Globiom: the basis for biofuel policy post-2020

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Background and introduction

Europe is starting to consider what its energy policy for transport should be for the 2020-2030 period and especially what it should do with biofuels as part of that.

In 2009 Europe decided in its Renewable Energy Directive (RED) that every member state should have at least 10% renewable energy in transport fuel by 2020. Subsequent 'national renewable energy action plans' (NREAPS) suggested that almost all (9.4%) of this renewable energy in 2020 would consist of biofuels.

A year ago EU member states and the European Parliament agreed on a key amendment towards a final version of the RED and Fuel Quality Directive (FQD). The amendment was triggered by a clause in the original (2009) RED stating that the effects of indirect land-use change (ILUC) of biofuels should be studied and if the results were significant, they should be accounted for. The International Food Policy Research Institute (IFPRI) carried out the study; it concluded in 2011 that ILUC was significant and hence the policy should be reformed. This note will refer to the IFPRI results as *Mirage* since that was the model used. The main fallout from the three-year-long ILUC discussion was that food-based biofuels could only count for a maximum 7% towards the 10% target, and that the rest, ie, at least 3%, should come from other options such as advanced biofuels or renewable electricity.

The reform was controversial and hence the Commission decided more research on land-use change emissions was needed. The report was finished in 2015, but not published until 10 March 2016, a few weeks after closure of the consultation on a new RED for 2030, and following numerous requests for access by industry and NGOs, including T&E.

The so-called Globiom report (named after the model that was used and referred to as *Globiom* in this note) was written by IIASA, Ecofys and E4tech and commissioned by the energy directorate-general of the European Commission.

What Globiom does and does not do – and why we wrote this paper

The Globiom report only calculates land-use change (LUC) emissions resulting from additional demand for biofuels in Europe. It has more detail and somewhat more refinement than the Mirage study; for example, it analyses more feedstocks. It does not assess what the overall impact of biofuels is compared with fossil fuels. In order to do that, 'direct' emissions (for example, from tractors, fertilisers, etc) should be added and emissions from fossil petrol and diesel equivalents should be subtracted.

This is exactly what this paper does, putting the Globiom numbers in a wider context so that policy conclusions can be drawn. In order to avoid any 'subjective' interpretation or addition of data, we used numbers from Globiom, Mirage and numbers from EU law where possible.

We should stress here that this does not mean we endorse all values as such, or the assumptions underpinning them. Undoubtedly, better data can be found in many cases. The sole purpose of this paper is to 'complete' the Globiom picture with data that is as 'official' as possible.

In this note we used the terms food-based and first-generation (or 1G) biofuels interchangeably.

Share of different types of biofuels in 2020

We start with a table summarising what the two main 2020 scenarios of the report look like in terms of biofuels used. The first is the scenario before ILUC reform, the second is after the reform, i.e., the 7% cap on food-based biofuels.

Table: Shares of different types of feedstocks used for biofuels production in Europe in 2020 before and after ILUC reform, i.e., with the 7% cap

		2020 baseline scenario		**2020 7% cap scenario**	
		% of biofuels	% of overall transport energy	% of biofuels	% of overall transport energy
1G Biodiesel	Rape	35%	3.29%	30%	2.50%
	Soy	16%	1.50%	13%	1.13%
	Palm	16%	1.50%	13%	1.13%
	Sunflower	2%	0.19%	2%	0.19%
	1G biodiesel total	69%	6.5%	59%	5.0%
1G Bioethanol	Maize	9%	0.85%	9%	0.75%
	Wheat	5%	0.47%	4%	0.33%
	Sugar Beet	4%	0.38%	4%	0.33%
	Barley	2%	0.19%	2%	0.16%
	Sugar Cane	2%	0.19%	2%	0.15%
	1G bioethanol total	22%	2.1%	20%	1.7%
Non-food based (‘advanced’)	Short-Rotation Coppice	6%	0.56%	14%	1.20%
	Perennials	2%	0.19%	6%	0.47%
	Forest Residues	1%	0.09%	1%	0.06%
	Advanced total	9%	0.85%	21%	1.7%
Total		100%	9.4%	100%	8.4%

Note: the shares have been derived from Figures 13 and 14 of the Globiom report.

We then proceed with the key deliverable of the Globiom report – the greenhouse gas emissions resulting from LUC from additional biofuel cultivation to satisfy EU mandates under the two scenarios. Expressed per additional unit of biofuel use, the numbers are the same per scenario. For comparison, we add numbers from the Mirage study and compare them with Globiom.

Table 1: Land-use change (LUC) greenhouse gas emissions from Globiom and Mirage. Numbers are in grammes of CO2eq per MJ of final energy.

