BIOGRACE II

Harmonised Greenhouse Gas Calculations for Electricity, Heating and Cooling from Biomass

GHG calculations under the COM (2010)11 and the SWD

GHG calculation course for verifier trainers (solid and gaseous biomass)

Contents

1. Presentation of the BioGrace project
2. Background of GHG calculations
3. Introduction to BioGrace II
4. Calculation rules with some examples

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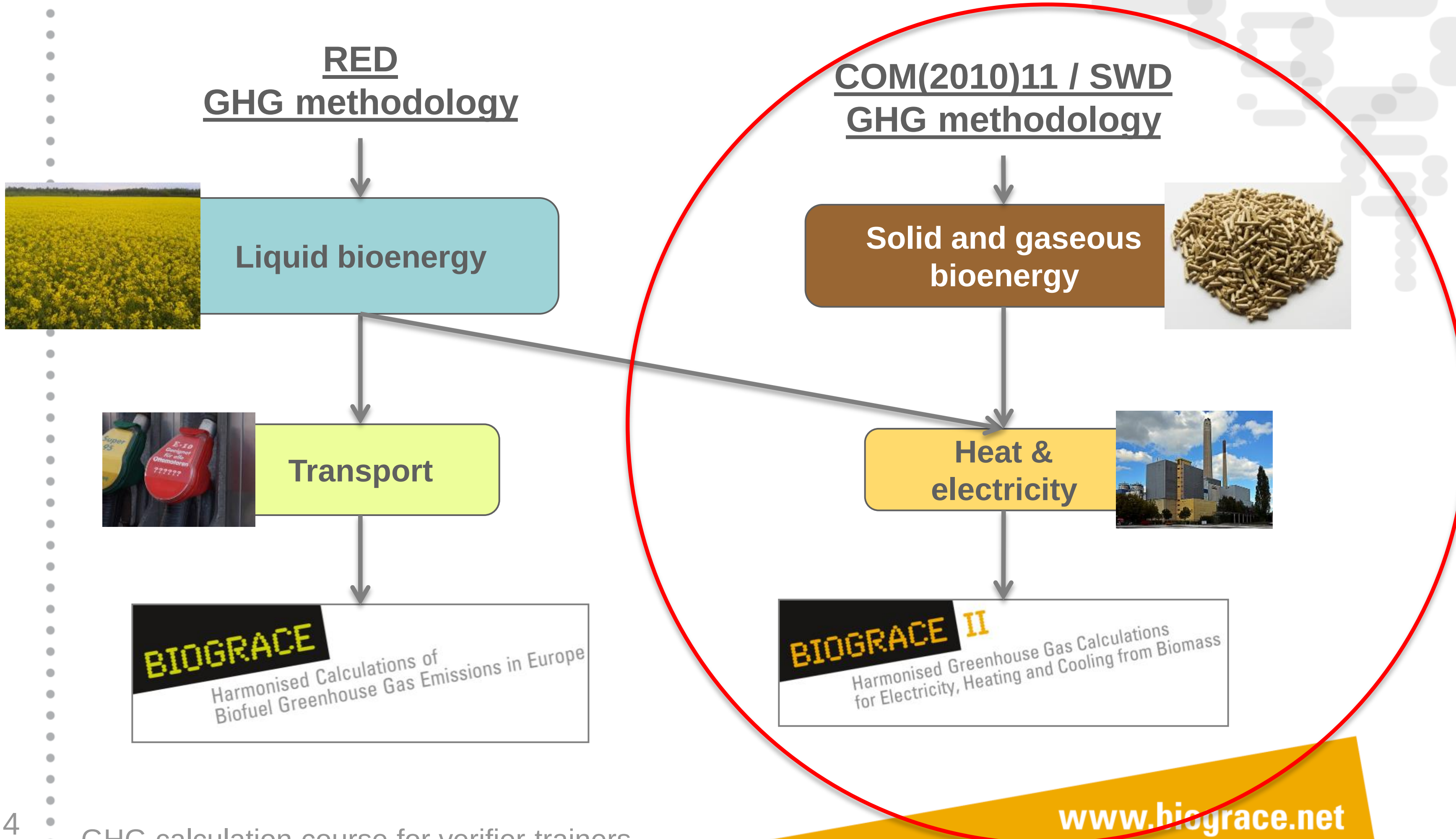
GHG calculations under the COM (2010)11 and the SWD

1. Presentation of the BioGrace Project

GHG calculation course for verifier trainers (solid and gaseous biomass)

Relationship between BioGrace I & II



BIOGRACE II

Harmonised Greenhouse Gas Calculations for Electricity, Heating and Cooling from Biomass

GHG calculations under the COM (2010)11 and the SWD

2. Background of GHG calculations

GHG calculation course for verifier trainers (solid and gaseous biomass)

Some comments before starting

- Course is interactive:
  - Questions and discussions most welcome !
  - Examples and exercises are important !
- Course focuses on verifying actual GHG calculations:
  - How to approve or disapprove with calculations?
  - Checking of data sources is not included
- Course focuses on the BioGrace II tool

Relevant documents

- Verification of actual GHG calculations can only be done if the verifier knows the requirements
  - from the European Commission (COM(2010)11, SWD(2014)259)
  - (from the voluntary scheme under which the verification is to take place)
- Please note that the content of the EC reports and staff working documents are not binding

Relevant documents

1. Report on sustainability criteria for solid and gaseous biomass COM (2010)11


EUROPEAN COMMISSION

Brussels, 25.2.2010
COM(2010)11 final

REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT

on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling

SEC(2010) 65 final
SEC(2010) 66 final

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0011:FIN:EN:PDF

Relevant documents

1. Report on sustainability criteria for solid and gaseous biomass COM (2010)11

- RED obliges Commission to report on sustainability requirements for energy uses of biomass other than biofuels (i.e. solid and gaseous fuels in electricity, heating and cooling)
- No binding criteria at EU level but recommendation to Member States on the development of their sustainability schemes (based on RED criteria)
- Proposal of an adapted GHG calculation methodology (Annex I)

Relevant documents

2. Commission Staff Working Document (SWD(2014)259): State of play on the sustainability criteria of solid and gaseous biomass

EUROPEAN COMMISSION

Brussels, 28.7.2014
SWD(2014) 259 final

COMMISSION STAFF WORKING DOCUMENT

State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU

http://ec.europa.eu/energy/renewables/bioenergy/doc/2014_biomass_state_of_play_.pdf

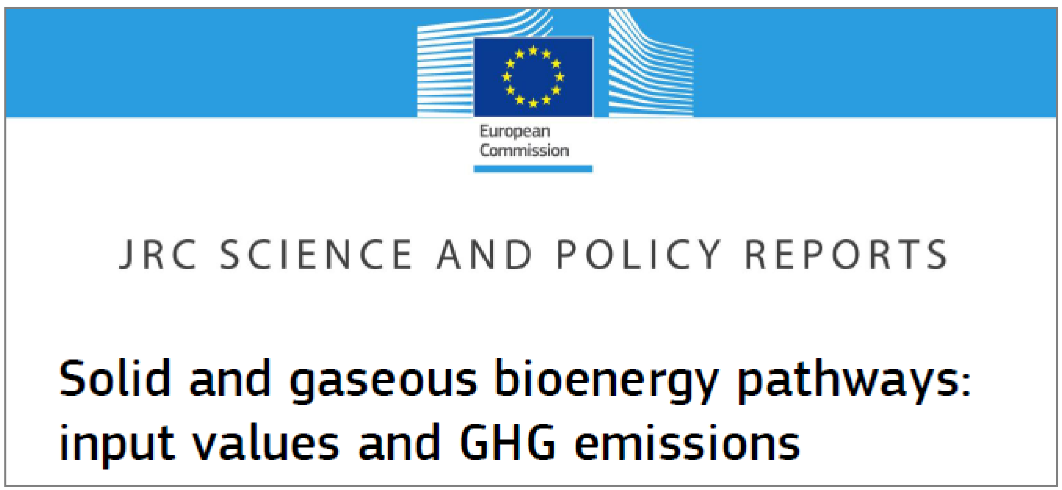
Relevant documents

2. Commission Staff Working Document (SWD(2014) 259)

- Increased demand and pressure towards Commission to take additional action related to sustainability at EU level
  - from the public, the Council and the Parliament
- SWD is to review the state of play of the sustainability of solid and gaseous biomass for electricity, heating and cooling
- Lists methodological adaptations compared to COM(2010)11 (box 2)
- Updated default values calculated by JRC

Relevant documents

3. JRC report on solid and gaseous pathways
Input values and GHG emissions


European Commission

JRC SCIENCE AND POLICY REPORTS

Solid and gaseous bioenergy pathways: input values and GHG emissions

https://ec.europa.eu/jrc/sites/default/files/eur26696_online_final_v3.pdf

Relevant documents

3. JRC report on solid and gaseous pathways

- Describes the assumptions made by JRC when calculating default and typical GHG emissions for solid and gaseous bioenergy pathways
- Gives the results of the calculations in terms of typical and default GHG emission values
- Applies the methodology set in COM(2010)11 and SWD(2014) 259

Sustainability criteria for solid biomass

- Only few countries have implemented some sort of legally binding sustainability criteria for solid biomass

Country	Status	Energy specific sustainability criteria
BE	Adopted in 2007	Financial incentives linked to GHG savings, SFM requirements for forest biomass
HU	Adopted in 2010	SFM requirements for forest biomass
IT	Adopted in 2012	Minimum GHG saving threshold for forest biomass
UK	Adopted in 2013	Minimum GHG saving threshold for solid and gaseous biomass, land use criteria for agricultural biomass, timber standard for woodfuel for heat and electricity
NL	Planned for end of 2014	GHG saving performance, forest carbon stock and ILUC impacts

