography.

construction of 15 bio-gas plants using animal wastes, with a total funding of around 4,5 million euros. In 2006, 1,5 million euros are available for single or associated farmers for the construction of bioelectricity or heating farm plants.

In France, according to the Rural Development Program (2006), specific measures supporting the energy use of wood products and by-products have been included in some of the Regional Programming Documents, in addition to the "programme bois-energie 2000-2006", realised by ADEME[246] and supporting research and investments for the construction of plants for heating from wood[247].

Specific measures aimed at supporting investments in specialised machinery for the bio-energy supply chain also result to have been included in the RDPs in Finland. Nevertheless, according to the Mid Term Evaluation (MTE) report, both the measures aimed at supporting energy (1.4: Promotion of the utilisation of bio-energy and renewable energy sources, and 2.2: Utilisation and management of forests and promotion of energy utilisation) resulted in a small number of implemented projects (see following paragraph).

As for the second group of cases, and basing on the information collected, no specific measures aimed at promoting the implementation at farm level of bio-energy related projects in the 2000-2006 programming period were present in the RDPs of The Netherlands, Scotland and a number of Italian regions[248].

Specific measures in the England Rural Development Plan (ERDP)

The ERDP for the programming period 2000-2006 has included the following measures specifically and exclusively aimed at promoting the implementation at farm level of bio-energy related projects:

Measure	Provisions
Investment in Agricultural Holdings: Energy Crops Scheme (ECS) for miscanthus	**Eligible actions** When miscanthus is grown as a renewable raw material for energy production, the support granted contributes to cover planting costs, including the purchase of planting material, ground preparation, weed control, fencing and first year cutback **Aid rate** Establishment grant of £920 per hectare.
Forestry – Afforestation of agricultural and non-agricultural land with Short Rotation Coppice (SRC)[249] as an energy crop	**Eligible actions** When SRC is grown on both agricultural land and non-agricultural land as a renewable raw material for energy production, the support granted contributes to cover establishment costs **Aid rate** Establishment grant of £1600 per hectare for SRC established on former livestock land (where the farmer loses livestock premia) and of £1000 per hectare on other eligible land
Forestry - Setting up associations of energy crop farmers	**Eligible actions** For producer groups legally formed by and consisting of members who are growing SRC for an energy end-use, the development of the association, including farmer recruitment and forming the legal structure, is supported. Where associations contribute to sustainable management through organising specialist activities such as planting and harvesting of crop, aid is granted also for the purchase of machinery (if used to provide services to members, not to generate revenue from outside the group). **Aid intensity** Grant aid rates equal to 50% of the total eligible one-off start-up costs.

Source: DEIAGRA elaboration of data and information retrieved in the ERDP (www.defra.gov.uk)

17.2.2 Achievement of the targets set by the RDPs

The degree at which the targets set by the RDPs for the measures aimed at promoting on-farm bio-energy related projects have been achieved, constitutes the second assessment criterion. Given the availability of

[246] Agence de l'Environnement et de la Maîtrise de l'Energie.
[247] Ministère de l'Agriculture e de la Pèche, *Plan de développement rural national*, 31/07/2006.
[248] Including Piemonte and Tuscany (in such RDPs are indeed present only measures which include some bio-energy related activities among the ones eligible for support, but which are not specifically and exclusively targeted at them)
[249] The term indicates a number of fast-growing multi-annual species like poplar, willow etc.

data, as well as the significant presence of such measures in the England Rural Development Plan (see box above), an analysis has been focused on this specific situation. Table 17.1 below shows the most recent data available on the issue.

Table 17.1 - England Rural Development Plan 2000-2006 - Progress against output targets

Measures	Key indicators	Targets	2004			2005			Cumulative up to March 2006	
			Achievements over the year	Cumulative up to the end of the year		Achievements over the year	Cumulative up to the end of the year			
				absolute value	in % of target		absolute value	in % of target	absolute value	in % of target
Investment in Agricultural Holdings - I) Energy Crops (Miscanthus)	Area under miscanthus (ha)	5.000	524	720	14,4%	291	1.011	20,2%	1.263	25,3%
Forestry - III) Energy Crops - Short Rotation Coppice	Area under short rotation coppice (ha)	16.700	144	1.019	6,1%	201	791	4,7%	831	5,0%

Source: DEIAGRA elaboration of data from "ERDP Annual Report 2004" and "ERDP Annual Report 2005" by DEFRA (www.defra.gov.uk)

From Table 17.1 above it is evident that the targets set were still very far from being achieved in March 2006. With the programming period 2000-2006 coming to an end, only areas equal to 25% of the target level have been cultivated with miscanthus for energy purposes, and only areas equal to 5% of the target set have been cultivated with SRC. Despite this, a positive trend seems to characterize investments in this sense, and specifically the areas destined to miscanthus, which results to be more than doubled from 2004.

Some information regarding the level of implementation of specific RDMs related to bio-energy can be also retrieved from the "Synthesis of Rural Development Mid-Term Evaluation[250]". Basing on the indications included in the report, only seldom specifically related to bio-energy, some preliminary results have been achieved for forestry related measures in Finland and Austria, and some positive signals regarding the presence and the implementation level of measures related to investments on farms also arrive from Germany (mainly bio-gas plants) and Italy.

Specific data regarding the number of supported projects for energy purpose were only cited for East Finland and North Finland, where respectively 48 and 21 projects related to wood for energy purposes were supported. A total number of 208 wood-based energy plants was registered for Finland. Moreover, it is registered that projects using wood as an energy source resulted to make up 37% of forestry scheme costs and 68% of forestry projects in East Finland, and 39% of forestry scheme costs and 70% of forestry projects in North Finland.

17.2.3 Farms concerned by the measures versus total number of farms in the Member State or region under study

A third criterion to assess whether and to what extent the relevant RDMs have been implemented according to the foreseen objectives is given by the share of the total number of farms in the Member State or region under study represented by the farms which implemented bio-energy related projects with the support of the relevant RDMs.

As the only complete quantitative data made available on the matter are referred to Austria, the analysis focuses on this Member State and on the Carinthia region, which was among the ones selected for the carrying out of the regional case studies.

As it can be seen from table 17.2 below, the implementation of bio-energy related projects funded through the relevant RDMs in Austria has interested only a very limited share of the total of the agricultural holdings in that Member State.

[250] AgraCEAS Consulting (2005), study commissioned by the Commission, DG Agriculture (in bibliography).

Table 17.2 - Relative importance of the holdings implementing projects associated with bio-energy and funded through the relevant RDMs - Austria (2003)

Type of RDM	Number of beneficiaries	number of beneficiaries on total number of holdings (%)
Investments in agricultural holdings	2.593	1,49%
Improving the processing and marketing of agricultural products	0	0,00%
Promoting the adaptation and the development of rural areas	348	0,20%
Other rural development measures in the EAGGF Guarantee Section	0	0,00%
Forestry - New system	48	0,03%

Source: DEIAGRA elaboration on Agrarmarkt Austria and Eurostat data

The same can be said with reference to the Carinthia region, as Table 17.3 below shows.

Table 17.3 - Relative importance of the holdings implementing projects associated with bio-energy and funded through the relevant RDMs - Carinthia (2003)

Type of RDM	Number of beneficiaries	number of beneficiaries on total number of holdings (%)
Investments in agricultural holdings	89	0,50%
Improving the processing and marketing of agricultural products	0	0,00%
Promoting the adaptation and the development of rural areas	19	0,11%
Other rural development measures in the EAGGF Guarantee Section	0	0,00%
Forestry - New system	less than 10	less than 0,05%

Source: DEIAGRA elaboration on Agrarmarkt Austria and Eurostat data

17.3 The effect of the RDMs on the volume of production of bio-energy and the related limiting factors

Given the limited amount of data and information retrieved on the implementation of the relevant RDMs (see box on limitations), the investigation on the effect of such measures on the volume of production of bio-energy and on the related limiting factors proved extremely difficult. In this respect it is also important to underline that:

1) The relevant RDMs can promote the implementation of bio-energy related projects at various stages of the bio-energy supply chain (biomass production; biomass processing into bio-energy sources; bio-energy production), and hence not necessarily at the final one. As a consequence, in a number of cases – i.e. where they support biomass production or biomass processing into bio-energy sources – they can have only indirect effects on the volume of production of bio-energy (for instance by promoting an increase in the available supply of forestry biomass for energy purposes). Such indirect effects are very difficult to assess and quantify.
2) Due to their economic rationale (see § 5.4), some of the relevant RDMs[251] can promote an increase in the overall production capacity for bio-energy, as they lower the fixed financial costs associated with the investments to be made to add new production capacity. However, an increase in the overall production capacity for bio-energy does not translate automatically in an increase in the volume of bio-energy production, especially if a more or less substantial part of such capacity remains unused. The RDMs cannot have any direct[252] influence on the actual utilization of the installed production capacity. A

[251] We refer to the ones supporting on-farm investment in equipment for the use of biomass as an energy source (Investment in agricultural holdings) and to the ones supporting energy production out of wood (Forestry).

[252] An indirect influence can nevertheless be exerted, for instance by promoting an increase of the supply of solid biomass by lowering planting costs, provided however that the increase in supply translates in lower biomass prices, and hence in lower bio-energy production costs.

number of factors other than the RDMs can indeed have an influence on the volume of bio-energy production, thus acting as promoting or limiting factors in this respect.

In the light of the considerations made at point 1) and 2) above, some indications will be given on the issues under study, based both on the evidence illustrated so far and on data and information retrieved in the market analysis, in the regional case studies and in the additional bibliography studied.

17.3.1 Assessment of the effect of the RDMs on the volume of production of bio-energy

In the Member States or regions for which data and information were available, the targets set for the relevant RDMs were very far from being achieved, at least in March 2006 (England), and the beneficiaries of the relevant RDMs represented only an extremely small fraction of the whole universe of farmers.

It is plausible to assume that the average production capacity of the on-farm bio-energy production plants whose construction was supported by the relevant RDMs is in most cases quite limited. Moreover, evidence from the regional case studies suggests that factors other than the relevant RDMs play a major role in granting the conditions for an efficient utilization of the capacity of on-farm plants, as it will be seen below.

If we consider the EU level, the market analysis has shown (§ 8) that in the case of electricity and heat generation from bio-gas, most of the bio-energy was produced in non-rural plants by non-agricultural feedstock. The effect of the relevant RDMs on the volume of bio-energy produced in these supply chains can hence be reasonably assumed as negligible, irrespective of the actual number of on-farm plants built with their support, which the evaluation team was unable to quantify.

In the case of electricity and heat generation from solid biomass through direct burning (excluding domestic heating), the share that can be attributed to on-farm plants is very difficult to quantify at both EU and Member State level; moreover, the evaluation team was unable to quantify the number of such plants built with the support of the relevant RDMs.

From the case studies concerning electricity and heat generation from the direct burning of solid biomass in the Oulu region of Finland and in Eastern England, we have seen that all the bio-energy was produced in industrial medium-to-large-scale plants, not in small on-farm plants.

In conclusion, if it is true that the evidence gathered on the matter is limited and fragmented, it is also true that no elements in it suggest that the relevant RDMs have played a relevant role in promoting an increase in the volume of production of bio-energy, especially from an EU-wide standpoint. This statement will be further justified by the findings of the analysis on the role of the promoting and limiting factors.

17.3.2 Promoting and limiting factors

If all the levels of the bio-energy supply chains under study in this evaluation questions are considered, it is evident that many factors – other than the relevant RDMs - can have an influence on the functioning of the supply chains themselves, and hence on the volume of production of bio-energy.

In this paragraph we will highlight the ones which were found to have the most relevant positive (*promoting factors*) and adverse (*limiting factors*) effects in this respect, on the basis of the evidence gathered in the framework of the regional case studies and retrieved in the additional bibliography studied.

Promoting factors

- The additional support granted at Member State level through feed-in tariffs to electricity generation from bio-gas or from solid biomass was found to be one of the crucial factors behind the expansion of production capacity (also through the construction of on-farm power plants) and the increase in the volume of bio-energy produced in Lower Saxony and in Carinthia (more in general, in Germany and Austria).
- The availability of cheap biomass not obtained from dedicated crops was found to be an important promoting factor in the case of heat and electricity generation from biomass in the Oulu region of Finland (peat is massively used) and in Eastern England (poultry litter is combined with straw), and in the case of heat and electricity generation from bio-gas in Lower Saxony and Carinthia (manure is combined with silage maize, especially in small size on-farm plants).

Limiting factors

- Technical and logistical problems at the various levels of the supply chain. In particular:

  - The limited diffusion of miscanthus and short rotation coppice in Eastern England (and in the rest of England as well) was found to be mainly attributable to still semi-experimental cultivation techniques and to a high variability of the yields.
  - The limited scope for on-farm or nearby use of the heat produced was found to limit the diffusion of more cost-efficient combined heat and power (CHP) plants in Lower Saxony.
  - The distance between the site where biomass (and forestry biomass in particular) is produced and the site where it is processed was found to be a very important limiting factor in all the situations studied.
- In Lower Saxony it was found that very complicated and time-consuming permission procedures have to be endured before the building of a bio-gas plant can start: this reduced the attractiveness of such investment especially for small farmers, discouraging many of them.
- An unfavourable attitude towards bio-gas plants in some local communities was found to be a relevant limiting factor to their diffusion in Lower Saxony.

17.4 Synergies between the RDMs and measures financed by other Structural funds leading to the production of bio-energy

A number of measures financed by other structural funds, and by the European Regional Development Fund (ERDF) in particular[253], can support the development of the bio-energy supply chains and an increase in the volume of production of bio-energy.

In the field of bio-energy production the ERDF supports – among various project typologies – also the construction of combined heat and power (CHP) plants with a capacity of up to 5 thermal MW fuelled by forestry biomass, and of the related heat distribution networks. Potential synergies with the relevant RDMs concerning the production of forestry biomass for energy purposes can hence be identified for these specific measures funded by ERDF[254].

No elements were found in the framework of the regional case studies which could suggest that such potential synergies have actually fostered the production of bio-energy. The only available information at present regards Portugal where, according to the recent "Synthesis of Rural Development Mid-Term Evaluation", all the investments in waste treatment and renewable energy sources were conducting using the ERDF Structural Fund. Nevertheless, neither in this case evidence regarding actual synergies between the two types of measures emerged.

17.5 Judgment

Despite the scarcity of data and specific information regarding the measures under study, some indications can be given mainly basing on the collected data and information and on the bibliography on the theme.

- The implementation of specific RDMs[255] results to be limited, at present, to relatively few Member States and Regions. Specific information in this sense could only be found for the United Kingdom, Finland, Austria, Germany and Italy.
- Among the measures under study, forestry measures (chapter VIII) result to have achieved some results, in terms of supported projects, in Finland and Austria, where a significant number of projects for the energy use of wood and wood products have been funded during the last years.
- Measures falling in chapter I concerning investments in equipment for the use of biomass as energy source were found to have already achieved some results in Austria and Germany, as well as in some

[253] Other support programmes at EU level which can lead to synergies with the relevant RDMs are Intelligent Energy for Europe (EIE), ALTENER, SAVE and LIFE.

[254] However, according to some experts, the adoption of a non-integrated approach in the support of the bio-energy supply chains centred on forestry biomass, with the ERDF supporting the construction of energy generation plants and with the EAGGF – through the Rural Development Plans – supporting the production of forestry biomass for energy purposes, limits the overall effectiveness of the two supporting actions, and of the synergies which may originate between them (see in this respect Passalacqua F. and Tondi G., *Lo strumento concertativo per il supporto della filiera Biomasse-Energia. L'esempio della Regione Toscana* (Coordination as a tool to support energy production from solid biomass. The Tuscany experience), www.etaflorence.it).

[255] It is useful to remind here that the only measures considered are those *specifically and exclusively aimed at promoting the implementation at farm level of bio-energy related projects*, since such inclusion proves that a special attention was given by the Member State or region which elaborated the RDP to the implementation at farm level of bio-energy related activities. Where such activities can benefit only from the support granted by non-specific measures, they actually compete with other non-bioenergy related activities for the support granted by such measures, and hence may be – in theory at last – less effectively promoted.

Italian regions. Projects in this framework are mainly related to bio-gas production from maize (Austria and Germany) and animal waste (Italy and Germany).

- Measures falling in chapter I concerning support for planting multi-annual biomass crops, have been implemented in the United Kingdom, where however a limited number of projects was found to have been supported. Consequently, the area cultivated with such crops is still very far from having reached the targets set.

Generally speaking, the level of implementation of specific measures related to bio-energy production, as well as the number of supported projects, has to be deemed as very limited at EU level. Only "spot" satisfying levels of implementation could be achieved in Finland (mainly related to energy use of forestry products) and Austria (also related to bio-gas plants).

As a consequence, the **actual effect of RDMs** under study on the overall production of energy from biomass has to be considered **limited**, even though a reliable quantitative estimate of this effect is at present unfeasible.

Finally, no evidence emerged about significant actual synergies between the RDMs and measures financed by other Structural funds leading to the production of bio-energy.

18 EVALUATION QUESTION 5

"To what extent do/have the measures (direct aid measures and rural development measures) work/worked in synergy to promote the cultivation and competitiveness of crops cultivated for energy use? To what extent do/have the measures work/worked in synergy to increase the volume of production of bio-energy?"

The relevant issues to tackle in the framework of EQ 5 are the following:

1) To identify the possible synergies in the action of direct aid measures and of rural development measures.
2) To assess whether and to what extent the synergies identified at point 1) above (cause) have promoted the cultivation of energy crops (effect).
3) To assess whether and to what extent the synergies identified at point 1) above (cause) have promoted the competitiveness of energy crops versus other raw materials for energy use (effect).
4) To assess whether and to what extent the synergies identified at point 1) above (cause) have promoted an increase in the volume of production of bio-energy (effect), through the chains of cause-effect relations considered in the framework of EQ 2, 3 and 4.

The elaboration of the **methodology** for answering this evaluation question was deeply influenced by the limitations highlighted in the answer to evaluation question 4.

Given the scarce and fragmented data retrieved on the implementation of the relevant RDMs, an analysis centred on the use of quantitative indicators proved to be unfeasible. A qualitative analysis was hence carried out to identify the potential synergies between DAMs and RDMs in promoting the cultivation and competitiveness of crops cultivated for energy use and the increase in the volume of production of bio-energy, on the basis of the models illustrated at § 5.4.

Once the potential synergies were identified, an analysis of the findings of evaluation questions 1, 2, 3 and 4, of the regional case studies and of the market analysis was carried out in order to identify elements which could (or could not) suggest that the potential synergies identified also had actual effects with respect to the promotion of the cultivation and competitiveness of energy crops and/or to an increase in the volume of production of bio-energy.

18.1 Identification of the Direct Aid Measures, of the Rural Development Measures, of the sources of biomass and of the sources of bio-energy concerned

To the purposes of this evaluation question, it is useful to recall with precision the DAMs and the RDMs concerned (see Table 18.1 below), which are described in detail at § 5.

Table 18.1 – Direct Aid Measures and Rural Development Measures concerned.

Direct aid measures	Rural development measures
- Aid for energy crops (AEC) - Non food on set aside regime (NFSA)	Chapter I: - on-farm investment in equipment for the use of biomass as energy source; - support for planting multi-annual biomass crops; Chapter VII: - investment in installation for first treatment of biomass (e.g. packaging); - investment in installation for the production of by-products (e.g. non refined plant oils); Chapter VIII: - non industrial processing and marketing of forestry products/afforestation; Chapter IX: - promoting the adaptation and development of rural areas.

The exclusion of the arable crop area payments (granted before the implementation of decoupling) and of the SPS from the DAMs which are to be investigated in this evaluation question is motivated by the fact that both DAMs are not specifically targeted at promoting the cultivation of energy crops.

It is nevertheless important to remind that:

- Before the implementation of decoupling, the arable crops area payments and the non-eligibility for area payments of some kinds of energy crops (grass, short rotation forestry, sugar beet) and - after the implementation of decoupling - the partially coupled support for arable crops may have caused unintended effects on the relative shares of the different kinds of energy crops (favouring the diffusion of some kinds of energy crops at the expense of other kinds) (see EQ6).

- The SPS contributes indirectly to create an environment which is favourable to the development of energy crops: as income support for farmers is no longer linked to the quantity and type of crop, farmers are now free to respond to favourable demand dynamics in the markets of biomass for energy purposes (see EQ1).

As far as the relevant sources of biomass and of bio-energy are concerned, they are listed in Table 18.2 below.

Table 18.2 – Relevant sources of biomass and of bio-energy

Source of biomass	Source of bio-energy
Sugar beet; maize; barley; rye; wheat; potatoes	Bio-ethanol
Rape seed; sunflower seed; soybean	Bio-diesel
Maize; agricultural residues	Bio-gas
Cereals for direct combustion; willow; miscanthus; grass; agricultural residues; wood residues; thinning wood; other additional sources of biomass	Bio-energy from direct burning of biomass

18.2 Potential synergies between Direct Aid Measures and Rural Development Measures

In the framework of the evaluation study, the presence of a *synergy* between the action of DAMs and of RDMs can be identified in the following cases:

1) One (or more) DAMs and one (or more) RDMs act in the same direction, even if with different mechanisms, at the same level of the supply chain (*horizontal synergies*), and have a combined effect on the cultivation of energy crops to an extent that makes it possible to start downstream activities (production of bio-fuels; bio-energy generation) which can in turn contribute to promote further cultivation of energy crops.
2) One (or more) DAMs and one (or more) RDMs act in an integrated way, even if with different mechanisms, at different levels of the same bio-energy supply chain (*vertical synergies*), in such a way that they combine to promote both the cultivation of energy crops and the start of downstream activities (production of bio-fuels; bio-energy generation).

The analysis carried out at § 5 has shown that there are no DAMs and RDMs, among the ones under study, with objectives and action mechanisms in conflict with one another.

The potential synergies that have been identified for each of the relevant bio-energy supply chains are reported in the tables below.

Table 18.3 – Potential synergies in the bio-diesel supply chain

Supply chain levels concerned	Activities concerned	Relevant DAMs concerned	Relevant RDMs concerned	Potential horizontal synergies between DAMs and RDMs	Potential vertical synergies between DAMs and RDMs
Farm level	Cultivation of: rapeseed, soybean, sunflower	AEC NFSA	None	No	Yes (on-farm processing of oilseeds for the production of non-refined oils for energy use)
Processing level (on-farm)	Production of: non-refined oils		On farm investment in equipment for the use of biomass as energy source Investment in installations for the production of by-products (e.g. non refined plant oils)	No	

Table 18.4 – Potential synergies in the bio-ethanol supply chain

Supply chain levels concerned	Activities concerned	Relevant DAMs concerned	Relevant RDMs concerned	Potential horizontal synergies between DAMs and RDMs	Potential vertical synergies between DAMs and RDMs
Farm level	Cultivation of: sugar beet, maize, barley, rye, wheat, potatoes	AEC NFSA	None	No	No (on-farm processing of biomass for the production of bio-ethanol is unfeasible due to the large scale industrial technology used and the associated high level of investment needed)
Processing level (on-farm)	Production of: bio-ethanol		None	No	

Table 18.5 – Potential synergies in the bio-gas supply chain

Supply chain levels concerned	Activities concerned	Relevant DAMs concerned	Relevant RDMs concerned	Potential horizontal synergies between DAMs and RDMs	Potential vertical synergies between DAMs and RDMs
Farm level	Cultivation of: maize Production of: agricultural residues; other additional sources of biomass	AEC NFSA (DAMs are concerned for the cultivation of energy crops only)	None	No	Yes (on-farm processing of maize for the production of bio-gas; on-farm use of bio-gas for the production of heat and/or electricity)
Processing level (on-farm)	Production of: bio-gas		On farm investment in equipment for the use of biomass as energy source	No	

Table 18.6 – Potential synergies in the direct burning of biomass supply chain

Supply chain levels concerned	Activities concerned	Relevant DAMs concerned	Relevant RDMs concerned	Potential horizontal synergies between DAMs and RDMs	Potential vertical synergies between DAMs and RDMs
Farm level	Cultivation of: Cereals for direct combustion, willow, miscanthus, grass Production of: agricultural residues, wood residues, thinning wood, other additional sources of biomass	AEC NFSA (DAMs are concerned for the cultivation of energy crops only)	Support for planting multi-annual biomass crops	Yes (fast growing multi-annual biomass crops)	Yes (on-farm direct burning of biomass for the production of heat and/or electricity)
Processing level (on-farm)	Production of: heat electricity		On farm investment in equipment for the use of biomass as energy source Non industrial processing of forest products for energy purposes	No	

From the above tables it can be seen that in the four bio-energy supply chains under study only one potential horizontal synergy was identified, compared to 3 potential vertical synergies.

The potential synergies identified above are analysed in detail in the following paragraphs.

18.2.1 Potential synergies between the AEC and the relevant RDMs

The mechanism through which the AEC acts is the granting of an additional revenue which is specifically linked with the cultivation of energy crops. In the answer to the EQ 1, it was judged that – when market margins are tight or negative – the AEC is an effective tool to promote the cultivation of energy crops on non-set aside land, and hence the production of biomass for energy purposes. When market margins are high, the role of the AEC as incentive is not so important, and the cultivation of energy crops is carried out extensively also outside specific support regimes.

The mechanisms through which the relevant RDMs act are of three kinds (see in this respect § 5.4):

1) the reduction of fixed costs stemming from the introduction on the farm of innovations which are associated with the production of biomass for energy purposes or with the processing of such biomass into bio-energy sources/bio-energy, with the aim of promoting the introduction of such innovations;
2) the reduction of variable costs related to the cultivation of forestry - which can be used as a source of biomass for energy purposes - through the granting of premiums aimed at covering maintenance costs;
3) the granting of an additional revenue aimed at covering income losses caused by the activity at point 2 above.

The potential synergies that can be identified among the AEC and the relevant RDMs in the different bio-energy supply chains are described in detail in the following paragraphs.

18.2.1.1 Bio-diesel supply chain

The AEC can promote the cultivation on non-set aside lands of energy crops destined to the production of bio-diesel, i.e. oilseeds. Indeed substantial energy crop areas under the AEC have been cultivated with oilseeds (see the answers to the EQ 1 and 6).

No relevant RDM has the potential to promote the cultivation of oilseeds, as the RDMs targeted at promoting the production of biomass for energy purposes concern crops - fast growing multi-annual species, forestry – which cannot be used as feedstock for bio-diesel production: therefore, no horizontal synergy can be identified between the AEC and the RDMs under study.

The relevant RDMs can however promote the introduction on the farm of innovations which are associated with the processing of biomass into bio-energy sources/bio-energy (on farm investment in equipment for the use of biomass as energy source; investment in installations for the production of by-products, like non refined plant oils). As the activities which can be supported through the RDMs under study include on-farm processing of oilseeds for the production of non-refined oils for energy use, and on-farm conversion of such oils into heat and/or power, a potential vertical synergy between the AEC and these specific RDMs can be identified in this supply chain, as the action of the two measures combined may lead to a better valorisation of the energy oilseeds produced on the farm, which may in turn promote a further development of the cultivation of oilseeds for energy purposes on the farm itself.

18.2.1.2 Bio-ethanol supply chain

The AEC can promote the cultivation on non-set aside lands of energy crops destined to the production of bio-ethanol, i.e. cereals and – after the reform of the sugar CMO - sugar beet. Indeed significant – though not substantial - energy crop areas under the AEC have been cultivated with cereals (see EQ 1 and market analysis, § 8.1.1.3).

No relevant RDM has the potential to promote the cultivation of the crops at present most commonly used for the production of bio-ethanol. The RDMs targeted at promoting the production of biomass for energy purposes indeed concern crops - fast growing multi-annual species, forestry – whose use for the production of feedstocks destined to be processed into bio-ethanol is still in a semi-experimental phase (production of bio-ethanol from cellulosic feedstocks): therefore, no horizontal synergy can be at present identified in this respect between the AEC and the RDMs under study.

Moreover, due to the large scale industrial technology used at present in the production of bio-ethanol, and hence to the associated high level of investment needed, no possibility of starting an activity of on-farm processing of energy crops into bio-ethanol with the support of the RDMs targeted at promoting on-farm investment in equipment for the use of biomass as energy source and/or in installations for the production of by-products can be deemed feasible, and hence no potential vertical synergy between the AEC and the relevant RDMs can be identified at present in this bio-energy supply chain.

18.2.1.3 Bio-gas supply chain

The AEC can promote the cultivation on non-set aside lands of energy crops destined to the production of bio-gas, mainly represented by cereals, and silage maize in particular. Indeed significant – though not substantial - energy crop areas under the AEC have been cultivated with cereals (see EQ 1 and 6 and the market analysis, § 8.1.1.3).

For the reasons already seen for the bio-diesel and bio-ethanol supply chains[256], no relevant RDM has the potential to promote the cultivation of the crops at present most commonly used for the production of bio-gas: therefore, no horizontal synergy can be at present identified in this respect between the AEC and the RDMs under study.

Also in this case instead, the relevant RDMs can promote the introduction on the farm of innovations which are associated with the processing of biomass into bio-energy sources/bio-energy (on farm investment in equipment for the use of biomass as energy source; investment in installations for the production of by-products). As on-farm production of bio-gas from cereals (especially silage maize), and on-farm generation of heat and/or power from bio-gas are among the activities supported through the RDMs under study, a potential vertical synergy between the AEC and these specific RDMs can be identified in this supply chain, as the action of the two measures combined may lead to a better valorisation of the cereals produced on the farm, which may in turn promote a further development of the cultivation of cereals for energy purposes on the farm itself.

18.2.1.4 Direct burning of biomass supply chain

The AEC can promote the cultivation on non-set aside lands of energy crops for the production of biomass destined to direct combustion. Various energy crops among the ones eligible for the AEC can indeed be destined to such use, both annual (sorghum) and multi-annual (miscanthus, reed canary grass, short rotation forestry, etc.) ones. It has to be noted, however, that only short rotation coppice has been cultivated on a significant area under the AEC (see EQ 1 and 6 and the market analysis, § 8.1.1.4).

Among the relevant RDMs indeed the ones targeted at promoting the production of biomass for energy purposes concern crops - fast growing multi-annual species, forestry – whose products are commonly used in direct combustion for the generation of heat and/or power. Moreover, it has to be noted that among such crops short rotation coppice is eligible also for the AEC, and is grown over a non negligible area under this measure. Therefore, potential horizontal synergies can be identified between the AEC and these specific RDMs, especially when the crops are eligible for the support granted by both measures.

Moreover, the relevant RDMs can indeed promote - through the introduction on the farm of equipment for the use of biomass as energy source and for non industrial processing of forest products for energy purposes – the start of activities centred on the direct combustion of biomass produced on the farm itself with the support of the AEC for the generation of heat and/or power. Therefore, a potential vertical synergy between the AEC and these specific RDMs can be identified in this supply chain, as the action of the two measures combined may lead to a better valorisation of the biomass produced on the farm, which may in turn promote a further development of the cultivation of the concerned energy crops on the farm itself.

18.2.2 Potential synergies between the NFSA regime and the relevant RDMs

The mechanism through which the NFSA regime acts is centred on the authorization to grow non food crops – and energy crops among them – on set aside land, without having to renounce to set aside payments (with the only exception of sugar beet before the reform of the sugar CMO). The evidence gathered in EQ1 shows that the NFSA regime has been an effective incentive to the farmer to introduce and maintain the cultivation of energy crops over the evaluation period (especially where market margins for the energy crops are negative or tight[257]). However the NFSA regime features "intrinsic" limits in the rate of compulsory set-aside and in the commitments of the "Blair House Agreement".

The mechanisms through which the relevant RDMs act have been described in § 5.4.

[256] The RDMs targeted at promoting the production of biomass for energy purposes indeed concern crops - fast growing multi-annual species, forestry – which are unsuitable for the production of feedstock destined to be processed into bio-gas.
[257] This was the case in three out of eight representative situations studied at regional level.

The potential synergies that can be identified among the NFSA regime and the relevant RDMs in the different bio-energy supply chains are described in the following paragraphs. Only the peculiarities with respect to the synergies between the AEC and the relevant RDMs, previously described, will be highlighted.

18.2.2.1 Bio-diesel supply chain

No relevant peculiarities are to be highlighted. Oilseeds are grown over a substantial area also under NFSA regime (see EQ 1 and 6 and the market analysis, § 8.1.1.3).

No horizontal synergies between the NFSA regime and the relevant RDMs can be identified, for the same reasons described in the case of the AEC.

Potential vertical synergies analogous to the ones identified between the AEC and the relevant RDMs can be identified also between the latter and the NFSA regime.

18.2.2.2 Bio-ethanol supply chain

A relevant peculiarity concerns the fact that until 2006 the cultivation of sugar beet under the NFSA regime implied the renounce to the set-aside payments. Such limitation was removed, with effect from the 2006 campaign onwards, with the reform of the sugar CMO. Cereals are grown under significant – though not substantial – areas also under the NFSA regime, but tend to have lesser importance on the total area in comparison with the case of the AEC. Sugar beet is also grown under the NFSA regime, albeit over a rather limited area[258] (see EQ 1 and 6 and the market analysis, § 8.1.1.3).

Neither horizontal nor vertical synergies between the NFSA regime and the relevant RDMs can be identified, for the same reasons described in the case of the AEC.

18.2.2.3 Bio-gas supply chain

No relevant peculiarities are to be highlighted. Cereals are grown under significant – though not substantial – areas also under the NFSA regime, but tend to have lesser importance on the total area in comparison with the case of the AEC.

No horizontal synergies between the NFSA regime and the relevant RDMs can be identified, for the same reasons described in the case of the AEC.

Potential vertical synergies analogous to the ones identified between the AEC and the relevant RDMs can be identified also between the latter and the NFSA regime.

18.2.2.4 Direct burning of biomass supply chain

The most relevant peculiarity concerns the fact that, according to art. 56.4 of Council Regulation (EC) No 1782/2003, Member States are authorised to pay national aid up to 50 % of the costs associated with establishing multi-annual crops intended for biomass production on set aside land (this provision was already present in Council Regulation (EC) 1251/1999, at art. 6.3). It has to be noted that the authorisation to Member States to pay such national aid is at present limited to multi-annual crops grown on set aside land, and therefore it does not apply in the case of multi-annual crops benefiting from the AEC. Such provisions could probably change soon, as the Commission has recently proposed allowing the Member States to grant national aid of up to 50% of the costs of establishing multi-annual crops also on areas on which an application for the AEC has been made[259]. This peculiarity has its relevance with respect to the horizontal synergies which can be identified between the NFSA regime and the relevant RDMs, as far as the production of biomass for direct combustion from multi-annual crops is concerned.

However, it has to be noted that the areas cultivated with short rotation coppice under the NFSA regime have indeed been of very modest extent (see EQ 1 and 6 and the market analysis, § 8.1.1.3).

Potential vertical synergies analogous to the ones identified between the AEC and the relevant RDMs can be identified also between the latter and the NFSA regime.

[258] At least until the last year for which detailed actual data are available, i.e. 2004.
[259] European Commission, Press release IP/06/1243, 22/09/2006, "Renewable energy: Commission proposes to extend energy crop aid scheme to all Member States "
http://europa.eu/rapid/pressReleasesAction.do?reference=IP/06/1243&format=HTML&aged=0&language=EN&guiLanguage=en

18.2.3 Effects of the potential synergies identified

On the basis of the elements illustrated so far, we can conclude that among the potential synergies identified:

1) All have the ability to promote the cultivation of energy crops, through the activation of on-farm downstream activities centred on the processing of biomass for energy purposes, which can give added value to the biomass produced on the farm itself.
2) The horizontal synergy identified in the bio-energy supply chain centred on the direct burning of biomass has the ability to promote the competitiveness of the energy crops concerned (fast growing multi-annual species). From the farmer's standpoint it combines additional revenues (through the AEC or the economic advantages inherent in non food crop cultivation under the NFSA regime) with reduced costs (through the support for planting multi-annual biomass crops granted through the RDMs, and also the authorization to Member States to pay national aid up to 50 % of the costs associated with establishing multi-annual crops intended for biomass production on set aside land, and possibly soon also under the AEC): therefore it increases the gross margin of the concerned energy crops. From the processor's standpoint, it lowers the biomass price that the farmer deems appealing.
3) The vertical synergies identified all have the ability to promote an increase in the volume of bio-energy production, as they promote an expansion of the biomass processing capacity for energy purposes (on-farm plants) and have positive effects on the economics of the portion of the bio-energy supply chain which is activated at farm level (additional revenues from DAMs for the cultivation of energy crops are combined with a reduction of financial fixed costs in the operation of on- farm processing plants).

18.3 Actual effects of the potential synergies identified

Among the findings of evaluation questions 1, 2, 3 and 4, of the regional case studies and of the market analysis, the following elements emerge which can (or cannot) suggest that the potential synergies identified at 6.2 actually have had effects on the cultivation and competitiveness of energy crops and/or on the volume of production of bio-energy:

1) In England SRC[260] and miscanthus were eligible for both the support granted by specific measures of the Rural Development Plan, on one side, and the support granted by the AEC (on non-set aside land) or the NFSA regime (on set aside land), on the other: however, despite the presence of such potential horizontal synergy between RDMs and DAMs, in the answer to evaluation question 4 it was highlighted that the area under these two multi-annual energy crops has remained very far from reaching the target levels set. This suggests that the actual effects of the potential horizontal synergy identified on the cultivation and competitiveness of SRC and miscanthus in England were at best very modest.
2) In the answer to the EQ 4 some indications emerged which suggest that the potential vertical synergies identified in the supply chains centred on bio-gas production had non negligible, even if limited, effects in the sole case of bio-gas production from maize in Austria and Germany. No elements emerged instead from the regional case studies that could suggest that the potential vertical synergies identified in the supply chains centred on direct burning of biomass had relevant actual effects on their development, in particular with respect to the volume of bio-energy production.
3) In the market analysis (§ 8) and in the answer to the EQ 1 it was highlighted that only modest areas have been cultivated under the AEC and the NFSA regime with crops destined to bio-gas production or to direct combustion: this suggests that the actual contribution of these DAMs to the vertical synergies identified in these supply chains is at best modest, especially as regards the effects on the volume of production of bio-energy.
4) From the answer to the evaluation question 2 it emerged that only a modest contribution was given by the AEC and the NFSA regime in the achievement of a price level for crops cultivated for energy use allowing these crops, and sources of bio-energy gained from these crops, to be competitive to other energy sources: this implies that the contribution of these DAMs to the potential vertical synergies identified as regards the effects on the competitiveness of energy crops cannot be deemed relevant.

In conclusion, none of the above elements suggests the presence of actual synergies between DAMs and RDMs which could have resulted in significant effects on the cultivation and competitiveness of energy crops and/or on the volume of production of bio-energy.

[260] The term indicates a number of fast-growing multi-annual species like poplar, willow etc.

However, it must be remembered that the scarce and fragmented data which were retrieved on the implementation of the relevant RDMs (see the answer to the evaluation question 4), in particular as regards the construction of on-farm plants for the production of bio-energy sources and of bio-energy, made it impossible to quantify the actual contribution of the relevant RDMs to the horizontal and vertical synergies identified.

18.4 Judgment

The scarce and fragmented data which were retrieved on the implementation of the relevant RDMs (see the answer to the evaluation question 4), in particular as regards the construction of on-farm plants for the production of bio-energy sources and of bio-energy, have made it impossible to pass from a purely qualitative analysis to a quantitative one: as a consequence, the evaluation team is not in the position to formulate judgments on the extent at which the concerned measures (DAMs and RDMs) work/have worked in synergy to promote the effects specified in the evaluation question.

A number of potential horizontal and vertical synergies was however identified in the bio-energy supply chains under study, with the ability:

- In the case of vertical synergies, of promoting both the cultivation of energy crops, (through the activation of on-farm downstream activities centred on the processing of biomass for energy purposes, which gives added value to the biomass produced on the farm itself) and the increase in the volume of bio-energy production (by promoting an expansion of the biomass processing capacity for energy purposes - construction of on-farm plants – and also through positive effects on the economics of the portion of the bio-energy supply chain which is activated at farm level).
- In the case of horizontal synergies, of promoting the competitiveness of the energy crops concerned.

The concerned bio-energy supply chains were the following:

- bio-diesel (vertical synergies);
- bio-gas (vertical synergies);
- direct burning of biomass (horizontal and vertical synergies).

On the basis of the available evidence, it is plausible to deem that the **identified potential synergies have actually had effects on the relevant aspects, to an extent which** cannot be exactly quantified, but **can be deemed as limited and concerning only specific situations** (bio-gas production from maize) **in two Member States**.

19 EVALUATION QUESTION 6

"Have the measures had any unintended effects on the relative shares of the different kinds of energy crops produced, in particular: did they privilege a certain type of energy crop? Have the measures had any significant unintended effects on the production of competing crops, in particular crops for food (e.g. cereals) and feed use?"

The relevant issues to tackle in the framework of EQ 6 are the following:

1) To identify, among the measures under study, the ones which can have – because of their functioning mechanisms - unintended effects on the relative shares of the different kinds of energy crops.
2) To assess whether and to what extent the support provided through the measures identified (cause) results in such differences in terms of relative profitability among the various kinds of energy crops that one/some of them is/are markedly more profitable than the others (effect).
3) If the cause-effect relation at point 2) above is verified, to assess whether and to what extent this results in unintended effects in terms of relative shares of the different kinds of energy crops, i.e. in a distribution of the agricultural area under energy crops that is polarized[261] towards one or a few kinds of energy crops.
4) To identify, among the measures under study, the ones which can have – because of their functioning mechanisms - unintended effects on the production of competing crops, in particular crops for food (e.g. cereals) and feed use.
5) To assess whether and to what extent the support provided through the identified measures (cause) results in such differences in terms of relative profitability between the various kinds of energy crops, on one hand, and the main competing (non-energy) crops for food and feed use, on the other hand, that one or some of the former are markedly more profitable than one or some of the latter (effect).
6) If the cause-effect relation at point 5) above is verified, to assess whether and to what extent this results in unintended effects on the production of competing crops, i.e. in an expansion of agricultural area under the most profitable energy crops at the expense of the agricultural area under the less profitable competing crops.

Being issue- and measure-specific, the methodology for answering the question is synthetically explained at the beginning of each paragraph.

19.1 Identification of the measures which can have unintended effects on the relative share of the different kinds of energy crops

Taking into account the evolution of the measures over the evaluation period, and also their different functioning mechanisms, the following considerations apply:

- Under the NFSA regime, the amount of the "implicit subsidy"[262] is the same for all the kinds of energy crops (indeed, also for the other non food crops) that can be grown on set aside land. As a consequence, no specialisation towards one/some particular kinds of energy crops on set aside land can be considered deriving from it.
- As regards sugar beet, however, before the reform of the sugar CMO in 2006, farmers had to renounce to set aside payments (thus facing an opportunity cost) if they wanted to grow sugar beet for non food purposes on set aside land. This economic disadvantage could create unfavourable conditions for the cultivation of sugar beet under the NFSA regime. After the reform of the sugar CMO (i.e. from the 2006 sugar campaign onwards) this specificity, and the aforementioned potential effects, has ceased to exist.

[261] The polarized / non-polarized nature of a distribution is given by the relative importance of the elements which constitute a whole. If the elements which constitute a whole are, for instance, four, the polarized nature of their distribution increases when the % share of one or more element rises over 25% (which is the value at which all the elements have the same relative importance, as 100 / 4 = 25). A 28-25-25-22 distribution is not very polarized; a 45-35-10-10 distribution is very polarized. The degree of polarization of a certain distribution is measured by means of adequate indexes. The *Herfindahl-Hirschmann Index (HHI)* is an index of common use: it is given by the sum of the squares of the relative share of each component: in our case, HHI = $(A\%)^2 + (B\%)^2 + (C\%)^2 + (D\%)^2$. The use of squares permits to give a more than proportional weight to the elements with the biggest shares, and a less than proportional weight to the elements with the smallest shares. The value of the HHI for an absolutely non polarized distribution is always equal to (100/N) X (100/N) X N = 10.000/N. The value of the HHI rises above 10.000/N as the polarized nature of the distribution gets more marked. In the case of four elements, the HHI for an absolutely non-polarized distribution (25-25-25-25) is 10.000/4 = 2.500 [$(25)^2+(25)^2+(25)^2+(25)^2$ = 2.500]; for a 50-40-5-5 (polarized) distribution the HHI is $(50)^2+(40)^2+(5)^2+(5)^2$ = 4.150 > 2.500.

[262] As defined in the answer to Evaluation Question 1.

