BIOGRACE

Harmonised Calculations of
Biofuel Greenhouse Gas Emissions in Europe

BioGrace –
the biofuel GHG emission calculation tool

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Biofuels and bioliquids

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English › Areas › Renewable energy sources › Renewables › Biofuels and bioliquids

Current Status

The Slovak Republic has transposed the EP and Council Directive 2009/28/EC of 23 April 2009 (on the promotion of renewable energy sources and amending the subsequent repealing Directives 2001/77/EC and 2003/30/EC) and the EP and Council Directive no. 2009/30/EC of 23 April 2009 (amending Council Directive 98/70/EC as regards the quality of gasoline, diesel and gas-oil and introducing a mechanism to monitor and reduce greenhouse gas emissions and amending Council Directive 1999/32 / EC, as regards the quality of fuel used by inland waterway vessels and repealing Directive 93/12/EEC) through Act no. 136/2011 of 5April 2011, which amends Act no. 309/2009 Z. z. the promotion of renewable energy sources and high efficiency cogeneration and amending certain laws and amending the Act. 276/2001 Z. z. on regulation in network industries and amending certain laws as amended. The Act came into force on 1 May 2011. Amendment to the Act addresses the basic roles and responsibilities of competent authorities and economic operators in relation to demonstrating compliance with the sustainability criteria for biofuels production and bioliquids. Details of related measures will be resolved by the implementing regulation issued by the Ministry of the Environment.

Minister of Environment on 26 November 2010 ruled that the certification authority for verification of certificates of origin or biofuel bioliquids the Slovak Hydrometeorological Institute. Ministry of Environment will be the effective date of regulations implementing the Act. 309/2009 Z. z. recognize other qualified persons who are responsible for verifying certificates.

On 1 entered into force in September 2011 Ministry of Environment of the Slovak Republic. 271/2011 Z. Laws establishing sustainability criteria and targets for reducing greenhouse gas emissions from fuels. The Decree deals with the details of proving compliance with the sustainability criteria for biofuels and bioliquids. To calculate greenhouse gas emissions throughout the life cycle of biofuels or bioliquids can use the calculation program available at www.biograce.net.

Up

Contents

Renewable Energy Directive (RED)

Art 17: Sustainability criteria for biofuels

- Minimum GHG emission savings (17.2)
  - 35%, 50% (2017), 60% (2018)

Art 19: Calculation of the greenhouse gas impact

- Economic operators may use
  - default values (19.1.a)
  - actual values calculated according to Annex V.C (19.1.b)
  - sum of actual value and disaggregated default value (19.1.c)

Art 18: Verification of compliance with the sustainability criteria

- Independent auditors must check information (18.3)
- Can be part of voluntary certification schemes (18.4)

RED Annex V.a

Biofuel production pathway	Typical greenhouse gas emission saving	Default greenhouse gas emission saving
– Ethanol from wheat (lignite CHP)	32%	16%
– Ethanol from wheat (process fuel not specified)	32%	16%
– Ethanol from wheat (natural gas steam boiler)	45%	34%
– Ethanol from wheat (natural gas CHP)	53	47%
– Ethanol from wheat (straw CHP)	[illegible]	69%
– Ethanol from corn	[illegible]	49%
– Ethanol from sugar beet	[illegible]	52%
– Ethanol from sugarcane	71	71%
– FAME from rape seed	45%	38%
– FAME from palm oil	36%	19%
– FAME from palm oil (methane	62%	56%
– FAME from soy	40%	31%
– FAME from sunflower	58%	51%
– FAME from used cooking oil	88%	83%
– PVO from rape seed	45%	57%
– HVO from rape seed	51%	47%
– HVO from palm oil	40%	26%
– HVO from palm oil (methane capture)	68%	65%
– HVO from sunflower	65%	62%
– Biogas from dry manure	86%	82%
– Biogas from wet manure	84%	81%
– Biogas from MSW	80%	73%

<u>Ethanol from corn</u>
Default value: 49%

<u>Rape seed biodiesel</u>
Default value: 38%

RED Annex V.c: Methodology

Disaggregated default values

$$E = e_{ec} + e_{l} + e_{p} + e_{td} + e_{u} - e_{sca} - e_{ccs} - e_{ccr} - e_{ee}$$

- E: Total emissions from the use of the fuel
- e_{ec}: Extraction& cultivation of raw material
- e_{l}: Land use change
- e_{p}: Processing
- e_{td}: Transport& distribution
- e_{u}: Fuel in use = 0
- e_{sca}: Soil carbon capture
- e_{ccs}: Carbon capture and geological storage
- e_{ccr}: Carbon capture and replacement
- e_{ee}: Excess electricity from cogenertation

Why harmonisation of biofuel GHG calculations?

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

Cultivation of rapeseed			Calculated emissions			
Yield			**Emissions per MJ FAME**			
			g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
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} $year^{-1}$	6,07	0,00	0,00	6,07
Agro chemicals						
N-fertiliser	137,4	kg N ha^{-1} $year^{-1}$	9,08	0,03	0,03	18,89
CaO-fertiliser	19,0	kg CaO ha^{-1} $year^{-1}$	0,05	0,00	0,00	0,06
K_2O-fe						
P_2O_5-						
Pestic						
Seeding material						
Seeds- rapeseed	6	kg ha^{-1} $year^{-1}$	0,06	0,00	0,00	0,10

STANDARD VALUES		GHG emission coefficient			
	parameter:				
	unit:	gCO_2/kg	gCH_4/kg	gN_2O/kg	gCO_{2-eq}/kg
N-fertiliser		2827,0	8,68	9,6418	5880,6

Why harmonisation of biofuel GHG calculations?

EXAMPLE: Different results from same biofuel
("cherry picking" of the most beneficial standard values)

Parameter	Unit	Source			
		EC (RED Annex V)	Netherlands (Ecofys / CE)	UK RFA	Germany IFEU
Nitrogen Fertilizer	g CO_{2eq}/kg	5917,2	6367,0	6800,0	6410
P fertilizer	g CO_{2eq}/kg	1013,5	700,0	354 for TSP, **95** for rock phosphate, 596 for MAP	1180
K fertilizer	g CO_{2eq}/kg	579,2	453,0	333,0	663
CaO fertilizer (85%CaCO3+15%CaO,Ca(OH)2)	g CO_{2eq}/kg	130,0	179,0	124,0	297
Pesticides	g CO_{2eq}/kg	11025,7	17256,8	17300,0	1240
Diesel (direct plus indirect emissions)	g CO_{2eq}/MJ	87,6	76,7	86,4	89,1
Natural gas (direct plus indirect emissions)	g CO_{2eq}/MJ	68,0	53,9	62,0	62,8
Methanol (direct plus indirect emissions)	g CO_{2eq}/MJ	98,1	137,5	138,5	62,5

Why harmonisation of biofuel GHG calculations?

