# LCA studies for the harmonization of international biofuels sustainability assessment

## *Principles for an objective LCA assessmentof biofuels. Guidelines for the WEC Task Force on biofuels sustainability aspects*

## Introduction

An considerable amount of Life Cycle Analysis (*LCAs*) studies has been conducted for the assessment of biofuels production in Europe and in other parts of the world. Their purpose is the investigation and valuation of the environmental impacts of biofuels production (mainly as far as the greenhouse gases (GHG) and the energy balances are concerned) and the ranking of best performing pathways.

However for the same biofuels production pathway, LCA studies come up with very different results. That is why it is essential to design very carefully a reference study, especially when it constitutes the scientific underpinning of legislative measures having far-reaching implications for the industry. On the other hand, **considering all LCA studies conducted so far, a transparent and objective study to evaluate the performance of biofuels worldwide becomes essential in order to accurately reflect the genuine performances of biofuels.**

One example of biofuels LCA study is the one performed by the Commission Joint Research Center , in collaboration withEUCAR and CONCAWE[1] (referred herein as the JEC study) , which was integrated in the recently adoptedEU Renewable Energy Directive. The JEC study has therefore been elaborated by experts from the mineral oil and automotive industries, without input from the agricultural and bioenergy sectors. As a result, the scientific foundation of the new Renewable Energy Directive is still questioned by different stakeholders for the lack of balanced contributions from all parties and all fields of expertise.

In light of the above example, an objective reference LCA study detailing the performances of biofuels is needed in a twofold perspective:

- **The Renewable Energy Directive, an essential piece of European legislation, should be based on a study that was commonly accepted by all stakeholders as being objective, balanced, transparent and reflecting reality.** The JEC study needs therefore to be turned into a EU scientific reference for biofuels LCA, including the expertise from farmers and bioenergy producers.

- **Given the growing importance international trade flows of biofuels and bioenergy, there is an increasing need to create an internationally acceptable unified system measuring the sustainability and the GHG performance of biofuels.**

### *Case study: state of the art of current LCA studies for biodiesel*

The considerations below have been made taking biodiesel The example of biodiesel is however fully representative from the lack of unified scientific benchmark, which also prevails for other biofuels.

[1] "Wheel to wheels analysis of future automotive fuels and powertrains in the European Context", Joint Research Center (European Commission)-Eucar (European Council for Automotive R&D)- Concawe (The Oil companies European association for Environment, health and safety in refining and distribution) WTW study version 2c 03/2007;

While the JEC study was used as reference for obtaining default values for biofuels in the proposed European Renewable Energy Directive it presents values that are in some cases still lower when compared to other sources. Other very relevant studies showed that biodiesel pathways, especially from rapeseed and sunflower reduce GHG emissions usually by more than 55%. Below follows an overview of these studies:

*CIEMAT* Study[2] upon which the French Environment and Energy Agency *ADEME* based its research:

- GHG emissions for **rapeseed biodiesel** (EU grown rapeseed) is of 2332 g $CO_2$ equiv/kg (p. 96 LCA for alternative fuels for transport), saving 92 g $CO_2$ equiv/km from the 163g $CO_2$ eq/km emitted by Diesel 590, which accounts for **56,43% GHG emissions savings**;
- GHG emissions for **sunflower biodiesel** (EU grown sunflower) is of 1190 g $CO_2$ equiv/kg, saving 107g $CO_2$ eq/km, which accounts for **65,64% GHG emission savings**;

- **A 100% pure** biodiesel (**obtained from a mix of oils containing 40% soy, 25% rapeseed, 25% palm, 10% sunflower**) is accountable for 70,8 g $CO_2$ equiv/km compared to Diesel EN 590 (accountable for 163 g $CO_2$ equiv/km), therefore representing **56,44% GHG emissions savings.**
- **A 10**% biodiesel blend (into regular diesel) from the same mix of vegetable oils emits 154 g $CO_2$ eq/km compared to Diesel EN 590 (163 g $CO_2$ eq/km), which represents a 5,52% GHG emissions savings per km.
- **A 5**% biodiesel blend from the same mix of vegetable oils emits 158 g $CO_2$ eq/km compared to Diesel EN 590 (163 g CO2 eq/km), which represents a 3,06% GHG emissions savings per km.

- **A 100% pure** Biodiesel from **used vegetable oils** is accountable for 19 g $CO_2$ equiv/km, having **88,55 % GHG emission savings.**
- **A 10**% biodiesel blend (into regular diesel) from the same mix of used vegetable oils emits 149 g $CO_2$ eq/km compared to Diesel EN 590 163 g CO2 eq/km, which represents a 8,58 % GHG emissions savings per km.
- **A 5**% biodiesel blend (into regular diesel) from the same mix of used vegetable oils emits 156 g $CO_2$ eq/km compared to Diesel EN 590 163 g CO2 eq/km, which represents a 4,29 % GHG emissions savings per km

World Resources Institute *WRI* Study[3]:

- **Rapeseed biodiesel** accounts for a **64% GHG emissions savings** compared to fossil fuels.
- **Sunflower biodiesel** accounts for a **62% GHG emissions savings** compared to fossil fuel.