		Mirage, IFPRI	Globiom	Globiom vs Mirage
1G biodiesel	Rapeseed	54	65	+11
	Palm	54	231	+177
	Soy	56	150	+94
	Sunflower	52	63	+11
	1G biodiesel average	54	122	+68
1G bioethanol	Maize	10	14	+4
	Wheat	14	34	+20
	Sugar Beet	7	15	+8
	Barley		38	
	Sugar Cane	13	17	+4
	1G bioethanol average	10	21	+11
1G average		44	96	+52
Non-food based (‘advanced’)	Perennials		-12	
	Short-Rotation Coppice		-29	
	Forest Residues		17	
	Advanced total		-20	

‘Perennials’: mostly switchgrass and miscanthus.

‘Short-rotation coppice’: mostly willow and poplar.

The ‘average’ in each category is the average weighted according to expected market share in the 7% cap scenario.

In order to get an idea of the order of magnitude: EU law has ‘well-to-wheel’ GHG emissions of fossil petrol or diesel at 94 gCO2/MJ. The next table compares the sum of LUC and direct emissions.

Conclusions from this table are that, apart from the fact that Globiom assesses more fuels:

- Globiom confirms Mirage conclusions that LUC emissions from biodiesel made from vegetable oil far exceed those from bioethanol. This is largely due to the fact that vegetable oils, the main source of biodiesel, is often grown in the tropics, leading to high risk of tropical deforestation and associated peatland drainage. A recent paper from the Union of Concerned Scientists lists palm and soy as two of the four major drivers of tropical deforestation – together with beef and wood;
- For *all* first-generation biofuels assessed, Globiom arrives at higher LUC emissions than Mirage. There is not one single reason for this. Two important ones are that Globiom has a more detailed soil carbon modelling than Mirage, and that Globiom more fully captures the very strong link between palm expansion and deforestation/peat loss;
- Annually harvested crops store less carbon than land left abandoned, allowing grasses, trees and other vegetation and their carbon-storing roots to develop;

- Palm and soy-based biodiesel have LUC emissions that alone exceed the full lifecycle emissions of fossil diesel;
- Energy from plants that are not harvested annually, i.e., of which the roots are allowed to develop and store carbon (willow, poplar, miscanthus, switchgrass) score far better; according to Globiom they even have negative LUC emissions, meaning that cultivation of these plants typically stores more carbon than leaving the land untouched.

As a second step we add direct emissions from cultivation, transport, etc., as written down as 'typical values' in Europe's Renewable Energy Directive (Annex V.D). This leads to the following picture:

Figure 1: emissions from biofuels made from different feedstocks, composed of direct emissions (from Renewable Energy Directive) and land-use change emissions (from Mirage and Globiom studies)

