Green Gold Label Program

Introduction

This instruction document has been drawn up for all actors in the biomass supply chain, on behalf of the Green Gold Label Foundation (www.greengoldlabel.com) and is applicable to all GGL participants.

Scope

This instruction document contains the rules on data and reference values for the greenhouse gas (GHG) calculation for biomass. With the GHG calculation the fossil greenhouse gasses coming from fossil fuels used for producing the biomass are calculated. Comparing it against a reference value for the fossil fuel mix for the energy grid that the biomass is to replace, in order to decrease the amount of fossil GHG, the balance needs to be positive and above a given value. Because of market demand the GHG calculation has been brought in line with latest version of the BioGrace-II calculation tool.

The aim of this document is to provide lean, simple, accurate and open (with clear reference to all the values used and the origin) GHG calculations which data complies to the requirements of the Biograce II tool, and shall be reported in the Biograce II tool. The next participant in the chain shall use the previous and partial GHG calculations as input for their BioGrace-II Excel tool calculation.
Unless stated otherwise, the calculation is done with data collected over an annual period. Reporting shall include an explanation and source reference. When no specific data is available (disaggregated) default values in the appendices may be used under specific circumstances. These individual default values are noted in appendix 1 and the reference values on which they are based. Alternatively under specific circumstances the process default values and disaggregated process default values based on BioGrace-II may be used as noted in appendix 7.
Disaggregated default values and default values may only be used if actual values are unavailable and cannot be attained with maximum effort.

The methodology for the calculation of greenhouse gas (GHG) emissions in this document is based on the Report of the European Commission COM (2010) 11, plus additions from the European Commission Staff Working Document SWD (2014) 259. This methodology is used for calculating the default values as listed in SWD (2014) 259 and in JRC report EUR 27215 EN. This methodology is also included in the "Methodological background document" of the BioGrace-II tool.

Sections from the original methodological description that are not relevant for GGL certified material have been omitted. The parts that have been omitted concern GHG calculations of the relative emission reduction of the production of biogas/biomethane, of land use change, of improved agricultural management and of CO2 capturing and storage.

Reference
This instruction document complies with the GHG calculation as prescribed by the
- *Verification Protocol for Sustainable Solid Biomass for Energy Applications Commissioned by the Ministry of Economic Affairs and Climate policy December 2017*
- *BioGrace-II, the GHG calculation tool – Version 3.*

The calculation is done in compliance with the Report of the European Commission COM (2010) 11, plus additions from the European Commission Staff Working Document SWD (2014) 259. The adjusted formula where not relevant factors are omitted looks like:

[F.1]* $\mathbf{E = e_{ec} + e_p + e_{td} + e_u}$

where: E = total emissions from the use of the fuel;
e_{ec} = emissions from the extraction or cultivation of raw materials;

e_p = emissions from processing;
e_{td} = emissions from transport and distribution;
e_u = emissions from the fuel in use;

* Source Verification Protocol for Sustainable Solid Biomass for Energy Applications Commissioned by the Ministry of Economic Affairs and Climate policy December 2017 - Appendix 1
Methodology for the calculation of GHG emissions of solid biomass for the generation of electricity and heat.

