Lund University Master's Programme in International Environmental Science, LUMES

Greening the European Union with Biofuels: Policy Opportunities and Dilemmas

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Abstract

It is known that current patterns of transport are not sustainable. Greenhouse gas emissions contribute to climate change, while the sector's oil dependency is a threat for the security of energy supply. In order to improve the sustainability of the sector, the Directive 2003/30/EC was adopted. The directive promotes the use of fuels from biomass for transport purposes and establishes reference consumption targets. However, the Member States are responsible for the implementation of the Directive. As described in the progress reports of the Member States submitted to the European Commission in 2004 and 2005, the implementation process has not been effective. The overall aim of this paper is to suggest how the implementation process in the MS could be improved. For this purpose, policy opportunities and barriers are identified and policy changes are recommended. The analysis of existing and emergent opportunities and barriers suggests that the European Union policy for biofuels must be revised. Policy changes should include mandatory targets, the exclusion of tax incentives in favour of biofuels, the removal of import duties on biofuels, in addition to investments in advanced biofuels and redistributive measures in favour of the agricultural sector. Although effective, these measures are radically different from the current policy strategy. Their adoption is therefore considered problematic.

Keywords: directive, greenhouse gases, implementation, Member States, transport.

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1 Introduction

1.1 Background and Problem Definition

Historically, movements of goods and persons have been improved for the benefit of both individuals and society. It is generally recognized that transport activities are a key factor to social, regional and economic cohesion (Richardson, 2005) and Europe has largely benefited from affordable and convenient road transport modes. Over the past century, cars and roads have played a leading role in the development of European society (EEA, 2004a). Road transport has become an intrinsic feature of our life style. Private vehicles are considered an expression of values as freedom, individualism and personal success. Few people would be prepared to compromise much of any of the advantages offered by today's road transport.

On the other side, road transport's major impacts on human health and the environment are a challenge for Europe's sustainable development. According to Black (2000), sustainable transport is defined as *"transportation that meets the current needs without compromising the ability of future generations to meet their own needs"*. The European Commission (EC) recognised long time ago the need to improve transport systems as a key priority in the European Union's (EU) strategy for sustainable development (European Council 15/16 June 2001, Gothenburg). In particular, major obstacles to achieve sustainable transport include security of energy supply and emissions of greenhouse gases (GHG), combined with long-standing problems of congestion, noise and pollution (EC, 2003a).

In the last three decades, road transport has experienced a significant growth, both in passengers per kilometre and tonnes of goods per kilometre (EEA, 2004a). This trend described in Figure 1 is expected to continue in a near similar pace in the future. Increased traffic volumes are expected to affect the sector's energy demand, which today accounts for almost one third of final energy demand in the EU (EC, 2003a).

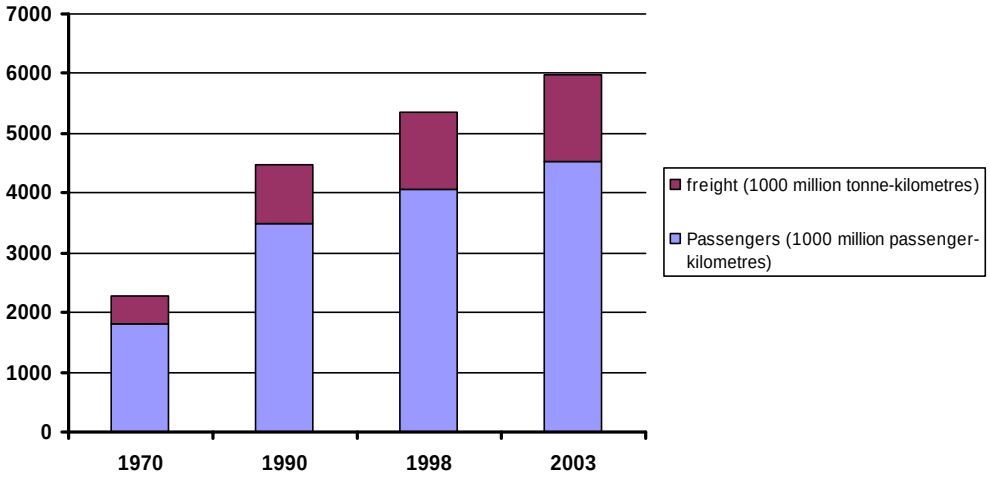

Figure 1. Growth of freight and passenger transport (EU 15).

Source: data is from the EU Energy and Transport Report 2000-2004 (EC, 2004b).

Notes:
1) Passenger transport modes include cars, busses and coaches.
2) Freight transport modes include only road.

Road transport energy demand is in large part supplied with oil and this dependency is already causing increasing strategic concerns. The EC estimates that 98% of the fuel used for transport is based on oil and that 70% of that oil is imported from non-EU countries (EC, 2001a). The EU does not have the natural resources needed to cover its domestic demand for energy. Moreover, the European oil production is expected to fall in the future, thus, imports will become, in practice, the only way to supply the road transport sector (EC, 2001a). Major world oil reserves will be confined in the Middle East area and a long-term reliance on these regions generate concerns over price fluctuations and possible interruptions of supply (Fisk, 2004). This fact, together with the predicted increase in demand (EC, 2003a), has significant repercussions in terms of security of energy supply of the EU's transport sector.

Road transport dependency on oil is not only a threat for Europe's security of energy supply, but it is also a major obstacle towards climate protection efforts. Climate change has been defined as the most challenging global problem of the 21st century. Although the existence of climate change may be disputed, some facts are acknowledged. Since the industrial revolution, the carbon dioxide[1] (CO2) level in the atmosphere has been constantly growing. Researchers have demonstrated that the changes in the concentration level are mainly dependent on human activities, primarily utilization of fossil fuels and deforestation (Baumert and Kate, 2002). The concentration of CO2 and other GHG in the atmosphere directly affects the Earth climate and, because of the rapid change experienced, as shown in Figure 2, global mean temperatures are expected to increase (IPCC, 2001). As the changes are relatively rapid compared with more natural cycles of the Earth they may cause several environmental problems such as rise of sea level, changes in precipitation, changes in the course of ocean currents, hurricanes, changes in biodiversity. In short, agricultural production, water supply, natural ecosystems and overall human development will be affected by the change of global climate. To prevent atmospheric concentrations of CO2 from exceeding a level of 460 ppmv, considered a sort of safety limit by the EU[2], global emissions would need to decrease dramatically during this century (Baumert and Kate, 2002).

The European transport sector is a major source of GHG emissions. In particular, emissions from road transport currently represent 19% the EU's total GHG emissions (EEA, 2004b). Moreover, GHG emissions increased 23% between the year 1990 and 2002 (EEA, 2004b) and this is expected to be the trend in the near future (EC, 2003a). In conclusion, transport's energy consumption and related GHG emissions are a serious obstacle towards climate change mitigation.

[1] Carbon dioxide (CO2), emitted from burning fossil fuels and land-use changes, is the most important GHG. Other important GHG are methane (CH4) from agriculture and waste, nitrous oxide (N2O) from agriculture and industry and industrial halogenated gases (CFCs and HCFCs) (EEA, 2005).
[2] The EU Environment Council meeting of 20 December 2004 established: *"stabilisation of concentrations well below 550 ppm CO2 equivalent may be needed"*. Concentrations of 550 ppm CO2 equivalent correspond to 460 ppm CO2 alone (EEA, 2005).

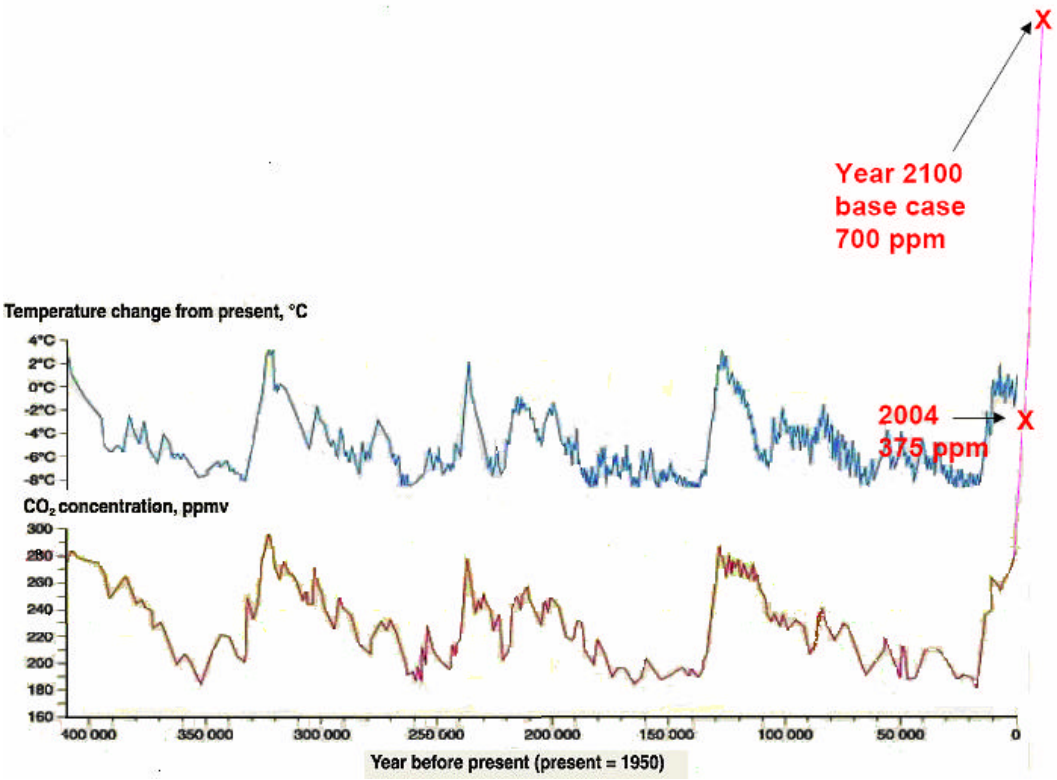

Figure 2. Temperatures and CO2 concentrations in the atmosphere over the past 400 000 years (from the Vostok ice core).

Source: The Graph of Temperatures and CO2 concentrations until the year zero is from the UNDP web site (www. http://www.grida.no/climate/vital/02.htm). The data for the years after the year zero are from the EEA Report (2005).

Notes:
1) CO2 concentrations from the year zero to 2100 are added to the figure.
2) The 2004 value is from the EEA (2005), while the 2100 is the value given in the baseline scenario elaborated by the EEA (2005).

In order to address the described challenges, the EU has decided to include transport fuels produced from biomass as part of its policy strategy towards sustainable development (EC, 2001b). However, only in 2003, with the adoption of the Directive 2003/30/EC (otherwise known as Biofuels Directive), the EU clearly showed the importance and the role of biofuels to improve security of energy supply and reduce GHG emissions from the road transport sector. This thesis investigates opportunities and barriers for the implementation of the Directive 2003/30/EC and its objectives in the EU Member States (MS).

The rational of the present paper relies on the current situation in Europe where people's perception of benefits and disadvantages of road transport is rapidly changing. We, as society, are experiencing reduced benefits due to oil price's increase, while our awareness of the transport's external costs is awaking.

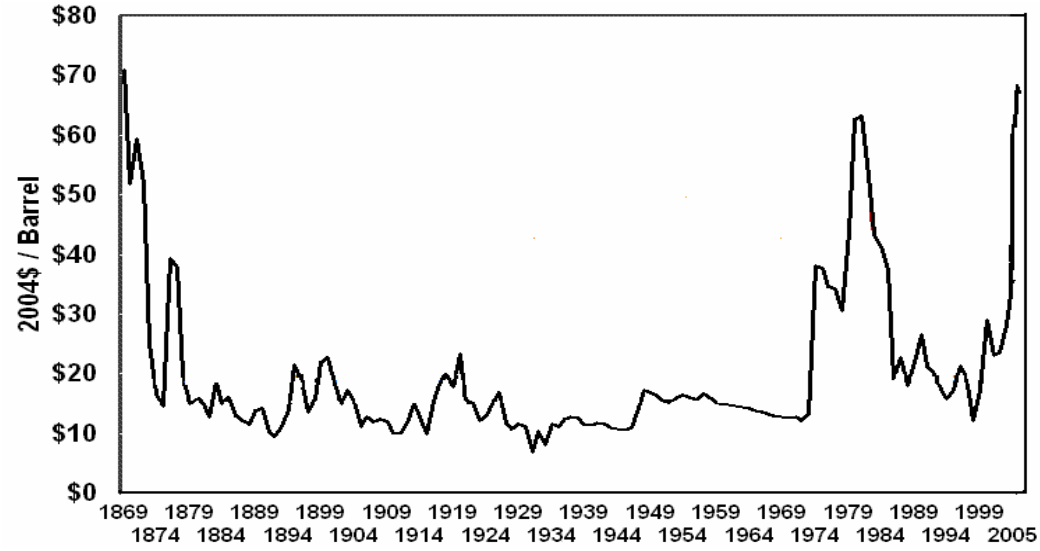

Figure 3 World oil prices from 1869 to 2005

Source: data is from WTRG Economics. Available at www.wtrg.com

1.2 Aims and Scope of the Study

The initial hypothesis of this research is that the MS will implement the Biofuels Directive. This hypothesis is sustained based on the fact that the majority of the MS has endorsed the Directive through out its legislative process due to a common perspective between the EC and the MS on the main driving forces behind the introduction of the Biofuels Directive.