National sustainability criteria for biomass used in heat and electricity (SWD(2014)259)

- Other GHG calculation tools in the UK and in Wallonia

Basics of actual GHG calculations

- For making GHG calculations, you need:
  1. A methodology / rules
  2. Data from the process,
     such as yield of feedstock, input of fertilisers, efficiency of conversion plant, natural gas and electricity input etc. etc.
  3. Numbers/coefficients to convert data into GHG emissions
  4. Data/numbers for the reference process

- Important to understand:
  - LCA studies can be complicated and time-consuming
  - GHG calculations under EU legislation are to some extend pragmatic, a number of assumptions have been made

Basics of actual GHG calculations

- <u>1. Methodology:</u> COM(2010)11 and SWD(2014)259

$$E = e_{ec} + e_l + e_p + e_{td} + e_u - e_{sca} - e_{ccs} - e_{ccr}$$

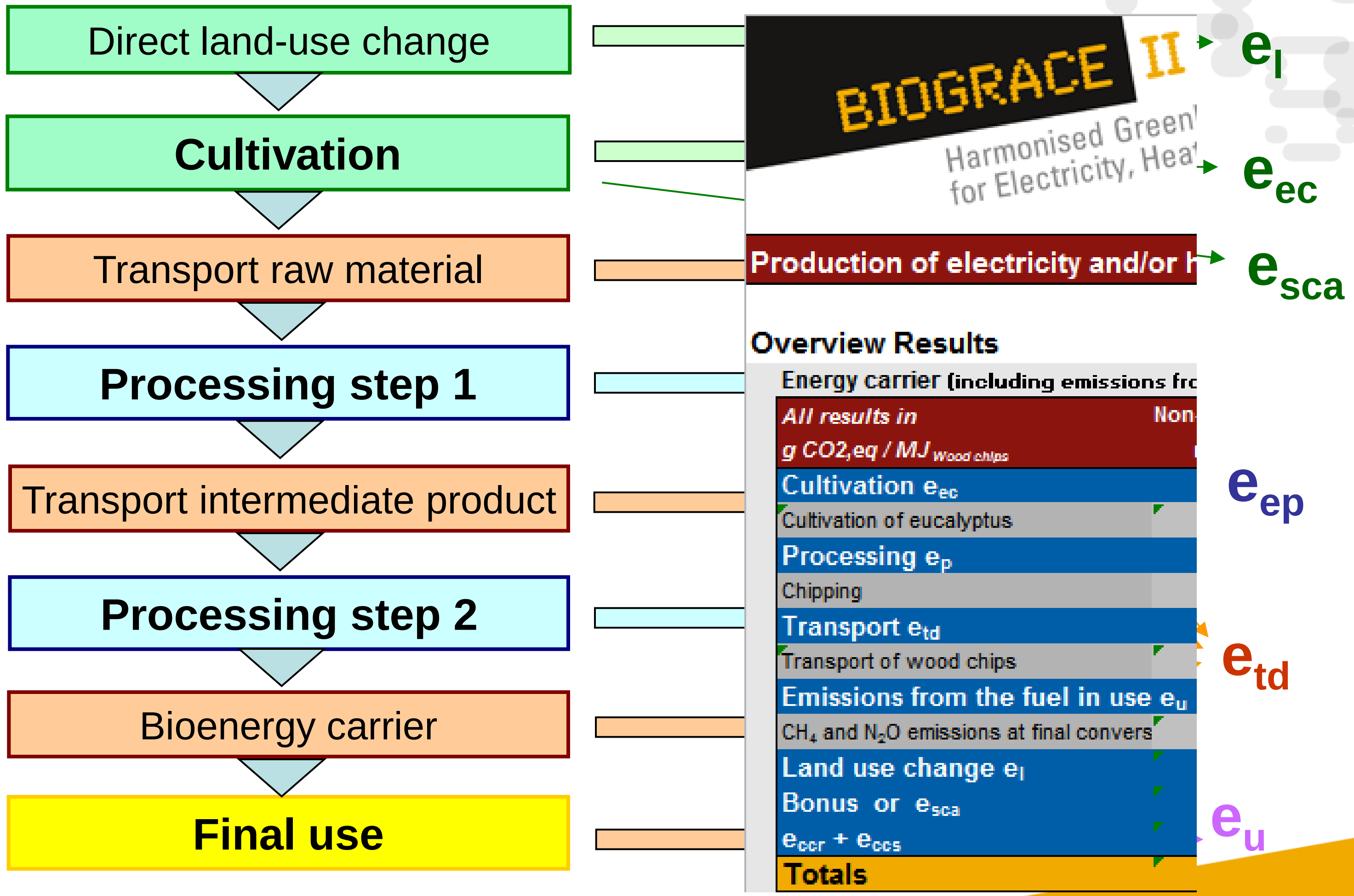
$ee_{ccs/ccr}$: very scarcely applied

e_u: Only CO_2 emissions are zero

e_l and e_{sca} : following the decision 2010/335/EU

e_{ec}, e_p, e_{td} = basic „disaggregated default values“

Basics of actual GHG calculations



Basics of actual GHG calculations

Methodology contains:

- The functional unit: gram $CO_{2,eq}$ per $MJ_{bioenergy\ carrier}$
- A rule that the default value is divided by the actual energy conversion efficiency
- A decision on how to deal with co-products:
  - Electricity, heat, cooling: allocation based on exergy
  - Others: allocation based on energy content
- A rule that for anaerobic co-digestion of different substrates, the mass-balance approach defined in the RED and in the COM(2010)11 is suspended.
- A rule that there is a bonus if manure is used for biogas / biomethane production

Basics of actual GHG calculations

Methodology contains:

- An approach how to calculate e_l and e_{sca}
- A bonus for biofuels from degraded and heavily contaminated land (definition still to be given)
- A rule that wastes and residues are considered to have zero emissions up to the process of their collection
- Emission values for reference systems (electricity, heat, cooling)

Basics of actual GHG calculations

- Methodology does **not** contain:
  - Values for emission coefficients
  - A precision of "defined region" for electricity from the grid
  - A statement on which small emissions can be neglected
- The communications (related to the RED) contain some of these topics, however, communications are non-binding

Basics of actual GHG calculations

- For making GHG calculations, you need:
  1. A methodology / rules
  2. Data from the process,
     such as yield of feedstock, input of fertilisers, efficiency of conversion plant, natural gas and electricity input etc. etc.
  3. Numbers/coefficients to convert data into GHG emissions
  4. Data/numbers for the reference process

- Important to understand:
  - LCA studies can be complicated and time-consuming
  - GHG calculations under EU legislation are to some extend pragmatic, a number of assumptions have been made

Basics of actual GHG calculations

2. Data from the process

- In this course further called "input data"
- We have not been able to receive examples on how companies collect such data and send them to verifiers
- We assume that verifiers need no training on how to verify actual numbers delivered, such as
  - amount of natural gas and electricity consumed in a biofuel production plant over a given time span
  - Yield of a crop and input of fertilisers, pesticides etc over a given time span

Basics of actual GHG calculations

3. Numbers/coefficients to convert data into GHG emissions

- Are, for instance:
  - Emission coefficients (*eg* gram $CO_2/CH_4/N_2O$ per MJ natural gas)
  - Lower heating values (MJ/kg)
  - Densities (kg/litre)
  - Transport efficiencies (MJ_{fuel} per ton per km)
  - Emissions of CH_4 and N_2O for boilers, CHP's (gram per MJ steam), trucks and ships (gram per ton per km)
- In GHG calculation tools these numbers/coefficients are assumed to be "fixed" or "standard"
- In this course further called "standard values"

Basics of actual GHG calculations

- Input data
- Standard values ("conversion factors")

Cultivation of eucalyptus			Quantity of product	Calculated emissions		
				Emissions per MJ wood pellets		
Yield				g CO_2	g CH_4	g N_2O
Eucalyptus (SRC)	25.867	kg ha^{-1} $year^{-1}$	2,5E+05 MJ_{SRC} ha^{-1} $year^{-1}$			
Moisture content	50%		1,000 MJ / $MJ_{SRC, input}$			
			1063 $kg_{Wood\ chips,\ wet}$ / $MJ_{Wood\ pellets}$			
Energy consumption						
Diesel	1.469	MJ ha^{-1} $year^{-1}$		0,57	0,00	0,00
CH_4 and N_2O emissions from use of diesel (agriculture)		(harvesting and chipping)		0,00	0,00	0,00
Agro chemicals						
Synthetic N-fertiliser (kg N)	228,2	kg N ha^{-1} $year^{-1}$		3,45	0,01	0,00
Manure	0,0	kg N ha^{-1} $year^{-1}$		0,00	0,00	0,00
CaO-fertiliser (calculated as kg CaO)	266	kg CaO ha^{-1} $year^{-1}$		0,09	0,00	0,00
K_2O-fertiliser (kg K_2O)	182,6	kg K_2O ha^{-1} $year^{-1}$		0,44	0,00	0,00
P_2O_5-fertiliser (kg P_2O_5)	87,5	kg P_2O_5 ha^{-1} $year^{-1}$		0,40	0,00	0,00
Pesticides	1,6	kg ha^{-1} $year^{-1}$		0,08	0,00	0,00
Field CO_2 emissions (acidification)	74,5	kg ha^{-1} $year^{-1}$		0,31	0,00	0,00
Seeding mate						
Seeds- eucalyp						
Field N_2O emis						
Field N_2O emissions can be calculated in the sheet N2O emissions GNOC				Total 5,34	0,01	0,02
			Result	g $CO_{2,eq}$ / $MJ_{Wood\ pellets}$		

STANDARD VALUES				
parameter:	GWP			
unit:	$gCO_{2,eq}$ / g	gCO_2/kg	gCH_4/kg	gN_2O/

