Policy Brief

Bioenergy from agriculture in the European Union –analysing opportunities and constraints

D12: Biomass and environmental effects. Strategies to mitigate negative environmental effects from biofuel production.

D13: Biomass and effects on future rural development. Strategies on how to increase information and knowledge transfer into rural areas and how to strengthen them.

D14: Biomass policy and its relation to the future WTO negotiations

Scientific Support to Policy

Contract n° 044437
Operative commencement date of the project: 1 May 2007
Final date of the project: November 2008

Sixth Framework Programme

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October 2008, Vienna Austria

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DOCUMENT INFORMATION

DOCUMENT NAME:	BIOENERGY FROM AGRICULTURE IN THE EUROPEAN UNION –ANALYSING OPPORTUNITIES AND CONSTRAINTS D12: BIOMASS AND ENVIRONMENTAL EFFECTS. STRATEGIES TO MITIGATE NEGATIVE ENVIRONMENTAL EFFECTS FROM BIOFUEL PRODUCTION. D13: BIOMASS AND EFFECTS ON FUTURE RURAL DEVELOPMENT. STRATEGIES ON HOW TO INCREASE INFORMATION AND KNOWLEDGE TRANSFER INTO RURAL AREAS AND HOW TO STRENGTHEN THEM. D14: BIOMASS POLICY AND ITS RELATION TO THE FUTURE WTO NEGOTIATIONS
REVISION:	
REV.DATE:	
CLASSIFICATION:	PUBLIC
STATUS:	FINAL

Executive summary

This policy brief discusses the main implications of energy crops production for the environment and EU rural development and in the context of international development. The brief outlines research needs and provides policy recommendations to support the development of a framework that allows sustainable bioenergy production.

An accumulated body of research findings suggests that the unregulated production and trade of bioenergy crops have negative environmental and socio-economic impacts all over the world. The main objective of this brief is to advance reasons for urgent action by the European Union to develop and implement a sustainability "standard" for bioenergy which considers: a) the life-cycle assessment of the different feedstocks' production processes so as to reduce green house gases (GHG) emissions; b) avoid a "single-solution" strategy, such as targeting biofuels instead of other more efficient bioenergies (e.g. biogas); c) considering the impact of land use change on GHG emissions; and d) considering the social and environmental impact of massive land use change in developing countries.

1 Introduction

1.1 Bioenergy in the EU

The European Union is committed to increase the use of renewable energy sources with the aim of reducing emissions of greenhouse gases and dependence on imported fossil fuels. Bioenergy has been identified as an important source of renewable energy. Bioenergy comes from any feedstock that is derived from biomass coming from agriculture energy crops; forestry and wood based industries; farm, municipal and industrial organic waste; and from marine sources (e.g. seaweed). Biomass can be used in the generation of electricity, heat (liquid or vapour state) and biofuels (liquid and Gaseous forms). Using bioenergy can be beneficial to achieve environmental objectives, reduce CO_2 emissions compared to fossil fuels and support rural development efforts, but there are also some risks and negative impacts linked to extensive use.

In 2005 renewable energy sources accounted for 6.7% of total EU energy consumption, 66% of this value was produced using bioenergy sources[1]. 15% of the total electricity came from renewable energy sources, and the EU expects this number to reach 21% in 2010[2]. In January 2008 the European Commission put forth an integrated proposal for Climate and Energy Action including setting an overall binding target for the European Union to achieve a **20% renewable energy share by 2020**. This package also includes a specific **10% minimum target** for the final energy used in road transport to come from renewable energies. This target is still controversially discussed among the European Parliament, the European Council and the Commission. However, achieving the current binding targets will require a substantial increase in land use and related natural resources (water, soil nutrients, biodiversity). Consequently, this policy is expected to have an impact on agricultural land use. Since agricultural land is approximately 50% of the total EU surface, increasing the share of agriculture energy crops may result in negative environmental and socio-economic outcomes for rural areas in the EU and outside of the EU.