EXAMPLE: Different results from same biofuel
(same input values but different standard values)

Production of FAME from Rapeseed

Emission reduction	
Fossil fuel reference (diesel)	
83,8	g $CO_{2,eq}$/MJ
GHG emission reduction	
38%	

Production of FAME from Rapeseed

Overview Results

All results in g $CO_{2,eq}$ / MJ_{FAME}	Total	Default values RED Annex V.D
Cultivation e_{ec}	27,7	29
Cultivation of rapeseed	27,29	28,51
Rapeseed drying	0,42	0,42
Processing e_p	16,5	22
Extraction of oil	3,29	3,82
Refining of vegetable oil	0,85	17,88
Esterification	12,39	
Transport e_{td}	1,3	1
Transport of rapeseed	0,15	0,17
Transport of FAME	0,73	0,82
Filling station	0,44	0,44
Land use change e_l	0,0	0
$e_{sca} + e_{ccr} + e_{ccs}$	0,0	0
Totals	**45,6**	**52**

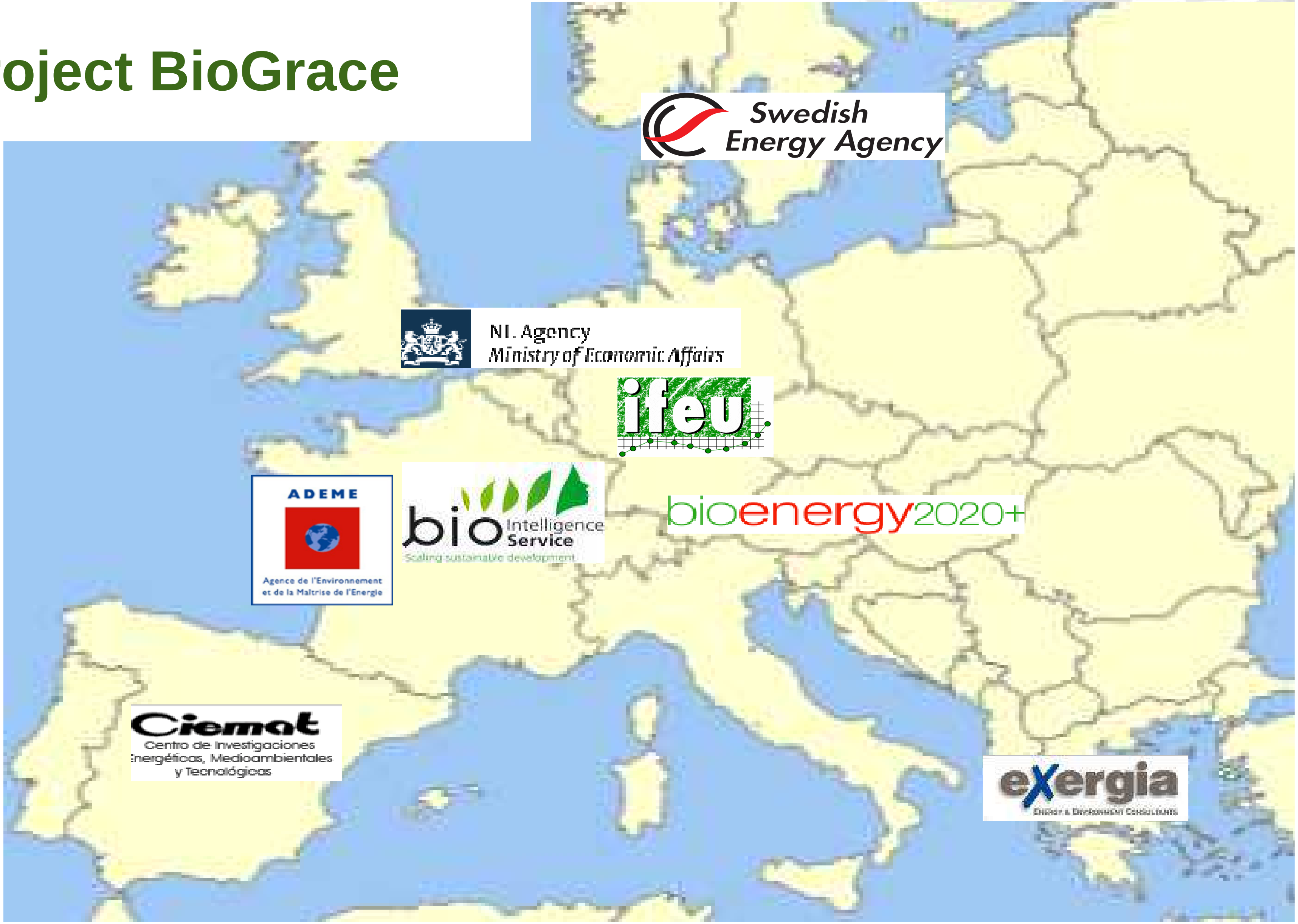
Emission reduction	
Fossil fuel reference (diesel)	
83,8	g $CO_{2,eq}$/MJ
GHG emission reduction	
46%	