Basics of actual GHG calculations

4. Data/numbers for the reference process

- Are defined in SWD(2014) 259
  - Electricity: 186 g CO_{2eq} / MJ
  - Heat: 80 g CO_{2eq} / MJ
  - Natural gas: 72 g CO_{2eq} / MJ
  - Cooling: 47 g CO_{2eq} / MJ

- Based on a marginal approach
  - In COM(2010)11 the European average was used

Verification of GHG calculations

When **verifying actual calculations**, a verifier should check:

1. Methodology and rules
2. Input data
3. Conversion numbers (standard values)
4. Data/numbers for the reference process
5. The calculation itself

BIOGRACE II

Harmonised Greenhouse Gas Calculations for Electricity, Heating and Cooling from Biomass

GHG calculations under the COM (2010)11 and the SWD

2. Introduction to the BioGrace II tool

GHG calculation course for verifier trainers (solid and gaseous biomass)

Directory / Navigation tool

BIOGRACE II
Harmonised Greenhouse Gas Calculations for Electricity, Heating and Cooling from Biomass
www.biograce.net
Co-funded by the Intelligent Energy Europe Programme of the European Union
About | Directory

Directory of pathways — Version 2.0.2 - draft in progress - December 2014

1 Wood chips from forest residues
2 Wood chips from short rotation coppice (Eucalyptus)
3 Wood chips from short rotation coppice (Poplar)
4 Wood chips from stemwood
5 Wood chips from industry residues
6 Wood briquettes or pellets from forest residues
7 Wood briquettes or pellets from short rotation coppice (Eucalyptus)
8 Wood briquettes or pellets from short rotation coppice (Poplar)
9 Wood briquettes or pellets from stemwood
10 Wood briquettes or pellets from wood industry residues
11 Agricultural residues
12 Pellets from straw
13 Pellets from bagasse
14 Palm kernel meal
15 Pure plant oil from rapeseed
16 Pure plant oil from sunflower seed
17 Pure plant oil from soybean
18 Pure plant oil from jatropha seed
19 Pure plant oil from palm oil
20 Waste cooking oil
21 Animal fats from animal waste
22 Biogas from wet manure
23 Biogas from maize
24 Biogas from biowaste
25 Biomethane from wet manure
26 Biomethane from maize
27 Biomethane from biowaste

Calculation of direct land use change (LUC)
Calculation of Improved Agricultural Management
Calculation of N_2O field emissions according to IPCC Tier 1
Calculation of N_2O field emissions with GNOC
Calculation of net heat and electricity efficiencies
Calculation of default values for co-digestion
Calculation of actual values for co-digestion (biogas)
Calculation of actual values for co-digestion (biomethane)
Final conversion only

About

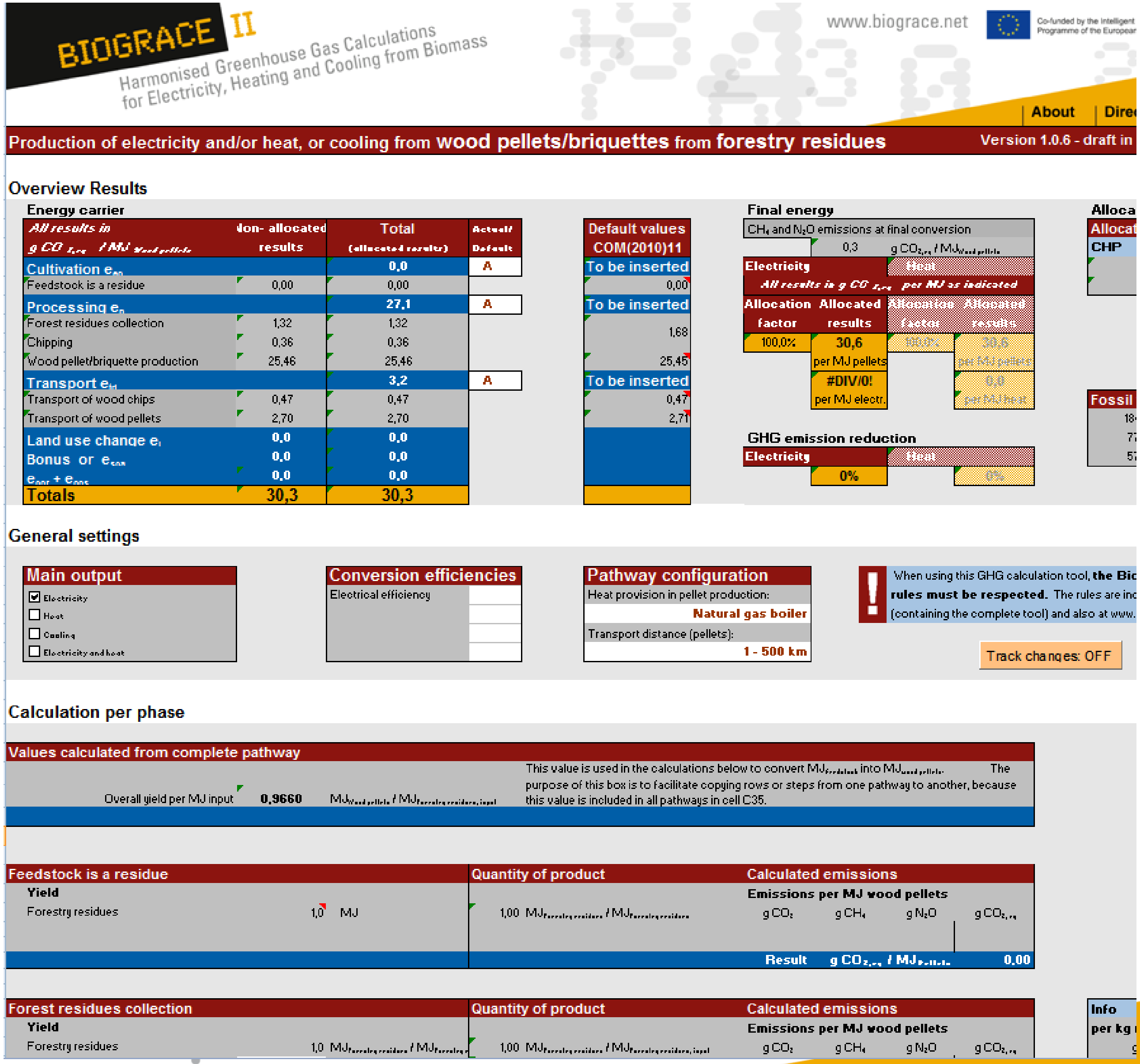
Standard values
User defined standard values
User specific calculations

- Includes all pathways for which a SWD default values exist
- One calculation sheet per pathway
- Easy directing to other sheets

BIOGRACE II

Harmonised Greenhouse Gas Calculations for Electricity, Heating and Cooling from Biomass

INTELLIGENT ENERGY EUROPE



I. Overview results

II. General settings

III. Calculation per phase

www.biograce.net

I. Overview results

Energy carrier

Final energy

Overview Results

Energy carrier

All results in g $CO_{2,eq}$ / MJ $_{Wood\ pellets}$	Non- allocated results	Total (allocated results)	Actual/ Default	Default values EC report
Cultivation e_{ec}		1,0	A	1
Cultivation and harvesting	0,98	0,98		0,98
Processing e_p		25,8	A	25,8
Chipping	0,36	0,36		25,81
Wood pellet/briquette production	25,46	25,46		
Transport e_{td}		3,2	A	3,2
Transport of roundwood	0,00	0,00		0,00
Transport of wood chips	0,47	0,47		0,47
Transport of wood pellets	2,70	2,70		2,7
Land use change e_l	0,0	0,0		
Bonus or e_{sca}	0,0	0,0		
e_{ccr} + e_{ccs}	0,0	0,0		
Totals	**30,0**	**30,0**		

Final energy

CH_4 and N_2O emissions at final conversion: 0,3 g $CO_{2,eq}$ / MJ $_{Wood\ pellets}$

Electricity		Heat	
All results in g $CO_{2,eq}$ per MJ as indicated			
Allocation factor	Allocated results	Allocation factor	Allocated results
84,9%	25,7 per MJ pellets	15,1%	4,6 per MJ pellets
	85,6 per MJ electr.		30,3 per MJ heat

GHG emission reduction

Electricity	Heat
53%	61%

Final conversion based on actual efficiency

I. Overview results

Energy carrier

All results in g $CO_{2,eq}$ / MJ $_{Wood\ chips}$	Non- allocated results	Total (allocated results)	Actual/ Default	Default values EC report
Cultivation e_{ec}		0,0	A	0,0
Feedstock is a residue	0,00	0,00		0,00
Processing e_p		1,73	A	1,7
Forest residues collection	1,38	1,38		
Forest residues seasoning	0,00	0,00		1,73
Chipping	0,36	0,36		
Transport e_{td}		3,35	A	3,4
Transport of wood chips	3,35	3,35		3,35
Land use change e_l	0,0	0,0		
Bonus or e_{sca}	0,0	0,0		
e_{ccr} + e_{ccs}	0,0	0,0		
Totals	**5,1**	**5,1**		**5**

Final energy

CH_4 and N_2O emissions at final conversion: 0,4 g $CO_{2,eq}$ / $MJ_{Wood\ chips}$

Electricity		Heat	
All results in g $CO_{2,eq}$		*per MJ as indicated*	
Allocation factor	Allocated results	Allocation factor	Allocated results
42,9%	2,4 per MJ chips	57,1%	3,1 per MJ chips
	14,8 per MJ electr.		5,2 per MJ heat

GHG e[illegible]n reduction

Electricity	Heat
[illegible]	93%

Allocatio[illegible]rs & references

Allocation [illegible]	
Production chain	
100,0%	to energy carrier
0,0%	to co-product(s)
CHP	
42,9%	to electricity
57,1%	to heat

