elobio
Biofuel policies for dynamic markets

Reconciling biofuels, sustainability and commodities demand

Pitfalls and policy options

Intelligent Energy Europe

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Pitfalls and policy options

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Table of contents

Tables

Figures

Executive summary

Increasing fossil fuel prices, energy security considerations and environmental concerns, particularly concerning climate change, have motivated countries to explore alternative energy sources including biofuels. Global demand for biofuels has been rising rapidly due to biofuel support policies established in many countries. However, proposed strong links between biofuels demand and recent years' high food commodity prices, and notions that increasing biofuels production might bring about serious negative environmental impacts, in particularly associated with the land use change to biofuel crops, have shifted public enthusiasm about biofuels. In this context, the ELOBIO project aims at shedding further light to these aspects of biofuel expansion by collecting and reviewing the available data, and also developing strategies to decrease negative effects of biofuels while enabling their positive contribution to climate change, security of supply and rural development. ELOBIO considers aspects associated with both 1st and 2nd generation biofuels, hence analyses effects on both agricultural commodity markets and lignocellulosic markets.

This project, funded by the Intelligent Energy Europe programme, consists of a review of current experiences with biofuels and other renewable energy policies and their impacts on other markets, iterative stakeholder-supported development of low-disturbing biofuels policies, model supported assessment of these policies' impacts on food, feed and lignocellulosic markets, and finally an assessment of the effects of selected optimal policies on biofuels costs and potentials. This project has been conducted by seven EU institutes of different backgrounds.

Results of the ELOBIO study show that rapid biofuel deployment without careful monitoring of consequences and implementation of mitigating measures risks leading to negative consequences. Implementing ambitious global biofuel targets for 2020, based on current 1st generation technologies, can push international agricultural commodity prices upwards and increase crop prices. Furthermore, land use change both through converting natural land to produce 1st generation biofuels, and by displacing existing agricultural activities to other areas, may drastically impact the greenhouse gas (GHG) emission reduction of biofuels production and use.

However, there are ways to reduce negative impacts. Even though shifting to second generation (2nd generation) biofuels appears to be one of the best solutions in terms of decreasing the pressure on agricultural commodity markets and improving GHG performances of biofuels, a mix of 1st and 2nd generation biofuels will be the likely future. In this respect, strategies to increase agricultural productivity, especially in developing countries where yields presently are low, stands out as one of the most important requirements. Food security and agricultural productivity improvements have been addressed as part of the millennium development goals (MDG's). But policy-driven biofuel production that impacts global agricultural markets should also become part of the policy framework that supports agricultural productivity increase in the world regions that are likely to be impacted most with increased biofuel demand.

2nd generation biofuels can decrease some of the pressure on agriculture commodities if they are produced from residues and crops cultivated on marginal lands. They are in addition expected to provide a substantial contribution to reducing GHG emissions**.** However, those technologies are still at demonstration stage and bringing them to the market requires policy measures that take into account their risk profiles and create a favourable and stable investment climate. A set of policy options, for instance combinations of high investment subsidies with soft loans, tax exemptions, and favourable crediting in relation to biofuel targets, can help overcome the initial investment barriers and enable larger volumes of 2nd generation biofuel penetration into the market.

Lignocellulosic feedstocks are also demanded by other sectors, particularly the energy sector to produce renewable electricity and heat, and the forest-based industries to produce wood products. Yet, policy support and initiatives can stimulate the synergies between the stationary energy sector and biofuels and the forest industry can include biofuels among the wide range of products already produced. One possible option is to stimulate supply side development by promoting dedicated biomass plantations to achieve learning and cost reduction in the production of short rotation woody plants and perennial herbaceous plants. This can for instance be done by linking credits for green electricity from co-firing applications with the requirement that a certain share of the biomass fuel is derived from production of such plants within EU. The integration of gasification-based biofuel plants in district heating systems is one option for increasing the energy efficiency and improving the economic competitiveness of such biofuels. Integration initiatives may involve cooperation between actors that earlier have not invested in biofuel production, such as municipalities having large district heating networks and power companies that see new opportunities for optimizing their production and improving resource use efficiency.

In an increasingly globalized economy, decreasing negative impacts of biofuels on commodity markets and the environment require not only integration of various policy domains but also strategies that are internationally recognized. The early stimulation and learning in new biomass supply systems and the involvement of new types of actors cooperating in biofuel production can facilitate a positive development by reducing strains between sectors and offering opportunities for improving economic and resource use efficiency.

Further details concerning the biofuel impacts on commodity markets and the strategies to overcome, and the underlying detailed studies, can be found on www.ELOBIO.eu.

1. Biofuels: urgency for low disturbing policy options

Global challenges posed by climate change and energy insecurity have generated an increasing interest on biofuels. Worldwide, biofuel production increased four-fold between 2000 and 2008 (see Figure 1). Around 90% of the bioethanol was produced in Brazil and the United States, while more than 54% of the biodiesel was produced in the European Union. In absolute terms bioethanol production amounted to 66 billion litres while slightly less than 15 billion litres of biodiesel was produced in 2008.

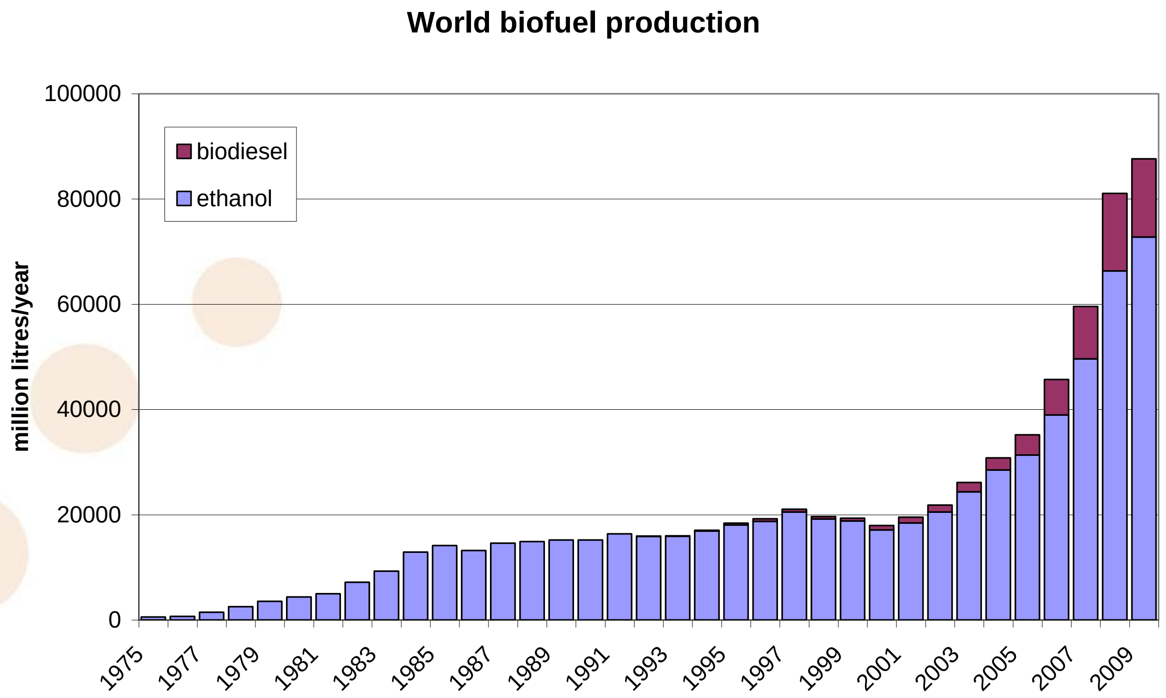


Figure 1 World biofuel production (2009 values are projected), data derived from (F.O.Licht's, 2009)

Biofuels are currently derived from existing agricultural commodities that differ by region. In the United States ethanol production used roughly 28% of the produced corn in 2008. The United States accounts for roughly 40% of world corn production and is the world's dominant corn exporter (55-60% of global corn trade) followed by Argentina and Brazil. Biodiesel is mostly produced from soybean oil in these three countries. Brazil presently uses about half of its sugar cane output to produce ethanol, while EU's ethanol is mostly produced from wheat or sugar beet. Biodiesel is primarily produced from rapeseed oil in EU and about 65% of EU vegetable oil production was used for biodiesel in 2008. Worldwide, about 98 million tonnes of grains (mainly corn and wheat) were used to produce bioethanol, representing 5.6%[1] of the total world grain production. Almost 330 Million tonnes of sugar feedstocks (sugarcane, sugar beet & molasses) were used worldwide to produce ethanol in 2008, mainly in Brazil. EU27

[1] This share represents the gross grain consumption of fuel ethanol. If the co-products, which are sold on the animal feed markets, are taken into account, the net grain consumption would be 4% in 2008.

used slightly less than 7 Million tonnes of sugar beet and beet molasses (small part) corresponding to about 5% of sugar beet output. Worldwide about 11.5 Million tonnes of vegetable oil (rapeseed, soy, palm oil) were used to produce biodiesel, representing 9% of worldwide vegetable oil market.

While biofuel production has been expanding rapidly based on the above mentioned agricultural commodities the world has experienced market price increases for major agricultural commodities such as grains and vegetable oils between mid 2006 and mid 2008 (see Figure 2). While there have been a number of factors contributing to the recent price increase in food prices (see Box 1) the likely impacts of biofuel production on world food and feed markets have been in the centre of attention the last couple of years.

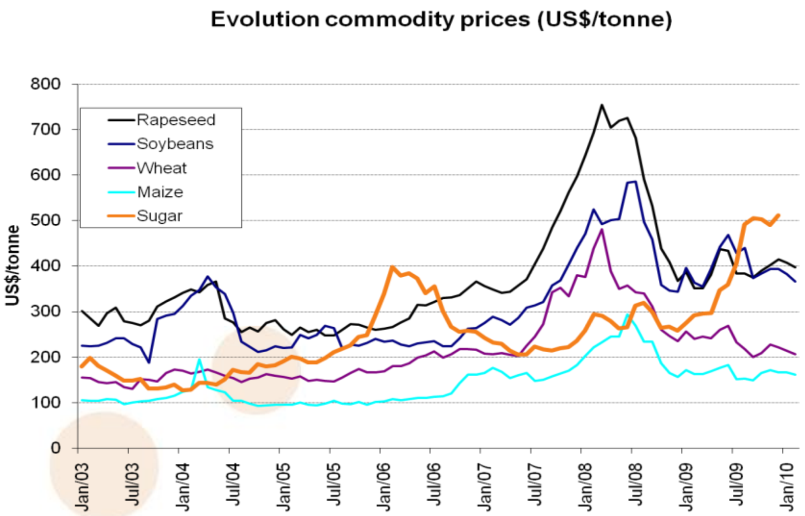


Figure 2 Evolution of commodity prices between 2003 and January, 2010
Source of the data: www.fao.org/worldfoodsituation/FoodPricesIndex

Box 1 Factors contributing to the recent increase in food prices (USDA, 2008)

- *Reduced agricultural R&D:* reduced agricultural research and development by governmental and international institutions may have contributed to the slowing growth in crop yields.
- *Increasing agricultural costs of production:* agricultural production costs have risen, especially for energy related inputs such as fertilizer, fuel and pesticides.
- *Higher demand for agricultural commodities:* over the last decade, strong global growth in average income combined with rising population has increased the demand for food, particularly in developing countries.
- *Declining value of the U.S. dollar:* as the dollar loses value relative to the currency of an importing country, it reduces that country's cost of importing. Since the United States is a major source of many agricultural commodities, foreign countries' imports of commodities from the United States began to rise. This put upward pressure on U.S. prices for those commodities. Further, since the world price of major crops are typically denominated in U.S. dollars, the depreciation of the dollar also raises prices (measured in dollars).
- *Increasing prices of crude oil:* In the period 2007-2008 crude oil prices increased from 50 to over 140 $US per barrel.
- *Adverse weather conditions:* adverse weather reduced crop production in some countries, resulting in lower production and contributing to the increase in the price of these commodities.
- *Speculating actors entering commodity markets:* after the downturn of financial

markets, the interest of hedge funds and sovereign wealth funds has turned to agricultural commodity markets over the last years. By pouring considerable financial resources into agricultural markets they significantly increased their liquidity and thus volatility.