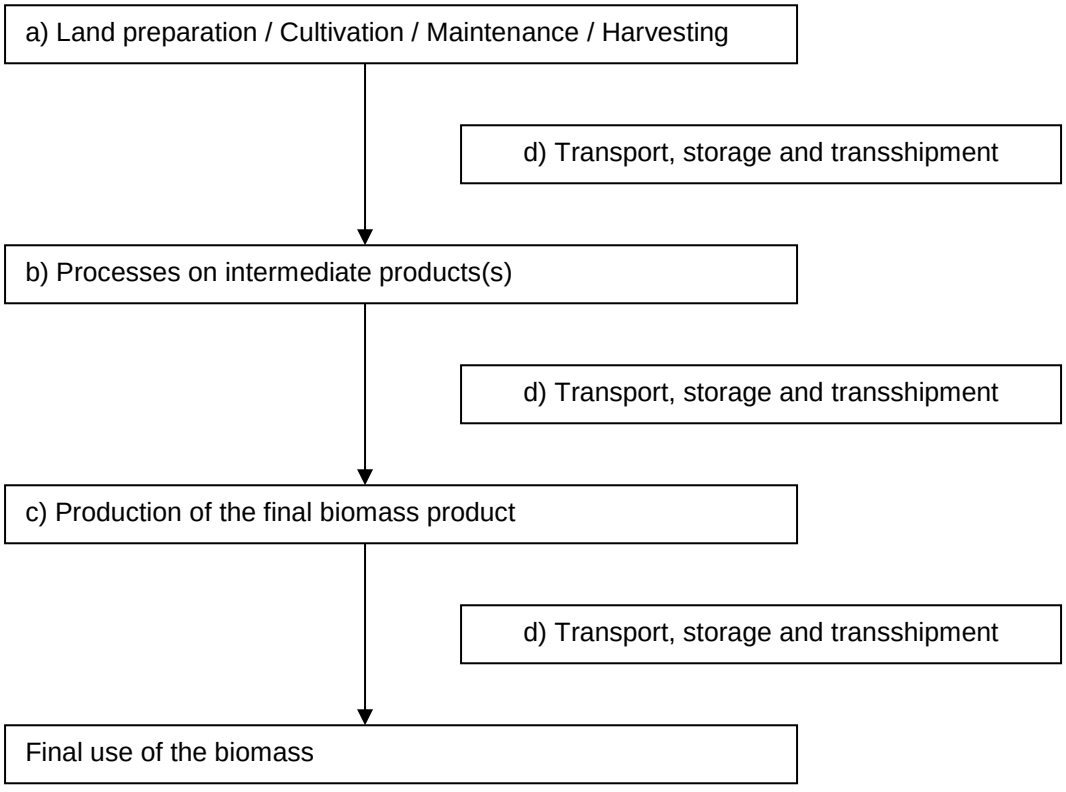
Disaggregate) default values and default values may only be used if actual values are unavailable and cannot be attained with maximum effort. Values for these disaggregated values are given in Appendix 1 and 7.If the actual transport distances and/or configuration of the production unit do not enable a choice of the right default value, the most conservative value shall be taken, meaning the value for the largest transport distance and/or a configuration using a natural gas boiler.

System description and rules

Systematical overview

For the collection of data the system is roughly divided into 4 grouped processes or process blocks.

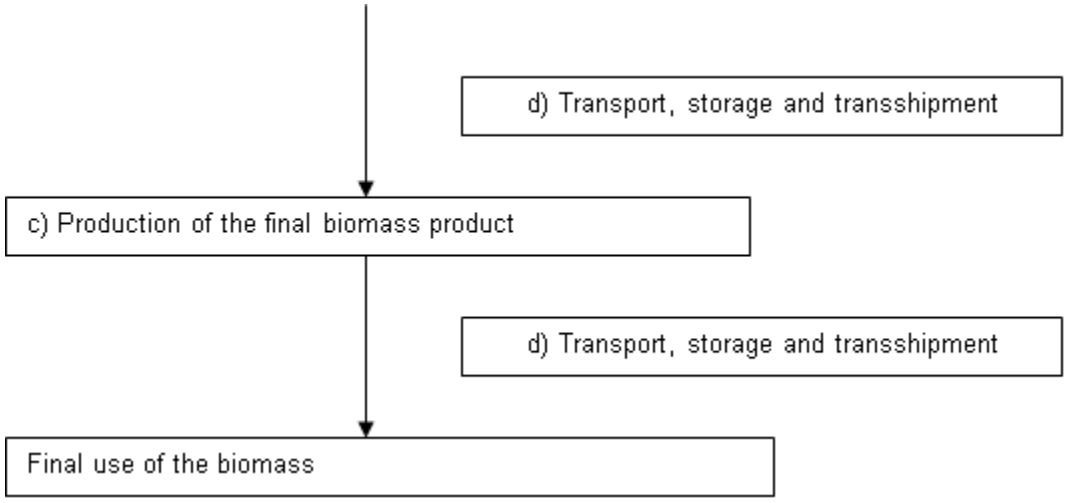
Figure 1: The systematical overview for biomass (calculation) chain of which the biomass is one of the main products produced:



Waste, secondary biomass and primary forest and agricultural crop residues, including treetops and branches, straw, bagasse, husks, cobs, nut shells and residues from processing, including crude glycerine

(glycerine that has not been refined), shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials.

Figure 2: The systematical overview for biomass (calculation) chain from the collection of biomass which is defined as residual flows or residues



GHG calculation:

Greenhouse gas emissions coming from fossil fuels that are collected and calculated at each process block shall be expressed in terms of grams of CO_2 equivalent per metric ton of fuel (gCO_2eq/ton) and communicated as required by the GGLS4 – Transaction and Product Certificate v2-2 standard as emissions from the extraction or cultivation of raw materials (e_{ec}), emissions from processing (e_p), emissions from transport and distribution (e_{td}) and emissions from the fuel in use (e_{td}), to be added up to a total emission for the biomass by the final user. Because of market requirements the communicated e_{ec} , e_p , e_{td} and , e_u shall be calculated using the Biograce-II tool.
When values for e_{td} or e_p already include the e_u portion they may be reported as e_{td} or e_p (CO_2-equivalent) and with zero e_u to prevent double counting the e_u part.