- The amount of the AEC is the same irrespective of the kind of energy crops, and therefore the same considerations at the first bullet point above can be made also in this case, albeit taking into account that, before the reform of the sugar CMO in 2006, sugar beet was not eligible for the AEC.
- On the basis of the considerations made at the first and third bullet points above, it can be said that both the NFSA regime and the AEC are neutral as far as the relative profitability of the various kinds of energy crops grown with the support of both these DAMs is concerned. The exception is represented by sugar beet which, until the reform of the sugar CMO in 2006, could be grown under the NFSA regime only by renouncing to set aside payments, and was not eligible for the AEC.
- Before the implementation of the decoupling, a differentiation of area payments according to the kind of crop (irrespective of its use for food, feed or non food purposes) was present in a number of Member States: this differentiation could act as an incentive for farmers to grow some kinds of crops instead of others, if the differences in the level of area payments resulted in a situation where some crops were markedly more profitable than others. If a specialization actually occurred in this case, it has to be deemed as an unintended effect of the measure.
- Some kinds of energy crops (e.g. short rotation coppice, miscanthus, reed canary grass, etc.) were not eligible to the arable crops area payments. This could have acted as an indirect incentive to the specialization towards energy crops which were eligible, as area payments provided an additional revenue whose amount could not be negatively affected by both technical and market risks.
- After the implementation of decoupling, the market margins of the crops have remained the only factor which can make one/some particular kinds of energy crops markedly more profitable than the others (with the partial exception of the Member States where a part of the support for arable crops remains coupled, i.e. France and Spain). In the full-decoupling Member States the SPS is therefore neutral as far as the relative profitability of the various kinds of energy crops is concerned.
- With respect to the relevant RDMs, the support they grant to the cultivation of a particular group of energy crops – i.e. multi-annual ones – is <u>intentionally specific</u> to these crops, and therefore no unintended effects can be identified.

In conclusion, the measures which can have unintended effects on the relative share of the different kinds of energy crops are the following:

1) The specificity concerning **sugar beet** before the reform of the sugar CMO: it was not eligible to the AEC and its cultivation was possible on set aside land only by renouncing to set aside payments.
2) The **arable crops area payments** (pre-decoupling context) and the **partially coupled support for arable crops** (post decoupling context), where differentiated values apply for some crops.
3) The specificity concerning the **non-eligibility to area payments of some kinds of energy crops** in the pre-decoupling context.

19.2 Unintended effects of the measures identified on the relative shares of the different kinds of energy crops.

In general, the rationale for the analyses made is the following:

1) To assess if marked differences in the relative profitability – generally, in the attractiveness for farmers - of certain energy crops can be caused by the measures identified.
2) Once the situation at point 1) above is verified, to assess if peculiarities can be identified in the distribution of the area under the interesting supporting measures among the different energy crops. Such peculiarities can be associated to a specialization – and a consequent polarization of the area under support - towards one or few kinds of energy crops.
3) If the situation at point 2) is also verified, to assess if it could be considered as an unintended effect of the measure or, conversely, the result of the action of factors other than the measure.

These analyses were carried out, for each of the measures identified, in the Member States where the cultivation of energy crops under such measures is most practised.

<u>Limitations of the analysis and validity of the results</u>

The limitations of the analysis derive from the methodology that was used to obtain the base data on the gross margins of energy crops, which are explained in detail in the market analysis at § 11.1[263]*. It is important to note that among the*

[263] Further details are given also in annex H of the market analysis.

three situations that were considered in the calculation of the gross margins of the energy crops in § 11.1 of the market analysis:

a) price of the energy crop X = price of the crop X for food/feed use;

b) price of the energy crop X = price of the crop X for food/feed use PLUS 10%;

c) price of the energy crop X = price of the crop X for food/feed use MINUS 10%;

the situation c) was systematically chosen to build the entire dataset for the carrying out of the analyses conducted to answer to this part of the evaluation question. The reason behind this choice is the following: as the analysis is referred to year 2004, according to some evidence gathered in the framework of the case studies in that year buyers still tended to pay lower prices for the products of energy crops than for the products of the same conventional crops. Some indications gathered in the same context suggest nevertheless that the extent of this spread between prices has tended to decrease in the following years, and therefore the present situation falls somewhere between situation a) and situation c) above[264].

19.2.1 Unintended effects of the specificity concerning sugar beet cultivation for energy purposes before the reform of the sugar CMO.

In theory, the obligation to renounce to set aside payments when growing non food sugar beet on set aside land could put this crop at a disadvantage in comparison with other kinds of non food crops grown on set aside land[265].

Table 19.1 below, shows that the opportunity cost (net of the implicit subsidy[266]) associated to the cultivation under the NFSA regime of sugar beet specifically destined to bio-ethanol production in France (the Member State where this activity is most practised) did not put this crop[267] at a disadvantage in terms of profitability versus the other energy crops.

Table 19.1 - France: Margins granted by the main energy crops under the NFSA regime and by fallow set aside - 2004

Crop	1) Price (Euros/T)	2) Yield (T/ha)	3) = 1 x 2 = Revenue (Euros/ha)	4) Variable costs (Euros/ha)	NFSA regime	
					5) Implicit subsidy - Opportunity costs (*) (Euros/ha)	6) = 3 - 4 + 5 =Gross margin (Euros/ha)
Sugarbeet bio-ethanol (A)	**25,00**	**75,00**	**1.875,00**	**630,00**	**-266,00**	**979,00**
Wheat	81,00	7,79	630,99	379,00	100,00	351,99
Rapeseed	171,00	3,60	615,60	376,00	100,00	339,60
Barley	78,30	6,50	508,95	358,00	100,00	250,95
Sunflower	198,90	2,36	469,40	331,00	100,00	238,40
Sugarbeet alcohol (B)	**15,00**	**75,00**	**1.125,00**	**630,00**	**-266,00**	**229,00**
Rye	77,40	5,05	390,87	331,00	100,00	159,87
Maize	12,90	62,44	805,48	836,00	100,00	69,48
Fallow set aside				100,00		-100,00

Notes:
(A): crop specifically destined to bio-ethanol production
(B): crop for generic alcohol production
(*): implicit subsidy = 100 Euros/ha; opportunity costs (renounce to set aside payments for sugar beet) = -366 Euros/ha
Source: DEIAGRA elaboration of data from Graham Brookes, "European arable crop profit margins" (2004/05); data sources for sugar beet: 1) France Betteraves; 2) CGB; 4) and 5) regional case studies

The distribution of the NFSA area in France among the different energy crops in 2004 is described in table 19.2 below.

[264] Further limitations derive from the data used to determine the margins of energy crops. As far as yields, prices, variable production costs and area payments are concerned, the source of data is the same used in the framework of the market analysis: Graham Brookes, "European arable crop profit margins" (2004/05).
[265] It is also important to remember that before the reform of the sugar CMO in 2006 sugar beet was not eligible for the AEC.
[266] Non food sugar beet grown on set aside land benefits from the implicit subsidy like all the other non food crops, as such incentive is inherent to the authorization to grow non food crops on set aside land, instead of leaving it fallow, and to the restriction of this authorization to a limited number of crops.
[267] The same cannot be said of non food sugar beet destined to generic alcohol production, which earned however a much lower price.

Table 19.2 - Non-food on set aside - France: areas 2004 per type of crop (ha)

Type of crop	Area	% on total	HHI score
Rapeseed	151.280,04	77,5%	6.006
Sunflower	17.098,86	8,8%	77
Wheat	9.686,12	5,0%	25
Other oilseeds	9.353,18	4,8%	23
Sugar beet	**4.056,23**	**2,1%**	**4**
Maize	1.278,09	0,7%	0
Miscellaneous plants and flowers	1.195,97	0,6%	0
Fruits	413,10	0,2%	0
Linseed	317,68	0,2%	0
Spices	236,30	0,1%	0
Beans	154,61	0,1%	0
Other vegetables	50,74	0,0%	0
Rye	29,19	0,0%	0
Short rotation coppice	21,09	0,0%	0
Barley	17,81	0,0%	0
Grass	10,55	0,0%	0
Oats	10,19	0,0%	0
Total	**195.209,75**	**100,0%**	**6.135**

Source: DEIAGRA elaboration on DG-Agri Unit D1 data
Note: the higher the HHI score, the more polarized towards one/few kinds of energy crops the distribution (see also note 261)

Despite being by far the most profitable energy crop, sugar beet was grown over a rather modest area under the NFSA regime in France in 2004. However, no elements can suggest that this was due to the specificity of the NFSA regime identified, as the profitability of the crop versus the alternatives was not significantly altered by it (i.e. an essential condition for unintended effects to arise was lacking).

As regards the unintended effects of the specificity under study in Member States other than France, these are difficult to be assessed, as no reliable data were retrieved on the profitability of sugar beet for bio-ethanol production in the other Member States before the reform of the CMO for sugar. However it can be noted that:

a) Theoretically speaking, the renounce to set aside payments might have negatively affected the relative profitability of the crop especially in the Member States where – at least for conventional sugar beet - yields are lower and production costs higher than in France. Indeed, in none of such Member States (e.g. Italy, Spain, Finland, etc.) the cultivation of non food sugar beet was practised under the NFSA regime in 2004[268].

b) However, in the case of Germany – i.e. the only Member State other than France where non food sugar beet was grown under the NFSA regime in 2004, although on just 20 hectares[269] - the above considerations cannot apply, as the yields and production costs of conventional sugar beet are close to the French ones. As in the case of France, it is difficult to explain the cultivation of such a limited area in Germany in terms of unintended effects of the specificity of the NFSA regime identified.

Evidence from the market analysis (§ 8.4 and 11.2.3) and the case studies (see in this respect also the EQ 10) suggests that factors other than the specificity of the NFSA regime can have combined to limit the extent of non food sugar beet area - both in general and under the NFSA regime:

- Absence of processing plants (distilleries capable of using sugar beets as feedstock) at a reasonable distance, and/or of plants producing ETBE in some Member States; in other words, insufficient (or outright absent) demand for sugar beets for energy purposes.
- Competition by cheaper types of feedstock obtained by crops which are technically simpler to grow than sugar beet, and also suitable to a wider range of agronomical conditions (e.g. wheat or barley).
- Competition by cheaper bio-ethanol, imported from third countries.

Theoretically speaking, the non eligibility of sugar beet for the AEC could have discouraged its cultivation for energy purposes on non-set aside land. It must however be underlined that such activity features relatively high market margins[270] in the Member States most suited to sugar beet cultivation - like France and Germany

[268] According to data from DG-Agriculture, unit D1.
[269] According to data from DG-Agriculture, unit D1.
[270] In the case of France, the market margin for sugar beet specifically destined to bio-ethanol production on non-set aside land in 2004 was estimated in 1245 Euros/ha, assuming a price of 25 Euros/T (source: France Betteraves), a yield of 75 T/ha (source: CGB) and

– and hence it is plausible that the non eligibility for the AEC had only limited effects on the relative profitability of the crop versus the alternatives (crops for food/feed use and energy crops eligible for the AEC).

In conclusion, the main reason behind a limited cultivation on non-set aside land of sugar beet for energy purposes in France and Germany in the 2004-2005 period (around 3.000 ha and 7.000 ha, respectively[271]) is not to be found in the non eligibility of such crop for the AEC. The factors highlighted above in the case of the NFSA regime (insufficient demand; competition by cheaper types of feedstock and by cheaper imported bio-ethanol) have surely had more relevance in determining such a situation.

Nevertheless, the disadvantage stemming from the non eligibility of sugar beet for the AEC could have been more significant in Member States where sugar beet cultivation features lower yields and higher production costs than in France or Germany.

19.2.2 Unintended effects of differentiated arable crops area payments.

Differentiated arable crops area payments can have two effects on the attractiveness of the various energy crops:

1) They can cause shifts in their relative profitability, i.e. a crop “X” whose market margin is low or negative can become more profitable than another crop “Y” with an higher market margin because the crop “X” is granted a higher area payment than crop “Y”.
2) Crops benefiting from higher area payments have a higher portion of their profitability which is not influenced by yield variability and/or market risks (“insurance” effect, already discussed in the case of AEC in the answer to the evaluation question 1). Therefore, their attractiveness for risk-averse farmers becomes higher.

Two separate but complementary analyses have to be carried out to assess the two above effects.

The effects at point 1) are assessed through a comparison between the profitability ranking of the various energy crops with and without the additional revenue granted by area payments.

The effects at point 2) are assessed through an *ad hoc* ranking based on the values assumed by the indicator “area payments on total gross margin”.

The analyses were carried out for some Member States which, besides having differentiated area payments in the pre-decoupling context, also had relevant areas under energy crops on non set aside land, namely France, Germany and Spain.

The results of such analyses are presented in Table 19.4, 19.5 and 19.6 below.

Some figures are also presented regarding the market margins of the main energy crops in two Member States where no differentiation existed among the various energy crops with respect to the amount of area payments, namely Austria and Denmark. Where such a situation applied, differences in the market margin determined the relative profitability of the various energy crops: area payments were neutral in this respect. The figures are presented in Table 19.3 below.

Table 19.3 - Comparison among the market margins (in Euros/ha) of different energy crops under the AEC in Austria and Denmark - 2004

Member states	Main types of energy crops					
	1st	Market margin	2nd	Market margin	3rd	Market margin
Austria	Maize	201,76	Rapeseed	- 119,42	Sunflower	- 176,90
Denmark	Rapeseed	240,84	Wheat	219,63	Barley	134,13

DEIAGRA elaboration on data from Graham Brookes, “European arable crop profit margins” (2004/05).

The main findings of the analyses can be summed up in the following:

a) The granting of higher area payments to maize and sunflower in France caused shifts in the relative profitability of the energy crops: maize became more profitable than rye and sunflower became more profitable than barley. The “insurance” effect was particularly marked in the case of maize (whose market margin was negative).

operating expenses of 630 Euros/ha (source: regional case studies). The additional revenue lost because of the non eligibility to the AEC – equal to 45 Euros/ha – had very limited relevance (3,6%) if compared to such a substantial margin.

[271] Sources: CGB (French sugar beet growers’ organization) for France; The German Farmers' Association for Germany.

b) In Germany, the area payment granted to maize was markedly higher than the ones granted to the other crops: this resulted in a remarkable shift in the relative profitability of energy crops, as maize became the most profitable one mostly by virtue of the higher area payment (its market margin was near-zero). The "insurance" effect was particularly marked in the case of rye, maize and wheat (crops with negative or tight market margins).

c) Also in Spain the area payment granted to maize was markedly higher than the ones granted to the other crops; in this case, however, this caused no shifts in the relative profitability of the main energy crops, as maize also featured the highest market margin. The highest "insurance" effect could be observed in the case of sunflower.

Once verified, for France and Germany, the condition for the area payments to have potential unintended effects on the relative shares of the different energy crops, it has to be verified whether a specialization towards the energy crops which were most favoured by higher area payments actually occurred in these Member States.

The results of such investigation are presented in Table 19.7 (distribution of the AEC area among the various energy crops in selected Member States, some with differentiated area payments, some not, for 2004) and Table 19.8 below (distribution of the energy crop area grown outside specific regimes in Germany for 2004 and 2005).

Table 19.4 - France: comparison among the relative profitability (in Euros/ha) of the main types of energy crops with and without area payments – 2004

Crops	1) Area payments	2) Market margin (area payments excluded)	3) = 1+2 = Total margin (area payments included)	4) = 1/3 (%) = area payments on total margin	Without area payments		With area payments		Area payments on total margin (%)	
					Rank	Crop	Rank	Crop	Rank	Crop
Maize	488,00	-30,52	457,48	106,7%	1	Wheat	1	Wheat	1	Maize
Sunflower	418,00	138,40	556,40	75,1%	2	Rapeseed	2	Rapeseed	2	Rye
Barley	339,00	150,95	489,95	69,2%	3	Barley	3	**Sunflower**	3	Sunflower
Rapeseed	339,00	239,60	578,60	58,6%	4	Sunflower	4	Barley	4	Barley
Rye	339,00	59,87	398,87	85,0%	5	Rye	5	**Maize**	5	Rapeseed
Wheat	339,00	251,99	590,99	57,4%	6	Maize	6	Rye	6	Wheat

DEIAGRA elaboration on data from Graham Brookes, "European arable crop profit margins" (2004/05).

Table 19.5 - Germany: comparison among the relative profitability (in Euros/ha) of the main types of energy crops with and without area payments - 2004

Crops	1) Area payments	2) Market margin (area payments excluded)	3) = 1+2 = Total margin (area payments included)	4) = 1/3 (%) = area payments on total margin	Without area payments		With area payments		Area payments on total margin (%)	
					Rank	Crop	Rank	Crop	Rank	Crop
Maize	474,00	3,15	477,15	99,3%	1	Rapeseed	1	**Maize**	1	Rye
Barley	348,00	65,59	413,59	84,1%	2	Barley	2	Rapeseed	2	Maize
Wheat	348,00	11,12	359,12	96,9%	3	Wheat	3	Barley	3	Wheat
Rapeseed	336,00	112,22	448,22	75,0%	4	Maize	4	Wheat	4	Barley
Rye	336,00	-47,99	288,01	116,7%	5	Rye	5	Rye	5	Rapeseed

DEIAGRA elaboration on data from Graham Brookes, "European arable crop profit margins" (2004/05).

Table 19.6 - Spain: comparison among the relative profitability (in Euros/ha) of the main types of energy crops with and without area payments - 2004

Crops	1) Area payments	2) Market margin (area payments excluded)	3) = 1+2 = Total margin (area payments included)	4) = 1/3 (%) = area payments on total margin	Without area payments		With area payments		Area payments on total margin (%)	
					Rank	Crop	Rank	Crop	Rank	Crop
Maize	359,00	233,04	592,04	60,6%	1	Maize	1	Maize	1	Sunflower
Wheat	195,00	158,78	353,78	55,1%	2	Wheat	2	Wheat	2	Barley
Sunflower	195,00	24,34	219,34	88,9%	3	Barley	3	Barley	3	Maize
Barley	151,00	96,78	247,78	60,9%	4	Sunflower	4	Sunflower	4	Wheat

DEIAGRA elaboration on data from Graham Brookes, "European arable crop profit margins" (2004/05).

Limitations of the analysis and validity of the results

Unintended effects of differentiated area payments concern all energy crops grown on non-set aside land which were eligible for area payments, not only energy crops grown under the AEC. The data on the AEC presented here are the only actual (non-estimated) figures available for all the Member States under study, though for year 2004 only. The actual breakdown by main groups of energy crops of the area outside specific regimes was retrieved instead only for Germany, for the years 2004 and 2005. It has however to be noted that the estimated area under energy crops outside specific regimes in France and Spain was relatively limited (see market analysis, § 8.1.1.4).

Table 19.7 - Main types of energy crops under the AEC in selected Member States – 2004

Member states	Main types of energy crops						Top 3 types: cumulated % of total area	Distribution of total area among the various types HHI score
	1st	% on total area	2nd	% on total area	3rd	% on total area		
Austria	Maize	68,7%	Rapeseed	16,9%	Other cereals	7,4%	93,0%	5.097
Denmark	Rapeseed	100,0%	None		None		100,0%	10.000
France	Rapeseed	95,6%	Sunflower	3,5%	Wheat	0,9%	100,0%	9.147
Germany	Rapeseed	72,0%	Rye	19,2%	Maize	7,3%	98,5%	5.604
Spain	Barley	89,2%	Wheat	5,8%	Sunflower	5,0%	100,0%	8.015
EU-15	**Rapeseed**	**76,2%**	**Rye**	**8,2%**	**Maize**	**4,1%**	**88,5%**	**5.920**

Source: DEIAGRA elaboration on DG-Agri Unit D1 data
Note: the higher the HHI score, the more polarized towards one/few kinds of energy crops the distribution (see also note 261)

Table 19.8 - Energy crops grown outside specific regimes in Germany: areas 2004 and 2005 per type of crop (ha)

Type of crop	2004			2005		
	Area	% on total	HHI score	Area	% on total	HHI score
Rapeseed	424.000	72,2%	5.214	588.200	74,1%	5.485
Starchy crops	125.000	21,3%	453	125.000	15,7%	248
Maize	22.000	3,7%	14	65.000	8,2%	67
Sunflower	9.200	1,6%	2	9.000	1,1%	1
Sugar beet	7.000	1,2%	1	7.000	0,9%	1
Total	**587.200**	**100,0%**	**5.685**	**794.200**	**100,0%**	**5.802**

Source: DEIAGRA elaboration of data from The German Farmers' Association, "Situationsbericht DBV 2005" (www.situationsbericht.de)
Note: the higher the HHI score, the more polarized towards one/few kinds of energy crops the distribution (see also note 261)

On the basis of the figures in Table 19.7 and .8 above, the following considerations can be made:

- In France, the crops which were most favoured in terms of relative profitability by the granting of higher area payments – sunflower and maize – covered only a limited share of the area under the AEC (sunflower) or were not cultivated at all (maize).
- In Germany, the crop which was most favoured in terms of relative profitability by the granting of higher area payments – maize – covered only a relatively limited share of the area under the AEC and outside specific regimes (though in this case its share on total increased remarkably between 2004 and 2005).

It can therefore be said that the unintended effects of differentiated area payments on the relative shares of the different kinds of energy crops were extremely modest.

Moreover, it has to be noted that the relative profitability of a crop in comparison with the alternatives is not the only factor which can influence the farmers' choices: in other words, the most profitable crop is not necessarily the most attractive to the majority of farmers, and hence the most common.

While it is true that in Austria and Denmark the most profitable energy crops – maize and rapeseed, respectively – were indeed the most common (see Table 19.3 and .7), it was not quite so in France, Germany and Spain (see Table 19.4-Table 19.8).

The undeniable polarization towards very few kinds of energy crops which emerges in the cases studied (see Table 19.7 and .8) cannot be explained only in terms of relative profitability of the crops themselves, and surely cannot be attributed to the existence of differentiated area payments.

Such polarization, in the situations where the most common energy crops are not the (theoretically) most profitable ones, can be explained by a combination of the following factors:

- Within a Member State, and even within a region, some kinds of energy crops are suited only to limited areas - where they can assure high margins – while their cultivation is too risky or even technically impossible in the remaining areas (this is especially true for countries with a very ample spectrum of agronomical situations within their territory, e.g. Italy and France).
- Just like in the case of crops for food and feed use, some kinds of energy crops are highly profitable, but also technically difficult, and therefore can be grown successfully only by a relatively limited number of farmers with adequate resources and know-how. To be common, a crop must be technically feasible for a high number of farmers.
- Some kinds of energy crops can be grown only if processing plants are available within a relatively limited radius, and their cultivation is therefore limited to the areas which surround the processing plants.

19.2.3 Unintended effects of the specificity concerning the non-eligibility to area payments of some kinds of energy crops.

When an energy crop was not eligible to area payments, farmers wishing to grow such crops must face an opportunity cost, caused by the renounce to area payments and also to their "insurance" effect against variations in yield and price, which can be remarkable especially in the case of crops which have no significant alternative use to the destination to energy purposes (indeed, some of the energy crops not eligible to area payments – e.g. miscanthus - are indeed in such a situation). This opportunity cost could have put these crops at a relative disadvantage in comparison with energy crops eligible to area payments.

Indeed, the energy crops which were not eligible to area payments – grass and short rotation forestry, and also sugar beet – occupied in 2004 only limited shares of the area under the AEC[272] in the EU-15 (see Table 19.9 below).

Table 19.9 - Aid for energy crops - EU-15: areas 2004 per type of crop (ha)

Type of crop	Area	% on total	HHI score
Rapeseed	211.017,32	76,2%	5.809
Rye	22.727,45	8,2%	67
Maize	11.272,86	4,1%	17
Short rotation forest trees	**9.188,00**	**3,3%**	**11**
Barley	7.370,58	2,7%	7
Wheat	5.403,95	2,0%	4
Sunflower	5.172,31	1,9%	3
Grass	**3.495,35**	**1,3%**	**2**
Other cereals	1.015,26	0,4%	0
Oats	183,58	0,1%	0
Beans	20,56	0,0%	0
Other oilseeds	2,58	0,0%	0
Miscellaneous	1,15	0,0%	0
Soybeans	0,00	0,0%	0
Total	**276.870,95**	**100,0%**	**5.920**

Notes: crops not eligible for area payments are in **bold types**
Source: DEIAGRA elaboration on DG-Agri Unit D1 data
Note: the higher the HHI score, the more polarized towards one/few kinds of energy crops the distribution (see also note 261)

However, no evidence coming from regional case studies (with special reference to the ones concerning Eastern England – for miscanthus and short rotation forestry – and Oulu Region – for reed canary grass) clearly suggested that the non-eligibility of such crops to the arable crops area payments was a relevant limiting factor to their diffusion. Semi-experimental production techniques, high variability in yields and limited market outlets emerged instead as the main limiting factors.

[272] For the reasons behind the use of figures concerning areas under the AEC, see the box on limitations at § 19.2.2 above. To our knowledge, however, no significant areas were cultivated outside specific regimes in the EU in 2004 with crops not eligible to area payments: see in this respect the market analysis, § 8.1.1, and also Table 19.8 above.

19.3 Differences in terms of profitability between the energy crops and the main crops for food and feed use[273].

Basing on data and information on the competitiveness of energy crops illustrated in § 11.1 of the market analysis[274], a comparison among the gross margins of the various energy crops, on one hand, and the margins of the main crops for food and feed use, on the other hand, was carried out at Member State level. The analysis was aimed at identifying the cases where the support granted through the relevant DAMs under study caused shifts in the relative profitability of energy crops versus the crops for food and feed use.

It is important to note that in the context of this evaluation question **only the support granted through the AEC constitutes a differential element which could favour the energy crops over the crops for food/feed use in terms of profitability**: energy crops grown under the NFSA regime are indeed not in competition with crops for food and feed use, which cannot be grown on set aside land.

Before the implementation of the decoupling (and also after its implementation, in the Member States where the support granted to arable crops remains partially coupled, i.e. France and Spain), the same level of area payments was granted to each kind of arable crop both in the case of energy use and in the case of food and feed use, and therefore did not constitute a differential element in this sense.

After the implementation of decoupling, the support granted to the farmers through the SPS cannot constitute, by design, a differential element which can favour an energy crop versus a conventional one.

Therefore, the analysis is focused on the possible shifts – attributable to AEC - in the relative profitability of the main energy crops in comparison with the main kinds of crops for food/feed use. In order to obtain a more comprehensive picture of the situations for the Member States under study, additional crops for food/feed use were included with respect to the ones considered at § 11.1 of the market analysis[275]. The results of this analysis are illustrated in Table 19.10[276].

Table 19.10 - Effects of AEC on the relative profitability of energy crops vs. crops for food and feed use

Member State	Shifts in the relative profitability caused by the AEC (energy crops margins' improvements over margins of crops for food and feed use)
Austria	Rapeseed energy > sunflower Sunflower energy > wheat and barley Barley energy > wheat and barley
Denmark	Barley energy > rye
France	Wheat energy > sunflower Rapeseed energy > sunflower Rye energy > rye and maize (grain)
Germany	Maize energy > rapeseed Rapeseed energy > barley Barley energy > maize (grain) and soft wheat

Source: DEIAGRA elaboration on data from Graham Brookes, "European arable crop profit margins" (2004/05)

The granting of the AEC indeed has caused, through the additional revenue it generates, some shifts in the relative profitability of energy crops versus crops for food and feed use. Such a situation could have been an incentive to expand the areas under the "winning" energy crops with improved margins at the expense of the areas under the "losing" food/feed crops, thus constituting the basis for unintended effects on the production of the latter. Such effects can be attributable to the AEC obviously on the sole areas benefiting from its support (hence not on the energy crop areas outside specific regimes).

[273] With respect to this analysis, due to similar methodology and analogue source of data, the same limitations cited at § 19.2 have to be taken into account.
[274] See also annex H of the market analysis.
[275] To be consistent, the data source used to determine the gross margins of these additional crops is the same that was used for the calculations made in annex H of the market analysis, i.e. Graham Brookes, "European arable crop profit margins" (2004/05).
[276] For a more detailed illustration of the results of this analysis, please refer to tables A.6.41-A.6.46 in the annex to this chapter.

19.4 Unintended effects on the production of competing crops for food and feed use.

Basing on the availability of data, and with the objective to assess if the potential for unintended effects cited above has resulted in actual effects, the areas under the various crops for food/feed use in 2003 (last year before the introduction of the AEC) were compared with those of 2004 (first year of implementation of the AEC). The analysis also took into account the evolution of the total usable agricultural area (UAA) in the Member States under study over the same two years, and the extent of the areas under the different energy crops under the AEC in 2004[277].

In an aggregate approach - i.e. without making distinctions among the various kinds of crops - if the UAA did not increase in a Member State between 2003 and 2004, clearly the energy crop area under the AEC cultivated in 2004 was subtracted to crops for food/feed use (or for non food uses, including energy when the crop was grown without AEC). If the UAA increased instead, it is important to compare the extent of such increase with the total area cultivated under the AEC, to assess how much of the latter could have found its place – in theory at last – on the "new" UAA added in 2004.

A crop-by-crop approach, instead, should allow to identify:

- actual "conversion" phenomena, i.e. when a certain crop for energy use actually substituted the same crop for food/feed use (e.g. energy sunflower in place of sunflower for food/feed use);
- actual "substitution" phenomena, i.e. which specific crop for energy use actually substituted another crop for food/feed use (e.g. energy rapeseed in place of wheat for food/feed use);

Information on such phenomena were retrieved through on field work, mainly interviews with stakeholders, for the regions selected for the case studies, and are summarized in the box below. It is anyway important to underline that such evidence cannot be used to derive conclusions at Member State level.

Conversion and substitution phenomena in the regions selected for the case studies

According to the interviewed stakeholders, the following conversion and substitution phenomena have taken place in the regions under study:

- In Lower Saxony, rapeseed for bio-diesel production and maize for bio-gas production have started to replace sugar beets (especially after the reform of the sugar CMO), wheat and rye for food/feed use and brewing barley (substitution phenomena).
- In Haute Normandie, rapeseed for bio-diesel has started to replace rapeseed (conversion phenomena) and, to a lesser extent, cereals for food use (substitution phenomena).
- In Carinthia, silage maize is more and more destined towards bio-gas production instead of being used as feed (conversion phenomena).
- In Oulu Region, reed canary grass has started substituting wheat for food use in the less favourable agronomical environments (substitution phenomena).

Some useful indications can be also given analysing the dynamics of the areas under the various crops for food/feed use over 2003-2004, and comparing such dynamics with the extent of the areas under energy crops with AEC in 2004. These indications regard:

- the actual evolution of the areas under the kinds of crops for food/feed use, net of the effect of the start of the cultivation of energy crops under AEC;
- the maximum theoretical extent of the conversion and substitution phenomena that may have occurred.

The relevant indicators in this respect are the following:

[277] To assess if the potential for unintended effects cited above has resulted in actual effects, a comparison between the dynamics of the areas under the various energy crops benefiting from the AEC, on one hand, and the dynamics of the areas under the main crops for food and feed use, on the other, would be needed. However, no data were available on the actual (non-estimated) breakdown by kind of energy crop of areas under AEC for the second year of the implementation of the measure (2005) at the moment of the drafting of the study: therefore a comparison between the situations existing in 2004 and 2005 was unfeasible.
It must be noted that an estimate of the distribution of the energy crop area under the AEC made by assuming that the distribution was the same registered in 2004 could not be considered a solution in the framework of the present evaluation question, as this would have implied that all the areas under the various kinds of energy crops did increase: being too strong, such an assumption would have led to unrealistic conclusions.

A. variation in the area of crop "X", net of the area of crop "X" under AEC;

B. area of crop "X" under AEC versus the variation at point A. above (for potential conversion phenomena);

C. area of energy crop "Y" under AEC versus the variation at point A. above of crop "X", where crop "Y" ("winning" energy crop) is the one which becomes more profitable than crop "X" ("losing" crop for food/feed use) as a consequence of the support granted through the AEC (for potential substitution phenomena).

If the indicator A is negative, a decrease in the area of crop "X" - net of the effect of the start of the cultivation of crop "X" for energy purposes under AEC in 2004 - occurred between 2003 and 2004, and therefore this situation needs to be investigated (some of the area which was lost may have been interested by conversion and/or substitution phenomena).

Indicator B measures the maximum theoretical extent of conversion phenomena occurred between 2003 and 2004: if indicator B is lower than 100%, conversion phenomena alone cannot explain the decrease in the area under crop "X", which must have been replaced not only by the same crop "X" destined to energy purposes under AEC, but also by other crops (for whichever use: food, feed, energy, other non food use); if indicator "B" is higher than 100%, the destination of crop "X" to energy purposes under AEC must have occurred also at the expense of crops other than "X", and therefore a combination of conversion and substitution phenomena must have occurred.

Indicator C measures the maximum theoretical extent of substitution phenomena resulting from the shifts in the relative profitability of energy crops vs. conventional crops which are caused by the granting of the AEC. The higher the indicator, the higher the maximum theoretical extent of substitution phenomena concerning the replacement of a "losing" conventional crop with a "winning" energy crop grown under AEC.

Limitations of the analysis and validity of the results

The extent of the areas under each kind of crop for food/feed use in the year 2004 was calculated by subtracting from the total area (all uses, including energy) the area for energy use under the AEC. This methodology actually leads to include under the "food/feed use" label also areas grown for non food purposes (including energy ones, whenever a crop is grown without benefiting from AEC, i.e. under NFSA regime or without no specific regime). Nevertheless, the important thing here is to calculate the variation in the area of a particular crop "net" of the effect of the start of the cultivation of the crop itself for energy purposes under the AEC, and the adopted methodology permits to do so.

The results of the analyses which were illustrated above are presented below in Table 19.11 (with respect to the aggregate approach) .12, .13, .14 and .15 (with respect to the crop-by-crop approach).

Table 19.11 - Aggregate approach: evolution of the total usable agricultural area between 2003 and 2004 versus total area under AEC in 2004 (ha)

Member State	2003	2004	Difference		(4) Total area under AEC in 2004	(4) / (3) (%)
	(1) Area	(2) Area	(3) = (2) - (1)	2004 on 2003 (%)		
Austria	3.373.618	3.374.461	843	0,02%	4.372	518,6%
Denmark	2.675.542	2.664.017	-11.525	-0,43%	4.850	not relev.
France	29.598.944	29.631.668	32.724	0,11%	129.961	397,1%
Germany	16.974.213	17.020.365	46.152	0,27%	111.480	241,5%

DEIAGRA elaboration on data from European Commission-DG Agri and Eurostat (1, 2) and DG Agri Unit D1 (4).

As regards the aggregate approach, it can be seen from Table 19.11 that the total UAA in the Member States under study showed only modest increases or even decreased (Denmark).

As the increases were small with respect to the total area under AEC in 2004 in such Member States, i.e. the additional UAA alone was insufficient to fully accommodate the cultivation of energy crops under AEC in that year, such activity must therefore have taken place – in part at least – by replacing conventional crops (but possibly also non food crops grown without specific regime on non-set aside land).

Coming to the crop-by-crop approach, from the analysis of the relevant indicators (Table 19.12, .13, .14 and .15) the following indications emerge:

- Austria: the most relevant net decreases (indicator A) occurred for rapeseed, common wheat and barley; as the areas under such crops destined to energy purposes and benefiting from the AEC were small or non-existent in 2004, the extent of conversion or substitution phenomena can be deemed as extremely limited (indicators B and C).

- Denmark: the most relevant net decreases (indicator A) occurred for barley, rye and sugar beet; as the area under AEC in 2004 was relatively small and wholly cultivated with rapeseed, only extremely limited conversion and substitution phenomena could have occurred (indicators B and C).
- France: among the main crops, only dry pulses, durum wheat and rye did not show net decreases (indicator A). As the rapeseed area under AEC was substantial in 2004 (much more than triple than the net decrease of conventional rapeseed), it cannot be assumed that it derives only from the conversion of areas which in 2003 were destined to conventional rapeseed (or to rapeseed outside specific regime); also significant substitution phenomena are likely to have occurred (indicator B). Moreover, the substitution of "losing" conventional sunflower with "winning" energy wheat under AEC may have occurred, but only in a limited measure (indicator C).
- Germany: the most relevant net decreases (indicator A) occurred for rye, rapeseed and sugar beet. The rapeseed area under AEC was substantial in 2004 (nearly equal to the net decrease of conventional rapeseed): therefore significant areas under conventional rapeseed (or non food rapeseed grown without specific regime) in 2003 could have been converted to energy rapeseed under AEC in 2004, even if also the substitution of crops other than rapeseed is plausible. The substantial net decrease of conventional rye cannot instead be explained solely in terms of conversion to energy rye under AEC (indicator B).

Table 19.12 - Austria, crop-by-crop approach: relevant indicators

Crops	2003		2004								
	(1) Area (ha)	Share in UAA (%)	(2) Area (ha)	Share in UAA (%)	(3) Area under AEC in 2004 (ha)	(4) = (2) - (3) Net area 2004 (area under AEC excl.) (ha)	"Winning" energy crop under AEC in 2004	(5) "Winning" energy crop under AEC in 2004 - area (ha)	Indicator A = (4) - (1) variation in the net area 2003-2004 (ha)	Indicator B = (3) / (Indicator A in absolute value) (%)	Indicator C = (5) / (Indicator A in absolute value) (%)
Common wheat	288.764	8,6	272.508	8,1	0	272.508	Sunflower (E)	272	**-16.256**	**0,0%**	**1,7%**
Barley	200.948	6,0	191.333	5,7	0	191.333	Sunflower (E)	272	**-9.615**	**0,0%**	**2,8%**
Grain maize	172.230	5,1	178.702	5,3	3.003	175.699			**3.469**	**not relevant**	**not relevant**
Rapeseed	55.383	1,6	35.284	1,0	739	34.545			**-20.838**	**3,5%**	**not relevant**
Rye	47.145	1,4	45.664	1,4	0	45.664			**-1.481**	**0,0%**	**not relevant**
Dry pulses	46.087	1,4	44.525	1,3	0	44.525			**-1.562**	**0,0%**	**not relevant**
Sugarbeet	44.724	1,3	44.737	1,3	0	44.737			**13**	**not relevant**	**not relevant**
Sunflower	21.381	0,6	28.988	0,9	272	28.716	Rapeseed (E)	739	**7.335**	**not relevant**	**not relevant**

DEIAGRA elaboration on data from European Commission-DG Agri and Eurostat (1, 2) and DG Agri Unit D1 (3, 5).
Note: the "winning" energy crops are compared only with the "losing" conventional ones (see table 5)

Table 19.13 - Denmark, crop-by-crop approach: relevant indicators

Crops	2003		2004								
	(1) Area (ha)	Share in UAA (%)	(2) Area (ha)	Share in UAA (%)	(3) Area under AEC in 2004 (ha)	(4) = (2) - (3) Net area 2004 (area under AEC excl.) (ha)	"Winning" energy crop under AEC in 2004	(5) "Winning" energy crop under AEC in 2004 - area (ha)	Indicator A = (4) - (1) variation in the net area 2003-2004 (ha)	Indicator B = (3) / (Indicator A in absolute value) (%)	Indicator C = (5) / (Indicator A in absolute value) (%)
Barley	824.509	30,8	697.056	26,2	0	697.056			**-127.453**	**0,0%**	**not relevant**
Common wheat	576.624	21,6	666.363	25,0	0	666.363			**89.739**	**not relevant**	**not relevant**
Rapeseed	84.139	3,1	122.000	4,6	4.850	117.150			**33.011**	**not relevant**	**not relevant**
Sugarbeet	57.806	2,2	48.745	1,8	0	48.745			**-9.061**	**0,0%**	**not relevant**
Rye	46.349	1,7	31.622	1,2	0	31.622	Barley (E)	0	**-14.727**	**0,0%**	**0,0%**

DEIAGRA elaboration on data from European Commission-DG Agri and Eurostat (1, 2) and DG Agri Unit D1 (3, 5).
Note: the "winning" energy crops are compared only with the "losing" conventional ones (see table 5)

Table 19.14 - France, crop-by-crop approach: relevant indicators

Crops	2003		2004		(3) Area under AEC in 2004 (ha)	(4) = (2) - (3) Net area 2004 (area under AEC excl.) (ha)	"Winning" energy crop under AEC in 2004	(5) "Winning" energy crop under AEC in 2004 - area (ha)	Indicator A = (4) - (1) variation in the net area 2003-2004 (ha)	Indicator B = (3) / (Indicator A in absolute value) (%)	Indicator C = (5) / (Indicator A in absolute value) (%)
	(1) Area (ha)	Share in UAA (%)	(2) Area (ha)	Share in UAA (%)							
Common wheat	5.230.342	17,7	4.832.757	16,3	1.208	4.831.549			-398.793	0,3%	not relevant
Grain maize	1.830.858	6,2	1.822.309	6,1		1.822.309	Rye (E)	0	-8.549	0,0%	0,0%
Barley	1.642.504	5,5	1.630.181	5,5		1.630.181			-12.323	0,0%	not relevant
Rapeseed	1.036.420	3,5	1.126.250	3,8	124.209	1.002.041			-34.379	361,3%	not relevant
Sunflower	616.042	2,1	615.769	2,1	4.545	611.224	Wheat (E)	1.208	-4.818	94,3%	25,1%
Dry pulses	437.261	1,5	458.186	1,5		458.186			20.925	not relevant	not relevant
Sugarbeet	437.734	1,5	384.691	1,3		384.691			-53.043	0,0%	not relevant
Durum wheat	335.507	1,1	406.648	1,4		406.648			71.141	not relevant	not relevant
Potatoes	162.294	0,5	159.846	0,5		159.846			-2.448	0,0%	not relevant
Rye	28.648	0,1	33.654	0,1		33.654	Rye (E)	0	5.006	not relevant	0,0%

DEIAGRA elaboration on data from European Commission-DG Agri and Eurostat (1, 2) and DG Agri Unit D1 (3, 5).
Note: the "winning" energy crops are compared only with the "losing" conventional ones (see Table 19.10)

Table 19.15 - Germany, crop-by-crop approach: relevant indicators

Crops	2003		2004		(3) Area under AEC in 2004 (ha)	(4) = (2) - (3) Net area 2004 (area under AEC excl.) (ha)	"Winning" energy crop under AEC in 2004	(5) "Winning" energy crop under AEC in 2004 - area (ha)	Indicator A = (4) - (1) variation in the net area 2003-2004 (ha)	Indicator B = (3) / (Indicator A in absolute value) (%)	Indicator C = (5) / (Indicator A in absolute value) (%)
	(1) Area (ha)	Share in UAA (%)	(2) Area (ha)	Share in UAA (%)							
Common wheat	3.014.620	17,8	3.103.446	18,2	466	3.102.980	Barley (E)	290	88.360	not relevant	not relevant
Barley	1.970.335	11,6	1.979.472	11,6	290	1.979.182	Rapeseed (E)	80.236	8.847	not relevant	not relevant
Rapeseed	1.296.648	7,6	1.283.357	7,5	80.236	1.203.121	Maize (E)	8.124	-93.527	85,8%	8,7%
Rye	728.388	4,3	624.945	3,7	21.459	603.486			-124.902	17,2%	not relevant
Sugarbeet	459.400	2,7	440.545	2,6	0	440.545			-18.855	0,0%	not relevant
Grain maize	398.745	2,3	461.697	2,7	8.124	453.573	Barley (E)	290	54.828	not relevant	not relevant
Potatoes	284.078	1,7	295.266	1,7	0	295.266			11.188	not relevant	not relevant

DEIAGRA elaboration on data from European Commission-DG Agri and Eurostat (1, 2) and DG Agri Unit D1 (3, 5).
Note: the "winning" energy crops are compared only with the "losing" conventional ones (see Table 19.10)

From the evidence presented above, it can be concluded that:

- On aggregate, with only a modest expansion of the usable agricultural area in the Member States where the cultivation of energy crops under the AEC was concentrated in 2004, i.e. Germany and France, such activity must have taken place – in part at least – by replacing conventional crops (but possibly also non food crops grown without specific regime on non-set aside land).
- Relevant *conversion phenomena* concerning rapeseed occurred in France and Germany: the additional revenue granted by the AEC is to be deemed a relevant factor in the switch from a food/feed to an energy destination of this crop.
- The *substitution phenomena* for which a conventional crop has been replaced by an energy crop due to the effect of the AEC, and so the possible "unintended effect of the AEC", can instead never be deemed to be relevant in the Member States under study.

It is however important to remember that in a real context many reasons - other than the additional revenue granted by the AEC - can lie behind the decision regarding *conversion* as well as *substitution* of these crops: for example favourable/unfavourable dynamics in the market of the respective products, agronomical and technical issues, etc. Hence, actual conversion or substitution phenomena cannot be explained exclusively as unintended effects of the AEC on the production of competing crops.

Finally, it is also important to underline that such **conversion or substitution phenomena have concerned a very limited portion of total usable agricultural area in the EU** (the area under the AEC in 2004 – around 277.000 ha - was **about 0,2%** of the total UAA in the EU-15 – about 130 Mio ha).

19.5 Judgment.

Unintended effects of the measures on the relative shares of the different kinds of energy crops.

Among the measures under study, those which have the potential to cause unintended effects on the relative shares of the different kinds of energy crops were identified in the following (in parenthesis the action mechanisms with respect to unintended effects):

1) The specificity concerning **sugar beet cultivation for energy purposes before the reform of the sugar CMO in 2006. Under the NFSA regime, such activity implied the renounce to set aside payments** (farmers wishing to grow non food sugar beet on set aside land had to face an opportunity cost, hence this crop could be put at a disadvantage versus the other non food crops). Moreover, **prior to such reform sugar beet was also not eligible for the AEC**.
2) Before the implementation of decoupling, the **arable crops area payments** (the granting of higher area payments for some kinds of crops could cause shifts in the relative profitability of the various kinds of energy crops, granting an economic advantage to the crops with higher area payments) and after the implementation of decoupling, the **partially coupled support for arable crops** (where differentiated amounts apply for some crops).
3) Before the implementation of decoupling, the **non-eligibility for area payments of some kinds of energy crops** (grass, short rotation forestry, sugar beet) (farmers wishing to grow energy crops not eligible for area payments had to face an opportunity cost, hence these crops could be put at a disadvantage versus the energy crops which were instead eligible).

