Assessment of BioGrace GHG calculation tool

Version as submitted 19 February 2013

Summary

An assessment has been made on compliance of the BioGrace GHG calculation tool (hereafter referred to as "BioGrace") as submitted to the European Commission for recognition, with the sustainability criteria of Directive 2009/28/EC.

The assessment results indicate that the scheme meets the mandatory sustainability requirements of Directive 2009/28/EC on GHG.

Scheme scope:

- Feedstock: Any
- Geographic regions: Any
- Fuel chain: Whole supply chain
- GHG calculation scope: Calculating actual values and for calculating combinations of actual and disaggregated default values.
- Note that the BioGrace scheme is GHG tool and does not contain any land-use, chain of custody or audit requirements.

Background

The BioGrace project aims to harmonise calculations of biofuel greenhouse gas (GHG) emissions and support the implementation of the EU Renewable Energy Directive (2009/28/EC) and the EU Fuel Quality Directive (2009/30/EC) into national laws. BioGrace is a project funded within the Intelligent Energy Europe Programme.

BioGrace has developed a GHG calculation tool in MS Excel (the BioGrace tool) that economic operators, auditors and other interested parties can use to perform GHG calculations for biofuels pathway. The BioGrace tool currently replicates the 22 biofuel default pathways in Annex V, part C of Directive 2009/28/EC, and includes separate calculation worksheets for each of these pathways. BioGrace has also developed a list of standard conversion values for GHG calculations, which has been published on the European Commission's transparency platform.

The BioGrace tool has been developed by the partners of the "BioGrace-I" project (see http://www.biograce.net/home). Since the end of the project, the organisations Agency NL, IFEU and BIO IS together form the consortium (and are the legal entities) responsible for keeping the BioGrace GHG calculation tool up-to-date. This consortium can be contacted through Agency NL.

BioGrace is seeking formal assessment and recognition by the European Commission for the BioGrace tool as a 'voluntary scheme' to demonstrate compliance with Article 17(2) of Directive 2009/28/EC.

BioGrace GHG tool assessment process

The BioGrace tool was assessed using the following approach.

1. Assessment of BioGrace tool supporting documentation

The following documents were assessed:

- User manual for the BioGrace greenhouse gas calculation tool
- BioGrace calculation rules

2. Assessment of selected BioGrace tool biofuel pathways

The following biofuel pathways were assessed:

- E-Wt (NG-b): A comparison was made of the entire biofuel pathway with the annotated example prepared for the European Commission in 2010.
- E-Wt (NG-chp): The assessment specifically focussed on the CHP calculation and how it compared to the natural gas steam boiler.
- E-Wt (Str-chp): The assessment specifically focussed on the CHP calculation and how it compared to the natural gas CHP system.
- F-Po (CH_4 capt): The assessment specifically focussed on the CH_4 capture calculation.
- H-Po, H-Rs, H-Sf: The assessment specifically focussed on the hydrogenation of vegetable oils.
- CNG-wM: The assessment focussed on the entire biofuel pathway.

3. Assessment of selected BioGrace calculation sheets

The BioGrace tool includes a number of calculation sheets which were assessed:

- LUC: The calculation methodology was checked and tested by comparing the calculated results with the annotated example prepared for the European Commission in 2010.
- Esca: The calculation methodology was checked and tested with an example calculation.
- N_2O emissions IPCC: The calculation methodology was checked and tested with an example calculation.

4. Assessment of selected BioGrace tool calculation sheets – adapting pathways for the calculation of actual values

The BioGrace tool allows changes to be made to the default pathways which were assessed by:

- Modifying input values
- Adding specific standard values / user defined standard values
- Adding new input in pathway

Assessment results

The summary results of the assessment are presented in the table below. Note that the BioGrace scheme does not contain any land-use, chain of custody or audit requirements. The detailed assessment results are available in Annex 1.

Table 1: Assessment results – summary

RED Article	BioGrace Version as submitted 19 February 2013	Comments
Sustainability criteria		
17(2): Greenhouse gas emissions savings	**Y**	
17(3): Conservation of biodiversity	**n/a**	Not applicable to BioGrace.
17(4): Conservation of carbon stocks	**n/a**	Not applicable to BioGrace
17(5): Conservation of peatlands	**n/a**	Not applicable to BioGrace.
Chain of Custody		
18(1): Use of a mass balance system	**n/a**	Not applicable to BioGrace.
Recognition of other voluntary schemes	**n/a**	Not applicable to BioGrace.
Audit Quality		
18(3): Adequate standard of independent auditing	**n/a**	The BioGrace scheme is a GHG tool and does not contain any specific audit requirements. However economic operators wishing to use the BioGrace tool for RED compliance, whether through a national system or in combination with another EC-recognised voluntary scheme, will be required to undertake third party independent auditing. **Furthermore, verifiers will need to: 1. ensure that the "for compliance" version of the tool is used in all cases (i.e. with the track changes button set to "ON"); 2. check that "previous and partial GHG calculations" were calculated using the BioGrace tool.**

Annex 1: Detailed assessment results

Sustainability criteria

The sustainability criteria detailed below are the mandatory sustainability criteria of the RED: Article 17(2).

Article 17(2): Greenhouse gas emissions savings	**The use and production of biofuels and bioliquids should lead to reductions in greenhouse gas emissions compared to fossil fuels**
1.2 The greenhouse gas emission saving from the use of biofuels and bioliquids shall be calculated in accordance with RED Article 19(1)-19(3), Annex V and Commission Decision 2010/335/EU of 10 June 2010.	
Guidance: Greenhouse gas emissions from any land-use change that has occurred since 1 January 2008 shall be taken into account in the greenhouse gas calculation, according to the methodology in the RED Annex V.	
Assessment	
1. Assessment of BioGrace tool supporting documentation **BioGrace calculation rules, version 4c** • 1. Introduction: The BioGrace GHG calculation rules are in line with the methodology as given in Annex V.C of the RED and in the communication and decision from the European Commission: Communication on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels [OJ C160, page 8] and Commission decision of 10 June 2010 on guidelines for the calculation of land carbon stocks for the purpose of Annex V to Directive 2009/28/EC (2010/335/EU) [OJ L151 page 19], with one exception as explained in footnote 13. • 1.1 Updates to this document: For the few items where the BioGrace calculation rules differ from the CEN standard under preparation, additional work on harmonising these rules will take place. This might cause that the BioGrace GHG calculation rules will be updated in the future. Another cause for update might be when the methodology in Annex V is updated, according to the RED article 19.7. When this document is updated, it will be sent to the European Commission within the procedure of accepting BioGrace as a voluntary scheme. The updated documents would need to be reassessed and approved by the Commission. • 2.1.1 BioGrace calculation rules are binding: If the BioGrace Excel tool, the BioGrace calculation rules shall be respected. An auditor checking actual calculations shall not approve the calculations when the calculation rules were not respected. • 2.1.2 Actual calculations shall be audited and shall be made with the "for Compliance" version of the Excel tool: When actual calculations are made to show compliance with the RED/FQD GHG criteria[1], then the calculations shall: be subject to third party independent auditing; and be made with the	