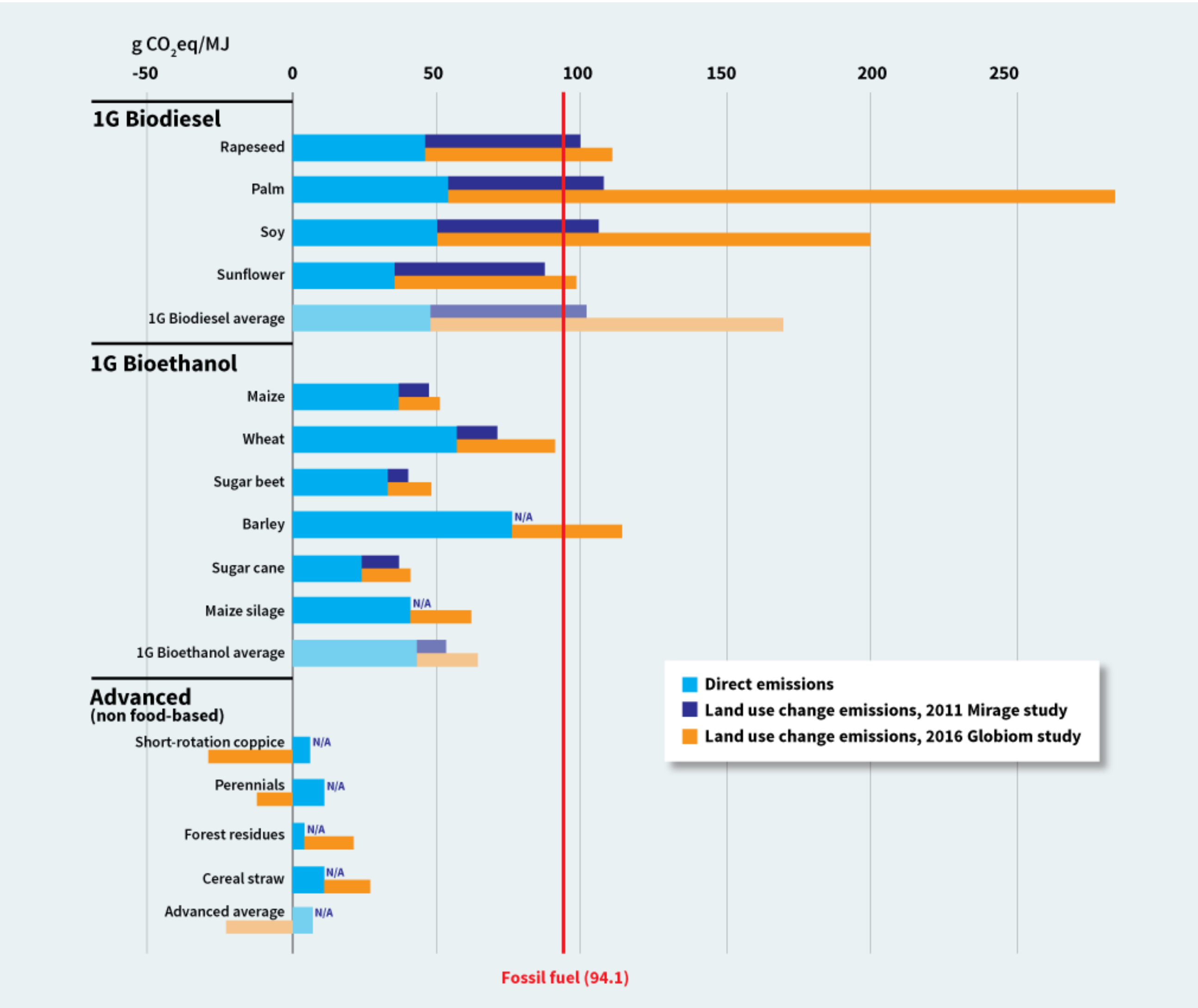


Table 2: the sum of direct (typical values in RED) and land-use change emissions (from Globiom) of biofuels derived from different feedstocks. All values in g CO2eq/MJ

		direct emissions (RED typical values)	LUC emissions	Total emissions	% of fossil diesel or petrol
1G biodiesel	Rapeseed	46	65	111	118%
	Palm	54	231	285	303%
	Soy	50	150	200	213%
	Sunflower	35	63	98	104%
	1G biodiesel average	48	122	171	181%
1G bioethanol	Maize	37	14	51	54%
	Wheat	57	34	91	97%
	Sugar Beet	33	15	48	51%
	Barley	76	38	114	121%
	Sugar Cane	24	17	41	44%
	1G bioethanol average	43	21	63	67%
1G average		47	96	143	152%
Non-food based (‘advanced’)	Short-Rotation Coppice	6	-29	-23	-25%
	Perennials	11	-12	-1	-1%
	Forest Residues	4	17	21	23%
	Advanced average	7	-23	-16	-17%
Average		39	72	110	117%