The analyses carried out showed that:

a) In the case of the peculiar treatment of sugar beet under the NFSA regime (point 1 above), in France - where most of the sugar beet for bio-ethanol production was grown under the NFSA regime before the reform of the sugar CMO - this crop remained the most profitable one on set aside land also with the handicap of the renounce to set aside payments. Hence, an essential condition for unintended effects to arise was lacking. However, in other Member States, where conventional sugar beet yields are lower, and production costs higher than in France, the above handicap may have – in theory at least - somewhat discouraged the cultivation of non food sugar beet under the NFSA regime. No evidence was however retrieved suggesting that such handicap actually was the most relevant reason behind the absence of non food sugar beet areas on set aside land in most Member States: indeed also other factors were found to play an important role (insufficient - or outright absent - demand for sugar beets for energy purposes; competition by cheaper types of feedstock obtained by crops which are technically simpler to grow than sugar beet, and also suitable to a wider range of agronomical conditions (e.g. wheat or barley); competition by cheaper bio-ethanol, imported from third countries). Analogous considerations can be made for the non eligibility of sugar beet for the AEC.

b) The granting of higher area payments to some types of energy crops indeed caused shifts in the relative profitability in France (maize improved over rye and sunflower over barley) and Germany (maize became the most profitable energy crop on non set aside area); no shifts were caused instead in Spain. However, all the crops benefiting from the shifts were found to have rather modest shares (always less than 8%) of the area cultivated with energy crops both under the AEC and outside specific regimes in the Member States studied, i.e. they were very far from being the most common kinds of energy crops.
c) Energy crops not eligible for area payments in the pre-decoupling context were indeed found to have very modest shares (less than 4%) of the area cultivated with energy crops on non set aside land in the EU. However, evidence coming from the regional case studies suggested that this situation was caused by factors other than the non eligibility for area payments (semi-experimental production techniques, high variability in yields and limited market outlets).

In conclusion, **none of the identified measures was judged to have caused significant unintended effects on the relative shares of the different kinds of energy crops**.

Unintended effects of the measures on the production of crops for food and feed use

Among the measures under study, the AEC was identified as having the potential of distorting competition between energy crops and food/feed crops, as it could cause shifts in the relative profitability of the former versus the latter (some kinds of energy crops could become more profitable than some kinds of crops for food/feed use thanks to the additional revenue granted by the AEC). Such shifts were indeed found to occur in the four Member States studied (Austria, Denmark, France, Germany).

The data and information analysed showed that:

a) As the increases in the usable agricultural area in France and Germany between 2003 and 2004 were insufficient (30-45.000 ha) to fully accommodate the cultivation of energy crops under the AEC in 2004 (110-130.000 ha), such activity had taken place also by replacing food/feed crops (or non food crops grown without specific regime on non-set aside land).
b) The most relevant shifts in the destination of specific kinds of crops (from food/feed use to energy use) had occurred in France and Germany for rapeseed (energy rapeseed area under the AEC in 2004 corresponded to at least 85% of the area lost by conventional rapeseed between 2003 and 2004).
c) The most relevant phenomena featuring the substitution of specific kinds of crops for food/feed use with other kinds of crops for energy use had occurred in France (where energy rapeseed area under the AEC in 2004 was nearly three times the area lost by conventional rapeseed between 2003 and 2004), with energy rapeseed substituting mostly cereals for food/feed use.

Evidence from the case studies confirmed that such phenomena had occurred.

We can therefore judge that:

1) **The AEC is to be deemed the decisive factor behind the observed shifts in the destination** of specific kinds of crops **(from food/feed use to energy use).** Evidence from the case studies showed that the prices of rapeseed for energy use still tended to be lower than prices for conventional rapeseed when the AEC was introduced: hence the price cannot be deemed a decisive factor in this respect.
2) **In the case of the observed phenomena of substitution** of specific kinds of crops for food/feed use with other kinds of crops for energy use, **the AEC is not the only factor behind them**, as **also other factors have played a significant role**, though to an extent which is difficult to quantify and compare with the one played by the AEC. Among these factors the most relevant can be identified in:
    - **favourable price dynamics in the market of agricultural products for energy uses**, fostered in particular by the remarkable and rapid growth in the production of bio-fuels in the EU (see EQ 1, 2 and 3);
    - **unfavourable price dynamics for the conventional agricultural products** (evidence from the regional case studies suggested that falling wheat prices were also a relevant factor behind wheat substitution with energy rapeseed in France).

It is however very important to remind that **the above phenomena have concerned only an extremely limited portion of the total usable agricultural area in the EU-15** (**about 0,2%** in 2004).

Hence the identified measure – i.e. the **AEC – cannot be deemed to have caused significant distortions in the competition between energy crops and crops for food/feed use** at EU level over the evaluation period.

20 EVALUATION QUESTION 7

"To what extent have the measures contributed to the diversification of income of farmers and the creation of jobs in rural areas? Is the farm income attributed to energy crops cultivation significant? Give a detailed answer according to typology of farm and regional situation".

The relevant issues to tackle in the framework of EQ 7 are the following:

1) To assess whether and to what extent the support provided through both direct aid measures and rural development measures (cause), has contributed to the diversification of income of farmers through the activities supported by these measures, in the rural areas where said activities are practised (effect).
2) To assess whether and to what extent the portion of farm income resulting from the activities supported by the measures under study is significant with reference to total farm income.
3) To assess whether and to what extent the support provided through both direct aid measures and rural development measures (cause), has contributed to the creation or the maintaining of jobs in the rural areas where the activities supported by these measures are practised (effect).

The **methodology** for answering the question is summarised below.

Judgment criteria, indicators and information sources

Judgment Criteria (JC)	Indicators (IND)	Information sources
JC 1: relative importance in numerical terms of the farms where the activities supported by the relevant measures are practised, within the Member State / region under study	**IND 1.1)** (number of holdings where the activities concerned are practised under specific support)/(total number of holdings) X 100	**Number of holdings where the activities concerned are practised under specific support**: DG Agriculture J.1 (CATS database) **Total number of holdings**: EUROSTAT
JC 2: relative importance of the portion of farm income resulting from the activities supported by the measures under study on total farm income	**IND 2.1)** (portion of farm income resulting from the activities concerned under specific support)/(total farm income) X 100. **Threshold value** = 20%	**Portion of farm income resulting from the activities concerned under specific support**: DEIAGRA estimates on data from DG Agriculture J.1 (CATS database) and from the regional case studies **Total farm income**: EUROSTAT
JC 3: estimated additional labour requirements potentially generated by the activities supported by the measures under study	**IND 3.1)** additional annual working units generated by the activities supported by the measures under study with respect to the most common alternative activity	**Additional annual working units**: DEIAGRA estimates on data from EUROSTAT, DG Agriculture J.1 (CATS database) and from the regional case studies

20.1 Diversification of the income of farmers through the activities supported by the measures under study

To assess the role of the measures under study in contributing to the diversification of the income of farmers in the areas where the activities supported by these measures are practised, it was carried out a study – differentiated by type of relevant measure - on the relative importance of the holdings cultivating energy crops under specific regimes on the total number of holdings within the regions selected for the case studies, in terms of both number of holdings and agricultural area. The higher this relative importance, the more important the role of the measures under study in the diversification of the income of the whole population of farmers in that geographical entity.

Limitations of the analysis and validity of the results

The study about the diversification of the income of farmers was carried out at both Member State and regional level (for the regions selected for the case studies).

As far as Direct Aid Measures are concerned, the most recent data available at the moment of the drafting of this report were those for 2004 (therefore before the implementation of decoupling).

As far as the Rural Development Measures are concerned, quantitative data on their implementation were retrieved only for Austria and for the Carinthia region (see the box on limitations in the answer to the EQ 4). Consequently, no systematic analysis could be made on the diffusion of such measures among farmers in other EU Member States and/or regions.

The data on the implementation of the AEC and of the NFSA regime were sourced by Unit J.1 of DG-Agriculture from the Clearance Audit Trail System (CATS) database. Figures derived from CATS database are to be deemed as "indicative", both because the quality of the data depends on the quality of the computer data provided by the Member States, and also because Unit J.1 does not have any other source of information to confirm such figures.

Another limitation stems from the fact that the analyses are referred to a specific year since no adequate time series of data on the implementation of the measures under study were available, especially at regional level, and especially for AEC (no data available for 2005). In the case of NFSA, it was not deemed correct to average data referred to years where the rate of compulsory set aside was 10% (2002 and 2003) with data referred to a year (2004) where such rate was 5%.

Tables below report the results of the analysis[278], which was carried out at both Member State (table 20.1 and 20.2) and regional level (table 20.3 and 20.4) for AEC and NFSA.

Table 20.1 - Importance of agricultural holdings practising the cultivation of crops under the aid for energy crops in the EU, 2004

Member States	1) Number of agricultural holdings practising the cultivation of crops under the AEC (units)	Importance of 1) on total number of agricultural holdings in the Member State (%)	2) Agricultural area under the AEC (ha)	Importance of 2) on total utilised agricultural area in the Member State (%)
Austria	513	0,30%	3.497	0,11%
Denmark	211	0,43%	4.808	0,18%
Finland	131	0,17%	n.a.	n.a.
France	18.844	3,07%	129.324	0,47%
Germany	3.028	0,73%	117.271	0,69%
Ireland	34	0,03%	812	0,02%
Luxembourg	106	4,24%	n.a.	n.a.
Spain	376	0,03%	6.775	0,03%
Sweden	733	1,08%	14.522	0,46%
The Netherlands	15	0,02%	141	0,01%
United Kingdom	614	0,22%	30.712	0,19%

Source: DEIAGRA elaboration on data from Eurostat and DG AGRI J.1 (derived from the Clearance Audit Trail System (CATS) database) (1, 2)

Table 20.2 - Importance of agricultural holdings practising the cultivation of crops under the non food on set aside regime in the EU, 2004

Member States	1) Number of agricultural holdings practising the cultivation of crops under the NFSA regime (units)	Importance of 1) on total number of agricultural holdings in the Member State (%)	2) Agricultural area under the NFSA regime (ha)	Importance of 2) on total utilised agricultural area in the Member State (%)
Austria	3.022	1,74%	7.968	0,24%
Belgium	481	0,88%	5.434	0,39%
Denmark	3.502	7,21%	13.005	0,49%
Finland	144	0,19%	842	0,04%
France	45.138	7,35%	190.386	0,68%
Germany	32.596	7,91%	211.577	1,25%
Ireland	N/A	N/A	N/A	N/A
Italy	4.309	0,22%	11.948	0,09%
Luxembourg	265	10,60%	N/A	N/A
Spain	4.434	0,39%	N/A	N/A
Sweden	2.305	3,39%	N/A	N/A
United Kingdom	3.492	1,24%	41.713	0,26%

Source: DEIAGRA elaboration on data from Eurostat and DG AGRI J.1 (derived from the Clearance Audit Trail System (CATS) database) (1, 2)

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[278] A detailed description of the data which constitute the basis for the analysis is given in tables A.7.1-A.7.46 in the annex 2 to this section.

Table 20.3 – Importance of agricultural holdings practising the cultivation of crops under the aid for energy crops in selected regions, 2004

Regions	1) Number of agricultural holdings practising the cultivation of crops under the AEC (units)	Importance of 1) on total number of agricultural holdings in the region (%)	2) Agricultural area under the AEC (ha)	Importance of 2) on total utilised agricultural area in the region (%)
DE9 - Niedersachsen	280	0,50%	4.860	0,19%
ES41 - Castilla y Leon	130	0,12%	1.820	0,03%
FR21 - Champagne-Ardenne	3.220	12,54%	26.450	1,68%
FR23 - Haute-Normandie	1.120	7,88%	5.510	0,71%
UKH - Eastern England	180	0,81%	9.160	0,67%

Source: DEIAGRA elaboration on data from Eurostat and DG AGRI J.1 (derived from the Clearance Audit Trail System (CATS) database) (1, 2)

Table 20.4 - Importance of agricultural holdings practising the cultivation of crops under the non food on set aside regime in selected regions, 2003

Regions	1) Number of agricultural holdings practising the cultivation of crops under the NFSA regime (units)	Importance of 1) on total number of agricultural holdings in the region (%)	2) Agricultural area under the NFSA regime (ha)	Importance of 2) on total utilised agricultural area in the region (%)
DE9 - Niedersachsen	4.870	8,66%	27.290	1,04%
ES41 - Castilla y Leon	2.230	2,10%	17.300	0,32%
FR21 - Champagne-Ardenne	6.160	24,00%	50.050	3,18%
FR23 - Haute-Normandie	3.490	24,54%	23.730	3,04%
ITE1 - Toscana	80	0,09%	540	0,07%
UKH - Eastern England	1.050	4,71%	21.540	1,57%

Source: DEIAGRA elaboration on data from Eurostat and DG AGRI J.1 (derived from the Clearance Audit Trail System (CATS) database) (1, 2)

As far as the relevant RDMs are concerned, it was found that in Austria and in the Carinthia region only a very limited share[279] – less than 1,5% - of the total number of farms benefited from the support granted through such measures in 2003. No quantitative data were retrieved for the other Member States: however some elements suggest that similar situations are to be found also elsewhere in the EU, for instance in England, Italy and Finland (see in this respect the answer to the evaluation question 4).

Among the evidence gathered through the analysis, the following traits are noteworthy:

1) In numeric terms, the share of the holdings practising energy crop cultivation under the AEC is extremely limited in most Member States (Table 20.1): only in Luxembourg, France and Sweden the measure was implemented by at least 1% of the agricultural holdings, and even in these three Member States the relative importance of the holdings practising energy crop cultivation under the AEC on total number of holdings never goes above 5%.
2) The share of the holdings practising energy crop cultivation – among other - under the NFSA is instead generally much higher (Table 20.2), being above 7% in Luxembourg, Germany, France and Denmark, and falling between 1% and 3,5% in Sweden, Austria and the United Kingdom.
3) If the study about the role of the AEC in the diversification of the income of farmers is carried out at regional level, for the regions selected for the case studies, the situation pictured at point 1) reappears (table 20.3), although with two notable exceptions: in Champagne Ardenne and Haute Normandie energy crop cultivation under the AEC is practised by, respectively, 12,5% and nearly 8% of the holdings.
4) At regional level, the share of the holdings practising energy crop cultivation under the NFSA regime (table 20.4) reaches 25% in Champagne-Ardenne and Haute-Normandie, and about 9% in Niedersachsen, while it is quite limited or even negligible in the other regions; in terms of area, the highest shares on total can be found in Champagne-Ardenne, Haute-Normandie, Eastern England and Niedersachsen (1-3%).

[279] Indeed for some of the relevant RDMs the share of the total number of farms is much lower: bio-energy related projects benefited from the support of forestry measures in less than 0,03% of the farms in Austria and in less than 0,01% of the farms in Carinthia.

5) The importance of agricultural area under AEC on total agricultural area is quite limited (less than 1%) at both Member State and regional level (with the only exception of Champagne Ardenne, where the share of agricultural area under AEC on total agricultural area is 1,7%). The importance of agricultural area under NFSA on total agricultural area is equally limited (less than 1,5%) at Member State level, but can be higher at regional level (both in Champagne-Ardenne and Haute Normandie such areas represent more than 3% of total agricultural area of these regions).
6) As far as the holdings practising energy crop cultivation under the AEC are concerned, their share on total in numeric terms is much lower in all the Member States and regions under study, if compared to the values that apply for energy crop cultivation under the NFSA regime.

On the basis of the above elements, it can be concluded that in most Member States and regions under study, the diffusion of income diversification strategies based on energy crop cultivation under **AEC** has been quite limited, while the diversification strategies based on energy crop cultivation under the **NFSA regime** have fared better, especially in Germany, France and Denmark. Moreover, the substantial increase in the **area of energy crops without specific regime** (increase mostly concentrated where the market margins tend to be high, and particularly in Germany, see § 8.1.1.4 and the EQ 1), lead to think that the **level of biomass price** - whose increase is a result of an expanding demand for biomass destined to energy purposes - is a **driver behind the adoption of income diversification strategies centred on the cultivation of energy crops** at least as important as the support granted by the DAMs under study.

As concerns the diffusion of income diversification strategies based on the activities supported by the relevant **RDMs**, this was found to be limited (less than 1,5% of the farms) in the two areas for which quantitative data were retrieved[280], i.e. Austria and the Carinthia region.

20.2 Significance of the portion of farm income resulting from the activities supported by the measures under study with reference to total farm income

In order to get to a full assessment of the role played by the measures under study in the diversification of farm income, it has been analysed the importance of the share of total farm income generated by the activities supported by these measures.

Limitations of the analysis and validity of the results

The analysis was conducted for energy crop cultivation under the AEC and NFSA regime in the regions of Niedersachsen, Castilla y Leon and Champagne-Ardenne, thus on a regional scale, basing on data collected through the regional case studies[281].

As no actual data on income generated by these activities and diversified by farm typology were available, some estimates were made of the portion of farm income resulting from the activities supported by the measures under study, in order to approximate a number of situations that might be deemed representative - from a qualitative if not a quantitative (statistical) standpoint – of:

1) *the most significant bio-energy supply chains to be found in the EU, as far as both the kinds of energy crops and the types of bio-energy sources were concerned[282];*
2) *characteristics at farm level that could reflect the most common situation to be found in the region under study[283].*

The above choices limit the possibility to extend the validity of the results of the analysis to broader geographical areas, i.e. to "generalise" its main findings.

[280] Non-systematic information sourced from literature (see EQ 4) reports that a modest number (about 70) of projects related to the use of wood for energy purposes was funded through the RDMs in Finland, and that 15 bio-gas plants using animal wastes were funded in the Emilia Romagna region of Italy.

[281] The reasons behind this choice were basically the following:
- No specific data on the economics of energy crops were available through FADN, thus making unfeasible a systematic analysis at Member State level based on data retrieved from a single, ample and methodologically coherent database.
- Being forced to base the analysis on data collected in the framework of the regional case studies from heterogeneous, "spot" sources, it was deemed prudent to limit the geographical scope of the analysis to the specific area where data were retrieved.

[282] For Niedersachsen, two kinds of energy crops among the most common in the region (rapeseed for bio-diesel production and maize for bio-gas production) were considered; the same analysis was made for Castilla y Leon (sunflower for bio-diesel production and barley for bio-ethanol production were chosen), also studying the effects of different cultivation techniques (dry and irrigated crops); for Champagne-Ardenne, common wheat for bio-ethanol production was chosen as energy crop.

[283] To achieve the objective at point 2) above, a "typical" farm was identified, which was characterised - for the relevant variables (total farm income, agricultural area, agricultural area under energy crops) - by values equal to the average ones that applied in the region. As no actual data diversified by farm typology were available as far as the activities supported by the measures under study were concerned, it was deemed that referring the estimates to different hypothetical farm typologies was risky and also that, all considered, the value added that could be obtained from such an operation in terms of a better picture of real situations was very limited.

The aforementioned estimates were based on Standard Gross Margin (SGM) data - as defined by Eurostat. For each of the regions under study, an "average standard gross margin per holding" was calculated dividing the total SGM for the total number of holdings in the region.

To estimate the portion of farm income resulting from the activities supported by, respectively, AEC and NFSA, the following two situations were assumed as representative:

a) In the case of the AEC, the "typical" farm (as defined above) grows energy crops under the AEC on an area equal to the average area under AEC per holding benefiting from such measure in the region under study.

b) In the case of NFSA regime, agricultural area under compulsory set aside regime in the "typical" farm is entirely destined to the cultivation of energy crops under the NFSA regime.

This methodology, and the assumptions at a) and b) above, could lead to over- or underestimate the portion of farm income resulting from the activities supported by AEC and NFSA regime in real farms whose characteristics deviate substantially from those of the "typical" one.

The assessment of the role of AEC in the diversification of farm income is also based on the analysis of the opportunity costs *associated with the cultivation of energy crops instead of conventional crops. Such analysis has been carried out taking the most common conventional crop (for food or feed use) in the regions under study as the alternative to the energy crop. This simplified approach was chosen to analyse a situation which could be relevant for the highest possible number of farmers in those regions, as not all the theoretically possible alternative crops are actually suited to all the farms. Moreover, this choice permitted to keep the complexity of the analysis (i.e. the number of comparisons to be made) within manageable limits. Obviously this solution does not permit to investigate on specific situations where farmers can choose among a higher number of feasible alternatives.*

Another limitation stems from the fact that the analyses are referred to a specific year and not to an average of recent years (which would have minimized the bias linked to specific conditions of a particular year). This was due to the unavailability of adequate time series of data on the economics of energy crops and on the implementation of the measures under study[284]*.*

As far as the rural development measures are concerned, besides the limitations highlighted in the previous box, it has to be noted that such measures do not grant additional revenue, but reduce fixed financial costs associated with investments in bio-energy related projects. Their effects on farm income are therefore indirect and difficult to estimate. Moreover, the profitability of the activities on which such projects are centred varies greatly, and can be significantly influenced by factors other than the support granted by the relevant RDMs. No datasets on the actual profitability of such activities seem to exist, but only spot data referred to specific projects or to purely theoretical situations. Finally, no data on the profitability of such activities were provided by the interviewed stakeholders in the framework of the regional case studies, for confidentiality reasons. For all these reasons, a reliable estimate of the contribution of the relevant RDMs to farm income was unfeasible.

Results from the estimates[285] of the portion of farm income resulting from the activities conducted under the AEC and the NFSA regime in the three selected regions, are illustrated in Table 20.5, .6 and .7 below.

Three types of indicators were used:

- "Gross" contribution of the measures under study to the diversification of farm income: portion of farm income resulting from the energy crops grown under the AEC and the NFSA regime; it corresponds to the upper limit of the contribution of the measures, since it is assumed that their role as policy incentives to the cultivation of energy crops is always decisive or relevant, while it is not so actually (see EQ 1).
- "Net" contribution of the measure (for the AEC only[286]): importance of AEC payments on total income per holding.
- Opportunity costs[287] associated to the cultivation of energy crops under the AEC and the NFSA.

[284] As far as the available data permitted to do so, the evaluation team tried not to choose "peculiar" years (e.g. year 2004 in the case of NFSA regime, as it was the only year over the 1999-2005 period when the rate of compulsory set aside was not 10%, but 5%) in order to find a partial remedy to this limitation.

[285] The data used for the estimates, and the details of the estimates themselves are illustrated in the annex 2 to this section (tables A.7.47-A.7.58).

[286] In the case of energy crop cultivation under the NFSA regime, the set aside payments cannot be considered a contribution of the measure to the diversification of farm income, as they are granted also to non food crops other than energy ones, or to fallow set aside (see the answer to the evaluation question 1). The contribution of the NFSA regime to the diversification of farm income is therefore given by the market margin of the energy crops grown on set aside land plus the "implicit subsidy" (economic advantage over fallow set aside - i.e. the avoided cost of land maintenance - plus the fact that there are less opportunity costs associated to energy crops grown under the NFSA regime: see EQ1 and § 5.4). It must be kept in mind that such "implicit subsidy" differs in nature from the AEC because it is not a monetary component. Therefore a "net" contribution of the NFSA regime to farm income cannot be identified.

[287] Such opportunity costs arise from the fact that a certain kind of conventional crop (for food or feed use) could be cultivated on the land destined to a certain kind of energy crop: if the unit margin of the latter is higher than that of the former, the cultivation of the energy crop contributes to generate additional income for the farmer; conversely, if the opposite is true, the cultivation of the energy

The analysis of the opportunity costs associated to the cultivation of energy crops under the AEC was carried out for a number of representative situations in some of the regions selected for the case studies. They have been estimated with reference to the most common conventional crop in the same region (for the limitations of the estimates see the box above). As regards the opportunity costs associated to the cultivation of energy crops under the NFSA regime, it is plausible that they are rather limited: non food crops for purposes other than energy have very limited market outlets and are often suited only to peculiar agronomical conditions, hence they constitute a feasible gainful alternative to the cultivation of energy crops only in very specific cases. Due to lack of data and information on the techno-economic features of non food crops for uses other than energy, an estimate of the opportunity costs associated to the cultivation of energy crops under the NFSA regime could not be carried out.

Table 20.5 – Estimate of the importance of income from the cultivation of energy crops under the aid for energy crops in selected regions, 2004[288]

Regions	Type of activity	1) Average standard gross margin per holding (Euros/unit)	2) Average margin per holding from energy crop cultivation (A)(B) (Euros/unit)	Importance of 2) on 1) (%)	3) Average amount of AEC per holding* (Euros/unit)	Importance of 3) on 1) (%)
DE9 - Niedersachsen	Rapeseed cultivation for energy use (biodiesel production)	82.495,20	11.577,21	14,03%	781,07	0,95%
	Maize cultivation for energy use (biogas production)	82.495,20	7.984,29	9,68%	781,07	0,95%
ES41 - Castilla y Leon	Sunflower cultivation for energy use (biodiesel production) - dry culture	24.578,48	3.122,00	12,70%	630,00	2,56%
	Sunflower cultivation for energy use (biodiesel production) - irrigated culture	24.578,48	4.886,00	19,88%	630,00	2,56%
	Barley cultivation for energy use (bio-ethanol production) - dry culture	24.578,48	2.828,00	11,51%	630,00	2,56%
	Barley cultivation for energy use (bio-ethanol production) - irrigated culture	24.578,48	2.310,00	9,40%	630,00	2,56%
FR21 - Champagne-Ardenne	Common wheat cultivation for energy use (bio-ethanol production)	108.479,16	5.667,86	5,22%	369,64	0,34%

Source: DEIAGRA elaboration on data from Eurostat (1), DG AGRI J.1 (derived from the Clearance Audit Trail System (CATS) database) (2, 3) and regional case studies (2)
(A) Area under AEC per holding is equal to the average value that applies in the region; estimate is made for a holding with the features of the average holding in the region
(B) Total margin = market margin + area payment + AEC

crop instead of the conventional crop gives rise to an opportunity cost, inasmuch the farmer renounces to a certain amount of income generated by the conventional crop. An analysis of the opportunity costs associated with the cultivation of energy crops in alternative to the cultivation of crops for food/feed use is therefore essential to assess the contribution of the AEC to the diversification of farm income.

[288] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.

Table 20.6 - Estimate of the opportunity costs associated to the cultivation of energy crops under the AEC in selected regions, 2004[289]

Regions	Type of activity (energy crops)	1) Unit margin (A) (Euros/ha)	Alternative activity (most common conventional crop in the region)	2) Unit margin (Euros/ha)	3) Unit opportunity cost = (1)-(2) (Euros/ha)	4) Average opportunity cost per holding associated to energy crop cultivation (B) (Euros/unit)
DE9 - Niedersachsen	Rapeseed cultivation for energy use (biodiesel production)	667,00	Common wheat	422,74	244,26	4.239,66
	Maize cultivation for energy use (biogas production)	460,00	Common wheat	422,74	37,26	646,73
ES41 - Castilla y Leon	Sunflower cultivation for energy use (biodiesel production) - dry culture	223,00	Barley	283,20	-60,20	-842,80
	Sunflower cultivation for energy use (biodiesel production) - irrigated culture	349,00	Barley	283,20	65,80	921,20
	Barley cultivation for energy use (bio-ethanol production) - dry culture	202,00	Barley	283,20	-81,20	-1.136,80
	Barley cultivation for energy use (bio-ethanol production) - irrigated culture	165,00	Barley	283,20	-118,20	-1.654,80
FR21 - Champagne-Ardenne	Common wheat cultivation for energy use (bio-ethanol production)	690,00	Common wheat	661,10	28,90	237,39

Source: DEIAGRA elaboration on data from: regional case studies (1); Graham Brookes, "European arable crop profit margins" (2004/05) (2); DG AGRI J.1 (derived from the Clearance Audit Trail System (CATS) database) (4);
(A) Total margin = market margin + area payment + AEC
(B) Area under AEC per holding is equal to the average value that applies in the region; estimate is made for a holding with the features of the average holding in the region
Note: The negative numbers in the last two columns indicate that an opportunity cost is associated to the cultivation of energy crops under the AEC.

Table 20.7 - Estimate of the importance of income from the cultivation of energy crops under the non food on set aside regime in selected regions, 2003[290]

Regions	Type of activity	1) Average standard gross margin per holding (Euros/unit)	2) Maximum average margin per holding from energy crop cultivation (A)(B) (Euros/unit)	Importance of 2) on 1) (%)
DE9 - Niedersachsen	Rapeseed cultivation for energy use (biodiesel production)	82.495,20	1.806,46	2,19%
	Maize cultivation for energy use (biogas production)	82.495,20	840,21	1,02%
ES41 - Castilla y Leon	Sunflower cultivation for energy use (biodiesel production) - dry culture	24.578,48	511,95	2,08%
	Sunflower cultivation for energy use (biodiesel production) - irrigated culture	24.578,48	1.157,00	4,71%
	Barley cultivation for energy use (bio-ethanol production) - dry culture	24.578,48	404,44	1,65%
	Barley cultivation for energy use (bio-ethanol production) - irrigated culture	24.578,48	215,02	0,87%
FR21 - Champagne-Ardenne	Common wheat cultivation for energy use (bio-ethanol production)	108.479,16	2.210,73	2,04%

Source: DEIAGRA elaboration on data from Eurostat (1) and regional case studies (2)
(A) Area under NFSA per holding is equal to 10% (rate of compulsory set aside) of the agricultural area of a holding with the features of the average holding in the region
(B) Total margin = market margin + "implicit subsidy" (for details on the estimate of this component, please refer to the answer to the evaluation question 1)

[289] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.
[290] In the case of the NFSA regime, the evaluation team chose not to use in the analysis data for year 2004 (though available) as it was the only year over the 1999-2005 period when the rate of compulsory set aside was not 10%, but 5%.

It is assumed as "relevant" a threshold of **20%** of the total farm income (here, total SGM per holding): the portion of farm income resulting from activities supported by AEC and NFSA regime is compared to this threshold. Basing on results from the tables above, the following main findings can be identified:

1) In a "typical" farm of the regions selected, the importance of the "gross" contribution[291] to farm income coming from energy crops under the AEC was found to be significant especially in the Castilla y Leon and Lower Saxony regions, as in such regions the role of the AEC as policy incentives to the introduction of energy crops in the farms is decisive (Castilla y Leon) or at least relevant (Lower Saxony) (see the answer to the evaluation question 1). Indeed in a "typical" farm of the two regions the importance of the gross contribution to farm income coming from energy crops cultivated under the AEC falls within the 9,5-20% range: such contribution is however not high enough to cross the relevance threshold.
2) The "net" contribution[292] of the AEC to the diversification of farm income (as defined above) is obviously much more limited than its "gross" contribution (as defined above), as it always remains below 3%.
3) While in Lower Saxony and Champagne-Ardenne the cultivation of energy crops under the AEC, instead of the most common conventional crop, generated significant additional income (especially in the case of rapeseed in Lower Saxony), in Castilla y Leon it gave rise to significant opportunity costs in three cases out of four (the irrigated culture of sunflower for bio-diesel production being the only exception).
4) In a "typical" farm of the regions selected for the assessment, the importance of the "gross" contribution to farm income coming from energy crops cultivated under the NFSA regime falls within a 0,9-4,7% range, and cannot therefore be deemed relevant.
5) If the situations analysed are variously combined on the same "typical" farm, however, the "gross" contribution of energy crops under both NFSA regime and AEC can reach levels that go beyond the 20% relevance threshold: if the cultivation of sunflower (irrigated culture) under AEC is combined with the same activity on NFSA in the "typical" farm of the Castilla y Leon region, the importance of the gross contribution of the two measures combined to total farm income can reach 24,6% (19,9% + 4,7%).

In conclusion, among the cases under study:

- the one concerning the cultivation of sunflower (irrigated culture) under the AEC in the Castilla y Leon region featured the highest gross contribution of the AEC to the diversification of farm income; the cultivation of this crop under the AEC also had an economic advantage over the cultivation of the most common crop for food and feed use;
- the one concerning the cultivation of rapeseed under the AEC in Lower Saxony featured the greatest advantage, in terms of additional income, over the cultivation of the most common crop for food and feed use.

In the other cases, the portion of farm income resulting from the activities conducted under the AEC and especially the NFSA regime was indeed rather modest. Moreover, it should be reminded that this corresponds to the **upper limit of the contribution of the measures**, since it is assumed that their role as policy incentives to the cultivation of energy crops is decisive or relevant in all farms (see the answer to EQ 1).

The importance of AEC payments on total income per holding, was found to be always very modest.

The portion of farm income resulting from the energy crops grown under the AEC and the NFSA regime was found to be above the relevance threshold of 20% of total farm income only in the case of the cultivation of irrigated sunflower in the Castilla y Leon region.

Summarising, the **contribution of the measures under study to the diversification of farm income was found to be relevant, or at least significant, only in a very limited number of specific situations**.

20.3 Contribution of the measures under study to the creation or the maintaining of jobs in rural areas

To assess the contribution of the measures under study to the creation or the maintaining of jobs in rural areas, an analysis was carried out to estimate the ability of energy crops to create jobs at agricultural level.

[291] Portion of farm income resulting from the energy crops grown under the AEC or the NFSA regime; it corresponds to the upper limit of the contribution of the measures.
[292] Importance of AEC payments on total income per holding.

The potential that some kinds of energy crops under the NFSA regime and the AEC show as far as the creation of jobs in agriculture is concerned was estimated for the regions of Niedersachsen, Castilla y Leon and Champagne-Ardenne.

Limitations of the analysis and validity of the results

The analysis was carried out at regional level on a number of selected regions (see the reasons illustrated for the analysis at § 20.2 above). The regions were chosen to cover not only a good number of significant bio-energy supply chains to be found in the EU, as far as both the kinds of energy crops and the types of bio-energy sources were concerned, but also significant situations as far as the diffusion of the measures under study was concerned (see § 20.1):

a) Champagne Ardenne was chosen because energy crops under both AEC and NFSA have a quite high diffusion in the region;

b) Castilla y Leon was chosen because its situation was somehow the opposite of that of Champagne Ardenne;

c) Niedersachsen was chosen because its situation fell "somewhere in the middle" between those of the other two regions.

The above differentiation was very important, because the potential for job creation of the measures depends also on their diffusion within a certain geographical entity.

The estimates of the ability of energy crops to create jobs at agricultural level were made on the basis of the following assumptions and methodology:

1) The "typical" farm for each region (as previously defined at § 20.2) was chosen as the representative unit.

2) The representative situations considered were the same considered to quantify the contribution of the measures to farm income (see § 20.2 above).

3) The estimate was made following a socio-economic approach, instead of a purely technical one, as this was deemed more in line with the relevant issue proposed by the evaluation question. The estimate was based on the ability of energy crops to create income[293], as to be created/maintained a job must be able to generate income for the worker and also for his/her employer (in the case of hired labour).

4) To carry out the estimate, the Standard Gross Margin per Annual Working Unit (AWU) was calculated for the "typical" holding in each region: this permitted to express in terms of "annual working units equivalent" the margin generated by energy crops in the "average" holding.

5) The final step consisted in multiplying A) the number of "AWU equivalents" of energy crops per holding that applied, for each of the representative situations considered <u>BY</u> B) the number of holdings practising the cultivation of energy crops under NFSA regime or AEC in the region under study. This permitted to get to an estimate of the potential for job creation in agriculture referred to the whole region.

The most serious limitation of the above method stems from the fact that, in practice, the crop with the best unit margin (i.e. with the highest number of "AWUs equivalent" per hectare) is not necessarily the one with the highest work requirements on the basis of its cultivation technique. In this cases, an energy crop creates the possibility to hire workers which are actually not needed to cultivate it, i.e. an overestimate of actual work requirements occurs[294]. As a partial remedy to the limitations of the method used, the evaluation team tried to draw further indications on this issue from "spot" data and information retrieved in the case studies (see below).

For a correct assessment of the potential of the measures under study in creating/maintaining jobs in rural areas, their "net" contribution in terms of jobs had to be assessed: to this purpose, a comparison was carried out with the number of jobs which would have been created/maintained by destining the land under energy crops to the most common alternative use. This simplified approach was chosen to analyse a situation which could be relevant for the highest possible number of farmers in those regions, as not all the theoretically possible alternative uses of land are actually suited to all the farms. Moreover, this choice permitted to keep the complexity of the analysis (i.e. the number of comparisons to be made) within manageable limits. Obviously this solution did not permit to investigate on specific situations where farmers could choose among a higher number of feasible alternatives.

The assessment of the "net" contribution of energy crops grown under the AEC with the above method presented no particular difficulties: the steps 1-5 above were carried out also for the most common crop for food/feed use in the region, and the number of jobs that resulted was compared to the ones obtained by carrying out the steps 1-5 for the energy crops under study.

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[293] Standard Gross Margin as defined by Eurostat was again chosen as the best available approximation of farm income; see also § 20.2 above.

[294] It is however also true that no farmer will cultivate a crop with high work requirements if it does not grant him/her an adequate margin. Moreover, also the method based on actual work requirements per hectare has its drawbacks, which stem mainly from the fact that such requirements for a particular crop vary widely, according to the type of cultivation technique (which can be more or less intensive, depending on the yield levels to be pursued) and to the type and hourly productivity of farm machinery (the higher the working capacity of farm machinery, the lower the number of working hours per hectare needed).

In the case of energy crops grown under the NFSA regime, the most common alternative use of land is fallow set aside. The estimate of the "net" contribution in terms of jobs generated by energy crops under the NFSA regime was made by subtracting from their "gross" contribution an estimated number of "AWU equivalents" associated with fallow set aside[295].

As far as the assessment of the <u>real</u> number of jobs created/maintained in rural areas with the contribution of the measures under study, two major problems arose:

- *Only "spot" data, sometimes referred to very specific situations (e.g. a particular bio-fuel plant) were retrieved in the framework of the case studies. Most of the data about the creation of jobs retrieved in the framework of the case studies were indeed estimates themselves; in many cases the methodology for the estimates was non specified, or appeared to be unreliable.*
- *An even more serious issue lies however in the fact that it has proved virtually impossible to assess what portion of the <u>real</u> jobs at the various level of the bio-energy supply chain (and especially of the jobs in the downstream sectors) was created with the contribution of the measures, and what was not.*

A selection of data and information on the creation of real jobs in rural areas are presented in a box at the end of this paragraph, together with the description of the specific conditions and of the related limitations which apply, with the aim to provide at least some indications on the actual occupational effects of the implementation of activities concerning some of the bio-energy supply chains under study.

Another limitation stems from the fact that the analyses are referred to a specific year and not to an average of recent years[296] (which would have minimized the bias linked to specific conditions of a particular year). As far as the available data permitted to do so, it was tried not to choose "peculiar" years[297] to find a partial remedy to this limitation.

As regards the assessment of the contribution of the RDMs to the creation or the maintaining of jobs in rural areas, no data and information were retrieved on the features of the projects which could permit an estimate of their work requirements. Moreover, especially in the case of on-farm plants producing bio-energy, factors other than the support granted by the RDMs influence their ability to stay in business, and hence their ability to create or maintain jobs. Some data were retrieved on the actual work requirements of downstream operations in the framework of the regional case studies: such data – which are presented in the box at the end of this paragraph - can give an indication on the actual "gross" contribution of the relevant RDMs in terms of jobs created or maintained, when they are referred to small-scale on-farm plants.

In the light of the above limitations, the results of the analyses illustrated so far are to be deemed as indicative, and – given the regional and sector dimensions of the analysis – it is not possible to extend their validity to broader geographical areas and/or to the whole bio-energy supply chain, i.e. to "generalise" the main findings of the analysis itself.

The results of the analyses[298] are reported in the tables below.

[295] The steps 1-5 of the method to calculate the number of "AWU equivalents" cannot be carried out in the case of fallow set aside, as this particular use of land implies a cost for land maintenance, not a positive margin. Hence, it was assumed that 3 working hours per year, equivalent to 3/2.200 = 0,0014 AWUs per year, were required for the land maintenance per hectare of fallow set aside.

[296] Unfortunately, this solution proved not to be an option, as no adequate time series of data on the economics of energy crops, on the implementation of the measures under study and on the actual jobs associated with the various levels of the bio-energy supply chains under study were found.

[297] For instance year 2004 in the case of NFSA regime, as it was the only year over the 1999-2005 period when the rate of compulsory set aside was not 10%, but 5%.

[298] The data used for the estimates are illustrated in the annex 2 to this section (tables A.7.59-A.7.64).

Table 20.8 - Estimate of the ability of energy crops under the non food on set aside regime to create jobs at agricultural level in Niedersachsen, 2003[299]

Items	Values
1) Average utilised agricultural area per holding (ha/unit)	46,7
2) Average standard gross margin per holding (Euros/unit)	82.495
3) Maximum area under NFSA in an average holding (ha)	4,67
4) Rapeseed for energy use - NFSA: unit margin (Euros/ha)	387,00
5) Maize for energy use - NFSA: unit margin (Euros/ha)	180,00
6) = 3x4 = Maximum margin per holding from rapeseed for energy use-NFSA (Euros)	1.806,46
7) = 3x5 = Maximum margin per holding from maize for energy use-NFSA (Euros)	840,21
8) Standard gross margin per annual working unit in the average holding (Euros/AWU)	47.748,77
9) = 6/8 = Maximum margin per holding from rapeseed for energy use-NFSA expressed in equivalent AWUs	0,0378
10) = 7/8 = Maximum margin per holding from maize for energy use-NFSA expressed in equivalent AWUs	0,0176
11) Number of agricultural holdings practising the cultivation of crops under the non food on set aside regime (units)	4.870
12) = 9x11 = Estimate of the ability of energy rapeseed under the non food on set aside regime to create jobs at agricultural level (AWUs)	184
13) = 10x11 = Estimate of the ability of energy maize under the non food on set aside regime to create jobs at agricultural level (AWUs)	86
14) AWUs needed for land maintenance per hectare of fallow set aside	0,0014
15) = 3x14 = AWUs per holding needed for land maintenance when 3) is destined entirely to fallow set aside	0,0064
16) = 11x15 = AWUs needed for land maintenance in the region when 3) is destined entirely to fallow set aside	31
17) = 12-16 = estimate of the net contribution of energy rapeseed under the non food on set aside regime to the creation of jobs at agricultural level (AWUs)	153
18) = 13-16 = estimate of the net contribution of energy maize under the non food on set aside regime to the creation of jobs at agricultural level (AWUs)	55

Source: DEIAGRA elaboration of data from Eurostat (1, 2, 8), Landwirtschaftskammer Hannover (4, 5) and DG AGRI J.1 (11)
Rows 4, 5: total margin = market margin + "implicit subsidy" (for details on the estimate of this component, please refer to EQ 1, § 14.2.2)
Row 14: 3 working hours per hectare per year, equivalent to 3/2.200 = 0,0014 AWUs

Table 20.9 - Estimate of the ability of energy crops under the aid for energy crops to create jobs at agricultural level in Niedersachsen, 2004[300]

Items	Values
1) Average utilised agricultural area per holding (ha/unit)	46,7
2) Average standard gross margin per holding (Euros/unit)	82.495
3) Average agricultural area under the AEC per holding (ha/unit)	17,4
4) Rapeseed for energy use - AEC: unit margin (Euros/ha)	667,00
5) Maize for energy use - AEC: unit margin (Euros/ha)	460,00
6) = 3x4 = Average margin per holding from rapeseed for energy use-AEC (Euros)	11.577,21
7) = 3x5 = Average margin per holding from maize for energy use-AEC (Euros)	7.984,29
8) Standard gross margin per annual working unit in the average holding (Euros/AWU)	47.748,77
9) = 6/8 = Average margin per holding from rapeseed for energy use-AEC expressed in equivalent AWUs	0,242
10) = 7/8 = Average margin per holding from maize for energy use-AEC expressed in equivalent AWUs	0,167
11) Number of agricultural holdings practising the cultivation of crops under the aid for energy crops (units)	280
12) = 9x11 = Estimate of the ability of energy rapeseed under the aid for energy crops to create jobs at agricultural level (AWUs)	68
13) = 10x11 = Estimate of the ability of energy maize under the aid for energy crops to create jobs at agricultural level (AWUs)	47

Source: DEIAGRA elaboration of data from Eurostat (1, 2, 8), Landwirtschaftskammer Hannover (4, 5) and DG AGRI J.1 (3, 11)
Rows 4, 5: total margin = market margin + area payment + AEC

[299] In the case of the NFSA regime, the evaluation team chose not to use in the analysis data for year 2004 (though available) as it was the only year over the 1999-2005 period when the rate of compulsory set aside was not 10%, but 5%.
[300] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.