Renewable fuel or renewable energy is assumed to produce zero CO2 when burning (but (may) still produce CH4 and N2O from the fuel in use).

Disaggregated default values and default values may only be used if actual values are unavailable and cannot be attained with maximum effort. Values for these disaggregated values are given in Appendix 1 and 7.If the actual transport distances and/or configuration of the production unit do not enable a choice of the right default value, the most conservative value shall be taken, meaning the value for the largest transport distance and/or a configuration using a natural gas boiler.

Appendix 1: Reference values and calculation factors

The reference values below are derived from the BioGrace-II Excel tool - version 3 and Verification Protocol for Sustainable Solid Biomass for Energy Applications Commissioned by the Ministry of Economic Affairs and Climate policy December 2017

1a. Transport emissions

CO_2 emissions and energy per fuel type

	Default CO2 emission factor (gCO2-eq/MJ)
Diesel	87,64
HFO	84,98
HFO for maritime transport	87,20
Methanol	99,57
Hard coal	111,28
Lignite	116,98
Wheat straw	1,80
Natural gas (4000 km, Russian NG quality)	66,20
Natural gas (4000 km, EU Mix qualilty)	67,59

Source* BioGrace_standard_values_-_version_4_-_Public

If no more accurate of process specific values are available the relevant figures below should be used.

CO_2-equivalent transmissions per transport type

	Fuel efficiency (MJ/t.km)	gCH4/t.km	gN2O/t.km
Truck for dry product (Diesel)		0,005	
Truck for liquids (Diesel)	1,008	0,005	
Ocean bulk carrier (Fuel oil)	0,204	0,0003	0,00072
Ship /product tanker 50kt (Fuel oil)	0,124		
Local (10 km) pipeline	0,000		
Rail (Electric, MV)	0,210		

Source* BioGrace_standard_values_-_version_4_-_Public

The standard emission values that are used by JRC (to calculate the default values) and that are included in the BioGrace-I and –II tools include empty return (or in case of shipping partly empty return)

Densities of different fuel types

	Density (kg/m3)
Diesel	832
Gasoline	745
HFO	970
HFO for maritime transport	970
Ethanol	794
Methanol	793
FAME	890
Syn diesel (BtL)	780
HVO	780
PVO	36

Source* BioGrace_standard_values_-_version_4_-_Public

1 B. Emissions from heat and power production

Reference figures for power production or heating from fossil fuels

The reduction in CO2-eq emissions is calculated to be a minimum of 70% per year on average based on the EU reference value. The average emissions shall have a maximum of 56g CO2-eq/MJ for electricity and 24g CO2-eq/MJ for heat. No consignment of biomass shall result in emissions above 74g CO2-eq/MJ for electricity and 32g CO2-eq/MJ for heat. The calculated maximum CO2-eq emission levels are based on the most recent European Commission publication on sustainability criteria for biomass and the reference values provided for fossil fuels.

CO_2 equivalence for other Greenhouse gasses

Greenhouse gas	CO_2 equivalence
CO_2	1
CH_4	25
N_2O	298

Source: BioGrace additional standard values - version 4d

Informative values for boiler efficiencies

type	Electricity ($GWh_{electricity}$ / year)	Input (in kilo ton of pellets per year)	Efficiency based on GWh production
100% coal firing			35%*
Combustion in coal plant (co-firing)	750	400	39.24%*

* Only actual values may be used in the final calculations

1C. Emissions from forest operations and land use change

Fertiliser use

N-fertiliser (kg N)

	gCO2-eq/kg
Ammonium nitrate (AN)	3468,6567
Ammonium sulphate (AS)	2723,8095
Ammonium nitrate sulphate (ANS)	3161,5385
Anhydrous ammonia	2831,7073
Calcium ammonium nitrate (CAN)	3670,3704
Calcium nitrate (CN)	4348,387097
Urea	1934,782609
Urea ammonium nitrate (UAN)	2693,333333

P2O5-fertiliser (kg P2O5)

	gCO2-eq/kg
Triple superphosphate (TSP)	543,75000
Rock phosphate 21%P2O5 23%SO3	95,00000
Mono ammonium phosphate (MAP) 11%N 52%P2O5	1028,84615
Di-Ammonium-Phosphate (DAP) 18%N 46%P2O5	1552,17391

K2O-fertiliser (kg K2O)

	gCO2-eq/kg
Muriate of Potash (MOP) 60%K2O	413,33333

Other fertilisers

	gCO2-eq/kg
NPK 15-15-15	5013,33333
MgO (kg MgO)	769,00000
Sodium (Na) fertiliser (kg Na)	1620,00000

Residues (feedstock or input)

	gCO2-eq/kg
EFB compost (palm oil)	0,00000
Filter mud cake	0,00000
Manure	0,00000
Vinasse	0,00000

Source: BioGrace additional standard values - version 4d

Land use change

For the calculation of carbon stock emissions from land use change, the rules laid 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.