At the same time, increased demand in the EU for bioenergy has resulted in some negative repercussions outside of the EU. Many developing countries in Africa, Asia and Latin America, stimulated by high demand

[1] Dworak, T., Schlegel, S., Kaphengst, T. et al.(2007). EU Bioenergy Policies and their effects on rural areas and agriculture policies (AGRINERGY). Survey D3: General Survey- Impacts of agricultural biomass production in the EU September 2008, Berlin , Germany.
[2] Online resource: Energy.eu (2006) accessed in (Oct. 2008). Available at: http://www.energy.eu/#renewable

for bioenergy, already started to produce energy crops and process bioenergy. These countries often do not have the institutional capacity to control the intense use of natural resources, the conversion of tropical forest into plantations of energy crops, the violation of land property rights and unfair terms of trade.

1.2 Background and aims of this policy brief

The AGRINERGY project funded under the 6th EU Framework program for research aims to support the development of a sustainable policy framework which promotes the production of biomass from agriculture while ensuring sustainable development of rural areas (social, economic, environmental).

This policy brief is the last step of the AGRINERGY project and aims to advance policy and research recommendations to European policy makers to ensure a sustainable production of bioenergy in- and outside of the European Union. It is the result of an in-depth literature research, an expert workshop and a large-scale conference, all prepared under the framework of the AGRINERGY project. In this paper the following issues are discussed:

- Reminder: Political objectives of bioenergy in the EU and related policies
- Effects of production of energy crops on the environment
- Effects of production of energy crops on the rural areas of the EU (socio-economic)
- Effects of EU bioenergy policies outside Europe

Each part provides an overview and briefly describes main expected challenges and research needs.

2 Reminder: Political objectives of bioenergy development in Europe and related policies

Climate change pressures, increasing scarcity of fossil energy sources and uncertainty of supply has increased EU policy makers' interest in bioenergy. In addition, bioenergy promises to provide energy in an environmentally friendly way through reduction of GHG emissions and to provide new income opportunities for rural areas. To further support bioenergy production, a great deal of European legislation has been passed in recent years. As the EU is an important consumer of energy, EU policies will not only influence how the industry will develop in Europe, but it will also have an impact at the global level. The most important policies addressing directly or indirectly the issue of bioenergy and their related impacts are presented in Table 1.

Table 1 - EU Bioenergy related policies, instruments and expected effects

Policy area	Instruments	Effect on production of energy crops
Common Agriculture Policy	Rural development measures	❖ Support production of energy crops. The extent of the support and the focus differs among Member States.
	Cross compliance	❖ Enforces pre-existing and minimum environmental standards. Its impacts on biofuels are variable as cross compliance is implemented on a voluntary basis and there are no specific requirements for production of energy crops or forest.
	Energy crop premium	❖ Supports the increase in production of bioenergy crops currently (in 2007) with a premium of 31€ per hectare[3].
	Set aside obligations	❖ Support production of energy crops as it allows production of energy

[3] 45€ per hectare until reach the threshold of 2 Million hectares in the EU. Beyond that the premium paid is reduced, for example in 2007 it was 31€ per hectare. Source: http://www.info-agrarportal.de/index.php?/content/view/full/324/(object)/7143