The overall aim of this paper is to indicate how the Biofuels Directive could be effectively implemented in the MS in order to move the road transport sector towards sustainable patterns. For this purpose, five objectives are pursued:

- To define the main features of biofuels in use today as transport fuels and biofuels which could be in use in the next decade;
- To identify the driving forces and objectives of the EU policy in the field of biofuels for transport;
- To assess the implementation in the MS of the EU Directive 2003/30/EC;
- To identify policy barriers and opportunities for effective implementation of the EU policy in the MS;
- To recommend policy changes in order to exploit opportunities and overcome the barriers towards effective implementation.

The named objectives can be transformed in the following research questions:

- What are the main barriers and the opportunities for effective implementation of the EU biofuels' policy in the MS?
- Which policy changes are needed to exploit the opportunities and overcome the barriers of effective implementation?

1.2.1 Limitations

Limitations to the scope of this study should be recognised. First, this study is focused on the implementation of EU Directive 2003/30/EC and national policies adopted in the EU-25 MS. European countries not member of the EU are not included in the research. Additionally, although the importance that actors such as car producers, oil companies and in general the public have for the achievement of the Directive's objectives, the focus of this research is exclusively on national governments and EU institutions. Other actors are not included in the research scope due to limited resources to investigate actors operating at different levels in 25 country-specific contexts.

Second, in discussing the option of importing biofuels from non-EU countries, only Brazilian bioethanol is used as an example because the case is well documented and it represents the cheapest biofuel available on the world market. The question whether the Brazilian production is sufficient to supply the EU demand and to what extent, is not a concern of this research.

Finally, although in general terms, the EU Directive 2003/30/EC supports the use of transport fuels from biomass and alternative fuels, this study does not investigate or take into account the development of hydrogen as transport fuel. The hydrogen option is considered a long-term and uncertain development of the alternative fuels sector.

1.2.2 Outline on the Thesis

In chapter 2 the methods and materials used to attain the objectives of the thesis are described, while chapter 3 presents the theoretical background in the policy analysis domain, which is relevant as starting point for this research. The main features of automotive fuels from biomass are described in chapter 4 with focus on fuels properties such as production costs, GHG emissions, production potentials in the EU and environmental effects for both first generation and advanced biofuels. Chapter 5 highlights the EU regulatory system in support of biofuels including both sector specific policies and policies adopted in other areas such as agriculture and trade. In chapter 6, the empirical data regarding the implementation of the EU policy in the national policy contexts is assessed. The analysis based on the empirical material is performed in chapter 7 by focusing on the identification of policy interactions and goal conflicts that affect the policy implementation process in the MS. Whereas, in chapter 8, the results from the analysis performed in chapter 7 are used to discuss policy changes to solve the implementation problems in the MS. Finally, the conclusions of the study are presented in chapter 9.

2 Methods and Materials

2.1 Methodology

The present paper is a case study that employs qualitative research methods. The case-study approach is considered appropriate in order to understand the reasons why policy implementation succeed or fail. The key problem with policy is that the way in which policies are formulated means that researchers have no control over the events. Thus, experimental designs are typically not feasible and even the opportunities for rigorous comparison using observational design can be limited (Keen and Packwood, 1999). In other words, case study design was adopted for this research because it can cope with and provide insight into complex real events, with the "case" providing a source of explanations for developments (Keen and Packwood, 1999).

2.2 Materials

In order to achieve the objectives of this thesis, the research has been based on the description and analysis of relevant material consisting of secondary data such as books, scientific articles, legal acts, official reports.

Scientific articles, books and reports have been consulted with the aim to provide to the reader a general overview of technical and economic characters of biofuels. However, the data presented in chapter 4 are based on estimates, averages and simplifying assumptions of the literature. Values such as production costs, GHG balances and costs of GHG emissions abatement change rapidly in consideration of time and location, technologies and feedstocks. The function of the data presented in the chapter is simply to inform the reader about orders of magnitude.

To accomplish the aim of chapter 5, besides the sources used for the previous chapters, legal material such as EU Directives, international Conventions, Treaties and official documents of legislative procedures have been used. It is know that the EU legislative procedure documents are only partly available to the public. In the chapter only publicly available material has been taken into account, thus to the exclusion of national governments opinions regarding the documents.

In order to assess the implementation process of the EU biofuels' policy in the EU MS, the national progress reports submitted to the EC by the MS in fulfilment of art. 4 of the Directive 2003/30/EC have been consulted. The MS' progress reports offer a unique chance to create an overview of the governments' official position on Directive 2003/30/EC. It is acknowledged that the MS' progress reports do not always contain all the required information and that more data could be collected through out other sources. However, no other sources of information were consulted. In justification of that, is the fact that language limitations would have misguided the research process. In order to set a common ground for all the MS, only the official progress reports were included in the research material.

All the progress reports available at the time of this research (years 2004 and 2005) have been consulted. However, in the case of Estonia, Finland, Greece, Hungary, the Netherlands, Portugal, the Slovak Republic and Spain, the 2005 report was not available. As consequence, only the reports from 2004 have been used. Additionally, there were no reports at all available for Italy and Luxemburg. It should be noted that, as a tendency, the reports from 2004 contain a smaller range and number of measures compared to reports from 2005. This difference should be considered when observing the data presented in chapter 6. Similarly, most MS focused on possible motivations for target differential in 2004, whereas, national indicative targets and policy measures were mostly adopted in 2005.

3 Theoretical Background: Policy Implementation and the Relevance of Policy Interaction

Implementation is the *raison d'être* of any policy. It is the moment when a policy becomes reality or not. In fact, according to Glachant (2001), "*implementation is policy viewed from the perspective of its practical consequences for implementation bodies and policy targets"*. This perspective is crucial, since the success of a policy can only be judged on the impacts it has on the ground (Glachant, 2001).

The existence of an implementation gap or deficit in the EU is generally recognized (see, *inter alia*, Jordan, 1999). Implementation remains the weakest stage in the EU environmental policy process, with persistent concerns about whether the laws are fully, effectively and correctly transposed into domestic law (formal compliance) and whether the objectives are met in practice at national level (practical compliance) (McCormick J., 2001). Concerning the effectiveness of the implementation of EU Directives, Knill and Lenschow (1998) define it *"as the degree to which the formal transposition and the practical application of supranatural measures at the national level correspond to the objectives defined in the European legislation"*.

Effective implementation of EU laws into heterogenic national contexts is a difficult task. Hill and Hupe (2002) recently cited a formula by Ripley and Franklin (1982), which puts appropriate emphasis on the complexity of the implementation process, defined as a process involving "*many actors holding diffuse large and complex mix of government programs that require participation from numerous layers and units of government and who are affected by powerful factors beyond their control"* (Ripley and Franklin,1982 in Hill and Hupe, 2002: 61). Because of such level of complexity, numerous obstacles can rise in the process towards effective policy implementation.

In this context, political science and public policy researchers have identified a wide set of factors that may apply to implementation in general. Two broad approaches to policy implementation are found in the literature: the top-down and the bottom-up approach (Schucht, 2001). Briefly, top-down models see policy the way it is and evaluate implementation in respect to the achievement of the policy's goals, whereas, bottom-up models focus on the perceptions and interests of the actors affected by a policy problem and investigate the interaction between those actors (Schucht, 2001). Differently, some studies interprets the implementation process of environmental policy, especially of EU Directives, as *"a piece in a patchwork of policy processes arising from different governance levels (international, European, national) and in different policy arenas (environmental and non-environmental)"* (Glachant, 2001).

In line with such approach, this study subscribes to the notion of policy interactions as being a key element, both positive and negative, on implementation outcomes. According to Lenschow (2002), goal conflicts and policy dilemmas are key constraints for policy implementation. Policy dilemmas appear when policy strategies consistent with one end involve actions that are inconsistent with other aims. Decision-makers deal with dilemmas every time they introduce measures to address one problem, which cause the amplification of other important problems (Cohen and Paris, 1982). Furthermore, policy dilemmas are nothing new, they simply reflect well-known goal conflicts based on the positions of different actors. However, the open recognition of dilemmas can help interaction between actors and factors, leading to reduced conflict (Nilsson and Nilsson, 2005). In case policy conflicts are effectively solved, the interaction between different policies may become an opportunity for effective policy implementation (Glachant, 2001). The challenge is to address the most relevant conflicts in the context of a comprehensive policy strategy.

In the case of the Biofuels Directive, the initial hypothesis is that because the MS agree with the objectives of the Directive they will promote its effective implementation within the national context. Therefore, the objectives and the targets of the Directive can be expected to be achieved. However, the complexity of the implementation process could affect the effectiveness of the policy process. In this context of practical difficulty, it is of paramount importance the definition of policy interactions, which may create goal conflicts and policy dilemmas during the implementation process. A pragmatic and problem-oriented approach is used in this study in order to define which policy conflicts may cause problems to the policy implementation in the MS and, furthermore, how these conflicts may be transformed into opportunities.

4 Transport Fuels from Biomass: an Overview

4.1 What are Biofuels?

"Biofuels" is a term that commonly denotes liquid or gaseous fuels made from biomass. The biomass can have different sources: starches from cereals, grains and sugar crops; hemocellulosic and cellulosic materials from grass, trees and waste products from agriculture and forestry; animal fats and vegetable oils; organic waste materials and animal manure (IEA, 2004).

In the next sections, the most common types of biofuels and conversion technologies in use in the EU are described. Nevertheless, it should not be neglected that a greater variety of fuels and process technologies are today technically available. In the last part of this chapter, the most promising advanced biofuels and related production technologies are described.

4.2 First Generation Biofuels

First generation biofuels are those automotive fuels that today, or in a short term, can be technically and commercially available in significant quantities on the market. In the EU, the most widely consumed biofuels for transport are biodiesel, bioethanol and biogas (IEA, 2004).

4.2.1 Bioethanol

Bioethanol can be produced by any biological feedstock that contains appreciable amounts of sugar or material that can be converted into sugar. In the EU, suitable feedstocks are wheat and sugar beets, but also grains like barley and corn (EurObserv'ER, 2005a). State of the art bioethanol production is performed by microbiological fermentation of sugar or starch crops. The most common and simple way to produce bioethanol is to use biomass that contains six carbons sugars that can be converted by fermentation directly to bioethanol (IEA, 2004). However, in the case of starch, which is a polymer made up of sugars, before the sugars can be fermented into bioethanol the starch needs to be depolymerised by hydrolysis (Murphy and McCarthy, 2005). Moreover, bioethanol can also be produced from the conversion of lignocellulosic material through different technical processes, which are the object of the last part of this chapter.

Bioethanol is used in pure form, in dedicated vehicles, or mixed with mineral petrol. Conventional petrol vehicles in the EU are technically compatible with 5-10% (volume) bioethanol, known as E5-E10 (IEA, 2004). To go behind 10% blends, minor engine and fuels system modifications are needed (Fulton, 2005). For high blends, up to 85%, vehicles must be equipped with a sensor system that detects the bioethanol content and automatically adjusts the engine. In addition, bioethanol can be blended with conventional diesel, but further research is needed in this regard (IEA, 2004).

A further exploitation path for bioethanol is the production of the antiknock additive ethyl tertiary butyl (ETBE). Bioethanol can be transformed into EBTE by reaction with isobutylene. EBTE is blended, up to 15%, with conventional petrol and used in existing petrol engines without any modification. EBTE shows excellent performance and benefits in replacing aromatics and benzene (Specht et al., 2005).

4.2.2 Biodiesel

Biodiesel is a generic name for methyl esters made by transesterification, a chemical process that reacts plant oil or animal fat with methanol[3]. Rapeseed oil is the most common feedstock for biodiesel in the EU, resulting in rapeseed methyl ester (RME). However, other oleaginous plants such as sunflower and soya, waste oil from cooking and animal fats can also be used for biodiesel production (EurObserv'ER, 2005a).

Biodiesel is used in compression-ignition diesel engines in pure or blended form. European fuel standards allow biodiesel up to 5% (volume) in conventional diesel[4]. However, according to the IEA (2004), conventional engines can run on pure biodiesel (B100) and any blend ratio. This point is debated, but it is generally agreed that only minor changes are necessary to make conventional diesel engines compatible with high blends of biodiesel (Prankl et al, 2004).