Appendix 2: Minimal values for certification:

Minimum level of greenhouse savings GGL default			
	Minimal annual GHG reduction	Maximum annual emmission	Maximum individual delivery emmission
Biomass for electricity	70%	56g CO2-eq/MJ	74g CO2-eq/MJ
Biomass for heat	70%	24g CO2-eq/MJ	32g CO2-eq/MJ

Source: Verification Protocol for Sustainable Solid Biomass for Energy Applications Commissioned by the Ministry of Economic Affairs and Climate policy December 2017, Requirements for total GHG savings

Appendix 3: Factors and multipliers

1 metric ton (MT)	1000 kilogram (kg)
1 hectare	10,000 square meter (m^2)
1 hectare	2.47 acres
1 acre	0.4047 hectares
1 joule (J)	0.239 calories (cal)
1 calorie	4.1868 J
1.0 British thermal unit (Btu)	1055.056 joule (1.055 kJ)
1 pound (lb)	0.4535924 kg
1000 Btu/lb	2.33 gigajoule per tonne (GJ/t)
1 Watt (W)	1 Joule/second (J/s)
1 Kilowatt Hour (kWh)	3.6 megajoule (MJ)
1 Btu/hr	0.2930711 W
1 liter	0,001 m^3
1 (us) mile	1.609347 kilometer (km)
1 inch (in)	2.54 cm
1 foot	0.3048 meter (m)
1 square foot (sq ft)	0.09290304 m^2
1 horsepower (hp)	745.6999 W
1 sea mile (or nautical mile)	1852 m
1 knot	1.852 km/hr
1 RTK	1 Revenue Ton Kilometer (train transport)

Multiplication Factor		Symbol	Prefix
10^{12}	1,000,000,000,000	T	tera
10^{9}	1,000,000,000	G	giga
10^{6}	1,000,000	M	mega
10^{3}	1,000	k	kilo
10^{2}	100	h	hecto
10^{1}	10	da	deca
1	1		
10^{-1}	0.1	d	deci
10^{-2}	0.01	c	centi
10^{-3}	0.001	m	milli
10^{-6}	0.000001	μ	micro
10^{-9}	0.000000001	n	nano

10^{-12}	0.000000000001	p	pico

To get from	to	Multiply by
Carbon	CO_2	3.664
CO_2	Carbon	0.2729
kg	MT	0.001
MT	kg	1000

Appendix 4: Emissions to be included and excluded in the calculations

Emissions of waste materials
To be excluded from the calculations:
- Emissions of broken equipment
- Emissions of packaging material

Emissions of indirect processes:

To be excluded from the calculations:
- Emissions and energy used for home-work travels of employers
- Emissions from the manufacture of machinery and equipment shall not be taken into account.
- Emissions and energy used for de production of packaging materials
- Emissions for constructing infrastructure
- Emissions for building factories, processing units and offices.
- Emission values resulting from land use,
- CO2 emissions from combustion of biomass

Emissions from indirect impacts
To be included in the calculations:
- CH_4 and N_2O from the final combustion are taken into account.
- .

Appendix 5: Electricity generation mix per region

Only information shall be used from official government documents or websites. The below table shall be used as reference as of the date of publication of this instruction document. The most recent official data of the electricity generation mix shall be used for the calculations.