Table 20.10 - Niedersachsen, 2004[301]: estimate of the net contribution of energy crops under the aid for energy crops to the creation of jobs at agricultural level (additional jobs created with respect to the most common crop for food/feed use in the region)

Items	Values
1) Average utilised agricultural area per holding (ha/unit)	46,7
2) Average standard gross margin per holding (Euros/unit)	82.495
3) Average agricultural area under the AEC per holding (ha/unit)	17,4
4) Most common crop for food/feed use = common wheat: unit margin (Euros/ha)	422,74
5) = 3x4 = Average margin per holding from the cultivation of common wheat on (3) (Euros)	7.337,56
6) Standard gross margin per annual working unit in the average holding (Euros/AWU)	47.748,77
7) = 5/6 = Average margin per holding from the cultivation of common wheat on (3) expressed in equivalent AWUs	0,154
8) Number of agricultural holdings practising the cultivation of crops under the aid for energy crops (units)	280
9) = 7x8 = Estimate of the jobs created at agricultural level by the cultivation of common wheat on (3) (AWUs)	43
10) Estimate of the ability of energy rapeseed under the aid for energy crops to create jobs at agricultural level (AWUs)	68
11) Estimate of the ability of energy maize under the aid for energy crops to create jobs at agricultural level (AWUs)	47
12) = 10-9 = estimate of the net contribution of energy rapeseed under the aid for energy crops to the creation of jobs at agricultural level (AWUs)	25
13) = 11-9 = estimate of the net contribution of energy maize under the aid for energy crops to the creation of jobs at agricultural level (AWUs)	4

Rows 10 - 11: see table 20.9 for the sources
Source: DEIAGRA elaboration of data from Eurostat (1, 2, 6); Graham Brookes, "European arable crop profit margins" (2004/05) (4); DG AGRI J.1 (3, 8)

Table 20.11 - Estimate of the ability of energy crops under the non food on set aside regime to create jobs at agricultural level in Castilla y Leon, 2003[302]

Items	Values	
	Dry culture	Irrigated culture
1) Average utilised agricultural area per holding (ha/unit)	51,2	51,2
2) Average standard gross margin per holding (Euros/unit)	24.578	24.578
3) Maximum area under NFSA in an average holding (ha)	5,12	5,12
4) Sunflower for energy use - NFSA: unit margin (Euros/ha)	100,00	226,00
5) Barley for energy use - NFSA: unit margin (Euros/ha)	79,00	42,00
6) = 3x4 = Maximum margin per holding from sunflower for energy use-NFSA (Euros)	511,95	1.157,00
7) = 3x5 = Maximum margin per holding from barley for energy use-NFSA (Euros)	404,44	215,02
8) Standard gross margin per annual working unit in the average holding (Euros/AWU)	30.311,17	30.311,17
9) = 6/8 = Maximum margin per holding from sunflower for energy use-NFSA expressed in equivalent AWUs	0,0169	0,0382
10) = 7/8 = Maximum margin per holding from barley for energy use-NFSA expressed in equivalent AWUs	0,0133	0,0071
11) Number of agricultural holdings practising the cultivation of crops under the non food on set aside regime (units)	2.230	2.230
12) = 9x11 = Estimate of the ability of energy sunflower under the non food on set aside regime to create jobs at agricultural level (AWUs)	38	85
13) = 10x11 = Estimate of the ability of energy barley under the non food on set aside regime to create jobs at agricultural level (AWUs)	30	16
14) AWUs needed for land maintenance per hectare of fallow set aside	0,0014	0,0014
15) = 3x14 = AWUs per holding needed for land maintenance when 3) is destined entirely to fallow set aside	0,0070	0,0070
16) = 11x15 = AWUs needed for land maintenance in the region when 3) is destined entirely to fallow set aside	16	16
17) = 12-16 = estimate of the net contribution of energy sunflower under the non food on set aside regime to the creation of jobs at agricultural level (AWUs)	22	70
18) = 13-16 = estimate of the net contribution of energy barley under the non food on set aside regime to the creation of jobs at agricultural level (AWUs)	14	0

Source: DEIAGRA elaboration of data from Eurostat (1, 2, 8), interviews (4, 5) and DG AGRI J.1 (11)
Rows 4, 5: total margin = market margin + "implicit subsidy" (for details on the estimate of this component, please refer to the answer to the evaluation question 1)
Row 14: 3 working hours per hectare per year, equivalent to 3/2.200 = 0,0014 AWUs

[301] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.
[302] In the case of the NFSA regime, the evaluation team chose not to use in the analysis data for year 2004 (though available) as it was the only year over the 1999-2005 period when the rate of compulsory set aside was not 10%, but 5%.

Table 20.12 - Estimate of the ability of energy crops under the aid for energy crops to create jobs at agricultural level in Castilla y Leon, 2004[303]

Items	Values	
	Dry culture (*)	Irrigated culture (*)
1) Average utilised agricultural area per holding (ha/unit)	51,2	51,2
2) Average standard gross margin per holding (Euros/unit)	24.578	24.578
3) Average agricultural area under the AEC per holding (ha/unit)	14,0	14,0
4) Sunflower for energy use - AEC: unit margin (Euros/ha)	223,00	349,00
5) Barley for energy use - AEC: unit margin (Euros/ha)	202,00	165,00
6) = 3x4 = Average margin per holding from sunflower for energy use-AEC (Euros)	3.122,00	4.886,00
7) = 3x5 = Average margin per holding from barley for energy use-AEC (Euros)	2.828,00	2.310,00
8) Standard gross margin per annual working unit in the average holding (Euros/AWU)	30.311,17	30.311,17
9) = 6/8 = Average margin per holding from sunflower for energy use-AEC expressed in equivalent AWUs	0,103	0,161
10) = 7/8 = Average margin per holding from barley for energy use-AEC expressed in equivalent AWUs	0,093	0,076
11) Number of agricultural holdings practising the cultivation of crops under the aid for energy crops (units)	130	130
13) = 9x11 = Estimate of the ability of energy sunflower under the aid for energy crops to create jobs at agricultural level (AWUs)	13	21
13) = 10x11 = Estimate of the ability of energy barley under the aid for energy crops to create jobs at agricultural level (AWUs)	12	10

Source: DEIAGRA elaboration of data from Eurostat (1, 2, 8), interviews (4, 5) and DG AGRI J.1 (3, 11)
Rows 4, 5: total margin = market margin + area payment + AEC

Table 20.13 - Castilla y Leon, 2004[304]*: estimate of the net contribution of energy crops under the aid for energy crops to the creation of jobs at agricultural level (additional jobs created with respect to the most common crop for food/feed use in the region)*

Items	Values	
	Dry culture (*)	Irrigated culture (*)
1) Average utilised agricultural area per holding (ha/unit)	51,2	51,2
2) Average standard gross margin per holding (Euros/unit)	24.578	24.578
3) Average agricultural area under the AEC per holding (ha/unit)	14,0	14,0
4) Most common crop for food/feed use = barley: unit margin (Euros/ha)	283,20	283,20
5) = 3x4 = Average margin per holding from the cultivation of barley on (3) (Euros) (*)	3.964,80	3.964,80
6) Standard gross margin per annual working unit in the average holding (Euros/AWU)	30.311,17	30.311,17
7) = 5/6 = Average margin per holding from the cultivation of barley on (3) expressed in equivalent AWUs	0,131	0,131
8) Number of agricultural holdings practising the cultivation of crops under the aid for energy crops (units)	130	130
9) = 7x8 = Estimate of the jobs created at agricultural level by the cultivation of barley on (3) (AWUs)	17	17
10) Estimate of the ability of energy sunflower under the aid for energy crops to create jobs at agricultural level (AWUs)	13	21
11) Estimate of the ability of energy barley under the aid for energy crops to create jobs at agricultural level (AWUs)	12	10
12) = 10-9 = estimate of the net contribution of energy sunflower under the aid for energy crops to the creation of jobs at agricultural level (AWUs)	-4	4
13) = 11-9 = estimate of the net contribution of energy barley under the aid for energy crops to the creation of jobs at agricultural level (AWUs)	-5	-7

(*): barley for food/feed use = average value (no distinction is made between dry and irrigated culture)
Rows 10 - 11: see table 20.11 for the sources
Source: DEIAGRA elaboration of data from Eurostat (1, 2, 6); Graham Brookes, "European arable crop profit margins" (2004/05) (4); DG AGRI J.1 (3, 8)

[303] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.
[304] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.

Table 20.14 - Estimate of the ability of energy crops under the non food on set aside regime to create jobs at agricultural level in Champagne-Ardenne, 2003[305]

Items	Values
1) Average utilised agricultural area per holding (ha/unit)	61,4
2) Average standard gross margin per holding (Euros/unit)	108.479
3) Maximum area under NFSA in an average holding (ha)	6,14
4) Wheat for energy use - NFSA: unit margin (Euros/ha)	360,00
5) = 3x4 = Maximum margin per holding from wheat for energy use-NFSA (Euros)	2.210,73
6) Standard gross margin per annual working unit in the average holding (Euros/AWU)	68.740,06
7) = 5/6 = Maximum margin per holding from wheat for energy use-NFSA expressed in equivalent AWUs	0,0322
8) Number of agricultural holdings practising the cultivation of crops under the non food on set aside regime (units)	6.160
9) = 7x8 = Estimate of the ability of energy wheat under the non food on set aside regime to create jobs at agricultural level (AWUs)	198
10) AWUs needed for land maintenance per hectare of fallow set aside	0,0014
11) = 3x10 = AWUs per holding needed for land maintenance when 3) is destined entirely to fallow set aside	0,0084
12) = 8x11 = AWUs needed for land maintenance in the region when 3) is destined entirely to fallow set aside	52
13) = 9-12 = estimate of the net contribution of energy wheat under the non food on set aside regime to the creation of jobs at agricultural level (AWUs)	147

Source: DEIAGRA elaboration of data from Eurostat (1, 2, 6), FADN (4) and DG AGRI J.1 (8)
Row 4: total margin = market margin + "implicit subsidy" (for details on the estimate of this component, please refer to the answer to the evaluation question 1)
Row 10: 3 working hours per hectare per year, equivalent to 3/2.200 = 0,0014 AWUs

Table 20.15 - Estimate of the ability of energy crops under the aid for energy crops to create jobs at agricultural level in Champagne-Ardenne, 2004[306]

Items	Values
1) Average utilised agricultural area per holding (ha/unit)	61,4
2) Average standard gross margin per holding (Euros/unit)	108.479
3) Average agricultural area under the AEC per holding (ha/unit)	8,2
4) Wheat for energy use - AEC: unit margin (Euros/ha)	690,00
5) = 3x4 = Average margin per holding from wheat for energy use-AEC (Euros)	5.667,86
6) Standard gross margin per annual working unit in the average holding (Euros/AWU)	68.740,06
7) = 5/6 = Average margin per holding from wheat for energy use-AEC expressed in equivalent AWUs	0,082
8) Number of agricultural holdings practising the cultivation of crops under the aid for energy crops (units)	3.220
9) = 7x8 = Estimate of the ability of energy wheat under the aid for energy crops to create jobs at agricultural level (AWUs)	266

Source: DEIAGRA elaboration of data from Eurostat (1, 2, 6), FADN (4) and DG AGRI J.1 (3, 8)
Row 4: total margin = market margin + area payment + AEC

Table 20.16 - Champagne-Ardenne, 2004[307]*: estimate of the net contribution of energy crops under the aid for energy crops to the creation of jobs at agricultural level (additional jobs created with respect to the most common crop for food/feed use in the region)*

Items	Values
1) Average utilised agricultural area per holding (ha/unit)	61,4
2) Average standard gross margin per holding (Euros/unit)	108.479
3) Average agricultural area under the AEC per holding (ha/unit)	8,2
4) Most common crop for food/feed use = common wheat: unit margin (Euros/ha)	661,10
5) = 3x4 = Average margin per holding from the cultivation of common wheat on (3) (Euros)	5.430,46
6) Standard gross margin per annual working unit in the average holding (Euros/AWU)	68.740,06
7) = 5/6 = Average margin per holding from the cultivation of common wheat on (3) expressed in equivalent AWUs	0,079
8) Number of agricultural holdings practising the cultivation of crops under the aid for energy crops (units)	3.220
9) = 7x8 = Estimate of the jobs created at agricultural level by the cultivation of common wheat on (3) (AWUs)	254
10) Estimate of the ability of energy wheat under the aid for energy crops to create jobs at agricultural level (AWUs)	266
11) = 10-9 = estimate of the net contribution of energy wheat under the aid for energy crops to the creation of jobs at agricultural level (AWUs)	11

Row 10: see table 20.14 for the sources
Source: DEIAGRA elaboration of data from Eurostat (1, 2, 6); Graham Brookes, "European arable crop profit margins" (2004/05) (4); and DG AGRI J.1 (3, 8)

On the basis of the above estimates, the main findings to highlight are the following:

[305] In the case of the NFSA regime, the evaluation team chose not to use in the analysis data for year 2004 (though available) as it was the only year over the 1999-2005 period when the rate of compulsory set aside was not 10%, but 5%.
[306] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.
[307] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.

1) The estimated "net" potential[308] that energy crops under the NFSA regime have in creating jobs at agricultural level in the regions concerned falls within a 0-150 units range: the minimum level is associated with energy barley (irrigated culture) in Castilla y Leon, while the maximum levels are reached with energy wheat cultivation in Champagne-Ardenne and with energy rapeseed cultivation in Niedersachsen.
2) The estimated "net" potential that energy crops under the AEC have in creating jobs at agricultural level is much lower than that of energy crops under the NFSA. It is quantified in 4-25 units in Niedersachsen and 11 units in Champagne-Ardenne. The situation in Castilla y Leon is peculiar, inasmuch in three cases out of four the cultivation of energy crops under the AEC actually is at a disadvantage in comparison with the most common conventional crop in the region (barley) in terms of ability to create jobs: only the cultivation of energy sunflower (irrigated culture) has a modest advantage over the most common conventional crop.
3) The higher "net" potential of the NFSA regime in comparison with that of AEC for the creation of jobs at agricultural level is consistent with the technical features inherent to the two environments: while in the case of energy crops grown under the NFSA regime the most common alternative use of set aside land – i.e. leaving it fallow - has a low labour intensity, in the case of energy crops grown under the AEC the labour requirements of the most common energy crops – which are for the most part conventional crops destined to energy purposes – are not so different from, and in many cases equal to, those of the crops grown for food or feed uses they substitute.

If the number of AWUs resulting from the "net" potential for job creation of the measures under study, is compared with the total number of AWUs in the regions concerned (see Table 20.17 below), the former is indeed a modest one.

Table 20.17 - Estimate of the net contribution of the relevant activities to the creation of jobs at agricultural level versus total number of Annual Working Units (AWUs) in the regions concerned

Regions	Relevant activities	1) Estimate of the net contribution of the relevant activities to the creation of jobs at agricultural level (AWUs)	2) Total number of AWUs in the region (Eurostat data, 2003)	3) Importance of 1) on 2) (%)
Niedersachsen	Energy rapeseed cultivation under the NFSA regime	153	97.200	0,16%
Niedersachsen	Energy rapeseed cultivation under the AEC	25	97.200	0,03%
Niedersachsen	Energy maize cultivation under the NFSA regime	55	97.200	0,06%
Niedersachsen	Energy maize cultivation under the AEC	4	97.200	0,00%
Castilla y Leon	Energy sunflower cultivation (dry culture) under the NFSA regime	22	85.920	0,03%
Castilla y Leon	Energy sunflower cultivation (dry culture) under the AEC	-4	85.920	1) is negative
Castilla y Leon	Energy sunflower cultivation (irrigated culture) under the NFSA regime	70	85.920	0,08%
Castilla y Leon	Energy sunflower cultivation (irrigated culture) under the AEC	4	85.920	0,00%
Castilla y Leon	Energy barley cultivation (dry culture) under the NFSA regime	14	85.920	0,02%
Castilla y Leon	Energy barley cultivation (dry culture) under the AEC	-5	85.920	1) is negative
Castilla y Leon	Energy barley cultivation (irrigated culture) under the NFSA regime	0	85.920	0,00%
Castilla y Leon	Energy barley cultivation (irrigated culture) under the AEC	-7	85.920	1) is negative
Champagne-Ardenne	Energy wheat cultivation under the NFSA regime	147	40.510	0,36%
Champagne-Ardenne	Energy wheat cultivation under the AEC	11	40.510	0,03%

1): see tables 20.8-20.16 for the sources; years of reference: 2003 for energy crops under the NFSA regime[309]; 2004 for energy crops under the AEC[310]

[308] We remind that the "net" potential of the measures under study in creating/maintaining jobs in rural areas is equal to their total contribution in terms of jobs minus the number of jobs which would have been created/maintained by destining the land under energy crops to the most common alternative use.
[309] In the case of the NFSA regime, the evaluation team chose not to use in the analysis data for year 2004 (though available) as it was the only year over the 1999-2005 period when the rate of compulsory set aside was not 10%, but 5%.
[310] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.

Actual occupational effects of the implementation of activities concerning some of the relevant bio-energy supply chains in the regions under study

As far as the **agricultural level** is concerned, the following data and information retrieved in the framework of the regional case studies are noteworthy:

- Niedersachsen: Energy rapeseed tends to substitute cereals like rye, barley and – with the present favourable market dynamics – also common wheat, i.e. crops with similar labour requirements. As far as energy maize is concerned, its introduction in the farms allows for a different crop rotation which actually reduces work loads of farmers in peak times during harvest. Energy maize is harvested in late summer or autumn: this contributes to sharing the work load of the farms among all harvest seasons, instead of concentrating it in mid-summer (which is the case when only crops like wheat, barley, rye and rapeseed are grown). This situation surely benefits the farmers, but it is obviously not conducive to the hiring of extra workers.
- Castilla y Leon: To improve the profitability of energy crops, which tends to be poor in the region, an increasing number of farmers is trying the use of labour-saving techniques - in particular direct (no-tillage) sowing: again, this development is surely going to benefit the farmers, but it will not be conducive to the hiring of extra workers.
- Champagne-Ardenne: energy wheat tends to substitute wheat for food/feed use or similar cereals, i.e. crops with similar labour requirements.

As far as the **downstream levels** (biomass processing into bio-energy sources and/or bio-energy) are concerned, it is not possible to assess whether the DAMs under study have a relevant influence on the construction and operation of processing plants. In the case of on-farm plants (like those dedicated to the production of pure vegetable oil for energy purposes, or bio-gas plants, or direct combustion heat and/or power plants), the support granted by rural development measures may have been essential to build the plant itself, but this statement cannot be extended to all on-farm plants, and surely not to industrial-scale operations (bio-diesel and bio-ethanol plants). This said, the following data and information are noteworthy:

- Niedersachsen: The oil mill at Wittingen, with a capacity of 10,000 tons per year, employs three full-time employees, each of them working 6 hours per day in a three-shift system. The remaining working time is needed for stand-by-for emergency duties since the oil mill is fully automated. One employee is responsible for marketing and 1.4 jobs/year are dedicated to bookkeeping. The board of managers consists of two members. As regards bio-gas production, the interviewed experts estimated that about 2.200 working hours per year, i.e. a full-time worker, are required to run a 500 KW bio-gas plant. Usually there is also a stand-by operator who runs the plant during holidays, illness and so on of the plant operator. The bio-energy village of Jühnde features a 750 KW bio-gas plant and a wood chips combined heat and power plant, which together require 1,3 jobs/year. Less than one AWU per year is generally required for the operation of small-scale on-farm plants.
- Castilla y Leon: No plants are at present in operation in the region. However, the estimated full time jobs per year required by the 10 planned industrial operations (bio-diesel and bio-ethanol plants) vary between 10 and 100 units for each plant, depending on its production capacity.
- Champagne-Ardenne: the bio-ethanol plant at Arcis-sur-Aube employs 50 full-time workers.

20.4 Judgment

Contribution of the measures under study to the diversification of the income of farmers

The diffusion of the cultivation of energy crops under the AEC and the NFSA regime - i.e. the diffusion of the farm income diversification strategy based on such activity among the whole population of farmers - was found to be very low in most Member States. In 2004[311] the beneficiaries of the AEC represented less than 1,5% of the total number of farms in all Member States except France (3%) and Luxembourg (4,2%); the beneficiaries of the NFSA regime in the same year represented more than 4% of the total number of farms in Denmark, France and Germany (7-8%) and in Luxembourg (10%). Only in one out of five regional situations studied in the case of the AEC, and only in two of the six studied in the case of the NFSA regime, the beneficiaries represented more than 9% of the total number of farms.

[311] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.

We can therefore judge that – the partial exceptions above notwithstanding - **the contribution of the AEC and of the NFSA regime to the diversification of income of farmers is very modest**[312].

As regards the RDMs, the data and information available - though limited and fragmented - suggest that the diffusion of the income diversification strategies centred on the activities funded by such measures can be deemed as very limited (a few thousands projects) at EU level.

Relevance of income resulting from the activities supported by the measures under study on total farm income.

The portion of farm income resulting from the energy crops grown under the AEC and the NFSA regime, corresponding to the upper limit of the contribution of the measures[313], was found to be in the 5-15% range in six out of seven representative regional situations analysed[314] (on the basis of average data at regional level).

The activities concerned were found to provide additional income - with respect to the income granted by the most common crop for food/feed use in the region - in four cases out of seven, but always for rather modest amounts (higher than 1.000 Euros per holding only in one case).

Above all, AEC payments represent less than 3% of total income in all the situations studied.

In the light of these findings, it can be judged that **the portion of farm income that can be attributed to energy crops cultivation under the AEC and the NFSA regime was on average not relevant in nearly all the representative situations studied at regional level[315].**

It is important to underline that the portion of income granted by the cultivation of energy crops outside these specific regimes (which was practised in the EU on an area of around 1 million ha in 2005) was not considered in the analysis.

Finally, it has to be noted that it was impossible to estimate the portion of farm income attributable to the support granted by the RDM to on-farm investments in bio-energy related activities, as a great number of factors other than such support are also relevant in making such activities economically viable once started.

Contribution of the measures under study to the creation/maintaining of jobs in rural areas

When compared to the number of jobs which would have been created or maintained in the representative regional situations studied by destining the land to fallow set aside - in the case of the NFSA regime – or to the most common conventional crop for food/feed use - in the case of the AEC - energy crops grown under the two measures were found to create or maintain few (if any) additional jobs[316]: always less than 160 Annual Working Units at regional level in the case of the NFSA regime, never more than 25 Annual Working Units at regional level in the case of the AEC.

In the light of this findings, it can be judged that **the contribution of the NFSA regime and of the AEC to the creation/maintaining of jobs in rural areas has not been significant[317].**

As regards instead the contribution of both the Rural Development Measures and the Direct Aid Measures to the creation of jobs in the processing stage of the bio-energy supply chains, it proved impossible to assess the share of such jobs that can surely be attributable to the measures, given the high number of other factors that can play a role in this respect.

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[312] This was the case at least until 2004 for the AEC and at least until 2003 for the NFSA regime.

[313] It corresponds to the upper limit of the contribution of the measures, since it is assumed that their role as policy incentives to the cultivation of energy crops is always decisive or relevant, while it is not so actually (see EQ 1).

[314] To estimate the portion of farm income resulting from the activities supported by, respectively, AEC and NFSA, the following two situations were assumed as representative: A) In the case of the AEC, the "typical" farm grows energy crops under the AEC on an area equal to the average area under AEC per holding benefiting from such measure in the region under study. B) In the case of NFSA regime, agricultural area under compulsory set aside regime in the "typical" farm is entirely destined to the cultivation of energy crops under the NFSA regime. The methodology used for the estimates, and the assumptions at A) and B) above, could lead to over- or underestimate the portion of farm income resulting from the activities supported by AEC and NFSA regime in real farms whose characteristics deviate substantially from those of the "typical" one."

[315] This was the case at least until 2004 for the AEC and at least until 2003 for the NFSA regime.

[316] The analyses are referred to year 2004 for the AEC, and to year 2003 for the NFSA regime. In the case of the AEC, only data for 2004 campaign (financial year 2005) were available at the moment of carrying out the analysis. In the case of the NFSA regime, the evaluation team chose not to use in the analysis data for year 2004 (though available) as it was the only year over the 1999-2005 period when the rate of compulsory set aside was not 10%, but 5%.

[317] This was the case at least until 2004 for the AEC and at least until 2003 for the NFSA regime.

21 EVALUATION QUESTION 8

"To what extent have the measures contributed to the fair standard of living for farmers concerned, do these farmers form a significant proportion of EU farmers? Give a detailed answer according to the typology of the farm and the regional situation".

The relevant issues to tackle in the framework of EQ 8 are the following:

1) To assess whether and to what extent the support provided through both direct aid measures and rural development measures (cause), has contributed – through the cultivation of energy crops and, possibly, the start of downstream activities on the farm - to the achievement of a fair standard of living for the farmers concerned (effect).
2) To assess whether and to what extent the farmers who have achieved a fair standard of living through the measures under study are a significant portion of the total of EU farmers.

The **methodology** for answering the question is summarised below.

Judgment criteria, indicators and information sources

Judgment Criteria (JC)	Indicators (IND)	Information sources
JC 1: comparison among annual incomes per work unit in the farms practising the activities supported by the relevant measures and in non-agricultural sectors	**IND 1.1)** Average annual income per work unit in the farms where the activities supported by the measures under study are practised **IND 1.2)** Average annual income per work unit in the farms where the activities under study are NOT practised **IND 1.3)** Average annual income per work unit in non-agricultural sectors	**IND 1.1 and 1.2**: FADN **IND 1.3**: EUROSTAT - European Structure of Earnings Survey (SES 2002)
JC 2: relative importance in numerical terms of the farms where the activities supported by the measures under study are practised ON the total of EU agricultural holdings	**IND 2.1) (**number of farms where the activities supported by the measures under study are practised) / (total number of EU agricultural holdings) X 100	**Number of farms where the activities supported by the measures under study are practised**: DG Agriculture J.1 (CATS database) **Total number of EU agricultural holdings**: EUROSTAT

21.1 Contribution of the measures under study to the achievement of a fair standard of living for the farmers concerned

The first step to be made in order to assess the contribution of the measures under study[318] to the achievement of a fair standard of living[319] for the farmers concerned, is the comparison among the levels of individual annual income in the farms where the activities supported by the measures under study are practised, in the farms where such activities are not practised, and in non-agricultural sectors.

Limitations of the analysis and validity of the results

The main limitations derive from the only partial comparability between the available indicators of individual annual income in agricultural and non agricultural sectors, in the form in which they are provided by the responsible subjects at EU level (FADN and Eurostat).

Two indicators provided by FADN can be used as indicators of individual income in agriculture: Farm net value added per AWU (FADN code SE 425) and Family farm income per family working unit (FADN code SE 430).

The former is a very approximate indicator of individual income in agriculture, as it includes wages paid (FADN code SE 370), Rent paid (FADN code SE 375) and interest paid (FADN code SE 380), while it does not include the balance of

[318] The contribution of the arable crop area payments (granted before the implementation of decoupling) and of the SPS is not investigated in this evaluation question, since they cannot be specifically associated with the cultivation of energy crops.

[319] This concept is defined according to art. 33 of the EC Treaty, which indicates the increase of "the individual earnings of persons engaged in agriculture" as the main way to meet the objective of ensuring "a fair standard of living for the agricultural community", and more precisely according to the resolutions following the 1959 Stresa Conference, in particular as far as the objective of permitting "the capital and labour used in European Agriculture to receive remuneration comparable with that which they obtain in other sectors of the economy" is concerned.

subsidies and taxes on investments (FADN code SE 405). Moreover, it is referred to annual work units (FADN code SE 010), and therefore also to hired workers (not only to farmers and to their family members working on the farm).

The latter is a less approximate indicator, as it excludes external factors (FADN code SE 365, i.e. SE 370 + SE 375 + SE 380) and includes the balance of subsidies and taxes on investments (FADN code SE 405), and is referred to family work units (FADN code SE 015) only. However, it still includes a number of income components which do not derive from the sole working activity (e.g. profits, interest from own capital, etc.).

As for non agricultural sectors, the indicator of individual income for which the most recent (2002) data are available, i.e. the gross annual earnings in "Industry and services" provided by the European Structure of Earnings Survey (SES) by Eurostat, is instead exclusively made of income components deriving from the sole working activity; moreover, two further factors limit the comparability with Family farm income per family working unit (FADN code SE 430):

- *the exclusion from the field of observation of a number of categories which are quite similar to family working units in a farm*[320]*;*
- *the very structure of the indicator itself, which includes in the gross annual earnings also social security contributions payable by wage earners and retained by the employer.*

Assumed the inopportunity of elaborating an ad hoc indicator for agricultural incomes[321] *some indications on the achievement of a fair standard of living in the EU agricultural sector were however drawn on the comparison between Family farm income per family working unit (FADN code SE 430) and gross annual earnings in "Industry and services" according to SES.*

The FADN database discriminates between farms with fallow set aside and farms growing non food crops *– including energy crops - on set aside (also in combination with fallow set aside). This second category can satisfactorily approximate the situation of farms growing* energy crops on set aside*, given the fact that a very high share of crops grown under the NFSA regime is actually made of energy crops (see the answer to the evaluation question 1). This cannot assure, however, that higher values for income in farms growing non food crops on set aside land can be automatically attributed to the cultivation of energy crops, as this outcome could derive from other activities practised in the farms of the sample*[322]*.*

The FADN database also theoretically foresees the discrimination of farms growing energy crops under the AEC, but data result to be still unavailable due to the too limited number of such farms in the FADN sample. No analysis concerning the AEC could therefore be made through the use of FADN data.

Some useful indications in the context of the question are also provided by the answer to the evaluation question 7, through the estimates of the portion of farm income granted by energy crops grown under the AEC (see § 20.2). According to these estimates, energy crops grown under the AEC would generate little additional income (if any) in comparison with the most common alternative crops for food/feed use. It is therefore reasonable to assume that the differences in average individual income between the farms with energy crops grown under the AEC and the other farms, are not to be attributed to the presence/absence of energy crops grown under the AEC itself.

Regarding the role of RDMs for the achievement of a fair standard of living, some plausible qualitative considerations on the matter can be made when opportune. In this respect in fact, limitations regarding quantitative data (see § 20.2) do not allow for exhaustive and reliable answers.

The results of the comparison between the individual income indicators selected for the analysis are reported in Table 21.1 below.

[320] In particular: owners, directors or managers whose remuneration wholly takes the form of a share in profits; family workers who are not employees of the enterprise or local unit; own-account workers.

[321] Given the non-optimal comparability between Family farm income per family working unit (FADN code SE 430) and gross annual earnings in "Industry and services" according to SES, the elaboration of an *ad hoc* indicator on the basis of FADN data, in order to obtain a better comparability with SES, would have implied a very heavy additional work burden, while the added value for the evaluation study deriving from such an operation was at best unclear, in the light of the considerations that will be made below, and also because the possibility of carrying out an up-to-date comparison between agricultural and non-agricultural income indicators is anyway seriously limited by the fact that the last SES survey was conducted in 2002 (SES surveys are made every four years).

[322] Only an in-depth, ad hoc analysis of the income structure of the farms in the FADN sample could lead to an estimate of the part of Family farm income per family working unit deriving from the cultivation of energy crops on set aside land. However, the additional work burden needed for such an analysis would have given a limited added value to the evaluation study, mainly because:

1. Such estimate would however have suffered from the limitations inherent to the use of data by FADN – which has the farm as its focus - to investigate the economics of individual activities practised on the farm: a relevant number of assumptions (sometimes quite strong) have indeed to be made in order to carry out such investigations.
2. No energy crop grown on set aside land was found to grant a gross margin markedly higher than those granted by the cultivation of the most common conventional crops on non-set aside land (see in this respect the answers to the evaluation questions 1 and 6), and therefore an essential prerequisite for the ability of the energy crops grown on set aside land to increase significantly the family farm income was lacking a priori.
3. Over the evaluation period, only in a few years the rate of compulsory set aside was higher than 10%: as the rate of compulsory set aside constitutes a practical limit to the cultivation of energy crops under set aside in a farm, this situation – combined with the one at point 2 above – further limited the ability of the energy crops grown on set aside land to increase significantly the family farm income.

Table 21.1 - Comparison between individual income indicators in agriculture and in "Industry and services", 2002 (Euros)

Member State	1) Farm net value added per AWU (FADN SE 425)		2) Family farm income per family working unit (FADN SE 430)		3) Gross annual earnings "Industry and services" - mean values (SES survey 2002)
	1a) holdings with non food crops on set aside*	1b) holdings without non food crops on set aside	2a) holdings with non food crops on set aside*	2b) holdings without non food crops on set aside	
Belgium	50.983	45.686	35.750	32.328	30.694
Denmark	37.577	42.387	-13.004	-890	41.736
Germany (including ex-GDR from 1995)	28.452	25.760	13.557	14.121	34.622
Greece	n.a.	11.151	n.a.	9.331	18.751
Spain	n.a.	26.478	n.a.	26.779	21.063
France	33.625	24.918	23.443	18.576	29.139
Ireland	n.a.	32.893	n.a.	31.308	32.912
Italy	30.937	43.071	27.435	42.166	25.808
Luxembourg (Grand-Duché)	40.718	35.260	28.934	26.638	38.103
Netherlands	n.a.	45.819	n.a.	18.755	33.683
Austria	27.282	23.332	21.777	19.594	32.434
Portugal	n.a.	15.826	n.a.	26.805	13.609
Finland	n.a.	23.893	n.a.	19.201	30.965
Sweden	39.988	22.843	11.048	6.135	32.056
United Kingdom	39.992	37.901	27.327	27.841	38.538
Member State	**(1a) - (3)**	**(1b) - (3)**	**(2a) - (3)**	**(2b) - (3)**	
Belgium	20.289	14.992	5.056	1.634	
Denmark	-4.159	651	-54.740	-42.626	
Germany (including ex-GDR from 1995)	-6.170	-8.862	-21.065	-20.501	
Greece	n.a.	-7.600	n.a.	-9.420	
Spain	n.a.	5.415	n.a.	5.716	
France	4.486	-4.221	-5.696	-10.563	
Ireland	n.a.	-19	n.a.	-1.604	
Italy	5.129	17.263	1.627	16.358	
Luxembourg (Grand-Duché)	2.615	-2.843	-9.169	-11.465	
Netherlands	n.a.	12.136	n.a.	-14.928	
Austria	-5.152	-9.102	-10.657	-12.840	
Portugal	n.a.	2.217	n.a.	13.196	
Finland	n.a.	-7.072	n.a.	-11.764	
Sweden	7.932	-9.213	-21.008	-25.921	
United Kingdom	1.454	-637	-11.211	-10.697	

Source: DEIAGRA elaboration of data from FADN and Eurostat - European Structure of Earnings Survey (SES 2002)

From the data presented above, it emerges that the agricultural sector was still at a clear disadvantage in comparison with non-agricultural sectors as far as individual income was concerned, also with specific reference to the farms where non food crops were grown on set aside. The only exceptions indeed were limited to Belgium and Italy. Farms with non food crops on set aside fared better (in some cases just slightly better) than farms without such crops in Belgium, France, Luxembourg, Austria and Sweden.

Moreover, the following considerations can be made, especially in the light of the relevant measure of the gaps in terms of income which can be observed in most Member States:

1) A profitability of energy crops grown under the AEC and/or the NFSA regime markedly higher than that of the main crops for food and feed use would be needed to contribute significantly to narrow such gap. As such a situation was not observed for any of the energy crops most commonly grown under the AEC or the NFSA regime (see in this respect the market analysis, § 11.1[323]), an essential prerequisite for the ability of the energy crops grown with the support of the aforementioned DAMs to increase significantly the family farm income is lacking *a priori*.
2) The answer to the evaluation question 7 showed that in most all the cases even the gross contribution of energy crops under the AEC and the NFSA regime, to the total standard gross margin of an average agricultural holding (there assumed as an approximation of farm income) was rather limited (well below 20% of the total standard gross margin). Moreover, it was found that energy crops grown under the AEC generate little additional income (if any) in comparison with the most common alternative crops for food/feed use.

On this basis, regarding Belgium and Italy, it cannot be sustained the hypothesis that the achievement of a fair standard of living in the farms growing non food crops on set aside might systematically be a result of this specific activity alone.

This does not exclude the possibility that in a number of specific cases a significant improvement of the income of farmers may have been caused by the introduction of energy crops (or - more probably – by the start on the farm of downstream activities centred on the processing of biomass for energy purposes, funded by the RDMs under study). However, as explained in the answer to the EQ 1, the introduction of energy crops in a farm is not necessarily an effect of the AEC or of the NFSA regime, which indeed constitute a decisive incentive in this respect only in situations mostly associated with negative or tight

[323] Further evidence in this respect can be found also in the annex H to the market analysis and in tables A.6.47-A.6.52 in the annex to the evaluation question 6.

market margins[324]: in such situations the profitability of the energy crop is poor, and hence the possibility of achieving a fair standard of living through the additional income generated by the introduction of the energy crop is virtually non-existent.

As seen in the answer to the EQ 1, the NFSA regime, and even more the AEC, play a very limited role as an incentive to the introduction on the farm of the energy crops with the highest market margins[325] which – because of their satisfactory profitability – could play a more relevant role in helping farmers to achieve a fair standard of living. Such energy crops are indeed extensively grown in the EU also without the support of specific regimes.

Finally, from a more general standpoint, it is not plausible that the possible achievement of a fair standard of living through the introduction on the farm of energy crops under the AEC or the NFSA regime has been a widespread phenomenon: in fact only a very limited share of agricultural holdings in the EU has applied to benefit from the support of both the AEC and the NFSA regime, as Table 21.2 and Table 21.3 below show. Further evidence of the low degree of diffusion of these measures in the EU agricultural sector is given in the answer to the evaluation question 7.

Table 21.2 - Importance of agricultural holdings practising the cultivation of crops under the non food on set aside regime in the EU, 2004[326]

Member States	1) Number of agricultural holdings practising the cultivation of crops under the NFSA regime (units)	Importance of 1) on total number of agricultural holdings in the Member State (%)	2) Agricultural area under the NFSA regime (ha)	Importance of 2) on total utilised agricultural area in the Member State (%)
Austria	3.022	1,74%	7.968	0,24%
Belgium	481	0,88%	5.434	0,39%
Denmark	3.502	7,21%	13.005	0,49%
Finland (1)	144	0,19%	842	0,04%
France	45.138	7,35%	190.386	0,68%
Germany	32.596	7,91%	211.577	1,25%
Ireland	N/A	N/A	N/A	N/A
Italy	4.309	0,22%	11.948	0,09%
Luxembourg	265	10,60%	N/A	N/A
Spain	4.434	0,39%	N/A	N/A
Sweden	2.305	3,39%	232.865	7,45%
United Kingdom	3.492	1,24%	41.713	0,26%
EU-15	**99.544**	**1,60%**	**741.792**	**0,59%**

(1) 2002

Source: DEIAGRA elaboration on data from Eurostat and DG AGRI J.1 (derived from the Clearance Audit Trail System (CATS) database)

Table 21.3 - Importance of agricultural holdings practising the cultivation of crops under the aid for energy crops in the EU, 2004[327]

Member States	1) Number of agricultural holdings practising the cultivation of crops under the AEC (units)	Importance of 1) on total number of agricultural holdings in the Member State (%)	2) Agricultural area under the AEC (ha)	Importance of 2) on total utilised agricultural area in the Member State (%)
Austria	513	0,30%	3.497	0,11%
Denmark	211	0,43%	4.808	0,18%
Finland	131	0,17%	n.a.	n.a.
France	18.844	3,07%	129.324	0,47%
Germany	3.028	0,73%	117.271	0,69%
Ireland	34	0,03%	812	0,02%
Luxembourg	106	4,24%	n.a.	n.a.
Spain	376	0,03%	6.775	0,03%
Sweden	733	1,08%	14.522	0,46%
The Netherlands	15	0,02%	141	0,01%
United Kingdom	614	0,22%	30.712	0,19%
EU-15	**24.605**	**0,39%**	**307.862**	**0,24%**

Source: DEIAGRA elaboration on data from Eurostat and DG AGRI J.1 (derived from the Clearance Audit Trail System (CATS) database)

In conclusion, no elements among the evidence presented above suggest that the introduction of energy crops on the farm – in the cases where it was mainly driven by the AEC and the NFSA regime – has contributed significantly to the achievement of a fair standard of living for the EU farmers. Moreover, no elements emerged in the framework of the regional case studies which could unequivocally suggest that improvements (if any) in the standard of living of the farmers practising the activities supported by the

324 Such were the cases concerning sunflower and barley cultivation for energy use in the Castilla y Leon region, and reed canary grass cultivation in the Oulu region of Finland.

325 Such were the cases concerning rapeseed cultivation for bio-diesel production in Lower Saxony and in Haute Normandie, silage maize cultivation for bio-gas production in Carinthia and wheat cultivation for bio-ethanol production in Champagne-Ardenne.

326 At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.

327 At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available.

DAMs and/or the RDMs under study were mainly achieved as a consequence of the support granted through them, and not of other factors.

21.2 Judgment

As none of the energy crops most commonly grown in the EU under the AEC or the NFSA regime was found to grant a profitability markedly higher than that of the main crops for food and feed use, an essential prerequisite for the ability of such crops to increase significantly farm incomes was found to be lacking *a priori*. It is also noteworthy that, according to EQ 1, the NFSA regime and the AEC are a decisive factor in the introduction of energy crops on the farms only when their market margins are negative or tight, i.e. in situations not conducive to the achievement of a fair standard of living through the additional income generated by the cultivation of such crops.

Moreover, in the EQ 7 it was also found that energy crops grown under the AEC generate little additional income (if any) in comparison with the most common alternative crops for food/feed use, and it was judged that, in most cases, the portion of farm income attributable to energy crops cultivation under the AEC and the NFSA regime was not relevant[328].

Finally, in the EQ 7 we found that the farm income diversification strategies centred on the cultivation of energy crops under the AEC or the NFSA regime featured a very low diffusion among the EU farmers.

In the light of the evidence presented here and of that derived from EQ 1 and 7 (briefly recalled above), it can be judged that **the contribution of the AEC and of the NFSA regime** – by promoting the introduction of energy crops on the farm - **to the achievement of a fair standard of living for the EU farmers has not been significant from a general standpoint[329]**.

The more plausible exceptions to the above judgment are represented by farm-specific cases featuring the start of on-farm bio-energy production activities funded by the Rural Development Measures under study: however, as noted in the judgment of the EQ 7, a great number of factors other than the support granted by these measures are also relevant in making such activities economically viable once started.

[328] It is important to underline that the portion of income granted by the cultivation of energy crops outside these specific regimes (which was practised in the EU on an area of around 1 million ha in 2005) was not considered in the analysis.
[329] This was the case at least until 2004 for both the AEC and the NFSA regime.

22 EVALUATION QUESTION 9

"Is the crop production for energy use/bio-energy industry able to survive without additional support through public policies at Member States level and/or additional non-CAP support on EU level? List and put in relation additional agricultural and non-agricultural measures on Member States level as well as additional non-CAP support on EU level which is aimed at supporting the production of crops for energy use/promotion of bio-energy"

The **relevant issues** to tackle in the framework of EQ 9 are the following:

1) Identification of:
   - the additional agricultural and non-agricultural measures at Member States level;
   - the additional non-CAP support at EU level;

   aimed at supporting the production of crops for energy use and/or the promotion of bio-energy.
2) To quantify the support level granted by the various measures at point 1) above.
3) To compare the support level at point 2) above with the support level granted by the direct aid measures and the rural development measures.
4) To assess whether crop production for energy use and/or the bio-energy industry are able to survive without the support granted by the measures at point 1) above, i.e. with the only support of the direct aid measures and of the rural development measures under study.

The **methodology** for answering the question is summarised below.

Judgment criteria, indicators and information sources

Judgment Criteria (JC)	Indicators (IND)	Information sources
JC 1: cumulated support granted by DAMs and RDMs <u>versus</u> cumulated support granted by additional agricultural and non-agricultural measures at Member States level and additional non-CAP support at EU level	**IND 1.1)** cumulated support granted by DAMs and RDMs **IND 1.2)** cumulated support granted by additional agricultural and non-agricultural measures at Member States level and additional non-CAP support at EU level	**Amount of the support granted by DAMs and RDMs**: see answer to the EQ 2. **Amount of the additional support at Member State level**: COM (2005) 627 final; Eurostat; National Authorities for Energy and Transports; National Associations for bio-energy / bio-fuels
JC 2: unit costs of an energy unit generated from biomass with the sole support of DAMs and RDMs <u>versus</u> unit costs of an energy unit generated from conventional sources	**IND 2.1)** Estimated full cost of an energy unit generated from biomass with the sole cumulated support of DAMs and RDMs **IND 2.2)** Full cost of an energy unit generated from conventional sources	**Full cost of an energy unit**: DEIAGRA estimates on the basis of data from: COM (2005) 627 final; Eurostat; National Authorities for Energy and Transports; National Associations for bio-energy / bio-fuels; individual operators interviewed in the regional case studies; technical literature

22.1 Identification of the additional support measures at Member State and EU level.

It was chosen to concentrate on the additional support measures at Member State level which have an impact on the economics of the downstream stages of the bio-energy supply chains under study[330]. Non-CAP measures at EU level which have an impact on the economics of the bio-energy supply chains indeed exist[331]: nevertheless, they are mostly Directives (not Regulations), which have therefore to be adopted and implemented by Member States through adequate national rules.

22.2 Economic effects of additional support.

The various support schemes implemented by the measures at Member State level for the production of bio-energy can be divided, according to the mechanisms they use to support bio-energy production, in two great groups:

1) support schemes centred on the price level of bio-energy and/or of the sources of bio-energy;

[330] Please refer to § 6 for the identification and for the detailed description of these measures and of the relations existing among them.
[331] Please refer to § 6 for a detailed description of these measures.

