BIOGRACE

Harmonised Calculations of Biofuel Greenhouse Gas Emissions in Europe

The BioGrace Excel GHG calculation tool - Basics

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Demonstrated in Excel Spreadsheet vs.3

Steps from cultivation to filling station

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

e_{ee}: combined with **e_p**

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

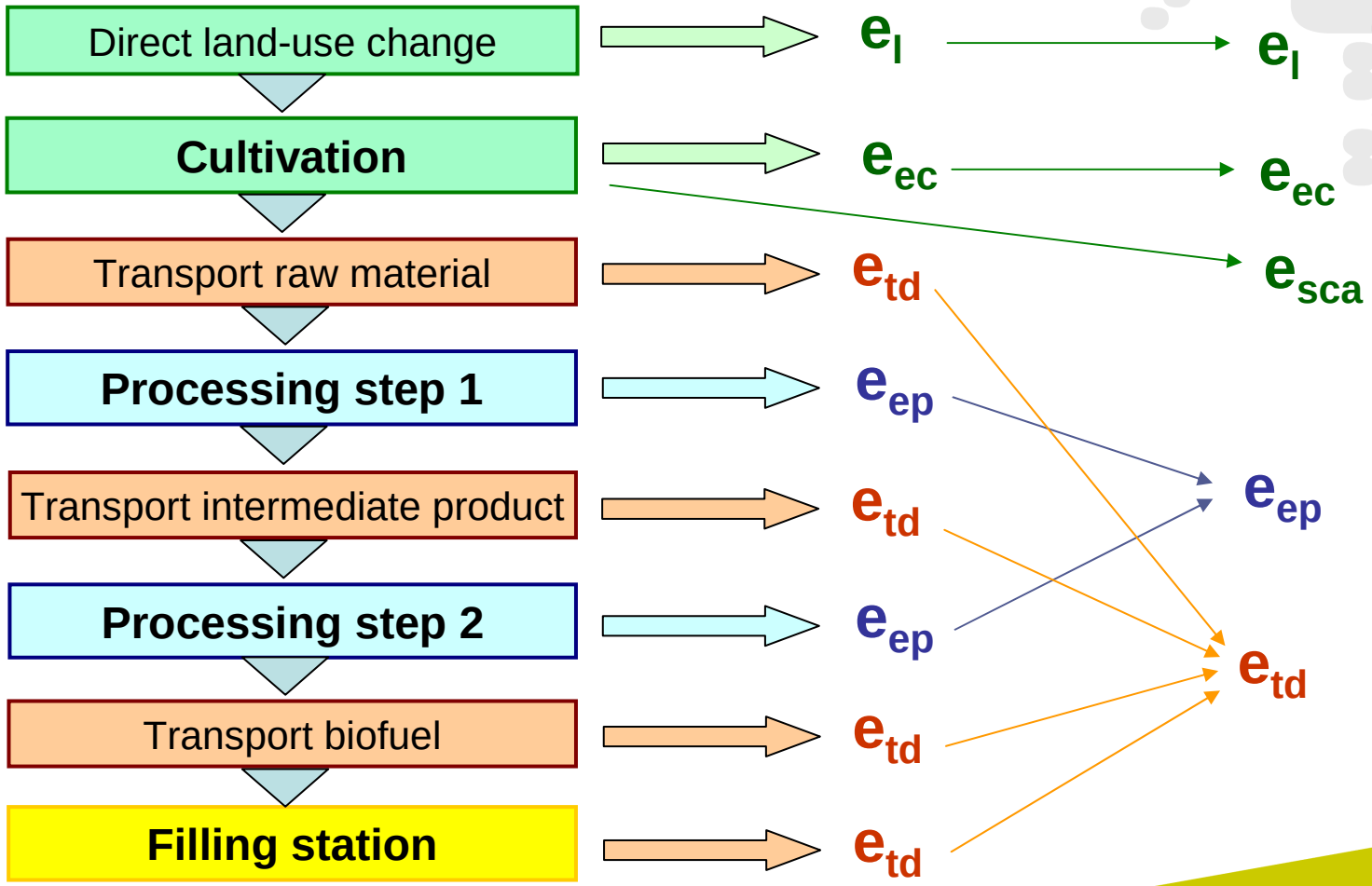
e_{sca}: methodology still under discussion