		crops on set aside land. Carries potential trade-offs with objectives for nature protection since set-aside land often has a high biodiversity value.
Environmental policy	Nature conservation – Fauna, Flora and Habitats Directive	❖ Allows biomass production and extraction from special areas of conservation sites, under the condition that there are site-specific management plans in place. These site specific management plans can be suitable instruments to regulate biomass production. However, they need to be appropriately implemented in national planning instruments.
	Water Policy – Water Framework Directive (WFD)	❖ Limits intensive production of energy crops through regulating water consumption. The WFD is not yet fully implemented and the objectives of the Nitrate Directive are still a target for many of the EU Member States.
Trade policy	Import duties for bioethanol and tariffs for biodiesel, special treatments for developing countries	❖ Most trade policies limit imports of processed biofuels, however imports of agricultural resources are favoured. The use of tariff escalation[4] favors imports of crops over other more value added forms of biomass products. At the same time, land conversion and expansion of energy crops are supported in other parts of the world. This strategy favours the processing of biodiesel and bioethanol in the EU.
	Sustainability standards (Part of the proposal Directive on the promotion of the use of energy from renewable sources (COM(2008) 19 final 2008/0016 (COD))	❖ Issues being currently addressed include, requirements for GHG saving potential, exclusion of high value natural areas for biomass extraction, compatibility with international labour conditions and land rights[5]. WTO trade policy could influence or even prevent the implementation of sustainability standards for biomass trade. Removing trade distortions could potentially promote sustainable production and trade, however this requires more research (see research needs in section 5.3).
Structural policies	Intelligent energy Europe	❖ Promotes efficiency and renewable energy in the EU. Linked to two programmes STEER and ALTERNER
	Cohesion fund	❖ Supports development of renewable energy projects (including biomass energy production), developing rail transport, supporting intermodality, strengthening public transport
	European Regional Development Fund	❖ Supports renewable energy projects
Climate and energy package of the EU	Proposal of Directive on the promotion of the use of energy from renewable sources (COM(2008) 19 final 2008/0016 (COD))	❖ Promotes the production of biofuels by setting a target of 10% obligatory incorporation of renewable in the transport sector by 2020. Biofuels will have to deliver greenhouse gas savings of at least 35 per cent compared to conventional fuels, rising to 50 per cent in 2017.
	Proposal of Fuel Quality Directive	❖ Would revise the fuel quality specifications set in Directive 98/70/EC. Commits fuel suppliers to monitor greenhouse gas emissions and reduce them by 1 % every year between 2011 and 2020. A new petrol blend would allow for up to 10 % ethanol content.

[4] Tariff escalation refers to a situation where tariffs rise along supply chains. This practice results in protection from processed products in importing countries. Thus, tariff escalation effectively limits the scope for processing of agriculture and labour-intensive products in exporting countries.
[5] See for more information: http://www.biofuelwatch.org.uk/docs/eu_biofuels_policy.pdf

3 Effects of production of energy crops on the environment

3.1 Overview

As a major land user in Europe (approx. 50% of total land area), agriculture has a significant impact on environmental resources such as water, soil, biodiversity. The ambitious bioenergy targets in Europe will further lead to increased demand for land[6] and to agricultural intensification[7]. In one year (2006/07) the production of rapeseed in the EU increased by 14%, and it is now the fourth most important crop by area in the EU[8]. A further growth would directly contribute to an increased loss of biodiversity as monoculture systems of rapeseed production are favoured by producers.

The current estimate of total land potential for energy crops in the EU is approximately 20 to 59 million hectares[9]. The main concern is that a large-scale growth of energy crops to achieve the political targets for bioenergy will work directly against other policies aiming to reduce agricultural pressures on the environment. Furthermore, bioenergy markets are also dynamic as fossil fuel price rise and feedstocks for bioenergy production are in shortage.

3.2 Main challenges

Currently the biggest challenge is to control large-scale **conversion of permanent grasslands, Natura 2000 sites** and **set aside** land to energy crop land due to increased prices of energy crops. Large-scale conversion of permanent grasslands to high-input production of energy crops would lower water quality and contribute to an excess of nitrates and phosphates. Set-aside land has gained high significance as an "ecological compensation area" within high productive agricultural landscapes[10]. However, since the last CAP reform in 2003, set-aside land can also be used for the cultivation of non-food crops such energy crops, and conversion of the land into energy crops was reported in NATURA 2000 sites. This runs contrary to the EU policy on protection of biodiversity as the long-term set aside land for cultivation of high input energy crops can lead to loss of valuable habitats and threaten endangered species. In July 2008, the European Commission announced that set-aside is to be abolished permanently and therewith increased the risk of negative environmental impacts.

