

## The BioGrace II tool

### General approach and structure

## Directory

### Directory of pathways

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- 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](#)
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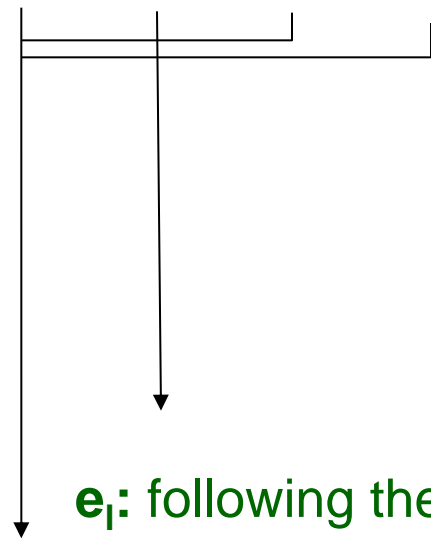
11 [Pellets from biomass](#)

- Easy direction to other sheets
- One calculation sheet per pathway
- Additional sheets:
  - LUC
  - $e_{sca}$
  - N<sub>2</sub>O field emissions
  - Standard values
  - Final conversion only

➔ **Example: Wood pellets from forestry residues**

## Steps from cultivation to final energy

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



$e_{ccs/ccr}$ : technology not in place

$e_{sca}$ : methodology still under discussion

$e_u$ : maybe relevant for biogas pathways

$e_l$ : following the decision 2010/335/EU

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

### Production of electricity and/or heat, or cooling from wood pellets/briquettes from forestry residues

Version 1.0.4 - draft

#### Overview Results

Energy carrier	Non-allocated results	Total (allocated results)	Actual Default	Default values COM(2010)11	Final energy	Allocation
<b>All results in g CO<sub>2,eq</sub> / MJ wood pellets</b>					<b>All results in g CO<sub>2,eq</sub> per MJ as indicated</b>	
<b>Cultivation e<sub>cul</sub></b>		<b>0,0</b>	<b>A</b>		<b>Production</b>	
Feedstock is a residue	0,00	0,00			Allocation factor	100,00
<b>Processing e<sub>pr</sub></b>		<b>2,4</b>	<b>A</b>		Allocated results	0,00
Forest residues collection	1,60	1,60			Allocation factor	100,00
Chipping	0,44	0,44			Allocated results	100,00
Wood pellet/briquette production	0,34	0,34			Allocation factor	100,00
<b>Transport e<sub>tr</sub></b>		<b>12,4</b>	<b>A</b>		Allocated results	100,00
Transport of wood chips	1,33	1,33			Allocation factor	100,00
Transport of wood pellets	11,09	11,09			Allocated results	100,00
<b>Land use change e<sub>luc</sub></b>	<b>0,0</b>	<b>0,0</b>			Allocation factor	100,00
Bonus or e <sub>cnr</sub>	0,0	0,0			Allocated results	100,00
e <sub>non</sub> + e <sub>cnr</sub>	0,0	0,0			Allocation factor	100,00
<b>Totals</b>	<b>14,8</b>	<b>14,8</b>			Allocated results	100,00

## I. Overview results

#### General settings

**Main output**  
 Electricity  
 Heat  
 Cooling  
 Electricity and heat

**Conversion efficiencies**  

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**Pathway configuration**  
 Heat provision in pellet production:  
**Wood pellet CHP (ORC)**  
 Transport distance (pellets):  
**above 10 000 km**

**!** When using this GHG calculation tool, the BioGr rules must be respected. The rules are included in the user manual (containing the complete tool) and also at www.BioGr.

Track changes: ON

## II. General settings

#### Calculation per phase

Feedstock is a residue	Quantity of product	Calculated emissions
<b>Yield</b>		<b>Emissions per MJ wood pellets</b>
Forestry residues	1,0 MJ	g CO <sub>2</sub> g CH <sub>4</sub> g N <sub>2</sub> O   g CO <sub>2,eq</sub>
	1,00 MJ <sub>forestry residues</sub> / MJ <sub>forestry residues</sub>	
		<b>Result g CO<sub>2,eq</sub> / MJ<sub>pellets</sub> 0,00</b>