Fossil fue[illegible]erences	
184	g $CO_{2,eq}/MJ_{electricity}$
77[illegible]	g $CO_{2,eq}/MJ_{heat}$
[illegible]	g $CO_{2,eq}/MJ_{cooling}$

I. Overview results

Allocation factors and references

Allocation factors & references

Allocation factors	
Production chain	
100,0%	to energy carrier
0,0%	to co-product(s)
CHP	
100,0%	to electricity
100,0%	to heat

Fossil fuel references	
184	g $CO_{2,eq}/MJ_{electricity}$
77	g $CO_{2,eq}/MJ_{heat}$
57	g $CO_{2,eq}/MJ_{cooling}$

Allocation of by-products and main products in production chain: Lower Heating Value

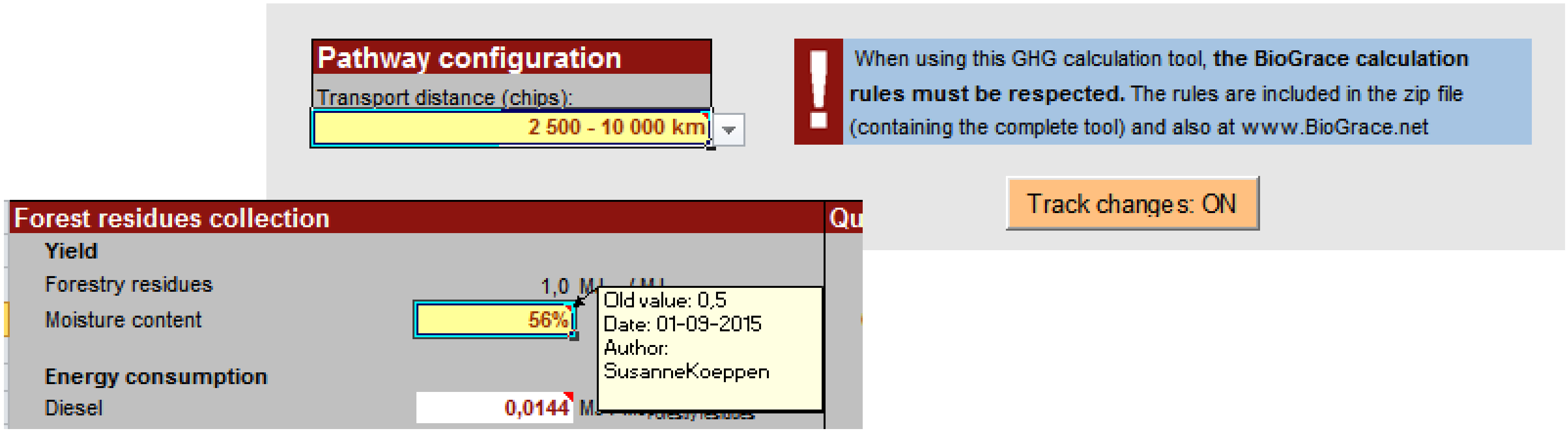
Allocation of electricity and heat (CHP) according to Carnot efficiency:

$$EC_{el} = \frac{E}{\eta_{el}}\left(\frac{C_{el} \cdot \eta_{el}}{C_{el} \cdot \eta_{el} + C_h \cdot \eta_h}\right)$$

(along and at the end of pathway)

When actual calculations are done:

- The Biograce rules must be followed
- Track changes must be switched on:
  - Highlights all changes
  - Shows editor's name and old values in the comment field



II. General settings

Main output
☐ Electricity
☐ Heat
☐ Cooling
☑ Electricity and heat

Conversion efficiencies	
Electrical efficiency	15,0%
Thermal efficiency	60,0%
	56,0%
Temp of useful heat (°C)	150,0

Pathway configuration
Heat provision in pellet production:
Natural gas boiler
Transport distance (pellets):
1 - 500 km

Without filling this in, NO GHG emissions reductions will be calculated !

Please note!

Please note !

When starting to use this Excel tool, you should first enter values in the "General settings" by choosing the main output, by entering the conversion efficiencies and by choosing the most appropriate pathway configuration (note that boiler/CHP settings and transport distances can always be adjusted to actual values further down this calculation sheet).

If you do not select the main output and enter conversion efficiencies, there will be no GHG emission reduction calculated for electricity, heat or cooling, which is the purpose of this tool. The tool can then be used for information purposes and will give a result in g CO2,eq per MJ of energy carrier and (in the info boxes in column N) in g CO2,eq per kg of energy carrier for solid and liquid biomass.

☐ Do not show this screen any more

Close

Indication of actual (A) and default values (D)

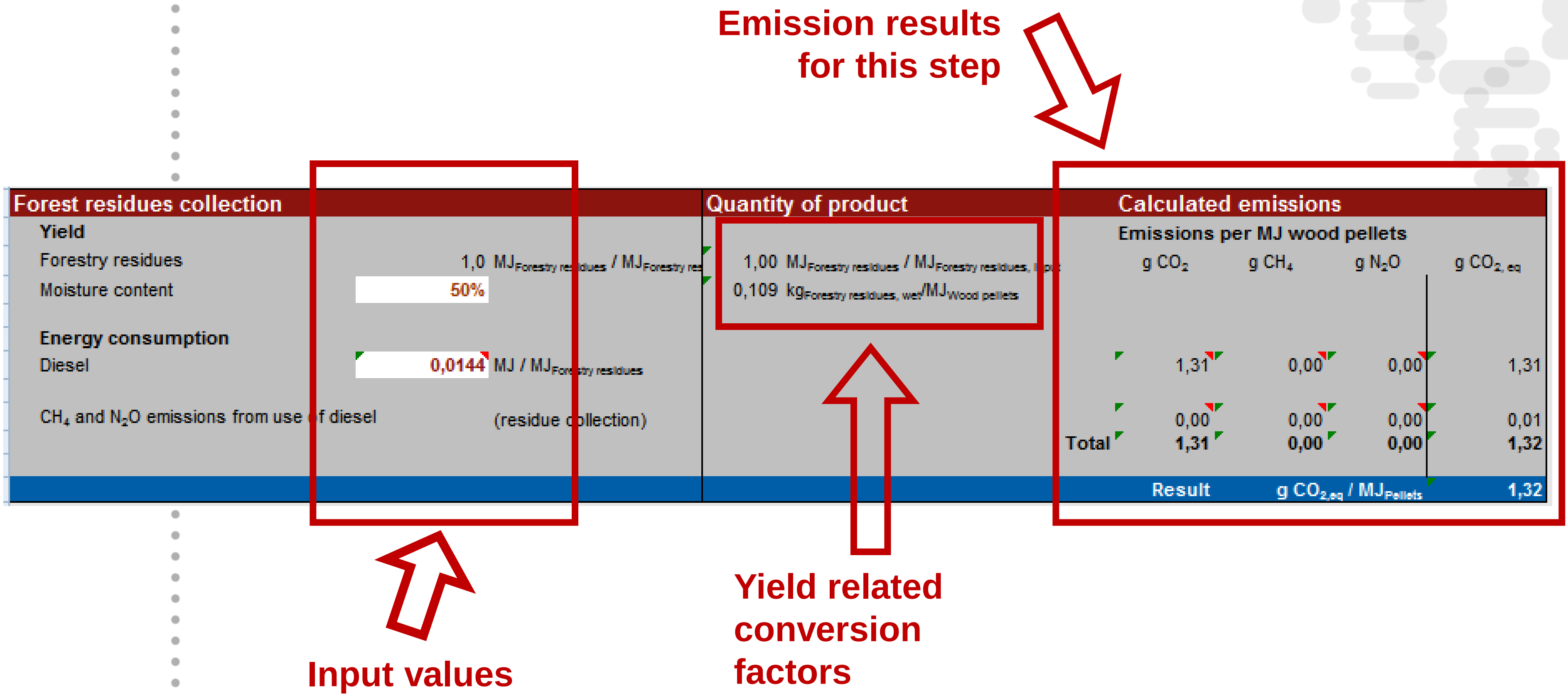
Overview Results

Energy carrier (including emissions from the fuel in use)

All results in g $CO_{2,eq}$ / $MJ_{Wood\ chips}$	Non- allocated results	Total (allocated results)	Actual/ Default	Default values IPC report
Cultivation e_{ec}		0,0	D	
Feedstock is a residue	0,00	0,00		0,00
Processing e_p		1,9	A	
Forest residues collection	1,48	1,48		
Forest residues seasoning	0,00	0,00		1,86
Chipping	0,38	0,38		
Transport e_{td}		11,7	A	11,7
Transport of forestry residues	0,00	0,00		0,00
Transport of wood chips	11,70	11,70		11,69
Emissions from the fuel in use e_u		0,5	A	0,5
CH_4 and N_2O emissions at final convers	0,50	0,50		0,50
Land use change e_l	not applicable			
Bonus or e_{sca}	not applicable			
e_{ccr} + e_{ccs}	0,0	0,0		
Totals	**14,1**	**14,1**		**14**

Old value: A
Date: 01-09-2015
Author:
SusanneKoeppen

III. Calculation per phase – Cultivation e_{ec}



III. Calculation per phase – Cultivation e_{ec}

Calculated emissions			
Emissions per MJ wood pellets			
g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
1,31	0,00	0,00	1,31
0,00	0,00	0,00	0,01
1,31	**0,00**	**0,00**	**1,32**
Result	g $CO_{2,eq}$ / $MJ_{Pellets}$		1,32

Info	
per kg residu	per ha, year
g $CO_{2,eq}$	kg $CO_{2,eq}$
12,01	-
0,13	
12,14	

Results related to different units

Principle of calculation

- Input data
- Standard values ("conversion factors")