The environmental impacts linked to agricultural energy crop production patterns (e.g. monoculture, high input farming, organic farming) are very context and location specific. Positive or negative impacts of energy cropping patterns depend on former land use. The comparison given in Table 2 shows which land use practices tend to result in lower impacts on the environment.

Table 2 - Effects of different land use practices related to energy crops production on the environment

	Lower environmental impact	**Higher environmental impact**

[6] European Commission, Directorate General for Agriculture and Rural Development, Directorate G. (2007): Economic analysis, perspectives and evaluations, G.2. Economic analysis of EU agriculture, Note to file, Subject: The impact of a minimum 10% obligation for biofuel use in the EU-27 in 2020 on agricultural markets, 30 April 2007)

[7] One indicator used to measure efficiency of a energy crop is yields per hectare. EEA, European Environmental Agency (2006), How much bioenergy can we produce without harming the environment? EEA report no. 7/2006. Copenhagen.

[8] Ollier, C. Utz, H. (2007). Main crop areas in the European Union in 2007. Statistics in focus. Agriculture and Fisheries 86. Eurostat. Available online: http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-07-086/EN/KS-SF-07-086-EN.PDF

[9] Dworak, T., Schlegel, S., Kaphengst, T. et al.(2007). EU Bioenergy Policies and their effects on rural areas and agriculture policies (AGRINERGY). Survey D3: General Survey- Impacts of agricultural biomass production in the EU September 2008, Berlin , Germany.

[10] EEA, European Environmental Agency (2006), How much bioenergy can we produce without harming the environment? EEA report no. 7/2006. Copenhagen.

Type of crops being used	❖ Perennial crops such as willow and poplar short rotation coppice, reed canary grass	❖ Annual crops, such as maize, potatoes, sugar beet and oilseed rape[11]
Cropping systems	❖ Small-scale production plots/units	❖ Large-scale production plots/units
Land use practices	❖ Zero or reduced input of fertilisers, herbicides and pesticides	❖ Increased input of fertilisers and plant protection products
	❖ No or very low needs for irrigation	❖ Need for irrigation
	❖ Reduced heavy machinery usage and fuels consumption.	❖ High usage of heavy machinery and fuels consumption
	❖ Limited use of crops residues	❖ Overuse of crop residues
Selected site for production	❖ Agricultural land	❖ Natural 2000 areas, set-aside areas

Green house gases emissions over the whole lifecycle

Green house gases (GHG) emissions are also a factor that needs to be taken into consideration when planning the further development of bioenergy sources. Many research and activities have been undertaken to calculate the energy balance for different biomass products and bioenergy technologies[12], ending up in diverse results[13]. However, it has to be noted that to date an overall **life-cycle-assessment for bioenergy has not been done sufficiently**[14], neither for bioenergies nor for fossil energies.

3.3 Possible strategies and research needs

To address the challenges above, the following strategies below should be investigated more in detail. So that the conversion to bioenergy from energy crops leads to reductions in GHG emissions when compared to the use of fossil fuel equivalents, it would be beneficial:

- ❖ to give priority to crops with a high energy yield per hectare, although this may conflict with other environmental objectives stated above;
- ❖ to give priority to conversion techniques that result in higher yields of energy per unit of feedstock (e.g. biogas instead of biofuels); and
- ❖ to measure and compare impacts based on an overall life cycle assessment, taking land use practices as well as direct and indirect land use change into account. **This requires developing a life cycle assessment** for all kind of fuels (bio and fossil) considering their GHG emissions and their impacts on biodiversity. Currently life cycle assessments are not fully comparable between fossil fuels and biofuels and do not consider land use change in the analysis.