version "for compliance" of the Excel tool[1] in which the "track changes" option is always turned on. This will allow an auditor that will check the calculations to easily find the actual input numbers that were used for the calculation. Footnote 1: The "Version for compliance" is the version of the tool that is opened after it has been downloaded from www.BioGrace.net. The "Version for testing" is the version that is created after pressing the orange button "Track changes" causing that track changes is turned off. Please note that track changes cannot be turned on again after turning it off.

- 2.1.3 Actual values shall be made using GWP of 1, 23 and 296: […] Actual calculations shall be made with the Global Warming Potentials of 1 for CO_2, 23 for CH_4 and 296 for N_2O. A verifier checking actual calculations shall verify that the Global Warming Potentials of 1 for CO_2, 23 for CH_4 and 296 for N_2O have been used[1].
- 2.1.4 Units of the numbers shall not be changed: The units of the input numbers shall not be changed. Therefore the user of the BioGrace Excel tool must convert actual data collected into the units of the BioGrace Excel tool. Auditors checking actual calculations shall make sure that the actual input numbers have been converted into the right units, and that the units in the BioGrace Excel tool have not been changed.
- 2.2 Standard values, 2.2.1 BioGrace harmonized list of standard values: 1. For inputs, (by-/co-)products, process related emissions and transport modes not listed on the harmonised list of standard values, · reliable information[6] is given showing where these standard values were obtained; […]. Footnote 6: Reliable information means that only standard values defined by scientifically peer-reviewed academic studies are accepted. Furthermore, any data used shall lie within the commonly accepted data range.
- 2.2 Standard values, 2.2.2 BioGrace list of additional standard values: BioGrace has developed a list of additional standard values. When using a standard value that does not come from the BioGrace list of standard values, it is recommended to take a number from this list of additional standard values - if available on this list - and to include the reference that is given in this list as reliable information on how the value was determined. Doing so, still the rules above (under points 1 and 2) shall be respected.
- 2.2 Standard values, 2.2.3 Standard value for fertilizer: The standard value for a fertilizer can only be used when making a calculation using regional averaged input data for cultivation. When making an actual calculation for cultivation with **input data at the farm-level** and the **fertilizer type is *known*** the standard value for this specific type of fertilizer shall be applied […].When making an actual calculation for cultivation with **input data at the farm-level** and the **fertilizer type is *unknown*** the **highest standard value for that fertilizer shall be applied**. [Relevant standard values indicated for N, P and K fertilisers in Table 1.]
- 2.3 Cut-off criteria: All emissions from processes and products used and associated with the system the economic operator has defined must be included in the GHG calculation. However, if the contribution of that input or process to the total emissions of the biofuel pathway is lower than 0.1 g CO_2eq/MJ biofuel, it may be excluded. [A process for determining whether the 0.1 g CO_2eq/MJ biofuel threshold is met is provided, and includes a table with specific Mass or Energy thresholds. Units: kg/MJ, MJ/MJ, MJ ha^{-1} $year^{-1}$, kg ha^{-1} $year^{-1}$. These thresholds were checked for a number of input parameters and pathways and found to be sufficiently conservative with respect to the 0.1 g CO_2eq/MJ biofuel threshold.]

[1]: This can be checked in cells D10, D11 and D12 of the sheet "Standard values" in the BioGrace GHG tool.

- 2.4 Combining disaggregated default values and actual values: A user may calculate greenhouse gas emissions of his biofuels by using disaggregated default values for cultivation, processing and/or transport. In the BioGrace GHG calculation tool, this can be done by choosing "A" (actual values) or "D" (disaggregated default values) in the box next to the calculation result for cultivation, processing and transport.
- 2.5 Use of starting values in the BioGrace GHG tool: […] Actual GHG values can be calculated by replacing the starting values with actual input vales. When changing a starting value into an actual value, all other starting values in that part of the biofuel production chain (either cultivation, processing or transport) shall be changed into actual values as well, including the starting values of other steps within the same part of the biofuel production chain (either cultivation, processing or transport). There is one exception to this rule which is given in paragraph 2.5.1. Cultivation and processing can consist of several steps and transport does in most pathways consist of several steps. Both a cultivation and a processing step are defined as an operation at a distinct geographical location. A transport step is defined as the movement of a material from one cultivation or processing step to the next. A transport step can therefore consist of several transport modes (for instance transport by truck, followed by transport by ship). The separate steps are visible in the BioGrace Excel tool, the user of the tool must understand that this rule for changing starting values applies to all inputs for cultivation, all inputs for processing and/or all inputs for transport (except for the exception given below).
- 2.5.1 Starting value for the distribution of fuel: The starting values for distribution of the fuel in the step "Transport to filling station" or (in case of
- biogas) "CNG filling station" may be kept when making actual calculations. As a consequence a standard coefficient is used for the transport of the fuel to the filling station plus consumption of electricity in the filling station. This standard coefficient is 0,93 g $CO_{2,eq}$ per MJ of ethanol, 0,80 g $CO_{2,eq}$ per MJ of FAME, 0,74 g $CO_{2,eq}$ per MJ of HVO, 0,81 g $CO_{2,eq}$ per MJ of PVO and 2,84 g $CO_{2,eq}$ per MJ of biomethane.
- 2.5.2 Starting values shall be unchanged if a disaggregated default value is chosen: Starting values shall not be changed in parts of the biofuel production pathway for which a disaggregated default value is chosen. Example: if a disaggregated default value is chosen for "processing" in the pathway "FAME from Rapeseed", then none of the starting value in the steps "Extraction of oil", "Refining of vegetable oil" and "Esterification" shall be replaced by actual input numbers. When the user wants to use actual values in any part of these steps then all the numbers in all these steps must be replaced by actual values (see calculation rule 2.5) and the "A" (Actual values") shall be selected next to "Processing" at the top of the calculation sheet.
- 2.6 Using the result(s) from previous and partial GHG calculations: Some voluntary certification schemes (that are used to show compliance with the sustainability criteria for biofuels) allow that GHG calculations are made for part of the biofuel pathway and – after verification – are used as input in a new calculation for the rest of the biofuel pathway. In order to use the result from previous partial GHG calculations in the BioGrace Excel tool:
  - These previous partial calculations shall have been made using BioGrace.
  - These results of the previous calculation shall be expressed in g $CO_{2,eq}$ per kg of feedstock (including moisture) or in g $CO_{2,eq}$ per kg of raw vegetable oil.
  - The economic operator that uses these previous and partial GHG calculations as input for the Biograce Excel tool must have received, and must