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“

Steps from cultivation to filling station



Steps from cultivation to filling station

The aggregation on top

Production of FAME from Rapeseed (steam from natural gas boiler)

Overview Results

All results in g $CO_{2,eq}$ / MJ_{FAME}	Non- allocated results	Allocation factor	Allocated results	Total	Default values RED Annex V.D
Cultivation e_{ec}				28,9	29
Cultivation of rapeseed	48,63	58,6%	**28,49**		28,51
Rapeseed drying	0,72	58,6%	**0,42**		0,42
Processing e_p				21,7	22
Extraction of oil	6,53	58,6%	**3,83**		3,82
Refining of vegetable oil	1,06	95,7%	**1,02**		17,88
Esterification	17,61	95,7%	**16,84**		
Transport e_{td}				1,4	1
Transport of rapeseed	0,30	58,6%	**0,17**		0,17
Transport of FAME	0,82	100%	**0,82**		0,82
Filling station	0,44	100%	**0,44**		0,44
Land use change e_l	**0,0**	58,6%	**0,0**	**0,0**	0
$e_{sca} + e_{ccr} + e_{ccs}$	**0,0**	100%	**0,0**	**0,0**	0
Totals	**76,1**			**52,0**	**52**

Cultivation e_{ec}

Cultivation of rapeseed			Quantity of product	Calculated emissions			
Yield			**Yield**	**Emissions per MJ FAME**			
Rapeseed	3.113	kg ha^{-1} $year^{-1}$	73.975 $MJ_{Rapeseed}$ ha^{-1} $year^{-1}$	g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Moisture content	10,0%		1,000 MJ / $MJ_{Rapeseed, input}$				
By-product Straw	n/a	kg ha^{-1} $year^{-1}$	0,073 $kg_{Rapeseed}/MJ_{FAME}$				
Energy consumption							
Diesel	2.963	MJ ha^{-1} $year^{-1}$		6,07	0,00	0,00	6,07
Agro chemicals							
N-fertiliser (kg N)	137,4	kg N ha^{-1} $year^{-1}$		9,08	0,03	0,03	19,00
CaO-fertiliser (kg CaO)	19,0	kg CaO ha^{-1} $year^{-1}$		0,05	0,00	0,00	0,06
K_2O-fertiliser (kg K_2O)	49,5	kg K_2O ha^{-1} $year^{-1}$		0,62	0,00	0,00	0,67
P_2O_5-fertiliser (kg P_2O_5)	33,7	kg P_2O_5 ha^{-1} $year^{-1}$		0,76	0,00	0,00	0,80
Pesticides	1,2	kg ha^{-1} $year^{-1}$		0,28	0,00	0,00	0,32
Seeding material							
Seeds- rapeseed	6	kg ha^{-1} $year^{-1}$		0,06	0,00	0,00	0,10
Field N_2O emissions	3,10	kg ha^{-1} $year^{-1}$		0,00	0,00	0,07	21,61
			Total	**16,92**	**0,03**	**0,10**	**48,63**
			Result	**g $CO_{2,eq}$ / MJ_{FAME}**			**48,63**

fill in actual data

fill in actual data

Yield		
Rapeseed	3.113	kg ha^{-1} $year^{-1}$
Moisture content	10,0%	
By-product Straw	n/a	kg ha^{-1} $year^{-1}$
Energy consumption		
Diesel	2.963	MJ ha^{-1} $year^{-1}$
Agro chemicals		
N-fertiliser (kg N)	137,4	kg N ha^{-1} $year^{-1}$
CaO-fertiliser (kg CaO)	19,0	kg CaO ha^{-1} $year^{-1}$
K_2O-fertiliser (kg K_2O)	49,5	kg K_2O ha^{-1} $year^{-1}$
P_2O_5-fertiliser (kg P_2O_5)	33,7	kg P_2O_5 ha^{-1} $year^{-1}$
Pesticides	1,2	kg ha^{-1} $year^{-1}$
Seeding material		
Seeds- rapeseed	6	kg ha^{-1} $year^{-1}$
Field N_2O emissions	3,10	kg ha^{-1} $year^{-1}$