4.2.3 Biogas

Biogas is a mixture of methane (up to 60%) and carbon dioxide resulting from the anaerobic fermentation of organic material recovered from sludge, manure and waste (EC, 2004a). The gas can be upgraded and compressed for use in vehicles equipped for natural gas. At present, biogas has a very small market share in the EU, but its use could increase as number of vehicles using gaseous fuels increases and filling stations become more readily available (IEA Bioenergy, 2005).

4.3 Energy Content of Biofuels

Fuels are energy carriers and their value is based on the amount of energy they bring. Fuels' energy content can vary because transport fuels are not chemically homogenous compounds, but are made of a mix of elements (Novem/Ecofys, 2003). Reference values of mineral and biofuels energy content used in this study are shown in Appendix. In general, both bioethanol and biodiesel show a lower energy content per litre compared to conventional petrol and diesel fuels (Fulton et al., 2004). Throughout this thesis, the energy content is considered a central issue since the targets of the EU policy are set on energy basis. Additionally, in order to make an objective comparison between mineral fuels and biofuels, it is important to take into consideration the difference into to energy content of the fuels.

4.4 European Production Potentials

As described, biofuels can be produced from different feedstocks: food feed-crops like grain, sugar and oil-seed, dedicated bioenergy crops and non-crops sources like waste. Currently, non-crops sources supply only a small share of raw material for biofuels' production and potentials for future development are limited (IEA, 2004).

Land availability and suitability are fundamental factors to assess biofuels' production potential. In the EU, the production of first generation biofuels is based on food feed-crops such as sugar beet, wheat and rapeseed. Several studies have investigated how much land would be needed to grow those crops in order to displace conventional transport fuels. A study presented by the IEA (2004) states that the production of bioethanol and biodiesel needed to displace 5%, on energy basis, of transport fuels in 2010 would require 20% of the total cropland area in the EU. Similarly, Jensen P. (2003) concludes that biofuels crops would take up between 6.7 and 13.1% of EU cropland area in

[3] The term "Biodiesel" sometimes refers to synthetic diesel obtained from biomass through thermal gasification and other processes. Through out this thesis the term biodiesel is used as synonym of RME made from transesterification of oils and fats.
[4] The European fuel standards are illustrated in Chapter 5.

2010 if 5.75% of transport fuels had to be displaced. The two studies are based on specific assumptions. However, it is possible to state that meeting a substantial increase in biofuels demand in the EU over the next years, using conventional grain, sugar and oil-seed crops would require a considerable allocation of cropland. To conclude, cropland availability is a primary limiting factor to the expansion of the European biofuels' production.

4.5 Biofuels' Production Costs

The object of this section is to give some indications concerning biofuels' production costs in the EU. Production costs of biofuels vary and depend on a wide range of factors such as crop type, agricultural practices, land and labour costs, conversion plant size, processing technologies, price of by-products. Generally, the largest cost component is the plant feedstock, whereas operating costs are one-third of the total cost per litre, of which the energy needed to run the conversion facility is an important component (IEA, 2004).

Despite continuous improvements in production efficiency and yields, biofuels produced in the EU are still costly compared to mineral fuels. The price of mineral fuels is based on the oil price on the international market, whereas biofuels' costs present a wide range of values changing over time and location. The cost estimates used in this study, reported in Table 1, have been elaborated by Jungmeier et al. (2005), who reviewed 73 academic researches in order to provide a comprehensive collection of costs for the EU. Three ranges of costs are presented including the lowest, the most likely (best values) and the highest. Note that due to the difference in energy content between biofuels and mineral fuels, the total cost per litre in Table 1 is given per energy-equivalent litre.

Table 1. Cost estimate of biofuels produced using current technology.

Fuel	Cost at the pump (€2004/1000L energy-equivalent)			
	Feedstock	Low	Bets Estimate	High
Bioethanol	Sugar crops	875	1265	1855
	Starch crops	809	1173	1572
	Brazilian sugarcane	117	294	351
Biodiesel	Oil seeds	755	945	1092
	Used oil/fat	354	454	545
Petrol	Fossil fuel		500	
Diesel	Fossil fuel		540	

Source of data is Jungmeir et al. (2005).

Notes
1) The data is expressed in $€_{2004}$ and does not include excise duties and VAT.
2) The "best estimates" for fossil fuels are average EU 25 consumer prices in force on 17/10/2005. Available from the EU Oil Bulletin at http://www.eu.int/comm/energy/oil/bulletin/2005/weekly-prices-without-taxes-2005-10-17_eur_25.pdf.

Cheaper biofuels are potentially available in non-EU countries in South America and Asia. One example is bioethanol produced in Brazil (see Table 1). Currently, Brazil has a significant cost advantage in the production of bioethanol compared with European producers due to the high productivity of sugarcane crops in Brazil and the use of by-products to provide energy to processing plants. Additionally, the country has high capacities for export (Ryan et al., 2005). Nevertheless, bioethanol produced in Brazil is subjected to import tariffs in the order of 0.102-0.192 €/l.

To be competitive on the transport fuels market, biofuels' price must cover the production and distribution costs and be in line with mineral fuels' prices. As seen in Table 1, the final price paid by consumers in the EU for mineral petrol and diesel is lower than the cost of biofuels, except for bioethanol produced in Brazil[5]. However, the price of mineral fuels is strictly dependent on the price of crude oil on the international market.

4.6 Greenhouse Gas Emissions

Biofuels may provide a partial solution to reduce GHG emissions. Burning biofuels release no more GHG into the air than the GHG absorbed when the biomass was growing. However, on a well-to-wheel (WTW) life-cycle analysis, biofuels are not 100% carbon neutral because some conventional fuel is used in the production process. Most studies show that, compared to mineral fuels, the use of biofuels brings to a reduction in WTW GHG emissions (IEA, 2004). Consequently, depending on the production pathway, emissions may vary from near zero to as high or even higher than mineral fuels (Henke et al., 2005).

The cost of reducing GHG emissions is dependent on the WTW GHG reduction per kilometre and the incremental cost of the fuel used. The estimation of GHG emissions and energy balance for biofuels is complex because the full life cycle of the fuels and not just direct emissions must be considered. In the literature, a wide range of values is found. For consistency with the data presented in Table 1, CO2-equivalent[6] emissions and related reduction costs in Figure 4 are also from the Jungmeier et al. (2005) review.

[5] However, in addition to the production cost for Brazilian biofuels an additional transportation cost of 0.03-0.05 €/l must be added (IEA, 2004).

[6] An "equivalent CO_2" corresponds to the concentration of CO_2 that would cause the same amount of radiative forcing as a given mixture of CO_2 and other greenhouse gases (IPCC, 2001).

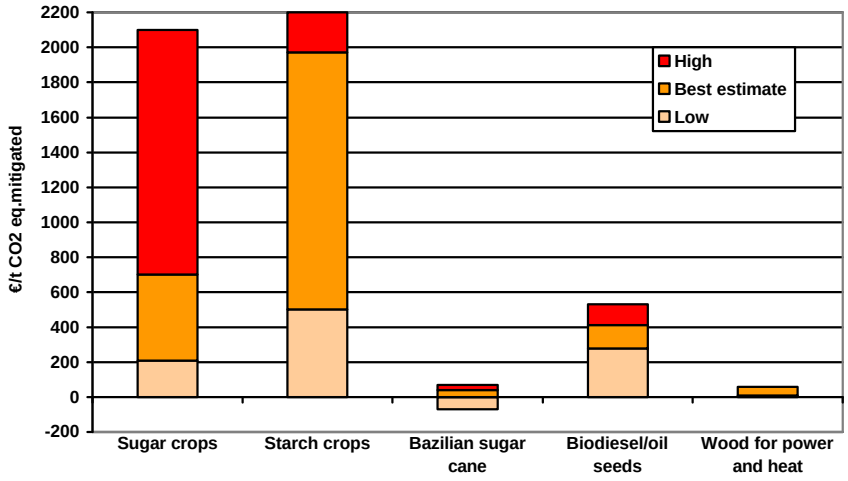

Figure 4. Range of estimates for values of biofuels mitigation costs expressed in €/tCO2 eq. emissions.

Source: data for liquid biofuels are from Jungmeier et al. (2005), while data for heat and power produced using wood are from Henke et al. (2005).

Notes for liquid biofuels:
1. The values are calculated as follow: price difference between biofuel and fossil fuel (on energy equivalent basis) divided by tonnes of CO2 saved using biofuels.
2. Low CO2 mitigation costs are estimated from (low biofuel cost – fossil fuel price)/high estimation savings; high CO2 mitigation costs are estimated for (high biofuel cost – fossil fuel price)/low CO2 emission savings; best estimate costs utilise best estimate values for the biofuel costs and CO2 emission savings.
3. All CO2 emissions represent full WTW life-cycle emissions.

There appears to be significant difference between the cost of GHG reductions with other European produced biofuels compared to cost efficient reductions through Brazilian bioethanol and heat and power production using wood. It is known that reductions of GHG emissions within the transport sector using biofuels are less cost efficient than using biomass for heat and power production (Henke et al., 2005). An exception is bioethanol produced in Brazil from sugarcane. As shown in Figure 4, the cost per tonne of CO2-equivalent emissions abatement of using Brazilian bioethanol is very low compared to other biofuels. The cost is even negative in the case of low cost estimates. Values between zero and -70 €/t of CO2-equivalent mitigated are possible in consideration that Brazilian biofuel processing plants are net exporters of electricity produced from the use of sugarcane by-products to provide energy (Fulton, 2004).

4.7 Environmental Impacts

Biofuels are considered less detrimental for the environment and for human health than mineral transport fuels. In addition to the described reduction of GHG emission, biofuels used in pure form or blended with mineral fuels can reduce tailpipe emissions of carbon monoxide (CO), sulphur dioxide (SO2) and particulate matter (IEA, 2004). However, tailpipe emissions of some compounds, like acetaldehyde in the case of bioethanol and NOx for biodiesel, have been found to increase (IEA, 2004).

Although biofuels generally perform better than mineral fuel during consumption, production is investigated for possible negative impacts on the aquatic environment, on biodiversity and natural amenities (EEA, 2004).

4.8 Advanced Biofuels

Biofuels described in the previous sections, referred as first generation, are based on production processes well developed and commercially available. However, a second group of biofuels is being developed, which does not rely on food crops as feedstock (Murphy and McCarthy, 2005).

As seen in this chapter, bioethanol from food crops and biodiesel from oils have limited potentials due to land availability considerations. Furthermore, technical break-through improvements are not expected in the sector and costs will probably decrease only moderately in the next years. New biofuels based on biomass conversion have the potential to overcome these limitations and de-couple production of fuels from the production of food (IEA, 2004).

Advanced biofuels from biomass can be produced using several different technical processes. Currently, two main pathways are being explored: bioethanol from lignocellulosic biomass and biomass thermochemical conversion. The first method consists in converting the cellulose and hemicellulose components of plants into alcohol by first transforming them into sugar by hydrolysis, while the lignin part is used to produce heat and power (Murphy and McCarthy, 2005). This process is more complicated than converting starch into alcohol (IEA, 2004). On the other side, a wider variety of potential feedstocks would be available such as crops residues, trees, grass and also forestry residues, municipal organic waste and paper process waste.

The second method, the thermochemical conversion or gasification approach, consists in two steps: first, the biomass is gasified and then the gas is converted into final fuels. A huge variety of synthetic fuels can be produced from the gas obtained after the gasification process, referred as syngas. Bioethanol, methanol, synthetic diesel and petrol, DME (dimethyl ether), methane and hydrogen are fuels with different features, but produced, in this case, from the same biomass resources (IEA, 2004).

In spite of differences, the two processes share relevant advantages compared to first generation biofuels such as production potentials, reduction of conflicts with land use for food production and cost-efficient reduction of GHG emissions (IEA, 2004).

In the literature there is a consensus about the benefits achievable with advanced biofuels, although a wide range of values can be found. However, it is difficult to predict when these new technologies will become commercially available. Governments and private companies in countries where land is widely available are strongly interested in developing technologies to exploit biomass resources and to start new businesses. However, at present, there are no commercially operated gasification plants in the EU and activities are at a research, development and demonstration stage (Kavalov and Peteves, 2005). Similarly, production of bioethanol from lignocellulosics is under development and it is not expected to become commercially available before 2010 (Mabee et al., 2004).

The cost of producing advanced biofuels is still economically not feasible (Kavalov and Peteves, 2005). However, over the next decades, advanced biofuels' cost may drop significantly to be equal to the price of petrol (Fulton, 2005). According to the Novem/Ecofys study (2003), the estimated cost for bioethanol from lignocellulosic biomass is near 600 €/1000 l in the medium term and 380 € /1000 l for the long term. In fact, prices may fall below the price of producing conventional biofuels due to the availability of cheap feedstock. Consequently, the cost of GHG emissions abatements is also expected to fall. In the medium term is about 300 €/ tonne CO2-eq and near 100 €/tonne CO2-eq. in the long term **(**Novem/Ecofys, 2003).

