BIOGRACE II

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

The BioGrace Excel tools

General structure and comparison

Susanne Köppen
IFEU
Public workshop
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Purpose of the tools

- Create transparency regarding the calculation of default values
  - ➔related to EU-RED and to Report on solid and gaseous biomass
- Allow correct and (relatively) easy actual calculations
  - Change input values
  - Modify pathways
  - Create new pathways
- Enable harmonised GHG calculation under regulations for biofuels as well as electricity and / or heat production

Directory

Directory of pathways | Version 4c for Compliance

Directory

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 1.0.6 - draft in progress - March 2014**

1. Wood chips from forest residues
2. Wood chips from short rotation forests
3. Wood chips from round wood
4. Wood chips from industry residues
5. Wood briquettes or pellets from forest residues
6. Wood briquettes or pellets from short rotation forestry
7. Wood briquettes or pellets from roundwood
8. Wood briquettes or pellets from wood industry residues
9. Agricultural residues
10. Pellets from straw
11. Pellets from bagasse
12. Palm kernel meal
13. Biogas from wet manure
14. Biogas from maize
15. Biogas from biowaste
16. Biomethane from wet manure
17. Biomethane from maize
18. 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 N2O field emissions with GNOC
Calculation of net heat and electricity efficiencies
Calculation of default values for co-digestion

About

Standard values
User defined standard values

- Easy direction to other sheets
- One calculation sheet per pathway
- Additional sheets:
  - LUC
  - e_{sca}
  - N_2O field emissions
  - Standard values
  - (Final conversion only)
  - (Net efficiencies)
  - (Co-digestion)

BIOGRACE
Harmonised Calculations of Biofuel Greenhouse Gas Emissions in Europe

Production of Ethanol from Sugarbeet (steam from NG boiler)

Overview Results

All results in g $CO_{2,eq}$ / MJ $_{Ethanol}$	Non- allocated results	Allocation factor	Allocated results	Total	Actual/ Default	Default values RED Annex V.D
Cultivation e_{ec}				11,5	A	12
Cultivation of sugarbeet	16,08	71,3%	11,46			11,54
Processing e_p				26,3	A	26
Ethanol plant	36,82	71,3%	26,26			26,42
Transport e_{td}				2,3	A	2
Transport of sugarbeet	1,11	71,3%	0,79			0,84
Transport of ethanol to de	0,60	100,0%	0,60			1,10
Transport to filling station	0,93	100,0%	0,93			0,44
Land use change e_l	0,0	71,3%	0,0	0,0		0
Bonus or e_{sca}	0,0	100,0%	0,0	0,0		0
e_{ccr} + e_{ccs}	0,0	100,0%	0,0	0,0		0
Totals	55,6			40,1		40

I. Overview results

When using this GHG calculation tool, **the BioGrace**
The rules are included in the zip file in which you downloac

Calculation per phase

Track changes: ON

Cultivation of sugarbeet			Quantity of product	
Yield			**Yield**	
Sugar beet	68.860	kg ha^{-1} year^{-1}	280.605	MJ ha^{-1} year^{-1}
Moisture content	75,0%		1,000	MJ / MJ
			0,451	kg/MJ
Energy consumption				
Diesel	6.331	MJ ha^{-1} year^{-1}		
Agro chemicals				
N-fertiliser (kg N)	119,7	kg N ha^{-1} year^{-1}		
Manure	0,0	kg N ha^{-1} year^{-1}		