Forest residues collection	Quantity of product	Calculated emissions	Info per kg resi
<b>Yield</b>		<b>Emissions per MJ wood pellets</b>	g CO <sub>2,eq</sub>
Forestry residues	1,00 MJ <sub>forestry residues</sub> / MJ <sub>forestry residues</sub>	g CO <sub>2</sub> g CH <sub>4</sub> g N <sub>2</sub> O   g CO <sub>2,eq</sub>	
Moisture content	50%		
	0,167 kg <sub>forestry residues, wet</sub> / MJ <sub>wood pellets</sub>		
<b>Energy consumption</b>			
Diesel	0,0120 MJ / MJ <sub>forestry residues</sub>	1,57   0,00   0,00   1,59	10
CH <sub>4</sub> and N <sub>2</sub> O emissions from use of diesel (residue collection)		0,00   0,00   0,00   0,01	0

## III. Calculation per phase

### I. Overview results

Energy carrier

Final energy

Energy carrier	Non- allocated results	Total (allocated results)	Actual/ Default	Default values COM(2010)11
<b>All results in <math>g CO_{2,eq} / MJ_{Wood\ pellets}</math></b>				
<b>Cultivation <math>e_{ec}</math></b>		0,0	<input type="text" value="D"/>	
Feedstock is a residue	0,00	0,00		
<b>Processing <math>e_p</math></b>		2,4	<input type="text" value="A"/>	
Forest residues collection	1,60	1,60		
Chipping	0,44	0,44		
Wood pellet/briquette production	0,34	0,34		
<b>Transport <math>e_{td}</math></b>		12,4	<input type="text" value="A"/>	
Transport of wood chips	1,33	1,33		
Transport of wood pellets	11,09	11,09		
<b>Land use change <math>e_l</math></b>	0,0	0,0		
<b>Bonus or <math>e_{sca}</math></b>	0,0	0,0		
$e_{ccr} + e_{ccs}$	0,0	0,0		
<b>Totals</b>	<b>14,8</b>	<b>14,8</b>		

Final energy			
Electricity		Heat	
<i>All results in <math>g CO_{2,eq}</math> per MJ as indicated</i>			
Allocation factor	Allocated results	Allocation factor	Allocated results
100,0%	14,8	100,0%	14,8
	per MJ pellets		per MJ pellets
	0,0		0,0
	per MJ electr.		per MJ heat

GHG emission reduction	
Electricity	Heat
0%	0%



Indication of actual and default values

### I. Overview results

Energy carrier

Final energy

#### Energy carrier

All results in $g CO_{2,eq} / MJ_{Wood\ pellets}$	Non- allocated results	Total (allocated results)	Actual/ Default
<b>Cultivation <math>e_{ec}</math></b>		0,0	D
Feedstock is a residue	0,00	0,00	
<b>Processing <math>e_p</math></b>		2,4	A
Forest residues collection	1,60	1,60	
Chipping	0,44	0,44	
Wood pellet/briquette production	0,34	0,34	
<b>Transport <math>e_{td}</math></b>		12,4	A
Transport of wood chips	1,33	1,33	
Transport of wood pellets	11,09	11,09	
<b>Land use change <math>e_l</math></b>	0,0	0,0	
<b>Bonus or <math>e_{sca}</math></b>	0,0	0,0	
$e_{ccr} + e_{ccs}$	0,0	0,0	
<b>Totals</b>	<b>14,8</b>	<b>14,8</b>	

Default values COM(2010)11

#### Final energy

All results in $g CO_{2,eq}$ per MJ as indicated			
Allocation factor	Allocated results	Allocation factor	Allocated results
100,0%	14,8 per MJ pellets	100,0%	14,8 per MJ pellets
	0,0 per MJ electr.		0,0 per MJ heat

#### GHG emission reduction

Electricity	Heat
0%	0%

**Final conversion based on actual efficiency**

## 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 <sub>2,eq</sub> /MJ <sub>electricity</sub>
77	g CO <sub>2,eq</sub> /MJ <sub>heat</sub>
57	g CO <sub>2,eq</sub> /MJ <sub>cooling</sub>

Allocation of by-products and main products in production chain: lower heating value

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

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

## II. General settings

Main output	Conversion efficiencies	Pathway configuration
<input type="checkbox"/> Electricity	Electrical efficiency 25,0%	Heat provision in pellet production:
<input type="checkbox"/> Heat	Thermal efficiency 85,0%	Wood pellet CHP (ORC)
<input type="checkbox"/> Cooling	Temp of useful heat (°C) 150,0	Transport distance (pellets):
<input checked="" type="checkbox"/> Electricity and heat		above 10 000 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 CO<sub>2</sub>,eq per MJ of energy carrier and (in the info boxes in column N) in g CO<sub>2</sub>,eq per kg of energy carrier for solid and liquid biomass.