keep in his administration, a delivery note that shall contain the following information:

  - The result of the previous calculation.
  - The GHG calculation tool, including version number, that was used to calculate the result of the previous calculation.
  - A statement on what has been included in this calculation: cultivation and/or feedstock transport and/or an oil mill and/or raw vegetable oil transport to the next processing unit.
  - Whether or not land use change has occurred and – if so – whether land use change has been included in the calculation.
  - Whether improved agricultural management has been included in the calculation.
  - Once European Commission has defined severely degraded or heavily contaminated land and if applicable: a statement that the feedstock was produced on severely degraded or heavily contaminated land, allowing to use the 29 g CO2,eq/MJ bonus.
  - A statement that the calculation and the information on land use change has been verified by an independent verifier during an earlier audit, and that since that audit the feedstock and process inputs have not changed.

- Values expressed expressed in g CO2,eq/kg biofuel, which have been previously calculated and which have been verified by an independent auditor, may be put into the BioGrace tool. Changing such a value will overwrite all values and calculations in that step. There are two different kind of values that can be entered, for which the following requirements shall be taken into account:
  - 1. One or more unallocated results for individual steps: a) Result(s) for individual step(s) (like cultivation and/or transport and/or the oil mill) shall be entered in the cells with white background colour in column N for the corresponding step. b) In the result section (cells A6-E20) it shall be indicated in row E that an "individual result from a previous calculation" has been inputted, causing the result line(s) (rows A-G) for the individual step(s) in question to become orange-coloured.
  - 2. One result for multiple steps: […]
- 2.7 Use of the sheet "user specific calculations": […] For the sheet "user specific calculations" the following calculation rules apply:
  - The entire content of this sheet shall be subject to third party auditing;
  - Calculations made on this sheet shall be company/user specific;
  - The outcome of calculations made on this sheet shall be intermediate results that serve as input values in other BioGrace GHG calculation sheets (the sheets with the calculations on the biofuel production pathways);
  - This sheet shall not be used to calculate results to be entered in column N of other BioGrace GHG calculation sheets ("use of results from previous and partial GHG calculations" as explained in paragraph 2.6);
  - All calculations made on this sheet shall comply with the BioGrace calculation rules.
- 3. Cultivation, 3.1 Field N_2O emissions: When calculating emissions of N_2O from cultivation, both direct and indirect emissions shall be included. For this calculation one of the methods laid down in the IPCC guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11 (2006) tier one,

two or three shall be used. The data established in this methodology is to be used when calculating field N_2O emissions.

- 3. Cultivation, 3.2 Use of average values: For cultivation, it is allowed to use average values for geographical areas at the level of NUTS-2 areas or more fine-grained level. In the reports that had to be prepared in accordance with RED article 19.2, member states have listed average GHG emission values at such levels. These values are, however, calculated in different member states and the calculation of some values might not have been done in accordance with the BioGrace calculation rules. It is therefore not allowed in the BioGrace calculations to use the GHG emission results from these reports directly. However, the input data, for example yield and amount of N-fertilizer, may be used if they are complete. In the calculation, the appropriate standard value from the BioGrace list shall be applied. The studies according to article 19.2 can be found on the EC Transparency platform.
- 3. Cultivation, 3.3 Use of aggregate or measured values [Text based on EC non-paper].
- 3. Cultivation, 3.4 Non-artificial fertiliser: GHG emissions from a non-artificial fertiliser consist of emissions from its production and from its use. No emissions are allocated to the production of manure until the point of collection. However when field N_2O emissions are calculated, the contribution from manure is to be included according to IPCC tier 1 (see 3.1 above).
- 4. Processing, 4.1 Use of actual values: Actual values for emissions from processing steps (e_p in the methodology) in the production chain must be measured or based on technical specifications of the processing facility. When the range of emissions values for a group of processing facilities to which the facility concerned belongs is available, the most conservative number of that group shall be used.
- 4. Processing, 4.2.1 Energy allocation: The lower heating value to be used is the LHV for the whole product and not just the dry part of it. The wet content of the product shall be included. For products with a moisture content of 10 % (based on mass) or lower, an approximation to dry product is allowed. No emissions can be allocated to heat.
- 4.2.2 Allocation between co-products and the fuel: [Accurate explanation of how emissions are allocated to co-products. Two examples are provided: with/without feedback loop.]
- 4.3 Electricity use: Emissions from using grid electricity shall be calculated from the average emission intensity for the country in which the electricity is taken from the grid. Country-average emission intensities for electricity shall be taken from the BioGrace list of additional standard values. It is not allowed to use the average emission intensity for the EU electricity mix.[13] Therefore when making an actual calculation in the BioGrace Excel tool a user-defined standard value for electricity shall be used. In case the BioGrace list of additional standard values does not contain an average value for the national grid and such a value cannot be obtained from other sources, it is allowed to use the value for "Other Africa", "Other Asia", "Other South and Central America" in the BioGrace list of additional standard values for countries in Africa, Asia and South and Central America respectively. Average emissions from a power plant can be applied only if the power plant is not connected with the grid. Emissions shall be averaged over the last year for which data are available. Footnote 13: This rule therefore deviates from "Communication on the practical implementation …. [OJ C160, page 8]" which states that the most logical choice is to take the average emission intensity for the EU. The reason for deviating from "the most logical

choice" from the Communication, is that under other voluntary sustainability schemes it is allowed the use the national average emission intensity also for EU countries and because BioGrace aims to avoid disharmonised calculation rules.