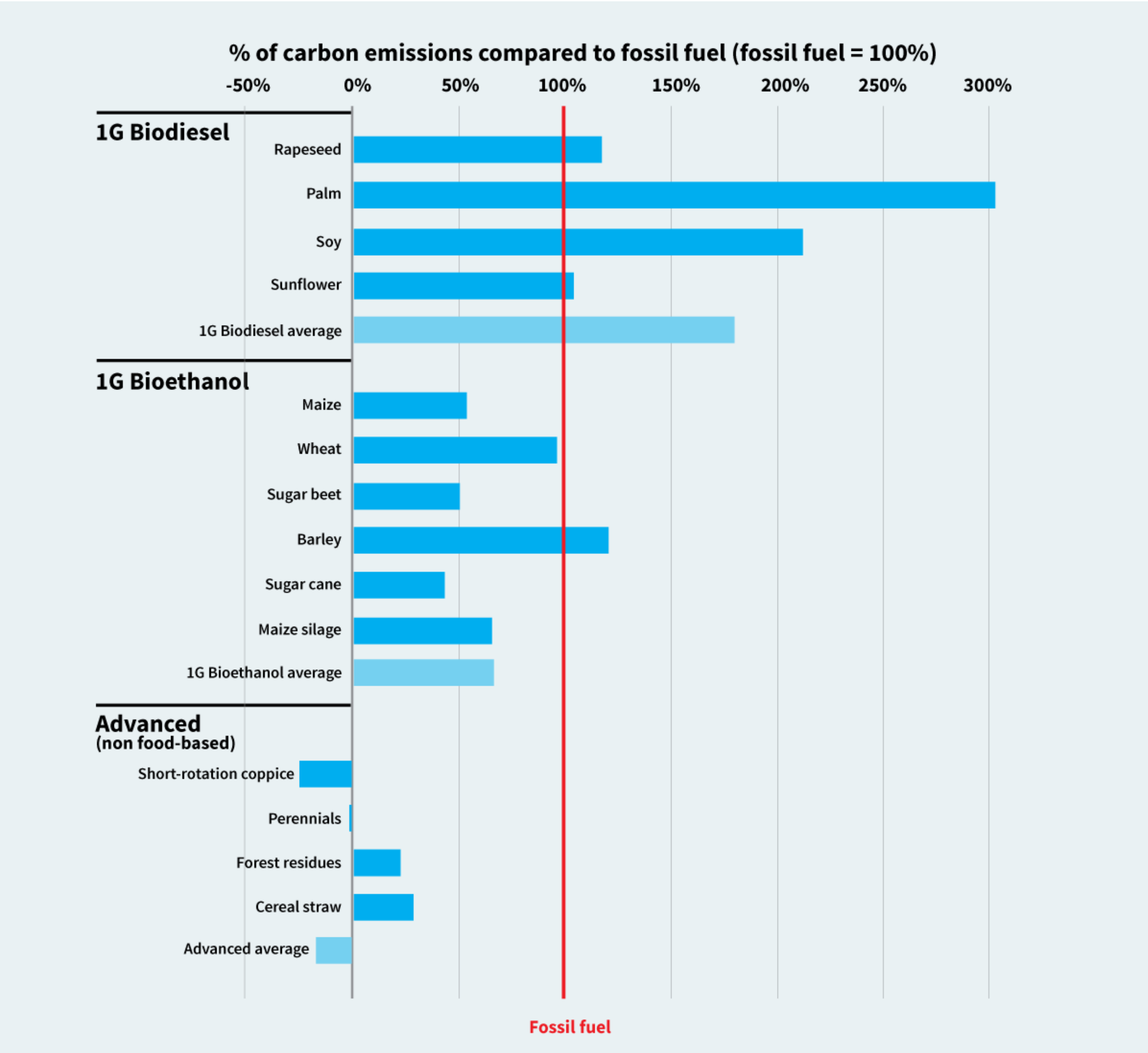
The RED typical value for palm is 32 if there is methane capture at the oil mill. This would reduce the ‘% of fossil diesel or petrol’ number for palm from 303% to 280%.

The number for barley comes from JRC/Concawe/Eucar Well-to-wheels report version 4a.

The number for perennials is the average of switchgrass and miscanthus values from ICCT paper.

Graphically the results are presented below.

Figure 2: Lifecycle GHG emissions from Globiom and Renewable Energy Directive compared with fossil fuel baseline.



Below follow conclusions from the table and the graph.

On average, biodiesels from virgin vegetable oil – which take almost 70% of the EU biofuel market – lead to around 80% higher emissions than the fossil diesel they replace. Palm and soy-based biodiesel is even three and two times worse respectively. Mirage also found they are worse than fossil diesel but typically only by around 10%. Food-based ethanol has around a 30% GHG benefit on average, with remarkable variations – bioethanol made from wheat and barley scores like fossil petrol or worse, whereas maize and sugar-based bioethanol reach around 50% of the fossil petrol value. On average biodiesel is almost three times worse than bioethanol. On average, first-generation biofuels (weighted average of 1G biodiesel and 1G bioethanol) have around 50% higher lifecycle emissions than their fossil equivalents.

Including poorly-performing bioethanol from wheat and barley, 76% of biofuels in Europe expected in 2020 score similar or worse than the fossil fuels they replace.

Another key finding is that advanced biofuels made from non-annually harvested crops score very well. However, they are currently crowded out by policy support for first-generation biofuels. Given ongoing stagnation in the market, the shares Globiom expects for 2020 seem optimistic.

Now we assess what this means for the overall impact of EU biofuel policy. For that we need to calculate the expected shares of different types of biofuel in the mix before and after ILUC reform. See below.