2) support schemes centred on the exemption from/reduction of taxes on the production of bio-energy and/or of the sources of bio-energy.

The economic effect of support schemes at point 1) above is a higher price level for the supported energy sources, while the economic effect of support schemes at point 2) above is a reduction of the production cost of the supported energy sources.

22.3 Quantification of the additional support and assessment of the ability of the bio-energy supply chains to survive without additional support through public policies at Member States level.

To assess the ability of the different bio-energy supply chains under study to survive without additional support through public policies at Member States level, an analysis was carried out to compare the profitability of the downstream activities in these chains, with and without the support granted through the national measures under study.

A comparison is also carried out with the contribution to the profitability of the aforementioned activities granted by the AEC[332] through its effects on the price of biomass (see also EQ 2).

It is important to underline that – from the processors' standpoint - the support granted by the AEC does not constitute an explicit monetary component to be factored in the calculation of the full cost of a bio-energy unit, but a reduction in the cost of feedstocks achieved through lower biomass prices.

As regards instead additional support at Member State level, from the processors' standpoint is takes the form of:

1) An additional revenue, granted through supported electricity prices, in the case of electricity generation.
2) An avoided cost, in the form of exemption from excise duties (which would otherwise have to be passed on by producers to purchasers of bio-fuels via higher prices) in the case of bio-fuels.

Once the two support components – the AEC versus additional support at Member State level - are given the correct meaning defined above, an analysis of their relative importance can be made through the comparison of each one with the full cost of an energy unit.

The biomass prices used for the analysis are actual prices (usually a minimum and a maximum one, or a single price when it can be deemed representative), not estimated ones, and were retrieved in the framework of the case studies.

The results of this analysis, which was carried out for each of the bio-energy uses which are relevant for the evaluation (generation of electricity; heating; transport), are reported in the paragraphs that follow. This analysis was based on data and information illustrated in more detail[333] in the market analysis at § 11.

Limitations of the analysis and validity of the results

Being sector-specific, the methodology and limitations concerning the estimate of additional support are synthesised in footnotes in each of the following paragraphs.

As regards the estimate of the full cost of an energy unit[334], the main limitations are associated with the assumptions made for a number of variables in the computation model used, especially when a fixed value is assumed for - at least potentially - different situations. The most sensitive variables in this respect are those concerning:

- *as regards the estimate of the fixed costs: the investment cost, the installed capacity and the life time of the plant;*
- *as regards the estimate of the variable costs: the annual production of the plant, the efficiency of the production process, and the price of feedstock.*

The main consequence is that the estimates of the full cost of an energy unit are to be deemed "representative" only for situations which are close to the one defined by the assumptions, and not for the countless actual situations where one or more variables feature markedly different values from the ones assumed for the estimate.

It was tried anyway to limit this problem by picturing (through the use of different combinations of values) a number of situations that might be deemed representative - from a qualitative if not a quantitative (statistical) standpoint – of the

[332] We remind that such comparison is unfeasible for the NFSA regime, as its effects on price are solely indirect ones, whose extent is very difficult to quantify (see EQ 2).
[333] Further information can be found also in the annexes F and G of the market analysis.
[334] We remind here that such cost corresponds to the level of remuneration that, over the life time of the plant, allows to cover all fixed and variable costs, thus permitting to repay the amount invested by the producer in the plant with a rate of return equal to a given discount rate.

most significant bio-energy supply chains to be found in the EU, with respect to the features of both the fixed assets of the plant and the production technique used in it[335]*.*

As regards the comparison – from the processors' standpoint - between the support granted by the AEC and the additional support granted at Member State level, it is important to note that:

1) *the AEC is granted to the farmers, and is referred to an hectare of energy crops;*
2) *additional support at Member State level is granted to the producers of bio-energy and bio-fuels, and is referred to a unit of the final product.*

Hence, for a correct comparison between the support typologies at 1) and 2) above:

- *it must be assumed that the support granted by the AEC to farmers is fully converted into lower biomass prices to be paid by processors (see EQ 2):*
- *the support granted through the AEC has to be referred to a unit of the final products, through adequate conversion factors.*

As technical parameters which determine the above conversion factors (energy crop yields; energy content of biomass; efficiency of the conversion process of biomass into bio-energy or bio-fuels) actually vary significantly from case to case, average and/or representative values have to be considered.

22.3.1 Electricity

The technologies for the generation of electricity from biomass that were considered in the analysis are reported in Table 22.1 below[336].

Table 22.1 – Relevant technologies for the generation of electricity

Code	Description
BFBC A	BFBC plant; minimum straw price (43.5 €/t)
BFBC B	BFBC plant; maximum straw price (120 €/t)
BFBC C	BFBC plant; miscanthus (73.12 €/t)
BFBC D	BFBC plant; reed canary grass (31.9 €/t)
Biogas A	Biogas plant; minimum maize silage price (15.5 €/t)
Biogas B	Biogas plant; maximum maize silage price (33 €/t)

Notes: BFBC = Bubbling Fluidised Bed Combustor plant

The analysis was carried out at Member State level through a comparison of the full costs estimated for these technologies in the market analysis with:

- the wholesale price of electricity;
- **the support granted through policies at Member State level and/or non-CAP support measures at EU level for electricity generated from biomass**; in the case of the generation of electricity from biomass, the measure of the support level is given by the price at which a producer is able to sell an energy unit[337].

The results of the comparison are reported in Figure 22.1 and Figure 22.2 below for, respectively, generation of electricity from solid biomass and from bio-gas.

With respect to the contribution to the profitability of the activities under study granted by the DAMs through their effects on the price of biomass, it is important to remind that – among the cases studied in the EQ 2 - only in the one concerning electricity generation from reed canary grass (BFBC plant) in the Oulu region, the effect of the granting of the AEC on the full cost of an energy unit was found to be non negligible (in absence of the AEC such cost was estimated at 73,19 Euros/MWh instead of 68,84 Euros/MWh). The

[335] A more detailed explanation of the methodology used to estimate the level of additional support and the full cost of an energy unit, as well as of the related limitations, is given in the market analysis, at § 10 (additional support) and 11.2 (full cost of an energy unit). See also annexes F and G of the market analysis.

[336] From now on, please refer to the market analysis § 11.2 for a detailed description of these technologies and of the methodology used to estimate the associated production costs.

[337] In this footnote a synthetic description of the **methodology** for the estimate of the additional support is given. In the case of feed-in tariff schemes (FI), the additional support corresponds to the tariff itself. In case of tradable green certificate schemes (TGC) the revenue earned by the seller is given by the market price of electricity plus the market price of the TGC. The support level in figures 1 and 2 includes both the sources of revenue. As to the other instruments, support level includes the electricity price plus premium for RES-electricity in the case of a premium feed-in tariff scheme (PFI), and estimates the total revenue in case of tendering procedures (TEN). Differences regarding the duration of the support schemes were harmonised by establishing a 15-year duration for support schemes and converting actual durations by using a 6.6% interest rate. The use of such harmonisation procedure constitutes a **limitation** of the analysis, but was also unavoidable for the carrying out of a comparison among schemes of different duration.

granting of the AEC alone was however very far from making such activity competitive with the generation of electricity from fossil fuels (the full cost of an energy unit from pulverised coal was estimated at 45,07 Euros/MWh).

Table 22.2 below reports the results of a comparison[338] between the importance of the support granted through the AEC and that of additional support granted at Member State level in the case of electricity generation, assuming the full cost of an energy unit as a reference term.

Figure 22.1 - Estimated full costs vs support levels and wholesale price for electricity – generation of electricity from solid biomass.

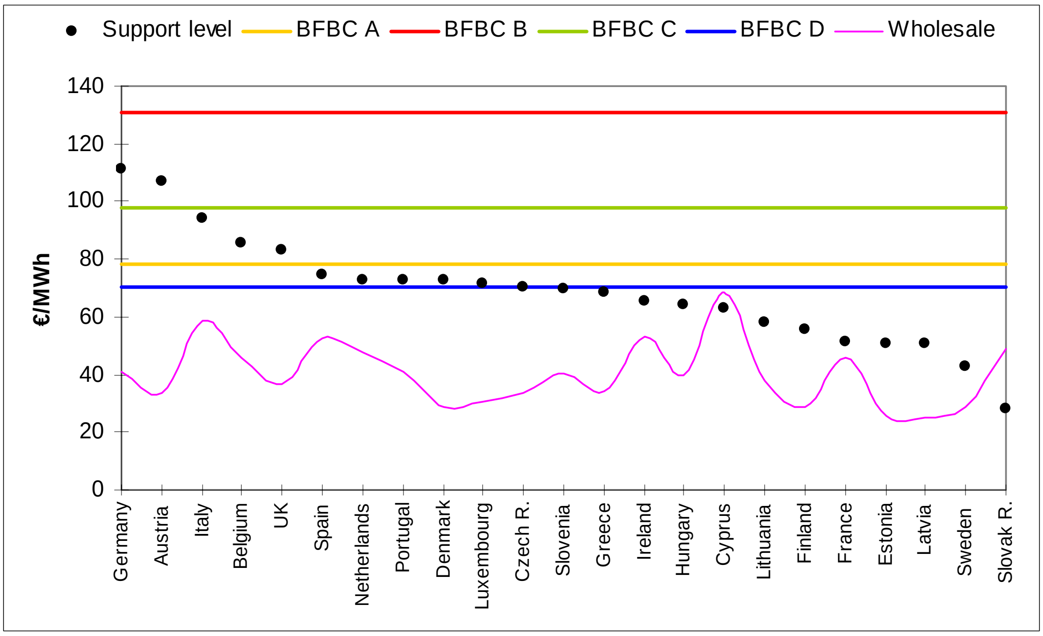
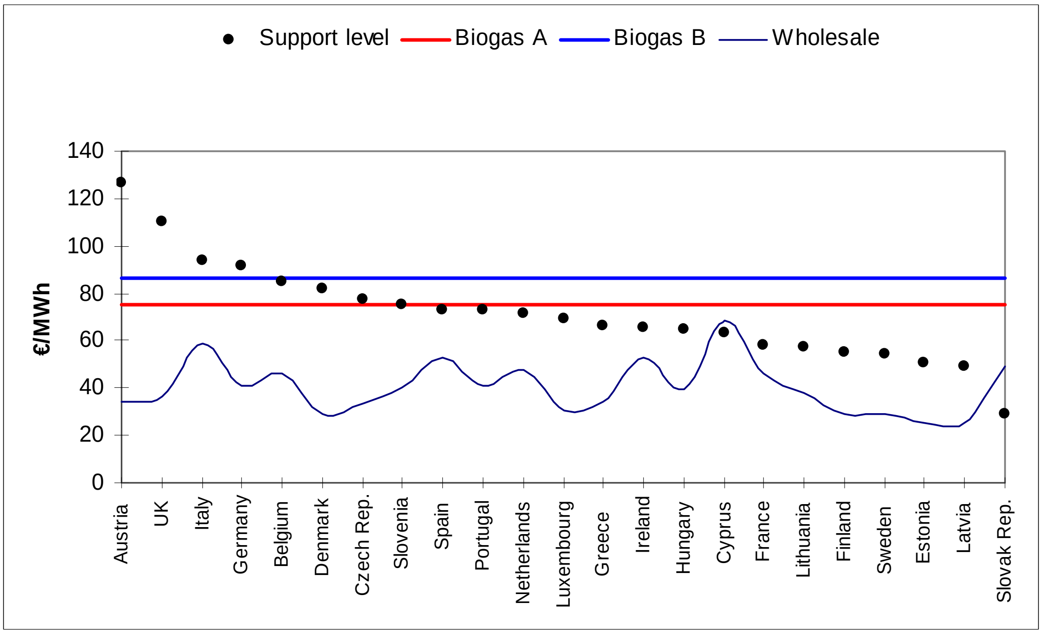


Figure 22.2 - Estimated full costs vs support levels and wholesale price for electricity – generation of electricity from bio-gas.



338 The comparison is carried out for three representative situations referred to electricity generation through direct combustion of reed canary grass, in three Member States among the most suited to the cultivation of such energy crop – Finland, Denmark, Sweden – featuring different levels of support for electricity produced from biomass.

Table 22.2 – Electricity generation from direct burning of biomass: AEC support versus additional support at national level

Technology / Member State	1) Biomass needed per MWh (T)	2) Average energy crop yield (T / ha)	3) = 2 / 1 = MWh / ha	4) AEC (Euros / ha)	5) = 4 / 3 = AEC (Euros / MWh)	6) Wholesale electricity price (Euros / MWH)	7) Supported electricity price (Euros / MWh)	8) = 7 - 6 = Additional support at national level (Euros / MWh)	9) Full cost of an energy unit (Euros / MWh)	10) = 5 / 9 (%) = AEC support vs full cost of an energy unit	11) = 8 / 9 (%) = Additional support at national level vs full cost of an energy unit
Bubbling Fluidised Bed Combustor plant; reed canary grass (price = 31,9 €/T) / Finland	0,2	9,0	45,0	45,00	1,00	28,87	55,71	26,84	70,12	1,4%	38,3%
Bubbling Fluidised Bed Combustor plant; reed canary grass (price = 31,9 €/T) / Denmark	0,2	9,0	45,0	45,00	1,00	28,87	72,86	43,99	70,12	1,4%	62,7%
Bubbling Fluidised Bed Combustor plant; reed canary grass (price = 31,9 €/T) / Sweden	0,2	9,0	45,0	45,00	1,00	28,87	42,86	13,99	70,12	1,4%	19,9%

Source: DEIAGRA elaboration on data from:
1) Interviewed experts; 2) Eubia website; 6) NordPool (electricity exchange); 7) COM (2005) 627 final; 9) DEIAGRA estimate (see § 11.2.1)

From the above figures, it can be seen that the order of magnitude of the support granted through the AEC (second last column) is markedly lower than that of the additional support granted at Member State level (last column): in the representative cases studied for electricity generation from direct burning of biomass, the AEC corresponds indeed to around 1% of the full cost of an energy unit, whereas the additional non-CAP support corresponds to 20-63% of the full cost of an energy unit.

If a hypothetical situation is considered, featuring:

- the absence of the AEC, and hence – in theory at least – higher full unit costs of an energy unit for biomass-based technologies;
- the presence of the sole additional support (which acts on the revenues of bio-energy producers, not on production costs);

a loss of profitability for biomass-based electricity producers, and hence a loss of competitiveness versus fossil fuel-based electricity, can be hypothesised.

However, as the support granted by the AEC corresponds to a very small fraction of the full cost of an energy unit (see Table 22.2), a theoretically decisive or relevant role of such support for the profitability and competitiveness of biomass-based electricity - also in presence of additional support at Member State level - can be hypothesised only where the supported price of biomass-based electricity is very close to its unit full cost[339], and hence only in few specific situations (see Figure 22.1 and Figure 22.2).

In the case of generation of electricity from solid biomass, it is evident that in no Member State the wholesale electricity price is able to cover the full production costs, irrespective of the technology used. The same can be said for the case of generation of electricity from bio-gas. Consequently, **in no Member State the bio-energy supply chains centred on these specific activities would be able to survive without the support granted through policies at Member State level and/or non-CAP support measures at EU level**, as the full cost of an energy unit cannot be covered by the wholesale electricity price alone[340].

22.3.2 Heating

The technologies for the generation of heat from biomass that were considered in the analysis are reported in Table 22.3 below.

[339] This could be the case of burning reed canary grass in a BFBC plant in Luxembourg, or of a maize-fed biogas plant – in the case of maximum maize price – in Belgium (see Figure 22.1 and Figure 22.2).

[340] Indeed for a good half of the Member States even the supported prices are unable to cover the full cost of an energy unit obtained from reed canary grass with a BFBC plant. The generation of electricity from miscanthus with a BFBC plant is profitable at the supported prices in Germany and Austria only. Also the generation of electricity from bio-gas obtained from silage maize is profitable at the supported prices only in some Member States, especially when the price of silage maize is high.

Table 22.3 – Relevant technologies for the generation of heat

Code	Description
Boiler B	Boiler; maximum straw price (120 €/t)
Boiler D	Boiler; reed canary grass (31.9 €/t)
Gas. B	Gasifier plant; maximum straw price (120 €/t)
Gas. D	Gasifier plant; reed canary grass (31.9 €/t)

The analysis was carried out at Member State level through a comparison of the full costs estimated for these technologies in the market analysis with:

- the cost of an heat unit generated from natural gas;
- the cost of an heat unit generated from diesel oil.

The results of the comparison are reported in Figure 22.3 and Figure 22.4 below.

It is important to note, however, that **no national support schemes for the generation of heat from biomass have been identified.** With respect to the contribution to the profitability of the activities under study granted by the **DAMs** through their effects on the price of biomass, it is important to remind that in both the cases studied in the EQ 2 – generation of heat from reed canary grass in the Oulu region, through a boiler or a gasifier plant – the granting of the AEC caused only a rather limited shift in the full cost of an energy unit (from 36,25 Euros/MWh to 34,71 Euros/MWh with the use of a boiler; from 61,26 Euros/MWh to 59,63 Euros/MWh with the use of a gasifier plant).

Figure 22.3 - Estimated full costs of the relevant technologies vs. heat generation from natural gas.

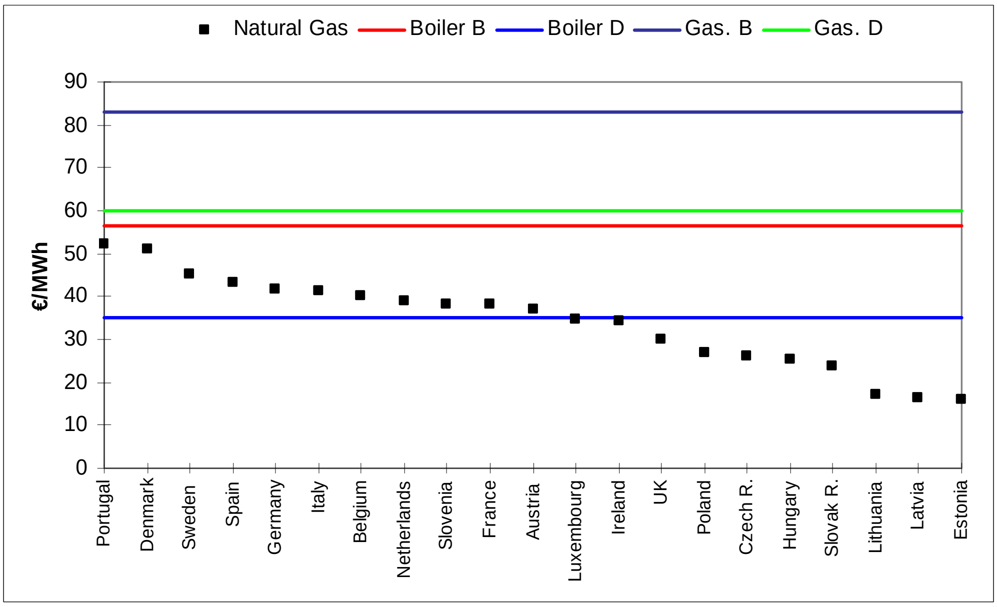
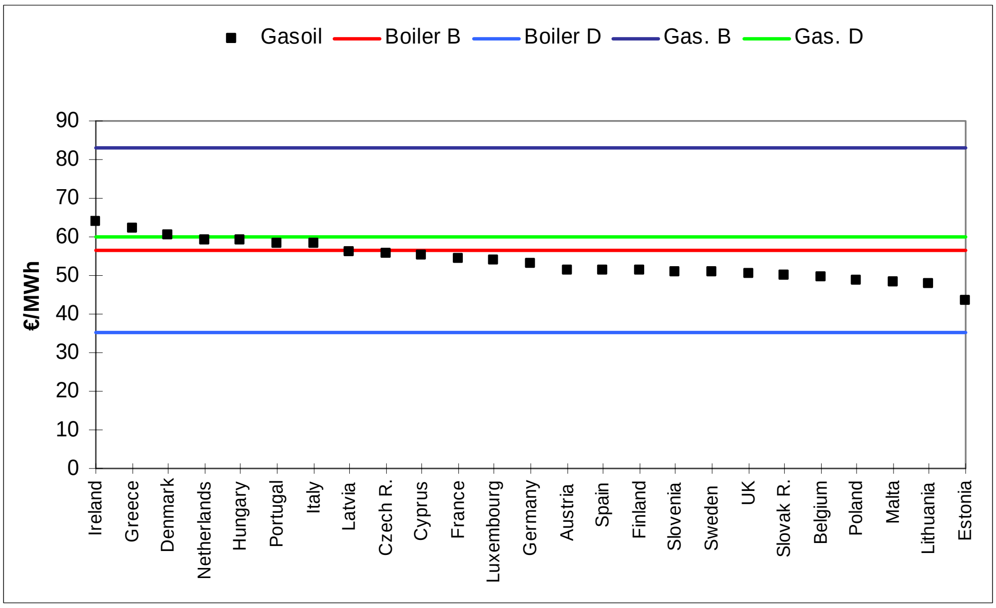


Figure 22.4 - Estimated full costs of the relevant technologies vs. heat generation from diesel oil.



From the above figures it can be seen that:

- Heat generation from biomass is not competitive in terms of costs of production with heat generation from natural gas, with the exception of direct combustion of reed canary grass in a boiler and for a price of reed canary grass of 31,9 Euros/t.
- In some Member States, due to high price levels for diesel oil, the generation of heat from biomass through direct combustion of straw in a boiler ("boiler B") and – albeit to a lesser extent - through the gasification of reed canary grass ("gas D") appears to be competitive with heat generation from diesel oil. The generation of heat through direct combustion of reed canary grass (at a price of 31,9 Euros/t) in a boiler ("boiler D") is instead competitive with heat generation from diesel oil in all Member States.

In conclusion:

- Heat generation from the analysed biomass can be competitive in terms of costs of production with heat generation from natural gas only in the case of direct combustion of reed canary grass in a boiler. However, it has to be taken into account that the cultivation of reed canary grass cannot be deemed technically feasible and economically profitable in all agronomical conditions.
- In the case of heat generation from diesel oil, the present high levels of the price of diesel oil make a greater number of available technologies competitive, in particular those based on boilers fed with straw or reed canary grass and the one based on gasifier plants fed with reed canary grass (as concerns the cultivation of reed canary grass, however, the above considerations apply).
- It is important to note, however, that no national support schemes for the generation of heat from biomass were found.

22.3.3 Transport

The technologies for the production of bio-diesel that were considered in the analysis are reported in Table 22.4 below.

Table 22.4 – Relevant technologies for the production of bio-diesel

Code	Description
EU Rapeseed A	EU - Bio-diesel from rapeseed - price 195 €/t
EU Rapeseed B	EU - Bio-diesel from rapeseed - price 230 €/t
EU Sunflower A	EU - Bio-diesel from sunflower - price 160 €/t
EU Sunflower B	EU - Bio-diesel from sunflower - price 257 €/t

Table 22.5 below reports instead the technologies for the production of bio-ethanol that were considered in the analysis.

Table 22.5 – Relevant technologies for the production of bio-ethanol

Code	Description
EU Sugar beet A	EU - Bio-ethanol from sugar beet - price 11 €/t
EU Sugar beet B	EU - Bio-ethanol from sugar beet - price 26 €/t
EU Wheat A	EU - Bio-ethanol from wheat - price 95 €/t
EU Wheat B	EU - Bio-ethanol from wheat - price 111 €/t
EU Barley	EU - Bio-ethanol from barley - price 104€/t
EU Straw	EU - Bio-ethanol from straw - price 204 €/1000 l bio-ethanol

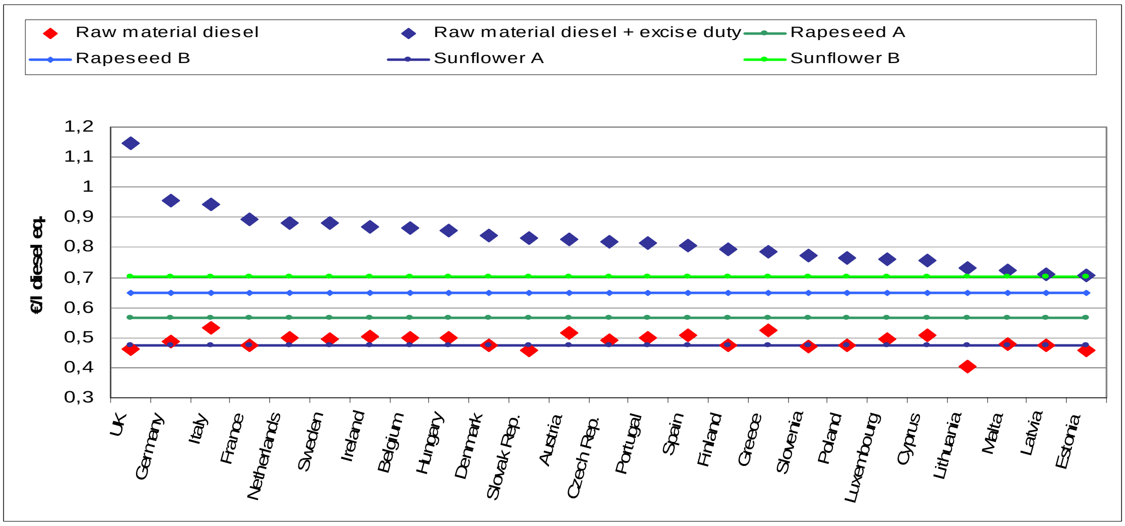
With respect to the contribution to the profitability of the activities under study granted by the **DAMs** through their effects on the price of biomass, it is important to remind that, among the six cases (three for bio-diesel, three for bio-ethanol) studied in the EQ 2:

- as regards bio-diesel, the granting of the AEC caused a relevant shift in the unit full cost of production only when it was obtained from sunflower grown in the Castilla y Leon region, for a sunflower price of 160 Euros/t (the unit full cost shifted from 0,582 to 0,474 Euros per litre of diesel equivalent);
- As regards bio-ethanol, the support granted by the AEC caused a relevant shift in the unit full cost of production in two cases, concerning bio-ethanol production from barley or wheat grown in the Castilla y Leon region (when barley was used as feedstock, the unit full cost shifted from 0,762 to 0,679 Euros per litre of petrol equivalent; when wheat was used, the shift was from 0,690 to 0,626 Euros per litre of petrol equivalent).

Coming to the contribution of the **additional support**, Figure 22.5 below shows that the bio-diesel is less competitive than conventional diesel oil in terms of "pure" full cost of production (i.e. with a tax regime not differentiating bio-diesel from conventional diesel oil): bio-diesel production from sunflower represents the only exception, albeit for a sunflower price of 160 Euros/t, which is indeed rather low.

It is therefore only the level of excise duties applied to conventional diesel oil that can reduce or even reverse this disadvantage for bio-diesel (provided that it is granted an exemption from such excise duties).

Figure 22.5 - Estimated full costs of the relevant technologies for bio-diesel production vs. cost of conventional diesel oil (with and without excise duties).



As far as bio-ethanol is concerned, Figure 22.6 below shows that the bio-ethanol is less competitive than petrol in terms of "pure" full cost of production (i.e. with a tax regime not differentiating bio-ethanol from petrol): bio-ethanol production from sugar beet constitutes a partial exception to this, but only for a sugar beet price of 11 Euros/t with 16% sucrose content, which is probably too low to be appealing for a relevant share of EU sugar beet producers.

Again, it is the level of excise duties applied to petrol that can reduce or even reverse this disadvantage for bio-ethanol (provided that it is granted an exemption from such excise duties). Moreover, it has to be noted that in the EU until now bio-ethanol is not used pure in automotive engines, but only as an additive (ETBE) to petrol, produced in oil refineries.

Figure 22.6 - Estimated full costs of the relevant technologies for bio-ethanol production vs. cost of conventional petrol (with and without excise duties).

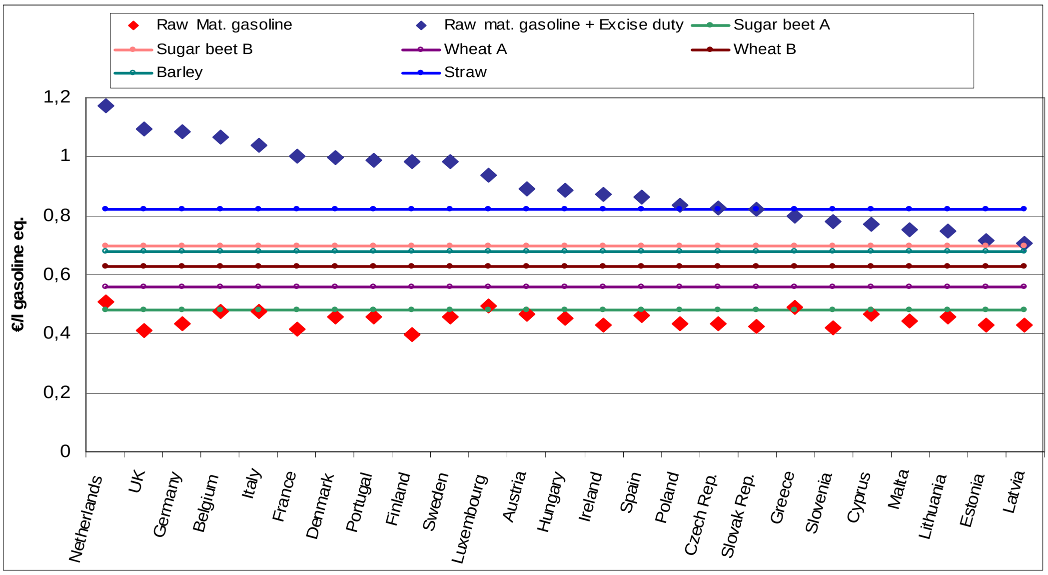


Table 22.6 and Table 22.7 below report the results of a comparison[341] between the importance of the support granted through the AEC and that of additional support granted at Member State level in the case of, respectively, bio-diesel and bio-ethanol production, assuming the full cost of an unit of such bio-fuels as a reference term.

Table 22.6 – Bio-diesel: AEC support versus additional support at national level

Technology / Member State	1) Average energy crop yield (litres bio-diesel / ha)	2) Conversion factor to diesel equivalent	3) = 1 / 2 = Litres diesel equivalent / ha	4) AEC (Euros / ha)	5) = 4 / 3 = AEC (Euros / litre diesel equivalent)	6) Additional support at national level - excise duty exemption (Euros / litre diesel equivalent)	7) Full cost of an energy unit (Euros / litre diesel equivalent)	8) = 5 / 7 (%) = AEC support vs full cost of an energy unit	9) = 6 / 7 (%) = Additional support at national level vs full cost of an energy unit
Bio-diesel from rapeseed (price 195 €/T) / Germany	1.327	1,088	1.220	45,00	0,037	0,470	0,565	6,5%	83,3%
Bio-diesel from rapeseed (price 195 €/T) / France	1.343	1,088	1.234	45,00	0,036	0,417	0,565	6,5%	73,9%
Bio-diesel from rapeseed (price 230 €/T) / Germany	1.327	1,088	1.220	45,00	0,037	0,470	0,649	5,7%	72,4%
Bio-diesel from rapeseed (price 230 €/T) / France	1.343	1,088	1.234	45,00	0,036	0,417	0,649	5,6%	64,2%

Source: DEIAGRA elaboration on data from:
1) Eubia website; 2) IPTS; 6) DEIAGRA estimate on Eurostat data; 7) DEIAGRA estimate (see § 11.2.3)

Table 22.7 – Bio-ethanol: AEC support versus additional support at national level

Technology / Member State	1) Average energy crop yield (litres bio-ethanol / ha)	2) Conversion factor to petrol equivalent	3) = 1 / 2 = Litres petrol equivalent / ha	4) AEC (Euros / ha)	5) = 4 / 3 = AEC (Euros / litre petrol equivalent)	6) Additional support at national level - excise duty exemption (Euros / litre petrol equivalent)	7) Full cost of an energy unit (Euros / litre petrol equivalent)	8) = 5 / 7 (%) = AEC support vs full cost of an energy unit	9) = 6 / 7 (%) = Additional support at national level vs full cost of an energy unit
Bio-ethanol from wheat (price 95 €/T) / France	2.554	1,472	1.735	45,00	0,026	0,589	0,559	4,6%	105,4%
Bio-ethanol from wheat (price 111 €/T) / France	2.554	1,472	1.735	45,00	0,026	0,589	0,626	4,1%	94,1%

Source: DEIAGRA elaboration on data from:1) Eubia website; 2) IPTS; 6) DEIAGRA estimate on Eurostat data; 7) DEIAGRA estimate (see § 11.2.3)

[341] The comparison is carried out in two of the most important bio-fuel producers in the EU, i.e. Germany and France, for six representative situations (four for bio-diesel production from rapeseed and two for bio-ethanol production from wheat) featuring different biomass price levels (maximum and minimum) and different levels of additional support at Member State level.

From the above figures, it can be seen that the order of magnitude of the support granted through the AEC (second last column) is markedly lower than that of the additional support granted at Member State level (last column): in the representative cases studied, the AEC represents indeed between 4% and 6,5% of the full cost of an energy unit whereas the additional non CAP support represents between 60% and 105% of the full cost of an energy unit.

If a hypothetical situation is considered, featuring:

- the absence of the AEC, and hence – in theory at least – higher full unit costs of bio-diesel or bio-ethanol;
- the presence of the sole additional support (which is useful to consider here in terms of prices for conventional diesel and petrol set at levels higher – and hence less competitive - than those allowed by their production costs, because of the imposition of excise duties which have to be passed on to the final consumer);

a loss of competitiveness can be hypothesised for bio-diesel and bio-ethanol versus conventional diesel and petrol.

However, as the support granted by the AEC corresponds to a small fraction of the full cost of an energy unit (see Table 22.6 and 22.7), a theoretically decisive or relevant role of such support for the profitability and competitiveness of bio-fuels - also in presence of additional support at Member State level - can be hypothesised only where (see Figure 22.5 and Figure 22.6) their unit full cost is very close to the price – excise duty included - of conventional fuels. Such a situation was found however only for bio-diesel from sunflower (maximum price) in Latvia and Estonia, and for bio-ethanol from sugar beet (higher price) in the same Member States. As both Latvia and Estonia – applying SAPS - could not benefit from the AEC over the evaluation period (and also because sugar beet was not eligible for the AEC until the reform of the sugar CMO in 2006), it can be deemed that the hypothetical situation described above has never occurred in practice over the evaluation period, and hence it is plausible that the AEC has never played a decisive or relevant role from this standpoint *until now*.

In conclusion, without the support at Member State level, typically granted by a tax regime which exempts bio-fuels (bio-diesel and bio-ethanol) from excise duties, in general **bio-fuels could not be competitive in terms of cost of production with conventional fuels** (diesel oil and petrol). The only exceptions to this are represented by bio-diesel production from sunflower (but only when sunflower price is 160 Euros/t) and by bio-ethanol production from sugar beet (but only for a sugar beet price of 11 Euros/t, probably too low to be appealing for most EU farmers).

22.4 Judgment

In the light of the above evidence, it can be judged that **it is at present impossible, with the available technologies and with the present levels of biomass prices, that most of the bio-energy supply chains under study may survive without additional support at Member State level and/or non-CAP support at EU level**. Such technologies are indeed generally still unable to compete with conventional technologies based on the use of fossil fuels in terms of costs of production.

It is also to remind that in the EQ 2 it was judged that neither the AEC nor the NFSA regime have contributed significantly to achieve a price level for crops cultivated for energy use allowing these crops and sources of bio-energy gained from these crops to be competitive to other energy sources.

It is also worth noting that the order of magnitude of the support granted through the AEC[342] is markedly lower than that of the additional support granted at Member State level, both in the case of electricity generation from biomass (1,4% of the full cost of an energy unit versus 19-62%) and in the case of bio-fuels production (4-6,5% of the full cost of an energy unit versus 64-105%).

The support granted by the aid for energy crops corresponds to a very small fraction of the full cost of an energy unit; moreover, it is plausible to deem that it was decisive for the profitability and competitiveness of bio-energy ***only*** in very few specific situations - in comparison with an hypothetical situation featuring the sole additional support at Member State level – (the supported price of biomass-based electricity has been very close to its unit full cost only in few cases; the unit full cost of bio-fuels has never been very close to the price – excise duty included - of conventional fuels over the evaluation period).

A partial exception to the above judgments has to be made:

[342] An analogous indicator cannot be calculated for the support granted by the NFSA regime because – differently from the AEC – it is not an explicit monetary amount, but an "implicit subsidy" with reference to alternative uses of set aside land.

- for certain technologies for the generation of heat from biomass (based especially on the use of reed canary grass or straw as feedstock), which appear to be competitive even without the support from national schemes;
- for the production of bio-diesel and bio-ethanol from specific raw materials (sunflower and sugar beet), provided however that the price paid for them remains quite low (160 Euros/ton and 11 Euros/ton, respectively).

It is however unclear if these very peculiar technologies can be applied on a large scale in the EU, both for agronomical and technical issues concerning the cultivation of the crops used to provide the needed biomass (this is especially the case of reed canary grass) and for profitability issues (this is especially the case of sugar beet).

23 EVALUATION QUESTION 10

"To what extent have conditions observed at Member State level, such as availability of processing facilities, costs, industries, general attitude toward renewable energy sources, the demand situation in Member States, facilitated/hindered the production of crops for energy uses and respectively the promotion of bio-energy?"

The relevant issues to tackle in the framework of EQ 10 are the following:

1) to identify all the elements characterising "conditions observed at Member States level" that are to be deemed relevant in the context of the EQ;
2) to assess whether and to what extent the action of the elements at point 1) above - which we will call "system factors" - (cause) has facilitated or hindered the production of crops for energy use and/or the promotion of bio-energy (effect).

The methodology for answering the question is based on the system approach, whose rationale is explained below at § 23.1. Being the methodology factor-specific, it will be synthetically presented in the paragraphs dealing with each specific category of factors.

23.1 The rationale behind the system approach

The production of crops for energy use and the supply of bio-energy are likely to be influenced by several factors. Those arising from the implementation of the CAP measures which are relevant for the study have been treated in the former evaluation questions. In this respect, such measures can be seen as *endogenous* factors[343].

Other factors and conditions stem:

- from technical and intrinsic aspects of the production processes;
- from the structure of the "environment" where the measures exert their influence.

We will refer to these factors as *exogenous* factors, which can play in different ways and at different levels, according to their nature. The analysis of these factors indeed requires a system vision of the problem.

Keeping in mind the general plot of the Bio-Energy Supply Chain, the main exogenous factors can be individuated in the following: social and cultural environment; institutional and policy framework; economic factors; technical factors; organisation of the BESC. In the next paragraphs we will briefly describe the nature of the exogenous factors and the way in which they can influence the production of crops for energy uses and of bio-energy; then we will apply this rationale to the results coming from the case studies.

We will refer to the production of crops for energy use and the production of bio-energy as innovations (from now on, *bio-energy innovation*). We will look at those activities in terms of accessibility by the economic actors, taking into account the nature of the barriers that hinder the access to the sector or to specific activities from the standpoint of a potential incomer (farmer/processor/user).

23.2 Exogenous factors

In the next paragraphs we will recall and describe the main exogenous factors and their role as potential critical factors for the development of the BESCs under study. Then, on the basis of this conceptual background, we will comment the result of case studies and provide evidence from them. Tables included in Box 21.1 show the relevant results coming from case studies. For each case study, the limiting and success factors are outlined synthetically.

23.2.1 Social and cultural environment

The **demand of bio-energy** is a primary economic factor exerting a backwards influence on the development of the BESCs. Demand is basically influenced by **economic** constraints, but is also determined by the willingness to accept the technical, social and environmental pros and cons of the bio-energy innovation (e.g. consumer habits in using new kinds of fuels or new heating facilities, acceptance of plants

[343]Factors specifically concerning the measure (*measure specific factors*), which are related to the characteristics of the measures themselves, to the way in which they are implemented, to the factual mechanisms they induce at farm level in order to orientate the farmers' decisions.

installed in the neighbourhood and of the environmental consequences at local level, etc.) and, eventually, to pay for them.

Social and cultural factors also affect producers. Farmers in particular may be asked to accept more or less important innovations regarding the organisation of the farm. Farmers might better accept the innovation if they are sensitive to the new role they are "assigned" by the society as producers of RES.

Case studies show that social acceptance of bio-energy is generally diffused. Farmers complain for technical and economic constraints connected to the production of biomass, but in general consider energy crops as an opportunity to differentiate farm business, given some basic conditions that are mainly of economic nature. In most cases, local communities seem to be aware of the social and environmental benefits stemming from bio-energy plants at local level, and hence accept their presence (Haute Normandie). In Finland, where the energy market is free, companies delivering electricity can even compete on the market with "bio-energy branded" products, to capture the attention of the consumer.

Nevertheless, problems arise at local level concerning the real willingness to pay (not only in currency but in terms of social and individual difficulties to be faced) for bio-energy. The Nieder-Sachsen case study reports on the adverse position of local communities about the installation of bio-gas plants close to towns, which seems mainly due to lack of information about the real consequences and opportunities. The same case study reports that the wider public is willing to switch to bio-diesel as long as it is about 0,10 Euros cheaper than conventional diesel (the expected spread raises to 0,25-0,30 Euros for haulage companies and farmers). In Spain, in spite of a general acceptance of the overall benefits related to the use of RES, the demand for bio-fuels is poor and this is considered a factor hindering the development of the sector, which combines with infrastructural problems (i.e. the lack of adaptation of the motor industry to the technical requirements of the bio-fuels). It is also interesting to note that in France the supermarket chains (controlling a 9 to 14% market share of automotive fuels) do not always advertise about the inclusion of bio-components in their fuels.

23.2.2 Institutional and policy framework

Besides the EU regulations, individual Member States generally have national and regional regulations concerning the use and the promotion of RES. Such regulations operate at different levels of the BESC by using different tools[344].

Given the production cost of energy produced respectively from fossil sources and from RES[345], economic and financial incentives are considered a crucial factor for the development of the sector. Inasmuch social awareness of the energy problems (mainly supply and environmental problems) is also a relevant factor, non-monetary tools like **information** and **formation** can be effective, at both demand and supply level.

The institutional environment includes all the institutions which directly or indirectly contribute - through **assistance, research, planning**, etc. - to reach the goals set by the RES policy. The existence and the functioning of these institutions, both public and private, is a relevant system factor which helps the development of the BESC.[346]

The adoption of bio-energy innovation may require investments, whose implementation is linked to side problems that are administered at local level, like **environmental impact of the plants, safety regulations, administrative permits**, etc. Within the institutional and regulatory environment, administrative procedures and requirements seem to play a special role in the actual implementation of the RES policies, acting (or being perceived) in some cases as intangible barriers to the actual access to bio-energy innovation.

Almost all case studies have highlighted the lack of competitiveness of the BESCs in comparison with the supply chain based on fossil fuel. The role of public incentives for the development of the BESCs is thus considered fundamental. The public action mainly concerns the market of bio-energy sources and bio-energy, but also involves the investments in the energy sector. Besides the direct action on market and investments (i.e. by way of pricing and financial aids), public initiatives actually intervene in other ways that appear to be decisive, namely:

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[344] - See § 5 and 6 and Annexe B, in particular for the review of national regulations and for the description of the measures in use; EQ 9 for the economic analysis of the additional support at Member State level and for the related judgment.

[345] - See § 10 and 11.2.

[346] The institutional environment also includes institutions having a role in the organisation of the BESC. This aspect is treated separately in a paragraph dedicated to the *BESC organisation*.

- Determining reliable expectations among the actors about the political plans for the sector. In this respect, **establishing clear targets on a long a term perspective** may contribute to mitigate the perception of the risk that the operators associate to the investment in the sector.
- Promoting **research** on the critical aspects of the BESCs and spreading its results, providing **assistance to the investors**.
- Promoting or assuming direct responsibility in the **coordination** of the BESCs.

Nieder-Sachsen region has experienced a long run increase in the number of bio-gas plants that has strongly accelerated in coincidence with the start of the Act on Market Incentives in Favour of Renewable Energies (*MAP*) and with the RES Act (*EEG*). Conversely, temporarily less favourable conditions have slowed the growth pace of the sector. The positive impact of public incentives is also reported in France - where policy (and institutional) framework (featuring ambitious targets for bio-energy, long term agreement among supply chain actors, involvement of social and economic parties, including motor industries and oil companies) contributes avoiding uncertainty about the development of the sector. Eastern England in the United Kingdom, Karnten in Austria and Oulu Region in Finland have had similar experiences. Conflicting regulatory frameworks (like in the case of Spain) are reported as important co-factors in limiting the final demand of bio-fuels, even within a favourable institutional framework.

As regards the administrative factors, case studies do not provide evidence in general of problems regarding the implementation of AEC schemes or of rural development measures concerning bio-energy activities[347]. On the contrary, some problems seem likely to arise from the institutional context where these activities take place. In Nieder-Sachsen, for instance, the installation of plants for the processing of biomass needs to comply with a relevant number of laws and regulations concerning general safety requirements for buildings, environmental conservation, as well as the production of energy itself[348]. As a consequence, investments in bio-energy innovation start a number of activities which are submitted to many controls – especially in well developed administrative systems. In some cases, the complexity of laws and controls may hinder the development of specific activities, even if financially supported.