Contents

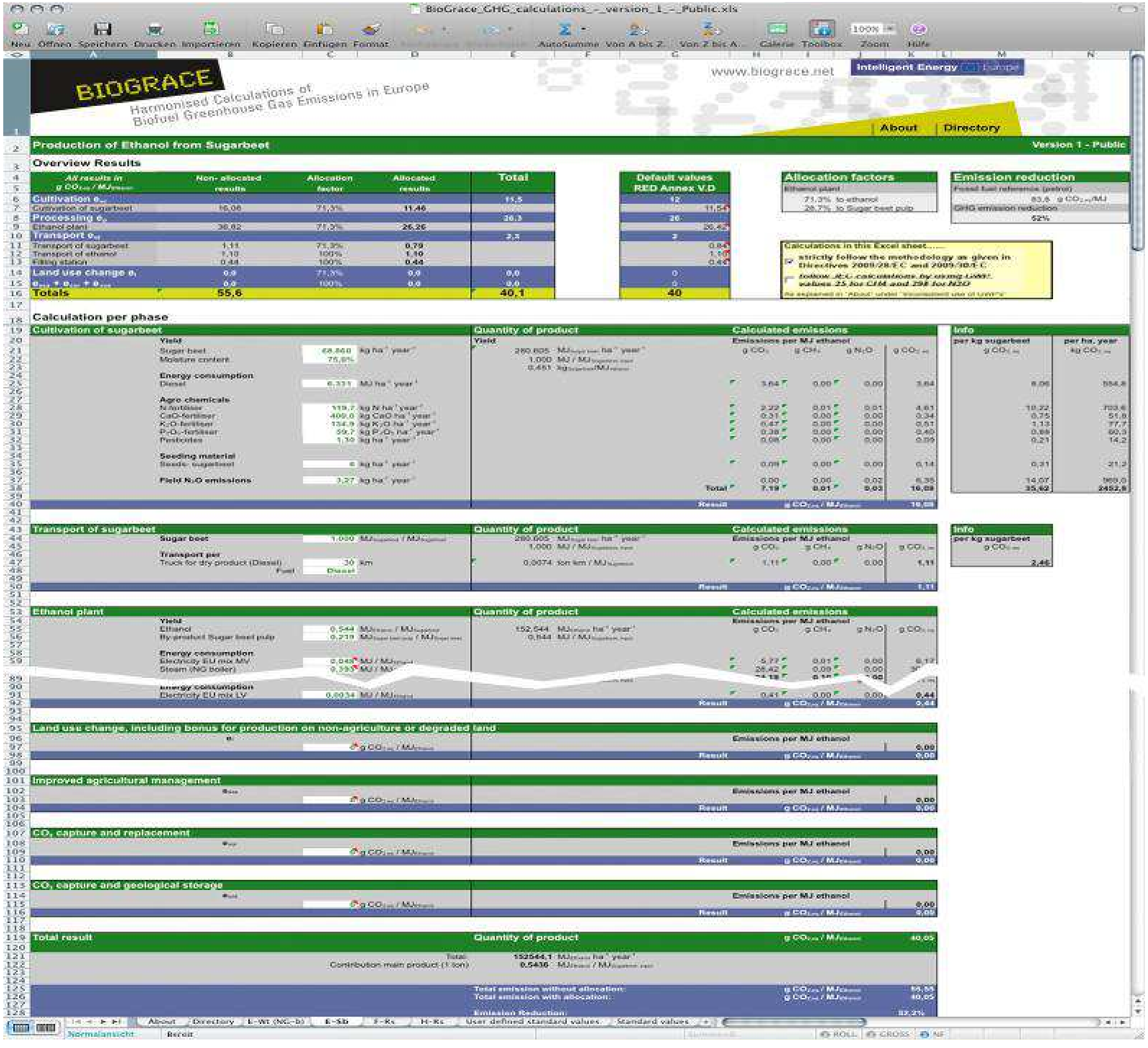
Project BioGrace

- **BIO**fuel **GR**eenhouse gas emissions: **A**lignment of **C**alculations in **E**urope
- Key objectives are
  1. Cause transparency
  2. Cause harmonisation
  3. Facilitate stakeholders
  4. Disseminate results
- Products
  1. One list of standard values
  2. Excel GHG calculation tool
  3. Harmonised national GHG calculators
  4. Voluntary certification scheme
     1. Detailed calculation rules
     2. Additional list of standard values

Project BioGrace



The Excel tool



One list of standard values

Version 3 - Public

STANDARD VALUES parameter: unit:	gCO$_2$/kg	gCH
Global Warming Potentials (GWP's)		
CO_2		
CH_4		
N_2O		
Agro inputs		
N-fertiliser	2827,0	8,68
P_2O_5-fertiliser	964,9	1,3
K_2O-fertiliser	536,3	1,5
CaO-fertiliser	119,1	0,2
Pesticides	9886,5	25,5
Seeds- corn	-	
Seeds- rapeseed	412,1	0,9
Seeds- soy bean	-	
Seeds- sugarbeet	2187,7	4,6
Seeds- sugarcane	1,6	0,0
Seeds- sunflower	412,1	0,9
Seeds- wheat	151,1	0,2
EFB compost (palm oil)	0,0	0,0
Fuels- gasses		
Natural gas (4000 km, Russian NG quality)		
Natural gas (4000 km, EU Mix qualilty)		
Fuels- liquids		
Diesel		
Gasoline		
HFO		
Ethanol		
Methanol		
FAME		
Syn diesel (BtL)		
HVO		
Fuels / feedstock / byproducts - solids		
Hard coal		
Lignite		
Corn		
FFB		
Rapeseed		
Soybeans		
Sugar beet		
Sugar cane		
Sunflowerseed		
Wheat		
Animal fat		
BioOil (byproduct FAME from waste oil)		
Crude vegetable oil		
DDGS		
Glycerol		
Palm kernel meal		

Syn diesel (BtL)	780	44,0
HVO	780	44,0
Hard coal		26,5
Lignite		9,2
Corn		18,5
FFB		24,0
Rapeseed		26,4
Soybeans		23,5
Sugar beet		16,3
Sugar cane		19,6
Sunflowerseed		26,4
Wheat		17,0
Animal fat		37,1
BioOil (byproduct FAME from waste oil)		21,8
Crude vegetable oil		36,0
DDGS		16,0
Glycerol		16,0
Palm kernel meal		17,0

Condensed list of standard values, version 3 - Public

This file gives the standard values as published on www.biograce.net in Word format.

Two Word versions of this list exist:

1. A complete list of standard values, containing all the values as listed in the Excel version
2. A condensed list showing the most important standard values

This file contains the condensed list.

Abbreviations and definitions used can be found in the Excel file on the web page http://www.biograce.net/content/ghgcalculationtools/standardvalues.

1 Global Warming potentials

CO_2	1	g $CO_{2,eq}$ / g CO_2
CH_4	23	g $CO_{2,eq}$ / g CH_4
N_2O	296	g $CO_{2,eq}$ / g N_2O

2 GHG emission coefficients

N-fertiliser	5880,6	g $CO_{2,eq}$/kg N
P_2O_5-fertiliser	1010,7	g $CO_{2,eq}$/kg P_2O_5
K_2O-fertiliser	576,1	g $CO_{2,eq}$/kg K_2O
CaO-fertiliser	129,5	g $CO_{2,eq}$/kg CaO

Both Excel and Word versions available at **www.BioGrace.net**

Achievements

- European Commission makes reference to list
- 5 Member States make reference:
  - Denmark, Netherlands, Slovakia, Spain, UK
- Another 4 MS committed to do so
- One voluntary scheme makes reference
- 4 national calculators harmonised
  - Germany, Netherlands, Spain, UK
- Follow up project BioGrace II (solid&gaseous biomass) already under final negotiation

- Voluntary scheme: approval expected in the coming months

Contents

BioGrace as a voluntary certification scheme

- BioGrace voluntary scheme will consist of a zip file with
  1. BioGrace Excel GHG tool
  2. BioGrace calculation rules
  3. BioGrace user manual
- BioGrace scheme does not contain requirements on audits and mass balance
- GHG tool can be used as "add-on" to existing schemes
  - BioGrace has to be used together with another scheme

BioGrace has submitted GHG tool to EC for recognition as a voluntary scheme in May 2011; 21st in the queue

BioGrace as an add on to existing voluntary schemes

- Current voluntary cert. schemes
  - ISSC -> already refers to BioGrace
  - RTRS, 2BSvs -> allow for external calculator
  - Bonsucro, Greenergy -> only sugar cane, do not require GHG calculations
  - RSBA (Abengoa) -> company run; no calculator
  - RSB -> own database: ecoinvent

6 ISCC list of emission factors

The choice of emission factors has an impact on the results of the GHG emissions calculation. In the framework of the Directive 2009/28/EC there is no official list of emission factors available which must be used. Consistent literature on emission factors is limited, the variance of individual factors may be large and for some inputs emission factors might not be available at all or just an approximation can be used. However, to avoid cherry picking and to assure that GHG emissions calculation and audit takes place on an objective, transparent and verifiable basis, ISCC has developed a list of emission factors. This list covers the most relevant emission factors. It should be used for all GHG emissions calculation and audits within the ISCC System. The list was developed based on experience from a two year ISCC pilot phase and from the operational phase in 2010. The list draws wherever possible from the BioGrace project. Where no values are available from BioGrace other commonly accepted databases have been used.

The ISCC list of emission factors can be supplemented and/or amended. Any ISCC Member, client or certification body can submit a new value or an update for an existing value. This proposal should be submitted to ISCC for verification and approval together with a rational of why the value should be used. Whenever a new list of emission factors is published it will be distributed via the usual channels (email, ISCC Homepage) to ISCC Members, clients and certification bodies.