- *Policies adopted by some exporting and importing countries to mitigate their own food price inflation:* the raise in commodity prices caused domestic food prices at the consumer level to rise in many countries. In response to rising food prices, some countries began to take protective policy measures designed to discourage exports. The objective was to increase domestic food supplies and restrain increases in food prices. However, such measures typically force greater adjustments and higher prices onto global markets.

Besides concerns over negative socioeconomic effects the possible environmental impacts – particularly related to land use change including deforestation causing biodiversity losses and greenhouse gas (GHG) emissions – have reduced the public enthusiasm and put pressure on the policy process to adjust the policy agenda.

Ambitious policy targets for biofuels

The rapid expansion of biofuels production and consumption has mainly been driven by the policy support in a number of countries (see Table 1). For instance in Europe the Common Agricultural Policy and the Energy Policies promoting renewable energy were the main drivers of biofuel production. The EU Biofuels Directive has set an indicative target of 5.75% for 2010. Furthermore, the Renewable Energy Directive has laid down a binding target of 10% of renewable fuels in total gasoline/diesel sales by 2020. In the USA the Renewable Fuels Standards of 2005 and 2007 have given a boost to biofuel production. The Energy Independence and Security act of 2007 included a major expansion of renewable fuel standards to 36 billion gallons (136 million m^3) in 2022. Of this amount, 3 billion gallons (11 million litres) must be 2nd generation biofuels in 2016, increasing to 21 billion gallons (80 million m^3) in 2022. Brazil, a country with a long history on biofuel use, achieved more than 50% of fuel consumption in the gasoline market from sugarcane based ethanol in 2008. While current production in Brazil amounts to 19 million m^3/year in 2007, plans are announced to extend this production to 35 million m^3/year in 2015, of which 20% would be for export.

Table 1 Voluntary and mandatory targets for transport fuels in major countries.

Country/Region	Mandatory, voluntary or indicative target
Australia	At least 350 million litres of biofuels by 2010
Canada	5% renewable content in gasoline by 2010
European Union	5.75% by 2010, 10% by 2020
Japan	0.6% of auto fuel by 2010; a goal to reduce fossil oil dependence of transport sector from 98% to 80% by 2030
New Zealand	3.4% target for both gasoline and diesel by 2012
United States	12 billion gallons by 2010, rising to 20.5 billion gallons by 2015 and to 36 billion gallons by 2022 (with 16 billion gallons from advanced cellulosic ethanol)
Brazil	Mandatory 25% ethanol blend with gasoline; 5 percent biodiesel blend by 2010.
China	2 million tons ethanol by 2010 increasing to 10 million tons by 2020; 0.2 million tons biodiesel by 2010 increasing to 2 million tons by 2020.
India	5% ethanol blending in gasoline in 2008, 10% as of 2009; indicative target of 20% ethanol blending in gasoline and 20% biodiesel blending by 2017.

Indonesia	2% biofuels in energy mix by 2010, 3% by 2015, and 5% by 2020.
Thailand	2% biodiesel blend by 2008, 10% biodiesel blend by 2012; 10% ethanol blend by 2012.
South Africa	2% of biofuels by 2013

Objectives of ELOBIO

As mentioned, concerns related to the impacts of biofuels on commodity markets and on the environment can reduce public support and make actors hesitant to investing in biofuels. The ELOBIO project addresses these issues and develops strategies that can enhance the positive aspects of biofuel use while mitigating their negative impacts. It presents a vision on policy options that have the least negative impacts on other markets in food, feed and lignocellulosic materials. The project consists of i) a review of current experiences with biofuels and other renewable energy policies and their impacts on other markets, ii) iterative stakeholder-supported development of low-disturbing biofuels policies, iii) model supported assessment of these policies' impacts on food & feed and lignocellulosic markets, and iv) finally an assessment of the selected optimal policies on 2nd generation biofuels costs.

Even though the issues related to environmental concerns have not been the focus at the beginning of this project, the stakeholder discussions have expanded the scope of this study, and we included land use and GHG emission aspects of biofuels.

Stakeholder involvement

Stakeholder involvement in ELOBIO project plays a central role as the relevant DG officials, NGOs, biofuel/biomass industry, food and feed industry, energy sector, pulp and paper industry, researchers and the suppliers of raw material (agricultural crop and forestry) in this area involves in every step of the project. They have participated from the beginning to construct the policy packages intended to have low impact on other markets. Together with the stakeholders ELOBIO team identified the key issues and mechanisms that can lead to market disturbances. This information was used as an input to the modelling work undertaken in the later stages of the project. Primary results of the impacts of biofuel expansion on commodity markets were presented to the stakeholders to get their feedbacks on the methodologies applied and the first-order policies proposed. Based on the discussions the proposed policies were fine tuned.

One good example of their added value to the project is that they urged ELOBIO team to expand the project focus and cover some aspects of the sustainability issues. Moreover, they highlighted the importance of agricultural development and productivity increases as the vital precondition for responsible biofuels development. More investment in agriculture in developing countries that benefits both farmers and productivity, and priority to food security were some of the genuine conclusions of the stakeholders. Importance of stable agricultural markets and ways to reduce price volatility (i.e suggestion of policy measures such as countercyclical blending mandates), impacts of co-products of 1st generation biofuels, indirect land use change issues, competition regarding stationary versus transport sector, limiting biofuel feedstocks to residues and wastes, and introduction of 2nd generation biofuels and their possible impacts on lignocellulosic markets were the areas the stakeholders contributed strongly during the course of this project.

2. Biofuel policies and the ELOBIO scenarios conducted

In 2009, the European Union adopted the Renewable Energy Directive (RED) (Directive 2009/28/EC)which includes a 10% target for the use of renewable energy in road transport fuels by 2020. It also established the environmental sustainability criteria, including a minimum rate of GHG emission savings (35% in 2009 and rising over time to 50% in 2017) and restrictions on the types of land that may be converted to production of biofuels feedstock crops. The latter criterion covers direct land use changes only. Moreover, the Parliament and Council asked the Commission to examine the question of indirect land use change (iLUC), including possible measures to avoid this, and report back on this issue by the end of 2010. Likewise, Countries such as the United States, China, India, Indonesia, South Africa and Thailand have also adopted policy measures and set targets for the development of biofuels. While the justification of biofuel targets to enhance fuel energy security and to contribute to climate change mitigation and agricultural rural development is appealing, the reality is complex since the consequences of biofuels developments ranges from local to global level across interlinked social, environmental and economic domains, well beyond the national setting of domestic biofuels targets.
The potential of GHG savings is a key requirement for biofuel deployment. The extent of GHG savings varies widely for individual biofuel production chains. Calculation of GHG saving potentials are further complicated by consideration of indirect land use changes, i.e. displacement effects such as agricultural expansion that is at least partly induced by bioenergy feedstock production elsewhere. These issues have been in the centre of intense debates and controversy.

In ELOBIO, we defined a baseline scenario and two alternative biofuel expansion scenarios to be assessed in model simulations. While all scenarios assume transport energy demand as projected by International Energy Agency (IEA) in its World Energy Outlook (WEO) 2008 Reference Scenario (*WEO2008-Ref*), they differ in their assumed level of biofuel use and show some variation in the share of 2nd generation biofuel production technologies.

Box 2 ELOBIO modelling assumption

ELOBIO modelling work

The *Reference* scenario assumes that the biofuel share in 2008 will be constant and there will be no further expansion in the next decades. On the other hand, the scenario *WEO* assumes regional biofuel use up to 2030 as projected by *WEO2008-Ref* and 2nd generation conversion technologies becoming commercially available after 2015 and being deployed gradually. The scenario *TAR* assumes a fast expansion of biofuel production in accordance with mandatory, voluntary or indicative targets announced by major developed and developing countries. In *TAR* we assume an accelerated development of 2nd generation conversion technologies and permit rapid deployment. In *WEO* and *TAR* all other exogenous variables, such as population growth, technical progress and growth of the non-agricultural sector, are left at the levels specified in the reference projection.

In both scenarios, *WEO* and *TAR*, current shares in feedstock use are maintained into the future (e.g. for the US it is assumed that 90% of biofuel feedstock demand is from corn).

The model assumptions are summarised in Table 2.

Table 2 Scenario assumptions- Mtoe

	Baseline		WEO		TAR	
	2020	2030	2020	2030	2020	2030
Developed countries						
Final consumption of transport fuels			1505	1486	1505	1486
Biofuels consumption	45	45	63	80	117	178
Share of biofuels in transport fuels			4.2 %	5.4 %	8 %	12 %
Share of 2nd generation			4%	19%	33%	51%
Developing countries						
Final consumption of transport fuels			1174	1529	1174	1529
Biofuels			31	46	72	116
Share of biofuels in transport fuels			2.7 %	3.0 %	6 %	8 %
Share of 2nd generation			0 %	4 %	3 %	19 %

We also conducted a scenario variant for the two biofuel scenarios WEO and TAR, termed WEO-vP and TAR-vP to assess the impact of increased agricultural productivity.

Productivity increase assumptions are as follows.