Do not show this screen any more

Close



## II. General settings

### When actual calculations are done:

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

**!** When using this GHG calculation tool, the BioGrace calculation rules must be respected. The rules are included in the zip file (containing the complete tool) and also at [www.BioGrace.net](http://www.BioGrace.net)

Track changes: ON

Forest residues collection	
<b>Yield</b>	
Forestry residues	1,00 MWh
Moisture content	45%
<b>Energy consumption</b>	
Diesel	0,0120 MWh
CH <sub>4</sub> and N <sub>2</sub> O emissions from use of diesel	(residue collection)

Old value: 0,5  
Date: 10-23-2013  
Author:  
SusanneKoeppen

## III. Calculation per phase – Cultivation $e_{ec}$

multiplying input values with “standard values”

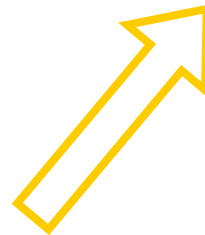
Forest residues collection		Quantity of product	Calculated emissions				
<b>Yield</b>			<b>Emissions per MJ wood pellets</b>				
Forestry residues	1,00 MJ <sub>Forestry residues</sub> / MJ <sub>Forestry residues</sub>	1,00 MJ <sub>Forestry residues</sub> / MJ <sub>Forestry residues</sub>	g CO <sub>2</sub>	g CH <sub>4</sub>	g N <sub>2</sub> O	g CO <sub>2,eq</sub>	
Moisture content	50%	0,157 kg <sub>Forestry residues, wet</sub> / MJ <sub>Wood pellets</sub>					
<b>Energy consumption</b>							
Diesel	0,0120 MJ / MJ <sub>Forestry residues</sub>		1,57	0,00	0,00	1,59	
CH <sub>4</sub> and N <sub>2</sub> O emissions from use of diesel (residue collection)			0,00	0,00	0,00	0,01	
			<b>Total</b>	<b>1,57</b>	<b>0,00</b>	<b>0,00</b>	<b>1,60</b>
			<b>Result</b>	<b>g CO<sub>2,eq</sub> / MJ<sub>Pellets</sub></b>		<b>1,60</b>	



Yield related conversion factors

## III. Calculation per phase – Cultivation $e_{ec}$

Calculated emissions				Info	
Emissions per MJ wood pellets				per kg residues	per ha, year
g CO <sub>2</sub>	g CH <sub>4</sub>	g N <sub>2</sub> O	g CO <sub>2,eq</sub>	g CO <sub>2,eq</sub>	kg CO <sub>2,eq</sub>
1,57	0,00	0,00	1,59	10,13	-
0,00	0,00	0,00	0,01	0,06	
1,57	0,00	0,00	1,60	<b>10,19</b>	
<b>Result</b>			<b>g CO<sub>2,eq</sub> / MJ<sub>Pellets</sub></b>	<b>1,60</b>	



Results related to different units

### III. Calculation per phase – Processing $e_p$

Wood pellet/briquette production		Quantity of product	Calculated emissions			
			Emissions per MJ wood pellets			
<b>Yield</b>						
Wood pellets	0,990 MJ <sub>Pellets, bruto</sub> / MJ <sub>Wood chips</sub>	0,966 MJ <sub>Pellets, bruto</sub> / MJ <sub>Forestry residues, in</sub>	g CO <sub>2</sub>	g CH <sub>4</sub>	g N <sub>2</sub> O	g CO <sub>2, eq</sub>
Wood pellets	0,687 MJ <sub>Pellets, nett output</sub> / MJ <sub>Wood chips</sub>	0,670 MJ <sub>Pellets, nett output</sub> / MJ <sub>Forestry residues, in out</sub>				
Moisture content	10%	0,058 kg <sub>Wood pellets, nett output</sub> / MJ <sub>Wood pellets</sub>				
<b>Energy consumption</b>						
Electricity (excl. input into boiler)	0,0499 MJ / MJ <sub>Pellets, bruto</sub>	(emissions are calculated below the light grey boiler/CHP box)				
Diesel	0,0020 MJ / MJ <sub>Pellets, bruto</sub>	(internal transport)	0,25	0,00	0,00	0,26
CH <sub>4</sub> and N <sub>2</sub> O emissions from use of diesel			0,00	0,00	0,00	0,00
Heat	0,1853 MJ / MJ <sub>Pellets, bruto</sub>					
Wood pellet CHP based on ORC	1 Emissions wood pellet CHP inc					
Wood pellet input / MJ electricity	6,1350 MJ / MJ <sub>Electricity</sub>	Plea				
Wood pellet consumption in CHP	0,3062 MJ / MJ <sub>Pellets, bruto</sub>	Amount of wood pellets used for generation of heat and electricity				
Heat output / MJ electricity	4,2699 MJ / MJ <sub>Electricity</sub>					
Electricity generation from CHP	0,0499 MJ / MJ <sub>Pellets, bruto</sub>					
Heat generation from CHP	0,2131 MJ / MJ <sub>Pellets, bruto</sub>	Heat generation is larger than heat demand, surplus heat is cooled away				
CH <sub>4</sub> and N <sub>2</sub> O emissions from Wood chip/pellet CHP (per MJ_electricity)			0,00	0,00	0,00	0,09
<b>Total electricity use in wood pellet production plus CHP</b>						
Electricity EU mix LV	0,0000 MJ / MJ <sub>Pellets, bruto</sub>	Should be zero as the CHP is dimension	0,00	0,00	0,00	0,00
		<b>Total</b>	<b>0,25</b>	<b>0,00</b>	<b>0,00</b>	<b>0,34</b>
		<b>Result</b>	<b>g CO<sub>2,eq</sub> / MJ<sub>Pellets</sub></b>			<b>0,34</b>