- 4.4 Emissions of N_20, CH_4 and CO_2 from the production unit: The GHG emissions include emissions from combustion of soffil fuels as well as any venting of methane and nitrous oxide to the atmosphere occurring during the process.
- 4.5 Handling of residues and waste: All operations that need to be carried out in order to dispose all waste and residues are included in the GHG emission calculation. Waste and residues leave the system without any GHG emissions. Waste and residues used for biofuel production have zero GHG emissions up and until the point of collection. If the waste or residue need further processing before it can be used in the biofuel process, the emissions from that processing shall be included in the biofuel GHG emission calculation.
- 4.6 Emissions from process heat: Waste heat is considered to have an emission factor of zero.
- 5. Land use change: For determining if the bonus for restored degraded land 29 g CO_2eq/MJ shall apply, the definitions laid down by the COM of degraded land and heavily contaminated land must be considered. Footnote: The European Commission has not yet defined degraded land or heavily contaminated land (September 2012). The degraded land bonus can only be applied once the European Commission has finalised the definition of degraded land.
- 6. Soil carbon accumulation via improved agricultural methods: When calculating soil carbon accumulation due to improved agricultural methods, the method in chapter 6 for land use change shall be applied. The emissions shall be divided over 20 years.

User Manual for the BioGrace Excel tool, version 4c

- 1. This user manual gives insight on how to understand and use the BioGrace Excel tool that is available through the website www.BioGrace.net. In fact, the tool (one file) contains two versions, which are: (1) BioGrace Excel tool - version 4c for Compliance, (2) BioGrace Excel tool - version 4c for Testing The only difference between these two versions is that in the version for Compliance the "track changes" is turned on, whereas in the Testing version it is turned off. The "for Compliance" version can be turned into the "for Testing" version by pressing on the orange button "Track changes". This user manual is about both versions of the tool, and with "the tool" reference is made to both versions of the tool.
- 2.1 First and fast navigation within the tool: […] N_2O estimates N_2O emissions in accordance with the IPCC methodology.
- 2.2 Colour-coding of Excel cells in calculation sheets: **Please note!:** in case a calculation is made that will be used to show the GHG performance of a biofuel as part of fulfilling the sustainability criteria of the RED or FQD, the "for Compliance" version must be used. In this "for Compliance" version the "track changes" is always turned on. This will cause that a change in a cell will be marked by a yellow background-colour and a red box around the cell. This helps to keep track of changes from the original document which will be helpful for any certification supervision of any actual value certification.
- 2.3 Comments: […] Comments appear with the usual format of Excel comments, as a small red triangle in the right corner of the commented cells.

[…]

- 2.4.1 General principles: […] Detailed calculation formulas can be seen by clicking each cell in the sheet. Methodological rules can be understood from looking at the formula calculated. All the different rules cannot be defined here. For more details, please refer to Annex V.C of the RED directive, and to the BioGrace calculation rules.
- 2.4.2 Presentation of a module: Input data: […] Result **from previous and partial GHG calculations**, it enables to make GHG calculations for part of the biofuel pathway and – after verification – use these values as inputs in a new calculation for the rest of the biofuel pathway.
- 2.4.3 Result module and general information: Global results to use: the first column of this part gives step by step actual results calculated for the present Excel sheet. The second column, column F, is very important to calculate final GHG emissions for this pathway. It enables using a mix of both disaggregated default value and disaggregated actual values. The box at the end of this part highlights this aspect.
- 2.4.4 Allocation modules: […] Total emission after allocation = Total emission before allocation x Ethanol energy content / Total energy content (ethanol + DDGS)
- 2.4.5 Units used: A major point of attention is that the tool is designed with all the data associated to specific units. **Therefore, to avoid any calculation errors, changing units is not permitted; instead the user shall convert his/her data collected into units that are used in the tool.**
- **3 Function 1: using the tool to have details on default value calculations:** In order to compare the calculations with the "RED values", the Global Warming Potentials 1 for CO_2, 25 for CH_4 and 298 for N_2O must be chosen (see paragraph 6.4 for details) as the RED default values were calculated with these Global Warming Potential. For most of the 22 default values as listed in RED Annex V, the corresponding calculation in the BioGrace tool gives a result that comes very close (deviation less than 0,1 g $CO_{2,eq}$/MJ) to the value calculated to derive the RED Annex V default value. For a number of reasons, there are larger deviations (up to several g $CO_{2,eq}$/MJ) for 5 of the 22 pathways: Ethanol from corn, FAME from waste vegetable or animal oil and the three biogas pathways (biogas from organic municipal waste, from wet manure and from dry manure). We expect that these differences will disappear in the future after the update of RED Annex V and the following update of the BioGrace tool.
- 4.1 […] Please note that: 1. In case a calculation is made that will be used to show the GHG performance of a biofuel as part of fulfilling the sustainability criteria of the RED or FQD, the "for Compliance" version must be used in which "track changes" is always turned on."; 2. Once the button "Track changes" has been pressed and the Track changes has been turned off (and simultaneously the version has changed from "for Compliance" into "for Testing"), this cannot be undone as, in contrast to previous versions of the Excel tool (version 4b and before) the button will be deactivated after pressing it once.
- 4.2 Using the result from previous and partial GHG calculations: Calculation sheets of the BioGrace tool allow that GHG calculations are made for part of the biofuel pathway and are used as input in a new calculation for the rest of the biofuel pathway. These inputs can take into account individual or multiple steps. Previous and partial GHG calculations that are used for input into BioGrace shall also have been made using BioGrace. Specific

calculation rules have been written in the document BioGrace calculation rules. These rules shall be followed while using the result from previous and partial GHG calculations. […] [Functionality was checked – see section 4 below.]:

- 4.3 Calculation a partial result for two or more combined steps: A user further downstream the biofuel production pathway is allowed to enter into the BioGrace Excel tool the result of a previous and partial GHG calculation.
- 4.4 Use of the sheet "user specific calculations": Modifications made on the sheet "user specific calculations" will not be tracked with "track changes" as all inputs into this sheet are per definition from the user. As a result, an auditor verifying an actual calculation shall always verify the data and calculations on the sheet "user specific calculations". Calculations made on this sheet shall be company/user specific meaning that it is not allowed to make more general calculations with the intention that some companies/users using this sheet will use this more general calculation, and others will not. […] Examples of company/user specific calculations for which this sheet is intended, are: […]
- 4.5, 4.6, 4.7 Description of "Adding specific standard values for existing input", "Adding an input in a pathway" and "Adding a new input in a pathway". [These were all checked – see section 4 below.]
- 6.1 Technical detail on specific issues: How to use the LUC sheet?: Land Use Changes (LUC) are to be taken into account in the GHG calculation of your product. A LUC occurs when the biofuel cultivation has a different carbon stock per hectare than a reference situation (e.g. conversion of non-highly biodiverse grassland into cropland). The RED methodology and the "Commission Decision of 10 June 2010 on guidelines for the calculation of land use carbon stocks for the purpose of Annex V of Directive 2009/28/EC" give precise instructions on when and how to take these carbon changes into account.
- 6.2 [Calculation of E_{sca}] The main difference comes from the fact that only carbon stock in soil is taken into account. Please note that if you have also a change in the above ground carbon stock or more globally in the land use type, you shall use the LUC sheet. **Do not use E_{sca} sheet if a Land use Change is also declared for the same biofuel.**
- 6.4 Inconsistency in use of global warming potentials Global warming potentials (GWPs) are used to convert methane and nitrous oxide in equivalent carbon dioxide. During the project, an inconsistency was found between the GWPs used for the calculation of default values listed in Annex V.A, Annex V.B, Annex V.D and Annex V.E of RED and the GWPs prescribed in Annex V.C point 5. For this reason, two calculations are possible in the tool through the following application in each excel sheet:
- 6.5 Declaring the 29g Bonus: If you are carrying out your own calculation and that your land enters into one of the two categories of land described in point 8, part C, of annex V of the RED, you can add an extra bonus of 29 g eCO_2/MJ to your pathway. This can only be done from the moment that the European Commission has defined degraded land and heavily contaminated land.

2. Assessment of selected BioGrace tool pathways

BioGrace tool, pathway 'Ethanol from wheat (steam from natural gas boiler)'

Assessment scope: Comparison of the BioGrace tool with the annotated example prepared for the EC and available on the EC's Transparency Platform, see http://ec.europa.eu/energy/renewables/biofuels/sustainability_criteria_en.htm

- The values that were used in the calculation of the annotated example were inputted in to the BioGrace tool to check whether the calculated results were consistent, or whether there were any differences between the calculated emissions per supply chain stage.
- The BioGrace tool calculated outputs for this adapted pathway were found to be very consistent with the annotated example:

- Total: 38.2 gCO_2/MJ (BioGrace) vs 37.99 gCO_2/MJ (Annotated example)
- Cultivation: 19.15 gCO_2/MJ (BioGrace) vs 19.01 gCO_2/MJ (Annotated example)
- Processing: 17.43 gCO_2/MJ (BioGrace) vs 17.43 gCO_2/MJ (Annotated example)
- Transport & Distribution: 1.60 gCO_2/MJ (BioGrace) vs 1.55 gCO_2/MJ (Annotated example)
    - Handling and storage: 0.04 gCO_2/MJ (BioGrace) vs 0 gCO_2/MJ (Annotated example) - these emissions were accounted for in the Cultivation emissions
    - Transport of wheat: 0.35 gCO_2/MJ (BioGrace) vs 0.34 gCO_2/MJ (Annotated example)
    - Transport of ethanol: 0.77 gCO_2/MJ (BioGrace) vs 0.77 gCO_2/MJ (Annotated example)
    - Filling station: 0.44 gCO_2/MJ (BioGrace) vs 0.44 gCO_2/MJ (Annotated example)
- Comments: Allocation factor: 60.4% (BioGrace) vs 60.4% (Annotated example)
- Note: The annotated example calculation was based on the global warming potentials listed in the RED (Annex V, section C, 5.). These are CO_2: 1, CH_4: 23 and N_2O:296. In order to compare the calculations on a like-for-like basis the BioGrace calculations also used the same GWPs.

BioGrace tool pathways 'Ethanol from wheat (steam from natural gas CHP)' and 'Ethanol from Wheat (steam from natural gas boiler)'

Assessment scope: CHP implementation using natural gas and comparison with natural gas boiler (without CHP)

- Processing (Ethanol plant):
- The 'Energy consumption' of electricity and steam for the ethanol plant are the same for both pathways, namely 0.076 MJ electricity / MJ ethanol and 0.509 MJ steam / MJ ethanol (see cells C71 and C72).
- External energy inputs for the natural gas boiler are specified as MJ natural gas input per MJ steam and Electricity input per MJ steam.

- External energy input for the natural gas CHP is specified as MJ natural gas input per MJ steam only.
- Natural gas boiler: The Electricity input per MJ ethanol is calculated from the Steam demand (cell C72) and the specific Electricity input per MJ steam (cell C77). Similarly, the Natural gas input per MJ ethanol is calculated from the Steam demand (cell C72) and the specific Natural gas input per MJ steam (cell C75).
- Natural gas CHP: The Electricity generated per MJ ethanol is calculated from the Steam demand (cell C72) and the specific Electricity production per MJ steam (cell C83). In the last line of the 'CHP calculation box' (cell C86), the Electricity consumption is subtracted from the Electricity generation, resulting in the electricity surplus. (Natural gas input is calculated as above.)
- The BioGrace tool bases the excess electricity emission credit on the emission factor for electricity production from a natural gas fired CCGT (NG CCGT). This is consistent with the RED Annex V, Section C 16, which states that, "*The greenhouse gas emission saving associated with that excess electricity shall be taken to be equal to the amount of greenhouse gas that would be emitted when an equal amount of electricity was generated in a power plant using the same fuel as the cogeneration unit*."

