elobio
Biofuel policies for dynamic markets

ELOBIO:
Effective and low-disturbing biofuel policies

Intelligent Energy Europe

Project summary

I. The problem

Increased demand for biofuels could have significant long-term impacts on several commodity markets. Current dispute on this issue (with rising prices in 2007-2008) requires responsible policy.

II. The objective

Formulation of *efficient and low-disturbing policy options* that enhance biofuels and minimizes the impacts on food, feed & biomass (power heat) markets.

III. The activities

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 evaluation of these policies' impacts on food & feed and lignocellulosic markets;
Assessment of selected optimal policies' impact on biofuels development, potentials and costs .

Factors contributing to higher agricultural commodity prices in 2007-2008

A number of factors contributed to the higher agricultural prices in 2007 and 2008 and are presented below.

- Increase in oil prices from 50 to 140 $/bl
  - ➢ also higher energy cost in agricultural production and transport
- Declining value US$
- Speculation → commodities
- Economic growth in China, India
  - ➢ increasing demand for energy and food + diet shift
- Temporary lower crop yields (mainly for grains)
- Decrease of stocks → price volatility
- Export restrictions

- **Growing biofuels demand**, creating a link between oil and food prices
  - ➢ studies reported specific impact of biofuels between 5 and 75% of total price increase

What was the global feedstock use to produce biofuels?

Worldwide around 98 Mtonnes of grains (wheat, barley, corn, …) were used for ethanol production, of which

- ➢ 87.4 Mtonnes in US => 28% of corn production
- ➢ 3.9 Mtonnes in EU27 => 2.6% of wheat production
- ➢ 4.3 Mtonnes in China => 1.5% of grain production

Worldwide around 328 Mtonnes of sugarcane & sugarbeet were used for ethanol, of which

- ➢ 302 Mtonnes in Brazil => 55% of sugarcane production
- ➢ 6.8 Mtonnes in EU27 (sugarbeet)

Worldwide around 11.5 Mtonnes or 9% of vegetable oils (rapeseed, soy, palm oil) were used for biodiesel, of which

- ➢ 6.7 Mtonnes in EU27 => 65% of vegatbale oil production (mainly rapeseed)
- ➢ 3.3 Mtonnes in North & South America => 12% (mainly soy)
- ➢ 1.2 Mtonnes in Asia: 3% (mainly palm oil)

What about the impacts on land use…

	Land use for biofuels [Million hectares]		Total arable land (excl. grassland)	% of arable land
	Ethanol	Biodiesel		
Argentina		0.73	28	2.6%
Brazil	3.0	0.45	59	5.8%
Canada	0.28		46	0.6%
China	0.97		143	0.7%
EU27	0.65	4.3	114	4.4%
United States	6.6	2.3	175	5.1%
TOTAL	**11.5**	**7.78**	**1421 (worldwide)**	**1.4%**

Figures 2008 [F.O. Licht's]

What are the indirect effects on other commodities and land use?

Future biofuel demand driven by policies are significant!

Voluntary and mandatory targets for transport fuels in major countries

Country/Region	Mandatory, voluntary or indicative target
Australia	At least 350 million liters 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

Source: Fischer et al., 2009

What are the future impacts of policy driven biofuel demand ?

Elobio focus

How to combine further growth of biofuels with prevention of unacceptable impacts on commodity markets?

Developing a vision on policy options with the least negative impacts on other markets in food, feed and lignocellulosic materials.

Scope: EU (in the global context)
Time frame*: 2020- 2030 (2050)*

Elobio project partners

ECN (NL)

COWI (DK)

VITO (BE)

IIASA (AT)

IPEO/ECBREC (PL)

Chalmers (SE)

CIEMAT (ES)

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Impacts of bio-fuel expansion on world food systems and the environment

Elobio approach to - "Low disturbing biofuel policies"

Stakeholder and Elobio team identified criteria for evaluation as:

- FOOD SECURITY
  Commodity price effects, rural income,
  risk of hunger, trade effects
- ENVIRONMENT
  Land use effects, GHG savings

Biofuel expansion scenarios are formulated as:

- *Scenario **WEO** – based on IEA, 2008*
- *Scenario **TAR** – applies announced biofuel targets*

Sensitivity variants are identified as**:**

- Importance of by-products (the sensitivity scenario **WEO-vD** and **TAR-vD** assume DDGS is not used as animal feed
- Applying growth in agricultural productivity
  - High productivity growth (Sub-Saharan Africa) + 7.5 % by 2025 and + 20% by 2050
  - Medium productivity growth (India, Pakistan, Argentina,….) + 4 % by 2025 and + 10 % by 2050
  - No changes (developed countries)
  - Land use restrictions

Transport Fuels in 2020 and 2030 according to the ELOBIO biofuel expansion scenarios: (Million Tons Oil Equivalent)

	WEO		*TAR*	
	2020	*2030*	*2020*	*2030*
Developed countries				
Transport fuels	*1505*	*1486*	*1505*	*1486*
Transport biofuels	*63*	*80*	*117*	*178*
Share of biofuels	*4.2%*	*5.4%*	*8%*	*12%*
Share of 2nd gen. biofuels	*4%*	*19%*	*33%*	*51%*
Developing countries				
Transport fuels	*1174*	*1529*	*1174*	*1529*
Transport biofuels	*31*	*46*	*75*	*116*
Share of biofuels	*2.7%*	*3%*	*6%*	*8%*
Share of 2nd gen. biofuels	*0%*	*4%*	*3%*	*19%*

Results: Impacts of 1st generation biofuels

On food prices

- Biofuel demand in addition to increased demand for food push international food commodity prices upwards.
- The accelerated deployment of 2nd generation biofuels, however, decreases the price impact in the TAR scenario.
- Protein feed prices are lower compared to the reference scenario due to larger volumes of co-products entering the market.
- Additional productivity growth rates have a strong impact on the price development of agricultural commodities, especially after 2030

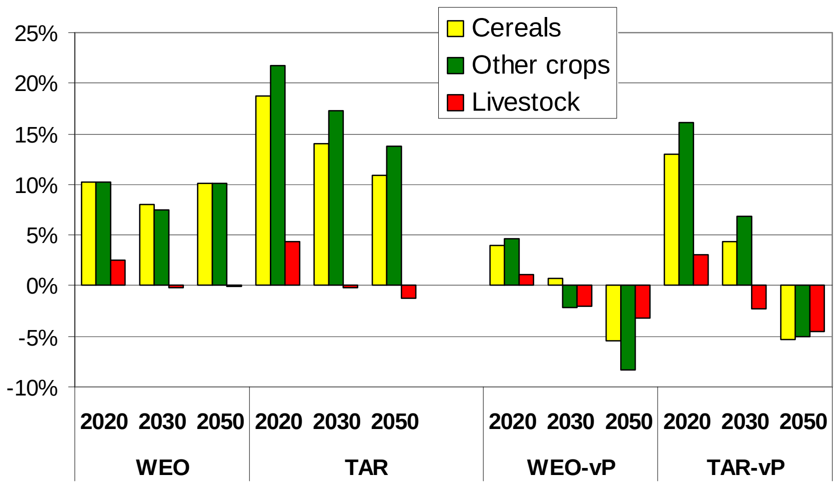

Figure 1 Percentage price changes, relative to REF
Source: IIASA world food system simulations, ELOBIO scenarios

On hunger

- The additional production of 1st generation biofuels 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.

- 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.