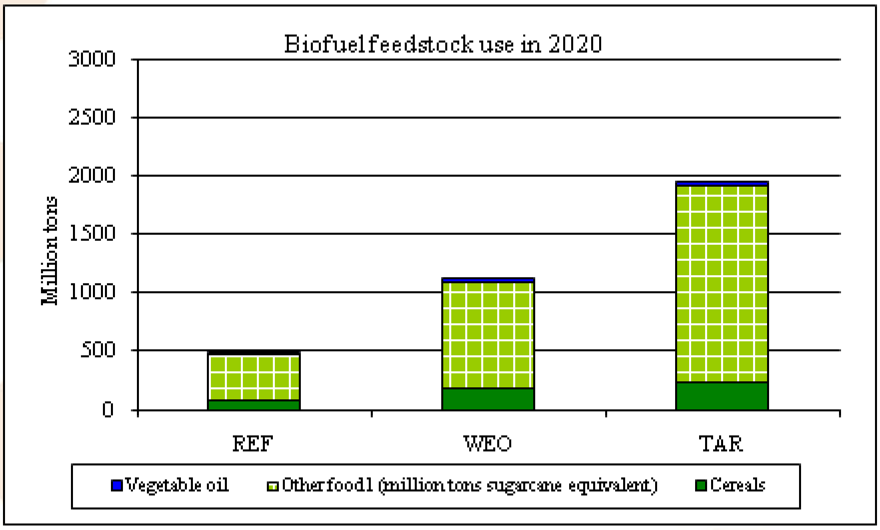
Country Group 1: high productivity growth (Sub-Saharan Africa)
+ 7.5 % by 2025 and + 20% by 2050

Country Group 2: medium productivity growth (India, Pakistan, Argentina,….)
+ 4 % by 2025 and + 10 % by 2050

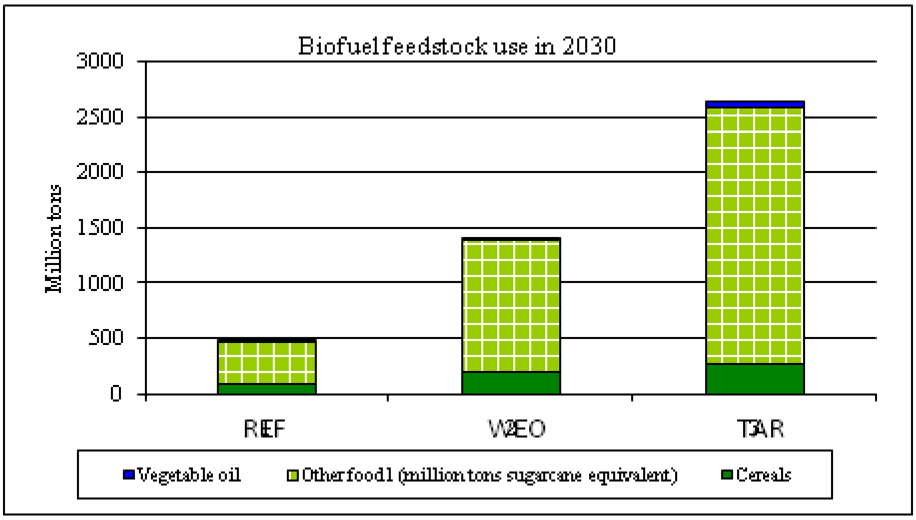
Group 3: no changes (developed countries)

3. Impacts of biofuel expansion

The ELOBIO modelling results indicate a significant increase in demand for conventional (first generation) feedstocks to meet the global biofuel targets (see Figure 3 for agricultural commodities demand for each scenario). Such a significant additional feedstock demand impacts production, consumption, and trade of agricultural commodities, leading to changes in agricultural prices on the international and national markets. This in turn affects the investment allocation and labour migration between sectors and also the allocation of resources within the agriculture sector.



(a)



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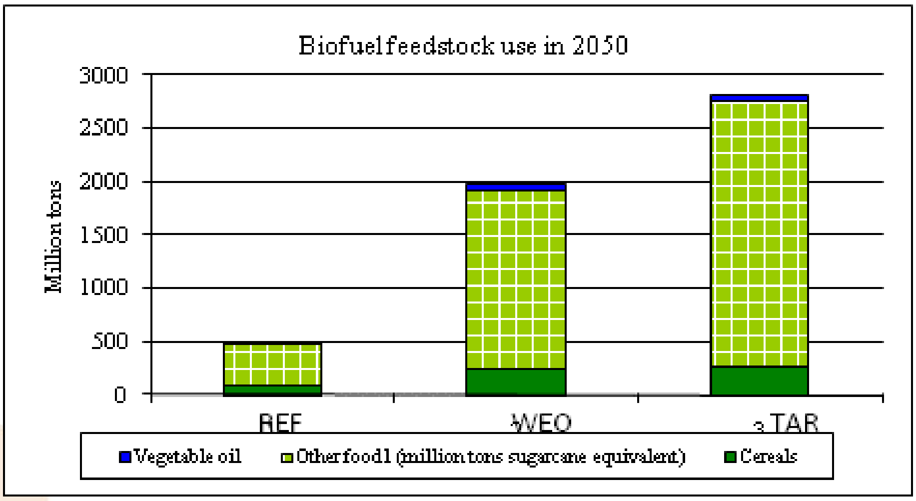

(c)

Figure 3 Use of agricultural commodities for biofuel production in different scenarios for 2020 (a), 2030(b), and 2050 (c)

3.1 Impacts on agricultural commodity prices

Biofuel demand, in addition to increased demand for food push international food commodity prices upwards. In 2020, both cereals and other crops experience price increases in the order of 10% to 19% for the different scenarios in this study. The accelerated deployment of 2nd generation biofuels, however, decreases the price impact in the *TAR* scenario. On the other hand, protein feed prices are lower compared to the reference scenario due to larger volumes of co-products entering the market.

The assumed additional productivity growth rates, however, have a strong impact on the price development of agricultural commodities, especially after 2030. Figure 4 presents the price developments in the biofuel scenarios, both with and without additional agricultural productivity growth, in comparison to the reference scenario.

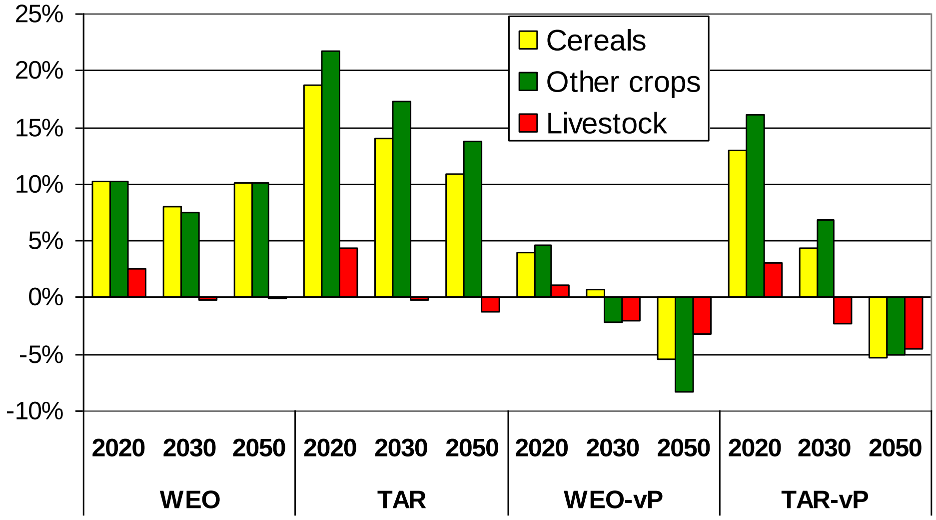

Figure 4 Agricultural prices for biofuel scenarios, relative to reference scenario
Source: IIASA world food system simulations, ELOBIO scenarios

3.2 Impacts on agricultural markets

Production increases in response to higher agricultural prices are stronger in developed countries (see Figure 5). On the other hand, the assumed productivity growth in the developing world increases the region's competitive position and stimulates higher production. Compared to the reference scenario (REF) the developed countries loose market shares and cereal production increases over time in the developing world.

As a result the value added from the crop and livestock sector increases compared to REF and the share of developing countries in total value added increases. Figure 6 highlights the gains in value added (additional value added) from the crop and livestock sector between 2020 and 2050 for the two biofuel scenarios (WEO and TAR) and their variants with additional growth in agricultural productivity (WEO-vP and TAR-vP respectively).

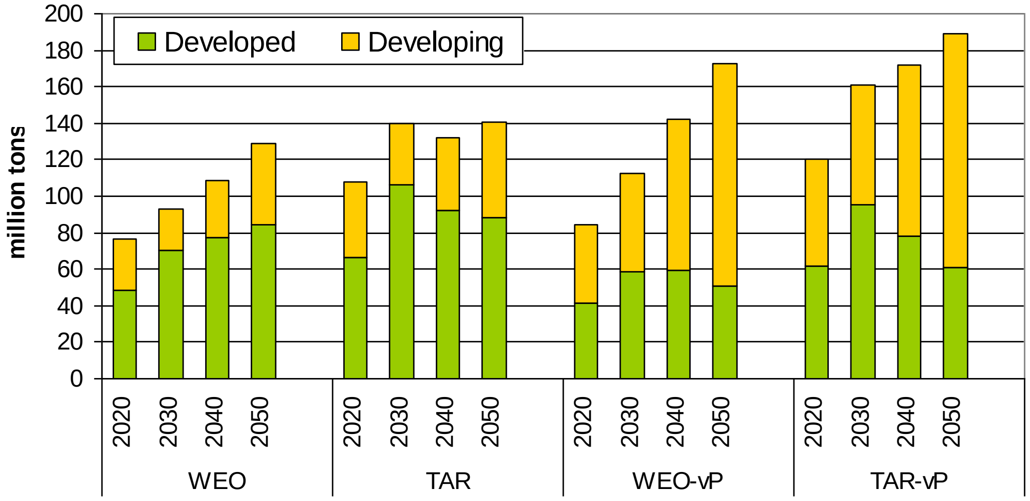

Figure 5 Additional cereal production for biofuel scenarios, relative to *REF*
Source: IIASA world food system simulations, ELOBIO scenarios

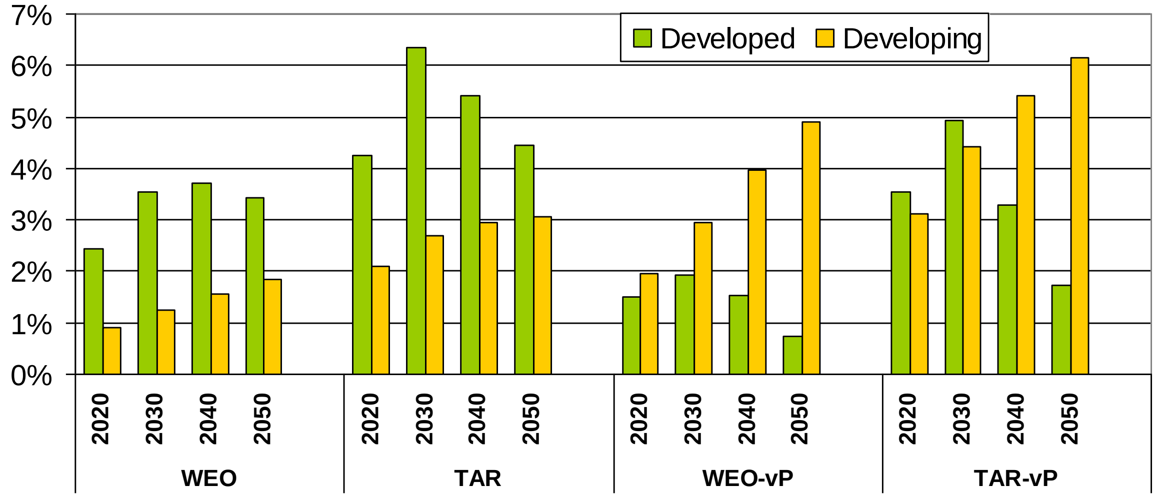

Figure 6 Gain in value added from crop and livestock sector due to biofuel consumption, relative to *REF*

Source: IIASA world food system simulations, ELOBIO scenarios

3.3 Impacts on hunger

The estimated number of people at risk of hunger used in the world food system model is based on FAO (FAO, 2001; 2008b) and relies on a strong correlation between the share of undernourished in a country's total population and the ratio of average per capita dietary food supply relative to average national per capita food requirements. The additional production of 1st generation biofuels, as indicated previously, causes higher prices and results in additional number of people at risk of hunger compared to the baseline scenario projections. Results show that Africa and South Asia account for more than two-thirds of the additional population at risk of hunger in developing countries across biofuel scenarios in 2020 as well as in 2030.