Forest residues collection			Quantity of product	Calculated emissions			
Yield				Emissions per MJ wood pellets			
				g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Forestry residues		1,0 $MJ_{Forestry\ residues}$ / $MJ_{Forestry\ res}$	1,00 $MJ_{Forestry\ residues}$ / $MJ_{Forestry\ residues,\ Input}$				
Moisture content	50%		0,109 $kg_{Forestry\ residues,\ wet}$/$MJ_{Wood\ pellets}$				
Energy consumption							
Diesel	0,0144	MJ / $MJ_{Forestry\ residues}$		1,31	0,00	0,00	1,31
CH_4 and N_2O emissions from use of diesel		(residue collection)		0,00	0,00	0,00	0,01
			Total	1,31	0,00	0,00	1,32
			Result	g $CO_{2,eq}$ / $MJ_{Pellets}$			1,32

STANDARD VALUES	GWP	GHG emissio			
parameter:	GWP				GHG emissio
unit:	$gCO_{2,eq}$/ g	gCO_2/kg	gCH_4/kg	gN_2O/kg	gCO_{2-eq}/kg

List of standard values

STANDARD VALUES					
parameter:	GWP				GHG emissio
unit:	$gCO_{2,eq}$/ g	gCO_2/kg	gCH_4/kg	gN_2O/kg	$gCO_{2\text{-}eq}$/kg
Global Warming Potentials (GWP's)					
CO_2	1				
CH_4	25				
N_2O	298				
Agro inputs					
N-fertiliser (kg N)		3794,0	7,93	7,3150	6172,1
P_2O_5-fertiliser (kg P_2O_5)		991,2	1,40	0,0532	1042,1
K_2O-fertiliser (kg K_2O)		547,9	1,60	0,0129	591,8
CaO-fertiliser (calculated as kg CaO)		65,2	0,12	0,0029	69,0
CaO-fertiliser (calculated as kg $CaCO_3$)		36,5	0,07	0,0016	38,7
Pesticides		10371,8	28,44	1,7145	11593,8
Seeds- barley		176,8	0,39	0,4005	305,9
Seeds- corn		176,8	0,39	0,4005	305,9
Seeds- corn (whole plant)		176,8	0,39	0,4005	305,9
Seeds- cottonseed					0,0
Seeds- jatropha					0,0

User defined standard values

User Defined Standard Values parameter: unit:	Comments	gCO2/kg	gCH4/kg	gN2O/kg	GHG emissio gCO2-eq/kg
User defined standard values					
Example 1 (diesel from standard values)					0
Example 2 (methanol from standard values)					0
Example 3 (N-fertiliser from standard values)		2827,0	8,68	9,6418	5917,2313
					0
Ammonium nitrate		2900,0	0,00	0,0000	2900
Urea		1707,0	0,00	0,0000	1707
Compound		5376,0	0,00	0,0000	5376
					0

fill in actual data

List of additional standard values

- When a standard value is not on the BioGrace-II 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.

Contains data for selections of

- mineral fertilizer types and other agro inputs
- conversion inputs (process chemicals)
- national electricity grids
- solid and gaseous biomass sources for energy
- transport (pipeline)

Wood pellet/briquette production			Quantity of product	Calculated emissions			
Yield				**Emissions per MJ wood pellets**			
				g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Pelletising efficiency	0,990	MJ$_{Pellets}$ / MJ$_{Wood\ chips}$	0,724 MJ$_{Pellets,\ gross}$ / MJ$_{Forestry\ residues,\ input}$				
Wood pellets	0,742	MJ$_{Pellets,\ gross}$ / MJ$_{Wood\ chips}$	0,724 MJ$_{Pellets,\ net}$ / MJ$_{Forestry\ residues,\ input}$				
Wood pellets	0,742	MJ$_{Pellets,\ net}$ / MJ$_{Wood\ chips}$	0,058 kg$_{Wood\ pellets}$/MJ$_{Wood\ pellets}$				
Moisture content of wood pellets	10%						
Factor from typical to default values	1,2						
Energy consumption							
Electricity (including input into boiler)	0,0499	MJ / MJ$_{Pellets,\ gross}$	(emissions are calculated below the light grey boiler/CHP box)				
Diesel	0,0020	MJ / MJ$_{Pellets,\ gross}$	(internal transport)	0,18	0,00	0,00	0,18
CH_4 and N_2O emissions from use of diesel				0,00	0,00	0,00	0,00
Heat	0,1853	MJ / MJ$_{chips}$					
Wood chip CHP (dimensioned on heat)	1	Emissions wood chip CHP	included in final results	Emissions from wood chip CHP			
Thermal efficiency of wood chip CHP	69,6	% (MJ$_{heat}$ / MJ$_{chips}$)	Click here for information on calculation strategy				
Wood chips to be fired in CHP are:	dried		The chips are dried towards same moisture content as chips fed to pellet mill, requiring additional heat inpu				
Wood chip consumption in CHP	0,3664	MJ / MJ$_{Pellets,\ gross}$	The formula to calculate the wood chip input into the CHP is explained in the user manual				
Electrical efficiency of wood chip CHP	16,3	% (MJ$_{electricity}$ / MJ$_{chips}$)	Please note that the CHP is dimensioned to the heat demand				
Heat generation from CHP	0,2550	MJ / MJ$_{Pellets,\ gross}$					
Heat supply to pellet mill	0,1871	MJ / MJ$_{Pellets,\ gross}$					
Heat supply for drying chips into CHP	0,0679	MJ / MJ$_{Pellets,\ gross}$					
Electricity generation from CHP	0,0597	MJ / MJ$_{Pellets,\ gross}$	Electricity generation is equal to or larger than electricity demand				
Electricity supply to pellet production	0,0499	MJ / MJ$_{Pellets,\ gross}$					
Surplus electricity	0,0098	MJ / MJ$_{Pellets,\ gross}$					
Use exergy to allocate emissions to heat and electricity							
Temperature of heat to pellet productior	150	°C					
Allocation factor electricity	0,3977		This factor is used to calculate the emissions allocated to the net electricity ouput of the CHP				
Allocation factor heat	0,6023		This factor is used to calculate the emissions allocated to the heat output of the CHP				
Calculate "apparent allocation factor" of emissions related to wood chips used in CHP							
Fraction CHP emissions to heat to pellet mill (into calculation)			0,4419				
Fraction CHP emissions to heat for drying CHP wood chips (into calculation)			0,1478				
Fraction CHP emissions to electricity to pellet mill (into calculation)			0,3324				
Fraction CHP emissions to surplus electricity (outside calculation)			0,0653	This is the fraction of the wood pellets to the CHP and the CHP emissions which			
Fraction CHP emissions to heat for drying wood chips to excess el. (outside calcul			0,0125	must be left outside the GHG calculation for the wood pellet pathway.			
Resulting "apparent allocation factor"			0,92				
Apply this "apparant allocation factor" to emissions related to CHP (CH4 and N2O emissions) and to emissions related to wood chip supply to CHP							
"Apparent amount of wood chips" needed for heat/electricity for wood pellet mill			0,3379	(this amount is used to calculate the net amount of pellets per MJ of wood chips)			
CH_4 and N_2O emissions from wood chip CHP			(only fraction into calculations)	0,00	0,00	0,00	0,14
Electricity use in wood pellet production plus CHP that is not supplied by CHP							
Electricity EU mix (0.4 kV)	0,0000	MJ / MJ$_{Pellets,\ gross}$	zero as CHP povides all electricity needed	0,00	0,00	0,00	0,00
			Total	**0,21**	**0,00**	**0,00**	**0,38**
			Result	g $CO_{2,eq}$ / MJ$_{Pellets}$			0,38

III. Calculation per phase – Transport e_{td}

Transport of wood chips			Quantity of product	Calculated emissions				
Wood chips	1,00	$MJ_{Wood\ chips}$ / $MJ_{Wood\ chips}$		**Emissions per MJ wood pellets**				
Moisture content	50%		0,976 $MJ_{Wood\ chips}$ / $MJ_{Forestry\ residues,\ input}$		g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
			0,153 $kg_{Wood\ chips,\ wet}$/$MJ_{Wood\ pellets}$					
Transport per								
Truck (40 ton) for chips (and similar siz	50	km	0,0051 ton km / $MJ_{Forestry\ residues,\ input}$		0,65	0,00	0,00	0,67
Fuel	Diesel			**Total**	**0,65**	**0,00**	**0,00**	**0,67**
				Result		g $CO_{2,eq}$ / $MJ_{Pellets}$		**0,67**

Transport of wood pellets			Quantity of product	Calculated emissions				
Wood pellets	1,000	$MJ_{Pellets}$ / $MJ_{Pellets}$		**Emissions per MJ wood pellets**				
			0,670 $MJ_{Pellets}$ / $MJ_{Forestry\ residues,\ input}$		g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Transport per								
Truck (40 ton) for pellets (Diesel)	0	km	0,0000 ton km / $MJ_{Forestry\ residues,\ input}$		0,00	0,00	0,00	0,00
Fuel	Diesel							
Freight train USA (diesel)	750		0,0294 ton km / $MJ_{Forestry\ residues,\ input}$		0,96	0,00	0,00	0,99
Fuel	Diesel							
Bulk Carrier class "Handy" - pellets	16500		0,6467 ton km / $MJ_{Forestry\ residues,\ input}$		10,10	0,00	0,00	10,10
Fuel	HFO for maritime transport							
				Total	**11,06**	**0,00**	**0,00**	**11,09**
				Result		g $CO_{2,eq}$ / $MJ_{Pellets}$		**11,09**