5 The European Union Regulatory Context

The aim of this chapter is to identify the driving forces and objectives of the EU policy in the field of biofuels for transport. The chapter is divided in three parts. First, the EU policy framework, which has supported the introduction of specific policy instruments, is described. Second, the main policy instruments adopted by the EU institutions in order to promote biofuels are described and discussed. Issues of interest are the objectives and the driving forces of such instruments. Finally, relevant links with other EU policy sectors are highlighted.

Below it is shown that the EU policy context became favourable to biofuels' introduction during the last decade. Since the ratification of the Kyoto Protocol (1997), the political interest in alternative fuels from renewable energy sources has constantly grown within the EU. The specific policy instruments adopted by the EU define the EU's policy strategy for the years to come, until 2010, and contain realistic targets, which compromise between the urgency of the problems and the physiological lead-time of policy measures. Additionally, it is highlighted that European policies in the trade, agriculture and fuel's standards sectors all have important interactions with biofuels' policy.

5.1 Policy Framework Background

For several years, the opportunity for a Directive in support of biofuels and alternative fuels had been considered. The Directive 2003/30/EC finds its political justification in some general policy instruments adopted at EU level in the last decade. In the light of this study, the most relevant instruments are the UN International Framework Convention on Climate Change (1992) and the Protocol to the Convention signed in Kyoto (1997), the two EC Communications to the European Council in the field of energy (1997 and 2000) and the Communication on transport issues (2001). All these instruments have shaped the EU policy framework in the last 10 years and opened the way for the introduction of specific policy instruments for alternative fuels.

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Climate change is a complex phenomenon which causes are strictly connected to the consumption of fossil energy resources. The problem received worldwide recognition in 1992 with the adoption of the UN Framework Convention on Climate Change. The instrument establishes that Parties included in annex I of the Convention shall reduce their GHG emissions in accordance with the Convention's objectives. However, the Convention does not imply binding obligations on the Parties. In 1997, the EU signed the Kyoto Protocol to the Convention, which entered into force in 2005. By doing that, the EU assumed a general obligation to reduce GHG emissions by the year 2010[7]. The GHG reduction negotiated for the entire EU 25 is established in -8% in respect to emissions recorded in the year 1990. Based on this obligation each EU MS has negotiated within the EU system different commitments to achieve the overall EU target (EEA, 2005). In this context, renewable energy resources, including energy from biomass (bioenergy), have received growing attention for their potential to contribute to GHG reduction targets.

In 1997, in order to promote renewable energy sources in the EU, the EC adopted a strategic action plan for the energy sector, titled "Energy for the Future: Renewable Sources of Energy" (EC, 1997).

[7] The Kyoto Protocol controls industrialised countries' emissions of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N20), plus three fluorinated industrial gases: hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6) (EEA, 2005).

In the document, bioenergy and transport are seen as sectors where action should be taken to solve and prevent climate related problems. Additionally, ambitious targets for renewable energies were introduced aiming to a 12% market share by the year 2010. Consequently, also targets for biofuels consumption were defined at 5 million tonnes oil equivalent by the year 2003 and 18 million by 2010 (EC, 1997).

In 2000, the EC published a new important document for the energy field, titled "Towards a European Strategy for the Security of Energy Supply" (EC, 2000). A significant point in the document was that in the short-medium term the EU does not have the possibility to influence the supply side of energy. However, it should invest resources to reduce its heavy dependence on external suppliers. To attain such a result, the EC has adopted a medium term target for the road transport sector corresponding to the displacement of 20% of transport fossil fuels by alternative fuels before the year 2020. During the last decade, the EC has come to recognize the strict connection existing between energy and transport issues.

In 2001, the EC intervened directly in the field of transport with the publication of a Green Paper titled "European Transport Policy for 2010: Time to Decide" (EC, 2001a). The concept of security of supply was introduced in the EU transport policy. Additionally, the risk of oil supply disruption was identified as one of the major threats for the future of the transport sector. The proposal included in the Green Paper was to balance the sector growth through improved efficiency and larger use of renewable energy resources, such as transport fuels from biomass (EC, 2001a).

In short, during the last decade the EU policy context has become favourable to biofuels introduction. Since the ratification of the Kyoto Protocol and the establishment of reduction targets, the political interest in alternative fuels from renewable energy sources as a means for climate protection has grown constantly in the EU. Furthermore, the dramatic increase of oil prices during the last decade, due to increased demand from countries such as China and India combined with null spare capacity in production countries, have brought the security of energy supply at the centre of the EU's energy and transport policy. In these settings, biofuels' policy entered into the EU policy context.

5.2 European Union Policy Instruments for Biofuels

In this section, the two main policy instruments adopted at EU level in support of biofuels are presented and discussed. First, the legislative procedure, which was concluded with the adoption of the Directive 2003/30/EC on the use of biofuels and other renewable fuels for transport, also known as the Biofuels Directive, is briefly described. Second, the main contents of the Biofuels Directive and the Directive 2003/96/EC on the Community framework for the taxation of energy products and electricity are presented and discussed.

In legal terms, a Directive of the European Community is a legislative act binding on MS in terms of goals and objectives to be achieved but leaves some choice to the MS concerning how to best bring this end about (McCormick, 2001). In the case of the Directive 2003/30/EC, the legislative procedure is described in Art. 251 of the Treaty creating the European Community. The three main actors taking part in the *"co-decision"* procedure of Art. 251 are the European Parliament, the Council of Ministers of the European Union and the European Commission. The formal legislative procedure begun in 2001 when the EC submitted a proposal for a Directive in support of the use of biofuels and alternative fuels for transport to the European Parliament and to the Council of the European Union (EC, 2001b). It is useful to recall that the European Parliament represents the European public at large, as it is directly elected by all citizens of the MS and it operates on the basis of a majority voting (Knill and Lenchow, 2003). Whereas, the Council is composed by the

ministers of the MS and it is dominated by consensus norms, however, in the *"co-decision"* procedure a qualified majority[8] is required (Knill and Lenchow, 2003). Furthermore, the procedure of Art. 251, in which the two institutions participate for the adoption of the proposal submitted by the EC, is today the *"normal legislative procedure"* covering more than half of the Community legislation (Rasmussen, 2003).

Once the Directive is adopted, MS have a deadline for transposal into national law, while the EC is responsible for monitoring the implementation process. In the case of not compliance, the Commission begins by sending the MS a "letter of formal notice". Afterwards, if the answer from the MS is not satisfactory, the EC delivers a "reasoned opinion". The final measure is to bring an infringement proceeding against the MS based on Art. 211 of the Treaty. However, this last option is an extreme and rarely applied measure (McCormick, 2001).

5.2.1 Directive for the Promotion of the Use of Biofuels

The Directive 2003/30/EC promotes the use of biofuels and renewable fuels for transport in the EU in order to achieve the EU targets in the energy, climate and transport sectors as described in the previous section. For the EU, the primary political drivers behind the development of biofuels are described in the Directive itself as being partly to improve the security of energy supply and partly to reduce the environmental impacts of the transportation sector (EC, 2001b). Other positive consequences such as rural development, environmental pollution, employment in rural areas and sustainable development in developing countries are taken into consideration for the adoption of the Directive (Explanatory Memorandum to the Directive 2003/30/EC).

Art. 3.1 of the Directive states that MS shall *"assure that a minimum proportion of biofuels and other renewable fuels is placed on their markets, and, to that effect, shall set national indicative targets"*. In doing so, the MS shall take into consideration reference targets of 2% for 2005 and 5.75% for 2010, calculated on the total fuel consumption of the transport sector (on energy basis). However, the MS can decide how to best achieve these targets. In this concern, the original proposal of the Biofuels Directive included mandatory targets (EC, 2001b). However, the Council considered that *"indicative targets would be more appropriate than mandatory ones, enabling MS to introduce the necessary measures in a gradual and flexible manner […]"* (Council of Ministers of the European Union, 2002).

Moreover, the Biofuels Directive confirms that national indicative targets should be set in accordance with country specific conditions. Nevertheless, it requires that where, due to national considerations, targets differ from the Directive reference values, the MS should properly justify them. Possible motivations are listed in Art. 4.1:

- *"Limited national potential for the production of biomass;*
- *The use of domestic biomass resources for other energy uses than transport;*
- *Specific technical or climatic characteristics of the national market for transport fuels;*
- *National policies that allocate comparable resources to the production of other transport fuels based on renewable energy sources."*

Art. 4.2 establishes that the EC will evaluate MS' progress reports in 2006 and, thereafter, every two years. If the EC concludes that the reference targets are missed without any appropriate

[8] Qualified majority is defined as 50% plus one of the Council's votes cast by a majority of the MS and representing at least 62% of the total population of the Union (Art. 205 of the Treaty establishing the European Community).

justification, it can recommend the adoption of national mandatory targets to the Council and the European Parliament.

Under the Directive 2003/30/EC, import of biofuels or raw material to support national consumption are not directly prohibited or restricted. In addition, Art. 1 establishes that the aim of the Directive is to promote *"the use of biofuels or other renewable fuels to replace diesel or petrol for transport purposes in each Member State, with a view to contributing to objectives such as meeting climate change commitments, environmentally-friendly security of supply and promoting renewable energy sources"*. Therefore, support to national or European production of biofuels is neither an aim nor a condition to meet.

Although not included among the Directives' aims, the positive effects on the development of European rural areas are stressed by the EC. In the Explanatory Memorandum to the Biofuels Directive, it is stated that *"increased production of raw material for biofuels could contribute to the rural economy through the creation of new sources of income and employment"* and this concept is reaffirmed in the Directive (preamble, point 15). Other positive impacts such as the reduction of air pollution emissions and the increase in biofuels trade with developing countries, which could support sustainable development in those countries, are mentioned in the Explanatory Memorandum to the Directive.

5.2.2 Energy Taxation Directive

In 2003, the Directive 2003/96/EC (Energy Taxation Directive) was adopted as a package with the Biofuels Directive. The objective of Energy Taxation Directive is to modify the set of minimum taxation levels for energy products introduced in 1992 by the Directive 92/81/EEC. Since 2003, the Directive 2003/96/EC has allowed MS to exempt bioenergy products from energy taxation. However, it is established that full or partial tax exemption may not over-compensate the cost-disadvantage of biofuels. Additionally, duty reductions schemes may be implemented only after submission and approval by the EC, which assess the compatibility of the measure with EU rules (Pricewaterhouse Coopers, 2005). A large number of MS has introduced fiscal policy instruments, based on Directive 2003/96/EC, to support national biofuels' consumption (see Chapter 6).

5.3 European Union Import Rules

The role of imports could become of primary importance for the MS that aim at achieving the targets of the Biofuels Directive. As described in this chapter, the Biofuels Directive does not prevent MS from importing biofuels or feedstock for biofuels production. Theoretically, imports can be supplied from other EU countries or from countries outside the Union. In the former case, the Treaty establishing the European Community explicitly prohibits the introduction of customs duties and charges with equivalent effect and quantitative restrictions between MS (Art. 25, 28 and 29). In the latter case, when biofuels or feedstocks are imported from outside the Union, EU import rules and tariffs apply.

In general, imports from outside the EU are subject to duties and restrictions depending on the classification of the product in the "common tariff schedule". In the case of bioethanol, for example, duties vary from 0.102 to 0.192 €/l[9]. The existence of such tariffs is motivated with the protection of the internal market and EU producers from price competitive non-EU products. It should be taken into account that import rules and tariffs are likely to become strategic issues if the EU demand increases faster than the production of biofuels. In this context, the EU Council (Regulation No.

[9] Tariffs on bioethanol depend on whether the fuel is denatured (0. 102 €/l) or undenatured (0.192 €/l). Information on tariffs is available on http://europa.eu.int/comm/taxation_customs/dds/en/tarhome.htm.

670/2003) introduced an import/export license scheme and gave to the EC the power to administer tariff quotas *"resulting from international agreements concluded in accordance with the Treaty […]."* Internationally, import duties are negotiated within the World Trade Organization (WTO) framework and, therefore, cannot be changed unilaterally by the EU. The WTO negotiations produce general rules that apply to all members states. A country can change its obligations only after negotiating with its trading partners (Pricewaterhouse Coopers, 2005). In this context, the EU is negotiating with Latin American countries to reduce tariffs for the import of bioethanol in the EU (Ryan et al., 2005).

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Additionally, with the mandate towards global trade liberalization and environmental sustainability, the WTO has started negotiations on the reduction or elimination of tariff and non-tariff barriers to environmental goods and services (EGS). However, there is no agreement on what should be included in this category and, therefore, whether biofuels are a part of the EGS category (Coelho, 2005). The OECD/EUROSTAT Informal Working Group in 1999 defined EGS as *"goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil as well as problems related to waste, noise and eco-systems"*. Removal of international trade barriers is a possible near future development in the context of WTO rules that could influence both biofuels' production and consumption within the EU.