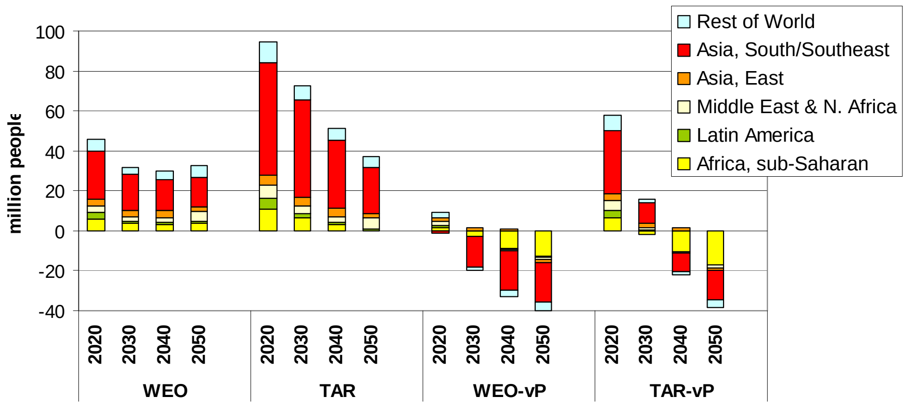

Figure 2 Additional people at risk of hunger, relative to REF
Source: IIASA world food system simulations, ELOBIO scenarios

Results: Impacts on land use

- 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.

- Additional crop productivity growth reduces the amount of arable land expansion.

- 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.*

- If DDGS were not used as animal feed an additional 5 to 8 million hectares arable land would be required globally

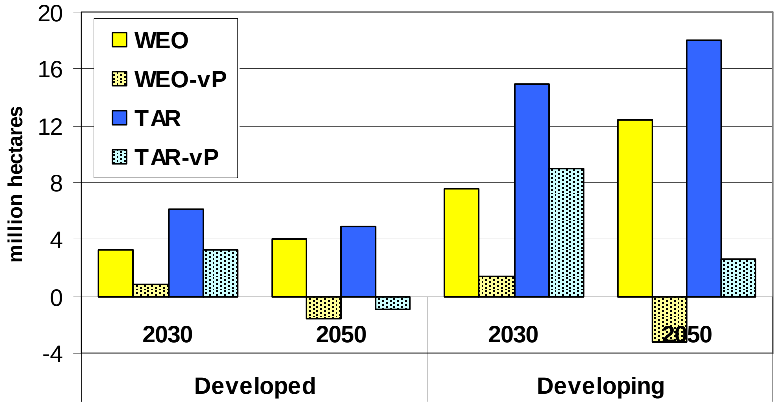

Figure 3 Additional arable land use, relative to REF
Source: IIASA world food system simulations, ELOBIO scenarios

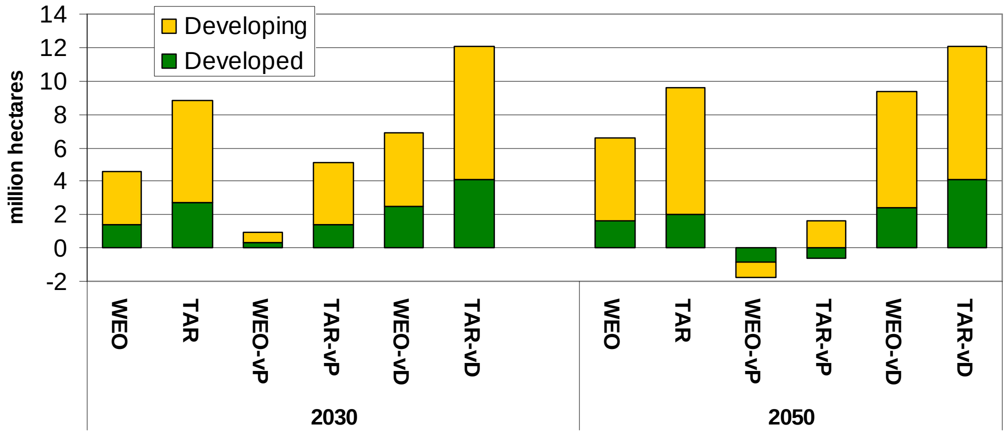

Figure 4 Additional deforestation, relative to REF
*Variant **-vP**: higher agricultural productivity; **-vD**: no use of DDGS*
Source: IIASA world food system simulations, ELOBIO scenarios

Results: Net GHG savings achieved

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.

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.

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.