Electric emission coefficients

Europe (EU - 28)	gCO2-eq/MJ
Austria	52,39448
Belgium	59,57408
Bulgaria	191,8034
Croatia	112,39632
Cyprus	263,57328
Czech Republic	197,2451
Denmark	116,04094
Estonia	321,2846
Finland	63,92556
France	22,726444
Germany	170,31314
Greece	243,26978
Hungary	120,37328
Ireland	164,36572
Italy	138,29894
Latvia	61,24036
Lithuania	127,79366
Luxemburg	82,64038
Malta	356,73982
the Netherlands	146,6885
Poland	287,025
Portugal	137,30656
Romania	176,61434
Slovakia	69,63522
Slovenia	122,22332
Spain	107,1372
Sweden	6,12592
United Kingdom	165,47838

Electric emission coefficients

Europe (Non-EU)	gCO2-eq/MJ
Albania	0,4282454
Belarus	212,09666
Bosnia and Herzegovina	274,16782
FYR Macedonia	307,12526
Gibraltar	269,61186
Iceland	0,370509
Kosovo	401,9856
Moldova	199,34236
Montenegro	142,14976
Norway	2,715784
Russia	171,74036
Serbia	275,2558
Switzerland	2,540202
Turkey	167,17544
Ukraine	167,2052

Electric emission coefficients

Africa	gCO2-eq/MJ
Algeria	193,04534
Angola	142,53904
Benin	271,86036
Botswana	372,5412
Cameroon	74,38872
Congo (DR)	77,71653
Congo (Rep.)	169,59086
Egypt	1,395886
Eritrea	155,65958
Ethiopia	312,65142
Gabon	2,815076
Ghana	151,69964
Ivory Coast	89,61172
Kenya	80,92002
Libya	255,23456
Mauritius	288,343
Morocco	244,7913
Mozambique	0,7918
Namibia	8,653456
Nigeria	138,50462
Senegal	227,05026
South Africa	338,0258
Sudan	71,08096
Tanzania	171,0152
Togo	45,03874
Tunisia	162,23028
Zambia	289,65938
Zimbabwe	338,8847
Other Africa	172,26812

Electric emission coefficients

Asia	gCO2-eq/MJ
Armenia	65,238336
Azerbaijan	183,96256
Bahrain	263,48656
Bangladesh	215,13722
Brunei	270,71404
Cambodia	189,85938
China (PR)	262,7002

Chinese Taipei	191,38716
Georgia	42,084696
Hong Kong	296,925
India	291,5066
Indonesia	295,83136
Iran	255,77942
Iraq	200,81404
Israel	270,4171
Japan	183,78652
Jordan	231,94664
Kazakhstan	246,3242
Korea North	85,12808
Korea South	193,87788
Kuwait	270,18008
Kyrgyzstan	16,282658
Lebanon	300,3698
Malaysia	246,93516
Mongolia	313,87102
Myanmar	75,21604
Nepal	1,718712
Oman	210,74534
Pakistan	149,8508
Philippines	188,47276
Qatar	171,5571
Saudi-Arabia	271,4175
Singapore	161,76256
Sri Lanka	181,58372
Syria	205,81768
Tajikistan	1,164492
Thailand	183,8375
Turkey	167,17544
Turkmenistan	294,72066
United Arab Emirates	193,70688
Uzbekistan	198,31868
Vietnam	149,39912
Yemen	234,24118
Other Asia	112,38292

Australia/Oceania	gCO2-eq/MJ
Australia	294,15418
New Zealand	55,20362

North America	gCO2-eq/MJ
Canada	54,62264
USA	180,20572

South and Central America	gCO2-eq/MJ
Argentina	143,93688
Bolivia	157,79298
Brazil	30,82064
Chile	178,8634
Colombia	44,74798
Costa Rica	19,20242
Cuba	338,42786
Dominican Republic	205,74878
Ecuador	112,13572
El Salvador	85,8764
Guatemala	98,6858
Haiti	218,35558
Honduras	128,22594
Jamaica	233,68666
Mexico	165,05674
Netherlands Antilles	254,23438
Nicaragua	149,469
Panama	108,5914
Paraguay	0,442555
Peru	102,4051
Trinidad and Tobago	235,59302
Uruguay	100,67972
Venezuela	96,1523
Other South and Central America	291,7707366

Appendix 6: Residual products with zero life-cycle

Waste, secondary biomass and primary forest and agricultural crop residues, including treetops and branches, straw, bagasse, husks, cobs, nut shells and residues from processing, including crude glycerine (glycerine that has not been refined), shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials)

Appendix 7: Total default values for GHG intensities

To accommodate the calculation of the greenhouse gas intensity of fuels, every participant in the chain shall collect sufficient and valid information. Values shall be calculated for this purpose, and only when with maximum effort these actual values cannot be attained, (disaggregated) default values may be adopted from BioGrace-II.
The calculations shall align with the methodology in this Instruction document. The tables in this appendix can be used for relevant default values if actual values are not available. Where an participant does not calculate its own values, passing the values from the tables below to the next participant shall suffice, both for the own values and for the values of previous participants. That information shall be sufficient to allow the correct category to be chosen. This information relates to:

- biomass energy;
- feedstock;
- configuration of pellet mill (where relevant);
- transport distance.

