POSSIBLE APPROACHES FOR OPTIMISING THE GHG BALANCE OF BIODIESEL PRODUCED FROM RAPESEED

Stefan Majer, Katja Oehmichen, Marek Gawor

German Biomass Research Centre (non profit research company)
Torgauer Straße 116; Leipzig, Germany
Phone: +49-341-2434-411; Fax: +49-341-2434-113; Mail: stefan.majer@dbfz.d

INTRODUCTION

With enactment of the EU Directive on the promotion of the use of energy from renewable sources (RES-D), a number of binding sustainability criteria for the production and use of biofuels has been introduced. Amongst other criteria, the EU Directive includes specifications with regard to the reduction of greenhouse gas (GHG) emissions by means of biofuel production and use. Meeting these reduction targets will in future be a mandatory condition for the recognition of a fuel as part of the national biofuel quota to fulfill the RES-D targets for the transport sector until 2020. It is specified within the RES-D, that biofuels have to demonstrate a reduction of the GHG emissions of at least 35% in comparison to fossil fuels after the Directive has been transposed into national law. In two subsequent stages this reduction target is to be raised to 50% (in the year 2017) and 60% (in the year 2018 for new installations starting their production from 2017). /1/

According to the RES-D specifications, this required reduction of the GHG emissions can be demonstrated by own calculations of the biofuel producer, the use of so-called default values, or by means of a combination of default values and own calculations. However, by considering the default values it becomes clear that the sole application of these standard values will not be sufficient for the most biofuels to achieve compliance with the subsequent GHG reduction targets of 50% and 60%. The default values are intended to represent a conservative average of the GHG emissions resulting from the production and use of the biofuels which are displayed in Appendix V of the Directive. However, this approach raises the question about the data basis used for the calculation of the default values. Furhermore, it is not clear which reduction of the GHG emissions could be theoretically achieved for a process chain based on this background data which is optimised in terms of its GHG account.

These questions were analysed by a study conducted by the German Biomass Research Centre with financial support of the German Union for the Promotion of Oilseeds and Protein Plants. Example results and key findings of this work will be presented in the following sections.

GOAL AND SCOPE OF THE STUDY

In order to explain the RES-D default values for rapeseed biodiesel, the background data that has been used for the calculation was analysed in a first step. This was supported by a transparent explanation of the basic calculation process for determining the GHG emissions of a biofuel within the context of the RES-D.
Subsequently it was possible to identify the parameters with the most significant influence on the result for the individual stages of the process chain. Furthermore, the behaviour of these influence parameters has been investigated with the help of a sensitivity analysis. Thus, the possible optimisation potential of the individual process stage could be determined and described.

EXEMPLARY RESULTS AND CONCLUSIONS

Brief examination of the default value for the rapeseed production

The RES-D default value for the rapeseed cultivation contributes to approximately 56% (29 g CO_2/MJ biodiesel) to the overall RES-D default value for rapeseed biodiesel. Fig. 1 shows the assumptions for the main input parameters for the rapeseed production (left column) that have been used for the default value calculations. The right column in Fig. 1 indicates the GHG emissions related to these input materials and energies.

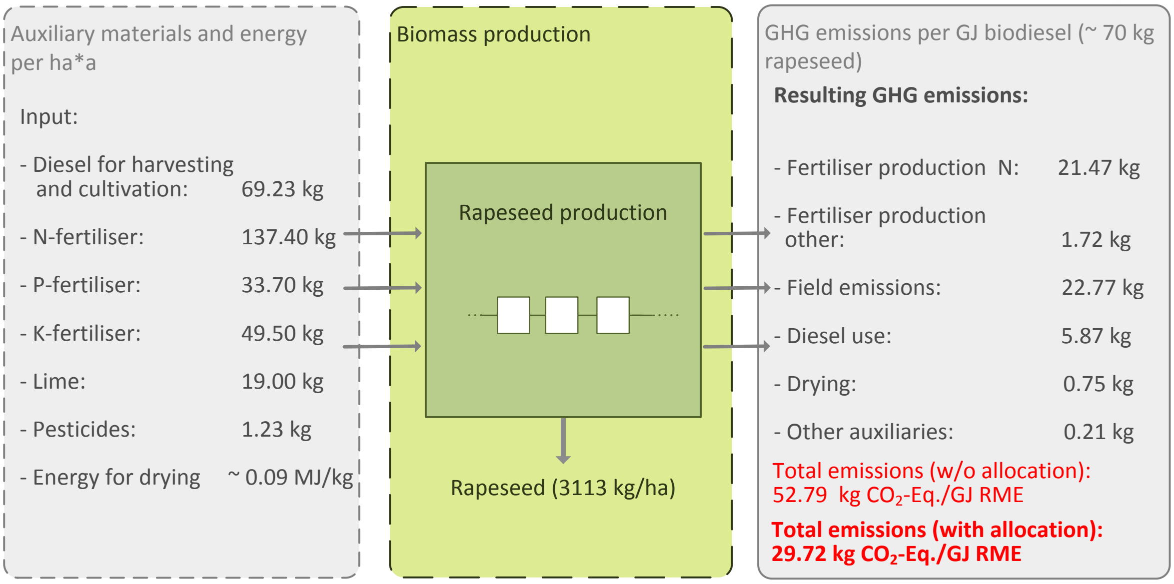

Fig. 1 Results of the GHG calculation for the rapeseed production proces, based on /2/, /3/, /4/, /5/