In version 3 and 4: still fixed value. In version 5: calculation sheet

Cultivation e_{ec}

Cultivation of rapeseed			Quantity of product	Calculated emissions			
Yield			**Yield**	**Emissions per MJ FAME**			
Rapeseed	3.113	kg ha^{-1} $year^{-1}$	73.975 $MJ_{Rapeseed}$ ha^{-1} $year^{-1}$	g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Moisture content	10,0%		1,000 MJ / $MJ_{Rapeseed, input}$				
By-product Straw	n/a	kg ha^{-1} $year^{-1}$	0,073 $kg_{Rapeseed}/MJ_{FAME}$				
Energy consumption							
Diesel	2.963	MJ ha^{-1} $year^{-1}$		6,07	0,00	0,00	6,07
Agro chemicals							
N-fertiliser (kg N)	137,4	kg N ha^{-1} $year^{-1}$		9,08	0,03	0,03	19,00
CaO-fertiliser (kg CaO)	19,0	kg CaO ha^{-1} $year^{-1}$		0,05	0,00	0,00	0,06
K_2O-fertiliser (kg K_2O)	49,5	kg K_2O ha^{-1} $year^{-1}$		0,62	0,00	0,00	0,67
P_2O_5-fertiliser (kg P_2O_5)	33,7	kg P_2O_5 ha^{-1} $year^{-1}$		0,76	0,00	0,00	0,80
Pesticides	1,2	kg ha^{-1} $year^{-1}$		0,28	0,00	0,00	0,32
Seeding material							
Seeds- rapeseed	6	kg ha^{-1} $year^{-1}$		0,06	0,00	0,00	0,10
Field N_2O emissions	3,10	kg ha^{-1} $year^{-1}$		0,00	0,00	0,07	21,61
			Total	**16,92**	**0,03**	**0,10**	**48,63**
			Result		**g $CO_{2,eq}$ / MJ_{FAME}**		**48,63**

conversion factors yield related

fill in actual data

Quantity of product

Yield

73.975	$MJ_{Rapeseed}\ ha^{-1}\ year^{-1}$
1,000	$MJ / MJ_{Rapeseed,\ input}$
0,073	$kg_{Rapeseed}/MJ_{FAME}$

yield related conversion factors raw material per final biofuel

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

Cultivation e_{ec}

multiplying input values with "standard values"

Cultivation of rapeseed			Quantity of product	Calculated emissions			
Yield			**Yield**	**Emissions per MJ FAME**			
Rapeseed	3.113	kg ha^{-1} $year^{-1}$	73.975 $MJ_{Rapeseed}$ ha^{-1} $year^{-1}$		g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Moisture content	10,0%		1,000 MJ / $MJ_{Rapeseed, input}$					
By-product Straw	n/a	kg ha^{-1} $year^{-1}$	0,073 $kg_{Rapeseed}/MJ_{FAME}$					
Energy consumption								
Diesel	2.963	MJ ha^{-1} $year^{-1}$			6,07	0,00	0,00	6,07
Agro chemicals								
N-fertiliser (kg N)	137,4	kg N ha^{-1} $year^{-1}$			9,08	0,03	0,03	19,00
CaO-fertiliser (kg CaO)	19,0	kg CaO ha^{-1} $year^{-1}$			0,05	0,00	0,00	0,06
K_2O-fertiliser (kg K_2O)	49,5	kg K_2O ha^{-1} $year^{-1}$			0,62	0,00	0,00	0,67
P_2O_5-fertiliser (kg P_2O_5)	33,7	kg P_2O_5 ha^{-1} $year^{-1}$			0,76	0,00	0,00	0,80
Pesticides	1,2	kg ha^{-1} $year^{-1}$			0,28	0,00	0,00	0,32
Seeding material								
Seeds- rapeseed	6	kg ha^{-1} $year^{-1}$			0,06	0,00	0,00	0,10
Field N_2O emissions	3,10	kg ha^{-1} $year^{-1}$			0,00	0,00	0,07	21,61
				Total	**16,92**	**0,03**	**0,10**	**48,63**
				Result		**g $CO_{2,eq}$ / MJ_{FAME}**		**48,63**