conversion factors yield related



## Conversion factors

0,966	$\text{MJ}_{\text{Pellets, bruto}} / \text{MJ}_{\text{Forestry residues, In}}$
0,670	$\text{MJ}_{\text{Pellets, nett output}} / \text{MJ}_{\text{Forestry residues, Input}}$
0,058	$\text{kg}_{\text{Wood pellets, nett output}} / \text{MJ}_{\text{Wood pellets}}$

**yield related conversion factors:**

→ raw material per final biofuel

**values as a function of input values  
and/or of the chain**

### Principle of calculation

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

Wood pellet/briquette production	Quantity of product	Calculated emissions					
<b>Yield</b>							
Wood pellets	0,990 MJ <sub>Pellets, bruto</sub> / MJ <sub>Wood chips</sub>	0,966 MJ <sub>Pellets, bruto</sub> / MJ <sub>Forestry residues, In</sub>	<b>Emissions per MJ wood pellets</b>				
Wood pellets	0,687 MJ <sub>Pellets, nett output</sub> / MJ <sub>Wood chips</sub>	0,670 MJ <sub>Pellets, nett output</sub> / MJ <sub>Forestry residues, Input</sub>	g CO <sub>2</sub>	g CH <sub>4</sub>	g N <sub>2</sub> O	g CO <sub>2,eq</sub>	
Moisture content	10%	0,058 kg <sub>Wood pellets, nett output</sub> / MJ <sub>Wood pellets</sub>					
<b>Energy consumption</b>							
Electricity (excl. input into boiler)	0,0499 MJ / MJ <sub>Pellets, bruto</sub>	(emissions are calculated below the light grey boiler/CHP box)					
Diesel	0,0020 MJ / MJ <sub>Pellets, bruto</sub>	(internal transport)					
CH <sub>4</sub> and N <sub>2</sub> O emissions from use of diesel			0,25	0,00	0,00	0,26	
Heat	0,1853 MJ / MJ <sub>Pellets, bruto</sub>		0,00	0,00	0,00	0,00	
Wood pellet CHP based on ORC	1	Emissions wood pellet CHP included in final results		Emissions from wood pellet CHP			
Wood pellet input / MJ electricity	6,1350 MJ / MJ <sub>Electricity</sub>	Please note: The CHP is dimensioned to the electricity demand					
Wood pellet consumption in CHP	0,3062 MJ / MJ <sub>Pellets, bruto</sub>	Amount of wood pellets used for generation of heat and electricity					
Heat output / MJ electricity	4,2699 MJ / MJ <sub>Electricity</sub>						
Electricity generation from CHP	0,0499 MJ / MJ <sub>Pellets, bruto</sub>						
Heat generation from CHP	0,2131 MJ / MJ <sub>Electricity</sub>	Heat generation is larger than heat demand, surplus heat is cooled away					
CH <sub>4</sub> and N <sub>2</sub> O emissions						0,09	
<b>STANDARD VALUES</b>							
Total electricity use in CHP		parameter: GWP	GHG emissions				
Electricity EU mix LV	0,0000 MJ / MJ <sub>Pellets, bruto</sub>	unit: gCO <sub>2,eq</sub> / g	gCO <sub>2</sub> /kg	gCH <sub>4</sub> /kg	gN <sub>2</sub> O/kg	gCO <sub>2,eq</sub> /kg	
		Should be zero as the CHP is dimensioned to the electricity demand	0,00	0,00	0,00	0,00	
			Total	0,25	0,00	0,00	0,34
<b>Result</b>							
			g CO <sub>2,eq</sub> / MJ <sub>Pellets</sub>			0,34	