[11] Dworak, T. et al. (2008). A review of the possible impact of biomass production from agriculture on water Background paper for the conference "WFD meets CAP - Looking for a consistent approach". A paper produced on behalf of the European Environment Agency

[12] Most recent studies on the energy balance and the environmental impacts of biofuels are:
Fleming, J., Habibi, S., MacLean, H. L. (2006). Investigating the sustainability of lignocellulose-derived fuels for light-duty vehicles. Transportation Research Part D 11, 146–159
European Commission, Joint Research Center (JRC); Conservation of Clean Air and Water in Europe (CONCAWE) (2006):
Zah,R.; Böni, H.; Gauch, M.; Hischier, R.; Lehmann, M.; Wäger, P.; (2007): Ökobilanz von Energieprodukten: Ökologische Bewertung von Biotreibstoffen. Schlussbericht;
Smeets, E.; Junginger, M.; Faaij, A.; Walter, A:, Dolzan; P. (2006): „Sustainability of Brazilian bio-ethanol", Universiteit Utrecht Copernicus Institute Department of Science, Technology and Society, Report NWS-E-2006-110, ISBN 90-8672-012-9.

[13] For a good overview of the debate on the energy balance of biofuels, see e.g. Morris, D. (2008): The Energetics of Ethanol: An Introduction and Link to Studies, available at http://www.newrules.org/agri/netenergy.html

[14] Sachverständigenrat für Umweltfragen, SRU (2007): Klimaschutz durch Biomasse: Sondergutachten. Berlin: Schmidt

To limit negative impacts on the environment from bioenergy from energy crops, there is a need to ensure that:

- research activities further focus on the development of **efficient conversion processes, increased efficiency of energy use** and **reduced energy consumption** so that lower amounts of biomass are required. This also includes investigations on how to increase the use and efficiency of crop residues (2nd generation biofuels). Thereby a favourable level of harvesting residues must be investigated to avoid negative side-effects on soil quality;
- **compensatory land** will be reserved for nature conservation and low input farming in the future;
- the **development of national action plans for biomass production** considers the impacts of conversion of landscapes to biomass feedstocks;
- farmers are trained in the establishment of diversified crop rotation systems;
- **agro-economic modelling** is applied through site specific research to distinguish bioenergy effects from other ongoing agricultural trends. More research is also needed to better understand the levels of environmental impact of different cropping systems and land use practices in the production of energy crops; and
- An additional **reliable land use change study is carried out** to provide a better picture of the potential land use change in and outside the EU and the effects on water, soil and climate.

4 Effects of production of energy crops on rural development in EU

4.1 Overview

Production of bioenergy is expected to contribute to rural development through **job creation** and **diversification of income opportunities** in rural areas. Perspectives for jobs creation are centred on new forms of biomass exploitation such as: collective heating, combined heat and power plants or producing biofuels that tend to be more labour intensive than fossil fuels. Currently there is a range of CAP financing mechanisms to strengthen production and processing of biomass in rural areas of the EU.

4.2 Main challenges

There are several challenges to address if bioenergy production is to become a new income opportunity for EU rural actors. First, characteristics, such as type and abundance of the biomass resources of a region/local, define the type of production path for bioenergy in that area[15]. Consequently, there are **no ideal/optimal processes for bioenergy production patterns that can be spread across Europe.**

The **scale of bioenergy production** can be large and corresponds to conversion bioenergy plants for industrial production such as ethanol distilleries, biodiesel plants, wood-pellets heating and power stations or large-scale biogas plants, which have been increasingly installed mainly in Germany. For these types of plants, increasing amounts of biomass have to be transported from supra-regional locations to a certain energy processing site. For smaller systems, such as single biogas-plants built on farms or small-scale wood combustion plants, biomass logistics is restricted to a local level and energy production mostly relates to satisfying agriculture holding/local community demands[16]. Both systems bear different opportunities and risk for rural areas, which are outlined in the Table 3.

[15] Rand, S., Bourdin, D., Brunori, G. et al. (2008). Innovations systems and processes in the field of environmental technologies: A cross-national analysis of differences in Germany, Switzerland, Italy, Latvia, France and Finland. Institute for Rural Development Research, Johann Wolfgang Goethe University, Frankfurt.