If the actual transport distances and/or configuration of the pellet mill do not enable a choice of the right default value, the most conservative value shall be taken, meaning the value for the largest transport distance and/or a configuration using a natural gas boiler.
Missing information from a part of the chain Where information is available to perform own emission calculations for a part of the chain and information is missing for another part, the participant may use disaggregated default values for the missing part of the chain to perform the calculation. Values for these disaggregated values are given in this Appendix.
This may happen when a company has information available for the calculation of its own emissions during transport, but not for emissions during cultivation and production. In such a case, the relevant default data for cultivation and production can be taken from BioGrace-II, whilst actual calculations can be made using the information on transport.
Calculating the greenhouse gas intensity of electricity and/or heat In order to enable calculation of the final greenhouse gas intensity of the generated electricity and/or heat, the final user of the biomass shall perform a calculation based on the input data of fuels used and the output data of electricity and/or heat produced by the plant. This converts the units in the tables below to the necessary value in the unit "amount of greenhouse gas per MJ electricity" or the unit "amount of greenhouse gas per MJ heat". The conversion efficiency of the plant shall be taken into account. The values in this appendix are adopted from the JRC report EUR 27215 EN, an update of the JRC report EUR 26696 EN of 2014 that was published as an appendix to the SWD (2014) 259 final report regarding sustainability criteria of solid and gaseous biomass. The full reference of the JRC report is:
Jacopo Giuntoli, Alessandro Agostini, Robert Edwards, Luisa Marelli, "Solid and gaseous bioenergy pathways: input values and GHG emissions", Report EUR 27215 EN, Joint Research Centre – Institute for Energy and Transport, 2015. Emission values are expressed per MJ biomass energy carrier delivered to the EP, not including the final conversion efficiency. Emission values resulting from land use, CO2 emissions from combustion of biomass and emissions from indirect impacts are not taken into account. CH_4 and N_2 O from the final combustion are taken into account. This is in accordance with the methodology used in the JRC report.

Section A – Process default values greenhouse gas emissions
Emission values are expressed on the basis of MJ final biomass delivered at the plant, final conversion efficiency is excluded. No land use emissions are included in these results nor are CO_2 emissions from the combustion of biomass or other indirect effect. Included are CH_4 and N_2O emissions from final combustion. This is in accordance with the methodology of the JRC report. Figures from Verification Protocol for Sustainable Solid Biomass for Energy Applications (Dec. 2017)

Biomass energy carrier	Feedstock	(where relevant) Configuration of pellet mill	Transport distance	Default value (g CO_2-eq per $MJ_{biomass}$)	Possible biomass category[6]
Wood chips	Forestry residues	N/A	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	6 8 14 25	1 & 2
	Short rotation coppice (Eucalyptus)	N/A	2.500 - 10.000 km	26	1 & 2
	Short rotation coppice (Poplar – fertilised)	N/A	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	9 11 17 28	1 & 2
	Short rotation coppice (Poplar – non-fertilised)	N/A	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	7 9 15 26	1 & 2
	Trunk-wood	N/A	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	6 8 14 25	1 & 2
	Wood industry residues	N/A	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	4 7 13 24	5
Wood pellets/briquettes	Forestry residues	Configuration 1: Natural gas boiler	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	36 36 38 42	1 & 2
		Configuration 2: Wood chip boiler	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	19 19 21 25	
		Configuration 3: Wood chip CHP	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	7 7 8 13	
	Short rotation coppice (Eucalyptus)	Configuration 1: Natural gas boiler	2.500 - 10.000 km	48	1 & 2
		Configuration 2: Wood chip boiler	2.500 - 10.000 km	34	
		Configuration 3: Wood chip CHP	2.500 - 10.000 km	22	
	Short rotation coppice (Poplar – fertilised)	Configuration 1: Natural gas boiler	1 - 500 km 500 - 10.000 km In excess of 10,000 km	38 40 44	1 & 2
		Configuration 2: Wood chip boiler	1 - 500 km 500 - 10.000 km In excess of 10,000 km	21 23 27	
		Configuration 3: Wood chip CHP	1 - 500 km 500 - 10.000 km In excess of 10,000 km	9 11 15	