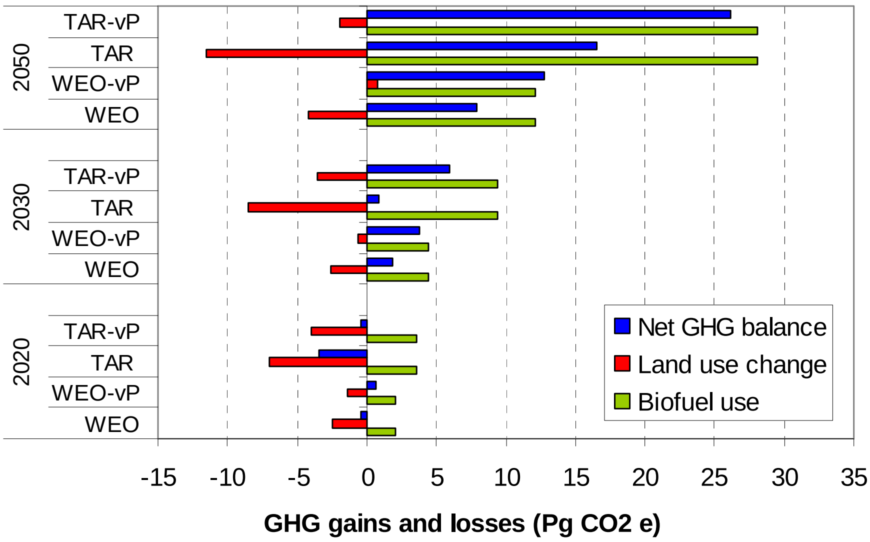

Figure 5 Cumulative net GHG savings of biofuel scenarios
Source: IIASA world food system simulations, ELOBIO scenarios

In summary…

- ‘Low disturbing’ biofuel development requires agricultural productivity increases to exceed food demand growth.
- Focusing on LDC yield gaps could bring about rural income growth, improve food security and provide plenty feedstocks without carbon-intensive land conversion.
- For GHG benefits to materialize, yield gap reduction, carefully monitored speed of biofuel expansion and regulation to avoid deforestation is important .

Lignocellulosic markets

Lignocellulosic biomass is demanded by industries, such as

- forestry-based industries,
- chemical industry,
- the heat and power sector,
- the biofuels industry

Increasing demand from a growing bioenergy sector is likely to put pressure on lignocellulosic markets and increase raw material costs for a number of wood products using raw materials such as sawdust, wood residues and low-grade timber.

Paying capacity for biomass can become very high

- climate/energy policies affecting stationary energy sector can drive food and land prices in the same way as obligatory biofuel targets – if development is slow for non-bioenergy alternatives in stationary energy



Paying capacity for biomass

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.