[16] Poster available at: http://www.insightproject.net/files/poster_bioenergy_DBO.pdf

Table 3- Potential risks and opportunities of bioenergy production for sustainable development of rural areas

	Risks for rural areas	Opportunities for rural areas
Diversification of income opportunities	❖ Production of bioenergy is outsourced with poor involvement of local level actors. Farmers are limited to energy crops production[17]. No or limited creation of jobs in rural areas.	❖ Biomass and bioenergy produced locally, involving different areas of work (e.g. construction, farming, management)[18]. Creation of new jobs and/or security of existing jobs.
Logistics and distribution networks	❖ Rural communities remain dependent of external energy production. ❖ Increase transport/traffic of biomass between regions or countries increasing GHG emissions and reducing security on the road.	❖ Reducing energy dependency of rural communities to large scale supply systems. ❖ Reduction in infrastructure costs due to shorter supply chains.
Local food markets	❖ Farmers switch from food production to energy production, resulting in local food supply breakdown.	❖ Increased income opportunities that allow farmers to follow their business and to further produce food.
Aesthetics considerations	❖ Production of bioenergy provokes changes in the regional landscapes, reducing tourism revenues and the potential for multi-functionality of rural areas.	❖ Production of bioenergy does not affect local landscapes and provides a further income opportunity to the existing ones.

4.3 Possible strategies and research needs

There is only little knowledge of the extent to which bioenergy cropping can strengthen rural areas in Europe, thus it is relevant to increase research activities in this area:

- In-depth analysis of local and regional case studies related to the implementation of EU targets at national level could **reduce the uncertainty of expected benefits** (e.g. job creation and environmental change). This study could help to identify **good practices**, **advantages and drawbacks of large or small-scale production of bioenergy** for the development of rural areas.
- **Support pilot projects** to demonstrate the long-term financial, social and environmental viability of the bioenergy enterprise.
- Analyse the **effects of different energy systems** (centralised vs decentralised) on EU rural development and the impacts of different energy systems on income distribution, job creation in the rural areas and value added for consumers.

5 Effects of EU bioenergy policies outside Europe

5.1 Overview

Meeting the ambitious EU bioenergy targets will require a considerable amount of imports as land needed for all food and non-food demands exceeds domestically available land. In addition, biomass productivity in tropical and sub-tropical regions is higher than in European continental regions, while the energy consumption is higher in European continental regions (such as the US and EU) than in the tropics. Therefore, growing demand for bioenergy in Europe is likely to have impacts on land use outside of the EU.

[17] More information: Thornley, P., Rogers, J., Huang, J. (2007). Technical Note Quantification of employment from biomass power plants. Renewable Energy 33 (2008) 1922–1927.
[18] More information: Thornley, P., Rogers, J., Huang, J. (2007). Technical Note Quantification of employment from biomass power plants. Renewable Energy 33 (2008) 1922–1927.

It is widely expected that the development of international biomass markets will contribute to development and poverty reduction in developing countries.
However, without a clear vision of how international biomass markets work, it is difficult to anticipate implications for economic, social and environmental development goals. There is no standardised customs classification of biomass products at WTO level; for example, there is no Harmonised Commodity Description and coding system distinguishing ethanol for fuel from ethanol for other purposes. The majority of the EU Member States have no standards or domestic regulations for the commercialisation of biofuels.
The European Parliament has stressed the importance of **sustainability criteria for biofuels** and has requested the Commission to undertake action towards a mandatory certification system for biofuels[19]. An international certification system and common sustainability criteria for biomass production and trade is currently under development. After the review process by the European Parliament (EP), the proposal of the Directive on the promotion of the use of energy from renewable sources now considers social and environmental standards for all bioenergy. This does not mean that all bioenergy in the EU has to comply with the standards, but it does mean that bioenergy that counts towards the renewable energies target and all biomass that is subsidized by the EU Member states has to comply with them[20]. The current EP discussion examines various sustainability issues such as deforestation, non-competition with food production, water and soil protection, labour conditions, land rights and protecting highly biodiverse areas[21]. However, proposals to protect 'high conservation value' land and permanent grassland were discarded. Moreover, negative indirect impacts will be ignored except for a small proportion of greenhouse gas emissions arising from indirect land use change being taken account in greenhouse gas calculations only for bioenergy in the transport sector starting from 2012[22].