23.2.3 Economic factors

Economic factors fall into several different categories. As stated before, bio-energy innovation requires more or less substantial innovation at farm and industrial level, whose implementation is mainly determined by the attractiveness of the sector, measured by the profit or margin expectations. The attractiveness of the sector depends in turn on other factors (technical, economic, institutional). Some of them have been briefly treated above (institutional factors); some others will be treated in the next paragraphs (technical factors and BESC organisation). Among the specifically economic factors, some should be considered in particular, namely:

- the **cost and the accessibility of the bio-energy innovation**;
- the **market of bio-energy**.

At farm level, producing biomass for energy uses is a costly process, as it requires investments, technical and organisational adaptation of the farm, and relationships with new actors (which may imply transaction costs). The same considerations are valid at industrial level, for the production of bio-energy sources or of bio-energy.

RES policies concur in determining the attractiveness of the bio-energy sector influencing, among others, the basic economic conditions: cost reduction for the actors of the BESC (access to capital), market price (i.e. tax exemption and/or price fixing), time perspective and duration of the support programs.

Besides the policy framework, market factors also play a primary role. Biomass for energy uses lacks sometimes of *technical specificity*: the same crop may have in fact different destinations (i.e. food, feed or non food); in other cases feedstocks are by-products of main processes carried out at farm level (like in the cases of manure, chicken litter, straw, etc.). With respect to the transformation processes, the different types of biomass show a certain degree of *substitution* as feedstocks. Finally, energy crops (like any other process) normally compete for land on the farm with other processes (*techno-economic competition*). The market of biomass is thus often **linked to the market of other products** (i.e. leading products,

[347] Only in the Nieder-Sachsen region the administrative obligations related to the cultivation of energy crops under the NFSA regime were found to play as a limiting factor for some farmers.
[348] Specifically, they concern: building construction and combustion systems, plant emissions, environmental effects, waste treatment and recycling, production and use of fertilizers, operation of steam boilers, energy laws and schemes, etc.

substitutes, the same product in alternative end uses[349]). Furthermore, in the long run, bio-energy is also linked to the **price of traditional energy sources** (fossil fuels). These situations may translate into price and/or supply volatility, and into a general uncertainty for the bio-energy sector.

Case studies report some interesting examples on the matter.

The Nieder-Sachsen case reports that price for rapeseed oil and bio-diesel is strongly influenced by the price of related commodities (soybeans, palm oil) on the international market. These prices are used as reference in the cultivation contracts between farmers and processors in the BESC. In the same region, some examples are reported concerning the effectiveness of techno-economic competition among crops (wheat vs. rapeseed, fodder vs. energy crop), and end-use flexibility (the price of rapeseed for energy uses follows the trend of the price of oleomargarine). Economic competition problems, making energy crop price and supply volatile, are also witnessed in Castilla-Leon region.

The case of Eastern England is an example of lack of technical specificity, as far as the region (and the United Kingdom in general) has mainly based the development of the BESC on the optimization of technical complementarity (straw and chicken litter are largely used as feedstock in power plants). In Oulu Region (Finland), reed canary grass is used together with peat in power plants. The price of canary grass largely depends on the price of peat.

It seems interesting to note that the above mentioned characteristics of the biomass market have not necessarily hampered the development of the BESCs in the long run, inasmuch the opportunities offered by techno-economic flexibility and complementarity constitute a success factor. Problems are however likely to rise in case of further development of the bio-energy sector.

23.2.4 Natural resources and technical factors

The **availability of adequate natural resources** determines the possibility to supply constant flows of biomass at economically affordable conditions for both the farmers and the industry.

Besides natural environment, some **technical factors** have an influence at the level of the farm and/or of the processing plants, and also at the level of the local supply system.

At the level of the farm and/or of the processing plants the following aspects can be considered as relevant:

- the **suitability of the energy crops to the environment** (local climate and soil), which influences their yields;
- the **technology and the organisation of the farms producing biomass**: available cultivation techniques, farm facilities, role of energy crops in the agronomic rotation, optimization of farm organisation, work load and work distribution;
- **efficiency of processing** technology.

As regards the local supply system, further aspects are to be considered:

- the **vicinity of plants** to biomass production areas (determining transportation costs);
- the **availability of structures and infra-structures**: machinery for cultivation/harvesting operations, logistic facilities, access to power network for individual producers;
- the **constant supply of biomass** for processing plants and **quality** problems;
- the relation between the **plant capacity** and the **land** feeding it (the *scale gap* between farms and processing plants).

These factors have some relevance in several cases. Farm organisation and optimization rise as primary problems at the basis of the BESC, inasmuch they may hinder the local supply of biomass, or limit the economic margin of the farmers. In the Castilla-Leon region the production of oilseeds seems unsuitable to the agronomic environment, leading to low yields and poor margins for the farmers and higher input costs for the processors. As the introduction of these crops is recent in this region, technology is not yet properly adapted to local conditions. This causes high production costs for these energy crops, and seems to be a primary obstacle for their development in the region. A similar problem - concerning the production of maize in mountainous areas (low content of dry matter due to the climate) - is reported in the Karnten region.

Cases are reported where the adoption of new energy crops is hindered by the lack of adequate machinery (for tillage, seeding, harvesting, etc.) on the farms, a problem that is generally overcome through the organisation of services operated by private firms or by agricultural co-operatives (machine-rings), generally

[349] Economic interactions also appear in the downstream phases of the BESCs, mainly through the by-products markets. In this case, the value-adding options through the selling of by-products influence the attractiveness of the bio-energy sectors and sub-sectors. For this aspect, see § 8.4.4.

widely diffused in all the Member States, but which sometimes constitute a bottleneck in the short-medium term (for example in Castilla-Leon region). When the supply chain shows a good level of coordination, this service is actually provided by the processors, even associated with other services (consulting, planning, etc.).

Farmer-owned plants processing biomass for energy uses (for example bio-gas plants) are in some cases not completely efficient, thus requiring further technological improvement to avoid structural bottlenecks for the development of the sector (Nieder-Sachsen, Karnten).

At regional level, some logistic problems at the interfaces between farms and processing plants, and between processing plants and bio-energy users appear, mainly linked to the transport of biomass and bio-energy, and to the access to the power distribution network. In Castilla-Leon region, structural and infrastructural problems seem to be relevant: the road network hardly fits the needs of biomass transportation; trucks, storage and distribution facilities are not adapted to bio-fuels; automotive companies do not provide guarantees in case of use of bio-fuels. Besides this, no local processing plants are working at present (but some are planned). In Eastern England no bio-diesel plants are working at present, and local rapeseed production is shipped to Germany. In France (Champagne-Ardenne) the future development of the promising bio-ethanol sector might be hindered by an inadequate railroad network.

23.2.5 BESC organisation

The organisation of the BESC can be defined as the way in which the actors operating within it establish economic or functional relationships with each other. The main actors operating within the BESC are farmers producing biomass, processors of biomass into bio-energy sources and bio-energy, distributors and operators of the power network. Two aspects mainly determine the organisation of the BESC: the **regulation of the economic transactions** (through contracts or simply through market mechanisms) and the **degree of coordination**[350] (vertical and horizontal) **among the levels of the BESC**.

Contracts concur to stabilize transactions (by limiting the risks for the actors which are associated to the marketing of products and to price and supply volatility), and to provide a reliable time perspective for the duration of the overall economic conditions. This aspect is relevant at different levels of the BESC and generally has a positive feedback on investments.

In a systemic perspective, supply chain coordination features remarkable advantages, as it is of great help in balancing the market power among actors, in co-ordinating and planning activities along the supply chain, in transmitting economic and political messages along it, in sharing economic risk and in facilitating the access to investments and innovation. Supply chain coordination is also a way to overcome the scale gap problem (see above) between farmers and processors. From an individual actor's perspective, however, a higher degree of coordination within the supply chain implies a limitation in his/her decisional freedom[351].

Case studies have highlighted that the features of the BESC organisation vary markedly among Member States, with some relevant effects on the performance of the whole system. The production of bio-ethanol in France (Champagne-Ardenne) functions on the basis of a strong coordination among all the levels of the supply chain. Such coordination takes different forms: farmers are horizontally integrated into farmers' co-operatives and, in this way, are also direct players at the industrial level, through the ownership of processing plants. Supply contracts are the means of vertical coordination between farmers' co-operatives and the producers of crude oil (like Total) which are responsible for the ETBE production. Suppliers of logistic services (transport firms) and end users (fleet owners, local authorities) are also involved. Besides this, the different actors are also involved in long term agreements or partnerships to develop common targets and projects. The case study from Haute Normandie has highlighted similar situations. A quite different situation is outlined for the Oulu Region in Finland. Vertical and horizontal coordination are virtually absent in this case, and the whole supply chain seems to be regulated mainly by market mechanisms, probably stemming from the competitive environment of the energy market.

Other case studies outline at varying degree the role and the importance of the BESC organisation. The case study on Tuscany shows lack of organisation among the actors of the BESC, which somehow concurs with

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[350] Under the term "coordination" we include a number of solutions which promote the adoption of coherent strategies and practices by a group of individual actors operating in a supply chain, in order to facilitate the achievement of common goals. Forms of horizontal coordination go from "soft" ones (e.g. the formation of producers' groups) to "hard" ones (e.g. the formation of co-operative firms); the same can be said for vertical coordination, going from "soft" forms (coordination by means of contracts and/or inter-industry agreements) to "hard" ones (backward of forward vertical integration through ownership).

[351] Such limitation increases with the transition from "soft" forms of coordination to "hard" ones.

other factors in the difficult development of the BESC itself[352]. In Nieder-Sachsen the role of horizontal integration (i.e. farmers' co-operatives) is reported as a crucial factor in overcoming some structural barriers to entry in the sector, namely the scale gap between agriculture and industry and financial problems linked to investments.

BESC organisation shows different degrees of complexity and efficiency[353]. The degree of complexity of the BESC organisation is not an absolute concept, however, as it should be put in relation with the industrial complexity and the dimension of the sector itself. Attention should be also paid to the regulation mechanisms at the basis of the supply chain, and to the competitive environment of the bio-energy market, as factors determining the type of BESC organisation.

Linked with the organisation of the BESC, on one side, and with the structure of the energy market, on the other side, are the conditions at which the producers of bio-energy can access the power network. Besides the existence of contracts, which are widely diffused (as reported in the case studies), some relevant situations can also be observed where power companies assume **larger market power in relation to the suppliers of bio-energy sources and/or biomass**. Some conditions lead to such an outcome. Among these: the technical substitutability of biomass (Finland); the weak bargaining power of the producers of bio-energy sources and of biomass (especially small producers and farmers) vis-à-vis large electric utility companies (Germany); the lack of regulation to entry the network (as concerns pricing, quality standardization, access sites, etc.).

[352] A similar situation was observed in Castilla-Leon (Spain), but in this region things are evolving rapidly.
[353] As regards *complexity*, case studies concerning France (featuring large scale industrial plants) witness for the need of a complex organisation, which also involves the participation of public authorities at national level, common planning and social awareness of the problems. Conversely, in regions where only local or regional plants – sometimes owned by farmers – are active, coordination forms might have different roles and relevance. As regards *efficiency*, it is worth noting that, generally speaking, national BESCs end in *administered markets*, as they are more or less strongly regulated by the *public actor*; Finland seems to be an exception, as end user market is quite competitive. BESC organisation varies very much among these cases, and there is the scope to question what is the relation between the supply chain organisation and the market in the context of the bio-energy sector.

Box 23.1 – Main findings from the case studies

Case study	Limiting factors	Success factors
Nieder-Sachsen, Germany Bio-gas from maize, energy grains, grass, liquid manure Bio-diesel from rapeseed, sunflower Direct burning of solid biomass (wood)	**Techno-economic problems**: crop rotation, competing agricultural processes, limited availability of long term rented land **Power networks** need upgrading **Administrative** bottlenecks **Imbalance in market power** of electric companies versus small producers (bio-gas) **Investments** are perceived as substantial and risky by farmers **Social acceptance**: social concern for bio-diversity and landscape, environmental problems of bio-gas plants. **Technology** needs to be developed	**Natural conditions**: specific and non specific processes **Vertical coordination:** agricultural co-operatives own plants and supply biomass; outsourcing of services (machine-rings) (bio-gas) **Long term contracts** at agricultural level (bio-gas) **Contracts for energy supply** (bio-gas) **Public action**: incentives for connecting power plants to the network; cost-based allowances; financial incentives for new technologies; tax exemption; regional and national support programs; consulting and information programs; public relations
Haute Normandie, France Bio-diesel	**Conflicting land uses** (food versus non food) if bio-diesel demand increases at the current rate.	**Strong vertical coordination**: long term agreements between farmers and processors; supply chain organisation and management; articulated institutional network (professional associations; public institutions; research, finance, consulting; public and private subjects involved) **Long term contracts** within the supply chain **Public action** (ambitious policy targets; fiscal measures; incentives to demand and production) **Value-adding for by-products** **Social acceptance** (for both economic and environmental objectives)

Champagne-Ardenne, France Bio-ethanol from sugar beet, converted in EBTE to be incorporated into petrol up to 15%.	**Conflicting interest of oil companies** concerning direct blending of ethanol vs. conversion into ETBE **Lack of infrastructures** (inadequate rail network) **Production cost of bio-ethanol**, not competitive with fossil fuels	**Strong vertical coordination**: farmers' co-operatives manage all phases of bio-ethanol production; also take care of technical assistance and logistics; articulated institutional network (professional associations; research); contract-based transactions. **Public action**: ambitious policy targets; fiscal measures; support to energy crops; incentives to demand and production **Social acceptance** is good in general

Castilla y Leon, Spain Bio-diesel, bio-ethanol	**Oilseed cultivation is recent** in the region and is not well suited to the climate; adequate cultivation technology is not always available. **Production costs** of energy crops are still high; more support is needed to make energy crops attractive **Biomass price and supply** are volatile **Lack of structures and infra-structures**: road, transportation means, link with distribution network; no processing plants working in the region (several planned); car engines not adapted to bio-fuels; car makers do not guarantee for bio-fuels **Supply chain organisation** is inadequate **Policy action** is not effective (insufficient time horizon) **Conflicting interest** of oil companies **Limited social demand** of bio-fuels, also due to limited information	**Effectiveness of CAP** measures as incentives to develop biomass production **Institutional framework** is articulated **Farm diversification** centred on energy crops is perceived as an opportunity **Vertical coordination** and **contracts** are at work (but not so diffused)

Tuscany, Italy Bio-diesel from sunflower	**Biomass supply** is limited (import substitution) **Farmers' acceptance** of new energy crops is critical **Attractiveness** of sunflower price for non food uses is low (CAP support is not sufficient) **Co-ordination** along the supply chain is lacking (*supply chain contracts* are next to come) **Long term contracts** are difficult to stipulate **Institutional action** and coordination are poor	**Policy action**: tax exemption for bio-fuels **Social acceptance** is good in general

Eastern England, United Kingdom Direct burning of biomass (forestry residues, straw, litter) Bio-diesel from rapeseed	**Uncertainty** about investments **Local plants** of bio-diesel are absent at present (rapeseed is exported to Germany) **Specialization in biomass** for specific energy uses is lacking (bio-energy is mainly based on complementary biomass) **Cultural barriers** about site selection **Investments** are perceived as substantial and risky	**Natural conditions** favour supply of biomass and of by products used as feedstocks (straw, chicken litter) **Long term contracts** **Institutional framework** is articulated and effective at different levels of the supply chain **Policy action:** incentives to investment for energy crops; de-taxation; many differentiated incentives for environmental purposes at regional level; disposal regulation favouring the use of biomass **Social acceptance** is good in general

Karnten, Austria Bio-gas from maize, manure	**Natural and structural conditions** are adverse in some cases (irregular plots, low yields in mountain areas) **On-farm plants** are often small and not very efficient	**Long term and flexible contracts** as concerns time, price fixing, transport **Policy action**: rules on production of electricity from biomass; pricing of energy from RES directly managed by the public authorities

Oulu, Finland Direct burning of biomass (reed canary grass, peat, others)	**Supply chain integration** (farmers do not own plants) **National incentives** for energy crops are inadequate **Transportation** cost from remote rural areas **Imbalance in market power** of energy companies versus farmers, due to the substitution among biomass types **Plant flexibility**: the functioning of plants is not based on energy crops (mainly on peat and wood)	**Institutional framework** is simple but efficient **Policy action**: tax advantage to plants for RES use; possibility to create quality brands for electricity from RES; ambitious targets for energy from RES; incentive for RES use in rural areas; free access to electricity network **Free energy market**, unregulated and competitive, consumers can choose between RES-based or traditional electricity **Social acceptance** is good in general

23.3 Conclusions

The previous evaluation questions – especially EQ 9 - showed that, with the available technologies and with the present levels of biomass prices, most of the bio-energy supply chains would not survive without non-CAP support granted at Member State and EU level. Besides this, case studies showed that also other factors may facilitate or hinder the production of bio-energy.

On the **supply side**, the relevant factors which result to be actual limiting/promoting ones are: (i) the availability of production structures and infrastructures; (ii) the organisation of the supply chain; (iii) the investments.

The **availability of production structures and infrastructures** appears to be a fundamental element for the development of bio-energy production. Besides the endowment of natural resources and the availability of processing plants, a number of other **technical factors** can facilitate or hinder the development of the bio-energy supply chains. From the case studies some emerge as particularly relevant: availability of technologies for the production of biomass at farm level; adequate infrastructure for the transportation and logistics of both biomass and bio-energy sources; access of individual suppliers (including farmers) to the distribution network. Some of these factors are not directly associated with production, but actually define the boundaries of the techno-economic system where the production is – or could be - located. Evidence from the case studies and the market analysis shows that the bio-energy supply chains can also develop on the basis of international trade of biomass or bio-energy sources, with absent (or limited) linkages with regional resources. However, if the development of the sector is also aimed at providing economic opportunities for the local systems, structural and infrastructural features at regional level (stability of biomass supply; location of the processing plants; transportation network; power distribution network) may emerge as important limiting factors.

The scale gap between agriculture and industry, the imbalance in the distribution of margins among actors, the lack of co-ordination in the use of the resources along the supply chain may also hinder the development of bio-energy production. These issues could be addressed through **adequate forms of horizontal and/or vertical coordination**, which would allow for: (i) a more efficient transmission of information from organisations to individuals, (ii) the formulation of rational long term expectations, (iii) the formulation of collective and individual development strategies. Given the social and economic relevance of the sector, public institutions should be leading actors in the coordination process. Case studies concerning France showed how the development of the sector can benefit from a coordinated organisation of the BESCs. It must nevertheless be underlined that BESCs which are mainly based on industrial large scale biomass processing could probably benefit more from horizontal and/or vertical coordination than BESCs where small scale processing activities at farm level are prevalent.

A very relevant issue stems from the fact that the development of the bio-energy supply chains requires substantial **investments** in farm adaptation, technology improvement at farm and industry level, research, structure and infrastructure adaptation. Case studies highlighted the role of the substantial investments needed as a limiting factor, and also provided evidence about the system factors hindering or facilitating such investments. Said factors are related to economic risks (uncertainty of the market, low attractiveness of the sector), administrative barriers, infrastructural bottlenecks (e.g. bio-energy distribution system), supply chain organisation (e.g. absence of long term contracts).

Finally, it must be underlined that **economic factors** (investments, market specificity, profitability at the different levels of the supply chain) are closely linked to the functioning of the **institutional framework**, and of the policies aimed at supporting the production and use of renewable energy sources. Such policies provide indeed direct means (e.g. pricing regulation) and context conditions (e.g. credibility in the implementation of the RES social project over the long period) very likely to influence and even determine the attractiveness of the bio-energy sector.

24 EVALUATION QUESTION 11

"What is the global contribution of the measures to reduced CO_2 emissions and the saving of fossil fuels? Consider the whole production chain, including by-products and the energy efficiency according to crop as regards transport, heating and electricity use. Answer the question according to the criteria defined to in the market analysis and outlook".

The relevant issues to tackle in the framework of EQ 11 are the following:

1) To estimate the global bio-energy volume generated by the activities supported by the measures under study, and its relative importance on the total volume of energy generated from biomass.
2) To estimate - taking into account the different uses (transports; heating; electricity) - the quantity of fossil fuels that would be needed to generate an energy volume equal to the one at point 1) above.
3) To estimate - taking into account the different uses (transports; heating; electricity) - the volume of CO2 emissions avoided through the use of the global bio-energy volume at point 1) above (which is equal to the emissions that would be caused by the use of the energy volume at point 2) above, obtained by fossil fuels).
4) To estimate the global contribution of the measures under study to:
   a) reduced CO_2 emissions;
   b) the saving of fossil fuels.

The general methodology used for the above estimates is the following.

Estimate of the global bio-energy volume generated by the activities supported by the measures under study.

1) Definition of adequate *technical coefficients* to convert the quantities of raw materials obtained through the cultivation of energy crops supported by the measures under study into bio-energy volumes, on the basis of the following conversion chain: (agricultural area under the various energy crops) => *yields per hectare* => (quantities of the various raw materials obtained through the cultivation of energy crops) => *energy content of the various raw materials* => (bio-energy volumes generated by the various raw materials).
2) Estimate of the bio-energy volumes generated by each kind of crop supported by the measures under study.
3) Estimate of the global bio-energy volume generated by the energy crops supported by the measures under study (sum of the volumes at point 2) above).

Estimate of the quantity of fossil fuels that would be needed in each of the different uses (transports; heating; electricity) to generate an energy volume equal to the bio-energy volume generated by the activities supported by the measures under study.

1) Estimate of the portion of the global bio-energy volume generated by the energy crops supported by the measures under study that is destined to each specific use.
2) Estimate of the quantity of fossil fuels that would be needed to generate an energy volume equal to the bio-energy volume generated by the energy crops supported by the measures under study, for each of the different uses.

Estimate of the volume of CO2 emissions avoided in each of the different uses (transports; heating; electricity) through the use of the bio-energy volume generated by the activities supported by the measures under study.

1) Definition of adequate *technical coefficients* to estimate the CO2 emissions generated by fossil fuels, taking into account the different uses (transports; heating; electricity).
2) Estimate of the volume of CO_2 emissions avoided in each of the different uses (transports; heating; electricity) through the use of the bio-energy volume generated by the activities supported by the measures under study (i.e. of the volume of CO_2 emissions that would be caused, in each of the three different uses, by the use of energy obtained by fossil fuels in volumes equal to those generated by the activities supported by the measures under study).

The *global contribution of the measures under study to reduced CO_2 emissions and the saving of fossil fuels* is then quantified by the *sum of the contributions determined for each of the different uses with the above methodology*.

Limitations and validity of the estimate of the contribution of the measures to reduced CO_2 emissions and the saving of fossil fuels

It is important to point out that the above estimates on the reduced CO_2 emissions and the saving of fossil fuels for the different uses are limited to the stage of consumption. This implies that such estimates do not consider the use of fossil fuels and the related GHG emissions in the upstream stages of the bio-energy supply chains concerned *(the production of primary energy sources (sources of biomass), their processing into bio-energy and transportation of either sources of biomass or bio-energy). In fact, while the consumption of bio-energy may be considered as carbon neutral[354], the whole production process for obtaining bio-energy normally generates GHG emissions, mainly depending on how much fossil fuel energy is required in the process itself. The main reasons behind our choice are illustrated at § 24.1).*

24.1 State of the art in the assessment of CO_2 emissions from fossil fuels versus CO_2 emissions from bio-fuels.

With a few notable exceptions – especially in the case of bio-fuels – scientists agree on the positive impact in terms of reduction of GHG emissions of bio-energy use as opposed to fossil fuel use. Moreover, they expect stronger emission abatement opportunities from second-generation bio-fuels (see for instance World Watch Institute 2006 on bio-fuels for transportation). However, their estimates on possible CO_2 emission reductions vary widely, depending on assumptions about system boundaries, values of key parameters and their weights in the analysis. For instance, opinions are divided concerning what stages of the crops' life cycle and what GHG have to be included. Besides this, different hypotheses on land-use change, use of fertilizers and level of irrigation required to grow energy crops are of crucial importance for assessing impacts at the feedstock production and harvest stage, while assumptions on conversion efficiency, source of process energy and use of co-products are paramount for the processing stage. Finally, the results of impact analyses are space-dependent, since climate, solar resources and soil productivity – which all affect crop yields – vary from one area (or country) to another. In the case of bio-fuels for transport, these differences lead to a wide range of diverging studies, some of which show significant GHG emission reductions – especially in contexts such as Brazil, where crop yields are very high – while others conclude on limited opportunities to cut GHG emissions, or they even suggest possible increases in GHG emissions (World Watch Institute 2006).

The absence of a consolidated state of the art, which could constitute the basis for a reliable "from field to engine" assessment, was the main reason behind the choice of the evaluation team to focus on the sole consumption stage.

24.2 Contribution of the measures under study to the reduction of CO_2 emissions and the saving of fossil fuel.

The will to reduce the GHG emissions is one of the main drivers for the development of bio-energy sources in the EU. Parallel to GHG emissions reduction, the use of bio-energy sources in the electricity, heating and transport sectors contributes to the displacement of fossil fuels in such sectors.

We analyse here the effects of the relevant CAP support measures on the reduction of CO_2 emissions and the saving of fossil fuel – **for the stage of consumption** - for electricity, heat and transport fuel production from bio-energy sources, which include solid biomass, bio-gas, bio-diesel and bio-ethanol.

24.2.1 Main assumptions on the contribution of the measures to the production of bio-gas, biomass for direct burning, and bio-fuels

Contribution of the measures under study to the production of bio-gas

The areas cultivated under the NFSA regime and the AEC with the energy crops which are most relevant for the production of bio-gas (maize above all), and hence the quantities of biomass obtainable from such

[354] The term carbon neutral is used here to indicate that exactly the same amount of CO2 that is absorbed by the plants through photosynthesis is released as a consequence of combustion of bio-energy sources obtained from such plants.

areas, are modest in absolute value (about 88% of the 240.000 tons of maize that we estimated as being produced on the area under the AEC and NFSA in 2005 were destined to bio-gas production).

Biomass from energy crops, including those outside specific regimes, constitutes only a fraction of a miscellaneous category of feedstocks for bio-gas production including also agricultural residues, other agricultural sources (e.g. manure) and municipal solid waste: this miscellaneous category was estimated as contributing as a whole to bio-gas production by 17% only.

Finally, the evidence presented in the EQ 4 suggests that only a limited number of projects centred on on-farm bio-gas production was funded in the EU by the RDMs under study, mostly in Germany and Austria.

Contribution of the measures under study to the production of biomass for direct burning

The cultivation of energy crops which are most relevant for direct burning (short rotation forestry above all) was practised on very limited areas under the AEC and the NFSA regime (less than 18.000 ha in 2005).

The evidence presented in the EQ 4 suggests that only a limited number of projects centred on on-farm use of wood for energy purposes was funded in the EU by the RDMs under study, mostly in Finland and France.

Contribution of non-CAP measures to the production of bio-gas and of biomass for direct burning

In the evaluation question 9 we judged that additional non CAP support at EU level and at Member State level[355], and not the support of the CAP measures, was decisive as regards the survival of the bio-energy supply chains centred on the generation of electricity from both solid biomass and bio-gas.

Contribution of the measures under study to the production of bio-fuels for the transport sector

In the case of transport, an estimate of the quantities of bio-diesel and bio-ethanol which were surely and solely produced by effect of the NFSA regime and the AEC was deemed impossible in the framework of this study.

In the answer to the EQ 1, we have seen that the AEC and the NFSA regime cannot be considered the only factors behind the decision of the farmers to grow energy crops under such regimes. Indeed, the role of the AEC and of the NFSA regime in this respect was found to be decisive only in specific conditions (low market margins of energy crops above all) which cannot be extended to the whole EU farming reality. Nevertheless, in order to set the areas where the role of the AEC and of the NFSA regime was decisive apart from the areas where it was not so, only an extremely detailed (region-by-region, or even farm-by-farm) in-depth analysis, covering the whole EU territory, would have avoided recurring to extremely strong and risky assumptions. Such analysis proved unfeasible in the context of the study.

Moreover, in the answers to the EQ 2 and 9 we have seen that the NFSA regime and the AEC cannot be considered decisive factors in assuring the economic viability of the bio-diesel and bio-ethanol supply chains; in particular, in the EQ 9 we judged that additional non CAP support at EU level and at Member State level was decisive for the survival of such supply chains.

As a partial remedy to the aforementioned limitations, it was decided to calculate the **upper limit of the potential contribution of the measures to the production of bio-fuels**, which is assumed to be equal to the quantities of bio-diesel and bio-ethanol obtainable from the whole quantity of biomass produced by the main energy crops which were relevant in this respect (oilseeds for bio-diesel; cereals and sugar beet for bio-ethanol) grown under both the AEC and NFSA regime in the EU in 2005.

However the actual contribution of the NFSA regime and the AEC to the reduction of CO_2 emissions and the saving of fossil fuel in the transport sector is probably much lower according to the following:

- Only a portion - which cannot be quantified – of the biomass obtained from the whole energy crop area under the AEC and the NFSA regime was produced solely thanks to the support granted by the measures (see EQ 1).

[355] Measures to promote bio-energy sources in the electricity sector include support schemes put in place pursuing Directive 2001/77/EC for the promotion of electricity from RES in the internal electricity market (see § 6 and Annex A.2). With reference to the transport sector, measures include support schemes put in place pursuing Directive 2003/30/EC for the promotion of bio-fuels and other renewable fuels for transport (see § 6 and Annex A.3). Finally, there is no legislation regarding renewable heat at the EU level , and therefore initiatives to support heat from RES – in particular bio-energy – lack continuity and are often implemented at the local level only (see § 6 and Annex A.4). Beside the direct effect of promoting the use of bio-energy sources for producing electricity, heat and fuels for transport, the above-mentioned measures contribute to cutting CO_2 emissions as well as to displacing fossil fuels in the three sectors of energy use. Since these measures often interact with other policy initiatives, it is however difficult to separately quantify and isolate the effects of the former and the latter in term of CO_2 emissions abatement.

- The role of the NFSA regime and of the AEC in assuring the economic viability of the bio-fuels supply chain, and hence in promoting the saving of fossil fuels and the reduction of CO_2 emissions by promoting the production and the use of bio-fuels, is not decisive (see EQ 2, 3 and 9).
- A debate is still under way within the scientific community over the actual contribution of bio-fuels use to the reduction of CO_2 emissions, especially where the whole bio-fuels supply chain – "from field to engine" - is considered. Indeed, according to some studies, only limited reductions can be achieved through the use of bio-fuels; according to other studies, the use of bio-fuels would even result in an increase in CO_2 emissions. Hence, the consideration of the sole consumption stage in the estimate of the upper limit of the contribution of the measures to the reduction of CO_2 emissions may lead to an overestimate of the actual contribution, in comparison with an estimate carried out for the whole bio-fuels supply chain, "from field to engine".

As regards the RDMs, their contribution to the reduction of CO_2 emissions and the saving of fossil fuel in the transport sector is assumed to be negligible, as:

- They are of no relevance in promoting the cultivation of the energy crops which provide the bulk of the biomass used as feedstock in the production of bio-diesel and bio-ethanol.
- According to the findings of the EQ 4 and 5, they have very limited relevance in promoting the production of bio-fuels for transport: only the construction of small scale on-farm plants for the production of vegetable oils directly used as fuels can be supported by the RDMs, which have instead no relevance in supporting the construction of the large scale industrial plants where the bulk of the EU bio-diesel and bio-ethanol production is obtained.

In conclusion, the **contribution of the measures under study to the reduction of CO_2 emissions and the saving of fossil fuel** is considered, in the context of this evaluation question, to be given by the **sole components concerning the transport sector, through the support granted by the NFSA regime and the AEC only**.

24.2.2 CO_2 emissions reduction and fossil fuel displacement in the transport sector

Overall around 3,18 Mt (2,88 Mtoe) of bio-diesel and 0,73 Mt (0,47 Mtoe) bio-ethanol[356] were produced in the EU in 2005 for use in the transport sector[357]. This is equal to 3,62 billion litre bio-diesel and 0,92 billion litre bio-ethanol. If the bio-ethanol from wine alcohol is not taken into account, the EU-25 production amounts to 0.56 Mt (0,36 Mtoe), i.e. 0.71 billion litre.

We estimate that 61% of the total volume of bio-diesel and 86% of the total volume of bio-ethanol produced in the EU can be attributed to the AEC and the NFSA regime. These percentages correspond to 1,94 Mt (1,76 Mtoe, i.e. 2,21 billion litres) of bio-diesel and 0,49Mt (0,32 Mtoe, i.e. 0,61 billion litres) of bio-ethanol. Our estimate takes into account the following energy crops: rapeseed and sunflower for bio-diesel production; sugar beet, common wheat, maize, barley and rye for the bio-ethanol production. We assume that:

- rapeseed and sunflower are entirely dedicated to bio-diesel production;
- sugar beet, common wheat, maize, barley and rye are entirely dedicated to bio-ethanol production. It is important to underline that this assumption leads to overestimate the quantity of these cereals used as feedstock in the bio-ethanol production, as cereals are also used – albeit to a rather limited extent (see market analysis, § 8.1) – also for the production of bio-gas and for direct combustion.

The upper limit of the potential contribution of the NFSA regime and of the AEC to the production of bio-diesel and of bio-ethanol has been therefore estimated on the basis of:

- the areas under the relevant energy crops which were estimated as being cultivated in 2005 under the NFSA regime and the AEC (see market analysis, §);
- the energy crops yields[358], in terms of toe/ha, in the case of bio-diesel and of bio-ethanol production (1,1 toe/ha for rapeseed, 0,9 toe/ha for sunflower, 4 toe/ha for sugar beet and 1,7 toe/ha for cereals).

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[356] Sources: EBB statistics, EurObserv'ER 2005 European Barometer of Renewable Energies, eBIO.
[357] The figure concerning bio-ethanol includes 0.17 Mt (0,11 Mtoe) bio-ethanol obtained from the distillation of wine alcohol, as a consequence of the distillation measure of the Common Market Organisation of wine (source DG-Agriculture).
[358] Source: DEIAGRA elaboration on EUBIA data

Assuming a fuel consumption substitution rate[359] of 1.088 litre bio-diesel per litre diesel and one of 1.472 litre bio-ethanol per litre petrol, the upper limit of the potential contribution of the NFSA regime and of the AEC to fossil fuel displacement is estimated in around 2.02 billion litre diesel and 0.42 billion litre petrol.

As far as CO_2 emissions are concerned, based on emission factors[360] of 734 gCO_2/litre diesel and 640 gCO_2/litre petrol, the upper limit of the potential contribution of the NFSA regime and of the AEC to the reduction of CO_2 emissions through the use of bio-fuels in the transport sector is estimated in around 1.76 Mt CO_2. These are made up by 1.49 Mt CO_2 avoided through the use of bio-diesel and 0.27 Mt CO_2 from the use bio-ethanol. It is worth reminding here that **the analysis only focuses on the stage at which bio-fuels and fossil fuels are consumed** (see § 24.1), and therefore bio-fuels may be considered as carbon-neutral.

The discussed results are summarised in Table 24.1 below.

Table 24.1 – Fossil fuel displacement and CO_2 savings from bio-fuels production associated with the AEC and the NFSA regime

	Bio-diesel	Bio-ethanol	Total
Total biofuels production (Mt)	3,18	0,73	3,91
Biofuels production excluding distillation maesure (Mt)	3,18	0,56	3,74
Upper limit of the potential contribution of the NFSA regime and of the AEC to biofuels production (Mt)	**1,94**	**0,49**	**2,43**
	Diesel	Gasoline	Total
*Substitution rates (l biofuel/l fossil fuel)**	*1,088*	*1,472*	
Total fossil fuel displacement (billion l)	3325,5	624,7	3950,2
Fossil fuel displacement excluding distillation measure (billion l)	3325,5	485,2	3810,7
Upper limit of the potential contribution of the NFSA regime and of the AEC to fossil fuel displacement (billion l)	**2028,6**	**417,3**	**2445,9**
*CO2 emission factors (gCO2/l)***	*734*	*640*	
Total CO2 emission savings (Mt)	2,44	0,40	2,84
CO2 emission savings excluding distillation measure (Mt)	2,44	0,31	2,75
Upper limit of the potential contribution of the NFSA regime and of the AEC to the reduction of CO2 emissions (Mt)	**1,49**	**0,27**	**1,76**

**Source: IPTS 2002a and IPTS 2002b*
***Source: EPA 2005*

24.3 Judgment

In the scientific literature, the estimates on the reduction of CO_2 emissions and the saving of fossil fuels achievable through the use of bio-energy and especially of bio-fuels vary widely, depending on assumptions about system boundaries, values of key parameters and their weights in the analysis. According to some studies, only limited reductions can be achieved through the use of bio-fuels; according to other studies, the use of bio-fuels would even result in an increase in CO_2 emissions. The absence of a consolidated state of the art, which could constitute the basis for a reliable "from field to engine" assessment, was the main reason behind the choice of the evaluation team to focus, in the context of this study, on the sole consumption stage (i.e. the use of fossil fuels and the related GHG emissions in the upstream stages of the bio-energy supply chains are not taken into account). Hence the estimated contribution of the measures

[359] Source: IPTS.
[360] Source: EPA.

corresponds to the **upper limit of the potential contribution of the NFSA regime and of the AEC to reduced CO_2 emissions and the saving of fossil fuels**.

As regards the **electricity sector and the heating sector**, the **contribution of the CAP measures under study to the reduction of CO_2 emissions and the saving of fossil fuel can be considered negligible**. Indeed, the CAP measures under study can be deemed to support the production of bio-gas and the direct burning of biomass - i.e. the bio-energy sources which are most relevant in the electricity and heating sector – only to an extremely limited extent. In the case of the use of bio-energy in the heating sector, it has also to be noted that no EU policy framework is currently in place to support it.

As regards the **transport sector**, the **upper limit of the potential contribution of the NFSA regime and the AEC to reduced CO_2 emissions and the saving of fossil fuels** was calculated by assuming that the quantity of bio-fuels produced by effect of the measures was equal to the quantities of bio-diesel and bio-ethanol obtainable from the whole quantity of biomass produced by the main energy crops which were relevant in this respect (oilseeds for bio-diesel; cereals and sugar beet for bio-ethanol) grown under both the AEC and NFSA regime in the EU in 2005[361]. The upper limit was estimated in:

1) A **fossil fuel displacement** of approximately **2.02 billion litre diesel** (attributable to bio-diesel use) and **0.42 billion litre petrol** (attributable to bio-ethanol use).
2) A **reduction of CO_2 emissions** of approximately **1.76 Mt CO_2**, of which 1.49 Mt CO_2 avoided through the use of bio-diesel and 0.27 Mt CO_2 avoided through the use of bio-ethanol.

However, the **actual contribution of the NFSA and the AEC to reduced CO_2 emissions and the saving of fossil fuels** is probably **significantly lower** (to an extent which was not possible to quantify in the framework of this study), especially because:

a. The AEC is not always decisive in the farmers' decision to grow energy crops (see EQ 1).
b. The role of the NFSA regime and of the AEC in assuring the economic viability of the bio-fuels supply chain is not decisive (see EQ 2, 3 and 9).
c. As already mentioned, only the stage of consumption was considered in this analysis.

A more in-depth and specific analysis of the environmental impacts of the AEC and the NFSA regime, including a "from field to engine" assessment of the CO_2 emission impacts, will be carried out in the context of the *Evaluation of the environmental impacts of measures taken by common market organisations and CAP direct support measures in the arable crops sector*, recently commissioned by DG Agriculture (results are expected by the end of 2007).

[361] **Relevant energy crops**: rapeseed and sunflower for bio-diesel production; sugar beet, common wheat, maize, barley and rye for the bio-ethanol production. The **upper limit of the potential contribution of the NFSA regime and of the AEC to the production of bio-diesel and of bio-ethanol** corresponds to the quantities of bio-diesel and bio-ethanol obtainable from the whole quantity of biomass produced by the relevant energy crops grown under both the AEC and the NFSA regime in the EU in 2005. **Energy crops yields**, in terms of toe/ha: 1,2 for rapeseed, 0,9 for sunflower, 4 for sugar beet and 1,7 for cereals. **Fuel consumption substitution rate** of 1,088 litre bio-diesel per litre diesel and of 1,472 litre bio-ethanol per litre petrol. **Emission factors** of 734 g CO_2/litre diesel and 640 g CO_2/litre petrol.

25 EVALUATION QUESTION 12

"What positive and negative environmental impacts (quantify) have the measures had through their effects on the primary production of energy crops? Base your analysis on existing studies and evaluations".

The relevant issues to tackle in the framework of EQ 12 are the following:

1) Assessing whether and to what extent the measures concerned have had some effects on the primary production of energy crops.
2) Assessing weather some positive or negative environmental impacts are connected to the production of energy crops with respect to the conventional use of land (traditional crops or fallow set aside).
3) Quantifying the positive and negative environmental impacts at point 2.

The general methodology used is the following.

As regards issue 1), the assessment was carried out in EQ 1 and EQ 4, to which the reader should refer for a description of the methodology used. Provided that the measures concerned have had some effects on the primary production of energy crops, the following methodology is applied with reference to issues 2 and 3.

For issue 2), a comparison is made – on the basis of the evidence provided by scientific literature on the matter - between the environmental impacts associated to the cultivation of the main energy crops and those associated to the most common conventional uses of land (cultivation of traditional crops or fallow set aside). The investigated aspects are the following:

- Soil erosion.
- Use of pesticides.
- Water balance.
- Biodiversity.
- Soil content of organic matter.
- Carbon sink.
- Nitrogen leaching.

Finally, as regards issue 3), a quantification of the impacts assessed at point 2) above is provided for the agricultural area concerned in the EU.

25.1 Relevant issue 1 - Assessing whether and to what extent the measures concerned have had some effects on the primary production of energy crops.

For the purposes of this evaluation question, some assumptions had to be made with respect to the portion of the area under energy crops in the EU whose cultivation could be considered as mainly driven by the measures under study which can be specifically associated with the primary production of the energy crops themselves.

Among the measures under study, the AEC and the NFSA regime were identified as the ones which can be specifically associated with the primary production of energy crops. Indeed, the rural development measures are more targeted at supporting the start of downstream and support operations in the bio-energy supply chains, and their support to the primary production of energy crops regards solely multi-annual species, and concerns mainly the production of forestry biomass (see in this respect the EQ 4).

In the answer to the EQ 1, it was seen that the AEC and the NFSA regime cannot be considered the only factors behind the decision of farmers to grow energy crops under such regimes.

Here, an estimate of the portion of the total energy crop area under the AEC and the NFSA regime which can be deemed as grown undoubtedly by effect of the sole support granted by the measures themselves (the farmer would have not decided to grow energy crops without such support), was impossible in the framework of this study. This estimate would have indeed required strong assumptions which would have seriously limited its reliability.

Therefore, as a partial remedy, it was decided to calculate the **upper limit of the contribution of the measures** to the primary production of energy crops, identified in the whole energy crop areas under the AEC and the NFSA regime. It should be noted that – in the light of the results of EQ 1, according to which only a portion of the total area under the regimes can be considered due to the sole support granted by the measures - the actual effects of the measures are probably significantly lower.

From the data and information reported in the market analysis[362] (§ 8.1.1.3) and in EQ 1 and 6, it appears that **rapeseed** is the most important energy crop cultivated under the NFSA regime and the AEC in the EU, followed at a great distance by sunflower, rye and maize. Rapeseed is the only energy crop grown under the AEC whose area has showed an increase which can be considered non negligible also in absolute terms: energy rapeseed under the AEC exceeded 430.000 ha in 2005, after just two years of implementation of the measure. It is also by far and large the prevalent energy crop grown under the NFSA regime on set aside land (more than 730.000 ha of energy rapeseed were grown under the NFSA regime in 2005, i.e. about 85% of total energy crop area on set aside land). Multi-annual energy crops are still grown over a very limited extent of the energy crop areas under the AEC and the NFSA regime (less than 18.000 ha in 2005). Therefore, they are not taken into account in this study when assessing the environmental effects coming from the measures concerned.

The most diffused energy crops result to be not crops which acquire an economic value only when destined to energy purposes (this is indeed the case for some of the less common energy crops, e.g. miscanthus), but crops traditionally cultivated for conventional (food and feed) uses and then destined also to energy purposes (this is true in the case of most oilseed and cereal crops that can be grown also for energy purposes, and also in the case of sugar beet).

In the answer to the EQ 6 we have seen that, as the extent of the usable agricultural area tends to remain fairly stable in the Member States, only a very limited part of the expansion of the energy crop areas grown under the AEC can be thought to have occurred on newly created usable agricultural area (which may be - but it is not necessarily so - the result of the conversion of natural non agricultural land).

In the case of energy crops grown on set aside land under the NFSA regime, the dynamics appear to be clearer, with energy crops occupying agricultural areas previously destined mostly to fallow set aside: indeed the cultivation of non food crops for uses other than energy has been practised only to an extremely limited extent on set aside land.