Contents

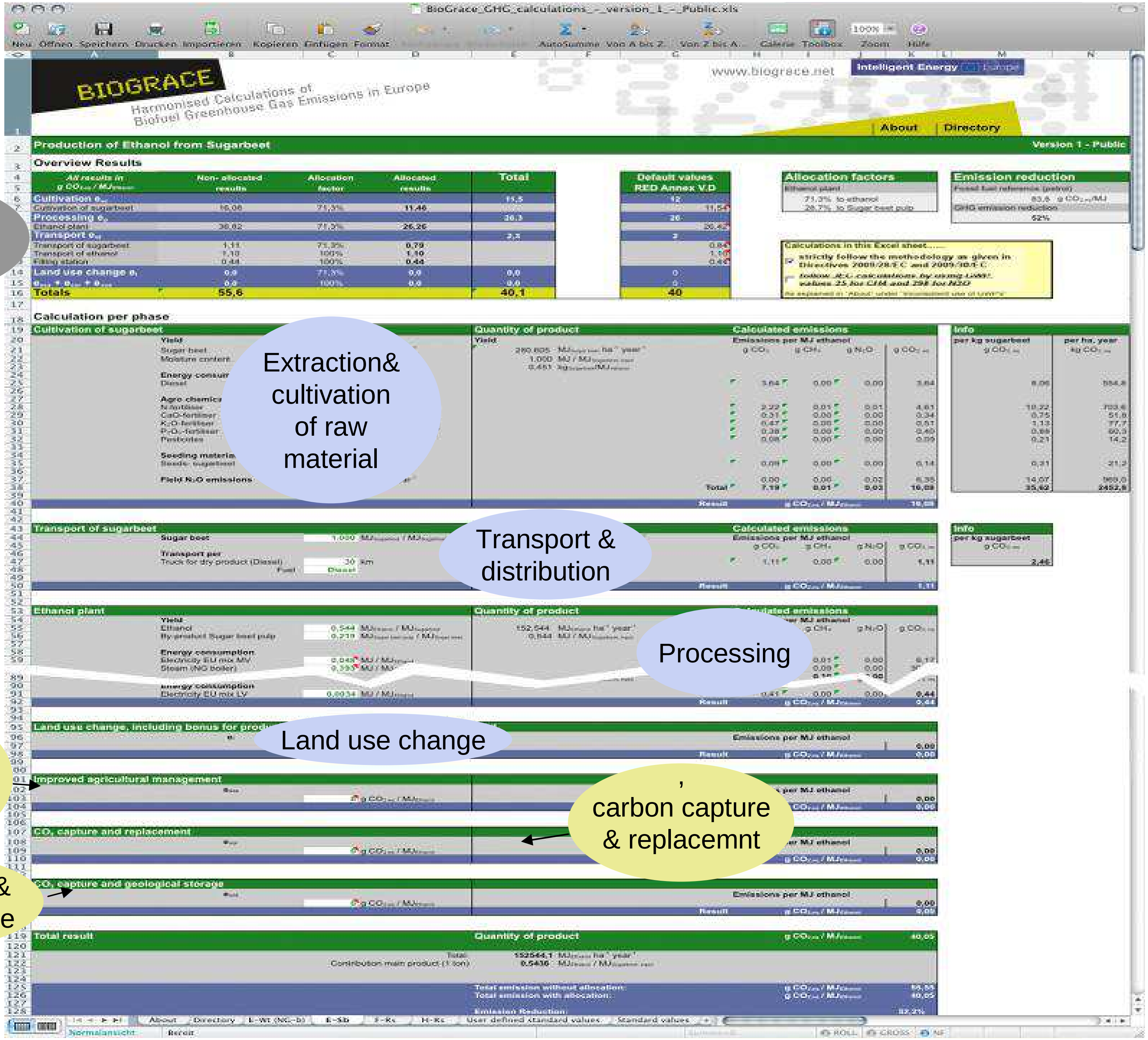
RED Annex V.c: Methodology

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

Disaggregated default values

- **Extraction& cultivation of raw material** → e_{ec}
- Land use change → e_l
- **Processing** → e_p
- **Transport& distribution** → e_{td}
- Fuel in use = 0 → e_u
- Total emissions from the use of the fuel → E
- Soil carbon capture → e_{sca}
- Carbon capture and geological storage → e_{ccs}
- Carbon capture and replacement → e_{ccr}
- Excess electricity from cogenertation → e_{ee}

The Excel tool



Before starting…

Take a look at

- the BioGrace calculation rules
- the BioGrace user manual
- the BioGrace additional list of standard values

BioGrace Calculation rules…

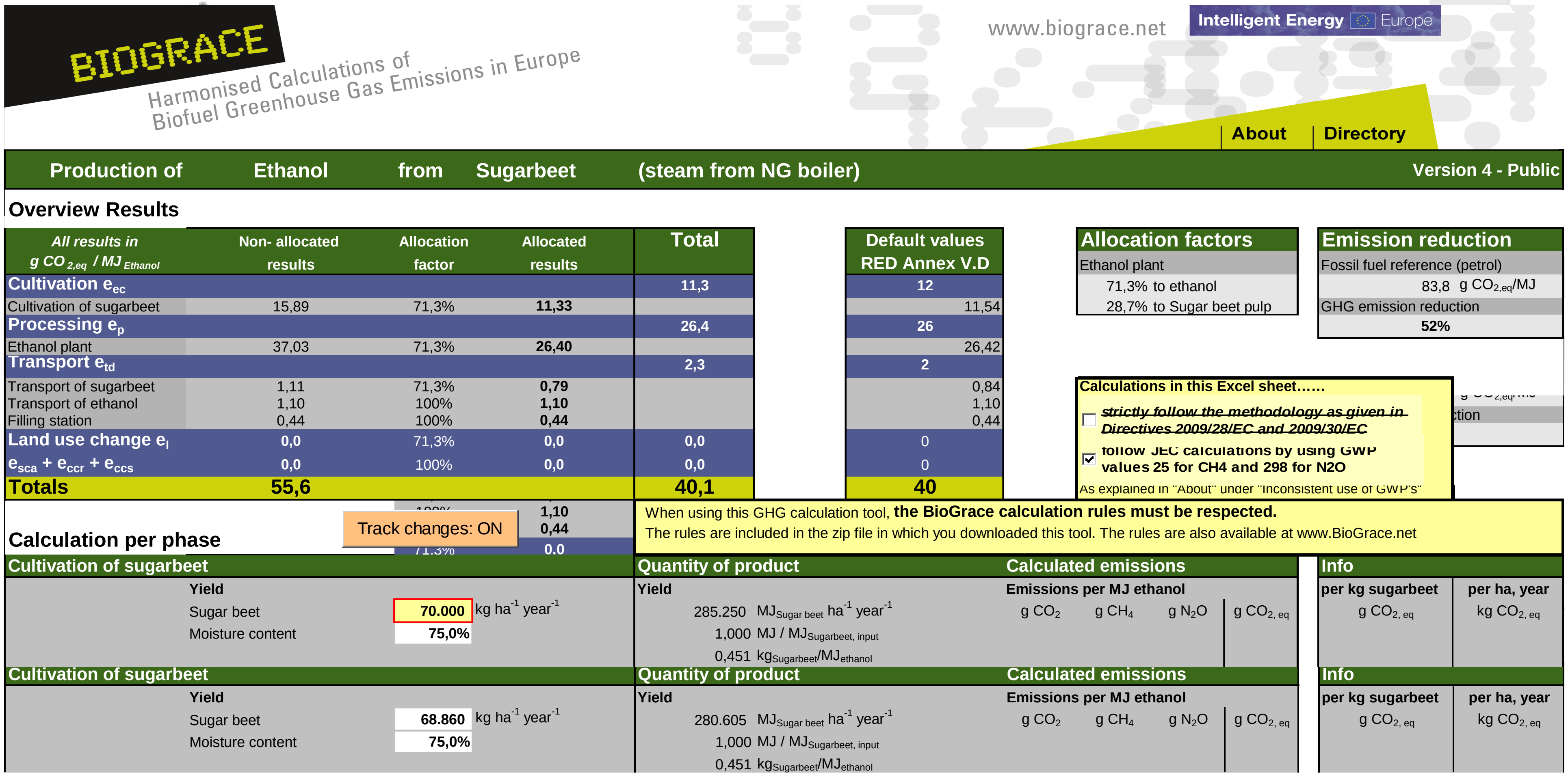
- define e.g.:
  - Which input data and standard values are allowed
  - Cut-off criterion
  - Combination of actual and disaggregated values
- are more detailed than methodology in RED Annex V.C