Even though the TAR scenario considers ambitious assumptions on 2nd generation biofuel introduction in the near future, the higher biofuel consumption in this scenario increases the number of people at risk of hunger by as much as 94 million (compared to *REF*) by 2020. The swift introduction of second generation technology in TAR scenario takes pressure off the competing food-feed-biofuel feedstock market and reduces the additional number of people at risk of hunger over time.

On the other hand additional agricultural productivity decreases the number of people at risk of hunger as it lowers the prices and increases the production and the value added in agriculture in developing countries. As Figure 7 illustrates, the productivity growth assumptions in WEO-vP and TAR-vP outweigh increases in the number of people at risk of hunger compared to baseline scenario with no additional biofuel demand after 2030.

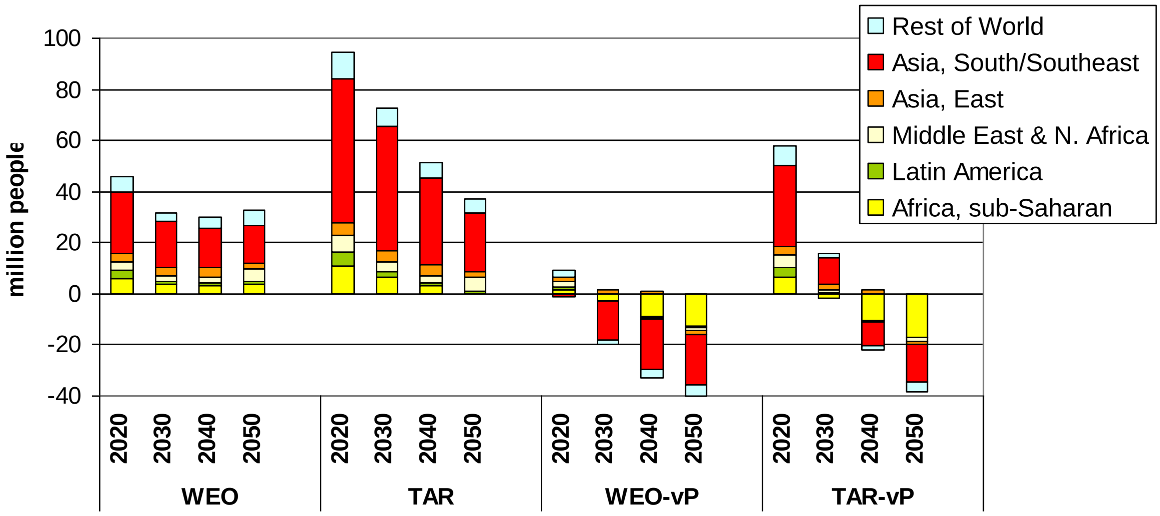

Figure 7 Additional people at risk of hunger in biofuel scenarios, relative to REF
Source: IIASA world food system simulations, ELOBIO scenarios

3.4 Impacts on environment

Arable land expansion

Around 1.6 billion ha of land are used for crop production, with nearly 1 billion ha under cultivation on the developing countries. During the last 30 years the world's crop area expanded by some 5 million ha annually, Latin America alone accounting for 35 % of this increase. The potential for arable land expansion exists predominantly in South America and Africa while there is little scope for expansion in Asia, which is home to some 60 % of the world's population.

The *Reference* scenario, where the 2008 biofuel production is kept constant for 2020, 2030 and 2050, indicates the arable land expansion to be around 120 million hectares by 2030 and 170 million hectares by 2050 to meet growing future food and feed demand of which Africa and South America together accounts for 85% of the expansion of cultivated land.. We calculated an additional 11 million hectare put into cultivation compared to reference scenario to meet the biofuel demand in 2030. This figure represents a 10 % net arable land expansion due to biofuel use in the *WEO* scenario. When the biofuel amount is doubled compared to *WEO*, around 22 million hectares is required to be put into arable land, representing a net arable land expansion of 18%. Due to accelerated deployment of 2nd generation biofuel technologies in TAR after 2020 little additional land is put into cultivation compared to the REF.

Additional crop productivity growth reduces the amount of arable land expansion. Figure 8 highlights the additional arable land required due to biofuel consumption for the biofuel scenarios WEO and TAR and their variants with higher crop productivity growth WEO-vP and TAR-vP respectively. Arable land expansion is not much affected by additional productivity until 2030. However, by 2050 the effects of increased productivity result in no or even lower arable land expansion compared to the reference scenario.

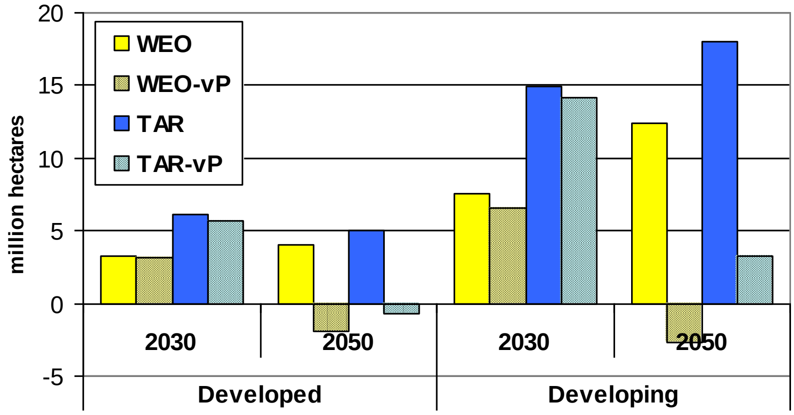

Figure 8 Additional arable land use in biofuel scenarios relative to reference scenario
Source: IIASA world food system simulations, ELOBIO scenarios

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Deforestation

A large and rapid increase in biofuel demand can cause agricultural land expansion into natural ecosystems via direct or indirect land use changes. The ELOBIO project explicitly modelled the land conversion and provided an estimation of the amount of additional deforestation directly and indirectly caused by biofuels feedstock production.. Land conversion is explicitly modelled to maintain full consistency between the spatial agro-ecological zones approach used for appraising land resources and land productivity and the expansion of cultivated land as determined in the world food system model. Estimates suggest that by 2030 biofuel feedstock production assumed in the WEO and TAR scenario causes some 5 to 9 million hectares of additional deforestation, a 10% increase compared to a world without biofuel expansion, with the vast majority occurring in Latin America. The land use change would have been larger if not the 1st generation biofuel co-products had substituted animal feed that requires land, such as soybean.

Due to increasing contribution from 2nd generation biofuels, the additional deforestation rates significantly slow down after 2030. It should be noted that in the biofuel scenarios potential production of lignocellulosic feedstocks for the 2nd generation production chains is assumed to occur on pastures and other wooded areas and will thus cause no additional deforestation.

However the assumed additional agricultural productivity growth in the scenarios WEO-vP and TAR-vP can counterbalance deforestation. By 2050 biofuel consumption causes no additional deforestation in the high agricultural productivity growth scenarios WEO-vP and TAR-vP.

Causes of deforestation are manifold making estimates of deforestation difficult and uncertain. Future forest conversion will depend on the willingness, priorities and capacity of national governments to protect forests and the effectiveness of legislation and other measures taken to reduce deforestation.

Enforcement of land use restrictions targeted at avoiding deforestation combined with increased agricultural productivity growth rates, especially in the developing world, would provide significant environmental benefits for increased biofuel deployment.

GHG emission savings

Carbon losses from vegetation and soils due land use changes (deforestation and grassland conversion) occur mainly at the time of land conversion. By 2050, additional grassland conversion due to biofuel consumption amounts to 11 and 15 million hectares for *WEO* and *TAR* respectively. In addition 6.6 and 9.6 million hectares can be attributed to additional deforestation.

GHG savings resulting from the replacement of fossil fuels with biofuels accumulate only gradually over time. For the biofuel scenarios *WEO* and *TAR* net GHG balances therefore do not become positive until after 2020. By 2050 the amount of 2nd generation biofuels increases GHG savings via biofuels use while at the same time only little additional land use conversion is required. This results in a maximum accumulated net GHG savings of 22 Pg (= Gton) CO_2 equivalents (*TAR* scenario). It should be noted that by 2050 it is assumed that 50% of biofuel consumptions is achieved from the 2nd generation conversion pathways.

Lower arable land requirement due to additional productivity increases (in the variant scenarios) result in less land use conversion, and thus, in an improved GHG balances of the biofuel scenarios For example by 2050 the scenarios WEO-vP and TAR-vP cause no additional deforestation compared to *Reference* scenario.

Figure 9 shows the accumulated GHG gains and losses for the two biofuel scenarios (WEO and TAR) and their variants with crop higher productivity growth (WEO-vP and TAR-vP). Cumulative net GHG savings are closely linked to the effects of arable land expansion and subsequent land use conversions. In the beginning the effect of the assumed higher crop productivity growth is primarily visible in the TAR scenario. In TAR-vP GHG emissions lost from land use conversions are about the same order as the GHG emissions saved by substitution of fossil fuels by biofuels.