5.4 European Common Agriculture Policy

The European Common Agriculture Policy (CAP) is highly relevant for the production of biofuels. The general objectives of the CAP are established in Art. 33 of the EC Treaty and include: increase agricultural productivity, ensure fair standard of living for farmers, stabilize markets, assure supplies and guarantee reasonable prices for consumers. However, the production of energy crops to support renewable energy from biomass was not a concern of the CAP until recent years. According to Nilsson and Nilsson (2005), agricultural policy has been slow to react to driving forces of energy and transport policy.

The basic element of the CAP is the common market, which shall guarantee free movement of agricultural products with in the EU and protect producers from competition and price variations on the world market (Henke et al., 2005). However, the common market system has created a wide range of undesirable side effects including excess of supply of most products and increasingly high expenditures for protecting and supporting the agricultural sector. In order to tackle these problems the CAP was partly reformed in 2003. Specific issues relevant for biofuels' production touched by the 2003 reform include the introduction of the Single Payment Scheme, the creation of set-a-side land and the energy crop premium. The Single Payment Scheme replaced direct payments to farmers. The payment scheme is no longer linked to what farmers produce, thus, farmers are more market oriented in the decision about what to produce (EC, 2003b).

In 2003, the EC included the development of rural areas among the advantages of implementing the Biofuels Directive (Explanatory Memorandum to the Directive 2003/30/EC). However, this consideration is based on the assumption that raw materials for biofuels are produced within the EU and not imported from third countries. In the former case, the CAP is a highly relevant factor. At present, farmers have three options under CAP rules to grow biofuels' feedstocks:

- Crops may be grown on cropland areas. In this case, producers receive both a Single Payment and an "energy crop premium" of 45 €/ha.
- Crops may be grown on set-a-side land. Set-a-side land is a percentage of agricultural land that is put a side and not used for food production in order to reduce production. Biofuels'

feedstocks can be grown on these areas and farmers receive a subside correspondent to historic references in relation to the crop that was cultivated before the areas was put a side.

In conclusion, farmers decide to grow biofuels' feedstocks only if expected revenues are higher than the profit for growing other crops. CAP subsidies do not affect directly farmers' decision in favour of biofuels' feedstocks. Nevertheless, the CAP supports European production of energy feedstock and prejudice international trade competition with third countries (Henke et al., 2005).

5.5 Fuels Standards and Norms

The need for standardization in the biofuels sector is due to the fact that, although production conditions and raw materials are different in different countries, the requirements from the application as automotive fuels are very similar all around Europe. Fuel standards are of high importance for the producers, suppliers and users of biofuels. Authorities need approved standards for the evaluation of safety risks and environmental pollution and, therefore, they are a prerequisite for biofuels' market introduction and commercialization (Prankl et al., 2004).

At EU level, the European Directive 1998/70/EC, amended by the Directive 2003/17/EC, has improved air quality and reduced harmful exhaust emissions by regulating certain quality parameters of fuels for combustion engine in driven vehicles (Prankl et al., 2004). Due to the continuous improvement of parameters, emissions of CO, NOx, Particulate Matter, VOC, Benzene and SO2 have significantly decreased in the last years and are expected to be further reduced until 2010 (EEA, 2004a). Concerning biofuels, the EU Directive 2003/30/EC establishes that biofuels must comply with Community legislation on fuel quality, vehicle emissions and air quality. Accordingly, biofuels' market penetration is subordinated to the achievement of air and fuel's quality standards. Additionally, stricter emission limits and technical specifications for automotive fuels could limit further market penetration of biofuels.

Concerning blending procedures, the Directive 1998/70/EC allows a maximum share of 5% (volume) of ethanol into petrol and 5% (volume) of biodiesel into mineral diesel. Following these requirements means that the Directive reference targets of 5.75%, on energy content, in 2010 cannot be achieved through blends of biofuels in conventional fuels, but it requires significant consumption levels of pure biofuels in dedicated vehicles. However, an amendment of the Directive 1998/70/EC is under evaluation in order to allow higher share of biofuels in blends (IEA Bioenergy, 2004).

6 Biofuels in the Member States of the European Union

This section deals with the implementation of the EU Directive 2003/30/EC in the MS as described in the national progress reports submitted by the national authorities to the EC. By the end of October 2005, only 15 MS have submitted their second national report. Estonia, Finland, Greece, Hungary, the Netherlands, Portugal, the Slovak Republic and Spain did not present their reports for 2005, thus, the reports from the year 2004 have been used. Furthermore, there are no reports at all available for Italy and Luxemburg. The national reports are published in the language of the Member State concerned. For most of the reports, English translations are provided on the Commission's website[10] and these have been used for this thesis.

[10] http://www.eu.int/comm/energy/res/legislation/biofuels_members_states_en.htm

The assessment of the implementation of the Biofuels Directive is performed in this section by observing four main issues: national indicative targets for biofuels consumption, sales of transport fuels and share of biofuels, official motivations for differentiation from the reference targets and national policy measures in place or planned to achieve national targets.

As presented below, this research suggests that the EU will not reach the Directive 2003/30/EC reference target of 2% in 2005. The arguments invoked by MS for differentiation show that agricultural potentials for feedstock production and economic constrains are the main barriers, whereas technical and environmental concerns seem to be of less importance to the MS. Table 2 presents a summary of the MS motivations for differentiation.

6.1 National Indicative Targets for Biofuels' Consumption

In Table 1, an overview of the MS's national indicative targets for biofuels' consumption is given. Indicative targets for 2005 and 2010 are compared with consumption levels in 2003 and 2004. EU average values are based on biofuels' consumption in the MS and total EU fuel consumption in 2004. Biofuels' consumption levels for 2003 were used when 2004 figures were not available.

Table 2. Member States' consumption of biofuels in 2003 and 2004; national indicative targets for 2005 and 2010 (in energy content)

Member State	2003 Consumption	2004 Consumption	2005 Target	2010 Target
Austria	0.06%	0.06%	2.5%	5.75% (2008)
Belgium	N.A	0%	2%*	N.T.
Cyprus	0%	0%	N.T.	N.T.
Czech Republic	0.9%	0.7%	0.7%	5.75%
Denmark	0%	0%	0%	N.T.
Estonia	0%	N.A.	0%	N.T.
Finland	0.1%	N.A.	0.1%	N.T.
France	0.7%	0.83%	2%	5.75%
Germany	1.4%	1.8%	2%	N.T.
Greece	0%	N.A.	0.7%	N.T.
Hungary	0%	N.A.	0.4-0.6%	N.T.
Italy	N.A.	N.A.	N.A.	N.A.
Ireland	0%	0.0003%	0.06%	N.T.
Latvia	0.3%	0.036%	2.0%	5.75%

Lithuania	N.A.	0.31%	2.0%	5.75%
Luxemburg	N.A.	N.A.	N.A.	N.A.
Malta	0.02%	0.1%	0.3%	N.T.
Poland	N.A.	0.3%	0.5%	N.T.
Portugal	0%	N.A.	1.15%	N.T.
Slovakia	0.18%	N.A.	2.0%	5.75%
Slovenia	N.A.	N.A.	0.65%	5%
Spain	1.09%	N.A.	2.0%	N.T.
Sweden	1.3%	2.3%	3.0%	5.75%
Netherlands	0.04%	N.A.	N.T.	2.0%
United Kingdom	0.04%	0.04%	0.3%	N.T.
EU total**	0.63	0.77	1.4	-

Source: the data is from the MS progress reports published on the web site of the EC. Available at http://www.eu.int/comm/energy/res/legislation/biofuels_members_states_en.htm.

Notes
* It refers only to the Flemish region.
** It is based on biofuels' consumption in 2003/2004 and total fuel consumption in the same year, excluding Italy and Luxemburg.
N.A.: the data is not available.
N.T.: the value is not set by the MS.

As shown in Table 1, biofuels' national targets are generally not in line with the reference target of 2% for 2005 and consumption levels are relatively small. Nine MS have national targets that meet the reference value for 2005. However, apart from Sweden which has already reached EU-target in 2004, few MS have a national indicative target equal or higher than 2% and, at the same time, are close enough to reach it. Among those MS, Germany and, probably, France and Spain may reach the 2% target in 2005.

Furthermore, it is noted that the growth rate of biofuels' consumption in the MS is not sufficient to achieve a European consumption level of 5.75% in 2010. From the data presented in the MS reports observed, the share of biofuels increased from 0.63% in 2003 to 0.77% in 2004. This amounts to an annual increase of 22.2% in energy content. Although the 2% target will be missed, biofuels' consumption will still grow significantly in 2005 because large countries, like Germany and France, have committed themselves to achievement of the EU targets.

On the other hand, the data presented in Table 1 must be read carefully. It should be considered that MS have different sizes and therefore different impacts on the achievement of the Directive's targets at EU level. Figure 5 offers an insight into this difference. National targets and consumption levels should be seen in this perspective.

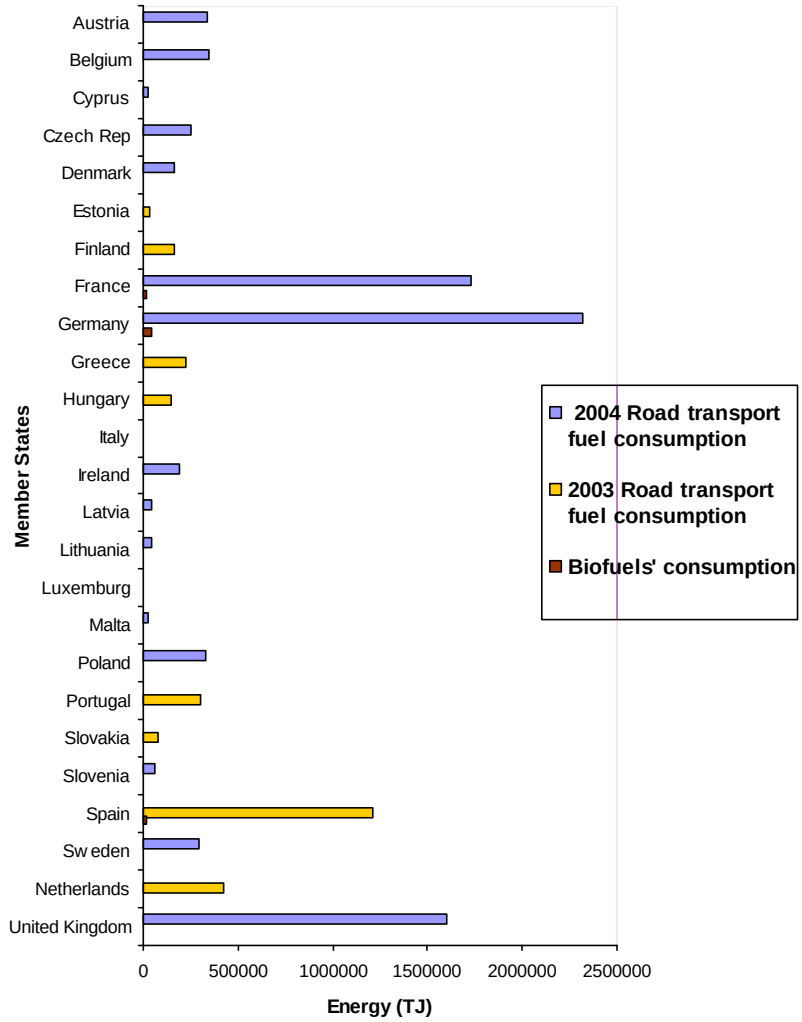

Figure 5. Total sales of fuels for transport in the MS and biofuels' share in energy content.

Source: the data is from the MS progress reports published on the web site of the EC. Available at http://www.eu.int/comm/energy/res/legislation/biofuels_members_states_en.htm

6.2 Overview of the Motivations Invoked for Differentiation

In this section, the reasons mentioned by MS for deviation from the Directive's target are categorised and counted in order to perform an analysis in the following chapters. It has to be pointed out that not all the reports mention clearly which are the obstacles to the implementation of the Directive. In Table 2, the results are summarized. MS that expect to meet the Directive's target in 2005 were not included in this section.