5.2 Main challenges

Bioenergy and the production of biomass can open a range of opportunities for developing countries in the tropics. However, recent developments have revealed serious trade-offs for ecosystems and rural population in developing countries. The expansion of global biofuel production is, to some extent, responsible for the increase of food prices leading to hunger and riots in many southern countries. A key issue is the unequal benefits of large-scale biomass production in developing countries[23]. With multinationals or powerful local businesses pushing forward the use of new land for cultivation of energy crops, additional pressure on land often results in:

- **massive land use changes** (logging of rainforest, conversion of food crops in energy crops land),
- **displacement of local communities or small-scale farmers**,
- **precarious employment** under large-scale biomass plantations (e.g. of sugarcane), and
- **increase in agricultural commodity prices,** because food and energy are competing for the same land[24]. This could exacerbate food security, especially in developing countries.

Under certain conditions, the liberalisation of biomass markets might have economic benefits. These benefits result from moving production of energy crops to countries where land and labour costs are lower and where land productivity is higher. However, these countries often lack economic and legal institutions, which are in place in the EU and the US and can enforce environmental laws and ensure democratic processes. Reports

[19] EC – DG TREN (February 2008) Sustainability criteria & certification systems for biomass production - final report. BiomassTechnology group. Enschede, Netherlands.
[20] Biofuelwatch (webpage accessed Oct. 2008). Available at: http://www.biofuelwatch.org.uk/docs/eu_biofuels_policy.pdf
[21] Biofuelwatch (webpage accessed Oct. 2008). Available at: http://www.biofuelwatch.org.uk/docs/eu_biofuels_policy.pdf
[22] Biofuelwatch (webpage accessed Oct. 2008). Available at: http://www.biofuelwatch.org.uk/docs/eu_biofuels_policy.pdf
[23] Sagar, A.D., Kartha, S. (2007). Bioenergy and sustainable development? Annual review of environment and resources, vol. 32, 131-167.
[24] Koh, L.P., Ghazoul, J. (2008). Review Biofuels, biodiversity , and people: Understanding the conflicts and finding the opportunities. Biological conservation 141, 2450-2460

from several NGOs and scientists have pointed out the abuse of power and displacement of local communities already occurring in many parts of the developing world.

Hand in hand with the social and economic problems mentioned above are also environmental drawbacks**.** Forest land in the tropics has a lower value than agricultural land. This provides an incentive for biomass production in forested areas containing high biodiversity and high carbon stocks. Without proper institutions to develop and enforce sound environmental laws, negative environmental effects such as deforestation will continue with expansion of biomass production, as it has been reported in many parts of the developing world[25]. The absence of enforced standards, regulations, efficient supply, and conversion technologies leads to biomass use that runs contrary to global environmental objectives such reduction of GHG emissions. Nevertheless, developing a global certification for sustainable biomass production faces several challenges:

- **Willingness to develop and implement an international certification system** with widely recognised sustainability criteria. It is not clear if the WTO would accept some of the required environmental criteria and social criteria, such as local prosperity, social wellbeing of local population, as they are not compliant with WTO rules[26]. If sustainability and democratic values are core values of the EU, then the EU should take measures to assure that its macro-level energy demands are not jeopardising developing countries (e.g. deforestation and human displacement).
- **Democratic participation** from a broad range of stakeholders, including land users and regional farmer organisations.
- Define and implement a certification system that is **practical, affordable and accessible to all** producers, while ensuring control and its enforcement.
- **Addressing indirect land use changes** that occur when biomass production displaces former land uses. These so called "leakage-effects" often have more severe impacts on eco-systems (e.g. deforestation), carbon stocks and land tenure than the biomass production itself.