Furthermore, the agricultural areas destined to the cultivation of energy crops under the AEC and the NFSA regime are of very limited extent if compared with the whole EU usable agricultural area:

- the energy crop area under the AEC was equal to 561.000 ha in 2005, which correspond to about 0,4% of the total usable agricultural area in the EU-15;
- the energy crop area under NFSA was estimated in about 835.000 ha in 2005, which correspond to about 0,6% of the total usable agricultural area in the EU-15.

Summarising, the most relevant effects of the measures concerned – identified in the AEC and the NFSA regime – on the primary production of energy crops are the following:

- in the case of the AEC, cultivation of more than 430.000 ha of energy rapeseed on non set aside land in 2005, which correspond however to less than 0,4% of total usable agricultural area in the EU-15;
- in the case of the NFSA regime, cultivation – mostly at the expense of fallow set aside – of more than 730.000 ha of energy rapeseed (less than 0,6% of total usable agricultural area in the EU-15).

25.2 Relevant issue 2 – Assessing weather some positive or negative environmental impacts are connected to the production of energy crops with respect to the conventional use of land (traditional crops or fallow set aside).

Regardless to the greenhouse gas emissions – which have been treated in the EQ 11 - whether or not the energy crops have positive or negative environmental effects depends on the **type of crop** and on **agricultural techniques**. Some different considerations may be done, in this framework, for crops cultivated under the AEC and under the NFSA regime.

25.2.1 Environmental impacts connected to the production of energy crops under the AEC

The most common energy crop grown under the AEC is by far rapeseed (78% of the total area under AEC), followed by rye (8%), maize (4%), wheat (2%) and sunflower (2%). Perennial crops still play a not relevant role in this framework.

As highlighted in the EQ1, in the specific case of AEC areas, these crops were almost never introduced *ex novo*; normally they are conventional crops, already cultivated on those areas, for which the end-use has

[362] See also the annex D to the market analysis for further details.

been switched from conventional to energy. No information is available in literature regarding the variation of cultivation techniques for rapeseed destined to energy use, versus conventional rapeseed. The same can be said for the other – less diffused – conventional crops destined to energy uses. It is realistic to state that agricultural practices do not differ substantially between the conventional and energy use, at least at present[363].

Possibly, selected low-input- high-yielding varieties shall be used for bio-energy over the next years. Literature reports, for example, of some interesting new hybrids of rapeseed, likely to determine environmental benefits due to a lower input requirement maintaining high yields (Bona et al., 1998)[364]. As for the other crops, literature refers interesting news about breeding programs on wheat varieties for types of feedstock very suited to ethanol production. Likewise, sugar beet varieties have been selecting for many years for ethanol, and some seeds companies trade interesting maize hybrids for energy[365]. However, at present the cultivation of hybrids is very *uncommon* due to their high costs, while commonly the same varieties and crop husbandry which are used for the conventional crop result to be maintained also in case of energy destination.

It can therefore be concluded that, for the most common energy crops grown under the AEC (rapeseed, rye, maize, sunflower), agricultural practices do not differ substantially, at the time being, between the conventional and energy use. Therefore, regardless to the cascading processes (e.g. greenhouse gas emissions) which have been discussed elsewhere (see EQ 11), for the most common energy crops grown under the AEC (rapeseed, rye, maize, sunflower), the environmental impacts due to changes in agricultural practices for the conversion of the crop from conventional to energy use, would result to be very limited.

Nevertheless, environmental impacts are not only linked to the conversion from conventional to energy use of a defined crop, but also to substitution phenomena (see EQ 6). A further analysis in this sense is developed on rapeseed, which is the most diffused crop under the AEC (78% in 2005). In the case of substitution, some significant changes in the environmental impacts of the cultivation might be expected, because of the different cultivation techniques which can characterise different crops. According to the areas where rapeseed for energy use results to be most present, the crop can be supposed to have mainly replaced wheat, growing cycles being overlapping. In this case, according to literature, very similar agricultural techniques are commonly adopted for rapeseed and wheat (Weiss, 1983). Most of the differences between the two crops concern the nitrogen dose, rapeseed generally absorbing 20-30% more nitrogen than wheat with positive effects on water quality (Toniolo and Mosca, 2001).

Water contamination by nitrates is one of the main problems associated with agriculture. Nitrates are well-known to be highly soluble and migrate easily into ground water. The leaching of nitrates depends on several factors, including climatic and biological ones, nonetheless the link between nitrogen supply and water pollution is widely demonstrated. Rapeseed is known to be an excellent catch-crop having a high intrinsic capacity to recover inorganic nitrogen from the soil during autumn-winter period, thus **preventing the N-leaching risks**. It was estimated that leached nitrogen of rapeseed was from 20 to 30% less than wheat. Therefore a positive effect on surface water and euthrophication could derive from replacing wheat with rapeseed[366].

As regards **carbon sink**, generally speaking rapeseed – together with sunflower – is considered an optimal carbon sink crop[367], but literature still lacks of specific information regarding the increase of carbon sink due to the replacement of other crops, and wheat in particular. Some experiences on rapeseed and sunflower report that both crops can be carbon sink or source depending on the yield level (Figure 25.2). Typically, the yield of rapeseed is above the break-even line, while that of sunflower approximates it, thus they could be considered as sink or source crops, respectively. In the case of rapeseed, using Figure 25.2 as baseline and considering an average grain yield of rapeseed equal to 3.7 t ha^{-1} (typically the average yield of Germany

[363] It could be stated that lower input techniques are likely to be used for energy crops in comparison to the conventional ones, due to the relative lower importance of quality of products in the first case (energy) towards the other. Nevertheless, this represents only a conjecture at present since no significant studies are available in literature on the matter. According to the evaluation team's knowledge, and basing on spot information and interviews with farmers, agricultural practices are normally the same for the two destinations.

[364] Becker (1987) reported that heterosis was up to 63% over the average parental yield. Sauermann and Finck (1998) showed as hybrids produce up to 20% more than standard cultivars, and this was also confirmed by Schuster et al. (1999).

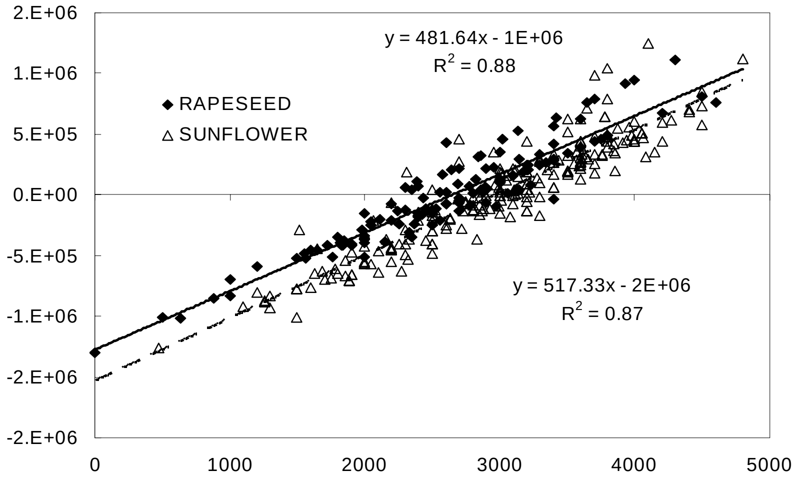
[365] It should be reminded that sugar beet was not eligible to AEC till 2006.

[366] Strosser et al., 1999 ; Aronsson *et al.*, 1998; Thorup-Kristensen *et al.*, 2003; Aronsson, 1998.

[367] Shepherd and Davies (1993) studied the carbon pathway from the rapeseed plant into the soil through the roots. They concluded that 17-19% of carbon was transferred to the roots; of that, 30-34% was released into the soil and 23±24% lost through respiration. 35±51% of the total carbon released into the rhizosphere, was permanently sequestered.

and France), carbon sequestration varies from 0.37 to 0.45 Mg ha^{-1} yr^{-1}. Since wheat monoculture was found to accumulate from 0.19 to 0.35 Mg ha^{-1} yr^{-1} (Liebig *et al.*, 2005), the effect on carbon sequestration given by replacing wheat with rapeseed can be promptly calculated. The notable range of variation in carbon sequestration may be explained by many variables such as climatic conditions, soil type, agricultural practices and initial soil carbon content.

*Figure 25.1 - **Soil carbon variation (g) as a function of grain yield (kg ha^{-1}).***



Source: Bona et al. (2003), modified

As far as the other environmental issues are concerned, no relevant differences can be neither found in literature nor logically sustained, regarding the effects of rapeseed and wheat cultivation on **biodiversity** and **habitats**, being the two crops actually very similar from this standpoint.

As for **erosion**, this aspect cannot be considered really relevant in this context, being the problem of erosion fundamentally limited to sloping lands, while rapeseed is almost entirely cultivated in plains, where lands are little or not at all affected by erosion phenomena.

As regards **pesticides**, no satisfactory information is available on the environmental effects of pesticides use in rapeseed cultivation, in comparison to the effects concerning the cultivation of wheat[368].

Finally, as far as **water consumption** is concerned, the comparison between rapeseed and wheat shows that no relevant differences exist in this sense between the two crops, being irrigation very uncommon for both of them, as the growing cycle takes place mostly during rainfall season. Despite this, the water consumption of rapeseed is generally higher than that of wheat, being the former more transpiring than the latter due to broader leaves, different canopy structure and deeper roots (Weiss, 1983). However no data are available in literature on the matter, nor with respect to the differences in water consumption between rapeseed and fallow set aside land: hence no conclusive estimates can be made regarding the possible water saving related to the presence of rapeseed for energy use.

25.2.2 Environmental impacts connected to the production of energy crops under the NFSA

As far as the cultivation on set aside land is concerned, the assessment of the environmental effects of energy crops results to be different from that developed in the case of AEC. In the case of NFSA in fact, these effects have to be compared with the impact connected with the sole possible alternatives on the same land, i.e. other non food crops and fallow set aside.

As in the case of the AEC, rapeseed is by far the most developed energy crops grown under the NFSA (84% in 2005), followed by sunflower (6%, see § 8.1.1.3, and the EQ 1). Taking into account the very rare presence of other non food crops on set aside land (see § 8.1.1.3), the only reasonable comparison – for the assessment of the environmental effects of energy crops cultivation – is between the cultivation of rapeseed and sunflower on one hand, and the fallow set aside on the other hand.

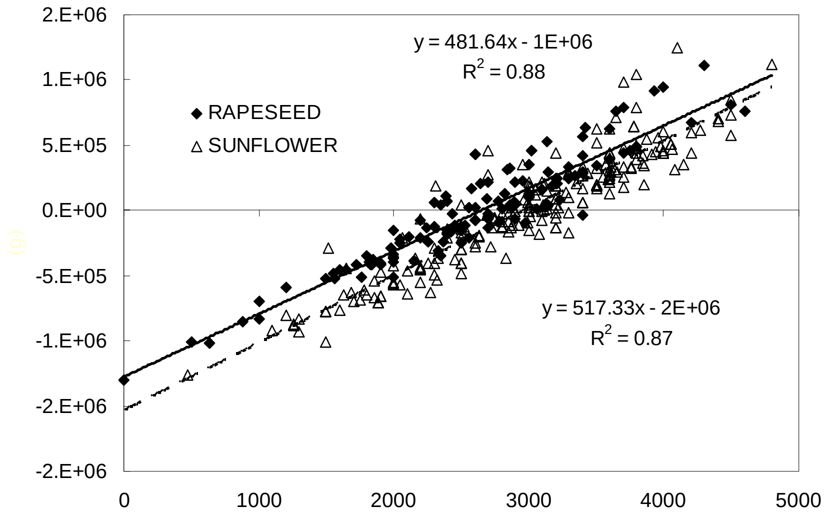
[368] Some spot information in this sense could be derived from a study on soil-plant system in Slovak republic, where Schlosserová (1992) demonstrated that rapeseed is able to intercept more pesticides than wheat leading to a less environmental pressure.

Referring to this peculiar situation, specific literature can be cited. Some authors retail of potential positive effect of rapeseed compared to fallow set aside, due to reduction in the **N-leaching** risks. Nevertheless, this highly depends on the adopted fertilizer dose and above all on which crops actually cover the set aside land. At this proposal, an evaluation study recently commissioned by the European Commission[369] shows that fallow set aside land may lead to a drastic reduction of leached N if compared with a traditional crop. Converting conventionally cropping lands into fallow set aside land N-leaching almost halved in France, and decreased 50 to 10 mg l^{-1} in Great Britain.

Some considerations in this sense can also be made regarding the effects of different **fertilization** levels. The cultivation techniques for rapeseed indeed, specifically as far as Central and Northern Europe areas are concerned, often adopt quite high levels of nitrogen fertilization, while no fertilization is normally foreseen on set aside land, even in case of a covered set aside.

As regards to the aspect of **soil carbon sink**, an assessment can be made regarding the effects of cultivating rapeseed or sunflower instead of leaving the land fallow. Referring again to Figure 25.2, and considering the carbon sequestration varying from 0.37 to 0.45 Mg ha^{-1} yr^{-1} for rapeseed in the most common conditions of cultivation[370], a comparison can be made with fallow set aside lands, which were found to cumulate from 0.17 to 0.40 Mg ha^{-1} yr^{-1} (Watson et al., 2000; Freibauer *et al.*, 2004). However, as cited before, it should be remembered that carbon sequestration may largely vary depending on climatic conditions, soil type, agricultural practices and initial soil carbon content.

*Figure 25.2 - **Soil carbon variation (g) as a function of grain yield (kg ha^{-1}).***



Source: Bona et al. (2003), modified

As for the **other indicators**, some qualitative indications regarding the effects of replacing fallow set aside with the most diffused energy crops – rapeseed and sunflower, in this case – can be provided on the basis of studies concerning set aside[371].

All these studies substantially agree in making a deep distinction between the environmental effects of a covered and well managed set aside land, and set aside lands kept not covered at all or only partially covered. While a number of positive effects can be identified in the first context, concerning not only nitrates but also erosion, fertility and biodiversity, the balance changes – often becoming negative – in the case of non-covered or partially covered set aside lands.

As regards **soil erosion**, the effect of a vegetable cover results to be always positively determinant in this sense, but not substantial differences are documented in this sense between a coverage with oilseed cultivations and a covered set aside. To the end of this evaluation however, considering that the largest part of lands are located in plain, which are slightly or not at all affected by erosion phenomena, this aspect seems not to play a relevant role.

[369] http://ec.europa.eu/agriculture/eval/reports/gel/chap6.pdf.
[370] Also here, the average yield in the areas of Germany and France have been considered for the calculations.
[371] OREADE - BRECHE, « Evaluation de l'impact des mesures communautaires concernant le gel des terres » (study commissioned by the EU Commission - DG Agriculture), 2002. Sebillotte, M., Allain, S., Doré, T., Meynard, J. M.,« La jachère et ses fonctions agronomiques, économiques et environnementales diagnostic actuel », 1993.

As for **pesticides** - even in absence of specific studies comparing set aside lands and oilseeds with regard to this issue – it can be said on a logical basis, that being the fallow set aside normally not treated at all, a negative environmental effect is likely to derive from any substitution of it with other crops, including rapeseed, even though this effect is impossible to quantify.

As regards the **water balance**, the presence of positive or negative effects due to the substitution of fallow set aside with oilseeds, result to be highly dependant on climate, periods of pasture and other factors. Generally speaking however, water consumption is normally lower in the case of covered set aside than in the case of the cultivation of any traditional crop.

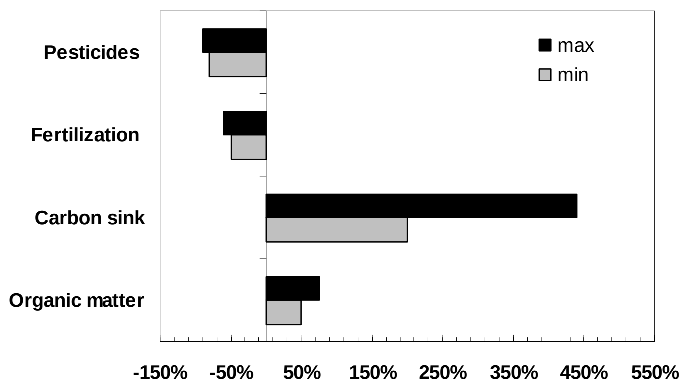
As regards **biodiversity and organic matter**, recent scientific studies show the positive role potentially played in this sense by set aside lands, thanks to the presence of a mixture of different species. Specifically, a positive effect is attributed to the rotational set-aside for the maintenance of certain populations of birds. Also here, a negative effect on the animal population is instead registered in the case of non-covered set aside.

Finally, in the light of the above mentioned carbon gain a slight increase of **organic matter** might be achieved by the cultivation of rapeseed, however this is not supported by backed studies and it could strongly vary depending on initial soil composition, climate course, mineralization rate etc.

25.2.3 First elements as regards the environmental impacts of the new dedicated energy crops

Generally speaking - according to the literature collected and the experts consulted – the recently introduced perennial crops grown for energy purposes result to have low input requirements and environmental pressure, whilst saving energy and increasing the sustainability. These crops specifically include **perennial** rhizomatous switchgrass, miscanthus, giant reed and some others that, except for the establishment year, do not require annual tillage and chemicals, and increase the soil organic matter. For example, with conventional tillage as a baseline, soil carbon sequestration under no-tillage systems was found to increase from 0.40 to 0.60 Mg ha^{-1} yr^{-1} (see Liebig *et al.*, 2005 and Franzluebbers, 2005 for an extended review), which is also consistent with estimates by IPCC[372] (0.30-0.50 Mg ha^{-1} yr^{-1}). In contrast, continuous cropping systems resulted to decrease C-sequestration of 0.05 Mg ha^{-1} yr^{-1} (Liebig *et al.*, 2005). A significant number of researches have been recently carried out on perennials crops and it is now well established that their cultivation can entail several environmental benefits compared to conventional annual crops. For example, in a study comparing perennial energy crops *vs.* conventional cropping systems (Fig. 23.1), the carbon sink and water use efficiency (Bonari and Venturi, 2004; VandenBygaart *et al.*, 2003) were found to substantially increase, while nitrogen leaching and soil erosion strongly decreased (Bonari, 2004). Nature conservation, soil compaction reduction and biodiversity protection could be other basic benefits coming from the exploitation of perennial crops.

Figure 25.3 - Range of input requirements, carbon sink and soil organic mater variation of a perennial crop compared to a conventional crop rotation of annual crops in Central Italy.



Source: Bonari, 2004 modified

[372] Intergovernmental Panel on Climate Change.

25.3 Relevant issue 3 – Quantifying the positive and negative environmental impact mentioned at issue 2

25.3.1 Methodology

According to Eurostat data, the land area of **rapeseed** has increased over the last ten years of about the same amount of that dedicated to energy. Thus it may be argued that conventional rapeseed uses were not modified, whilst the measures concerned led to extend rapeseed land area, either substituting conventional crops or set aside land. In this study we assume that rapeseed exceeding set aside lands replaced the most conventional crop having the most similar growth cycle. This crop is wheat both in Germany and France, i.e. the two only countries with a significant amount of rapeseed area. Basing on this, it was estimated that 211,017 hectares (i.e. an area corresponding to that cultivated with rapeseed under the AEC in 2004) of **wheat** and 388,648 hectares (i.e. an area corresponding to that cultivated with rapeseed under the NFSA regime in 2004) of **fallow set aside** areas have been replaced by rapeseed throughout the last ten years. The gain in carbon sink or the decrease of N-leaching due to the replacement of conventional crops or set aside areas with rapeseed were estimated comparing carbon sink or N-leaching in wheat (211,017 ha) or fallow set aside lands (388,648 ha) to an equivalent land areas of rapeseed.

Conclusions on environmental impacts of energy crops should be given taking into account the other environmental indicators, i.e. not only carbon sink and nitrogen leaching. For example, water quality, biodiversity, soil erosion, loss of organic matter, contamination, salinization may have an important role on the whole environmental benefits and judgment on energy crops. However, as specified later on, all these factors have been weakly or not studied so far, and unsatisfactory information is available in literature for this crop and specific situations. Therefore, only carbon sink and nitrogen leaching effects will be estimated, while a general description of the other issues will be given.

Carbon sink was obtained by multiplying coefficients found in literature concerning soil carbon sequestration of rapeseed, wheat and set aside land, typically fallow set aside. Specifically, the coefficients were as following: rapeseed: 0.37-0.42 Mg (C) ha^{-1} yr^{-1} (Bona *et al.*, 2003); wheat: 0.19-0.35 Mg (C) ha^{-1} yr^{-1} (Liebig *et al.*, 2005); fallow set aside land: 0.17 to 0.40 Mg (C) ha^{-1} yr^{-1} (Watson *et al.*, 2000; Freibauer *et al.*, 2004). These coefficients are strictly related to the environmental conditions, the soil type, the variety and other variables which can drastically change throughout the EU agricultural areas and obviously cannot be completely discussed here. Given the variation of pedo-climatic conditions an average value would provide unreliable results, therefore in this report a range of values are provided.

Nitrogen leaching was calculated using software SIMAPRO 7.0 based on CML 2000 method working on Ecoinvent Database – unit process, by the University of Leiden. Total nitrogen was converted into the euthrophication ion PO_4^{3-} by multiplying for 0.42. A 25% less nitrogen leaching was assumed for rapeseed replacing wheat (Toniolo and Mosca, 2001), and 30% less N-leaching was considered by replacing set aside land with rapeseed (Aronsson *et al.*, 1998; Thorup-Kristensen *et al.*, 2003). The effect of less N-leaching due to the cultivation of rapeseed was weighed on total euthrophication in EU15 and expressed as percentage.

Limitations and validity of methodology

Rapeseed area increased in the last ten years; in contrast, the whole EU agricultural land area did not increase. Consequently if the area of one crop increases there must be at least another crop which decreases. This area was supposed to be shared between wheat and set aside land. For the hectares exceeding the set aside area, wheat was assumed to be the only crop replaced by rapeseed, being the most important winter crop and having husbandry and growth cycle very similar to rapeseed. This is a limit of the methodology as it could not be unequivocally ascertained which type of crop was actually replaced by rapeseed. Another limit was to consider an average environmental condition for each Member State without discriminating soil types, weather conditions or farming facilities and skills. As such, the effects of soil type, crop management and climate were not included, while a global figure is presented.

Some more limitations derive from the lack of reliable information, in literature, regarding the environmental effects of the most relevant energy crop (identified in rapeseed) and the main alternatives (here identified, as explained above, in wheat and in the fallow set aside). The sole available data to this end regard carbon sink and nitrogen leaching, while only qualitative information – mainly based on logical comparison among different crops – are provided for the other environmental indicators.

25.3.2 Results

Results are summarized in Table 25.1. Basing on them, it could be argued that replacing wheat or set aside land with rapeseed may lead to positive or negative environmental impacts on carbon sequestration, depending on environmental and climatic conditions as well as on agricultural practices. To this end, it is important to underline that different environmental and climate conditions might lead to differently positive or negative results. For example, replacing wheat with rapeseed (i.e. the real scenario) almost 17,000 Mg yr^{-1} of soil carbon would be lost in the most pessimistic situation. Similarly, up to 11,600 Mg C yr^{-1} can be lost by replacing set aside land with rapeseed.

Both wheat- and set aside-replaced areas were found to reduce nitrogen leaching more or less relevantly depending on scenarios. These results are in agreement with other experiences demonstrating the high tendency of rapeseed to uptake nitrogen, whilst preventing nitrate contamination of sub-soil waters[373]. However, because of the very limited land area destined to rapeseed for energy use towards the total EU-15 agricultural land, the overall positive effect on euthrophication has to be considered insignificant.

Table 25.1 **-** *Carbon sink and nitrogen leaching gains given by the cultivation of rapeseed*

Land use	Replaced areas (ha)	C-sink (Mg yr^{-1}) Simulated scenario (without measures) min	max	Real scenario (with measures) min	max	Differences pessim.	optim.	N-leaching % total eutroph.
Wheat	211.017	40.093	73.856	56.975	88.627	-16881	48.534	-0.014
S-A	387.452	65.687	154.981	143.357	174.351	-11624	108.664	-0.058

The "real scenario" is given by the effects of measures concerned for energy use. The "simulated scenario" concerns the situation which would theoretically verify if the measures would not have been applied.
S-A = Fallow set aside.

25.4 Judgment

As regards the potential **environmental effects related to the cultivation of energy crops under the AEC**, the comparison between the most common energy crop under this scheme at the EU level (rapeseed) and the crop which rapeseed is most likely to have substituted (wheat)[374], lead to the formulation of the following judgments.

- As regards the effects on **biodiversity**, **pesticides** and **erosion**, no relevant differences were found between the two crops, and hence no major environmental effects concerning such aspects are plausible for rapeseed grown under the AEC. Moreover, the issue of erosion results not to be really relevant in this context, being erosion phenomena almost absent in the plain areas where the cultivation of rapeseed for energy purposes is most common.
- As regards **carbon sink**, rapeseed is generally considered an optimal carbon sink crop. However, according to literature, it results to be carbon sink or source depending on the yield level. Results deriving from the comparison between the two crops (rapeseed and wheat), put in evidence that replacing wheat with rapeseed, almost 17,000 Mg yr^{-1} of soil carbon would be lost in the most pessimistic situation, while in the most positive conditions, there would be an increase of around 48.000 Mg yr^{-1}.
- As regards **nitrogen leaching**, rapeseed is known to be an excellent catch-crop having a high intrinsic capacity to recover inorganic nitrogen from the soil during autumn-winter period, thus preventing the N-leaching risks. It was estimated that leached nitrogen of rapeseed was from 20 to 30% less than wheat. Therefore a positive effect on surface water and euthrophication could derive from replacing wheat with rapeseed. The maximum effect attributable to the measure (AEC) on nitrogen leaching is estimated in around 14‰ of the total euthrophication.

Summarising, the cultivation of **energy crops under the AEC** has, according to the available information, **limited environmental effects in general**, since it mainly replaces conventional crops with similar agricultural techniques and similar environmental effects.

As far as the potential **environmental effects related to the cultivation of energy crops under the NFSA regime** are concerned, a comparison was made between the most common crops under this regime (rapeseed and secondly sunflower) and the main possible alternative on the same land, represented by the

[373] Sieling et al., 1998; Jensen et al., 1997.
[374] In the case where rapeseed for energy purpose replaced conventional rapeseed (conversion of use for the same crop) no relevant effects can be estimated according to literature, because of very similar cultivation techniques.

fallow set aside[375]. To this end, the following judgments can be formulated.

- **Soil erosion**: no substantial differences are documented between a coverage with oilseed crops and a covered set aside.
- **Pesticides**: it can be said on a logical basis, that being the fallow set aside normally not treated at all, higher environmental risks are likely to derive from any substitution of it with other crops, including rapeseed, even though this effect is impossible to quantify.
- **Water balance**: generally speaking water consumption is lower in the case of covered set aside than in the case of the cultivation of any traditional crop. The cultivation of an energy crop may therefore lead to negative effects highly dependent on climate, periods of pasture and other factors.
- **Biodiversity**: a positive role in this sense is attributed to set aside lands, thanks to the presence of a mixture of different species. Specifically, a positive effect would be registered on the conservation of certain populations of birds, including for the rotational set aside. Replacing fallow set aside with an energy crop may therefore lead to negative effects on biodiversity.
- **Organic matter**: a slight increase of organic matter could be achieved through the cultivation of rapeseed, however this could strongly vary depending on initial soil composition, climate course, mineralization rate etc.
- **Carbon sink**: as already seen in the context of AEC, rapeseed results to be carbon sink or source depending on the yield level. Results deriving from the comparison between rapeseed and fallow set aside, quantify in 11,600 Mg C yr^{-1} the maximum level of carbon sink which could be lost attributable to the measures, in case of replacing of set aside land with rapeseed, and around 108,000 Mg C yr^{-1} the maximum possible increase.
- **Nitrogen leaching**: The substitution of fallow set aside with rapeseed was found to determine a reduction in nitrogen leaching. The maximum effect attributable to the measure (NFSA) is estimated in around 58‰ of the total euthrophication.

Summarising, the cultivation of energy crops under the NFSA regime (replacing fallow set-aside) may lead, according to the available information, to a reduction in environmental risks as regards the nitrogen leaching and the organic soil content and to higher environmental risks as concerns pesticides, water quantity, and biodiversity. As regards soil erosion and carbon sink, a general trend cannot be identified. The effects depend widely on site-specific conditions and on the management of fallow set aside land applied.

Despite all the above considerations, it is essential to remind that at present the **total area under the AEC and NFSA regimes represents a very limited share of the total EU-15 usable agricultural area** (less than 0,6% and 0,4% for the NFSA and the AEC respectively). Consequently, the **environmental effects at EU level** actually deriving from the application of the two measures ***until now*** should be considered **limited**.

Finally, looking at potential future developments of energy crops, it is worth citing the positive environmental effects which could derive by an expansion of the **cultivation of perennial ligno-cellulosic energy** crops, which – according to recent studies and researches – would require very limited agronomic inputs, whilst increasing carbon sink, organic matter, N-saving, soil compaction and erosion[376].

A more in-depth and specific analysis of the environmental impacts of the AEC and the NFSA regime will be carried out in the context of the *Evaluation of the environmental impacts of measures taken by common market organisations and CAP direct support measures in the arable crops sector*, recently commissioned by DG Agriculture (results are expected by the end of 2007).

[375] The hypothesis of "well managed" set aside is adopted, being substantially different the results in case of non-covered or partially covered set aside land.

[376] McLaughlin and Kszos, 2005; Lewandowski et al., 2003; Börjesson, 1999; McLaughlin and Walsh, 1998; Kort et al., 1998.

26 CONCLUSIONS ON THE EVALUATION QUESTIONS

In this paragraph, a synthesis of the judgments formulated in the evaluation work is provided, and the linkages among the judgments are highlighted. The judgments are grouped according to the kind of issues under study (the EQ concerned are indicated in parentheses).

26.1 Effects of the measures on the volume of production of biomass, bio-energy sources and bio-energy (EQ 1, 3, 4, 5, 9 and10)

Oilseeds, and **rapeseed** in particular, have been the leading energy crops grown in the EU under the AEC and NFSA regime over the evaluation period (EQ 1). The leading bio-energy sources, whose supply chain economics have been significantly influenced by these measures (through their effect on the economics of energy crop cultivation) have been **bio-diesel** and **bio-ethanol** (EQ 3).

26.1.1 Effects on the volume of production of energy crops (EQ 1)

AEC

The area under **AEC** has increased[377] from around 305.000 ha in 2004 to 560.000 ha in 2005, reaching about **1,2** million ha (provisional figure) in 2006. The maximum guaranteed area - 1,5 million ha - has not been exceeded. Since its introduction in 2004, the AEC has played a decisive[378] role as an incentive to the farmer to introduce the cultivation of or to increase the area under energy crops ***only*** where market margins for the energy crops are negative or tight or wherever the support granted by the AEC makes an energy crop more profitable than the most common alternative (non energy) crop. This was observed in four cases (three cases in one region, one case in another region) out of ten studied (six regions studied in total). Therefore, the effectiveness of the AEC as an incentive has been **limited to specific situations[379]**.

In the other situations, it is probable that the aid for energy crops has had some deadweight effects[380] which have diminished its efficiency[381].

Indeed, promoting factors other than the support granted by the AEC also have played an important role, especially where the market margins for the energy crops are high. This is proved by the existence of a substantial area on non-set aside land (around 700.000 ha in 2004 and about 1 million ha in 2005) which is cultivated with energy crops outside specific regimes. The granting of **additional support** through public policies at Member State level and/or through non-CAP measures at EU level (EQ 9), and other **favourable systemic factors** - in certain regions and bio-energy supply chains - (EQ 10) have been among the most important promoting factors.

Should the AEC be terminated, it is plausible to deem that decreases in the area under energy crops in the regions where the AEC plays a decisive role as an incentive could be avoided through slightly higher biomass price levels, needed to compensate the loss of the additional revenue granted by the AEC (see EQ 1 and EQ 2). The extent of the price increases needed would probably vary in the different regions, and could be zero in the regions where the AEC does not play a decisive role as an incentive.

NFSA regime

[377] According to figures from DG AGRI-D1. Year 2006: the areas for which the aid has been claimed communicated by the Member States are of about 1 million ha. However, figures for Ireland, Spain and United Kingdom still had to be communicated at 01/09/2006. The area under the AEC for these three Member States combined in 2005 was of about 120.000 ha (of which around 90.000 ha in the United Kingdom). Considering the substantial increase which occurred in the other Member States between 2005 and 2006 (about 100%), it is plausible that the total area under the AEC in 2006 is of about 1,2 million ha (= 1 + 0,2 million).

[378] The role of one of the measures under study is deemed "decisive" in this respect when we can reasonably be sure that, in absence of the support granted by the measure, no cultivation of energy crops would have taken place.

[379] Here it is worth reminding that the scope of the evaluation, as an ex-post evaluation, is limited to the EU-15 and the period until 2006. Therefore it does not cover the 10 new Member States.

[380] "Deadweight" is defined as effects which would have arisen even if the intervention had not taken place.

[381] Efficiency: best relationship between resources employed and results achieved in pursuing a given objective through an intervention. In the context of this evaluation only the budgetary costs of the intervention are considered, whereas other economic costs indirectly stemming from the intervention are not taken into account.

The NFSA regime acts as an incentive to the farmer to introduce, maintain and increase the cultivation of energy crops through both the avoided cost of land maintenance (with respect to fallow set-aside), and the fact that on set aside land there are no feasible gainful alternatives to the cultivation of non food crops. The area under the NFSA regime increased from 235.000 ha to over 1 million ha between 1993 and 1995. From 1996 onwards, the evolution of the energy crop area under NFSA regime has followed the variations in the rate of compulsory set aside, which constitutes an intrinsic limit of this measure. The extent of such area has also been constrained by the Blair House obligations, which constitute a relevant limiting factor to an increase of the set aside area under oilseeds. However, at a global level, within those two limits, the measure has been effective in promoting the primary production of energy crops on set aside land: the prove of such effectiveness is given by the fact that the plafond set by the Blair House Agreements was nearly filled in 1995, after just two years of implementation of the measure. In 2005, about 835.000 ha of energy crops were grown under the NFSA regime.

An advantage of the measure is that it achieves its effects with no additional cost for the EU budget with respect to the ordinary set aside regime.

Should the measure (i.e. the authorization to grow non food crops on set aside land) be terminated, the total supply of energy crops would decrease. No factual elements are available to quantify such decrease. Theoretically speaking, it could result – in the short period – in higher prices, and hence in an increased profitability of energy crops in the EU, provided however that the supply shortage is not covered instead by imports of biomass and/or bio-energy sources from third countries.

Limiting factors

The main **non measure-specific limiting factors to an increase in the production of biomass from energy crops** are identified in price levels (insufficient demand for biomass due to limited presence of processing plants at a reasonable distance from the producing areas) and agronomical constraints, which negatively influence the profitability and the feasibility of the crops.

26.1.2 Effects on the volume of production of bio-energy (EQ 3, 4, 5, 9 and 10)

The AEC and the NFSA regime could promote – in theory at least – an increase in the volume of production of bio-energy only by reducing the cost of the biomass used as feedstock, via the achievement of lower biomass prices. However, biomass price levels reached in presence of the support granted by the AEC and the NFSA regime are in most cases unable, alone, to make bio-energy competitive to energy generated from fossil fuels (EQ 2; EQ 9). Should the NFSA regime be terminated, the total supply of energy crops would probably decrease, but no factual elements are available to quantify such decrease. As regards the AEC, it can have effects on the volume of bio-energy only where the aid has been decisive in introducing the energy crops[382]. Therefore the measures have had an effect on the absolute level of the volume of bio-energy produced, however to an extent which it was not possible to quantify. Moreover, as the supply of both bio-fuels in the EU has practically doubled between 2003 and 2005, the increase in the supply of feedstock for bio-diesel and bio-ethanol production which has followed the introduction of the AEC in 2004 is unable to explain by itself an increase of this magnitude. It has also to be taken into account that no increase in the supply of feedstock for both bio-fuels were achieved on the area under the NFSA regime in the same period, and that the most remarkable increases must instead be attributed to energy crops grown outside specific regimes. In conclusion, the **NFSA regime** and the **AEC**, individually and/or in combination with one another, **have not played a decisive role in promoting the increase in the volume of bio-energy sources and of bio-energy which occurred in the last years of the evaluation period**.

The **level of implementation** of the RDMs specifically related to bio-energy production, as well as the number of supported projects, was found to be **very limited at the EU level**[383]. Satisfying levels of implementation were found to be achieved only in two Member States among those studied, and only for specific project typologies (mainly related to bio-gas production from maize and animal wastes and to

[382] The aid has been decisive in introducing the energy crops only in four cases (three cases in one region, one case in another region) out of ten studied (six regions studied in total).

[383] According to the available information, at least the following measures have been implemented over the evaluation period: forestry measures for projects for energy use of wood, measures concerning the investments in equipment for the use of biomass as energy source (mainly biogas from maize and animal waste), and measures concerning support for planting multi-annual biomass crops.

energy use of wood and wood products). The effect of **Rural Development Measures** on the volume of production of bio-energy has hence to be considered **limited**.

The Rural Development Measures are efficient[384] as regards the implementation of each individual project: the funding is granted only for projects which are actually accomplished. However, given the low number of projects accomplished at EU level, to a limited cost for their funding corresponded also a limited effectiveness.

As the Rural Development Measures promote mainly investments in fixed capital, the viability of the projects accomplished cannot be affected by a termination of the measures themselves.

The **synergies** identified between the Direct Aid Measures and the Rural Development Measures (EQ 5) have had effects on the volume of bio-energy to an extent which can be deemed as **limited** and concerning only **specific situations**.

Finally, on the basis of a systemic approach (see EQ 10) a number of **factors which may facilitate or hinder the production of bio-energy** was identified:

- Extent of the **required investments**. The main limiting factor in this respect was identified in market risks stemming from uncertainties associated with the actual implementation and duration of non-CAP support measures.
- **Supply chain organisation and relationships among the different levels of the supply chains**: insufficient horizontal and vertical coordination within the supply chains was found to be a limiting factor for their development, especially when the processing stage is centred on large scale industrial activities.
- **Structural and infrastructural factors** at regional level were found to be of particular relevance for bio-energy supply chains (bio-gas and direct burning of solid biomass) which rely on local markets for both the purchasing of feedstock and the sales of their products.

26.2 Effects of the measures on the choice of a specific crop among the various alternatives (EQ 6)

The measures which have the potential to cause unintended effects on the relative shares of the different kinds of energy crops are identified in the following:

- in the pre-decoupling context, the **arable crop area payments** (non-eligibility for area payments of some kinds of energy crops and possible differentiated payments by type of crop);
- in the post-decoupling context, the **partially coupled payments**;
- the **specificity concerning sugar beet cultivation** for energy purposes before the reform of the CMO for sugar in 2006 (renounce to set aside payments under the NFSA regime; non eligibility for the AEC).

However, **none of the identified measures has caused in practice significant unintended effects on the relative shares of the different kinds of energy crops**.

The measure which has the potential of distorting competition between energy crops and food/feed crops is the **AEC**, as it could cause shifts in the relative profitability of energy crops versus crops for food/feed use. Some shifts in the destination of a specific crop (from food/feed use to energy use) have indeed been observed, as well as substitutions of a crop for food/feed use (e.g. wheat) with another crop for energy use (e.g. rapeseed). However, the substitution of food/feed crops with energy crops seems to be mostly due to factors other than the measure, such as changes in price dynamics for different destinations of agricultural products, i.e. food/feed versus energy (except in two regions out of six studied, where the aid for energy crops was decisive in this respect – see EQ 1). Moreover, the above phenomena have concerned only an extremely limited portion of the total usable agricultural area in the EU-15 (about 0,2% in 2004 and 0,4% in 2005).

Hence the **AEC cannot be deemed to have caused significant distortions in the competition between energy crops and crops for food/feed use** at EU level over the evaluation period.

[384] See note 381.

26.3 Effects of the measures on the competitiveness of the production of bio-energy versus energy produced from other sources (EQ 2 and 9)

The **AEC** can have direct effects on biomass prices[385], which were however found to be generally **too limited** to contribute significantly to achieve a price level for energy crops allowing them and bio-energy gained from them to be competitive to other energy sources. As regards the **NFSA regime**, its effects on price are only indirect ones[386], whose extent could not be quantified. However, some qualitative considerations[387] suggest that its contribution has probably been **modest**.

The **contribution of the AEC and of the NFSA regime to the competitiveness of the sources of bio-energy** is therefore **very limited**: in the cases studied[388], the AEC[389] corresponded, in the case of electricity generation from biomass, to 1,4% of the full cost of an energy unit and, in the case of bio-fuels production, to 4-6,5% of such cost. In comparison, in the cases studied, the additional support granted at Member State level corresponded, in the case of electricity generation from biomass, to 19-62% of the full cost of an energy unit and, in the case of bio-fuels production, to 64-105% of such cost.

Indeed, it is **at present impossible**, with the available technologies and with the present levels of biomass prices, **that most of the bio-energy supply chains** under study **may survive without additional support at Member State level and/or non-CAP support at EU level**. Biomass-based technologies are in general still unable to compete with conventional technologies based on the use of fossil fuels in terms of costs of production.

The support granted by the **AEC** corresponds to a very small fraction of the full cost of an energy unit; moreover, it is plausible to deem that it was decisive for the profitability and competitiveness of bio-energy ***only*** in very few specific situations - in comparison with an hypothetical situation featuring the sole additional support at Member State level –(the supported price of biomass-based electricity has been very close to its unit full cost only in few cases; the unit full cost of bio-fuels has never been very close to the price – excise duty included - of conventional fuels over the evaluation period).

26.4 Effects of the measures on farmers' income, occupation and standards of living in rural areas (EQ 7 and 8)

The contribution of the AEC and of the NFSA regime to the **diversification of income of farmers** has been **very modest**[390]: the diffusion among farmers of the cultivation of energy crops under the AEC and the NFSA regime has been very low in most Member States over the evaluation period. In 2004[391] the beneficiaries of the AEC represented less than 1,5% of the total number of farms in all Member States but two; the beneficiaries of the NFSA regime in the same year represented more than 4% of the total number of farms only in four Member States. The same can be said for Rural Development Measures (only a few thousands projects specifically concerning bio-energy were funded by the measures at EU level).

The **portion of farm income** that can be attributed to energy crops cultivation under the AEC and the NFSA regime[392] was on average **not relevant**[393] in nearly all the representative situations studied at regional level. The portion of farm income resulting from the energy crops grown under the AEC and the NFSA

[385] To keep constant the profitability of energy crops in absence of the additional revenue granted by the aid for energy crops, an equivalent additional amount of market revenues should be granted via higher biomass prices.

[386] By promoting the cultivation of non food crops on set aside land, the non food on set aside regime increases the supply of biomass for energy purposes: if demand remains constant, or increases less than supply, this might result in lower biomass prices.

[387] Whenever the cultivation of an energy crop on set aside land is the only feasible alternative to fallow set aside, the farmer could accept – in theory at last - any price level (also lower than the ones actually paid) which makes energy crops cultivation more profitable than leaving the land fallow. However, no evidence emerged from the case studies suggesting that such potential of the NFSA regime to achieve cheaper biomass prices has actually been exploited.

[388] Different representative bio-energy supply chains in different representative regions of the EU.

[389] An analogous indicator cannot be calculated for the support granted by the NFSA regime because – differently from the AEC – it is not an explicit monetary amount, but an "implicit subsidy" with reference to alternative uses of set aside land.

[390] This was the case at least until 2004 for the AEC and at least until 2003 for the NFSA regime.

[391] At the moment of carrying out this analysis, only data for 2004 campaign (financial year 2005) were available. Data were sourced from the Clearance Audit Trail System (CATS) database by Unit J.1 of DG-Agriculture.

[392] It was impossible to estimate the portion of farm income attributable to the support granted by the Rural Development Measures to on-farm investments in bio-energy related activities, as a great number of factors other than such support are also relevant in making such activities economically viable once started.

[393] This was the case at least until 2004 for the AEC and at least until 2003 for the NFSA regime. The relevance threshold is 20%. It is important to underline that the portion of income granted by the cultivation of energy crops outside these specific regimes (which was practised in the EU on an area of around 1 million ha in 2005) was not considered in the analysis.

regime, corresponding to the upper limit of the contribution of the measures[394], was found to be in the 5-15% range in six out of seven representative regional situations analysed[395] (on the basis of average data at regional level).

The contribution of the NFSA regime and of the AEC[396] to the **creation/maintaining of jobs in rural areas** has **not** been **significant**[397]. When compared to the number of jobs which could be[398] created or maintained in the representative regional situations studied by destining the land to fallow set aside - in the case of the NFSA regime – or to the most common conventional crop for food/feed use - in the case of the AEC - energy crops grown under the two measures could create or maintain few (if any) additional jobs[399]: always less than 160 Annual Working Units at regional level in the case of the NFSA regime, never more than 25 Annual Working Units at regional level in the case of the AEC.