BioGrace tool pathway 'Production of Ethanol from wheat (steam from straw CHP)'

Assessment scope: CHP implementation using an agricultural crop residue (i.e. straw) as a fuel

- Processing:
- This pathway was compared with the CHP pathway assessed above (i.e. Production of Ethanol from wheat (steam from natural gas CHP)). The difference is that in this pathway an agricultural residue (straw) is used as the CHP fuel where in the previous pathway a fossil fuel (natural gas) is used. Straw is classified as an agricultural residue in the RED (see RED, Annex V, Section C 18).
- The RED Annex V, Section C 16 states that; "*Emission saving from excess electricity from cogeneration, e_{ee}, shall be taken into account in relation to the excess electricity produced by fuel production systems that use cogeneration except where the fuel used for the co-generation is a co-product other than an agricultural crop residue.*"
- As straw is an agricultural residue the above point 16 is valid. Consequently, the emission saving from the electricity from cogeneration (CHP) should be calculated in the same way as for the natural gas CHP pathway.
- The BioGrace tool is consistent with the RED Annex V, Section C 16 in this calculation as it bases the excess electricity emission credit on the emission factor for electricity production from a straw fired steam turbine (Straw ST).

BioGrace tool pathway 'Production of FAME from Oil Palm (process with methane capture at oil mill)' and 'Production of FAME from Oil Palm (process with methane capture at oil mill)'

Assessment scope: CHP implementation and methane capture

- Processing (Extraction of oil):
- The CHP calculations are consistent with the ethanol CHP pathways that were assessed above. However, the CHP is based on an unspecified fuel and Electricity supply. The user needs to specify the fuel type and if appropriate also add in the specific GHG emission coefficients in the 'User defined standard values' worksheet. [The functionality of this worksheet was checked – see section 4 below.]
- The comment in cells C73-74, "It is assumed that the demand of heat and electricity is met by combusting biomass residues that are locally available." clarifies why the Energy consumption values are zero.
- The emissions from the POME (Palm Oil Mill Effluent) are accounted for in a specific input cell C93. The 'Production of FAME from Oil Palm (process not specified)' pathway has a value of 1.32 gC_{H4}/MJoil, while the 'Production of FAME from Oil Palm (process with methane capture at oil mill)' pathway has a value of 0 gC_{H4}/MJoil.
- The two pathways are otherwise identical. This was verified by changing the methane emissions in the latter pathway to 1.32 gCH_4/MJ_{oil}, and also by changing the methane emissions in the latter pathway to 0 gCH_4/MJ_{oil}. In both cases the total pathway emissions are the same.

BioGrace tool pathway 'Production of Hydrotreated Rapeseed/Palm/Sunflower oil'

Assessment scope: Hydrogenation of vegetable oil

- Processing (Hydrogenation of vegetable oil):
- The emissions for hydrogenation are the same for each HVO pathway (i.e. 9.4 gCO_2/MJ). These are based on a natural gas CHP with input of hydrogen for the hydrogenation.
- The calculation functions the same as the natural gas CHP system assessed above, although it should be noted that the Energy consumptions for Electricity and Steam are both negative (in-line with the Neste Oil process).
- (Negative) emissions for the replaced Natural gas and Electricity are calculated based on Natural gas (4000 km, EU Mix quality) and Electricity EU mix MV.

BioGrace tool pathway 'Production of Biogas from wet manure as CNG'

Assessment scope: Entire pathway

- Cultivation:
- The RED, Annex V, Section C 18, which states that "*Wastes, agricultural crop residues, including straw, bagasse, husks, cobs and nut shells, and residues from processing, including crude glycerine shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials*."
- Although manure is not explicitly mentioned it can be inferred from the RED cultivation defaults for biogas that manure is considered a waste/residue (i.e. disaggregated default value for cultivation, e_{ec}, in Annex V, Section D is zero). The EC Communication 2010/C 160/02 further clarifies that manure is a processing residue.
- The BioGrace tool is consistent with the RED methodology and assumes that the cultivation pathway starts with the collection of wet manure.
- Processing:
- The surplus electricity from the biogas CHP results in a negative emission (as with the other CHP pathways discussed above) and a credit for the excess electricity taken. However, in this case the RED methodology has not been followed - as is mentioned in the tool itself. According to the RED and EC Communication 2010/C 160/02 the credit cannot be taken since the fuel of the CHP (i.e. biogas) is also the product of the process.
- BioGrace provides the following additional explanation on the calculation of the excess electricity (see comment in cell B50): *"In the steam production, electricity is produced in a larger amount than the electricity demand in the biogas plant. Therefore, the electricity demand in the biogas plant is in fact not a demand but a reduced electricity output. The output of electricity from the steam production is credited by the electricity from a natural gas fired combined cycle gas turbine (NG CCGT). As a consequence, also the electricity demand in the biogas plant is considered to be electricity from a NG CCGT to acknowledge for the fact that in practice this is not a demand, but a reduced electricity output. If the steam would have been produced in a boiler (without cogeneration of electricity), then the electricity input in the biogas plant should have been calculated as "Electricity EU mix MV". If the input of electricity would have been larger than the co-generated electricity from the steam production, than part of electricity input into the biogas plant would have been calculated as "Electricity (NG CCGT)", and part as "Electricity EU mix MV"."*
- The BioGrace tool differentiates between the 'Total Biogas output' and the 'Net Biogas output', in contrast to the JEC input data, which only has the total biogas output. An explanation is provided for this in cell C43; "*Part of the total biogas output is consumed in the CHP (in the fermentation step). In addition, part of the biogas output is lost as leakage. The public input-sheet on the JRC website only gives the total biogas output (0.7 MJ biogas/MJ manure), this needs to be corrected for biogas losses to CHP and leakage. This is done here.*"
- The credit for the production of the co-product N fertiliser is not in line with the RED. The rationale for this is provided as a comment in cell C47; "*During the BioGrace project, we found an inconsistency between the way the biofuel GHG default value (as listed in Annex V.A, V.B and V.D of the RED) has been calculated, and the methodology as listed in Annex V of the RED: A substitution credit was given for the by-product N-fertilizer whereas*

Annex V.C.17 requires allocation based on energy content. As soon as the JEC Consortium updates the default values using the Annex V consistent allocation approach, this will be updated in the BioGrace Excel file as well."

