

ILUC modelling baseline and scenarios

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Ecofys, IIASA and E4tech perform a study for the European Commission on the Indirect Land Use Change impact of conventional and advanced biofuels consumed in the EU. This assessment will be based on the GLOBIOM partial equilibrium model, developed at IIASA. This document presents certain key aspects of the study: the proposed baseline and main baseline assumptions, chosen feedstock scenarios, alternative scenarios and sensitivity analyses. A draft version of this document has been discussed in draft version with the project Advisory Committee, with the European Commission and with a wide group of interested stakeholders.

First of all, a **baseline** will be set up to take into account the evolution of main macro-economic indicators and policies. This baseline will serve as a reference for the study. A proposal for its main parameter assumptions is presented in Table 1. However, the range of plausible futures is wide and possible alternative developments will also be considered through two channels:

- 1) A sensitivity analysis will be performed on model parameters. This will highlight different developments of the model variables, for a same baseline. For instance, changing the elasticity of endogenous yield response can lead, for the same future food consumption patterns, to different land use changes;
- 2) Alternative policy scenarios will be modelled, with different EU biofuel options, in order to assess how a change in a specific baseline assumption can influence the results.

The baseline will be compared with several policy **scenarios**. Selected scenarios are listed in Table 3. First, feedstock-specific scenarios will be modelled; looking at the effect of increasing the incorporation level of one biofuel feedstock only (the list of **feedstocks** is presented in Table 2). Also, scenarios on the total EU biofuel mix in 2020 will be modelled. In addition, alternative scenarios will look at the use of abandoned farmland in the EU and lower or higher deforestation. There is a large recognition of the sensitivity of land use change impacts to behavioural parameters in economic models. For that reason, **sensitivity analyses** will be performed to explore uncertainty ranges around the results of these scenarios. This will be performed through Monte-Carlo simulations, i.e. the GLOBIOM model will be run a large number of times, drawing random values of parameters in a plausible distribution, to produce an estimate of the results distribution. The parameters that will be at the core of the sensitivity analysis are presented in Table 4.

This document is published on the project website www.globiom-iluc.eu where also other information on the ILUC modelling study can be found. Questions or suggestions to the consortium can be sent to ILUC@ecofys.com

Table 1. Main baseline indicator assumptions

Variable	Assumption	Source
Macroeconomics		
Population	SSP2 <i>The Shared Socio-economic Pathways (SSP) are consistent and harmonised prospective scenarios developed and widely used by the scientific community in the framework of research on climate change. The SSP2 scenario, called "Middle of the Road" assumes mostly prolongation of currently observed trends. World population in this scenario reaches 9.3 billion by 2050.</i>	SSP Database IIASA https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=about
GDP	SSP2 <i>The same scenario as above is used, which ensures consistency of GDP projections with population assumptions. In SSP2, the trend of fast growth in emerging regions continues. The world GDP per capita increases from USD 6,700 on average in 2005 to USD 16,000 in 2050. China's and India's GDP per capita are multiplied by more than ten in this period.</i>	SSP Database IIASA https://secure.iiasa.ac.at/web-apps/ene/SspDb/dsd?Action=htmlpage&page=about
Energy		
Energy prices	World Energy Outlook 2013 and EU Roadmap Reference scenario 2050 <i>Price of crude oil is assumed to slightly increase by 2030 to reach a level of USD 121 per barrel in real terms versus USD 109 in 2012. For the EU, imported gas prices increase from 65 USD in 2012 to 80 USD in 2030, whereas coal price is considered stable around 30 USD per barrel oil equivalent.</i>	World Energy Outlook 2013 www.worldenergyoutlook.org EU Energy Transport and GHG Emissions Reference scenario 2013 Trends to 2050 http://ec.europa.eu/energy/observatory/trends_2030/doc/trends_to_2050_update_2013.pdf
Fuel demand in EU transport	EU Roadmap Reference scenario 2050 <i>Total demand for transportation fuel is expected to decrease by about 10% between 2010 and 2030, whereas the share of diesel in car conventional fuels is shifted from 67% to 81% in 2030.</i>	EU Energy Transport and GHG Emissions Reference scenario 2013 Trends to 2050 http://ec.europa.eu/energy/observatory/trends_2030/doc/trends_to_2050_update_2013.pdf
Biofuel 1G Rest of the world	AGMIP 1G scenario (except for EU) <i>This scenario has been developed by a consortium of modelers working on global agricultural scenarios. The first generation biofuels assumptions follow the current commitments of the following countries:</i> - USA: Implementation of the 36 billion gallon mandate by 2022; 15 billion gallon from corn ethanol already in 2020 and 5 billion gallon from advanced non cellulosic biofuels (50% biodiesel and 50% sugar cane based). - Brazil: 25% of ethanol incorporation and stable incorporation of biodiesel; transportation fuel increase according to Petrobras business plan 2012-2016 - Argentina: Incorporation of 10% of biodiesel in diesel fuel by 2020; Ethanol remains little used.	Lotze-Campen et al., 2014 http://dx.doi.org/10.1111/agec.12092