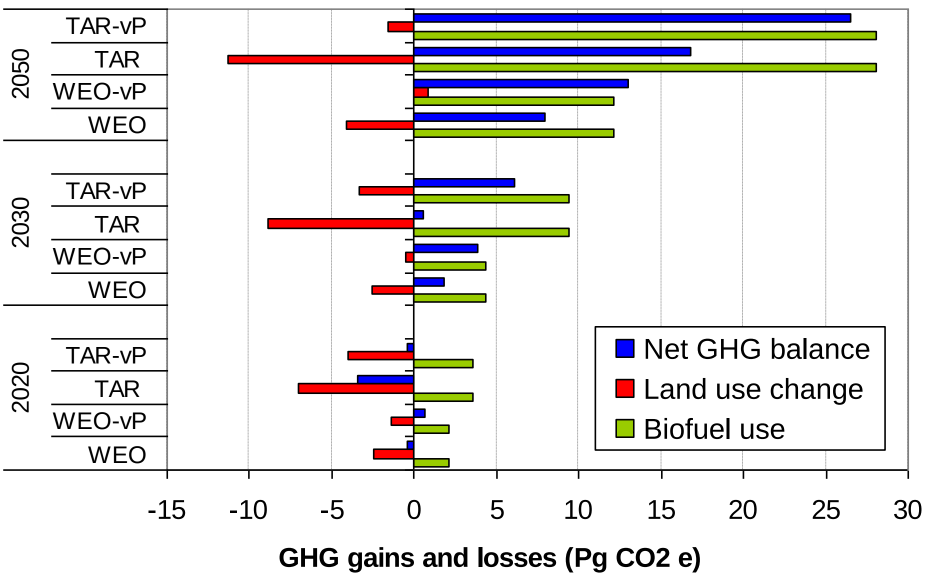
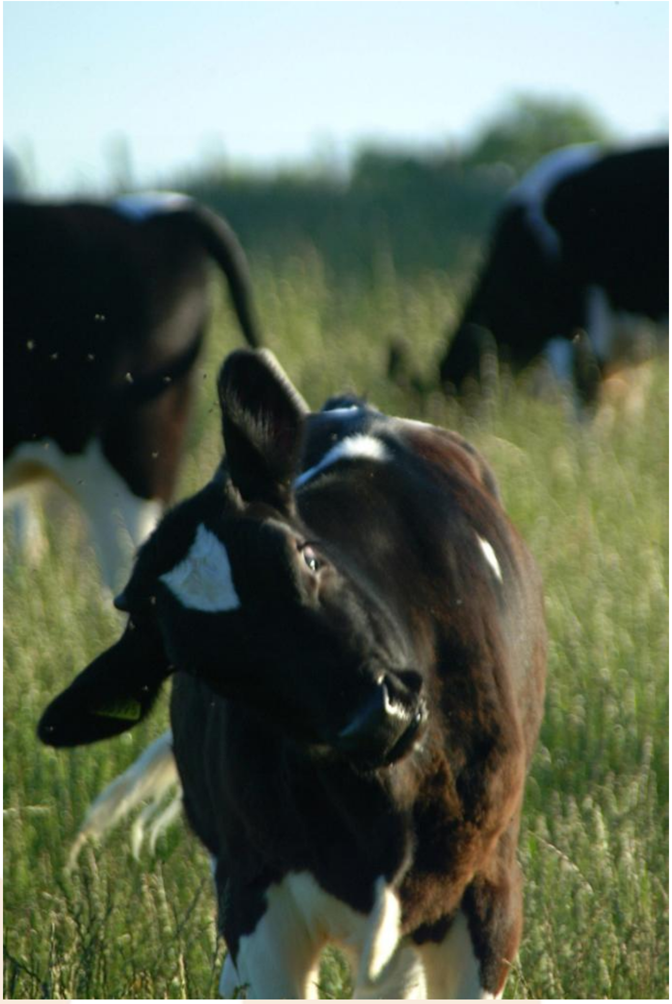


Figure 9 Cumulative net GHG savings of biofuel scenarios
Source: IIASA world food system simulations, ELOBIO scenarios

In 2020 the net emission balance is only slightly positive for the WEO-vP scenario while the other scenarios show higher GHG emissions compared to REF with no accelerated biofuel consumption. However, by 2030 all biofuel scenarios show a positive GHG emission balance, which increases further until 2050, especially for the scenarios WEO-vP and TAR-vP, which assume additional crop yield improvements.

How important are co-products?

The ELOBIO project explicitly analysed the role biofuel co-products play in land use change and GHG emissions. For every ton of ethanol produced from starchy crops, a ton of dried distiller's grains with soluble (DDGS) is produced. By allowing/not allowing that the DDGS produced is used as animal feed in the modelling it was possible to detect a significant variation in commodity price depending on DDGS availability, particularly for protein feed. Furthermore, the 'land saving' effect of using DDGS as animal feed was found to be 5-8 million hectares for the biofuel scenarios, with around two thirds of the effect in the developing world. Thus, if DDGS would not be used as animal feed the GHG balance of biofuel consumption would worsen significantly due to additional land use conversions and associated GHG emissions, of which a large part would take the form of deforestation in Latin America.



3.5 Comparison with the recent IFPRI study

In 2010, IFPRI published results of a study (Perrihan et.al, 2010) analyzing the impact of possible changes in EU biofuels trade policies on global agricultural production and the environmental performance of the EU biofuel policy adopted in the Renewable Energy Directive (EC, 2009). The study pays particular attention to the indirect land use (ILUC) effects and associated GHG emissions.

The ELOBIO modeling framework and the IFPRI analysis is comparable in the sense that they: (i) are based on a general equilibrium modeling approach[2]; (ii) account for co-products generated in the ethanol and biodiesel production processes and their role as inputs to the livestock sector; (iii) apply a land conversion module to determine GHG emissions resulting from the expansion of cultivated land as determined in the economic model; and (iv) use a scenario approach where the impact of a reference scenario on food and feed markets and the environment is compared with different biofuel scenarios.

The ELOBIO *reference* scenario assumes that the global biofuel consumption remains constant into the future at the 2008 levels. The biofuel scenarios introduce different levels of biofuel consumption throughout the world specified in the WEO and TAR scenarios. In contrast to the IFPRI study, where a large share of the EU's biofuels is imported sugarcane ethanol from Brazil, the ELOBIO scenarios assume that the current share of biodiesel and bioethanol and associated feedstock uses in a particular country is maintained into the future. The biofuels increase between 2008 and 2020 in the WEO scenario amounts to 63 Mtoe and is thus comparable with the assumptions for the globe in the IFPRI study. The target scenario TAR biofuels consumption is approximately twice a high compared to WEO reaching some 180 Mtoe globally by 2020. ELOBIO implies sensitivity runs assuming higher growth in agricultural productivity in selected developing countries (scenarios WEO-vP, TAR-vP).

The IFPRI study computes an average ILUC effect of the EU mandate to be between 17.7 g CO2eq/MJ (no trade liberalization) and 19.5 gCO2eq/MJ (with trade liberalization). It should be noted that IFPRI considers the share of ethanol in EU consumption to increase from current 19% to 45% in 2020 mainly imported by land use efficient sugarcane ethanol from Brazil. The report also acknowledges the fact that if the EU target is higher than 5.6% the land use emissions will be much higher.

Table 3presents direct and indirect land use emissions for the ELOBIO biofuel scenarios following the same calculation procedures as in the IFPRI study (see Table 11 and text on page 63). Accumulated land use emissions between current and 2020 or 2030 are annualized over 20 years (i.e. divided by 20) and divided by the delta of biofuel use between the reference and the particular biofuel scenario in the year 2020 or 2030.

Table 3 Land use emissions per MJ of biofuel use for different biofuel scenarios calculated for 2020 and 2030.

	First generation	**Second generation**	**TOTAL biofuels**	**EU 27** (weighted with EU shares)

[2] IFPRI applies an extended version of the MIRAGE model using an extended version of the Global trade Analysis Project (GTAP) database.

	2020	2030	2020	2030	2020	2030	2020	2030
WEO	61.5	46.4	9.6	5.2	58.9	38.0	61.5	41.9
WEO-vP	34.7	8.0	9.6	5.2	33.4	7.4	34.7	7.7
TAR	77.3	73.4	9.3	5.1	58.0	42.5	56.2	41.2
TAR-vP	42.5	24.9	9.3	5.1	33.0	15.9	32.2	15.6

ELOBIO results highlight the importance of the time dimension as well as the share of second generation biofuels in assessing biofuel impacts. Speed of first generation biofuel introduction combined with the assumed growth in agricultural productivity determines land use effects and net GHG balances.

The IFPRI study calculates an positive emission balance over the 20 year period of between 43 and 47gCO2/MJ emission savings due to the EU biofuels mandate. In contrast the ELOBIO study only achieves emission savings for the assumed biofuel scenarios after 2020 with the exception of the scenario WEO-vP, where the GHG balance is positive before 2020.

4. Formulating policy options to avoid negative impacts on agricultural commodity markets

The modelling results indicate that biofuels – with the assumed growth rates – will lead to higher agricultural commodity prices and negative environmental effects. But there are ways to decrease or even avoid such impacts. One main goal in ELOBIO has been to identify the most influential strategies and conveying that information to the relevant stakeholders. The below, sections elaborate on the strategies considered as the most influential in decreasing the impacts of biofuels on commodity markets while making them beneficial in relation to policy objectives within the transport sector.

4.1 Agricultural productivity

Low disturbing' biofuel development requires agricultural productivity increases to exceed the combined food, feed and biofuel demand growth.

In ELOBIO modelling agricultural productivity is treated as a function of fertiliser use and a technology factor with fertilizer use being endogenous and depending on demand and price. The technology factor is exogenously determined by region and crop type with resources derived from FAO projections and selected country studies. In the *Reference* scenario aggregate yields are projected to double and to increase by 50% in respectively the developing world and the developed world between 1990 and 2050. Results for regions are shown in Figure 10.

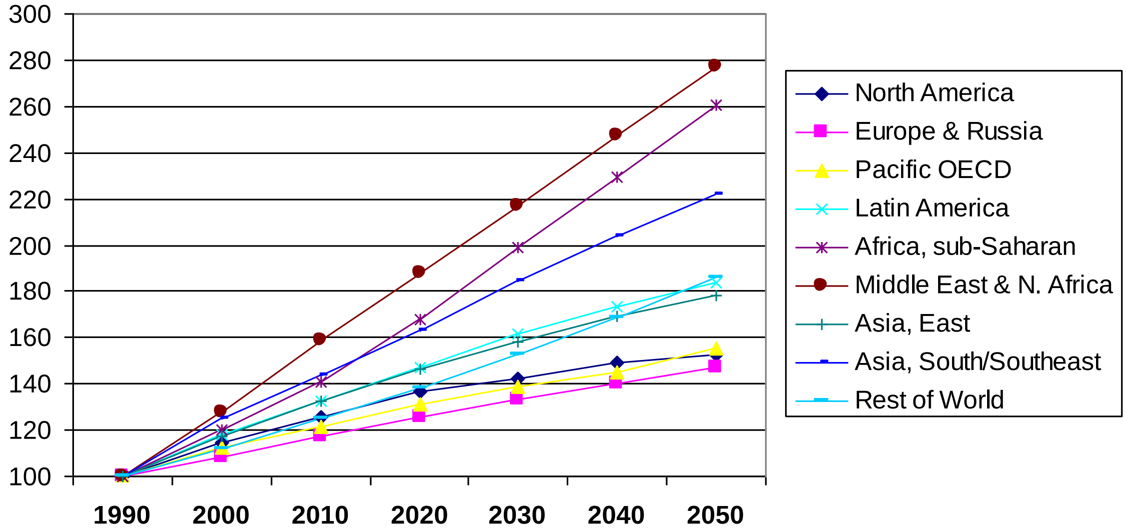


Figure 10 Aggregate Crop Yields, Index; Scenario *REF*
Source: IIASA world food system simulations; scenario ELOBIO-REF.

The modelling results show that a continuation of the linear increase in yields observed at the global level over the past decades will not be sufficient to meet demand for food, feed and biofuels at today's real prices or lower. However, there are still substantial yield gaps to exploit and large opportunities for productivity growth – not the least in many developing countries – and there is also scope for drastic productivity improvements in livestock production. There is also a large yield growth potential for dedicated bioenergy plants that have not been subject to the same breeding efforts as the major food crops, as is the case for sugar cane.