- The biogas upgrading is assumed to be done by pressurized water scrubbing (predefined in tool), which is consistent with the JEC input data. However, the method of defining the performance of the upgrading step (yield methane, energy consumption and methane leakages) is flexible enough to accommodate alternative upgrading technologies.
- Methane leakages are accounted for in the 'Biogas generation via fermentation' and 'CH_4 extraction' process stages.
- Transport:
- The transport of the wet manure to the AD plant is accounted for in-line with the RED methodology.
- The electricity consumption at the CNG filling station is accounted for and is consistent with the JEC input data (0.022 MJ/MJ_{CNG}).

3. Assessment of BioGrace tool calculation sheets

BioGrace tool 'Calculation of Land use change (LUC) emissions'

Assessment scope: 1. Check that the calculation methodology follows the EC Decision 2010/335/EU, 2. comparison of the BioGrace tool with the annotated example prepared for the EC and available on the EC's Transparency Platform, see http://ec.europa.eu/energy/renewables/biofuels/sustainability_criteria_en.htm

- The annotated example assessed the carbon stock impact of a land use change from grassland to cropland, cultivating sugar beet in the East of England (i.e. to calculate e_l). The calculated value was then added to the typical value for the sugar beet to ethanol pathway to verify whether the 35% greenhouse gas savings was met.
- The values that were used in the calculation of the annotated example were inputted in to the BioGrace tool in the 'LUC' worksheet to check whether the calculated results were consistent.
- BioGrace provides two calculation options.
    - Option 1. Default calculation (no actual and accurate data are available) – for mineral soils only
    - Option 2. Actual calculation Carbon Stocks and Carbon vegetation – for mineral soils and organic soils (Option 1 can be used to calculate C_{VEG})
- Option 1 was used in the assessment. Data for the following parameters for Actual land use and Reference land use were inputted into BioGrace tool:
    - Above and below ground vegetation: C_{VEG}
    - Carbon stock in mineral soil: SOC_{ST}, F_{LU}, F_{MG}, F_I
- Sufficient instruction is provided on how to find the default values for these parameters. For example, by referencing the specific tables in the Decision.

- Once these parameters are entered, the BioGrace tool automatically calculates the carbon stocks, CS_A and CS_R (units: tC/ha) and resulting LUC, e_l (units: $tCO_2eq/ha/yr$). The calculation follows the EC Decision.
- The calculated value for e_l was 2.29 $tCO_2eq/ha/yr$ (cell E56).
- The resulting LUC emissions can be included in any of the biofuel pathways by selecting 'Yes' to the 'Does land use change occur?' in Land use change section of the pathway (e.g. cell C106 in the E-Sb pathway).
- e_l was calculated as 15 gCO_2/MJ in the BioGrace tool (10.7 gCO_2/MJ after allocation), which is consistent with the annotated example. The total pathway emissions with e_l included were consistent with the annotated example (51.0 gCO_2/MJ).

- The calculation method to calculate C_{VEG} (actual and reference) in Option 1 was also assessed and was found to correct and laid out in an easy to follow format. The calculation method follows point 5 in the Commission Decision.
- The worksheet includes suggested values for specific parameters as per the Decision. Namely: CF_B (0.47), CFD_W (0.5) and CFL_I (0.4). In the calculation of C_{BGD} either CF_B or R can be used (i.e. B_{BGB} x CF_B or B_{AGB} x R). The value of 0.47 is only applicable to CF_B, and is clarified by a comment box in cell V41.

- Option 2 requires data to be entered for SOC and C_{VEG} (cells E76, E77, I76, I77). CS_A and CS_R are then calculated and the resulting land use change emissions calculated (cell E78).
- The input data used to verify Option 1 was used to check the calculation in Option 2. The calculated values were consistent.

BioGrace tool 'Improved Agricultural Management (e_{sca}) emissions'

Assessment scope: Check that the calculation methodology follows the EC Decision 2010/335/EU

- BioGrace provides two calculation options.
  - Option 1. Default calculation (no actual and accurate data are available) – for mineral soils only
  - Option 2. Actual calculation Carbon Stocks – for mineral soils and organic soils
- Option 1 was used in the assessment. The BioGrace example data for the following parameters for Actual land use and Reference land use:
  - Climate region, Soli type, Soil management, Input
  - Carbon stock in mineral soil: SOC_{ST}, F_{LU}, F_{MG}, F_I
- Sufficient instruction is provided on how to find the default values for these parameters. For example, by referencing the specific tables in the Decision.
- Once these parameters are entered, the BioGrace tool automatically calculates the soil carbon stocks, SOC_A and SOC_R (units: tC/ha) and resulting soil

carbon accumulation e_{sca} (units: $tCO_2eq/ha/yr$). The calculation follows the EC Decision.

- The calculated value for e_{sca} was 0.445 $tCO_2eq/ha/yr$ (cell E52).
- The resulting soil carbon accumulation emissions can be included in any of the biofuel pathways by selecting 'Yes' to the 'Does improved agricultural management occur' in Improved agricultural management section of the pathway (e.g. cell C123 in the E-Sb pathway).
- Using the pre-entered values in the rows 40-48, e_{sca} was calculated as 2.9 gCO_2/MJ (no allocation applied) for the E-Sb pathway. This was checked and found to be correct.

- The same input data used in the verification of Option 1 was also used to check Option 2. In this case, the calculated value was also 0.445 $tCO_2eq/ha/yr$ (cell E73).