Arguments invoked by MS in their progress reports:

1. *Budget limitations.* This includes both the loss of government revenues due to tax exemptions/reductions and general budget constrains.
2. *Focus on advanced biofuels.* Advanced biofuels are considered a viable option for future development of the sector. MS claim that the resources allocated for this purpose justify the delay of the market penetration of biofuels.
3. *Limited agriculture potential for production of biofuels from biomass.* MS claim that national agricultural potentials including land availability, soil fertility and land allocation for food production are limiting factors for the achievement of Biofuels' consumption targets.
4. *Use of biomass for the production of heat and power.* The allocation of feedstock for the production of heat and power, which reduces the domestic feedstock available for the production of biofuels, is considered a barrier.
5. *High production cost of biofuels*. Production costs of biofuels are higher than mineral fuels' costs and therefore they are less competitive on the fuels market.
6. *Cost-efficiency of reductions of GHG emissions.* MS find the promotion of biofuels a rather inefficient and ineffective way to achieve climate protection targets.
7. *Investments lead-time and low starting point.* MS argue that the introduction of biofuels on the market is still at the begin and that it will take some time before results are achieved.
8. *Technical suitability of vehicles*. The compatibility of current vehicles and engines with biofuels is questioned.
9. *Suitability of the fuel distribution system.* The fuel distribution system is not entirely compatible with the handling of biofuels, thus, investments could be required. In addition, there might be technical problems in connection with blending operations.
10. *Negative environmental impacts*. There are environmental concerns in regard of biofuels' production and its negative impacts on the aquatic environment, on biodiversity and natural amenities.
11. *Country energy self-sufficiency*. MS argue that energy security is not considered a relevant issue at national level due to national oil reserves and share of renewable source for energy production.
12. *Limited creation of employment*. Job creation in agricultural areas is considered being a limited and expensive consequence of biofuels' production.
13. *Limited production capability.* The lack of technology for biofuels' production is claimed to be a constraint.

Table 3. Arguments invoked in the Member States' reports to explain differentiation from the 2005 reference target of the Biofuels Directive.

MEMBER STATES / BARRIERS	Belgium	Cyprus	the Czech Rep.	Denmark	Estonia	Finland	Greece	Hungary	Ireland	Malta	the Netherlands	Poland	Portugal	Slovenia	UK	Total
National budget limitations	X		X	X								X				4
Focus on advanced biofuels				X		X					X					3
Limited agricultural potentials	X	X				X		X	X	X	X		X			8
Biomass heat/power production				X		X								X		3
High production costs	X															1
GHG emissions reduction cost				X		X			X			X			X	5
Investments lead-time and low starting point	X														X	2
Vehicles' technical suitability				X	X		X									3
Suitability of fuel distribution system				X					X							2
Negative environmental impacts				X					X						X	3
Country energy self sufficiency				X												1
Limited creation of employment				X												1
Limited production capability												X		X		2

Source: the data is from the MS' progress reports published on the web site of the EC. Available at http://www.eu.int/comm/energy/res/legislation/biofuels_members_states_en.htm.

It is clear that MS experienced several barriers for the implementation of the Biofuels Directive, the main ones are agricultural potentials for feedstock production, and economic constrains, while technical and environmental concerns seem to be of less importance.

The most reported obstacle is limited potential of agricultural production of feedstock. This factor includes land availability, crop competition for food and energy uses, climate conditions and soil fertility. Eight MS claim that this factor affects their national indicative targets.

In addition to that, some of the MS, which claim limited agricultural capacity, are at the same time investigating alternative feedstock sources. MS like Finland and Denmark arrive to claim that investments in advanced biofuels and alternative feedstock researches justify their low national targets.

Besides limitations in feedstock production, MS invoke economic constrains to justify their national targets. As shown in Table 2, five MS consider the promotion of biofuels a rather expensive and

inefficient way of achieving climate targets. They argue that the costs of reducing CO2 emissions by using biofuels are much higher than using biomass for heat and power production.

National budget limitations are another form of economic barrier mentioned in the MS' progress reports. Four MS argue that measures required to support biofuels are dependent on the availability of national funds. They consider both government's revenues loss due to tax rebates and the general availability of financial resources as important constraints of biofuels' policy. Thus, it is reasonable to argue that national governments are not willing to invest financial resources to support biofuels when costs seem high or disproportionate compared to attainable benefits. Several MS highlight in their reports the loss that national budgets bear as consequence of tax rebates. As shown in the next section, in order to control budget deficiencies some MS such as France and Portugal have established quotas for tax relief.

Technical and environmental issues that in theory could be important barriers for the development of the biofuels' sector are not widely reported by MS. Technical barriers for biofuels' consumption, like the suitability of vehicles and fuel distribution systems, are invoked by some MS. However, the MS's concern is limited as to whether biofuels use would give rise to technical problems and, if so, who will bear the additional costs.

Additionally, the often debated claim that biofuels could have negative impacts on the natural environment does not receive great attention by the MS. Denmark, Ireland and UK report to the EC about their concerns of possible detrimental impacts on the environment. However, in this case, like in the case of technical barriers, the arguments are not persuasive in quantity and quality. They do not add any new element to those that the EC has considered in the proposal of the Biofuels Directive (EC, 2001b).

6.3 Overview of the Policy Measures

In this section, national policy measures in place, or planned, are described. The majority of the MS has introduced in their national policy specific instruments in support of biofuels' consumption. First, the instruments are briefly described and then summarized in Table 3.

1. *Excise duty exemption/reduction.* Tax relieves have the purpose to lower the price of biofuels at the pump, thus, increase biofuels' competitiveness on the fuel market.
2. *CO2 tax exemption*. This measure aims to reduce biofuels' price at the pump in consideration of their carbon saving advantage compared to mineral fuels.
3. *Reduced tax for Flexi-Fuel Vehicles.* MS make use of tax cuts, like reduced registration fee and reduced road tax, to favour market introduction of Flexi-Fuel Vehicles (FFV).
4. *Feedstock production subsidies.* In addition to CAP's subsidies, a wide range of subsidies for agriculture production is available under different national schemes.
5. *Capital grants.* In order to facilitate investments in biofuels' production, distribution and consumption, MS have introduced capital grants schemes.
6. *Funds for research and development programs.* MS give financial support to research projects on a variety of subjects such as production costs abatement, advanced biofuels, performance of blends in fossil fuels.
7. *Mandatory use of biofuels*. MS introduce in their legal system a substitution obligation, which imposes fuel distributors to put a certain percentage of biofuels on the market (on the basis of fossil fuels sales) or alternatively imposes that all the transport fuels put on the national market contain a minimum percentage of biofuels.

8. *Fuel quality standards.* Quality standards for biofuels are introduced to improve consumers', car producers' and public authorities' reliability on biofuels.
9. *Government's voluntary action.* National and local governments become voluntarily involved in demonstration activities in favour of biofuels such as the use of biofuels to fuel their vehicle fleets.
10. *Congestion charge and parking fee exemption.* In this case, drivers are attracted by a combination of economic and practical incentives. This kind of measures is obviously affordable up to a certain level of participation.
11. *Availability of filling stations.* The availability of filling stations for biofuels is of fundamental importance to allow a greater use of biofuels.
12. *Pollution tax exemption.* Biofuels are exempted, in consideration of their good environmental performance, from specific taxes on endogenous activities, which are introduced in order to reduce negative impacts on human health and the environment of such activities.
13. *Environmental tax adjustment.* Taxes on activities that damage the environment are increased and labour taxes are reduced. Biofuels are exempted from the tax increase for the related environmental advantages.
14. *Information and public relation activities.* Information on the availability and the benefits of biofuels are supplied to the public.

Table 4. Policy measures presented in the MS' progress reports in 2004 and 2005.

MEASURES / COUNTRY	Measure 1	Measure 2	Measure 3	Measure 4	Measure 5	Measure 6	Measure 7	Measure 8	Measure 9	Measure 10	Measure 11	Measure 12	Measure 13	Measure 14
Austria	**X**						**X**							
Belgium	**X****			**X**	**X**	**X**								
Cyprus	**X****		**X**		**X**	**X**		**X**	**X**					
Czech Rep.	**X**					**X**	**X****	**X**						
Denmark		**X**				**X**								**X**
Estonia	**X**			**X**										
Finland	**X***					**X**								
France	**X**													
Germany	**X**					**X**								**X**
Greece														

Hungary	**X**													
Ireland	**X***			**X**		**X**								
Italy														
Latvia	**X**			**X**	**X**	**X**								
Lithuania	**X****			**X**			**X****					**X**		
Luxemburg														
Malta	**X**								**X**					
Netherlands														
Poland	**X**					**X**								
Portugal	**X**													**X**
Slovak Rep.														
Slovenia	**X**						**X**							
Spain	**X**													
Sweden	**X****	**X****				**X**			**X**	**X**	**X**		**X**	
UK	**X**				**X**	**X**			**X**					
Total	**19**	**1**	**1**	**5**	**4**	**11**	**4**	**2**	**4**	**1**	**1**	**1**	**1**	**3**

Source: the data is from the MS' progress reports published on the web site of the EC. Available at http://www.eu.int/comm/energy/res/legislation/biofuels_members_states_en.htm.
Notes
* Tax relief only for research projects
** Measures adopted but not implemented yet

Three categories of policy instruments have met the favour of national governments: economic instruments, measures to support research and development projects and government's involvement in demonstration activities. The most widely adopted are the economic instruments, but also research and development measures are often mentioned in the MS reports. Government's direct involvement in demonstration activities seams to have a small role in MS strategies. In the near future, tax breaks and mandatory use for biofuels are expected to have a greater role in MS' policy strategies.

Policy instruments already implemented in the MS are mainly to overcome economic barriers. Economic barriers consist of the cost disadvantage of biofuels compared to mineral fuels. To support biofuels' consumption MS have so far focused on measures like tax incentives, but also capital grants and agricultural subsidies, in order to increase biofuels' price competitiveness. The main difference between those instruments is that tax incentives directly affect consumption levels and only indirectly production, whereas the last two instruments have a direct effect on production and only indirectly promote consumption.

On a total number of 15 MS that have already introduced fuel tax breaks, four MS have adopted schemes only in support of research projects. One reason for that is that tax exemptions/reductions can become financially heavy for the national government, thus, difficult to justify. With the same purpose, MS like France, Portugal and Cyprus have adopted tax relief schemes based on quota systems. It can be concluded that generally MS are carefully evaluating the financial impacts of biofuels' support measures.

Most MS are aware that fiscal instruments have a direct and immediate effect on consumption levels, but also that those instruments must be guaranteed for a certain period if to influence positively production levels. For this reason, MS allow tax differentials for a minimum period of 4/5 years and not more than six years, in accordance with the EU Directive 2003/96/EC. Therefore, national policies will be linked for the next years to fiscal measures in support of biofuels consumption, without possibilities for fast changes in policy strategy.

Feedstock production subsidies and capital grants for investments in fuels production are also instruments widely used by MS to overcome economic barriers. Five MS have created national support systems in addition to CAP's financial incentives for farmers who decide to grow biofuels' crop feedstocks. The amount and availability of subsidies depends on the type of crops and type of land used. At the same time, four MS make use of capital grants as means of financial support for investments in biofuels' production activities. Both instruments directly influence national production levels, but they do not affect directly consumption levels because production can, in principle, be exported. Therefore, MS should be aware that those instruments do not assure or promote directly the achievement of EU reference targets.

Research and development programmes are considered key instruments for the development of national biofuels' sectors. Eleven MS are directly involved in funding research and development programmes. It is noted that research projects are developed in connection with national interests and potentials. Most of the countries involved in project funding report to the EC their interest in investigations concerning potentials of new technologies for biofuels' production, including extensive research into advanced fuels.

Governments' direct involvement in biofuels' demonstration activities has a minor role in MS strategies. Three MS mention that information on biofuels is given to the public in accordance with Art. 3.5 of the Biofuels Directive. In addition, four MS have voluntarily decided to use biofuels to fuel part of their vehicles' fleets. However, MS seem to consider of secondary importance the impact of this kind of measures on biofuels consumption levels.

In conclusion, having observed the policy instruments introduced in the MS in the past years it is possible to highlight two feasible developments in the MS's policy strategies for biofuels such as the increasing use of tax relief schemes and the introduction of mandatory use of biofuels. First, during the next years the introduction of tax rebates schemes will probably be observed in several MS. Four MS have already notified by the EC their national proposals, thus implementation is just a matter of time. Furthermore, few other MS discussed this policy option in their first progress report[11]. Another tendency seen from the MS' reports is the progressive introduction of mandatory targets for the consumption of biofuels. Some MS are discussing the opportunity, while others like Austria, Lithuania, Slovenia and the Czech Republic are already implementing mandatory quota for biofuels' consumption. The impact of these measures on consumption levels will be assessed in the coming years.

[11] Several MS mentioned the possibility to introduce policy instruments in their first report in 2004. Therefore, in the 2005 reports, which are available only for some MS, the introduction of policy instruments should be confirmed and described in details.

7 Policy Interactions and Conflicting Goals

In July 2005, the EC sent reasoned opinions to nine MS for not having fulfilled their responsibilities under the Directive 2003/30/EC. The EC noted that several MS deviated from the Directive's reference targets and, having examined their justifications, it concluded that the targets adopted by seven MS were not in compliance with the Directive's requirements[12]. The EC declared that *"the reasons given lack relevance, seem incorrect, put the desirability of the Directive itself into question, or would (if correct) apply to all Member States; or that the proposed target would not promote the use of biofuels."* (EC, 2005)[13].

As shown in chapter 6, MS' national targets do not comply with reference targets in several cases. Furthermore, national consumption levels in 2005 are expected to be lower than the reference value of 2% and the motivations invoked by the MS have been substantially rejected by the EC. All in all, it is possible to conclude that the Biofuels Directive suffers from an implementation deficit. The objective of this chapter is to identify and describe policy interactions, at EU and MS level, which affect the policy implementation process.