BIOGRACE
Harmonised Calculations of Biofuel Greenhouse Gas Emissions in Europe

Intelligent Energy Europe

One important rule:

“Use “track changes” for verification purposes”



BIOGRACE
Harmonised Calculations of Biofuel Greenhouse Gas Emissions in Europe

www.biograce.net

Intelligent Energy Europe

About | Directory

Production of	Ethanol	from	Sugarbeet	(steam from NG boiler)	Version 4 - Public

Overview Results

All results in g $CO_{2,eq}$ / $MJ_{Ethanol}$	Non- allocated results	Allocation factor	Allocated results	Total	Default values RED Annex V.D
Cultivation e_{ec}				11,3	12
Cultivation of sugarbeet	15,89	71,3%	11,33		11,54
Processing e_p				26,4	26
Ethanol plant	37,03	71,3%	26,40		26,42
Transport e_{td}				2,3	2
Transport of sugarbeet	1,11	71,3%	0,79		0,84
Transport of ethanol	1,10	100%	1,10		1,10
Filling station	0,44	100%	0,44		0,44
Land use change e_l	0,0	71,3%	0,0	0,0	0
$e_{sca} + e_{ccr} + e_{ccs}$	0,0	100%	0,0	0,0	0
Totals	55,6			40,1	40

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

Emission reduction	
Fossil fuel reference (petrol)	
83,8	g $CO_{2,eq}$/MJ
GHG emission reduction	
52%	

Calculations in this Excel sheet......
- [ ] ~~*strictly follow the methodology as given in Directives 2009/28/EC and 2009/30/EC*~~
- [x] follow JEC calculations by using GWP values 25 for CH4 and 298 for N2O

As explained in "About" under "Inconsistent use of GWP's"

Track changes: ON

When using this GHG calculation tool, **the BioGrace calculation rules must be respected.**
The rules are included in the zip file in which you downloaded this tool. The rules are also available at www.BioGrace.net

Calculation per phase

Cultivation of sugarbeet			Quantity of product		Calculated emissions				Info	
Yield			Yield		Emissions per MJ ethanol				per kg sugarbeet	per ha, year
Sugar beet	70.000	kg ha^{-1} $year^{-1}$	285.250	$MJ_{Sugar\ beet}$ ha^{-1} $year^{-1}$	g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$	g $CO_{2,eq}$	kg $CO_{2,eq}$
Moisture content	75,0%		1,000	MJ / $MJ_{Sugarbeet,\ input}$						
			0,451	$kg_{Sugarbeet}$/$MJ_{ethanol}$						

Cultivation of sugarbeet			Quantity of product		Calculated emissions				Info	
Yield			Yield		Emissions per MJ ethanol				per kg sugarbeet	per ha, year
Sugar beet	68.860	kg ha^{-1} $year^{-1}$	280.605	$MJ_{Sugar\ beet}$ ha^{-1} $year^{-1}$	g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$	g $CO_{2,eq}$	kg $CO_{2,eq}$
Moisture content	75,0%		1,000	MJ / $MJ_{Sugarbeet,\ input}$						
			0,451	$kg_{Sugarbeet}$/$MJ_{ethanol}$						

The aggregation box 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**

The Cultivation box

Cultivation of rapeseed			Quantity of product		Calculated emissions			
Yield			**Yield**		**Emissions per MJ FAME**			
					$g\ CO_2$	$g\ CH_4$	$g\ N_2O$	$g\ CO_{2,eq}$
Rapeseed	3.113	kg ha^{-1} $year^{-1}$	73.975	$MJ_{Rapeseed}$ ha^{-1} $year^{-1}$				
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} $year^{-1}$

separate calculation sheet

Cultivation e_{ec}

Cultivation of rapeseed			Quantity of product	Calculated emissions			
Yield			**Yield**	**Emissions per MJ FAME**			
				g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Rapeseed	3.113	kg ha^{-1} $year^{-1}$	73.975 $MJ_{Rapeseed}$ ha^{-1} $year^{-1}$				
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			
				g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
Rapeseed	3.113	kg ha^{-1} $year^{-1}$	73.975 $MJ_{Rapeseed}$ ha^{-1} $year^{-1}$				
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	
Yield		per kg rapeseed	per ha, year
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		

Calculation example "Old MacDonald's farm"

1. Steps from cultivation to filling station
2. Use individual input numbers
3. Navigate through tool
4. Standard values
5. Define own standard values
6. Cut-off criterion

Demonstrated in the Excel tool

Calculation of N2O field emissions

1. A major contributors to GHG emissions of most of the pathways
2. Default value : N_2O emissions calculated from a model (DNDC, average EU), except some pathways (IPCC Tier 1 for soybeans, palm trees, sugarcane)
3. For new pathways or when modifying the cultivation data from an existing pathways : BioGrace recommends to use IPCC Tier 1 estimation for this emission
   - Must be used for actual calculation

N_2O emissions : fill in few input data

A	B	C	D	E	F
Calculation of N2O emissions using the IPCC methodology					
This sheet calculates the emissions of N2O from the cultivation of the crop					
The calculations make use of IPCC methodology Tier 1 on the estimation of N_2O emissions from managed soils (1).					
For some crops (soybeans, sugarcane and palm trees) the additional hypothesis used in JEC calculations have been incorpo					
In the case of soybeans, the nitrogen content of below ground biomass was considered to be 0.074 kg N/(kg dry matter) ins					
In the case of sugar cane, N of above ground residues are not calculated using the IPCC methods. Alternatively additions of					
In the case of palm trees, N of above ground residues are calculated by the JEC considering that 0.22 t dry residues are retu					
(1) IPCC 2006, 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inv					
Crop data.					
Please enter the data for your crop in the blue cell					
Crop name	Sugar cane				
Crop yield (fresh matter)	1000	kg $_{fm}$/ha			
Humidity(%)	45,0%				
Crop yield (dry matter)	550	kg $_{dm}$/ha			
Straw yield (removed from the field)		kg dm/ha			
Amount of vignasse applied to the field (by defaul 0.94		kg of vignasse dr / kg sucar cane fm			
Amount of filter cake applied to the field (by defau 0.01)		kg of filter cake d /kg sugar cane fm			
N content of vignasse applied to the field (by defa lt 0.36)		kg N / t vignasse			
N content of filter cake applied to the field (by def ult 12.5)		kg N / t filter cake			
Carbon loss due to land use change	0	t/ha			
Is the crop irrigated OR is rainfall in rainy season minus potencial evaporation higher than soil water holding capacit ?	1	yes=1; no=0			

N_2O emissions

29				
30	**Direct N2O emissions from managed soils (Tier1).**			
31	Please enter the N additions in the form of synthetic or organic fertilizer in the blue cells			
32	N_2O emissions from N inputs: N_2O_N ...			
33				
34	F_{SN}		kg N/ha	N in synthetic fertilizer
35	F_{ON}		kg N/ha	N in organic fertilizer
36	F_{CR}	0	kg N/ha	N in crop residues
37	F_{SOM}	0,00	kg N/ha	N mineralized
38				
39	EF_1	0,01	0,003	0,03
40				
41				
42				
43				
44				
45		kg N_2O_N/ha		kg N_2O/ha
46	$N_2O\_N_{N\ inputs}$	0,00 0,00 0,00		0,00 0,00
47				