Input data

III. Calculation per phase – Final conversion

Final conversion (CH_4 and N_2O emissions only)						
Type of fuel used in end conversion	Wood pellet	Please note: these emissions will not be added to the pathway emissions (which are expressed per $MJ_{wood\ pellets}$) but will be added to the emissions per MJ_{heat} and per $MJ_{electricity}$ in the result section				
Type of end conversion	CHP					
Include following emissions	CH4 and N2O emissions from Wood pellet CHP		0,00	0,00	0,00	0,25
No emissions added to pathway emissions, emissions will be added in result section						0,00

- ➔ CH_4 and N_2O emissions only
- ➔ Depending on type of final conversion
- ➔ Added to emissions per MJ final energy (e.g. electricity) in the ‚Overview result' section

Final energy

CH_4 and N_2O emissions at final conversion			
	0,3	g $CO_{2,eq}$ / $MJ_{Wood\ pellets}$	
Electricity		Heat	
All results in g $CO_{2,eq}$ per MJ as indicated			
Allocation factor	Allocated results	Allocation factor	Allocated results
100,0%	12,0 per MJ pellets	100,0%	12,0 per MJ pellets
	47,9 per MJ electr.		0,0 per MJ heat

GHG emission reduction

Electricity		Heat	
	74%		0%

III. Calculation per phase – Total results

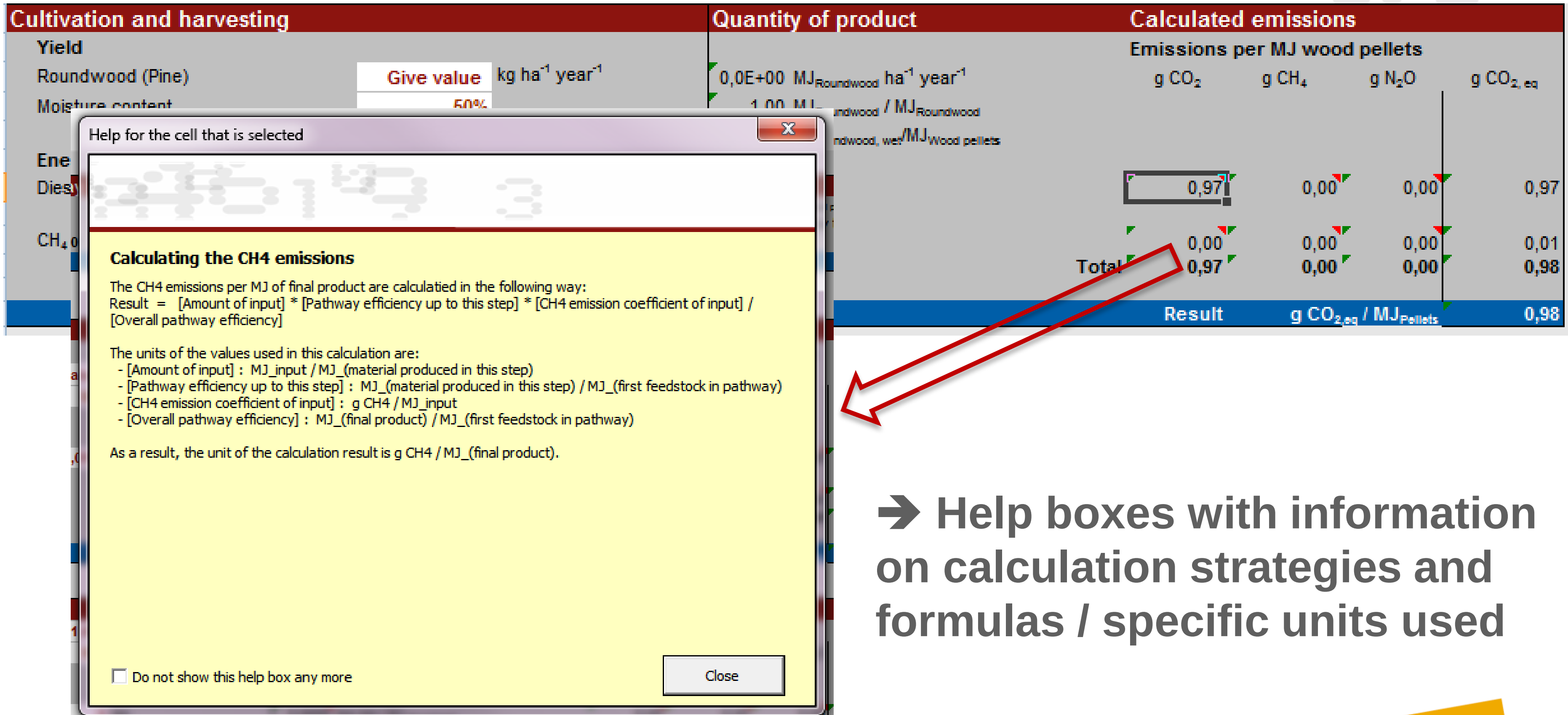
Consistency check		
Total emission without allocation	g $CO_{2,eq}$ / $MJ_{Pellets}$	11,73
Total emission with allocation	g $CO_{2,eq}$ / $MJ_{Pellets}$	11,73
Is pathway consistent?	Yes	
End of pathway		

GHG emissions per MJ energy carrier

➔ final conversion takes place in the overview result section

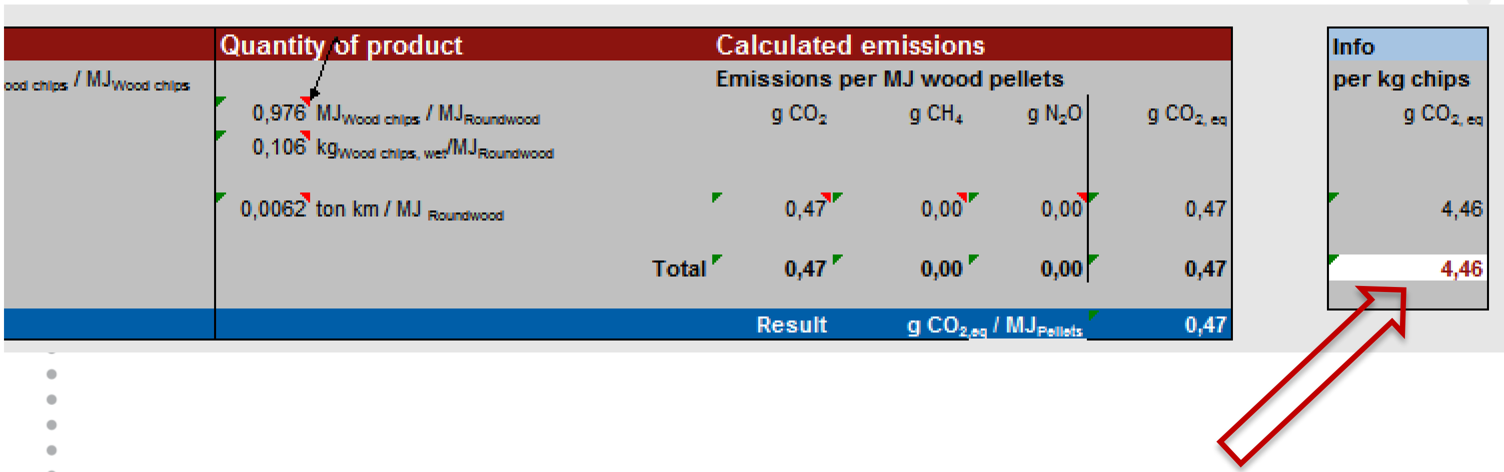
➔ without and with allocation

User-friendliness – Background information



➔ **Help boxes with information on calculation strategies and formulas / specific units used**

User-friendliness – Previous calculations



ood chips / $MJ_{Wood\ chips}$	Quantity of product	Calculated emissions: Emissions per MJ wood pellets	g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$	Info: per kg chips g $CO_{2,eq}$
	0,976 $MJ_{Wood\ chips}$ / $MJ_{Roundwood}$						
	0,106 $kg_{Wood\ chips,\ wet}$/$MJ_{Roundwood}$						
	0,0062 ton km / MJ $_{Roundwood}$		0,47	0,00	0,00	0,47	4,46
		Total	0,47	0,00	0,00	0,47	4,46
		Result		g $CO_{2,eq}$ / $MJ_{Pellets}$		0,47	

➔ **Possibility to insert emission results from previous / partial calculations**

User-friendliness – Actual calculations

Pathway configuration
Heat provision in pellet production:
Wood chip boiler/CHP (act. calc.)
Transport distance (pellets):
1 - 500 km

Wood chip boiler/CHP (actual calculatio	1	Emissions wood chip boiler/CHP (act. calc.) incl	
Thermal efficiency of wood chip CHP	give value	% (MJ_{heat} / MJ_{chips})	Click here for informa
Electrical efficiency of wood chip CHP	give value	% ($MJ_{electricity}$ / MJ_{chips})	
Determine size - Boiler/CHP is	Make selection from drop-down list		
Wood chips to be fired in CHP are:	dried		The chips are dried t
Wood chip consumption in CHP (heat at	0,0000	MJ / $MJ_{Pellets, gross}$	
Heat generation from CHP	#WERT!	MJ / $MJ_{Pellets, gross}$	
Heat needed (pellet prod, & drying chip	0,1871	MJ / $MJ_{Pellets, gross}$	#WERT!
Heat supply to pellet mill	#WERT!	MJ / $MJ_{Pellets, gross}$	
Heat supply for drying chips into CHP	#WERT!	MJ / $MJ_{Pellets, gross}$	
Surplus heat	#WERT!	MJ / $MJ_{Pellets, gross}$	In case heat is used
Electricity generation from CHP	#WERT!	MJ / $MJ_{Pellets, gross}$	#WERT!
Electricity used internally for pellet pr	#WERT!	MJ / $MJ_{Pellets, gross}$	
Surplus electricity	#WERT!	MJ / $MJ_{Pellets, gross}$	
Surplus heat from CHP is:	Not used useful		
Use exergy to allocate emissions to heat and electricity			
Electricity has carnot factor one:			Efficiency * carnot fa
Temperature of heat	give value	°C	
Thermal efficiency of heat	#WERT!	% (MJ_{heat} / MJ_{chips})	Efficiency * carnot fa
Temperature of surplus heat 1	give value	°C	
Thermal efficiency of surplus heat 1	#WERT!	% (MJ_{heat} / MJ_{chips})	Efficiency * carnot fa
Allocation factor electricity	#WERT!		This factor is used to
Allocation factor heat to pellet mill	#WERT!		This factor is used to
Allocation factor surplus heat	#WERT!		This factor is used to
Sum allocation factors heat	#WERT!		
Calculate "apparent allocation factor" of emissions related to wood chips used in CHP			
Fraction CHP emissions to heat into pellet mill (into calculation)			#WERT!
Fraction CHP emissions to heat for drying CHP wood chips (into calculation)			#WERT!
Fraction CHP emissions to electricity into pellet mill (into calculation)			#WERT!