5.3 Possible strategies and research needs

In order to ensure the development of sustainable bionergy cropping on the global scale the following issues should be considered:

- **Policy targets on biofuels have to be critically revised** regarding their impact on global land demand corresponding with threats to ecosystems, rural communities' wellbeing and food security.
- **The discussion on phasing out trade distortion instruments** (e.g. tariffs, local standards) has to be supported by more scientific investigations analysing the effects of such a phasing out with regard to social and environmental issues.
- **Learn from the experiences of independent certification organisations.** Internationally implemented private sustainability standards and certification schemes have accumulated experience in developing social and environmental standards that could be taken into account in the development of a EU sustainability standard for bioenergy.
- **Partnership with export countries** such as Brazil, Malaysia, South Africa and others but also with the US have to be built to ensure a sustainable biomass trade. This is also a prerequisite for the implementation of internationally accepted and universally valid sustainability standards. These partnerships would be important to increase reliability of the life cycle assessments of different energy crops.

[25] For example: Koh, L.P., Wilcove, D.S. (2007). Cashing in palm oil for conservation. Nature 448, 993–994; Fitzherbert et al. (2008): How will oil palm expansion affect biodiversity? Trends in Ecology & Evolution 23 (10): 538-545. Martinelli, L. and Filoso, S. (2008): Expansion of sugarcane ethanol production in Brazil: environmental and social challenges. Ecological Applications.18(4): 885-898.

[26] EC – DG TREN (February 2008) Sustainability criteria & certification systems for biomass production - final report. BiomassTechnology group. Enschede, Netherlands.

- Institutional requirements for **meaningful enforcement** have to be analysed and put into practice and limits of certification schemes have to be recognised and explored in detail.

6 Final remarks

Concerns about climate change, energy security and declining resources raise the debate on how to increase the use of renewable energy sources from 6.7% in 2005 to 20% in 2020 according to EU targets. Biomass, with the broadest application opportunities among renewable energies, plays on the one hand a key role to achieve the targets. On the other hand, there are limits to the sustainable production of biomass. Due to limited land potentials for domestic biomass production, the EU will be dependent on imports from other countries to achieve its renewable energy targets. In these countries, however, large-scale conversion of land often undermines environmental goals of EU policies and leads to unwanted social consequences. Moreover, biomass as a contributor for the reduction of energy imports is partly a misleading argument as most of the feedstocks for biofuels will be harvested outside of the EU. At the same time, intensification of land use within Europe as a consequence of higher demand for biomass may also work against the EU goals of environmentally friendly agriculture and sustainable rural development.

In order to achieve sustainable bioenergy production, the focus of the discussion should change to a more holistic view. Sustainability criteria and certification schemes can only contribute to environmentally friendly and socially acceptable biomass production if they are designed for all biomass uses (including agricultural production for food, feed and industrial crops). They have to be implemented on a global scale and be accompanied by other governance instruments. It has to be kept in mind that without proper institutional framework verification and control, compliance with standards cannot be guaranteed in many countries.

In addition, demand-driven policy measures to save energy such as compulsory emission limits for vehicles and incentives for more efficient buildings should gain much higher priority in EU energy and climate policies. It is evident that targets for the share of renewable energies in overall consumption are easier to achieve with increased efforts on energy efficiency and saving.

To conclude, bioenergy crops can be an alternative to fossil fuels in the short term if the risks are managed appropriately. In the long run, bioenergies will not solve our energy problems as the global energy demand is growing. Developments in more efficient conversion technologies (2nd generation biofuels) and improvements in energy efficiency will only shift the problem to the future, but these developments are unable to solve the growing demand problem. In order to solve this problem two ways out are possible: a) new energy technologies which are currently in an early stage of research (e.g. cold fusion), or b) less consumption due to changes in human living patterns.