F_{CR}	N in crop residues		
$AG_{DM(T)}$	0	kg/ha	
$Frac_{Renew(T)}$	1		
$R_{AG(T)}$	0,000		
$N_{AG(T)}$	0		
$Frac_{Remove(T)}$	#DIV/0!		
$R_{BG(T)}$	0,00		
$N_{BG(T)}$	0,000		
F_{CR}	0	kg N/ha	Eq 11.6
	0	kg N/ha	Eq 11.7A

	N_{AG}	slope	intercept	$AG_{DM(T)}$	$(AG_{DM(T)}$*100(	$R_{AG(T)}$	$R_{BG-BIO(T)}$	N_{BG}
Sugar beet	0,016	1,07	1,54	2,13	4,87	3,87	0,2	
Wheat	0,006	1,51	0,52	1,35	3,46	2,46	0,24	
Corn	0,006	1,03	0,61	1,18	3,14	2,14	0,22	
Sugar cane				0,00	1,00	0,00		
Rapeseed	0,006	1,09	0,88	1,48	3,69	2,69	0,22	
Sunflower	0,006	1,09	0,88	1,48	3,69	2,69	0,22	
Soybeans	0,008	0,93	1,35	1,86	4,38	3,38	0,19	
Palm	0,011			0,00	1,00	0,00		

N_2O emissions : direct and indirect emissions calculation

$N_2O_{(L)}$-N	Leaching				
F_{SN}		0	kg N/ha	N in synthetic fertilizer	
F_{ON}					
F_{CR}					
F_{SOM}					
Frac $_{LEACH}$					
EF_5					

$N_2O_{(ATD)}$-N	Volatilization			
F_{SN}	0 kg N/ha	N in synthetic fertilizer		
F_{ON}	0 kg N/ha	N in organic fertilizer		
Frac $_{GASM}$	0,2	0,05	0,5	
Frac $_{GASF}$	0,1	0,03	0,3	
EF_4	0,01	0,002	0,05	
	kg N2O_N/ha			
$N2O_{(ATD)}$-N	0,00	0,000	0,000	

Indirect N_2O emissions from managed soils (Tier1)				
	kg N_2O_N/ha			kg N_2O/ha
N_2O from atmospheric deposition of N	0,00	0,00	0,00	0,00
$N_2O_{(L)}$-N	0,00	0,00	0,00	0,00

Direct + Indirect N_2O emissions from managed soils (Tier1)							
	kg N_2O_N			kg N_2O			
Total N_2O emissions	0,01	0,00	0,00	0,01	0,00	0,00	per ha
	0,01	0,00	0,00	0,02	0,00	0,00	per kg
	0,0005	0,0000	0,0000	0,00	0,00	0,00	per MJ

Processing (oil extraction)

Extraction of oil			Quantity of product		Calculated emissions			
Yield					**Emissions per MJ FAME**			
Crude vegetable oil	0,6125	MJ_{Oil} / $MJ_{Rapeseed}$	44.861	MJ_{Oil} ha^{-1} $year^{-1}$	g CO_2	g CH_4	g N_2O	g $CO_{2,eq}$
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

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

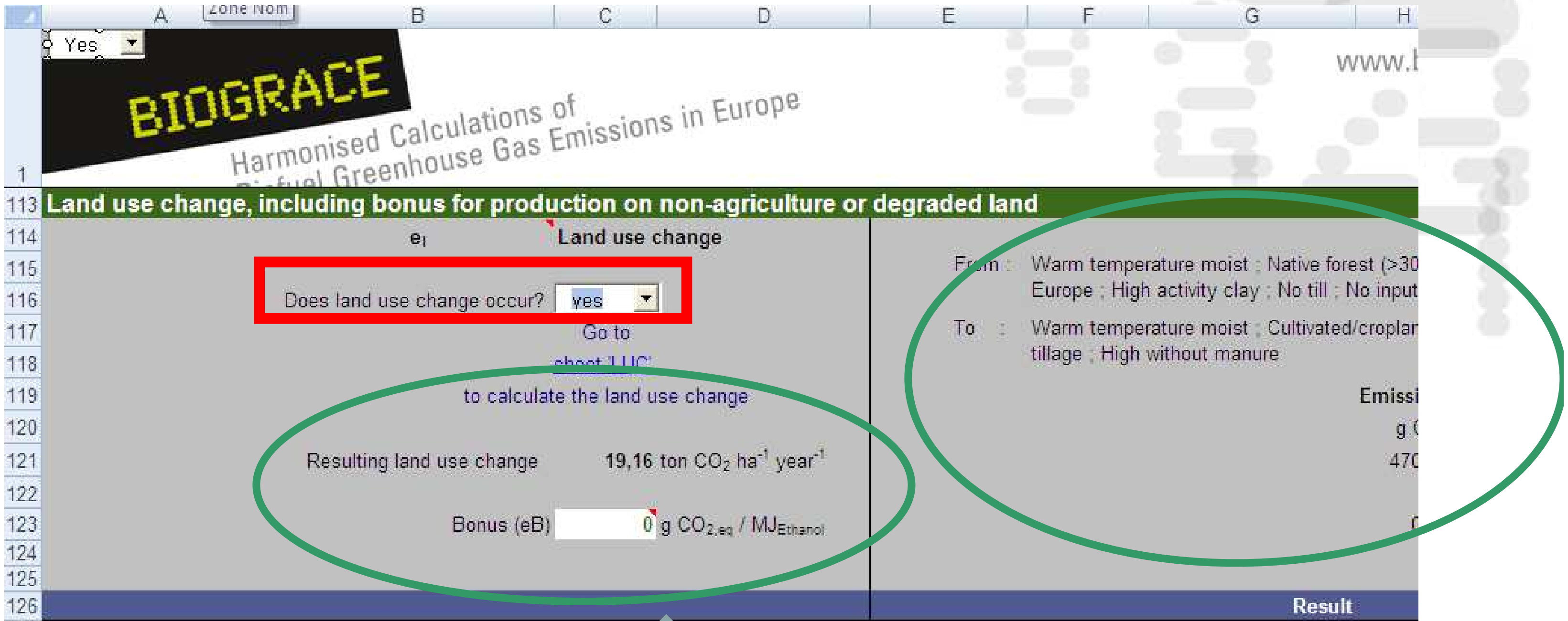
Filling station				Quantity of product				
	Yield	1,000	MJ_{FAME} / MJ_{FAME}	42790,9 MJ_{FAME} ha^{-1} $year^{-1}$	Emissions per MJ FAME			
				0,578 MJ / $MJ_{Rapeseed, input}$	g CO_2	g CH_4	g N_2O	g $CO_{2, eq}$
	Energy consumption							
	Electricity EU mix LV	0,0034	MJ / MJ_{FAME}		0,41	0,00	0,00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