➔ **Additional process energy options are already included**

BioGrace tool – Summary

Contents

- Rather easy to modify or build new pathways
- Own defined standard values and additional standard values
- With track changes on easy to verify
- BioGrace Calculation rules
- User manual

- Status
  - Version 2 of tool is online www.biograce.net
  - Version 3 will be published towards end of project (around May 2015)

BIOGRACE II

Harmonised Greenhouse Gas Calculations for Electricity, Heating and Cooling from Biomass

GHG calculations under the COM (2010)11 and the SWD

3. Calculation rules with some examples

GHG calculation course for verifier trainers (solid and gaseous biomass)

BioGrace calculation rules

1. Introduction

   The calculations… follow the methodology laid down in the two European Commission reports on sustainability of electricity, heat and cooling from solid and gaseous biomass: COM(2010)11 and SWD(2014)259

   [The liquid] *pathways follow the calculation methodology set up in the Renewable Energy Directive (RED). When RED Annex V will have been updated (see section 1.1) these pathways will be updated and follow the same methodology as the solid and gaseous pathways.*

There is one exception to that rule: for bioliquids, N_2O field emissions at the agricultural stage are calculating using the GNOC model whenever it is possible.

BioGrace calculation rules

2.1.1 If the BioGrace-II Excel tool is used, 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 made with the version “for Compliance” of the Excel tool in which the "track changes" option is always turned on.

BioGrace calculation rules

2.2.1 BioGrace-II harmonised list of standard values

2.2.2 BioGrace list of additional standard values

2.2.3 Standard value for fertiliser

See rule document

2.3 Cut-off criteria

"*If the contribution of that input or process to the total emissions of the biofuel pathway is lower than 0.1 g* $CO_{2,eq}$*/MJ biofuel, it may be excluded*"

This rule includes a table with mass and energy thresholds, see document

BioGrace calculation rules

2.4 Combining disaggregated default values and actual values
(This is 1:1 following RED article 19)

2.5 Use of starting values in the BioGrace-II GHG calculation tool
Summary: when making an actual calculation for one process step, starting values may be kept for another process step

"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)."

BioGrace calculation rules

2.6 Using the result(s) from previous and partial GHG calculations

If a result from previous partial GHG calculations is to be used in the BioGrace-II Excel tool, these previous partial calculations shall have been verified.

2.6 Use of the sheet “user specific calculations”

“The BioGrace-II Excel tool contains a sheet “User specific calculations” which allows users of the tool to make company- or user-specific calculations, such as converting company- or user-specific data into the format in which the data can be entered into BioGrace.”

BioGrace calculation rules

3.1 Field N_2O emissions

If the crop is included in the Global Nitrous Oxide Calculator (GNOC) model, the calculation shall be made in that model.

For all other crops, the sheet "N_2O emissions IPCC" in the Excel tool shall be used.

BioGrace calculation rules

The GNOC model

Nitrogen Source	Pathway	Method: Mineral Soils	Method: Peatland Soils
Mineral Fertilizer, Manure	Direct Emissions	FIE S&B (2006)[#], TIER2[^] *f(N input[*], Crop Type, Soil Parameters, Climate)*	IPCC (2006), TIER1[~] *f(N input, Climate Zone)*
		+	+
Crop Residues	Direct Emissions	IPCC (2006), TIER1 *f(N input from Crop Residues, Management Parameters -Residue Removal, On-Field Burning-)*	
		+	+
Mineral Fertilizer, Manure, Crop Residues	Indirect Emissions (leaching / volatilization)	IPCC (2006), TIER1 *f(N input, Environmental and Management Parameter -Leaching yes/no, Irrigation yes/no-)*	
		=	=
		Σ Soil N_2O Emissions	Σ Soil N_2O Emissions

[#] Fertilizer Induced Emissions (FIE) based on the model of Stehfest and Bouwman (2006)

[~] TIER 1 = global emission factor

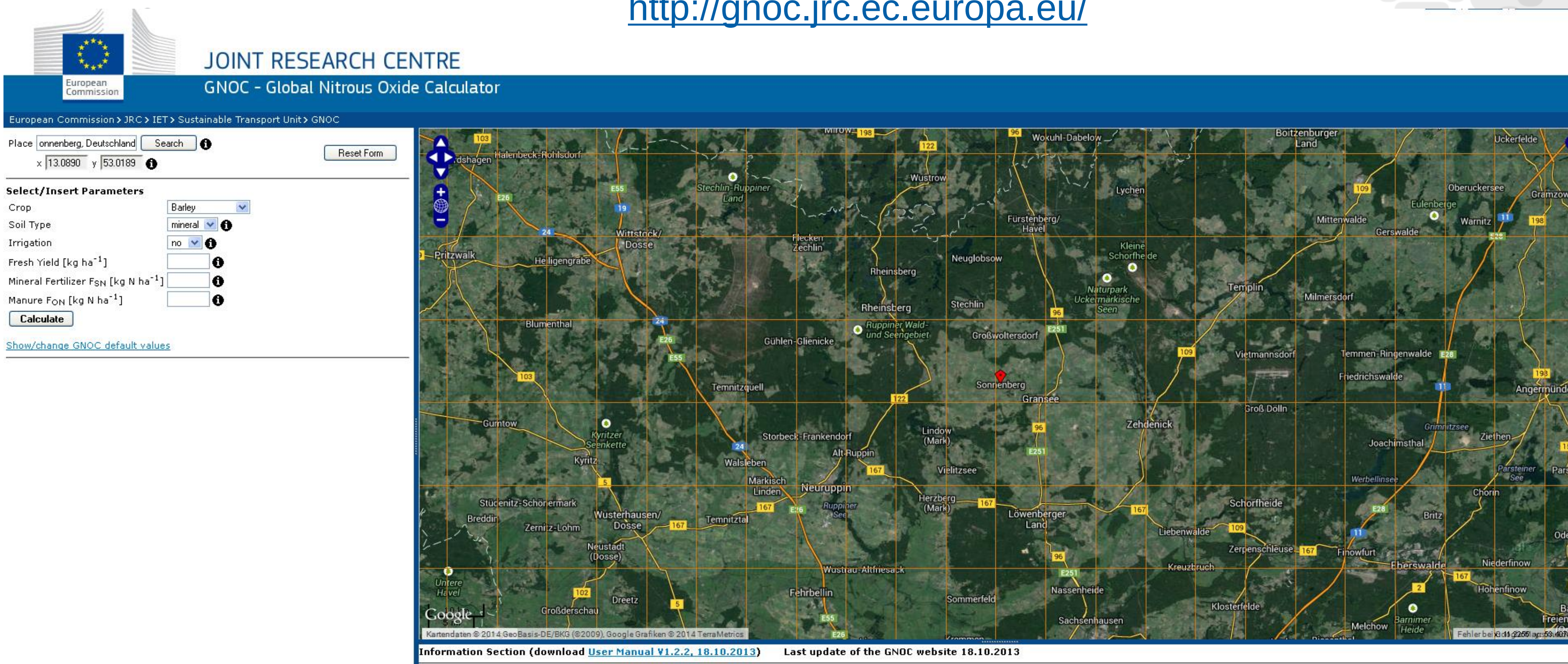
[^] TIER 2 = crop and site specific emission factor

[*] from mineral fertilizer and manure

BioGrace calculation rules

The GNOC model

http://gnoc.jrc.ec.europa.eu/



BioGrace calculation rules

3.2 Use of average values

3.3 Use of aggregated or measured values

3.4 Non artificial fertilizer

3.5 Actual input data for use of fertilisers

See rule document

BioGrace calculation rules

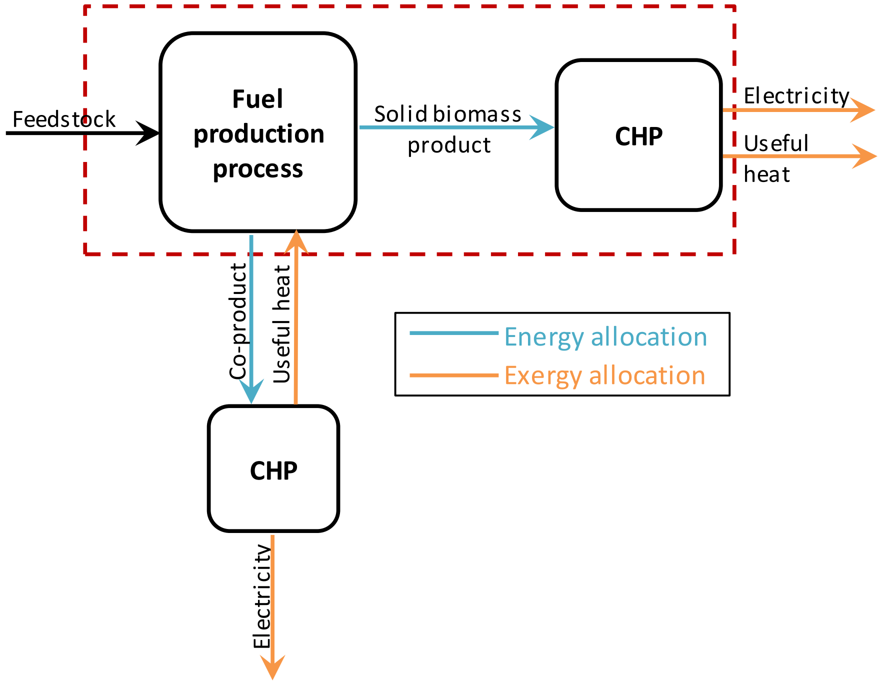
4.1 Use of actual values

"Actual values for emissions from processing steps (ep in the methodology) in the production chain must be measured or based on technical specifications of the processing facility"

4.2 Allocation

When allocating between heat, electricity and cooling, allocation based on exergy shall be used.
When allocating between other co-products, the allocation shall be based on the energy content of the products.