II. Calculation per phase

BIOGRACE II

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

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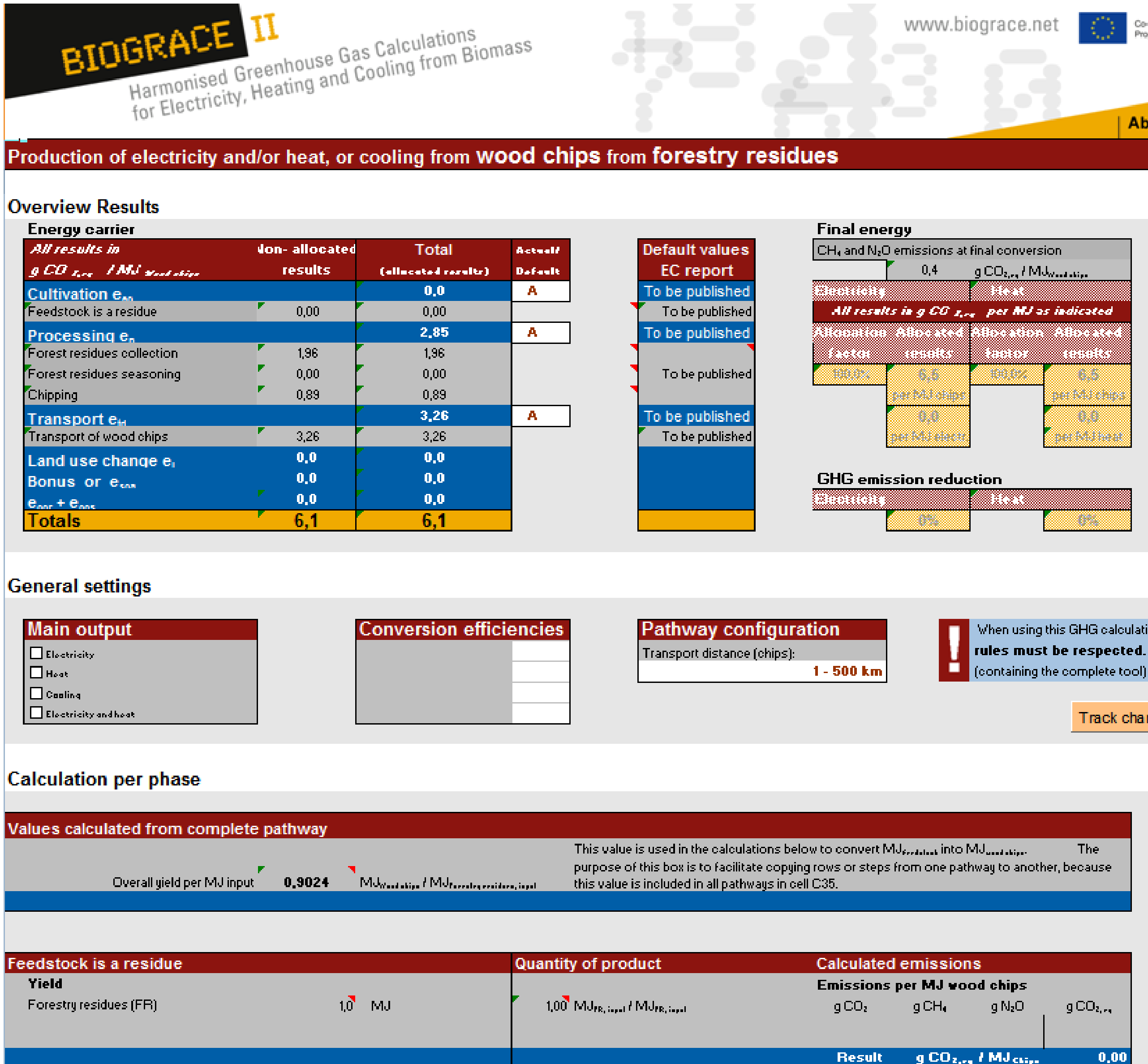


I. Overview results

II. General settings

III. Calculation per phase

Principle of calculation

Emission results
for this step

Forest residues collection			Quantity of product		Calculated emissions				
Yield					**Emissions per MJ wood chips**				
Forestry residues	1,0	MJ_{FR} / MJ_{FR}	1,00	MJ_{FR} / $MJ_{FR,\ input}$		g CO_2	g CH_4	g N_2O	g $CO_{2,\ eq}$
Moisture content	45%		0,106	$kg_{FR,\ wet}$/$MJ_{Wood\ chips}$					
Energy consumption									
Diesel	0,0200	MJ / $MJ_{Forestry\ residues}$				1,94	0,00	0,00	1,94
CH_4 and N_2O emissions from use of diesel		(forestry collection)				0,00	0,00	0,00	0,02
					Total	**1,94**	**0,00**	**0,00**	**1,96**
					Result	g $CO_{2,eq}$ / MJ_{Chips}			1,96

Input values

Yield related
conversion
factors

Principle of calculation

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

Forest residues collection			Quantity of product		Calculated emissions				
					Emissions per MJ wood chips				
Yield						g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Forestry residues	1,0	MJ_{FR} / MJ_{FR}	1,00	MJ_{FR} / $MJ_{FR, Input}$					
Moisture content	45%		0,106	$kg_{FR, wet}/MJ_{Wood chips}$					
Energy consumption									
Diesel	0,0200	MJ / $MJ_{Forestry residues}$				1,94	0,00	0,00	1,94
CH_4 and N_2O emissions from use of diesel		(forestry collection)				0,00	0,00	0,00	0,02
					Total	**1,94**	**0,00**	**0,00**	**1,96**
					Result		g $CO_{2,eq}$ / MJ_{Chips}		1,96