	<ul style="list-style-type: none"> - China: Stable ethanol incorporation rate; increase of 8% per year of fuel transport demand; biodiesel remains little used. - Canada: Incorporation of 5% of ethanol in gasoline by 2020; biodiesel remains little used (B2 mostly - not reported here). 	
Biofuel 2G Rest of the world	<p>US mandate projection according to US EIA</p> <p>AC advise to use another source than RFS targets to have a more realist 2G target for the US..</p>	RFS2, US EPA or IEA
Solid biomass	<p>IIASA or PRIMES</p> <p><i>Bioelectricity generation increase from 0.9 to 1.3 EJ/yr at the global level. Traditional use of biomass decrease in developing countries and stops by 2030, except in Africa where it is halved and stops in 2050.</i></p>	<p>Global Energy Assessment database</p> <p>www.iiasa.ac.at/web-apps/ene/geadb</p>
Biofuels EU 1G	3.3% conventional biofuels as in IFPRI 2011 baseline	
Biofuels EU 2G	Zero, as in IFPRI 2011 baseline	
Agriculture		
Crop yield	Historical projections based on 10 to 15 years regression	Historic yield projections. Source: FAOSTAT
Livestock productivity	<p>ANIMAL CHANGE</p> <p><i>Livestock feed conversion efficiencies increase in developing regions by up to 50-70% by 2050 for SSP2 but grow only slowly in Europe (below 5% increase).</i></p>	<p>ANIMAL CHANGE Projections</p> <p>www.iiasa.ac.at/web/home/research/researchPrograms/EcosyStemsServicesandManagement/D2.2_AnimalChange.pdf</p>
Diet patterns	<p>FAO</p> <p><i>Consumption per capita increases across the world from an average of 2,772 kcal/cap/day in 2005/2007 to 2,960 kcal/cap/day in 2030. Diet structure evolves with increased meat consumption per capita in developing regions. In developed regions some slight substitution occurs from bovine meat towards pig and poultry meat consumption. Milk consumption share also increases in diet.</i></p>	<p>Alexandratos and Bruisma, 2012</p> <p>www.fao.org/docrep/016/ap106e/ap106e.pdf</p>
Technical change processing	Fixed (assumptions to be updated)	
Common Agricultural Policy	<ul style="list-style-type: none"> - Status quo on direct payment - Figure for land currently abandoned in the EU (7.8%) and expected trend - no subsidy on energy crop - Ecological Focus Area policy assumed not to impact EU agricultural production 	Abandoned land based on European Farm Structure Survey (FSS)
Trade policies	<p>Status quo on trade policy except:</p> <ul style="list-style-type: none"> - recent WTO accession (China 2001, Russia 2012) - US-EU: Transatlantic Trade and Investments Partnership (TIPP), if signed - Free Trade Area of the Americas 	<p>World Trade Organization</p> <p>www.wto.org</p> <p>MAcMap tariffs database</p> <p>www.cepii.fr</p>