BioGrace calculation rules



The refinery rule stated in the RED and in the BioGrace I calculation rules is no longer valid if boilers or CHPs are used in the processing step.

BioGrace calculation rules

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.[14] "

[14]: *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.*

BioGrace calculation rules

4.4 Emissions of N_2O, CH_4 and CO_2 from the production unit

4.6 Emissions from process heat

} See rule document

4.5 Handling of residues and waste

"…… 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. ……"

What is a residue or waste can be different from one member state to another.
This will lead to difficulties when verifying actual calculations !

RTFO Guidance - Wastes and residues

Valid from 15 December 2011 - v4.5

This document contains lists of biofuel feedstocks which the Administrator has assessed and categorises them according to whether, in the Administrator's view, they are products or other materials such as wastes and residues which double count under the RTFO. Materials listed in Tables 2-4 receive two RTFCs for every litre/kg of biofuel. It should be used in conjunction with the RTFO Guidan… 8 of the… wastes…

This do… change… latest v…

Table 1- Products

Material	Description	Valid from
Virgin oils	Including, but not limited to, oils derived from palm, soy…	15/12/11
Tallo… fats)… 2[1]		
Tallow (anima… fats) category 3		

Table 2 - Residues from agriculture, aquaculture, forestry and fisheries

Material	Description	Valid from
Forest… residu…		15/12/11
Arbori… residu…		…1

Table 3 - Wastes & processing residues

Material	Description	Valid from
Waste wood	The treatment of waste wood in the RED GHG…	15/12/11
Used cooki… (UCO…		

Table 4 - Non-food cellulosic and ligno-cellulosic material

Material	Description	Valid from
Miscanthus	This is a non-food material commonly grown as an energy crop…	15/12/11
Shor… rotati… copp…		

Table 5 - Other materials

Material	Description	Valid from
Yellow grease	Yellow grease is the US term for used cooking oil but can be used for a wider range of materials including tallow for which particular requirements apply. Where suppliers have…	15/12/11

BioGrace calculation rules

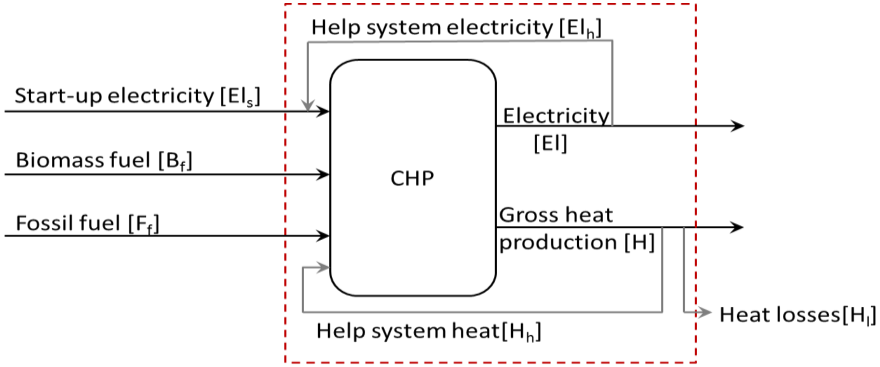
4.6 CHP providing heat to the processing step

4.8 Emissions from fuel in use

} See rule document

4.7 Electrical and thermal efficiency

The electrical and thermal efficiencies are calculated in the separate sheet “Calculate efficiencies”.



BioGrace calculation rules

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 [8].

For the calculation of carbon stock emissions from land use change, the rules lain down in Commission decision on guidelines for the calculation of land carbon stocks for the purpose of Annex V of Directive 2009/28/EC [OJ L151, page 19] shall be used. A template for this is included in the BioGrace Excel sheet."

"[8] The 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."

BioGrace calculation rules

6.1 Improved manure management

6.2 Soil carbon accumulation via improved agricultural methods

7 Co-digestion

See rule document

Some questions / exercises to practice

1. A company makes an actual calculation and contracts you to verify. At this moment of time, do you have to take into account the calculation rules?

Answer: Yes (rule 2.1).

2. A company uses BioGrace II to make actual calculations and a scheme to verify sustainability. The company argues that it should follow all scheme rules, even if they contradict BioGrace II rules. Is that correct?

Answer: No. Rule 2.1.1: BioGrace II calculation rules are binding

Some questions / exercises to practice

3. A company uses BioGrace II tool to make actual calculations and changes the unit within the tool to adapt with the input data they collected. Is that correct?

Answer: No. Rule 2.1.4: Units of input numbers shall not be changed

Some questions / exercises to practice

4. A company makes an actual calculation and provides you with an Excel file (copy of BioGrace Excel-II tool) with calculations made without track changes turned on. What to do?

Answer: You are allowed to refuse to verify until the company provides an Excel sheet with the whole calculation being made with track changes turned on. See rule 2.1.2

5. A company uses BioGrace II to make actual calculations and uses a long list of user defined standard values which are all lower than the BioGrace II standard values. What do you do?

Answer: Ask for proof that these specific inputs were used and ask for reliable information showing how these values were determined. If not provided, you cannot further verify

Some questions / exercises to practice

6. A company makes a calculation for pellets from stemwood using the BioGrace-II Excel tool with disaggregated default values for transport. The company only changes all the input data for the pelletising process, and leaves the input values / starting values for the chipping untouched. Do you allow that this is done?

Answer: This is not in line with the calculation rules (see rule 2.5)

Some questions / exercises to practice

7. A farmer makes an actual calculation for cultivation of eucalyptus using the BioGrace-II Excel tool. He uses measured (farm based data) for yield, fertiliser, pesticides, seeds and diesel use, and a literature value (incl. reference) for N_2O field emissions. Do you agree with this?

Answer: You should not. If actual data are used for cultivation, also the N_2O field emission should be based on these actual data.

Some questions / exercises to practice

8. A farmer makes an actual calculation for energy production from pure vegetable oil from rapeseed using the BioGrace Excel tool. He uses measured (farm based data) for yield, fertiliser, pesticides, seeds and diesel use, and a calculated value for N_2O field emissions. The calculation of the field emissions is done with the IPCC calculation sheet in the BioGrace-II tool. Do you agree with this?

Answer: You should not. The IPCC method / sheet only may be used if the crop is NOT included in the GNOC model. As rapeseed is included, this model should be used.

Some questions / exercises to practice

9. A farmer makes an actual calculation for energy production from pure vegetable oil from rapeseed using the BioGrace Excel tool. To make an allocation and calculate the GHG emissions related to a coproduct he used the exergy rule. Do you agree with this?

Answer: You should not. For bioliquids the RED Annex V calculation methodology applies, and it states that an allocation should be based on the energy content of the main product and the coproduct.

Some questions / exercises to practice

10. A farmer makes an actual calculation for cultivation of eucalyptus using the BioGrace-II Excel tool. He uses measured (farm based data) for yield, fertiliser, pesticides, seeds and diesel use, and a calculated value (using the BioGrace-II Excel sheet) for N_2O field emissions. He has used manure (organic fertiliser) only and has calculated zero emissions for the use of the manure. Do you agree with this?

Answer: You should agree to this, manure leads to zero emissions as it is a residue (see rule 3.4). You should check the calculation of the N_2O field emissions as manure leads to higher N_2O field emissions as compared to synthetic nitrogen fertiliser.

Some questions / exercises to practice

11. A company makes an actual calculation for Pure Vegetable Oil from rapeseed. It is demonstrated that the rapeseed cake has been sold as animal feed replacing soybean meal and a GHG credit for the rapeseed cake is calculated, which equals the GHG emission of the soy bean cake being replaced. Do you agree?

   Answer: No, this is the substitution method for taking into account the co-product rapeseed cake. Allocation based on energy content should be used (rule 4.2.3).

12. In an actual calculation electricity is taken from the grid in the UK. The average GHG emissions from electricity in the UK is being used to calculate the emissions. Is that correct?

   Answer: Yes (see rule 4.3).

Some questions / exercises to practice

13. In an actual calculation, a CHP is used in the processing step. The size of the CHP is scaled in a way to provide the process heat demand. At the same time surplus electricity is produced and fed into the grid. In the calculation, a credit is given for the amount of surplus electricity. Is that correct?

Answer: No, there are no credits for surplus electricity. The CHP should not be part of the system boundary, but rather all emissions have to be calculated and only those emissions caused by the amount of electricity and heat used internally should be taken into account. Allocation based on exergy has to be applied here (rule 4.2).

Some questions / exercises to practice

14. Is it possible to calculate a new default value for the production of biogas, from 75% of maize and 25% of biowaste ?

    Answer : Yes (the Co-digestion sheet for default values from BioGrace II tool, can be used)

Thank you for your attention

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