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

List of standard values

STANDARD VALUES parameter: unit:	GWP $gCO_{2,eq}$/ g	gCO_2/kg	gCH_4/kg	gN_2O/kg	GHG emissio gCO_{2-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	GHG emissio			
		gCO$_2$/kg	gCH$_4$/kg	gN$_2$O/kg	gCO$_{2-eq}$/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

Different units

Calculated emissions				
Emissions per MJ wood chips				
	g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
	1,94	0,00	0,00	1,94
	0,00	0,00	0,00	0,02
Total	**1,94**	**0,00**	**0,00**	**1,96**
Result	g $CO_{2,eq}$ / MJ_{Chips}			1,96

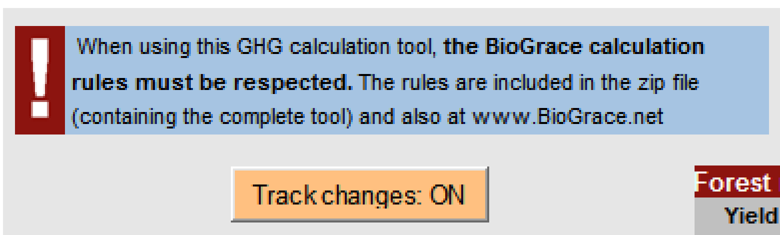
Info
per kg residues
g $CO_{2,eq}$
18,31
0,20
18,51

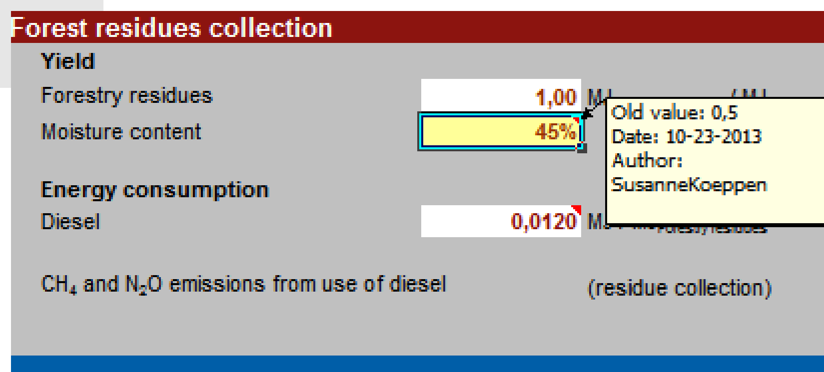
Results related to different units

Elements for verification

When actual calculations are done:

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






BIOGRACE II
Harmonised Greenhouse Gas Calculations for Electricity, Heating and Cooling from Biomass
14-02-2014
Biograce II specific calculation rules
Draft v1


BIOGRACE
Harmonised Calculations of Biofuel Greenhouse Gas Emissions in Europe
23/11/2012
BioGrace calculation rules
Version 4c

Differences between tools

- Final use of energy carriers
  - BG I: Liquid and gaseous **biofuels for transport**
  - BG II: Solid, gaseous (and liquid) bioenergy carriers for **electricity, heat and cooling**

    ➔ Tools do not mirror the EU regulation / report!
- Final reference unit
  - BG I: MJ energy carrier (transport fuel)
  - BG II: MJ final energy (heat, electricity)
    - default values refer to MJ energy carrier
    - ➔ user always has to include own / actual conversion efficiency

BG 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

BG II: Final conversion efficiency

Energy carrier

Final energy

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	To be published
Feedstock is a residue	0,00	0,00		To be published
Processing e_p		2,85	A	To be published
Forest residues collection	1,96	1,96		
Forest residues seasoning	0,00	0,00		To be published
Chipping	0,89	0,89		
Transport e_{td}		3,26	A	To be published
Transport of wood chips	3,26	3,26		To be published
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	6,1	6,1		

Final energy

CH₄ and N₂O 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
100,0%	6,5 per MJ chips	100,0%	6,5 per MJ chips
	0,0 per MJ electr.		0,0 per MJ heat

GHG emission reduction

Electricity		Heat	
	0%		0%

Final conversion based on actual efficiency

Differences between tools

- Differences in methodology
  - BG I: Allocation of co-products based on lower heating values;
    credits for surplus electricity from CHP (e_{ee})
  - BG II: Allocation of co-products based on lower heating values;
    Allocation in CHP based on exergy
    ➔ two different allocation factors