Contents

GHG Excel tool – additional items

1. Land use change
2. Improved agricultural management
3. CO_2 storage or replacement

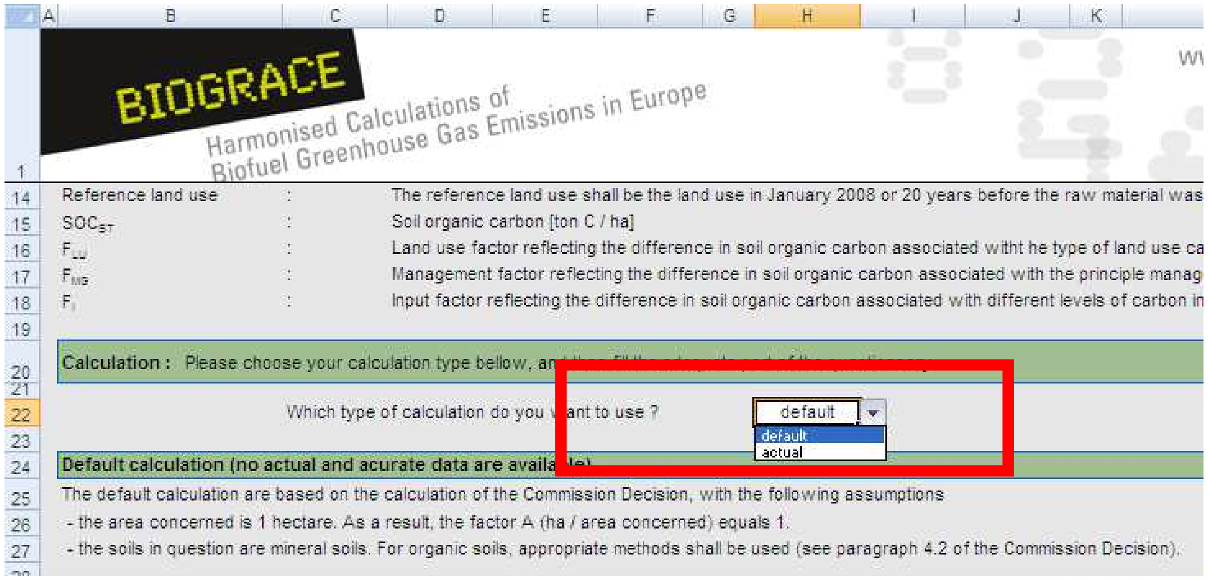
Step 1 : declare LUC in your pathway



Text appear

Step 2 : Go to the LUC excel sheet and read through this sheet. Get the Commission Decision 2010/335/EU.

Step 3 : Choose the type of calculation : default or actual and fill in the appropriate white cells.



Step 4 (default calculation) : use EC decision to fill out data

CS_A and CS_R are calculated with the following equation: $CS_i = C_{VEG} + SOC_{ST} * F_{LU} * F_{MG} * F_I$

	Actual land use		Reference land use		
Climate region	Warm temperature moist		Warm temperature moist		
Vegetation/crop (land use)	Cultivated/cropland		Native forest (>30% canopy cover)		
Above and below ground vegetation					
Ecological zone (if relevant)	-		Oceanic forest		Calculate value according to Chapter 5, or look up valu
Continent (if relevant)	-		Europe		
C_{VEG}	0	ton C / ha	84	ton C / ha	
Carbon stock in mineral soil					
Climate region	Warm temperature moist		Warm temperature moist		Determine using paragraph 6.1 of Commission Decisio
Soil type	High activity clay		High activity clay		Determine using paragraph 6.2 of Commission Decisio
Soil management	Full-tillage		No till		Determine using table 3 of Commission Decision
Input	High without manure		No input		Determine using table 3 of Commission Decision
SOC_{ST}	88	ton C / ha	88	ton C / ha	Loop up in Table 1 of Commission Decision, using clim
F_{LU}	0,69		1		Look up in Tables 2 - 8 of Commission Decision
F_{MG}	1		n/a		Look up in Tables 2 - 8 of Commission Decision
F_I	1,11		n/a		Look up in Tables 2 - 8 of Commission Decision