Increasing agricultural productivity, particularly in the regions lacking behind (such as Sub-Saharan Africa), will not only have a price dampening effect but will also decrease the number of people of risk of hunger. Furthermore, in the long term, biofuels could be produced on agriculture land no longer required for food production when the productivity improvements are high enough to outpace food demand growth. Less land conversion leads to improved GHG balances in the biofuel scenarios.

Policies promoting biofuels will need to ensure that possible negative impacts are mitigated. Therefore, such policies could – together with international agricultural policies and international development aid mechanisms – support efforts to enhance the agricultural productivity in developing countries, and ensure that these investments increase the ability of farmers to capture a larger share of the revenue. Thus, an integrated and international approach among energy, agriculture and development polices will be essential to promote the much-needed future productivity increases in the developing world. In addition, mitigating measures may still be needed in instances of high food commodity prices due to either rapid demand growth or supply side difficulties.

4.2 Land use restrictions

For GHG benefits to materialize, yield gap reduction in developing countries, carefully monitored speed of biofuel expansion and enforceable land use restrictions, especially avoiding deforestation, is important.

Sustainability criteria laid out in the adopted Renewable Energy Directive (EC, 2009) includes land use restrictions to avoid conversion of biodiverse lands. Paragraph 3 of Article 17 states that biofuels and bioliquids 'shall not be made from raw material obtained from land with high biodiversity value'. It clarifies this statement by defining the status of land that had one of the following statuses in or after January 2008

a) Primary forest and other wooded land;
b) Areas designated for nature protection; or
c) Highly biodiverse grassland that is:
  - (i) natural, namely grassland that would remain grassland in the absence of human intervention and which maintains the natural species composition and ecological characteristics and processes; or
  - (ii) non-natural, namely grassland that would cease to be grassland in the absence of human intervention and which is species-rich and not degraded, unless evidence is provided that the harvesting of the raw material is necessary to preserve its grassland status.

However, such land use restrictions cannot avoid the indirect effects of biofuels on these land types unless they become internationally recognised and applied not only for biofuel applications but all sorts of biomass use, including agriculture sector. It should also be noted that the strict exclusion of these types of land as a global criterion may not harmonize well with local development plans where conversion of certain shares of such ecosystems have been assessed as defendable from the perspective of biodiversity. The exclusion of land types where it is expected that conversion will lead to CO_2 emissions can be questioned from the perspective that it does not reflect that converting such lands for bioenergy use may eventually result in positive net GHG savings– with time lags depending on both land use change emissions and GHG savings achieved from the fossil fuel substitution. The present blank exclusion implies that the Commission uses a relatively short term perspective in their evaluation.

Causes of deforestation are manifold making estimates of deforestation difficult and uncertain. Future forest conversion will depend on the willingness, priorities and capacity of national governments to protect forests and the effectiveness of legislation and other measures taken to reduce deforestation.

4.3 Promoting 2nd generation biofuels

Some of the problems associated with 1st generation biofuels can be avoided by the production of biofuels from agricultural and forest residues and from dedicated plant production to the extent that this can use land not suitable for food production. Secondly, the energy yields per hectare achievable with cultivated 2nd generation feedstocks are expected to be higher than those of 1st generation biofuels (except for sugarcane ethanol) and biofuels produced from residues and 2nd generation feedstocks tend to achieve higher GHG savings. In addition, since there are several potential biofuel plants that are hardy and drought resistant and can be grown on marginal lands, demand for 2nd generation biofuels means new opportunities for farmers to diversify their land use. By shifting from conventional annual crops to perennial herbaceous and woody plants farmers can make productive use of marginal areas – e.g., sloping erodible soils – without damaging these soils. This is further discussed in the following section.

5. Lignocellulosic markets

Lignocellulosic feedstocks are demanded by a number of sectors, among which biofuels presently play a minor role. However, once the 2nd generation technologies are commercially available, they are expected to require significant amounts of lignocellulosic feedstocks. Moreover, the stationary energy sector is expected to use increasing volumes of lignocellulosic feedstocks for producing heat and electricity. In fact, the adopted renewable energy directive sets out binding renewable energy targets for each Member States to meet 20 % of the EU's overall energy consumption from renewable energy sources by 2020. In 2007, 6.7 % of the EU final energy consumption was met through biomass, corresponding to 67 % of the EU gross renewable energy consumption. Around 80% of this was lignocellulosic biomass.

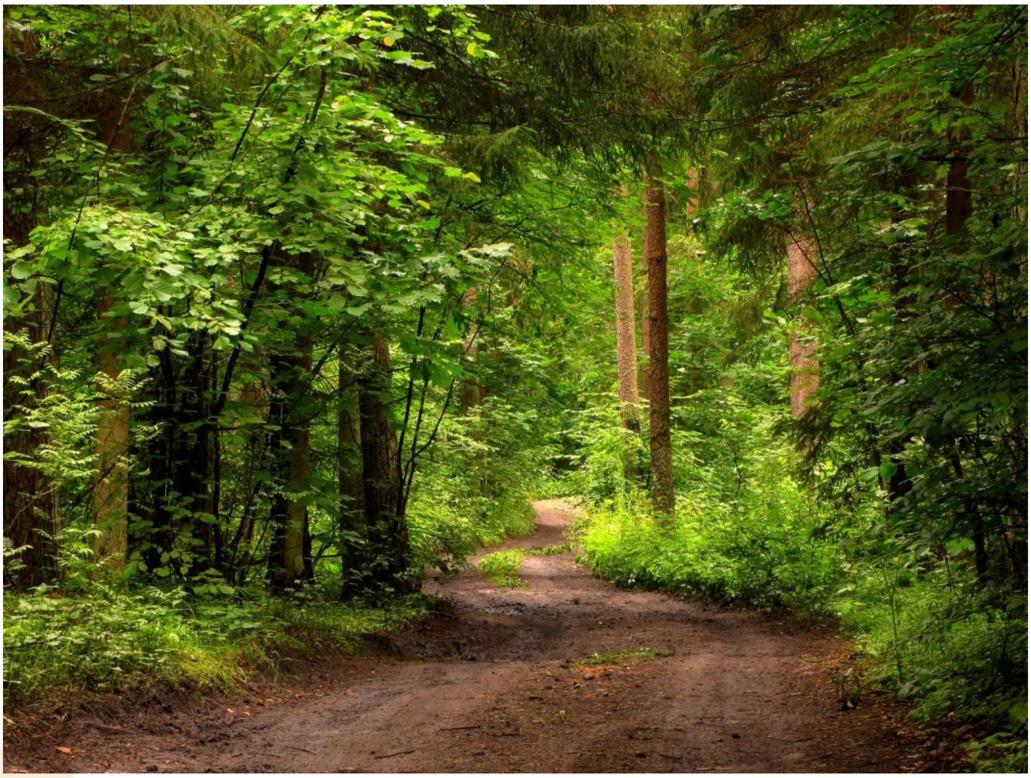
There is a growing concern from forest- based industries.

Increasing demand from a growing bioenergy sector is likely to put pressure on forest based industry and increase raw material costs for a number of wood products using raw materials such as sawdust, wood residues and low-grade timber. This can affect a number of products including pulp and paper, wood based panels, and a number of other manufactured wood products. Even though the stationary energy sectors currently make use of residues and wastes with no other value in local markets, elevated demand driven by policies could result in wood fibre price increases. Increased demand for forest bioenergy can also be an opportunity for the forest industry that can include bioenergy among the products produced. One example, the forest industry has generated substantial revenues from selling bioelectricity in countries that include policy instruments promoting renewable electricity.

Possible strategies for mitigating negative effects of inter-sectoral competition include (i) mobilizing forest resources (energy markets can offer more income for forest owners and thus catalyze harvest in new forest areas, induce new management regimes to increase total wood output from the forests), (ii) enhancing paper recovery and recycling, (iii) encouraging efficient suppliers of lignocellulosic crops in agriculture, and (iv) facilitating international trade in lignocellulosic materials.

Furthermore, biofuels can be produced along with wood-based chemicals and other products in bio-refineries that optimize biomass use and outputs according to market trends.

An important aspects at this stage is defining when and how 2nd generation biofuel technologies will have a large share in the market.



5.1 Strategies to promote 2nd generation biofuels

2nd generation biofuels have been stressed as the way to increase biofuel production while decreasing the negative impacts of 1st generation biofuels. However, those technologies are often associated with high capital costs and they are still at the demonstration scale. Investing in these technologies involves significant risks, which make actors hesitant to investing in development for bringing them to the market in large quantities. Therefore, those capital intensive technologies may require different policy strategies than 1st generation biofuels.

The ELOBIO project has defined the risk profiles of 1st and 2nd generation technologies in order to assess a set of policy measures to bring those biofuels into the market. Moreover, selected strategies that can reduce the initial risks and be used as stepping stones towards large penetration of biofuels in the market were investigated.

Based on the expert input[3], the weighted average capital cost (WACC [4]) for 1st generation biofuels is calculated as 7.17 %, while WACC for 2nd generation biofuel plants is estimated at 30% in the pre-commercial stage (until 2015) and decreasing to 7.17 % over time.

[3] Risk-profiles for first and second generation biofuels and the related financial parameters are based on input obtained through interviews and a survey of biofuel financing experts.

[4] The WACC is the minimum return required to satisfy its creditors, owners, and other providers of capital.

The initial question addressed was: Without any policy support will 2nd generation biofuels penetrate into the market in large quantities?

The ELOBIO modelling analysis clearly show that there will be hardly any private capital willing to invest in 2nd generation biofuels given the current cost of the technology and the predicted biofuel price (see Figure 11). Instead, actors will prefer investing in 1st generation biofuel plants in which the risk mainly is a question of feedstock costs. However, the recent discussions on the impacts of conventional feedstock demand on food prices and environment have favoured 2nd generation biofuels. Given that the initial risks of those technologies are covered by policy measures 2nd generation technologies may be able to offer cost competitive biofuels.