The contribution of the AEC and of the NFSA regime – by promoting the introduction of energy crops on the farm - to the **achievement of a fair standard of living for the EU farmers** has **not** been **significant** from a general standpoint[400]. As none of the main energy crops grown under the AEC or the NFSA regime was found to grant a profitability markedly higher than that of the main crops for food and feed use, an essential prerequisite for increasing significantly farm incomes was lacking *a priori*. Moreover, the NFSA regime and the AEC have been a decisive factor in the introduction of energy crops on the farms only when their market margins are negative or tight (see § 26.1), i.e. in situations not conducive to the achievement of significant additional income. Finally, energy crops grown under the AEC can generate little additional income (if any) in comparison with the most common alternative crops for food/feed use; the portion of farm income attributable to energy crops cultivation under the AEC and the NFSA regime has not been relevant[401]; the cultivation of energy crops under the AEC or the NFSA regime has had a very low diffusion among the EU farmers.

26.5 Environmental effects of the measures (EQ 11 and 12)

In the scientific literature, the estimates on the reduction of CO_2 emissions and the saving of fossil fuels achievable through the use of bio-energy and especially of bio-fuels vary widely, depending on assumptions about system boundaries, values of key parameters and their weights in the analysis. According to some studies, only limited reductions can be achieved through the use of bio-fuels; according to other studies, the use of bio-fuels would even result in an increase in CO_2 emissions. The absence of a consolidated state of the art, which could constitute the basis for a reliable "from field to engine" assessment, was the main reason behind the choice of the evaluation team to focus, in the context of this study, on the sole consumption stage (i.e. the use of fossil fuels and the related GHG emissions in the upstream stages of the bio-energy supply chains are not taken into account). Hence the estimated contribution of the measures

[394] We speak of "upper limit" because it is assumed that the role of the AEC and of the NFSA regime as policy incentives to the cultivation of energy crops is always decisive or relevant, whereas it is not so in practice (see EQ 1).

[395] To estimate the portion of farm income resulting from the activities supported by, respectively, AEC and NFSA, the following two situations were assumed as representative: A) In the case of the AEC, the "typical" farm grows energy crops under the AEC on an area equal to the average area under AEC per holding benefiting from such measure in the region under study. B) In the case of NFSA regime, agricultural area under compulsory set aside regime in the "typical" farm is entirely destined to the cultivation of energy crops under the NFSA regime. The methodology used for the estimates, and the assumptions at A) and B) above, could lead to over- or underestimate the portion of farm income resulting from the activities supported by AEC and NFSA regime in real farms whose characteristics deviate substantially from those of the "typical" one."

[396] As regards the contribution of both the Rural Development Measures and the Direct Aid Measures to the creation of jobs in the processing stage of the bio-energy supply chains, it proved impossible to assess the share of such jobs that can surely be attributable to the measures, given the high number of other factors that can play a role in this respect.

[397] This was the case at least until 2004 for the AEC and at least until 2003 for the NFSA regime.

[398] The estimate was made following a socio-economic approach, instead of a purely technical one, and was based on the ability of energy crops to create income, as to be created/maintained a job must be able to generate income for the worker and also for his/her employer (in the case of hired labour).

[399] The analyses are referred to year 2004 for the AEC, and to year 2003 for the NFSA regime. In the case of the AEC, only data for 2004 campaign (financial year 2005) were available at the moment of carrying out the analysis. In the case of the NFSA regime, the evaluation team chose not to use in the analysis data for year 2004 (though available) as it was the only year over the 1999-2005 period when the rate of compulsory set aside was not 10%, but 5%.

[400] This was the case at least until 2004 for both the AEC and the NFSA regime. The more plausible exceptions to the above judgment are represented by farm-specific cases featuring the start of on-farm bio-energy production activities funded by the Rural Development Measures under study: however many factors other than the support granted by these measures are also relevant in making such activities economically viable once started.

[401] It is important to underline that the portion of income granted by the cultivation of energy crops outside these specific regimes (which was practised in the EU on an area of around 1 million ha in 2005) was not considered in the analysis.

corresponds to the **upper limit of the potential contribution of the NFSA regime and of the AEC to reduced CO_2 emissions and the saving of fossil fuels**.

As regards the **electricity sector** and the **heating sector**, the contribution of the CAP measures under study to the reduction of CO_2 emissions and the saving of fossil fuel can be considered **negligible**.

As regards the **transport sector**, the upper limit of the potential contribution of the NFSA regime and the AEC to reduced CO_2 emissions and the saving of fossil fuels for the EU-25 was estimated[402] in:

- A fossil fuel displacement of approximately 2,02 billion litre diesel (attributable to bio-diesel use) and 0,42 billion litre petrol (attributable to bio-ethanol use). The total EU fuel consumption amounted to around 213 billion litres diesel and 140 billion litres petrol in 2005.
- A reduction of CO_2 emissions of approximately 1,76 Mt CO_2, of which 1,49 Mt CO_2 avoided through the use of bio-diesel and 0,27 Mt CO_2 avoided through the use of bio-ethanol.

However, the actual contribution of the NFSA and the AEC to reduced CO_2 emissions and the saving of fossil fuels is probably **significantly lower** (to an extent which was not possible to quantify in the framework of this study), especially because:

- The AEC is not always decisive in the farmers' decision to grow energy crops (see EQ 1).
- The role of the NFSA regime and of the AEC in assuring the economic viability of the bio-fuels supply chain is not decisive (see EQ 2, 3 and 9).
- As already mentioned, only the stage of consumption was considered in this analysis.

The cultivation of energy crops under the **AEC** has had, according to the available information, limited **environmental effects** in general over the evaluation period since it has mainly replaced conventional crops with similar agricultural techniques and similar environmental effects. The cultivation of energy crops under the **NFSA regime** (replacing fallow set-aside) may have led, according to the available information, to positive effects as regards the nitrogen leaching and the organic soil content and to negative effects as concerns pesticides, water quantity, and biodiversity. As regards soil erosion and carbon sink, a general trend could not be identified. The effects depend anyway widely on site-specific conditions, and on the management of fallow set aside land with which energy crops are compared.

As the total area under the AEC and NFSA regimes represents a very limited share of the total EU-15 usable agricultural area (in 2005 less than 0,6% and 0,4% for the NFSA and the AEC respectively), the environmental effects *at EU level* actually deriving from the application of the two measures *until now* should be considered limited.

Finally, looking at potential future developments of energy crops, it is worth citing the positive environmental effects which could derive by an expansion of the cultivation of perennial ligno-cellulosic energy crops, which – according to recent studies and researches – would require very limited agronomic inputs, whilst increasing carbon sink, organic matter, N-saving, and reducing soil compaction and erosion.

A more in-depth and specific analysis of the environmental impacts of the AEC and the NFSA regime, including a "from field to engine" assessment of the CO_2 emission impacts, will be carried out in the context of the *Evaluation of the environmental impacts of measures taken by common market organisations and CAP direct support measures in the arable crops sector*, recently commissioned by DG Agriculture (results are expected by the end of 2007).

[402] The estimate was made by assuming that the quantity of bio-fuels produced by effect of the measures was equal to the quantities of bio-diesel and bio-ethanol obtainable from the whole quantity of biomass produced by the main energy crops which were relevant in this respect (oilseeds for bio-diesel; cereals and sugar beet for bio-ethanol), grown under both the AEC and NFSA regime in the EU in 2005. Relevant parameters: Energy crops yields, in terms of toe/ha: 1,2 for rapeseed, 0,9 for sunflower, 4 for sugar beet and 1,7 for cereals. Fuel consumption substitution rate of 1.088 litre bio-diesel per litre diesel and one of 1.472 litre bio-ethanol per litre petrol. Emission factors of 734 g CO_2/litre diesel and 640 g CO_2/litre petrol.

OUTLOOK AND RECOMMENDATIONS

27 OUTLOOK FOR FUTURE MARKET DEVELOPMENTS FOR BIO-ENERGY

27.1 Introduction

In this section a series of hypothetical scenarios is presented, describing the possible situation of the EU market till 2020 in the perspective of complete fulfilment of the RES target.

For each sector of energy use (electricity, heat and transport) a forecast is made:

1) of the **overall energy demand**[403].
2) of the **portion of the overall energy demand coming from RES** (necessary to comply with the targets set at the EU level) and of the consequent derived demand of bio-energy sources (bio-fuels, bio-gas and biomass).

Three different scenarios – differing for the level of the EU self sufficiency for energy crops - are presented to picture the situation of **demand of energy crops** resulting from the expected demand evolution by sector of energy use.

The forecasts are made following the assumptions represented in Box 27.1[404].

Box 27.1 – Assumptions and main limitations of the model

Demand	Supply of biomass for energy purposes
- The foreseen evolution of final energy consumption by sector of energy use (electricity, heat and transport) is exogenous to the model (the source is represented by official forecasts[405]); - The market share of each bio-energy source calculated on the final energy consumption (for each sector of energy use) is assumed to be constant in the considered period and equal to the shares registered in 2004;	- The production technology is assumed to be a constant parameter, as the forecasts concern a medium-term period (from 2005 to 2020). Nevertheless, Box 2.2 also drafts a perspective scenario in the hypothesis of agricultural yields growing of 1% per year. - Solid biomass for the production of electricity and heat destined to self consumption are not taken into account.

27.2 The foreseen demand by sector of energy use

This section presents the expected demand evolution of electricity, heat and fuels coming from RES, given the foreseen demand by sector of energy use (electricity, heat and transport) and the EU targets. The demand of bio-energy sources resulting from the expected demand evolution by sector of energy use is then estimated.

27.2.1 Electricity

The final electricity consumption is expected to increase significantly[406] (see Table 27.1). In particular, it is expected to increase by 33%% from 2004 to 2020, with an average increasing annual rate of 7,4%.

[403] Source: Eurostat data and "European energy and transport", trends to 2030 – update 2005, Directorate general for energy and transport, European Commission.
[404] See the following sections for the specific assumptions concerning each bio-energy source.
[405] See footnote 403.
[406] See footnote 403.

Table 27.1 - Final electricity consumption

	2004	2005	Forecast		
			2010	2015	2020
Final electricity consumption	2.651.682	2.718.710	3.015.775	3.283.661	3.522.936

Gwh
Source: Eurostat for 2004 and "European energy and transport", trends to 2030 – update 2005, Directorate general for energy and transport, European Commission, for forecasts 2005-2020.

Table 27.2 – UE targets: electricity

	from 2010
Share of electricity consumption produced from RES	21%

Source: Directive 2001/77/EC
NB: Directive 2001/77/EC requires MS to set national indicative targets for the consumption of electricity produced from renewable energy sources (RES-E) by 2010, based on reference values identified in the Annex to the Directive. These objectives should lead to an overall target of 21% of gross electricity consumption for EU-25 Countries. In addition, Directive 2001/77/EC allows for direct and indirect mechanisms for the support of RES-E.

In order to comply with the EU targets in terms of share of electricity consumption produced from renewable energy sources, RES-E (see Table 27.2) and given the final electricity consumption (see Table 27.1), the demand of the electricity produced from RES is expected to have the following evolution (Table 27.3).

According to Table 27.3, the compliance with the EU targets implies a significant increase of the electricity produced from solid biomass and from biogas (87% between 2004 and 2020)[407].

Table 27.3 – Demand of electricity to comply with the EU targets

	2004	2005	Forecast		
			2010	2015	2020
Electricity to be produced by RES-E	450.000	500.000	731.469	790.547	841.213
among which:					
solid biomass	35.000	39.000	57.055	61.663	65.615
variation rate towards 2004		*11,43%*	*63,01%*	*76,18%*	*87,47%*
- among which energy crops	140	156	228	247	262
variation rate towards 2004		*11,43%*	*63,01%*	*76,18%*	*87,47%*
biogas	13.050	14.500	21.213	22.926	24.395
variation rate towards 2004		*11,11%*	*62,55%*	*75,68%*	*86,94%*
- among which energy crops and agricultural residues	1.958	2.175	3.182	3.439	3.659
variation rate towards 2004		*11,11%*	*62,55%*	*75,68%*	*86,94%*
Solid biomass/RES-E	***7,8%***	***7,8%***	***7,8%***	***7,8%***	***7,8%***
Biogas/RES-E	***2,9%***	***2,9%***	***2,9%***	***2,9%***	***2,9%***
Energy crops/solid biomass	*0,4%*	*0,4%*	*0,4%*	*0,4%*	*0,4%*
Energy crops and agricultural residues/biogas	*15,0%*	*15,0%*	*15,0%*	*15,0%*	*15,0%*

Gwh
Source: DEIAGRA elaborations

[407] It should be remembered (see box 2.1) that:

- Actually, the RES produced from solid biomass and bio-gas accounts for 7,8% and 2,9% of the total electricity produced by RES in 2004. Energy crops represent about 21% of the energy coming from solid biomass, whereas agricultural residues represent about 18% of the energy coming from bio-gas.
- We assume that the share of the electricity coming from solid biomass and bio-gas on the total electricity produced by RES remains constant in the considered period. Furthermore, we assume that the share of electricity coming from energy crops on the total electricity produced by solid biomass, as well as the share of electricity coming from agricultural residues on the total electricity produced by bio-gas, remain constant in the considered period.
- Given the evolution of electricity demand, the EU targets and given the above-mentioned assumptions, we point out that the electricity produced from solid biomass (among which the electricity coming from energy crops) and bio-gas (among which the electricity coming from agricultural residues) should increase about 87% from 2004 to 2020.

27.2.2 Heat

The final heat demand is expected to increase in the next years (see Table 27.3), in particular it is expected to increase about 22% from 2004 to 2020.

Table 27.4 – Final heat demand (from CHP and district heating)

	2004	2005	Forecast		
			2010	2015	2020
Final heat demand (from chp and district heating)	72.000	74.217	80.177	83.571	87.691

Ktoe
Source: "European energy and transport", trends to 2030 – update 2005, Directorate general for energy and transport, European Commission, for forecasts 2005-2020.

Table 27.5 – UE targets: heat

	2010
Share of final heat demand produced from RES	20%

Source: European Parliament final A6-0020/2006.
NB: As far as the heating sector is concerned no EU framework legislation has been set out to date for the promotion of RES. The European Parliament has recently adopted a motion for a resolution requesting the Commission to submit a legislative proposal on increasing the share of renewable energy for heating and cooling, following a series of recommendations provided by the Parliament itself (European Parliament final A6-0020/2006). The Commission's proposal should set a target for the share of RES in heating and cooling of at least 20% by 2020 as compared to the current share of approximately 10%.

In order to comply with the EU targets in terms of share of heating demand produced from renewable energy sources, RES-H (see Table 27.5) and given the final heat demand (see Table 27.4), the demand of heat produced from RES should have the following evolution (Table 27.6).

Table 27.6 – Demand of heat to comply with the EU targets

	2004	Forecast		
		2010	2015	2020
Heat to be produced by RES-H	2.024	16.035	16.714	17.538
among which:				
solid biomass	1.600	12.684	13.221	13.873
variation rate towards 2004		*692,75%*	*726,31%*	*767,04%*
- among which energy crops	6,40	50,74	52,88	55,49
variation rate towards 2004		*692,75%*	*726,31%*	*767,04%*
biogas	423	3.351	3.493	3.665
variation rate towards 2004		*692,26%*	*725,80%*	*766,51%*
- among which energy crops and agricultural residues	63	503	524	550
variation rate towards 2004		*692,26%*	*725,80%*	*766,51%*
Solid biomass/RES-H	***79,1%***	***79,1%***	***79,1%***	***79,1%***
biogas /RES-H	***20,9%***	***20,9%***	***20,9%***	***20,9%***
Energy crops/solid biomass	*0,4%*	*0,4%*	*0,4%*	*0,4%*
Agricultural residues/biogas	*15,0%*	*15,0%*	*15,0%*	*15,0%*

Ktoe
Source: DEIAGRA elaborations
NB: data do not take into account the heat produced by domestic apparatus[408]
According to Table 27.6, the compliance with the EU objectives implies an increase of the heat produced from RES from 427 Ktoe in 2004 to 17,5 Mtoe in 2020.

[408] See Box 27.1.

According to table 27.6 the compliance with the EU targets implies a significant increase of the heat produced from solid biomass and from biogas (770% between 2004 and 2020).

27.2.3 Transport

The total demand of fuels for transport[409] is expected to increase about 19% from 2004 to 2020.

Table 27.7 – Petrol and diesel demand evolution

	2004	2005	Forecast		
			2010	2015	2020
Total	350,24	360,61	377,20	400,00	416,30
among which:					
- gasoline	117,34	115,00	142,10	144,00	145,40
- diesel	172,60	175,00	182,10	194,00	207,60

Mtoe
Source: Eurostat for 2004 and "European energy and transport", trends to 2030 – update 2005, Directorate general for energy and transport, European Commission, for forecasts 2005-2020.

Table 27.8 – EU targets: transport

	2005	2010	2015	2020
Percentage of contribution of biofuels and other renewable fuels on the total quantity of fuels placed in the market (EU 25)	**1,40**	**5,75**	**5,75**	**5,75**

Source: Directive 2003/30/EC
NB: Following the White Paper "European Transport Policy for 2010: Time to Decide" (COM(2001) 370 final), Directive 2003/30/EC on the promotion of bio-fuels for transport requires MS to set national indicative targets to ensure that a minimum share of bio-fuels and other renewable fuels is placed into their markets for subsequent use in the transport sector. To this end, the Directive provides reference values for the share of bio-fuels of 2% and 5.75%, in 2005 and 2010 respectively, measured on the basis of energy content, and calculated as a percentage of all petrol and diesel placed in the market.

In order to comply with the EU targets in terms of percentage of contribution of bio-fuels and other renewable fuels on the total quantity of fuels placed in the market (EU-25) and given the total fuels demand, the demand of bio-ethanol and bio-diesel should have the following evolution.

Table 27.9 – Demand of bio-fuels to comply with the EU targets

	2004	2005	Forecast		
			2010	2015	2020
Bioethanol	0,21	1,61	8,17	8,28	8,36
Biodiesel	1,74	2,45	10,47	11,16	11,94
Total	1,95	5,05	21,69	23,00	23,94
Bioethanol/Total demand	***0,1%***	***0,4%***	***2,2%***	***2,1%***	***2,0%***
Biodiesel/Total demand	***0,5%***	***0,7%***	***2,8%***	***2,8%***	***2,9%***

Mtoe
Source: DEIAGRA elaborations

The compliance with the EU objectives implies an increase of bio-ethanol demand from 0,21 Mtoe in 2004 to 8,36 Mtoe in 2020 (+ 3804%) and an increase of bio-diesel demand from 1,74 Mtoe in 2004 to 11,94 Mtoe in 2020 (+ 586%).

[409] See footnote 406.

27.3 The foreseen demand of bio-energy sources

In this section, we estimate the demand of bio-energy sources resulting from the expected demand evolution by sector of energy use. We estimate, in particular, the demand of bio-fuels and bio-gas.

27.3.1 The demand of bio-fuels

The total demand of petrol and diesel for transport is expected to increase about 19% from 2004 to 2020.

In order to comply with the EU targets in terms of percentage of contribution of bio-fuels and other renewable fuels on the total quantity of fuels placed in the market (EU-25) and given the total fuels demand, the demand evolution of bio-ethanol and bio-diesel should have the trend highlighted in table 27.9.

27.3.2 The demand of bio-gas

The bio-gas demand is expected to increase[410] from 3.724 Ktoe in 2004 to 10.587 Ktoe in 2020.

Table 27.10 – Bio-gas demand evolution

		Forecast		
	2004	**2010**	**2015**	**2020**
Electricity	3.194,29	5.212,24	5.633,21	5.994,24
Heat	530,00	4.198,99	4.376,74	4.592,51
Total	**3.724,29**	**9.411,23**	**10.009,95**	**10.586,75**

Ktoe
Source: DEIAGRA elaborations
NB: It has to be taken into account that about 500 Mtoe are stocked

27.4 The foreseen demand of biomass

In this section, on the basis of the estimated demand of solid biomass presented above, an estimate is presented for the demand of energy crops and other biomass source which would derive from the context pictured above. After this preliminary estimate, the following paragraphs will show some different scenarios, based on different hypothesis in the level of self sufficiency for energy crops.

27.4.1 The demand of energy crops in the UE

Given the extent of the foreseen demand of **electricity** from biomass obtained by energy crops (see table 27.3), the yields in toe/ha (see Table 27.11) and given the supposed contribution of each energy crop[411] to the production of electricity (silo maize 70% and other cereals 30%), the areas are defined, which would be necessary to satisfy the electricity demand needed to achieve the EU targets (see Table 27.2).

Table 27.11 – Energy crops areas to comply with EU targets: electricity

	Toe/ha	2004	2005	Forecast		
				2010	2015	2020
Silo maize for solid biomass (direct burning)	2,50	9.632,00	10.732,80	15.701,42	16.969,56	18.057,14
Cereals* for solid biomass (direct burning)	1,43	7.216,78	8.041,56	11.764,30	12.714,45	13.529,32
Maize for biogas	2,50	9.199,54	10.261,03	15.011,25	16.223,64	17.263,42

Ha
Source: DEIAGRA elaborations
** other than maize*

[410] It is assumed that the yields of transformation of bio-gas into electricity and heat are 35% and 80% respectively. See also box 2.1.
[411] About 15% of the total bio-gas production is represented by agricultural residues, of which a very low percentage (about 2%) is represented by energy crops.

Silo maize and other cereals cultivated areas (for electricity production) would have to increase about 88% respectively (from 2004 to 2020) given the above mentioned assumptions, in order to comply with the targets.

Given the extent of the foreseen demand of **heat** from biomass obtained by energy crops, the yields in toe/ha and given the supposed contribution of each energy crop to the production of heat (silo maize 70% and other cereals 30%), we define the areas which would be necessary to satisfy the heat demand (see Table 27.6) needed to achieve the EU targets (see Table 27.5).

Table 27.12 – Energy crops areas to comply with EU targets: heat

	Toe/ha	2004	Forecast		
			2010	2015	2020
Silo maize for solid biomass (direct burning)	2,50	2.240,00	17.746,69	18.497,93	19.409,87
Cereals* for solid biomass (direct burning)	1,43	1.678,32	13.296,72	13.859,59	14.542,86
Maize for biogas	2,50	1.526,40	12.093,10	12.605,02	13.226,44

Ha
Source: DEIAGRA elaborations
** other than maize*

Given the above-mentioned assumptions the area dedicated to the production of silo maize for direct burning of solid biomass (for heat production) would have to increase from 2.240 to 19.409 ha from 2004 to 2020, whereas the area dedicated to the production of other cereals for the same purposes would have to increase from 1.678 to 14.542 ha. Furthermore, the area dedicated to the production of maize for bio-gas would increase about 767% from 2004 to 2020.

Given the extent of the foreseen demand of **bio-fuels** for transport – i.e. bio-ethanol and bio-diesel – (see table 27.9), given the yields in toe/ha (see Table 27.13) and given the supposed contribution of each energy crop to the production of bio-diesel (rapeseed 90% and sunflower 10%) and bio-ethanol (wheat, barley, rye and maize – depending on the agronomical and climatic conditions - 70%; sugar beet 30%), we define the areas which would be necessary to satisfy the bio-diesel and bio-ethanol demand needed to meet the EU targets (see Table 27.8)[412].

Table 27.13 – Energy crops areas to comply with EU targets: bio-fuels for transport

	Toe/ha	2004	2005	Forecast		
				2010	2015	2020
Rapeseed	**1,10**	1,42	2,00	8,57	9,13	9,77
Sunflower	**0,88**	0,20	0,28	1,19	1,27	1,36
Cereals	**1,43**	0,12	0,90	4,57	4,63	4,68
Sugar beet	**3,85**	0,01	0,08	0,42	0,43	0,43
		1,75	3,27	14,75	15,46	16,23

Million Ha
Source: DEIAGRA elaborations
** elaborations made on bio-diesel (rapeseed and sunflower) and bio-ethanol (cereals and sugar beet) data*

Given the above-mentioned assumptions rapeseed cultivated area for the bio-diesel production would have to increase **from 1,4 million hectares in 2004 to 9,8 million hectares in 2020** and cereals cultivated area for the bio-ethanol production would have to increase from 120.000 to 4,7 millions hectares in 2020.

25.4.1.1 The additional land use 2010 to comply with the EU targets in different scenarios

The following tables describe the potential impact deriving from the fulfilment of the EU targets in terms of land use (additional land to be destined to energy crops in 2010 towards the area destined to energy crops in 2004).
Three different scenarios are considered:

412 The area which is necessary to comply with the EU objectives in terms of bio-fuel production is estimated through the ratio between the energy crop *i* 's production to comply with the EU targets (given the contribute of the energy crop *i* to the production of a well defined bio-fuel) and the yield toe/ha of the specific crop.

1) the foreseen demand by sector of energy use (electricity, heat and transport), given the EU targets, is entirely covered by bio-energy sources and solid biomass produced within the EU-25 ("scenario 100");
2) the foreseen demand by sector of energy use (electricity, heat and transport), given the EU targets, is covered by bio-energy sources and solid biomass produced within the EU-25 for 75% ("scenario 75");
3) the foreseen demand by sector of energy use (electricity, heat and transport), given the EU targets, is covered by bio-energy sources and solid biomass produced within the EU-25 for 50% ("scenario 50").

Table 27.14 – Additional land use in 2010 to comply with the EU targets

		scenario 100					scenario 75					scenario 50				
	Land use 2004	Additional land use 2010			Total	*var. %*	Additional land use 2010			Total	*var. %*	Additional land use 2010			Total	*var. %*
		for biofuels	for biogas	for biomass			for biofuels	for biogas	for biomass			for biofuels	for biogas	for biomass		
Cereals	**52,30**	4,571	0,035	0,060	**56,97**	*8,9%*	3,428	0,026	0,045	**55,80**	*6,7%*	2,286	0,017	0,030	**54,63**	*4,5%*
of which					-					-					-	
- maize	6,50		0,035	0,030	6,56	*1,0%*		0,026	0,023	6,55	*0,7%*		0,017	0,015	6,53	*0,5%*
- other cereals	45,80	4,571		0,030	50,40	*10,0%*	3,428		0,023	49,25	*7,5%*	2,286		0,015	48,10	*5,0%*
Oilseeds (1)	**6,30**	9,757	-	-	**16,06**	*154,9%*	7,318	-	-	**13,62**	*116,2%*	4,878	-	-	**11,18**	*77,4%*
of which					-					-					-	
- rapeseed	4,00	8,567			12,57	*214,2%*	6,425			10,43	*160,6%*	4,283			8,28	*107,1%*
- sunseed	2,00	1,190			3,19	*59,5%*	0,892			2,89	*44,6%*	0,595			2,59	*29,7%*
- soyabeans	0,30				0,30	*0,0%*				0,30	*0,0%*				0,30	*0,0%*
Protein crops	**1,40**				**1,40**	*0,0%*				**1,40**	*0,0%*				**1,40**	*0,0%*
Flax and hamp	**0,20**				**0,20**	*0,0%*				**0,20**	*0,0%*				**0,20**	*0,0%*
Silage (2)	**5,00**				**5,00**	*0,0%*				**5,00**	*0,0%*				**5,00**	*0,0%*
Total arable crops	**65,20**	14,328	0,035	0,060	**79,62**	*22,1%*	10,746	0,026	0,045	**76,02**	*16,6%*	7,164	0,017	0,030	**72,41**	*11,1%*
Compulsatory set-aside (3)	1,90				1,90	*0,0%*				1,90	*0,0%*				1,90	*0,0%*
of which non food oil seed	0,50				0,50	*0,0%*				0,50	*0,0%*				0,50	*0,0%*
Voluntary set-aside	3,10				3,10	*0,0%*				3,10	*0,0%*				3,10	*0,0%*
Total set aside	5,00				5,00	*0,0%*				5,00	*0,0%*				5,00	*0,0%*
Total COP	**70,20**	**14,328**	**0,035**	**0,060**	**84,62**	*20,5%*	**10,746**	**0,026**	**0,045**	**81,02**	*15,4%*	**7,164**	**0,017**	**0,030**	**77,41**	*10,3%*
Sugar beet	**2,20**	0,424			2,62	*19,3%*	0,318			2,52	*14,5%*	0,212			2,41	*9,6%*
Total COP + sugar beet	**72,40**	14,752	0,035	0,060	**87,25**	*20,5%*	11,064	0,026	0,045	**83,54**	*15,4%*	7,376	0,017	0,030	**79,82**	*10,3%*

ha
Source: DEIAGRA elaborations
NB:
Source for land use 2004: European Commission, Directorate-General for Agriculture, "Prospects for agricultural markets and income in the European Union 2006-2013" (July 2006).
** biomass: auto-consumption excluded*
(1) on non set aside area
(2) excluding grass silage
(3) 5%

Referring to **"scenario 100"**, given the above-mentioned assumptions and given the estimates of the areas necessary to comply with the EU targets concerning bio-fuels, bio-gas and biomass, the total area destined to the production of arable crops would be expected to increase around **21%** from 2004 to 2010. The areas dedicated to the production of cereals and oilseeds would have to increase about **9%** and **155%** respectively. This scenario would be technically unfeasible for the following reasons:

1) agronomical limitations (issues related to crop rotation for rapeseed, which is the most common crop for bio-diesel production);
2) extremely intense competition for land between energy crops and crops for food/feed use, with the associated perturbations in the markets of agricultural commodities;
3) commitments of the Blair House agreement (for oilseeds areas under the NFSA regime).

Referring to **"scenario 75"**, the total area destined to the production of arable crops would have to increase around **15%** from 2004 to 2010. The areas dedicated to the production of cereals and oilseeds would have to grow by around **7%** and **116%** respectively. This scenario would be technically unfeasible – at least as regards oilseeds cultivation - for the same reasons highlighted for "scenario 100", while it would be more plausible as regards the cultivation of bio-ethanol crops.

As regards to **"scenario 50"**, the total area destined to the production of arable crops would have to increase around **10%** from 2004 to 2010. The areas dedicated to the production of cereals and oilseeds should increase by **4%** and **77%** respectively. From a technical standpoint, this scenario would be the one most close to feasibility also as regards the cultivation of oilseeds.

The way in which the above scenarios might become reality would certainly be geographically differentiated according to the following factors:

1) effectiveness of support policy at Member State level targeted at the downstream levels of the bio-energy supply chains;
2) present distribution of the overall production capacity in the bio-energy sector among the different bio-energy supply chains (bio-ethanol; bio-diesel; bio-gas; direct burning of solid biomass) in each Member State;
3) kinds of energy crops most suitable to the agronomical conditions specific to each Member State (e.g. as regards bio-diesel crops, sunflower might be preferable to rapeseed in the Mediterranean areas: this could make issues related to crop rotation less relevant).

Box 27.2 – Scenarios in case of increases in yields

Increase in energy crops yields

If an average growth in crops yields is hypothesised, equal to 1% per year[413], the total area necessary to satisfy the additional demand of biomass (see estimates above) decreases.

	2004	scenario 100		scenario 75		scenario 50	
	millions ha	millions ha	var. % 2004	millions ha	var. % 2004	millions ha	var. % 2004
Yield +0% per year till 2010							
Total COP + sugar beet	**72,40**	**87,25**	20,5%	**83,52**	15,4%	**79,81**	10,2%
Yield +1% per year till 2010							
Total COP + sugar beet		**82,72**	14,2%	**79,20**	9,4%	**75,70**	4,6%
Yield +1% per year till 2020							
Total COP + sugar beet		**75,62**	4,4%	**72,43**	0,0%	**69,25**	-4,3%

Though an average growth in crops yields of 0,5-1% per year is plausible, it has however to be underlined that the effects of such hypothesis are not enough to change dramatically the outcomes of the scenarios referred to year 2010 featuring no growth in crops yields (especially as regards their technical feasibility with respect to rapeseed cultivation)

Indeed, it is the time period for the achievement of targets (second last row versus last row in the table) which is decisive in improving the feasibility of the scenarios.

27.4.2 The demand of solid biomass in the UE

As far as the demand of solid biomass is concerned, given the estimated demand of solid biomass and bio-gas for direct burning, for electricity and heat[414], we estimate the demand of solid biomass different from energy crops.

The demand of solid biomass has been expressed in terms of Ktoe without estimating the demand in terms of areas. This choice can be justified in the following sense:

- as regard the category "forestry and wood", the heterogeneity of sources implies difficulties in estimating a well defined yield per hectare;
- as regard the category of "agricultural residues", the heterogeneity of sources and the fact that there is no specifically dedicated areas implies difficulties in estimating a well defined yield per hectare.

[413] See also EC – DG Agri in the document "*Prospects for Agricultural Markets and income in the European Union*" for the identification of a possible yearly rate of yield grow.

[414] See Table 27.3 and Table 27.6 respectively.

Table 27.15 – Demand of solid biomass other than energy crops in the EU

	2004	Forecast		
		2010	2015	2020
Solid biomass* for direct burning (heat)	1.992,00	15.792,50	16.460,15	17.271,89
Solid biomass* for direct burning (electricity)	8.565,60	13.963,21	15.090,79	16.061,85
Solid biomass* for biogas (heat) (1)	194,79	1.557,07	1.621,93	1.702,50
Solid biomass* for biogas (electricity) (1)	1.191,36	1.936,05	2.092,42	2.226,24
Total	11.943,75	33.248,82	35.265,29	37.262,48

Ktoe
Source: DEIAGRA elaborations
(1) Excluding landfills and sewage sludge
(*) Other than energy crops
Market demand for solid biomass excluded the share burned directly

Following table 27.15, the demand of solid biomass other than energy crops is expected to increase from 11.900 Ktoe in 2004 to 37.000 Ktoe in 2020.

27.5 Main findings

In the hypothesis that the targets set at EU level are achieved, and that the relative importance of the shares of each typology of energy source is not going to change with respect to year 2004, the main findings to highlight are the following:

1) The final demand of solid biomass in the three sectors of energy use (electricity, heating, transport) – excluding self consumption and biogas from landfills and sewage sludge - increases from around 14 Mtoe to around 61 Mtoe.
2) The portion of the final demand of solid biomass (see point 1) covered by energy crops increases from 2 to 24 Mtoe. This increase is almost entirely attributable to the foreseen increase in the demand of bio-fuels.
3) The intensity of the competition for land between energy crops and crops destined to food/feed uses varies according to:
   - the extent of biomass and/or bio-energy sources import from third countries (the extent of the area under energy crops varies from 7,5 to 15 million ha in the scenarios considered).
   - the evolution of average crop yields.
4) Given the main technical limitations[415] associated to the scenarios studied, the one most close to feasibility (in particular as regards the cultivation of oilseeds) appears to be the scenario featuring a foreseen demand of biomass from energy crops covered by EU-25 production for 50% ("scenario 50"). In such scenario, the total area destined to the production of arable crops would have to increase around **10%** from 2004 to 2010 in order to meet the targets set for bio-energy use. The areas dedicated to the production of cereals and oilseeds should increase by **4%** and **77%** respectively.

28 CAP SUPPORT, NON-CAP SUPPORT AND OTHER FACTORS

Generally speaking, results from the analysis of the EU market of biomass, bio-energy sources and energy from biomass, show **a very dynamic situation**, having rapidly evolved especially since 2003.

An important factor determining this dynamism and responsible for the fast development of the sector, is certainly to be identified in **policy measures** (see chapters 5 and 6), which in recent years have been adopted – at both primary production and processing level - with the objective of fostering the production and use of renewable types of energy.

[415] Agronomical limitations (issues related to crop rotation for rapeseed, which is the most common crop for bio-diesel production); extremely intense competition for land between energy crops and crops for food/feed use, with the associated perturbations in the markets of agricultural commodities; commitments of the Blair House agreement.

Relations between the policies and the market in the relevant sectors

As highlighted in the answer to the EQ 9, the development of the volume of bio-energy produced in the **electricity sector** has been mainly driven by the relevant non-CAP measures (feed-in tariffs; tradable green certificates combined with quota obligations) implemented both at EU and at Member State level[416]. Such development has promoted an increase in the demand of the bio-energy sources which are most commonly used in the generation of electricity, namely solid biomass and bio-gas. This has in turn resulted in an increased demand for the types of biomass which are most suited to direct combustion and for the ones which are most commonly used for the production of bio-gas. Only a relatively limited portion of such demand was covered by biomass produced in the EU from energy crops grown with the support the relevant CAP measures. The areas cultivated under the NFSA regime and the AEC with the energy crops which are most relevant for the production of bio-gas (maize above all), and hence the quantities of biomass obtainable from such areas, are modest in absolute value (about 88% of the 240.000 tons of maize that we estimated as being produced on the area under the AEC and NFSA in 2005 were destined to bio-gas production). The cultivation of energy crops which are most relevant for direct burning (short rotation forestry above all) was practised on very limited areas under the AEC and the NFSA regime (less than 18.000 ha in 2005). The rural development measures concerning the support for planting multi-annual biomass crops and those concerning forestry can play – in theory at least - a role with respect to the production of biomass destined to direct combustion; however, this role has been quite limited so far (see EQ 4). The same can be said for the funding of projects featuring on-farm production of biogas.

No relevant policy framework is in place in the EU with respect to the promotion of the use of bio-energy in the **heating sector**. Nevertheless, among the relevant CAP measures, all the ones which can promote an increase in the supply both of solid biomass for direct combustion and of feedstocks for bio-gas production can play – in theory at least - a role in this respect. These measures can be identified:

- in the rural development ones aimed at supporting the planting of multi-annual biomass crops and concerning forestry (with respect to the production of solid biomass for direct combustion);
- in the AEC and the NFSA regime (as regards especially the cultivation of short rotation coppice and grass for direct burning and the production of feedstocks for bio-gas production from cereals and grass).

As highlighted in the answer to the EQ 9, the increase in the supply of bio-fuels (bio-diesel and bio-ethanol) needed to cover the demand in the **transport sector** has been mainly driven by the relevant non-CAP measures (tax exemptions / reductions; mandatory blending of bio-fuels into conventional fuels) implemented both at EU and at Member State level[417]. Such increase in the supply has in turn resulted in an increased demand for biomass suited to bio-fuels production. It has to be noted however that a relevant part of the increased supply of bio-ethanol has been covered by imports from third countries. Biomass imports from third countries have instead played a much more limited role in providing the feedstocks needed for the production of bio-fuels (mostly in the case of bio-diesel). Among the relevant CAP measures, the NFSA regime and the AEC (in order of importance) have played a relevant role in providing the biomass needed to produce bio-fuels, mainly by promoting the cultivation of substantial areas under oilseeds destined to bio-diesel production (areas of much lesser importance were instead grown with energy crops for bio-ethanol production under the AEC and the NFSA regime). However, a portion of set aside land cannot be destined to the cultivation of energy crops destined to the production of bio-fuels because of the absence of processing plants at a reasonable distance. Finally, it is important to remember that a substantial area (about 1 million ha) is cultivated outside specific regimes with oilseeds for bio-diesel production and, to a lesser extent, crops destined to the production of bio-ethanol.

The evaluation of CAP measures (especially EQ9) has shown that a crucial role has been played by policy measures operating at the downstream activities level (industry, final demand) (see chapter 6[418]), while a less decisive role can be imputed to CAP measures (see chapter 5[419]).

The decisive role of incentives can be easily explained by considering that the production of energy from biomass still remains **economically less competitive** if compared with that of energy from traditional

[416] Indeed in the answer to the EQ 9 we have seen that – apart from peculiar situations – the bio-energy supply chains would not be economically viable without the additional support granted by non-CAP measures at EU and Member State level.
[417] Indeed in the answer to the EQ 9 we have seen that – apart from peculiar situations – the bio-energy supply chains would not be economically viable without the additional support granted by non-CAP measures at EU and Member State level.
[418] For further information on the matter, see also the annex to the Outlook and Recommendations.
[419] For further information on the matter, see also the annex to the Outlook and Recommendations.

sources (see § 11.2). In this framework, the policy measures operating on the downstream activities or the consumption (feed-in tariffs, tax exemption, green certificates, etc.) highly influence the actual possibility to produce (and use) bio-energy and consequently volumes of production in each Member State. Data regarding the last years show how production results to be highly developed in those Member States where the level of "support" (direct or indirect support) and/or the level of "extension" of this support (for instance, existence and dimension of quotas for bio-fuels in duty exemption regime) are higher.

Besides policy measures and incentives, several factors are likely to deeply influence the diffusion of energy from biomass. The presence/absence of these factors have already had some relevant effects on the present development of the BESC in the different Member States and regions, and the capacity of correctly individuating and managing them may become a necessary requirement in the next future.

On the basis of the analysis developed in the context of the study, as well as literature and bibliography[420], a series of relevant limiting factors can be identified, as described below.

Technical and economic barriers

- **Competition with fossil fuel**, which still remain economically more convenient than the bio-fuels, as highlighted in the market analysis (see § 11.2).
- The often **small size of bio-energy markets**, as well as the fact that biomass by-products are relatively new commodities. As a consequence markets may result immature and unstable, and – also due to a certain still existing policy uncertainty - it could be difficult for firms and operators to sign long-term and large-volume contracts.
- **Technical standards for bio-fuels**, which remain important obstacles for their use. As an example, the review of the EN 14214[421] standard is demanded by most operators, as it would increase the range of oils and raw materials which could be processed in bio-diesel and used as blended components in mineral oil fuels without significant effect on fuel performance.

Conflict with food and feed production and land availability

- Considering the structure and the present situation of the EU agriculture, the increase of areas destined to energy crops – needed to sustain the internal production of bio-energy – might determine a competition for land. The actual level of this competition will depend on the balance between EU internal production and import of solid biomass[422].Energy crop production in marginal areas in fact may result not economically sustainable, because of low yields which could result non consistent with the relatively high production costs of biomass. On the other hand, the destination to energy purposes of productive areas presently destined **to food production**, may have some negative consequences on the food market. Although food security is not likely to constitute a problem in developed countries, the detraction of a high share of land to food destination could result in a relevant raise in import of raw materials, or even in a displacement of food industries, with some effects also on prices and final markets. The increase registered in the price of rapeseed during the last year could be seen in this light.
- The use of by-products and agricultural residues[423] for energy purposes, could result in a scarcity in the **fodder market**, with consequent likely increases in price. Such scarcity might be partially limited by the possibility to use by products from the bio-fuel production as feedstock for animal feed[424].

Logistical and trade barriers

- Still existing **technical difficulties** regarding the **transport of biomass**, due to a lack of technologies able to increase the final density of most biomass types. Local transportation by truck (both in biomass exporting and importing countries) can result to be a high cost-factor, likely to influence the overall biomass cost.

[420] Faaij, Junginger et al., *Opportunities and barriers for sustainable international bio-energy trade: towards a strategic advice of IEA task 40*, www.fairbiotrade.org

[421] The standard EN 14214 imposes limitations to oils and feedstock which can be used for the production of bio-diesel. The partial or total elimination of such limitations would be likely to favour the use and diffusion of bio-diesel.

[422] See also § 7.2.

[423] According to the market analysis (§ 7) the main by-products and agricultural residues can be identified in the following: short rotation wood from forestry thinning, wood felling residues, straw from cereals, other residues from food and industrial crops, sawmill waste, manure, sewage sludge, organic fraction of municipal waste, used vegetable oils and fats

[424] Oil cake, glycerine, beet pulp, DDG's, CO_2, (see also market analysis, § 7).

- The lack of significant volumes of biomass locally concentred, which could also hamper **logistics**. A reduction of cost would probably be achievable through an enlargement of shipping volumes on a regular basis.
- **Long distance transport costs**, which have been increasing in recent years and could constitute an important obstacle to international trade.

29 POLICY RECOMMENDATIONS

Recommendation 1

Given the limited effectiveness of AEC at its current level, a decision needs to be taken whether to increase the amount of the AEC significantly in order to increase its effectiveness, or to abolish the measure and seek to promote the cultivation of energy crops through other, more effective tools. In any case, in pursuing the objective of increasing the production of energy crops, support measures would be needed, as it was demonstrated that the cultivation of energy crops, and more in general the production of bio-energy, would not be able to survive without being promoted through public policies.

Recommendation 2

As the NFSA regime was identified as an effective instrument to achieve the objective of promoting the development of energy crops, its continuation would be recommended, unless other equally effective measures would be put in place.

Recommendation 3

Where a limited uptake of rural development measures specifically related to bio-energy production is caused by a limited awareness of farmers about this possibility, improving the flow of related information is recommended.

Recommendation 4

As the organisation and the relationships among the different levels of the bio-energy supply chains are an essential factor for their development, the different forms of coordination, both horizontal and vertical, need to be developed. This concerns especially the creation of organisations of energy crops producers and the implementation of inter-industry agreements between such organisations and the organisations of biomass processors.

Recommendation 5

As the systems aimed at monitoring the implementation of the relevant policies during the evaluation period did not permit obtaining sufficiently specific data and information, the following improvements are needed:

- A complete picture of the implementation of rural development measures specifically targeted at promoting bio-energy production is needed. Data requirements concern the number of beneficiaries, the type of projects financed, the agricultural area concerned where relevant, and the budget.
- Information systems on the relevant markets in the bio-energy supply chains should cover the following data: areas, production, yields of energy crops without specific regime; systematic price series for the main agricultural products according to their use (food/feed, energy, other non-food uses).
- Further improvements aimed at allowing for a thorough analysis of specific issues emerged in this study concern: an assessment of the actual capacity of CO_2 emissions abatement and of fossil fuel saving of the various types of bio-energy (based on a full life cycle approach); an assessment of actual environmental impacts of the energy crops CAP measures (based on empirical studies).