Sellers price (Euro/GJ of biomass) CO_2 charge rising to 150 Euro/ton

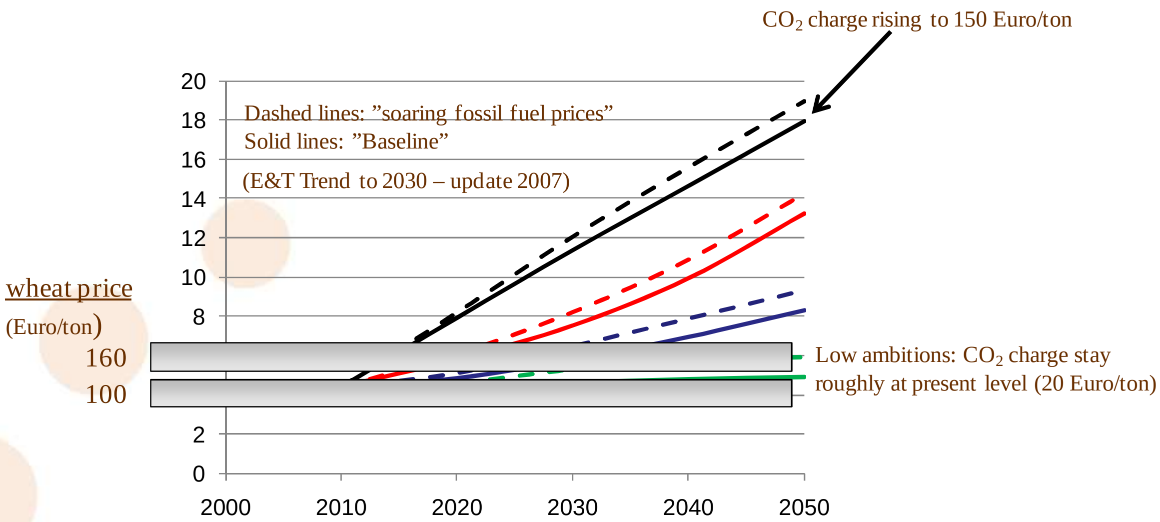

Figure 6 Illustration of the possible impact of high paying capacity for biomass in the stationary energy sector on food prices in EU

Synergies between biofuels and stationary energy sector

- 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 appears to be an attractive early option with longer term prospects depending of C price, CCS availability and attainable biomass share in the fuel mix .
- Results of the ELOBIO analyses using the Chalmers EU Power plant database indicate a potential in the existing power plant stock corresponding to about 50-90 TWh/yr of bioelectricity, or a biomass supply at about 500-900 PJ.
  - ➢ But, this may contribute to 2nd gen biofuels development by inducing earlier development of the supply infrastructure for 2nd gen biofuel feedstocks biomass,

- Integration of biofuel production in energy/industry combines can improve overall efficiency and economic performance
  - ✓ heat sinks provided by district heating systems

can support a large scale establishment of biofuel/heat/power polygeneration plant
  - ✓ however, competitiveness against CHP production crucial determinant of prospects for biofuel/heat/power polygeneration plants
  - ✓ restrictions on third party access to district heating networks can be a barrier against implementation

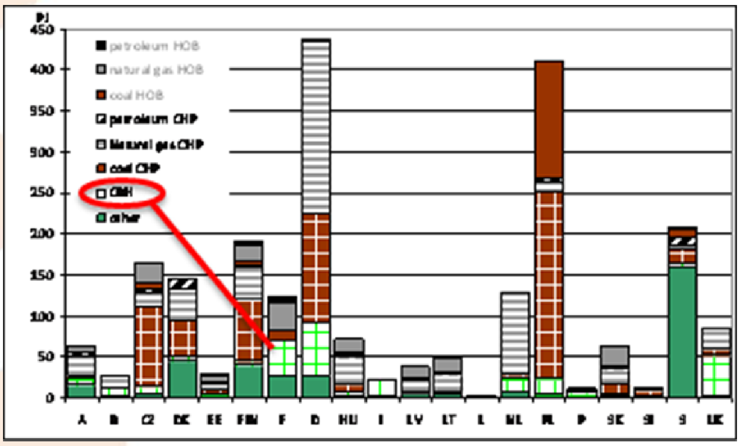

Figure 7 Heat sink allocation for making productive use of surplus heat from biofuel production corresponding to 10% of projected transport fuel use in 2020

Market penetration of 2nd generation biofuels - high technology risk

Due to its high technology risk, 2nd gen biofuel projects cannot obtain debt finance and need to be financed almost exclusively by venture capital, (safe for grants or investment subsidies) which implies a weighted average cost of capital (WACC) of 20 to 30%, or 3-5 times the cost of capital of 1st gen projects.

Risk Type	1st generation	2nd generation
Technology risk	Low-medium	High
Market risk	High	Medium
Regulatory/Policy risk	High	Medium
Geopolitical risk	Medium	Low
Stakeholder acceptance	High	Low

FINANCIAL PARAMETERS	1st gen	2nd gen
Short term		
Level of debt financing	50-80%	0%
Interest rate	6.5-8%	n.a.
DSCR	1.2-2.0	n.a.
Level of equity financing	20-50%	100%
Required return on equity	15-20%	20-30%
WACC	6.6-13.2%	20-30%
Long term	*Same for both*	

Market penetration of 2nd generation biofuels – policy measures

Achieving a significant contribution of 2nd gen to the transport fuel mix in the short-mid term will require considerable policy support.

A combination of investment subsidy and tax break achieves the highest production volumes (and market share) for 2nd gen but at a very high policy cost.