Biomass energy carrier	Feedstock	(where relevant) Configuration of pellet mill	Transport distance	Default value (g CO_2-eq per $MJ_{biomass}$)	Possible biomass category[6]
Wood pellets/briquettes	Short rotation coppice (Poplar – non-fertilised)	Configuration 1: Natural gas boiler	1 - 500 km 500 - 10.000 km In excess of 10,000 km	36 38 42	1 & 2
		Configuration 2: Wood chip boiler	1 - 500 km 500 - 10.000 km In excess of 10,000 km	19 21 25	
		Configuration 3: Wood chip CHP	1 - 500 km 500 - 10.000 km In excess of 10,000 km	7 9 13	
	Trunk-wood	Configuration 1: Natural gas boiler	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	36 36 38 42	1 & 2
		Configuration 2: Wood chip boiler	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	19 18 20 25	
		Configuration 3: Wood chip CHP	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	6 6 8 12	
	Wood industry residues	Configuration 1: Natural gas boiler	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	22 21 23 27	5
		Configuration 2: Wood chip boiler	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	11 11 13 17	
		Configuration 3: Wood chip CHP	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	4 4 6 10	
Agricultural production systems	Agricultural residues – density < 200 kg/m³ [7]	N/A	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	4 9 17 32	4
	Agricultural residues – density < 200 kg/m³ [8]	N/A	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	4 6 9 17	4
	Straw pellets	N/A	1 - 500 km 500 - 10.000 km In excess of 10,000 km	10 12 16	4
	Bagasse briquettes	N/A	500 - 10.000 km In excess of 10,000 km	6 10	4
	Palm kernel meal	N/A	In excess of 10,000 km	61	4
	Palm kernel meal (no CH_4 emissions from oil mill)	N/A	In excess of 10,000 km	40	4

Section B – Disaggregated process default values

Emissions are expressed per MJ biomass. In case of 'overall' process default values, see Part A Figures from Verification Protocol for Sustainable Solid Biomass for Energy Applications (Dec. 2017)

Biomass energy carrier	Feedstock	(where relevant) Configuration of pellet mill	Transport distance	Default value ($g\ CO_2$-eq per $MJ_{biomass}$)				Possible biomass category[9]
				Cultivation	Processing	Transport	Combustion emissions	
Wood chips	Forestry residues	N/A	1 - 500 km	0.0	1.9	3.6	0.5	1 & 2
			500 - 2.500 km	0.0	1.9	5.9	0.5	
			2.500 - 10.000 km	0.0	1.9	11.7	0.5	
			In excess of 10,000 km	0.0	1.9	22.8	0.5	
	Short rotation coppice [10] (Eucalyptus)	N/A	2.500 - 10.000 km	13.6	0.0	12.3	0.5	1 & 2
	Short rotation coppice (Poplar – fertilised)	N/A	1 - 500 km	3.9	0.0	4.2	0.5	1 & 2
			500 - 2.500 km	3.9	0.0	6.4	0.5	
			2.500 - 10.000 km	3.9	0.0	12.3	0.5	
			In excess of 10,000 km	3.9	0.0	23.4	0.5	
	Short rotation coppice (Poplar – non-fertilised)	N/A	1 - 500 km	2.3	0.0	4.2	0.5	1 & 2
			500 - 2.500 km	2.3	0.0	6.4	0.5	
			2.500 - 10.000 km	2.3	0.0	12.3	0.5	
			In excess of 10,000 km	2.3	0.0	23.4	0.5	
	Trunk-wood	N/A	1 - 500 km	1.1	0.4	3.6	0.5	1 & 2
			500 - 2.500 km	1.1	0.4	5.9	0.5	
			2.500 - 10.000 km	1.1	0.4	11.7	0.5	
			In excess of 10,000 km	1.1	0.4	22.8	0.5	
	Wood industry residues	N/A	1 - 500 km	0.0	0.4	3.6	0.5	5
			500 - 2.500 km	0.0	0.4	5.9	0.5	
			2.500 - 10.000 km	0.0	0.4	11.7	0.5	
			In excess of 10,000 km	0.0	0.4	22.8	0.5	
Wood pellets/briquettes	Forestry residues	Configuration 1: Natural gas boiler	1 - 500 km	0.0	32.5	3.4	0.3	1 & 2
			500 - 2.500 km	0.0	32.5	3.3	0.3	
			2.500 - 10.000 km	0.0	32.5	5.1	0.3	
			In excess of 10,000 km	0.0	32.5	9.4	0.3	
		Configuration 2: Wood chip boiler	1 - 500 km	0.0	15.2	3.6	0.3	
			500 - 2.500 km	0.0	15.2	3.4	0.3	
			2.500 - 10000 km	0.0	15.2	5.2	0.3	
			In excess of 10,000 km	0.0	15.2	9.7	0.3	
		Configuration 3: Wood chip CHP	1 - 500 km	0.0	2.8	3.6	0.3	
			500 - 2.500 km	0.0	2.8	3.5	0.3	
			2.500 - 10.000 km	0.0	2.8	5.3	0.3	
			In excess of 10,000 km	0.0	2.8	9.7	0.3	