	- WTO Doha 2013	
Biobased uses		
	Split out biobased uses from 'other biomass uses' in GLOBIOM and improve projections based on available literature.	
Land use		
Land protection	Protected areas from WDPA <i>The World Database on Protected Areas (WDPA) is the most comprehensive global dataset on terrestrial and marine protected areas. It is a joint project between the United Nations Environment Programme (UNEP) and the International Union for Conservation of Nature (IUCN), maintained at the UNEP World Conservation Monitoring Centre.</i>	World database on protected areas www.wdpa.org
Deforestation policy	Status quo after 2010 <i>Effect of policies put in place during the 2000s will be considered to the extent that their effects have been visible. Reference period for deforestation will be 2005-2013.</i>	Forest Assessment Report 2010 www.fao.org/forestry/fra/fra2010 plus more recent figures for 2010-2013.

Table 2. List of feedstocks for the scenario modelling

#	Conventional	#	Advanced
1.	Wheat (Ethanol)	1.	Wheat straw (Ethanol, butanol)
2.	Maize (Ethanol)	2.	Short rotation plantations (Ethanol, methanol, FT biodiesel, Bio DME)
3.	Rye (Ethanol)	3.	Forestry residues (Ethanol, methanol, FT biodiesel, BioDME)
4.	Sugar beet (Ethanol)	4.	Grassy crops (e.g. miscanthus) (Ethanol)
5.	Sugar cane (Ethanol)	5.	Silage maize (Biogas)
6.	Rapeseed (Biodiesel, HVO)	6.	
7.	Soybean (Biodiesel, HVO)	7.	
8.	Sunflower (Biodiesel, HVO)	8.	
9.	Palm oil (Biodiesel, HVO)	9.	

Table 3. List of scenarios to be modelled

#	Scenario	Nr of scenarios	Sensitivity Analysis
	Baseline		
A0	Baseline to 2030: see Table 1.		MC
	Central scenarios		
A	“Marginal feedstock”: A0 +1% biofuel consumption per feedstock	13	MC
A1	“Marginal feedstock for cereal straw”: A0 + <1% shock of straw ethanol for three selected Member States	3	MC
A2	“Marginal feedstock groups”: as A but with crop groups (ILUC proposal)	3	MC
B	“EU biofuel mix in 2020”: A0 + biofuel consumption forecasts from MS Progress Reports	1	MC
B1	“EU biofuel mix in 2020 with 5% cap”: B + cap at 5% of conventional biofuels	1	
B2	“EU biofuel mix in 2020 with 6% cap”: B + cap at 6% of conventional biofuels plus energy crops	1	
	Alternative scenarios		
C	“Biofuels + increased use of abandoned land in EU”: incentivised land expansion into EU abandoned land in the baseline + Scenario B	1	No
C1	“Biofuels + low deforestation ”: assumed lower deforestation worldwide in the baseline compared to recent trends + Scenario B	1	No
C2	“Biofuels + high deforestation”: assumed higher deforestation worldwide in the baseline compared to recent trends + Scenario B	1	No
	TOTAL NUMBER OF SCENARIOS	25	

Sensitivity analysis design

Sensitivity analyses will be performed using a Monte-Carlo approach. The number of runs per scenario will be fine-tuned in the course of the project (if possible, 1,000 per scenario)¹. Parameters to be targeted by the Monte-Carlo are:

- Demand elasticities
- Intensification costs for yield response
- Land conversion costs
- Trade costs
- Co-product substitution rates
- Substitution of vegetable oil

Distribution on these parameters will be assessed through literature surveys.

¹ FAPRI has already performed Monte-Carlo analysis with a number of 500 runs.