BG I: Allocation between products and co-products

Allocation factors
Ethanol plant
71,3% to ethanol
28,7% to Sugar beet pulp

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

Use of CHP during pathway:
- Credit for surplus electricity

BG II: Two different allocations

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

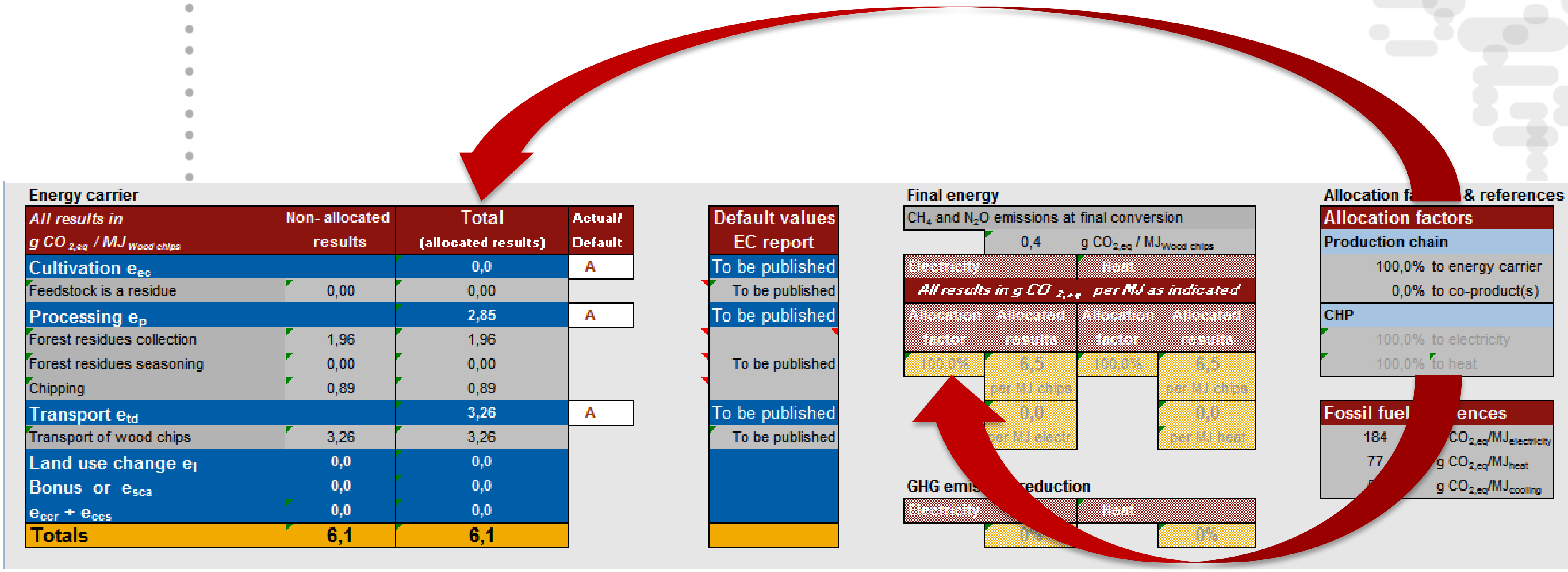
Allocation of by-products and main products in production chain: **<u>Lower Heating Value</u>**

Allocation of electricity and heat (CHP) according to <u>Carnot efficiency</u>:

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

(along and at the end of pathway)

BG II: Two different allocations



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	To be published
Feedstock is a residue	0,00	0,00		To be published
Processing e_p		2,85	A	To be published
Forest residues collection	1,96	1,96		
Forest residues seasoning	0,00	0,00		To be published
Chipping	0,89	0,89		
Transport e_{td}		3,26	A	To be published
Transport of wood chips	3,26	3,26		To be published
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	**6,1**	**6,1**		

Final energy

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

All results in g $CO_{2,eq}$ per MJ as indicated

Electricity		Heat	
Allocation factor	Allocated results	Allocation factor	Allocated results
100,0%	6,5 per MJ chips	100,0%	6,5 per MJ chips
	0,0 per MJ electr.		0,0 per MJ heat

GHG emis[illegible] reduction

Electricity		Heat	
	0%		0%

Allocation fa[illegible] & 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 [illegible]ences	
184	[illegible] $CO_{2,eq}/MJ_{electricity}$
77	g $CO_{2,eq}/MJ_{heat}$
[illegible]	g $CO_{2,eq}/MJ_{cooling}$

Differences between tools

- Differences in methodology
  - BG I: Emissions from use of bioenergy carrier are zero
  - BG II: **CO_2** emissions from use are zero
    ➔ CH_4 and N_2O emissions from final conversion are calculated

BG II: Emissions from final conversion

Final conversion (CH_4 and N_2O emissions only)