conversion factors yield related

fill in actual data

Cultivation e_{ec}

Results related to raw material or acreage

Cultivation of rapeseed		Info	
		per kg rapeseed	per ha, year
Yield			
Rapeseed	g $CO_{2,\,eq}$	g $CO_{2,\,eq}$	kg $CO_{2,\,eq}$
Moisture content			
By-product Straw			
Energy consumption			
Diesel	6,07	83,40	259,7
Agro chemicals			
N-fertiliser (kg N)	19,00	261,19	813,2
CaO-fertiliser (kg CaO)	0,06	0,79	2,5
K_2O-fertiliser (kg K_2O)	0,67	9,20	28,6
P_2O_5-fertiliser (kg P_2O_5)	0,80	10,96	34,1
Pesticides	0,32	4,36	13,6
Seeding material			
Seeds- rapeseed	0,10	1,41	4,4
Field N_2O emissions	21,61	296,99	924,7
	48,63	**668,31**	**2080,7**
	48,63		

Processing e_p Step 1, oil extraction

Extraction of oil			Quantity of product	Calculated emissions			
				Emissions per MJ FAME			
Yield				g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Crude vegetable oil	0,6125	MJ_{Oil} / $MJ_{Rapeseed}$	44.861 MJ_{Oil} ha^{-1} $year^{-1}$				
By-product Rapeseed cake	0,3875	$MJ_{Rapeseed\ cake}$ / $MJ_{Rapeseed}$	0,606 MJ / $MJ_{Rapeseed,\ input}$				
			0,029 kg_{Oil} / MJ_{FAME}				
Energy consumption							
Electricity EU mix MV	0,0118	MJ / MJ_{Oil}		1,47	0,00	0,00	1,58
Steam (from NG boiler)	0,0557	MJ / MJ_{Oil}					
NG Boiler				Emissions from NG boiler			
CH_4 and N_2O emissions from NG boiler				0,00	0,00	0,00	0,02
Natural gas input / MJ steam	1,111	MJ / MJ_{Steam}					
Natural gas (4000 km, EU mix	0,062	MJ / MJ_{Oil}		4,08	0,01	0,00	4,41
Electricity input / MJ steam	0,020	MJ / MJ_{Steam}					
Electricity EU mix MV	0,001	MJ / MJ_{Oil}		0,14	0,00	0,00	0,15
Chemicals							
n-Hexane	0,0043	MJ / MJ_{Oil}		0,36	0,00	0,00	0,37
			Total	**6,06**	**0,02**	**0,00**	**6,53**
			Result	**g $CO_{2,eq}$ / MJ_{FAME}**			**6,53**

fill in actual data

Transport e_{td} of FAME

Transport of FAME	to and from depot			Quantity of product		Calculated emissions			
	FAME	1,000	MJ_{FAME} / MJ_{FAME}	42790,9	MJ_{FAME} ha^{-1} $year^{-1}$	Emissions per MJ FAME			
				0,578	MJ / $MJ_{Rapeseed, input}$	g CO_2	g CH_4	g N_2O	g $CO_{2, eq}$
	Transport per								
	Truck for liquids (Diesel)	300	km	0,0047	ton km / $MJ_{Rapeseed, input}$	0,71	0,00	0,00	**0,71**
	Fuel	Diesel							
	Energy cons. depot								
	Electricity EU mix LV	0,00084	MJ / MJ_{FAME}			0,10	0,00	0,00	**0,11**
					Result		g $CO_{2,eq}$ / MJ_{FAME}		0,8225

fill in actual data

Filling station			Quantity of product					
	Yield	1,000	MJ_{FAME} / MJ_{FAME}	42790,9	MJ_{FAME} ha^{-1} $year^{-1}$	Emissions per MJ FAME			
				0,578	MJ / $MJ_{Rapeseed, input}$	g CO_2	g CH_4	g N_2O	g $CO_{2, eq}$
	Energy consumption								
	Electricity EU mix LV	0,0034	MJ / MJ_{FAME}			0,41	0,00	0,00	**0,44**
					Result		g $CO_{2,eq}$ / MJ_{FAME}		0,44

- Include new process steps
- Set up completely new biofuel production chains

Afternoon session "Practical calculation"

- Navigate through tool
- Standard values
- Define own standard values
- Inconsistent use of global warming potentials

BioGrace GHG calculations – version 3 - Public.xls

Thank you for your attention

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