Viewls[4] Project Study (piloted by the Dutch Research Institute Senternovem) and supported by the European Commission

- *"Compared to conventional fuels (160 to 190 g* $CO_2$ *eq/km) most biofuels have significantly reduced greenhouse gas emissions (minus 270 to 140 g* $CO_2$ *eq/km), whereas further reduction might be achieved (minus 170 to 110 g* $CO_2$ *eq/km) for future biofuel technologies.*

[2] "Analisis de Ciclo de Vida de Combustibles alternativos para el Transporte, Fase II Comparative LCA of Biodiesel and Diesel, Energy and Climate Change", CIEME 2006, p.96 - 108

[3] "Plants at the Pump: Biofuels, Climate Change and Sustainability", Brit Chills, Rob Bradley, World Resources Institute, Fig. A, p.3 and Fig. 3, p. 13 based on the studies: Fulton, L. et al. *Biofuels for Transport: An International Perspective*. Paris, France: International Energy Agency; 2004. Groode, Tiffany A. and John B. Heywood. *Ethanol: A Look Ahead*. Laboratory for Energy and Environment, Massachusetts Institute of Technology. Publication No. LFEE 2007-002 RP.; 2007. Hill, Jason et al. 2006. "Environmental, economic, and energetic costs and benefits of biodiesel and ethanol biofuels." Proceedings of the National Academy of Sciences (PNAS), Jul 2006. 103: 11206 – 11210; U.S. Environmental Protection Agency (EPA). 2007. Greenhouse Gas Impacts of Expanded Renewable and Alternative Fuels Use. EPA420-F-07-035. Washington, DC: EPA Office of Transportation and Air Quality; Worldwatch Institute. 2007.

[4] "Shift Gear to Biofuels" Final report of the VIEWLS project, VIEWLS project, Clear Views on Clean Fuels, which was supported by the European Commission (NNE5 - 2001 - 00619), p. 27 - 28

*The emissions may be minus, if the avoided emission of substituting conventional material with by-products from the biofuel production (e.g. rapeseed cake substituting for soy feed) and/or the emissions of the avoided reference use of the biomass, are higher than the emissions from the biofuel chain."*

- Biodiesel from oilseeds emits GHGs in a range from 50 to 140 g $CO_2$ eq /km, which accounts for **GHG savings up to 68,75%.**

French Environment and Energy Agency *ADEME*, Mineral and Energy Resources Agency *DIREM* and PriceWaterHouseCoopers Study[5] in 2002:

- This study used the mass allocation method for calculating the impacts of biofuels production. This implies that the energy content and the GHG emissions are allocated both to the biofuel and to the co-products along the whole production chain in accordance with their mass.
- **Rapeseed Methyl Ester** is responsible for 55,6 g C02 eq /MJ which **represents 70 % GHG savings**
- **Sunflower Methyl Ester** is responsible for 59,2 g CO2 eq/MJ which accounts for **a reduction of GHG emissions of 75%**.

Sustainable Energy Association in Normandy *EDEN* Study (in 2006):

- Using a systemic method, it is estimated that **RME** is responsible for 23,7 g $CO_2$ eq GHG emissions which represent 30% of the $CO_2$ eq emissions of diesel, therefore a **70% GHG savings**;
- If the **co-products are accounted** for and considered being used as animal feed, the GHG emissions are lower, 20,3 g $CO_2$ eq, that equals 26% of the diesel emissions, therefore having a **74% GHG emission reduction**.

MEO Consulting Team and the Institute for Energy and Climate Change (Institut fur Energetik und Umwelt GmbH) LCA Study[6]

- Biodiesel from **Used Cooking Oils** account for **87,1% GHG savings** compared to the fossil fuels reference 83,8 kg C02 eq/GJ

Swedish Institute for Food and Biotechnology Study[7] on Rapeseed Methyl Ester:

- **Rapeseed Biodiesel reduces** $CO_2$ **emissions by 54 to 61%[8] or even by 70%[9]**.

The above list of LCA studies is not fully up-to-date, new production performances and latest technical scientific developments would need new in-depth analysis and assessment to be made in the future.

### *Technical Aspects of Biofuels LCAs*

When engaging in the creation or the adoption of a LCA of the biofuels production chains, a series of prerequisites are relevant:

1. the methodology for accounting the main products energy balance (total energy expended or fossil energy expended)

2. the methodology for accounting the by-products[10] (allocation on mass or energy content or substitution)

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[5] "Energy and GhG balances of biofuels and conventional fuels", ADEME, DIREM, Report according to Ecobilan-PricewaterhouseCoopers work, November 2002.
[6] Audit of greenhouse gas emissions from biodiesel production, Meo Consulting Team, 2008
[7] "Emissions of greenhouse gases in a life cycle perspective and use of energy and land in production of RME from Swedish rapeseed", Swedish Institute for Food and Biotechnology, 2008
[8] idem, p. 3
[9] if the co-product allocation method is *system expansion* (crediting for avoided production due to the now available co-products) and if the fertilisers used are type Best Available Technique, idem. p.23

*(Consistency between the two methodologies is mandatory for an objective analysis)*

3. countries specificities to be considered (Ex: for NOx the global IPCC default is considered as unique for all countries which hampers the overall relevance)

4. fossil fuel reference based on the performance of the last barrel extracted

5. the definition of indicators – for the adoption of a study or of a set of studies, harmonized definitions of indicators are a prerequisite

6. data normalization if the chosen studies are using different indicators are considered

7. data sources : data must be characterized by independence, precision and representativeness

8. consistency of the methodologies, of the data that should lead to consistency of results in separate individual studies

9. critical review and monitoring ex post

## Conclusions

Against the background of a lack of consistent data and methodologies used world- wide and the availability of a multitude of balanced yet not fully updated Biofuels Life Cycle Assessments it appears particularly crucial to start working **towards an up-to-date objective and transparent Biofuels Life Cycle Analysis Study that should be established at international level**.

A common and transparent approach, gathering all interested stakeholders at international level, is necessary in order to draw meaningful conclusion from the comparison of different biofuels chains with the corresponding fossil fuels. Objective figures and methodologies need to be elaborated in order to enable the international measurement of biofuels sustainability.

[10] Some biofuels pathways produce per volume more co-products than produce actual fuel; moreover a market approach will show that some by-products are much more valuable than the actual biofuels according to the commodity markets fluctuations