## List of standard values

STANDARD VALUES		GWP		GHG emissio		
parameter:	unit:	gCO <sub>2,eq</sub> /g	gCO <sub>2</sub> /kg	gCH <sub>4</sub> /kg	gN <sub>2</sub> O/kg	gCO <sub>2,eq</sub> /kg
<i>Global Warming Potentials (GWP's)</i>						
CO <sub>2</sub>		1				
CH <sub>4</sub>		25				
N <sub>2</sub> O		298				
<i>Agro inputs</i>						
N-fertiliser (kg N)			3794,0	7,93	7,3150	6172,1
P <sub>2</sub> O <sub>5</sub> -fertiliser (kg P <sub>2</sub> O <sub>5</sub> )			991,2	1,40	0,0532	1042,1
K <sub>2</sub> O-fertiliser (kg K <sub>2</sub> O)			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 <sub>3</sub> )			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

parameter: unit:	Comments	GHG emissio			
		gCO <sub>2</sub> /kg	gCH <sub>4</sub> /kg	gN <sub>2</sub> O/kg	gCO <sub>2-eq</sub> /kg
<i>User defined standard values</i>					
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
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



### III. Calculation per phase – Transport $e_{td}$

Transport of wood chips		Quantity of product	Calculated emissions			
Wood chips	1,00 MJ <sub>Wood chips</sub> / MJ <sub>Wood chips</sub>		Emissions per MJ wood pellets			
Moisture content	50%	0,976 MJ <sub>Wood chips</sub> / MJ <sub>Forestry residues, Input</sub>	g CO <sub>2</sub>	g CH <sub>4</sub>	g N <sub>2</sub> O	g CO <sub>2, eq</sub>
		0,153 kg <sub>Wood chips, wet</sub> / MJ <sub>Wood pellets</sub>				
Transport per						
Truck (40 ton) for chips (and similar size)	50 km	0,0051 ton km / MJ <sub>Forestry residues, Input</sub>	0,65	0,00	0,00	0,67
Fuel	Diesel		Total	0,65	0,00	0,67
			Result	g CO <sub>2, eq</sub> / MJ <sub>Pellets</sub>		0,67

Transport of wood pellets		Quantity of product	Calculated emissions			
Wood pellets	1,000 MJ <sub>Pellets</sub> / MJ <sub>Pellets</sub>		Emissions per MJ wood pellets			
		0,670 MJ <sub>Pellets</sub> / MJ <sub>Forestry residues, Input</sub>	g CO <sub>2</sub>	g CH <sub>4</sub>	g N <sub>2</sub> O	g CO <sub>2, eq</sub>
Transport per						
Truck (40 ton) for pellets (Diesel)	0 km	0,0000 ton km / MJ <sub>Forestry residues, Input</sub>	0,00	0,00	0,00	0,00
Fuel	Diesel					
Freight train USA (diesel)	750	0,0294 ton km / MJ <sub>Forestry residues, Input</sub>	0,96	0,00	0,00	0,99
Fuel	Diesel					
Bulk Carrier class "Handy" - pellets	16500	0,6467 ton km / MJ <sub>Forestry residues, Input</sub>	10,10	0,00	0,00	10,10
Fuel	HFO for maritime transport		Total	11,06	0,00	11,09
			Result	g CO <sub>2, eq</sub> / MJ <sub>Pellets</sub>		11,09



### III. Calculation per phase – Total results

Total results			
Yield (in MJ biomass / hectare cropland / year)	no cropland		
Yield (in MJ biomass / MJ input)	0,6702 MJ <sub>Wood pellets</sub> / MJ <sub>Forestry residues, input</sub>		
Total emission without allocation:			g CO <sub>2,eq</sub> / MJ <sub>Pellets</sub> 14,81
Total emission with allocation:			g CO <sub>2,eq</sub> / MJ <sub>Pellets</sub> 14,81

### GHG emissions per MJ energy carrier

- final conversion takes place in the overview result section
- without and with allocation



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Programme of the European Union

*Thank you for your attention*

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