7.1 Policy Goals and Priorities: European Union vs. Member States

This section identifies and describes goal conflicts existing between EU and MS policies for biofuels. In order to do that, the EU policy described in chapter 5 is re-evaluated in connection with the findings of chapter 6.

Security of energy supply for transport activities, which was a primary objective of the Biofuels Directive, is not consistently recognized by the MS. The EC evaluates security of energy supply on a broad prospective, such as diversification of suppliers, in agreement with the outlook presented in the EU Green Paper for energy "Towards a European strategy for the security of energy supply" (EC, 2000). Whereas, the majority of the MS, with the exemption of few countries such as Sweden and partly the UK, evaluates the concept of security of supply as strictly connected to the concept of national energy self-sufficiency. Furthermore, MS do not consider biofuels imports from other EU countries an enhancement of the energy supply situation. In this case, the narrow interpretation given to the concept of security of energy supply is motivated by the fact that most MS support biofuels consumption through tax reduction measures. Moreover, governments are never enthusiastic over the idea of financing production in other countries.

Another important driving factor for the adoption of the Biofuels Directive was climate protection. Whereas, the EC has decided that investments in biofuels are on the right path towards the achievement of GHG emission targets and towards climate change mitigation, MS do not always agree with the EC position. They often claim that reductions of GHG emissions achievable through biofuels' consumption are not effective considering biofuels' GHG emissions balance, share of transport fuels potentially displaceable and country total GHG emissions.

MS have misinterpreted the role of a number of positive impacts that the EC is expecting from the achievement of the Directive targets such as the development of rural areas in the EU and the development of sustainable production in developing countries through the enhancement of trade in

[12] Countries not in compliance with the Directive's requirements are Denmark (target of 0.0%), Ireland (0.06%), Finland (0.1%), the United Kingdom (0.3%), Hungary (0.4-0.6%), Poland (0.5%) and Greece (0.7%) (EC, 2005).
[13] The motivations invoked by the MS for differentiation from the Directive's 2003/30/EC reference target are described in detail in chapter 6.

biofuels. Those effects, although carefully evaluated during the discussion of the legal text[14], cannot be considered primary drivers of the adoption of the Biofuels Directive. However, it has been shown that MS often mention the impacts on the development of rural areas among the main driving forces for the implementation of the national biofuels' policy. On the other side, they never mention the importance of trade in biofuels with developing countries as an argument for implementing the EU policy.

In short, most MS consider security of energy supply an important issue. However, biofuels are not seen as a good solution due to limited production potentials at national level. In addition, although biofuels are often included in national climate change strategies, they are not duly taken into account due to limited potentials and effectiveness. The major and often only concern for national governments is related to the development of rural areas and the agricultural sector.

7.2 Policy Dilemma: Agricultural Development vs. Sustainable Transport

The objective of this section is to identify and evaluate possible policy goal conflicts existing within the EU biofuels' policy in concern to biofuels' imports. In order to accomplish that, the Directive 20003/30/EC is analysed.

MS claim limited production potentials in connection with agricultural land to produce biofuels. Although MS are allowed under the Biofuels Directive to import biofuels, they often invoke agricultural limitations to justify national targets. Clearly, this attitude demonstrates that MS do not consider imports as a viable option to achieve the Directive's reference targets.

It is widely recognised that both countries in Europe and elsewhere do not encourage imports and, at the same time, for obvious reasons, have a tendency to favour national production. The EU biofuels' policy directly refers to this issue in contradictory ways. Art. 4.1 of the Directive 2003/30/EC provides that: *"Limited national potentials for production of biofuels"* constitutes an objective factor in order to justify national targets not complying with the Directive's reference targets. Moreover, in the Explanatory Memorandum to the Biofuels' Directive it is stated: *"Increased production of raw materials for biofuels will contribute to the multi-functionality of agriculture and provide a stimulus to the rural economy through the creation of new sources of income and employment"*. EU policy makers point out this positive effect because they are aware that development of rural areas is welcome among the agriculture sector and that the support of the agricultural sector will be beneficial for achievement of the Directive's targets. However, in this way they sustain an interpretation of the EU biofuels' policy, in which national production and agricultural development are primary factors. Conversely, Art. 1 of the Directive 2003/30/EC does not include rural development nor production of biofuels among the Directive's aims. Therefore, it must be concluded that imports of biofuels or feedstock material are allowed in order to support national consumption.

Taken this into consideration, it is possible to state that the EU policy is, in this concern, not straight forward and allows MS to move their policies away from the option of importing biofuels, creating conflicts between agriculture development and sustainable transport goals. In short, the implementation process during the first two years after the adoption of the Directive 2003/30/EC has been characterized by a negative approach towards imports partly due to the nebulous position assumed by the EU biofuels' policy.

[14] At least the case of rural development was carefully evaluated during the discussion of the EC proposal for a Directive in support of the use of fuels from biomass.

7.3 Free Trade vs. Security of Energy Supply and Climate Protection: A Dilemma?

This section focuses on policy interactions between international free trade principles and the goals of the EU biofuels' policy. As presented in this research, the EU is committed to climate protection and to a reduction of oil dependency in the transport sector. Simultaneously, the EU, representing all the MS, has been a member of the WTO since it was created in 1995. There are two levels of concern in connection to free trade principles: trade within the EU and with countries outside the EU.

The first issue is expressly recognized by the Biofuels Directive, which states that the principles of the EU common market should be protected from possible distortions.[15] The common market is an essential element for the EU and its protection from possible distortions has characterized the EU policy since its inception.[16]

In a broader perspective, as in the case of trade with countries outside the EU common market, the EC's interpretation of the concept of security of energy supply is considered compatible with trade liberalization and the principles of the WTO: *"raise standards of living, censure full employment and a large and steadily growing volume of real income and effective demand and expand the production of and trade in goods and services, while allowing for the optimal use of the world's resources in accordance with the objective of sustainable development"* (Lodefalk, 2004). In fact, trade liberalization promotes the diversification of suppliers, which is regarded as an improvement of the energy supply situation. However, as previously highlighted, the MS show a different position on the issue.

Comment [LDL3]: Did I explain somewhere what it the WTO?

On the other side, whether measures introduced to promote climate change mitigation could affect international trade is a debated issue (Lodefalk, 2004). In principle, the reduction of climate change emissions using the Kyoto Protocol mechanisms is compatible with WTO rules (Lodefalk, 2004). In this regard, WTO Members have agreed that trade and environment can and must be mutually supportive and climate change is an environmental problem almost universally recognised (Doha Declaration, Art. 6). However, in practice, concrete trade distortions should be considered and carefully avoided. There are two main areas of concern: subsidies, for agricultural production and for conversion facilities, and duties on imports.

Subsidies are widely used in the MS to support feedstock production and conversion facilities. It is crucial to assess whether these instruments can coexist with WTO rules. According to Lodefalk (2004), in order to avoid climate subsidies from being contrary to WTO rules, the following key characters should be considered: *"even-handedly and objectively applied"*, *"potential adverse effects"* should be carefully considered and, finally, they should be *"transparent"*. In conclusion, biofuels subsidies are potentially compatible with WTO rules. Nevertheless, each case should be individually evaluated.

In opposition, duties on biofuels' imports are generally considered contrary to WTO rules because perceived as charges or duties, which are applied in excess of bound tariffs in schedules of commitment (Lodefalk, 2004). [17] In this regard, Community customs tariff duties on biofuels are

[15] In the Directive 2003/30/EC it is stated: *"National policies to promote the use of biofuels should not lead to prohibition of the free movement of fuels […]"*.

[16] Arts. 25, 28 and 29 of the Treaty provide for a prohibition to implement customs duties and charges with equivalent effect and quantitative restrictions between Member States.

[17] Art. III: 2 of the General Agreement on Trade and Tariff establishes: *"The products of the territory of any contracting party imported into the territory of any other contracting party shall not be subject, directly or indirectly, to internal taxes or other internal charges of any kind in excess of those applied, directly or indirectly, to like domestic products."* (GATT, 1986).

seen in conflict with free trade rules. At present, negotiations to modify the European regulation are ongoing. However, this is a very slow and complex process (reference). Recent discussions included in the WTO's Doha Work Programme on certain trade and environment issues, beginning with the aimed liberalization of trade in environmental goods and services (EGS), could accelerate this process and benefit biofuels' trade (Coelho, 2005).

To conclude, free trade principles and trade liberalization are not in direct conflict with the goals of the EU policy for biofuels, security of energy supply and climate change mitigation. Nevertheless, some policy instruments such as subsidies and, especially, import duties should be carefully evaluated. In fact, policy interactions between WTO rules and increased trade liberalization are considered an opportunity for the development of biofuels' consumption in the EU. On the other side, if imports are to be limited to protect the biofuels' production sector in its infancy stage then the EU position on international trade principles must be revised, especially in the light of the latest development of the WTO's Doha round for EGS.

7.4 Policy Dilemma: Cost-efficient GHG Emissions Abatement vs. Biomass Use for Transport Fuels

As presented in chapter 6, several MS motivate their national indicative targets of biofuels' consumption by the fact that biofuels are a rather expensive and cost-inefficiency means of reducing GHG emissions. However, the EC does not accept this motivation to justify national targets (EC, 2005).

This section identifies and presents interactions among existing policies for climate protection at EU level, which may affect biofuels' policy implementation. In particular, overall targets for GHG emissions reduction are discussed in connection with the promotion of renewable energy from biomass and biofuels for transport.

At present, GHG emissions are the target of various national and European policies. Commitments have been growing in this sense for the MS in the last decade as a consequence of policies adopted by the EU institutions. Three goals have been set in relation to GHG emissions and biomass: reduction of overall GHG emissions in fulfilment of the obligations of the Kyoto Protocol, increasing the use of biomass for electricity and heat generation (EC, 1997) and use of biofuels as transport fuels. Although these goals are apparently converging towards the promotion of GHG emissions reduction they should be carefully assessed[18].

Potential conflicts are highlighted by setting a logical assumption: policy measures for climate protection are financially demanding and economic sectors are not willing to bear related costs. National governments are aware that above a certain cost-limit measures would become difficult to justify. As a consequence, MS have to decide whether to focus their limited resources in cost efficient measures, which reduce by the greatest amount overall GHG emissions, such as the use of biomass for heat and power production[19] or to concentrate on transport's GHG emissions and prioritize the achievement of targets in the biofuels' sector, though less cost efficient.

Investments in biofuels as a means to reduce GHG emission, though not in a cost-efficient way, can be sustained arguing that road transport is a major and fast growing source of GHG emissions and

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[18] In the preamble of the Directive 2003/30/EC, it is stated: *"Greater use of biofuels for transport forms a part of the package of measures needed to comply with the Kyoto Protocol, and of any policy package to meet further commitments in this respect"*.

[19] In chapter 4, costs of GHG emissions reductions using biofuels are compared with the use of biomass for heat and power production.

that biofuels are the only available short/medium term alternative to mineral fuels. However, until today, biofuels' development targets have been perceived by the MS as secondary to GHG emission reduction targets. The evaluation of climate protection measures is based on their cost efficiency. In this situation, MS do not have incentives to invest in expensive biofuels as part of their climate strategy when with the same economic effort a larger amount of GHG emissions could be avoided in other sectors

7.5 Policy Dilemma: Now vs. Later

This section focuses on the contradictions between the implementation of a short-term biofuels' policy and the exploitation of biofuels' potentials in a medium/long term perspective. In particular, the EU policy is evaluated under a time perspective and in connection with the potentials of advanced biofuels.

As described in chapter 4, advanced biofuels perform better than traditional biofuels (bioethanol from sugar crops and biodiesel from oilseeds). Both environmental and economical advantages are expected from the development of new technologies and processes for biofuels' production.

EU institutions have recognized the potential benefits of advanced biofuels (Explanatory Memorandum to the Directive 2003/30/EC). However, the Biofuels Directive neither refer directly to advanced biofuels nor invites MS to investigate and invest resources in this field. In addition, in 2001 the EC presented its position about alternative fuels that could each be developed up to the level of 5% or more of the total automotive fuel market by 2020. In the list, biofuels share between 6 and 8% of the total automotive fuels, while natural gas and hydrogen represent respectively 15 and 5% (EC, 2001b). Furthermore, the EC sees biofuels' potentials limited to a level around 8% of total transport fuel sales due to availability of agricultural land: *"Whereas biofuels will hardly be seen as a long-term high volume substitute for motor fuels because the limitation of available land, they deserve to be exploited in the short to medium term […]"* (EC, 2001b).