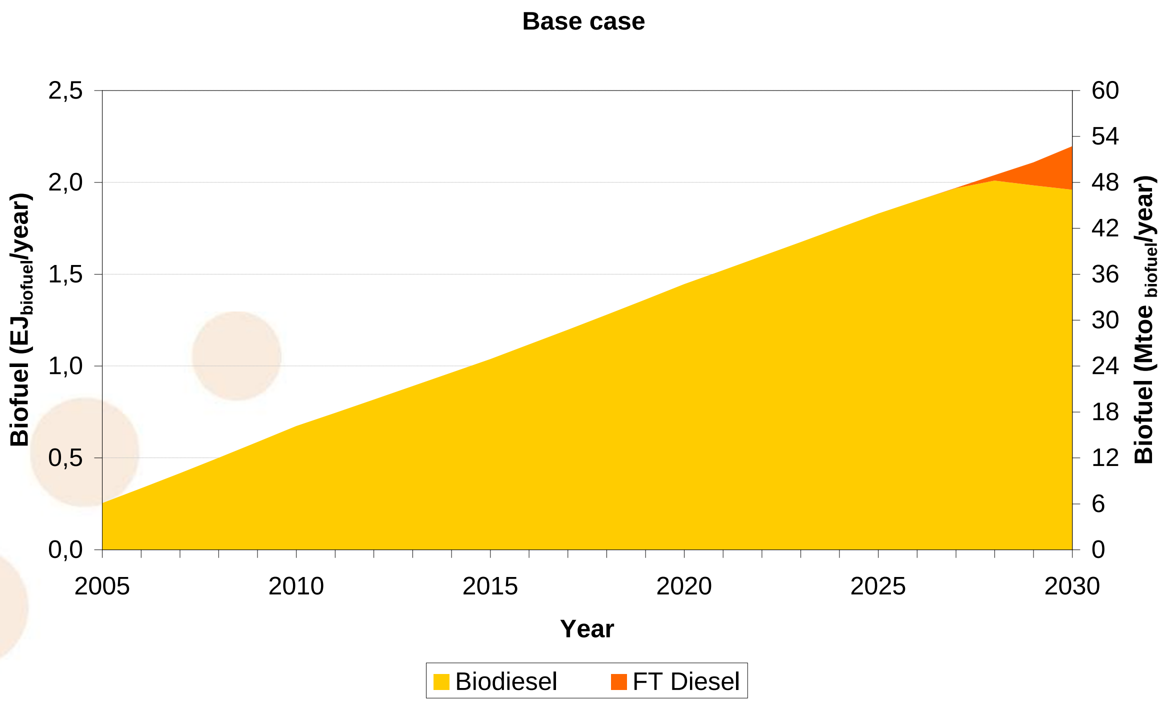


Figure 11 EU Biofuel mix under WACC = 7,17% for 1st generation technologies and 30% for 2nd generation until 2015 and 7,17% thereafter

Assessment of policy options for 2nd generation biofuels

Biofuels have traditionally been supported through tax exemptions. However, in the case of 2nd generation biofuels it can be essential that the technology risk is shared between the public and private sector; commercialization of these technologies will require an approach where industry and governments cooperate around R&D and demonstration towards commercialization. Continued support by governments is essential to scale up 2nd generation technologies and reduce the costs through increased production volumes and learning. The ELOBIO project conducted a number of cases where integrated packages of policy measures were assessed to address the financial risks of developing biofuel plants and enable commercialization.

The results show that significant amounts of initial investment subsidy (>50%) coupled with other policy measures , such as partial tax breaks, soft loans and double counting, can enable high shares of 2nd generation biofuels in the market by 2020 and 2030.

In particular, the combination of an initial investment subsidy with double counting of the produced biofuel towards the renewable transport fuels target could be an effective way of increasing the share of 2nd generation biofuels. While double counting can be a cost effective way of introducing 2nd generation biofuels on the market this measure could limit the total volume of this market. Therefore, we suggest using this measure with some caution, and assess its benefits regularly. At the instance it is judged that the 2nd generation biofuels have become commercially viable the support should end (See Box 3). Figure 12 illustrates a case in which initial 2nd generation production capacity is supported by both double counting and an investment subsidy. The latter is discontinued two years after first market introduction of 2nd generation biofuels, while double-counting is stopped in 2020. The figure shows the sharp increase in biofuel production when double counting is discontinued. Since 2nd generation biofuels have already become cost competitive their share in addition to 1st generation biofuels increase to fill the gap in order to meet the biofuel obligation.

Box 3 Double counting

Double counting

The Renewable Energy Directive allows 2nd generation biofuels to count double towards the renewable transport fuels target of 10% (in energy terms). For instance the target can be achieved through:

(i) 10% 1st generation biofuels, or
(ii) 2% 2nd generation biofuels and 6% 1st generation biofuels

However, from an investor's point of view (ii) will also require an additional 2 % fossil fuel to be equal to (i). Thus, in order for an investor to invest in the second case the cost of (i) shall be equal or lower than the cost of (ii) plus the cost of additional fossil fuel.

This feature makes the double counting measure more sensitive to fossil fuel price developments.

Moreover, this measure can limit the quantitative expansion of biofuels since they are counted double (in energy content).

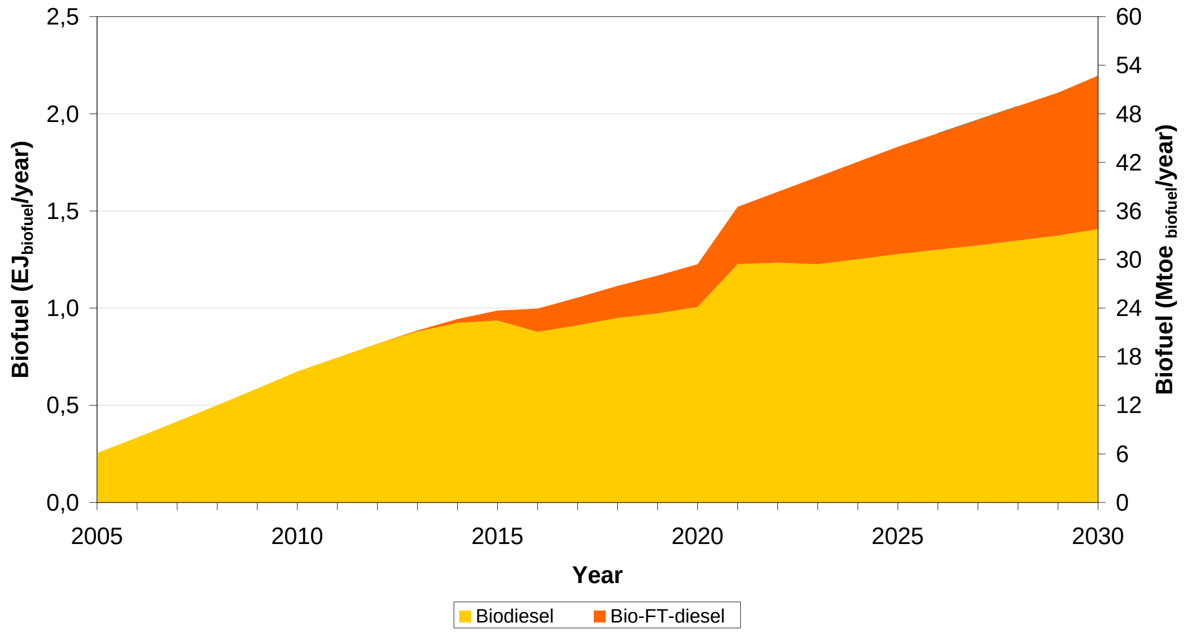


Figure 12 EU Biofuel mix for the case of double counting of 2nd generation biofuels and a 70% investment subsidy in the pre-commercial phase. In this case the double counting ends year 2020

5.2 Synergies between stationary energy sector and biofuels

As mentioned, the stationary energy sector can be expected to use large volumes of biomass fuels to produce renewable electricity and heat during the coming decade. Particularly, biomass co-firing with coal already allows low cost and efficient electricity production. Results of the ELOBIO analyses using the Chalmers EU Power plant database (see Deliverable 6.1 and 6.2 for further information) indicate a potential in the existing power plant stock corresponding to about 50-90 TWh/yr of bioelectricity, or a biomass supply at about 500-900PJ. This corresponds to 1.4 -2.5 % of the gross electricity demand in 2020, as projected in the PRIMES energy efficiency scenario.

Competition for biomass between the stationary energy sector and the biofuels industry may increase the feedstock prices, but policy makers in some member states may despite of this consider promoting lignocellulosic feedstock production while stimulating biomass co-firing. Such an early market introduction will enable development, learning and cost reduction on the biomass supply side and improve feedstock security for the 2nd generation biofuel plants in the mid-term. An important aspect at this point is that biomass use in co-firing plants depends on many factors including the relative development of the other renewable electricity options and their competitiveness, and the development of carbon capture and storage (CCS) in stationary energy sector. In the mid-term, when other renewable electricity options are expected to be cost competitive and coal CCS is developed, shifting the lignocelluloisc feedstock from co-firing to 2nd generation biofuel production can be a matter of regulation.

Nevertheless, biomass co-firing can stimulate lignocellulosic crop production and pave the way for developments of 2nd generation biofuels for transport.

Another important result – obtained from the Chalmers *Euroheatspot* model analyses – is that existing and prospective future district heating systems can in many EU countries offer an opportunity to make productive use of surplus heat from biofuel plants that are based on biomass gasification with subsequent synthesis to biofuels such as FT-diesel, DME and biomethane. When the excess heat generated is used in district heating systems, this will improve the energy efficiency of the biofuel systems and increase the cost competitiveness. ECN Biotrans model analyses indicate that heat sales may increase the cost competitiveness of 2nd generation biofuels and consequently speed up the introduction of those biofuels on the market by a couple of years. The targeting of this integration opportunity can help expansion of biofuels and reduce the total cost of policy support needed.

Figure 13 presents the present size of the district heating systems in the EU and the 2020 expansion potential based on the assumption that only 30% of the industrial heat demand from fossil fuels can be replaced by district heating due to discriminating industrial temperature demand (Werner, 2006).

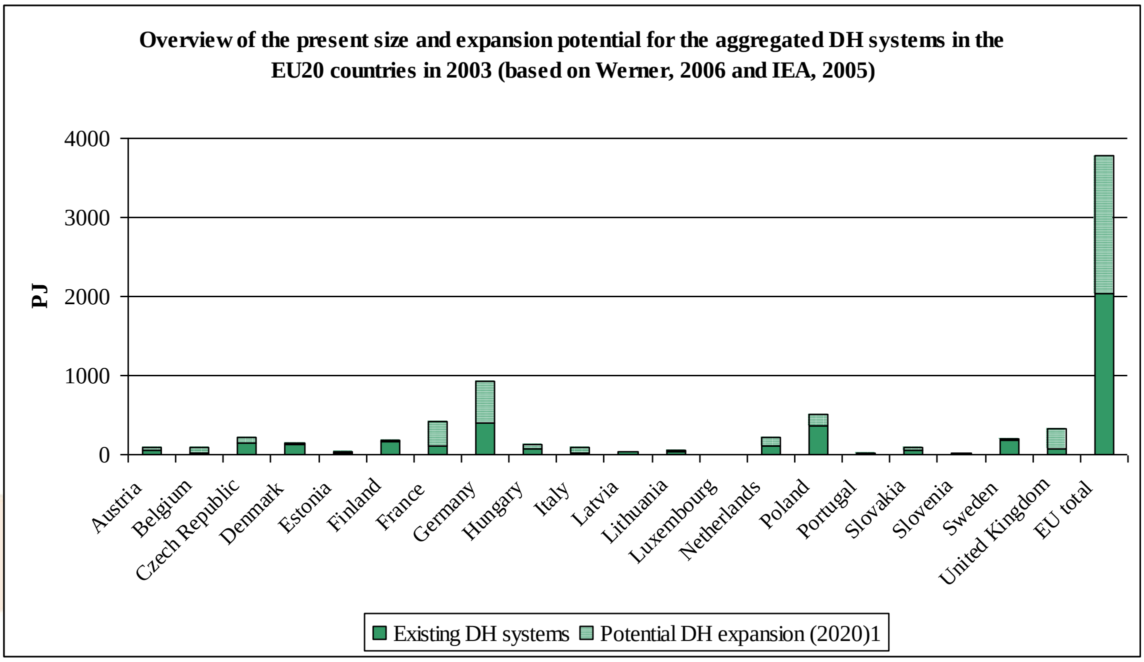


Figure 13 Overview of the present size and expansion potential for the aggregated DH systems in the EU20 countries in 2003 (based on Werner, 2006 and IEA, 2005)

5.3 Land use impacts of stationary energy sector

Even though 2nd generation biofuels are proposed as one way to alleviate the food vs. fuel competition such effects may still arise; policy induced demand for biofuel feedstocks combined with biomass demand from the stationary energy sector lead to increased land competition and this can lead to higher food commodity prices.