Main influencing factor for the result of the rapeseed production process is the production and use of industrial (synthetic) nitrogenous fertilisers. Changing the type of fuel used from fossil diesel to biodiesel and using other sources of nitrates provides considerable potential for GHG reduction on the default value for the rapeseed cultivation process. By varying these two parameters in the sample calculation, the emissions value was reduced by approx. 27 % from 53 kg CO_2 Eq./GJ (without by-product allocation) biodiesel to approx. 39 kg CO_2 Eq./GJ biodiesel (without by-product allocation) (cf. Fig. 2).

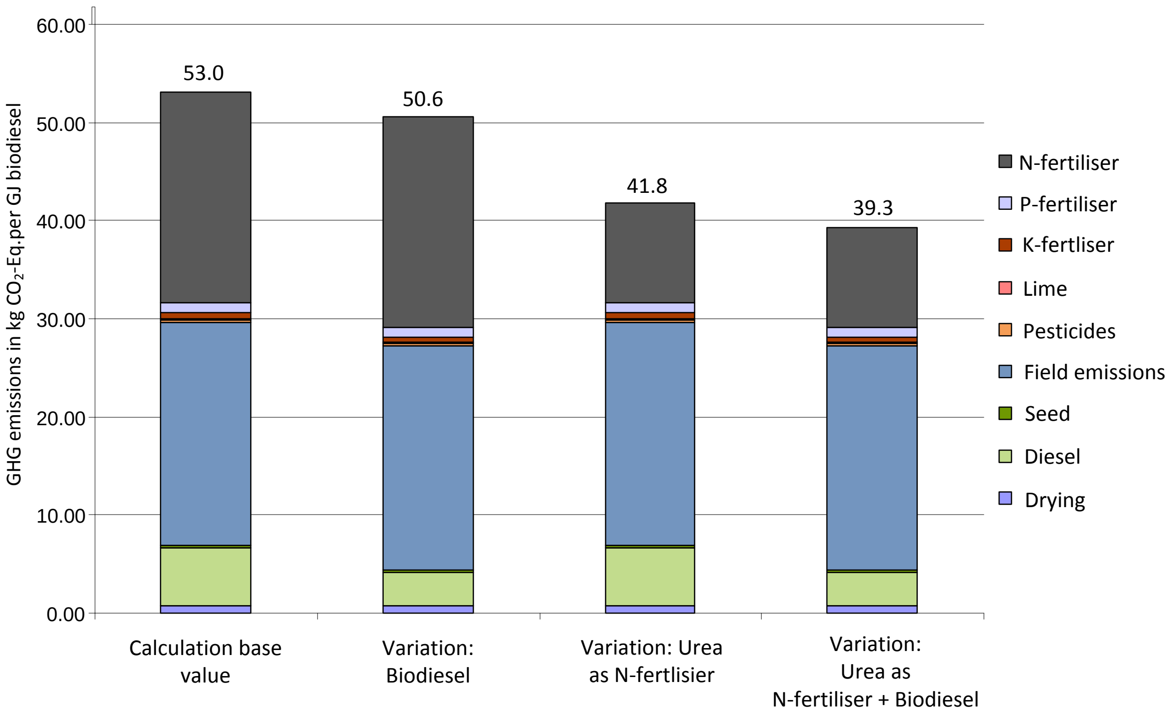

Fig. 2 Results of the sensitivity anlaisis for the calcluation of GHG emissions from the rapeseed cultivation process

Brief summary of the calculations for the remaining process steps of the biodiesel production

A similar approach was used to analyse the RES-D default value background data for the subsequent stages of the biodiesel process chain (mainly rapeseed oil production, refining and transesterification).

The amount of the GHG emissions resulting from these biomass conversion stages is mainly influenced by the use of the process heat and electricity as well as the chemical methanol. Furthermore, the influence of the type of the process energy used was investigated in the course of a sensitivity analysis. The improvement potential can be easily shown if an alternative, biogenic energy source is used. In this case the emissions from the rapeseed oil production process were reduced from approximately 3 to approximately 1.5 kg CO_2 Eq./GJ biofuel and for the biodiesel production process (refining and transesterification) from approximately 11 to approximately 6.4 kg CO_2 Eq./GJ biofuel for the fossil and biogenic energy sources, respectively. In the calculations for the transesterification process the potential for reducing GHG by using biomethanol as a process chemical was also investigated. However, this approach only led to a very slight reduction of the GHG emissions. In addition to the type of the energy sources used for process energy supplies, the process input data in the various stages of rapeseed oil production and biodiesel production was varied. The amount of the energy used for the purposes of the rapeseed oil production and biodiesel production was adjusted to the level of facilities operating with the state-of-the-art technology.