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7.1. Cropland

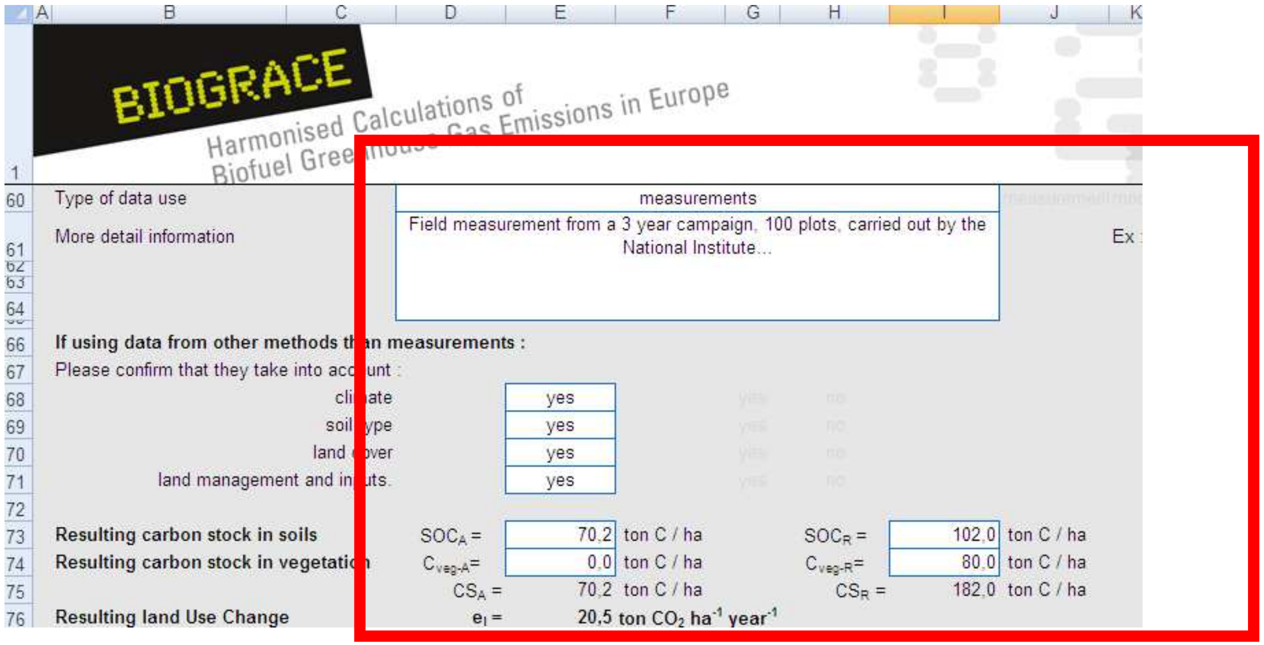
Table 2

Factors for cropland

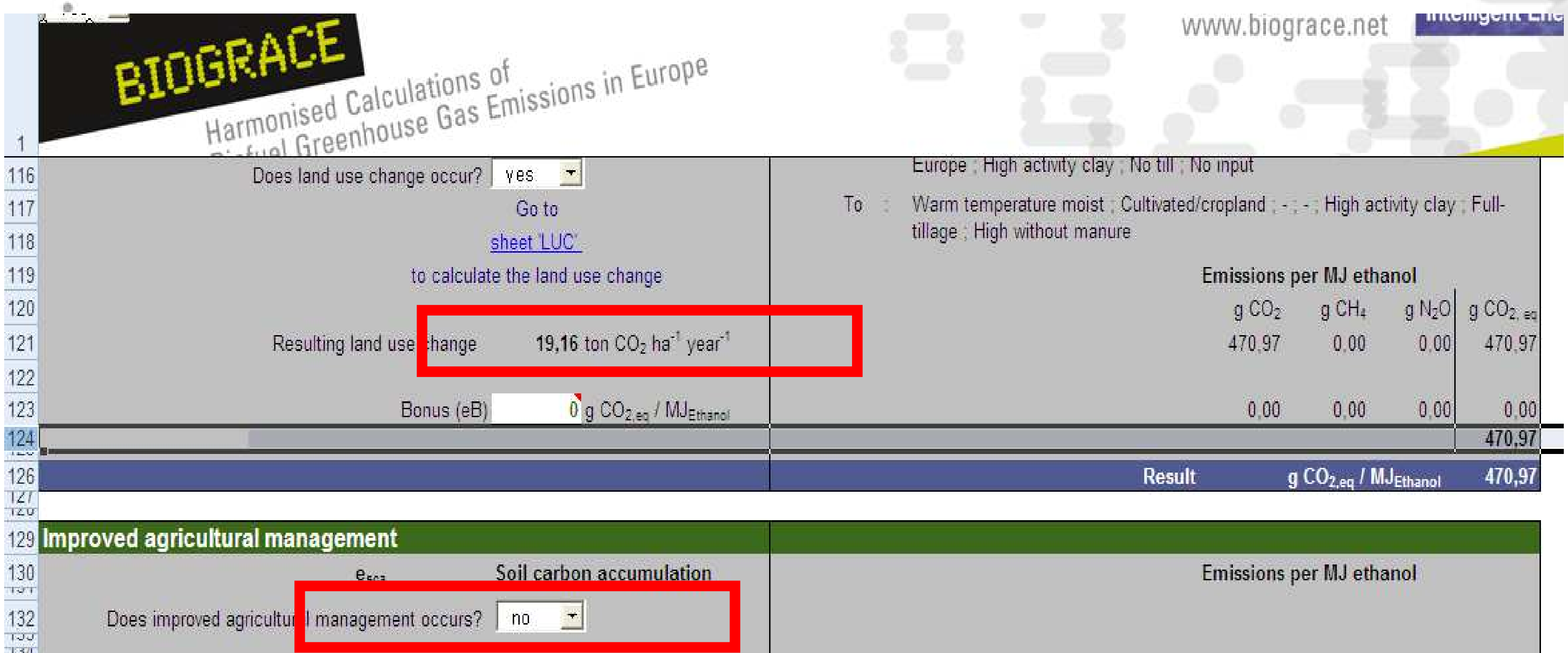
Climate region	Land use (F_{LU})	Management (F_{MG})	Input (F_I)	F_{LU}	F_{MG}	F_I
Temperate/Boreal, dry	Cultivated	Full-tillage	Low	0,8	1	0,95
			Medium	0,8	1	1
			High with manure	0,8	1	1,37
			High without manure	0,8	1	1,04
		Reduced tillage	Low	0,8	1,02	0,95
			Medium	0,8	1,02	1

Resulting carbon stock	CS_A =	67,4	ton C / ha	CS_R =	172,0	ton C / ha
Resulting LUC	e_l =	19,16	ton eq. CO_2 / ha / an			

Step 4 (actual calculation) : mind filling detailed information on the sources of the SOC data used.

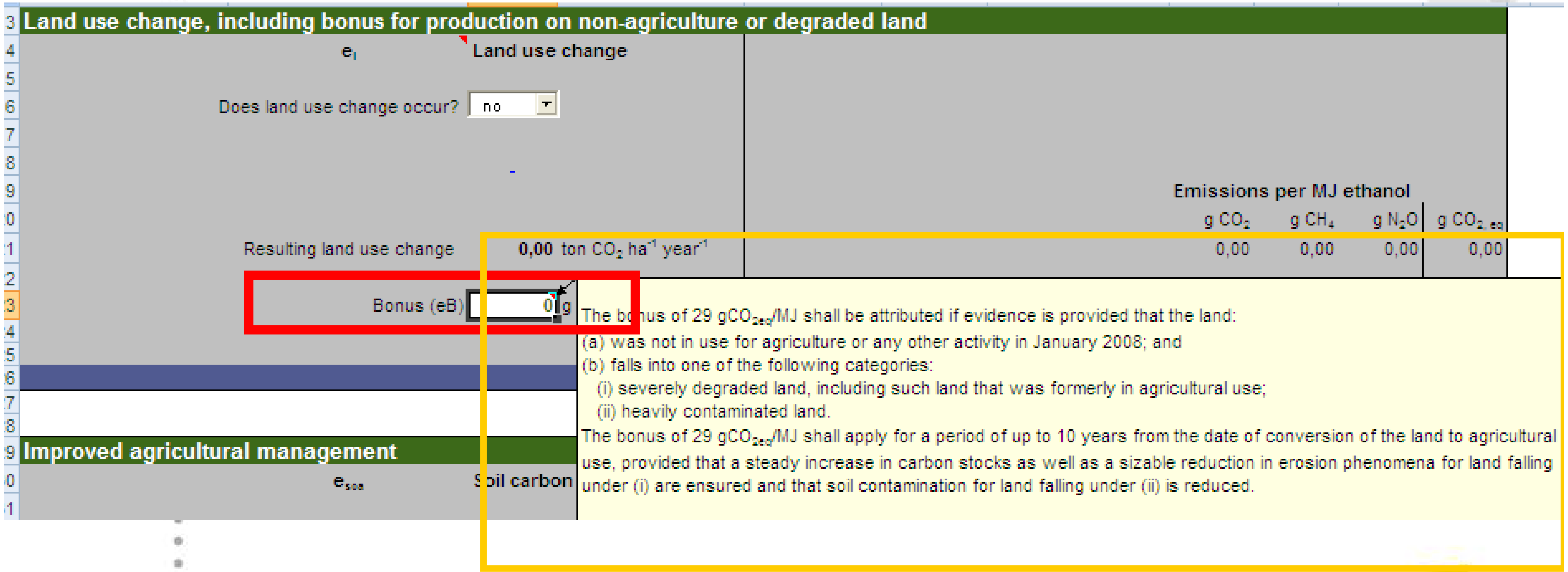


Step 5 : Check in the biofuel pathway that the LUC value is there. Please, also check that no Improved agricultural management is declared.



e_b bonus for degraded and contaminated lands :

- A specific line exits within the LUC module of each pathway.



Contents

1. Renewable Energy Directive
2. Project BioGrace
3. BioGrace as voluntary scheme
4. GHG Excel tool – incl. the calculation example
5. GHG Excel tool – additional items
6. Conclusion

The complete Excel tool

- One separate worksheet for each of the 22 biofuel pathways
- Standard values worksheet
- Separate worksheet for user defined standard values
- Extra worksheets for calculation of
  - direct land use change (based on Commission Decision)
  - carbon stock accumulation thanks to improved agricultural management (based on Commission Decision)
  - N_2O emissions (based on IPCC Tier 1)
- List of additional standard values
- User manual
- Calculations rules

Questions ?

Final remarks

- Version 5 will show new pathways according to the RED Annex V update; spring 2012
- BioGrace is not a certifier! We provide the calculation tool and will maintain it but we do not
  - help individual stakeholders make actual calculations
  - check actual calculations at the request of stakeholders
- BioGrace will offer further workshops for trainers of verifiers
- BioGrace II: Tool for use of solid and gaseous biomass in electricity, heating and cooling; start up spring 2012

Thank you for your attention

INTELLIGENT ENERGY EUROPE

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