Type of fuel used in end conversion	Wood chip	Please note: these emissions will not be added to the pathway emissions (which are expressed per $MJ_{wood\ chips}$) but will be added to the emissions per MJ_{heat} and per $MJ_{electricity}$ in the result section				
Type of end conversion	Boiler					
Include following emissions	CH4 and N2O emissions from Wood chip Boiler		0,00	0,00	0,00	0,41
	No emissions added to pathway emissions, emissions will be added in result section					0,00

Final energy

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

All results in g $CO_{2,eq}$ per MJ as indicated

Electricity: Allocation factor	Electricity: Allocated results	Heat: Allocation factor	Heat: Allocated results
100,0%	6,5 per MJ chips	100,0%	6,5 per MJ chips
	0,0 per MJ electr		0,0 per MJ heat

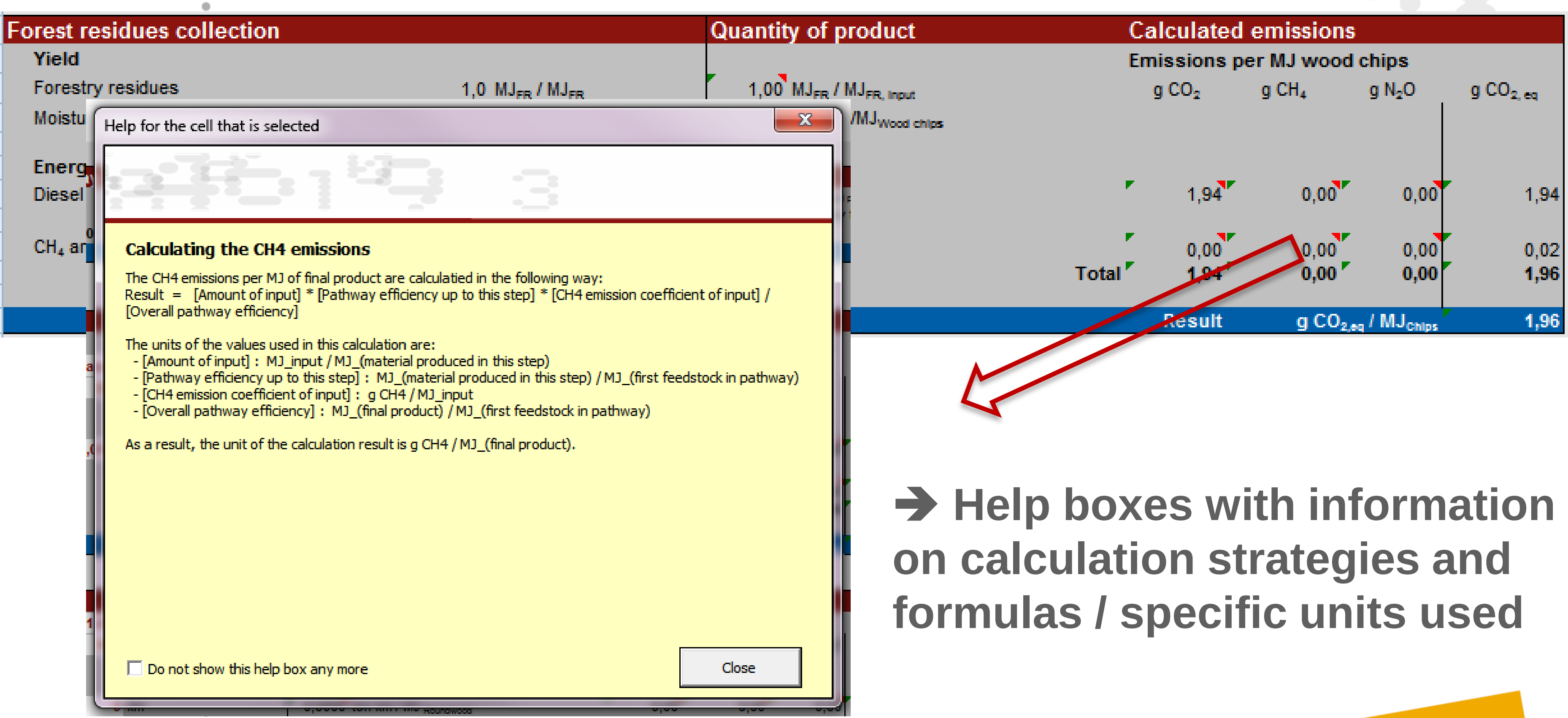
GHG emission reduction

Electricity	Heat
0%	0%

Differences between tools

- Elements that will be included in BG I in next update
  - comment boxes with background information on calculation ways
  - variations included in drop downs (e.g. transport distances, process energy carriers)

BG II: Background information



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

Co-funded by the Intelligent Energy Europe
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Thank you for your attention