Conclusions

Fig. 3 summarises the impact of the investigated optimisation approaches for the entire rapeseed biodiesel production chain based on the corresponding RES-D default value.

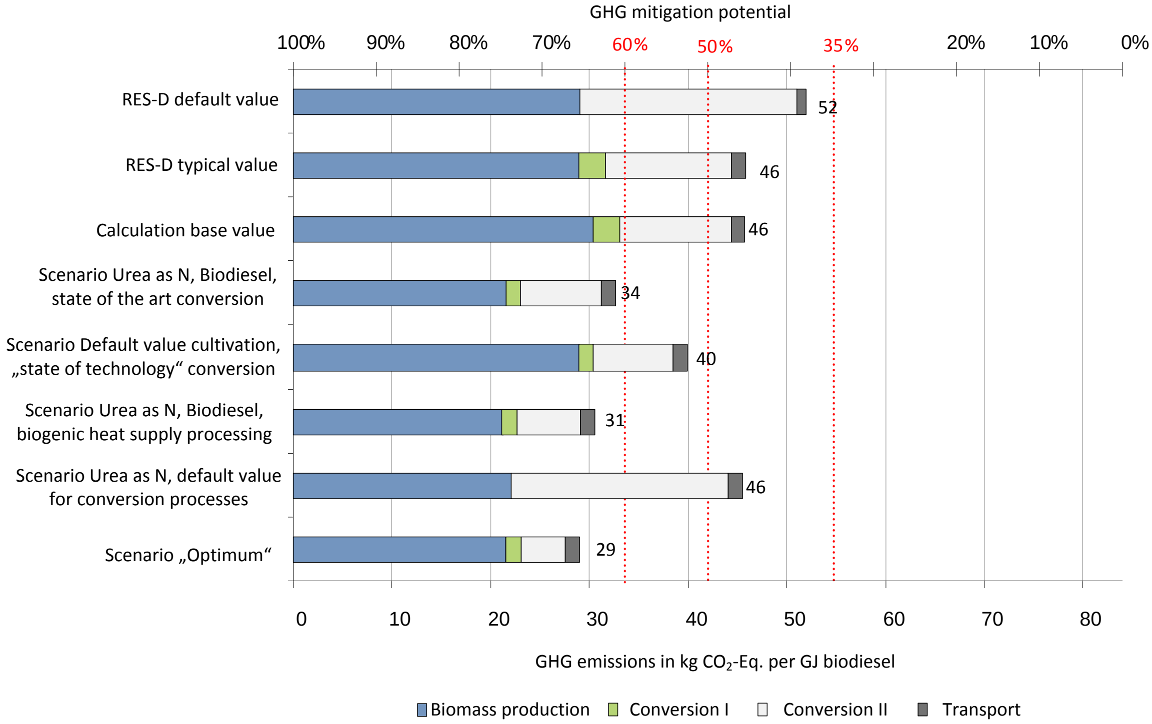

Fig. 3 *Overall results of the GHG emissions accounting for the entire rapeseed biodiesel process chain*

With GHG emissions of approximetaly 29 kg CO_2 Eq./GJ biofuel the maximum theoretical optimisation potential for the analysed sample process chain represented an improvement of approx. 45 % compared to the corresponding default value. Furthermore, this result represents a GHG mitigation potential of approximately 65 % compared to the fossil reference value of 83.8 kg CO_2 Eq./GJ which is defined by the RES-D. It must be pointed out that the optimisation options which are analysed in this study are focused solely on a potential improvement of reducing the emission of GHG. Combining these calculations and approaches with an analysis of economic feasibility was not part of the scope of the study.

The complete report is available at www.ufop.de.

References

/1/ European Union (2009) Directive 2009/28/EC of the Parliament and of the Council on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, Brussels, 23 April 2009.

/2/ JRC (2008) „JRC (2008) Update on Data on pathways for RES Directive.XLS“ EU Comission working Excel-Spreadsheet
/3/ JRC (2008) „Input_data_BIO 181108.XLS“ Available at: http://ies.jrc.ec.europa.eu/our-activities/support-to-eu-policies/well-to-wheels-analysis/WTW.html
/4/ Frischknecht, R. (2007) Ecoinvent 2007 database: Data v2.0
/5/ Bundesanstalt für Landwirtschaft und Ernährung (2010) Leitfaden Nachhaltige Biomasseherstellung, Bonn