Table: forecast 2020 GHG impacts of EU biofuels, as % of surface transport emissions. Totals are calculated based on shares expected in the 2020 7% cap scenario

		Globiom, baseline	**Globiom, 7% cap**
1G Biodiesel	Sunflower	+0.01%	+0.01%
	Rape	+0.59%	+0.45%
	Soy	+1.69%	+1.27%
	Palm	+3.05%	+2.29%
	1G biodiesel total	**+5.3%**	**+4.0%**
1G Bioethanol	Maize	-0.45%	-0.40%
	Wheat	-0.02%	-0.01%
	Sugar Beet	-0.18%	-0.16%
	Barley	-0.05%	-0.04%
	Sugar Cane	-0.11%	-0.08%
	1G bioethanol total	**-0.7%**	**-0.6%**
1G total		**+4.7%**	**+3.5%**
Advanced	Short-Rotation Coppice	-0.56%	-1.19%
	Perennials	-0.15%	-0.38%
	Forest Residues	-0.05%	-0.03%
	Advanced total	-1.0%	-2.0%
1G+ advanced total		**+3.7%**	**+1.4%**

The key results from this table are (all emissions related to *expected EU28 transport GHG emissions in 2020 without biofuels*):

- EU biofuel policy before ILUC reform would have *increased*, not decreased, emissions in 2020 by 3.7%;
- After ILUC reform – the 7% cap – EU biofuel policy will still likely increase emissions by 1.4%;
- First-generation biofuels increase EU28 transport GHG emissions by 4.7% and 3.5% before and after the cap respectively;
- A key conclusion from the data is hence that Globiom expect ILUC reform – capping first-generation biofuels – to be environmentally effective; it will likely reduce emissions from transport by 2.4% compared with no-reform. A tighter cap would logically have been more effective and might have turned EU biofuels policy into a net-positive for greenhouse gas emissions;
- Virtually all of the detrimental impact of biofuels can be explained from vegetable oil-based **biodiesel**. First-generation biodiesel alone is expected to increase EU 2020 GHG emissions by 4% even after ILUC reform, and by more than 5% before reform;
- The ILUC reform will likely make very little difference as regards emissions from first-generation bioethanol.

Biodiesel 2020: emissions of an additional 12 million cars

Even after ILUC reform, and obviously after subtracting fossil emissions, first-generation biodiesel will likely *increase* overall EU transport emissions by almost 4%. This is the equivalent of putting around 12 million additional cars on the road in 2020[1]. It is a lot more than the emissions saved from all lorry road charging systems in Europe, for instance.

Biofuels 2020: A loophole the size of 30 million cars

To make matters worse, if we do not change the rules member states can count the emissions from these biofuels as zero (0) in their greenhouse gas reporting towards the Paris agreement (global level) and the Effort Sharing Decision and the Emissions Trading System (EU level).

In other words, member states can count the expected 8.4% of biofuels in 2020 as zero-emissions, i.e., a net 8.4% reduction compared with oil use. In reality though this note shows they will likely increase emissions compared with oil by 1.4% because of poorly-performing first-generation biofuels especially biodiesel. All in all, this makes for a loophole worth almost 10% (8.4% + 1.4%) of transport GHG emissions, or more than 30 million cars' worth of emissions.

Policy recommendations

This note only looks as the climate performance of different types of biofuels. It does not look at competition with food or land use, two other key parameters for future policy. But this climate assessment alone already allows us to draw pointed conclusions.

The European Commission's January 2014 Communication on a 2030 framework for climate and energy says *'The Commission has already indicated, for example, that food-based biofuels should not receive public support after 2020.'* This note shows that this is a solid policy principle to start from because their lifecycle emissions are shown to be on average 50% higher than those from fossil diesel and petrol, phasing them out will hence reduce transport emissions significantly.

[1] Assuming 900MT CO2eq GHG emissions from EU28 surface transport in 2020, and 2.9t of CO2eq well-to-wheel CO2eq GHG emissions per car per year.

It is important to understand why biofuels made from perennials and short-rotation coppice (switchgrass, miscanthus, willow and poplar), which according to the Globiom report score so much better for the climate, have failed to gain any significant market share or attract investment so far.
One key reason is the continued support for first-generation biofuels which tells the market to deploy these inferior fuels instead of the better but currently yet more expensive ones. The EU and member states support first-generation biofuels in four ways:

1. by mandates;
2. by tax breaks;
3. by counting them as zero-emissions towards climate objectives;
4. by counting them towards renewable energy objectives.

In order to give better biofuels a chance, all four forms of support for first-generation biofuels should be ended. Specifically, this means: the EU 7% cap should fall to zero after 2020; zero-counting towards GHG emissions should be ended for biofuels above the cap (just like they cannot be counted towards renewable energy objectives); and the ban on state aid after 2020 should be maintained and enforced.

If we do not make a choice and keep stimulating both first-generation and advanced biofuels, first-generation will continue carrying the day, with all aforementioned consequences for transport emissions, not to mention land use/biodiversity and food issues.