BioGrace tool 'Calculation of N_2O emissions using the IPCC methodology'

Assessment scope: 1. Check that the calculation methodology follows the IPCC Tier 1 approach, 2. 2. comparison of the BioGrace tool with the annotated example prepared for the EC and available on the EC's Transparency Platform, see http://ec.europa.eu/energy/renewables/biofuels/sustainability_criteria_en.htm

- The 'Communication from the commission on voluntary schemes and default values in the EU biofuels and bioliquids sustainability scheme' states that all three IPCC tiers could be used. The BioGrace tool includes a calculation sheet using Tier 1. The calculation methodology that forms the basis of this calculation sheet is described in IPCC's 2006 document Çhapter 11 – N_2O emissions from managed soils, and CO_2 emissions from lime and urea application' (available from: http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_11_Ch11_N2O&CO2.pdf).
- The calculation sheet includes predefined defaults for 7 crops: Sugar beet, Wheat, Corn, Sugar cane, Rapeseed, Sunflower, Soybeans and Palm. Additional crops can be added.
- The worksheet clearly references the relevant IPCC formula (where appropriate).
- For imported feedstocks assumptions for the N additions from crop residues is provided (rows 9-13). It is stated that these assumptions were used in the JEC calculations. These changes can be changed by the user.
- All 7 predefined crops result in a final value in kg N_2O/ha/year.
- The following information needs to inputted for the calculation of soil N_2O emissions:
    - General information: Crop name (as above - using a drop down list), Crop yield, Humidity (%), Straw yield (removed from the field), Is the soil water saturation level high? (Not known, Yes, No - using a drop down list)
    - Specific information in case of Land Use Change or modified agricultural practises: What type of land use change is it? (Not concerned, Undetermined, Forest to arable, Meadow to arable, Arable to arable land, Other – using a drop down list)

- Specific information for some imported crops: Only applies to Sugar cane and Palm. For Sugar cane the amount of vinasse and filter cake, and their N content needs to be entered. For Palm an additional value for the amount of crop residue that is returned to the field needs to be entered. The tool includes comments that state what the RED value is. For example, for Palm this 0.22 kg dm / kg wet FFB (FFB = Fresh Fruit Bunches).
- Direct N_2O emissions from managed soils (Tier 1): N in synthetic fertiliser, organic fertiliser and crop residues

- F_{CR} (annual amount of N in crop residues (above and below ground) is calculated according to IPCC formula 11.6. An alternative calculation is done according to IPCC formula 11.7a, but this value is not used. Note: $Frac_{Renew(T)}$ (fraction of total area under crop T that is renewed annually) is fixed at 1 in the calculation. This is the value for annual crops.
- Quantity of nitrate leaching (NO3_N (kg)) is dependent on the soil water saturation level selection. If No is selected then $Frac_{LEACH(H)}$ is set to zero, otherwise it is set to 30% (in-line with IPCC methodology).
- The worksheet then automatically calculates the N_2O emissions in a final value in kg N_2O/ha/year (using default tables).

- A comparison of the calculated soil N_2O emissions in BioGrace and the wheat to ethanol annotated was made. These were found to be consistent except that the annotated example did not consider N_2O emissions from crop residues.

4. Assessment of BioGrace calculation tool – adapting pathways for the calculation of actual values

Using the GHG result from previous and partial GHG calculations

Assessment scope: a) Replicating the two step by step examples provided in the User Manual (section 4.2). Namely: 'for one or more unallocated results for individual steps' and 'for one value including multiple steps', and b) Additional testing of the functionality BioGrace tool using the instructions provided in section 4.2.

- The two step by step examples were replicated in the BioGrace tool following the instructions provided in section 4.2 of the User Manual. The results were found to be consistent with those published in the User Manual.
- Additional testing of the BioGrace tool was undertaken using the 'E-Wt (NG-b)' pathway. The cultivation emissions in cell N41 (306.01 gCO_{2eq}/kg wheat) were overwritten with 300 gCO_{2eq}/kg wheat and this updated the calculated results in row 7 of the 'Overview Results' table.

Modifying input values

Assessment scope: Modifying input values in the BioGrace tool, pathway 'Ethanol from wheat (steam from natural gas boiler)'

- This aspect was checked when the BioGrace tool was compared to the annotated example (see section 3) and followed the instructions provided in the BioGrace User Manual (section 4.1).
- Input values can easily be changed in the BioGrace tool by simply overwriting the original input value. The input values were changed for all calculation steps.
- As discussed above the BioGrace tool has a track changes button which can be used when changes are made to input values. The button is automatically switched on when the tool is opened, but can be deactivated. The BioGrace calculation rules section 2.1.2 explicitly states that; "When actual calculations are made to show compliance with the RED/FQD GHG criteria, then the calculations shall: be subject to third party independent auditing; and be made with the version "for compliance" of the Excel tool[1] in which the "track changes" option is always turned on.." (See also section 4.1 of the User Manual).
- If the track changes button is activated then the cell changes colour from white to yellow with a red-box around the cell. A comment box also appears with the previous input value indicated. However, this only records the previous input value and not the original (i.e. default) input value.

Adding specific standard values for an existing input

Assessment scope: Addition on a specific standard value in the BioGrace tool, pathway 'Ethanol from wheat (steam from natural gas boiler)'

- An amended standard value for N-fertiliser was added to the BioGrace tool in the 'User defined standard values' worksheet and then used in the above pathway following the instructions provided in the BioGrace User Manual (section 4.3). This was judged to be straightforward process (for a user that is reasonably competent in MS Excel).
- Once entered in the 'User defined standard values' worksheet the BioGrace tool automatically includes the new standard value in the 'Standard values' worksheet. When the input value name was changed to the new name (e.g. N-fertiliser-input) in the pathway worksheet the model then automatically calculates the GHG emissions based on the revised standard value.
- Note: The BioGrace tool and User Manual provide instructions on what to do if the GHG emission coefficients for the standard value are aggregated (i.e. gCO_2eq) vs disaggregated (i.e. gCO_2, gCH_4 gN_2O). The User Manual also explains what to do if the GHG emission coefficients are expressed in different units to those in the pre-defined standard value.

Adding new input in pathway

Assessment scope: Addition on an input value in the BioGrace tool, pathway 'Ethanol from wheat (steam from natural gas boiler)'

- Diesel usage was added as an additional input to the 'Handling and Storage' calculation step in the above pathway following the instructions provided in the BioGrace User Manual (section 4.4). This was judged to be straightforward process (for a user that is reasonably competent in MS Excel).
- The GHG emissions associated with new input were reflected in the 'Overview Results' summary table (i.e. for 'Handling & Storage', 'Transport e_{td}' and 'Totals').
- A check was performed to see whether the emission calculations were correctly copied for the new input. This was done by overwriting the original input (i.e. Electricity EU mix LV) and input value with the new input and input value (i.e. so that the pathway now included two diesel inputs with the same input value). The calculated values for both (diesel) inputs were the same.