Advanced biofuels represent a definitely promising future that needs investments. Several MS, especially those which have abundant land available but scarce cropland, acknowledged this point and reported to the EC their interest into new conversion technologies for fuels from lignocellulosic materials. Nevertheless, if investments are kept at current pace, advanced biofuels will not be available on the market within 10 years. The EU is partly responsible for the delay in development and market penetration of advanced biofuels. It is acknowledged that if MS are to implement the Directive 2003/30/EC and its targets, they must invest financial resources in support of biofuels that are already available on the market, which exclude those biofuels that still require technical development. Financial resources for the development of advanced biofuels are restrained because subordinate to the short-term consumption targets of the EU policy. This is potentially a dangerous lock-in situation for the future development of biofuels in Europe.

Comment [LDL4]: do I ba up clearly in chapter 4?

8 A Way Forward for the Biofuels' Policy in the European Union

The analysis performed in chapter 7 highlights substantial policy interactions between the biofuels' policy and other EU sectoral policies. Additionally, it identifies goal conflicts existing within the EU biofuels' policy itself. As a result, barriers and opportunities for an effective implementation of the EU policy for biofuels are identified and discussed in this chapter. It is assumed that if all the conflicts are considered and successfully addressed, a new set of opportunities for biofuels in the

EU is likely to reveal. In the following, policy changes that are likely to solve the described conflicts are suggested. The policy strategy is divided in two parts: short-term measures to achieve 2010 targets and medium/long term instruments to seize the full range of opportunities connected with the use of biofuels as automotive fuels.

Although each one of the suggested policy measures is selected to address a single dilemma, positive effects are expected from the interaction of the different measures. Thus, they can be seen as parts of a comprehensive policy strategy.

8.1 The Present; from Now Until 2010

The first group of measures is based on the principle that the EU as a whole must reach the reference targets of the Biofuels Directive in 2010. Therefore, policy measures should be easy to implement, simple to control, time effective and cost efficient. It is acknowledged that those are difficult conditions to fulfil, however the following instruments are an attempt to indicate a possible way forward in the field.

8.1.1 Clear Political Position and Consequent Policy Action

The implementation of the EU biofuels' policy in the MS has been characterized by an inversion of priorities. The main driving forces of the Directive 2003/03/EC, security of energy supply and reduction of GHG emissions, are demoted at best, if not neglected, while other factors such as agricultural and rural development are overemphasised, becoming the real driving factors of the policy implementation process. It is claimed that in order to solve this situation and achieve the EU reference target in 2010, a clear political position and consequent policy action should be taken by the EU.

The adoption of mandatory targets could be seen as an easy way out from the present situation towards the achievement of 2010 targets. According to this position, already in 2001 the EC proposed mandatory targets in the first draft of the Biofuels Directive, but, after being approved by the European Parliament, they were rejected by the Council on the motivation that indicative targets were *"more appropriate"* (Council of Minister of the European Union, 2002). Therefore, although Art. 4.2 of the Directive 2003/30/EC states that the EC shall submit where appropriate proposals for mandatory targets to the European Parliament and to the Council of Ministers of the European Union, it is questionable whether the national governments, represented in the Council, will accept such proposal and to what conditions.

In order to assess the possibilities for mandatory targets to be introduced in the EU policy, it is necessary to re-examine the problems previously highlighted, define which of them constitute a major barrier in this concern and suggest policy changes able to overcome such barriers. According to the analysis performed in chapter 7, two main arguments may seriously affect the position of the MS in front of a proposal for mandatory targets of biofuels' consumption. First, national governments are not enthusiastic at the idea of financing production in other countries. Second, national governments evaluate the policy instruments for reducing GHG emissions on the basis of their cost-efficiency.

It is argued that in order to address those concerns a policy measure consisting in the abolition of tax incentives as instruments suitable to favour biofuels consumption should be adopted.[20] In this way, the MS would not fear that national investments in biofuels are to the benefit of productions in other MS. Therefore, they would be more willing to invest in biofuels. Second, the cost-efficiency

[20] For this purpose, the tax discipline of the Directive 92/81/EEC and 2003/96/EC must be modified.

argument against biofuels would be revaluated if the investments required to reach the targets were reduced through the abolition of tax incentives and, at the same time, the cost-efficiency of biofuels was increased, for instance, introducing the policy changes suggested in section 8.1.3.

The policy changes proposed are considered one way to solve the conflicts previously highlighted between the EU and the MS policies for biofuels. However, there are several options about how to introduce mandatory use of biofuels at national level. For instance, it could be done by establishing an obligation on fuel distributors to add biofuels to the fossil fuels sold or to bring a certain quantity of biofuels on the market in a year period. Another option is to introduce a renewable fuels certificate system on the example of those created in the electricity market. Nevertheless, each of such mechanisms has its own advantages and disadvantages and the MS are responsible to choose how to reach the EU targets. Although the importance of such decision is recognized, the aim of this study is not to investigate which of these options would be more appropriate in the EU context.

8.1.2 Liberalizing International Trade of Biofuels

Import of biofuels is a critical issue that raises numerous concerns. Refused by the MS, allowed but not supported by the EU policy, biofuels' imports represent a crucial policy conflict between rural and agricultural development goals and the goals of the biofuels' policy. Interactions between those policies must be fully understood and addressed to achieve effective implementation of the biofuels' policy.

Furthermore, in connection with the issue of biofuels' imports, the principles of international trade and the current trend towards trade liberalization are seen as an opportunity for the development of the biofuels' sector within the EU. Nevertheless, to exploit trade opportunities for the achievement of biofuels consumption targets the EU policy should conform to the principles of international free trade. Among the policy changes required for that end, it is considered crucial to eliminate tariff and non-tariff barriers on biofuels' imports from non-EU countries. It is claimed that the liberalization of the market would lead to an improvement of the biofuels' price competitiveness on the EU market for transport fuels[21] and to a reduced domestic production. Important negative consequences, especially for the agricultural sector and the development of rural areas in Europe, are expected from the implementation of the suggested policy measure. However, those concerns are acknowledged and taken into account while suggesting liberalizing imports of biofuels from non-EU countries (see chapter 8.2).

8.1.3 Cost Efficient Climate Protection Using Biomass for Transport

The reduction of GHG emissions is a policy concern that deserves and receives high political commitment in the EU. However, EU regulations allow MS to decide whether to invest the limited financial resources in cost efficient emissions reductions using biomass for heat and power production or in costly reductions in the transport sector using biofuels. At present, national governments focus their climate policies on other energy consuming sectors rather than on road transport because measures to reduce GHG emissions are evaluated in relation of their cost-efficiency performance. Effective climate change policy should include both overall reductions and sectoral reductions of GHG emissions (EEA, 2005). However, in consideration of long-term reduction targets behind the commitments of the Kyoto Protocol, further action to reduce proportionally transport GHG emissions should be taken. Among suitable policy measures to fulfil simultaneously climate change commitments and biofuels' targets with limited financial resources,

[21] As shown in chapter 4, the price of bioethanol produced in Brazil would become competitive with conventional petrol if no import duties were applied on biofuels' imports.

this study proposes to direct MS biofuels' policies towards cost efficient GHG emissions reductions in the transport sector. For instance, through the import of biofuels which show a competitive cost of GHG emissions reduction (see Figure 4).

8.2 A Look into the Future; After 2010

The period after 2010 is characterized by a high degree of uncertainty because both reference targets and policy strategies are missing at EU level. The main assumption of the policy strategy hereby described is that the biomass in the EU is a valuable resource and it should be exploited in a sustainable and efficient way (EurObserv'ER, 2005b).

Briefly, in the next five years policy makers may introduce several changes in the EU biofuels' policy, such as the introduction of mandatory targets and reduction of import duties, which in turn could increase EU dependency on imports. It is known that to rely on imports is never an attractive long-term strategy. Therefore, efforts should be taken at EU level to exploit at best the European biomass potentials for instance through the development of advanced biofuels. In this regard, short-term targets should be set out in support of medium/long term goals. Consequently, in order to overcome the main obstacles concerning advance biofuels, namely high production costs and process reliability, investments in research and development projects should be increased.

As demonstrated in the previous chapter, the short-term targets of the Directive 2003/30/EC, which require MS to invest in first generation biofuels, could create a lock-in situation because they reduce the financial resources available for research and development projects for advanced biofuels. Financial resources for investments in advanced biofuels could become available if the financial burden on public budgets was eased for instance through the removal of tax incentives in favour of biofuels. This measure would improve governments' acceptance of biofuels' policies and provide financial resources for investments in advanced biofuels with the aim of having them on the fuel market at latest by the year 2010.

However, it is acknowledged that policy makers cannot ignore the role of sectors whose interests are only partly compatible with reforms (Lenschow, 2002). Reconciliation of conflicts also depends on (re)distributive policies. Therefore, negative effects on the agriculture sector and rural economies, due to the described policy changes, should be balanced through distributive policies. One option would be to involve European agriculture sector in building bio-energy production capacity for advanced biofuels. In this way, the goals of agricultural development and biofuels' policy could be partly harmonized. Nevertheless, it is important to remember that agricultural and rural developments are not primary goals of the EU biofuels' policy.

9 Conclusions

As hypothesised in this paper, the achievement of the objectives of the Biofuels Directive would move the transport sector towards more sustainable patterns. However, as demonstrated in the research, the implementation of the Biofuels Directive in the MS has not been as effective as initially hypothesised due to a wide range of factors.

Considering the Biofuels Directive, two primary and equally important driving forces have been identified, namely: the improvement of security of energy supply and the abatement of GHG emissions. They are equally important objectives of the Biofuels Directive. Moreover, positive

impacts in the development of rural areas and in the agricultural sector are also considered in the Directive.

Although MS largely acknowledge the objectives of the Directive, the reference target for 2005 will be missed. The implementation of the Directive into national contexts is proved complex. Policy interactions and goal conflicts restrain effective implementation. In this context, four significant barriers have been identified, namely: the *inversion of priorities* between the goals of the EU policy and the objectives of the MS' implementation, the *goal conflicts between agricultural development and sustainable transport*, the *policy dilemma about cost efficiency and climate protection* and the *risk of a lock-in situation* created by short-term commitments opposed to the development of medium/long term potentials. Nevertheless, opportunities for effective implementation also exist. One major opportunity is *international trade of biofuels*. Biofuels produced outside the EU are cheaper and, therefore, imports represent an opportunity to support consumption levels in the EU.

Once opportunities and barriers for effective policy implementation have been defined, it is time to suggest suitable changes. Opportunities should be exploited and barriers should be overcome and transformed into opportunities. For this purpose, four policy measures are recommended. First, *mandatory consumption targets* should be introduced. This measure is a simple and efficient way to achieve the 2010 target for the EU. Additionally, in order to overcome the political opposition of some MS in front of a proposal for mandatory targets to the Council of Ministers of the European Union, it is recommended to *exclude tax incentives* from the policy instruments available to MS to support biofuels' consumption. This measure is expected to encourage MS to invest in the sector. Second, *tariffs on biofuels' imports should be removed* in order to exploit the advantages connected with international trade of biofuels. Third, *research and development programmes* in support of advanced biofuels should be increased in order to exploit at best the potentials of new fuels and avoid lock-in situations. Finally, *redistributive policies* in favour of the EU agricultural sector should also be adopted. The involvement of the sector in the development of new production processes is necessary to support advanced biofuels and, at the same time, to reduce goal conflicts between agricultural policy and biofuels' policy.

The sustainability of the road transport in the EU will improve if the objectives of the Biofuels Directive are achieved. However, the complexity of the implementation process has created an implementation deficit, which challenges the sustainability of the road transport sector. Policy interactions create important barriers and at the same time interesting opportunities for effective implementation. Policy makers should recognize barriers and opportunities and handle them consequently with the objectives of the Directive. However, the policy changes suggested in this paper, although potentially suitable to achieve effective implementation of the Biofuels Directive, represent a radical change from the policy strategy currently adopted by the EU. The recommended policy changes will be introduced in the EU energy and transport policy only if a common position among the national governments and the EC is reached. For this purpose, further research should investigate the role of the EC as key facilitator for policy changes towards sustainable transport.

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Abbreviations

CAP	Common Agriculture Policy
DME	Dimethyl Ether
EC	European Commission
EEA	European Environmental Agency
EGS	Environmental Goods and Services
ETBE	Ethyl Tertiary Butyl
EU	European Union
FFV	Flexi Fuel Vehicles
GHG	Greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
MS	Member States of the European Union
RME	Rapeseed Methyl Ester
WTO	World Trade Organization
WTW	Well-To-Wheel
kJ	kilojoules

Appendix

Conversion energy factors of mineral fuels and biofuels for transport.

FUELS	Energy per litre	Energy per kg
Diesel	**36.4 kJ**	**42.8 kJ**
Petrol	**32 kJ**	**43.5 kJ**
Bioethanol	**21.1 kJ**	**26.7 kJ**
Biodiesel	**33.3 kJ**	**37.8 kJ**
Biogas	**21.4 kJ/ m3**	

Source: Bioenergy Information Network. Bioenergy conversion factors. Available on line at http://bioenergy.ornl.gov/papers/misc/energy_conv.html