Figure 14 illustrates this by showing the size of paying capacity for biomass in the stationary energy sector (in this case a large coal based power plant with possibility for biomass co-firing) in relation to wheat prices in the EU. The dashed and solid lines in this diagram show how the sellers' price for biomass develops over time given certain developments of fossil fuel prices and CO_2 charges (C tax or C prices within a C trading system). The two shaded horizontal bars show – for two different cereal prices – how much a farmer needs to be paid for biomass in order to obtain higher revenues from willow production than from cereal production. As can be seen, the paying capacity for biomass increases quite rapidly as the

CO_2 charges increase and soon becomes so high that farmers selling biomass can obtain higher revenues than from producing cereals, given the cereal prices that farmers have seen during the recent years.

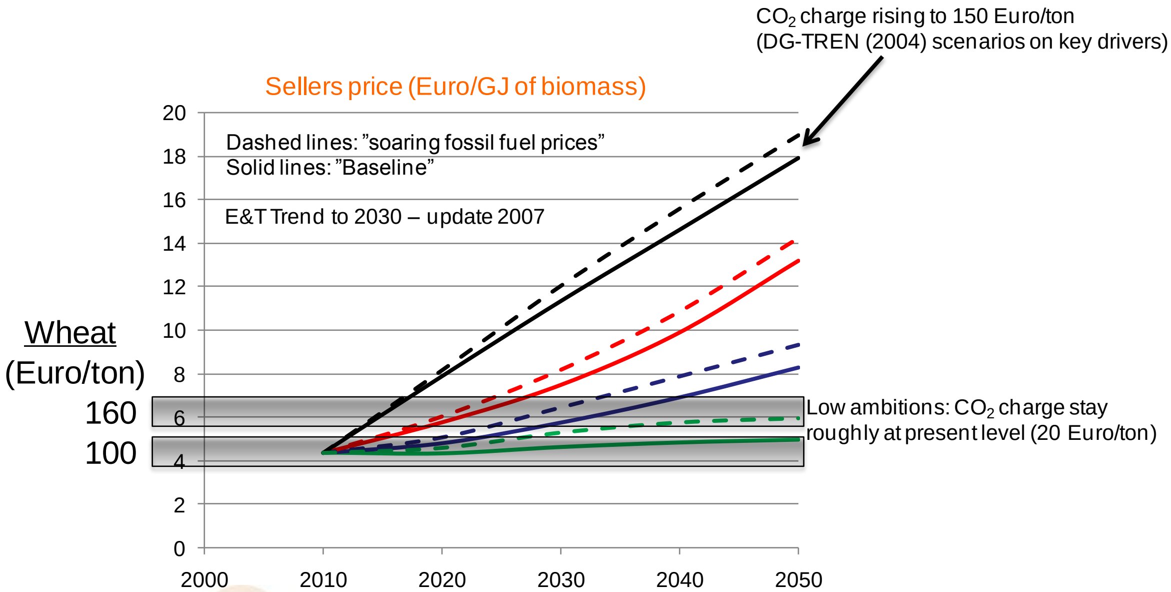


Figure 14 Illustration of the possible impact of high paying capacity for biomass in the stationary energy sector on food prices in EU

The dashed and solid lines show how the sellers price for biomass develops over time given certain developments for fossil fuel prices and CO_2 charges. The shaded horizontal bars show how much a farmer needs to be paid for biomass in order to be better off economically compared to staying with cereal production.

Even though farmers do not readily shift to lignocellulosic crops just based on higher returns, once the other barriers are overcome, such trends can be possible. This in return can cause land competition between food crops and lignocellulosic crops. In such instances new rules and regulations might be needed to promote lignocellulosic crop production on the more marginal lands. This could be done through strict measures, such as limiting the amount of land allowed to be used for lignocellulosic crop production, and through R&D on specific crops that have a production cost structure favouring production on marginal lands. In a scenario where C charges grow to high levels and other low-C options do not enter to stabilize energy prices, energy crops may eventually have to be taxed so as to avoid that food prices must grow to very high levels in order to stay competitive.

6. Limitations of the project and the sensitivities

The modelling work that analyses the impact of biofuel expansion on agricultural commodities does not explicitly model the EU renewable transport fuel target by 2020. Instead, it considers a global biofuel target that also takes into account a 10% biofuel target for the EU in 2020. Thus, the results shall not be interpreted as the impact assessment of EU biofuel target. However, in terms of policy design, taking into account the biofuels mandates in other economies is crucial as the EU’s biofuel or feedstock import will be affected by the demand from other world regions.

The WEO scenarios applies only one transport fuel scenario, namely the energy model derived reference scenario published in the World Energy Outlook 2008 by the International Energy Agency. The target scenario TAR has been constructed on the basis of announced biofuel targets before 2010. Historically targets and mandates have been by far the most important driver for increased biofuel demand. Political and socio-economic circumstances as well as technological developments have often been reasons for changing envisaged targets.

Today feedstocks for biofuel production are primarily derived from local production and the biofuel scenarios assume only small changes into the future. However biofuels may be traded more extensively in liberalized markets. For example, environmental impacts will change when more ethanol is produced from high yield crops such as sugar cane and imported into temperate zones (Europe and the United Stated).

The scenario analysis assesses the agronomic feasibility of biofuels targets but does not apply cost criteria to judge their economic viability, nor does it give specific consideration to possible other uses of biomass in the stationary sector (heat and electricity).

There are large uncertainties regarding the speed of second generation technologies development and deployment as well as costs and efficiencies. In the scenario analysis a plausible range for a possible contribution of second-generation feedstocks is considered via scenario variants, as proposed by current literature and expert opinion.

The assessments of net greenhouse gas emissions from biofuels presented in the study are subject to a considerable uncertainty range both with regards to life cycle results as well as land use change impacts. The range of individual biofuels feedstocks emissions information available in the literature has been used for both aspects.

The policy support to promote 2nd generation biofuels are very sensitive to the WACC criteria that are based on a limited number of data sample on financial parameters for biofuel projects. On the other hand, the concerns related to the impacts of 1st generation biofuels on agricultural prices and biodiversity and the financial risk these concerns may pose, is not taken into consideration.

Those factors may change the magnitude of the support needed, but our judgement is that conclusions are robust regarding what *type* of support measures that are most effective in bringing 2nd generation technologies into the market.

Not surprisingly, fossil fuel prices will play an important role in biofuel expansion, including the competition for feedstock to produce biofuel or electricity and heat. Particularly, oil prices will impact the competitiveness of 1st and 2nd generation biofuels. While higher oil prices can increase the feedstock costs, particularly the 1st generation biofuel feedstocks, such high oil prices may counteract with the double counting mechanism and make 2nd generation biofuels less attractive (in comparison to 1st generation biofuels).

Perennial energy crop plantations can help decreasing the pressures both on agricultural commodity markets and on lignocellulosic markets. They could be facilitated by policies that promote the use of biomass from short rotation plantations in power plants. The proposed stepping-stone function of biomass co-firing with coal presumes that it represents a near-term market for lignocellulosic biomass that gradually decreases over time, making place for 2nd generation biofuel technologies as the major subsequent use of the lignocellulosic biomass – benefiting from the already established biomass supply infrastructure. However, to the extent that new coal-fired power plants are built (possibly capture-ready and prepared for co-firing from the start) this option might prevail as a competing biomass use also on the longer term. Thus, if high demand leads to biomass scarcity and the longer term preference is to prioritize use of biomass resources for production of 2nd generation biofuels, there might be a need of specific measures for favouring such use since the stationary energy sector may develop a very high paying capacity for biomass. The biomass demand from stationary energy sector will critically depend on how policies shape the conditions for this sector and whether development leads to that other renewable energy technologies can offer a competitive alternative. Thus, climate change and renewable energy policies and incentives promoting alternative energy systems will be crucial determinants of inter-sectoral competition for biomass.

Significant synergies between biofuels and stationary energy sector may be realized if biofuel plants can be integrated with district heating systems. The analysis made in ELOBIO focused on biofuel plants that generate surplus heat from biomass gasification which could be used in district heating systems. But also biofuel plants that can function as heat sinks (e.g., ethanol plants) may be attractive from the perspective of district heating development since such plants represent balancing opportunities on the heat sink side that can help maximizing the productive use of heat over the year. Logistical issues might prevent 2nd generation installations to exploit the benefits of heat sales. BtL plants, for instance, will most likely have large capacities, and will be located in a harbour area, which may not always be close by the district heating systems. Nevertheless, where available such synergies could be incentivised by governments.

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ELOBIO Publications can be downloaded from www.elobio.eu

List of the publications

Name of the publication
Inventory of biofuel policy measures and their impact on the market (Luc Pelkmans & Leen Govaerts Kris Kessels, 2008)
Induced market disturbances related to biofuels (Luc Pelkmans, Kris Kessels, and Tjasa Bole, 2009)
Inventory and analysis of relevant policies in other sectors (Anna Wrobel, Ewa Gańko, Magdalena Rogulska, Helena Cabal, Natalia Caldés, Marta Santamaría, Lucila Izquierdo, Rosa Sáez, Carmen Lago, 2009)
Assessment of policy schemes - identification of the key features having effect on effectiveness and low-disturbing character of sector policies (Anna Wrobel, Magdalena Rogulska, Marzena Rutkowska, Ewa Ganko, Grzegorz Kunikowski, 2010)
Estimated demand and supply for different kinds of biomass(Anna Wróbel, Magdalena Rogulska,

Grzegorz Kunikowski, 2010)
Demand for lignocellulosic biomass in Europe (Ayla Uslu, Natalia Caldes Gomez, Marta Santamaria Belda , 2010)
1st ELOBIO stakeholder workshop: Report from the workshop: "Searching for new answers in the food-fuel debate - developing innovative options for EU biofuels policy" (Jeppe Lundbæk and Marc Londo, 2008)
2nd stakeholder consultation : Report from the: " Stakeholder consultation concerning modelling of impacts of EU biofuels policies: Early findings and call for stakeholder input to further analysis on Efficient and Low-disturbing Biofuels policies – *ELOBIO*" (Henrik Duer , Jeppe Lundbæk ,Lillah Lucie Emmik Sørensen , 2009)
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Results brochure

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