A combination of double counting and initial investment subsidy can achieve a significant deployment of 2nd gen nat the least policy cost.

If discontinued after learning effects have sufficiently lowered the cost of technology, it fulfils its purpose best.

Policy scenarios

Case	Policy option(s)
1a	Continuous (high) investment subsidy
1b	Investment subsidy gradually phased-out
2	Initial investment subsidy + parallel partial tax break
3	Initial (high) investment subsidy + subsequent soft loan
4a	Initial (high) investment subsidy + continuous double counting
4b	Initial (high) investment subsidy + double counting discontinued after 2020

Case	Effectiveness (2nd gen market share)		Efficiency (total policy cost in €$_{2005}$/GJ biofuel)
	2020	2030	2030
1a	☺☺ (~22,0%)	☺☺☺ (~40%)	☹☹ (~15)
1b	☺☺ (~22,0%)	☺☺ (~35%)	☹☹ (~10)
2	☺☺ (~25,0%)	☺☺☺ (~45%)	☹☹☹ (~20)
3	☺ (~14,7%)	☺☺ (~35%)	☹ (~5)
4a	☺☺ (~18,0%)	☺☺ (~30%)	☺ (~2)
4b	☺☺ (~18,0%)	☺☺ (~35%)	☺ (~1)

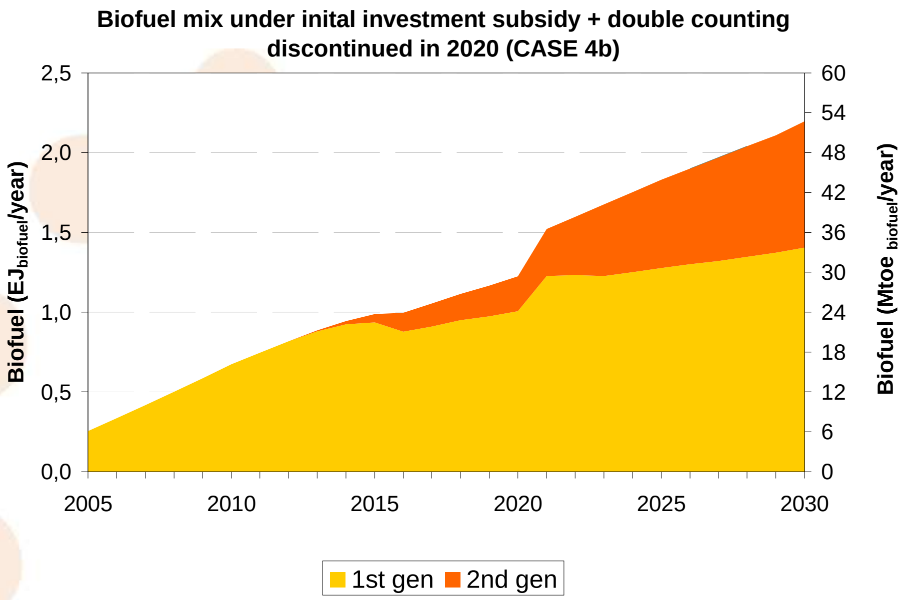

Figure 8 EU Biofuel mix for the case of double counting of 2nd generation biofuels and a 70% investment subsidy in the pre-commercial phase. In this case the double counting ends year 2020

Overall conclusions of the project

The ELOBIO 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.

There are substantial yield gaps to exploit and large opportunities for productivity growth in many developing countries – and there is scope for drastic productivity improvements in livestock production.

- **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 .**
- **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.**

Land use restrictions cannot avoid the indirect effects of biofuels unless they become internationally recognised and applied not only for biofuel applications but all sorts of biomass use, including agriculture sector.

Increasing demand from bioenergy sector is likely to put pressure on forest based industry and increase raw material costs.

Increased demand for forest bioenergy can also be an opportunity for the forest industry that can include bioenergy among the products produced.

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.

The ELOBIO results show that significant amounts of initial investment subsidy 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.

Policy makers in some member states may consider promoting lignocellulosic feedstock production while stimulating biomass co-firing.

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.

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.**