Biomass energy carrier	Feedstock	(where relevant) Configuration of pellet mill	Transport distance	Default value ($g\ CO_2$-eq per $MJ_{biomass}$)				Possible biomass category[9]
				Cultivation	Processing	Transport	Combustion emissions	
Wood pellets/briquettes	Short rotation coppice (Eucalyptus)	Configuration 1: Natural gas boiler	2.500 - 10.000 km	12.1	30.7	5.1	0.3	1 & 2
		Configuration 2: Wood chip boiler	2.500 - 10.000 km	15.4	12.9	5.2	0.3	
		Configuration 3: Wood chip CHP	2.500 - 10.000 km	16.1	0.4	5.3	0.3	
	Short rotation coppice (Poplar – fertilised)	Configuration 1: Natural gas boiler	1 - 500 km 500 - 10.000 km In excess of 10,000 km	3.5 3.5 3.5	30.7 30.7 30.7	3.4 5.1 9.4	0.3 0.3 0.3	1 & 2
		Configuration 2: Wood chip boiler	1 - 500 km 500 - 10.000 km In excess of 10,000 km	4.4 4.4 4.4	12.9 12.9 12.9	3.6 5.2 9.7	0.3 0.3 0.3	
		Configuration 3: Wood chip CHP	1 - 500 km 500 - 10.000 km In excess of 10,000 km	4.6 4.6 4.6	0.4 0.4 0.4	3.6 5.3 9.7	0..3 0.3 0.3	
	Short rotation coppice (Poplar – non-fertilised)	Configuration 1: Natural gas boiler	1 - 500 km 500 - 10.000 km In excess of 10,000 km	2.0 2.0 2.0	30.7 30.7 30.7	3.4 5.1 9.4	0.3 0.3 0.3	1 & 2
		Configuration 2: Wood chip boiler	1 - 500 km 500 - 10.000 km In excess of 10,000 km	2.6 2.6 2.6	12.9 12.9 12.9	3.6 5.2 9.7	0.3 0.3 0.3	
		Configuration 3: Wood chip CHP	1 - 500 km 500 - 10.000 km In excess of 10,000 km	2.7 2.7 2.7	0.4 0.4 0.4	3.6 5.3 9.7	0.3 0.3 0.3	
	Trunk-wood	Configuration 1: Natural gas boiler	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	1.1 1.1 1.1 1.1	31.1 31.1 31.1 31.1	3.4 3.3 5.1 9.4	0.3 0.3 0.3 0.3	1 & 2
		Configuration 2: Wood chip boiler	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	1.3 1.3 1.3 1.3	13.4 13.4 13.4 13.4	3.6 3.4 5.2 9.7	0.3 0.3 0.3 0.3	
		Configuration 3: Wood chip CHP	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	1.4 1.4 1.4 1.4	0.9 0.9 0.9 0.9	3.6 3.5 5.3 9.7	0.3 0.3 0.3 0.3	
	Wood industry residues	Configuration 1: Natural gas boiler	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	0.0 0.0 0.0 0.0	18.0 18.0 18.0 18.0	3.3 3.2 5.0 9.1	0.3 0.3 0.3 0.3	5
		Configuration 2: Wood chip boiler	1 - 500 km 500 - 2,500 km 2,500 - 10,000 km In excess of 10,000 km	0.0 0.0 0.0 0.0	7.3 7.3 7.3 7.3	3.3 3.2 5.0 9.2	0.3 0.3 0.3 0.3	
		Configuration 3: Wood chip CHP	1 - 500 km 500 - 2.500 km 2.500 - 10.000 km In excess of 10,000 km	0.0 0.0 0.0 0.0	0.3 0.3 0.3 0.3	3.4 3.2 5.0 9.2	0.3 0.3 0.3 0.3	

Biomass energy carrier	Feedstock	(where relevant) Configuration of pellet mill	Transport distance	Default value ($g\ CO_2$-eq per $MJ_{biomass}$)				Possible biomass category[9]
				Cultivation	Processing	Transport	Combustion emissions	
Agricultural production systems	Agricultural residues – density < 200 kg/m³ [11]	N/A	1 - 500 km	0.0	1.1	3.1	0.3	4
			500 - 2.500 km	0.0	1.1	7.2	0.3	
			2.500 - 10.000 km	0.0	1.1	15.4	0.3	
			In excess of 10,000 km	0.0	1.1	30.7	0.3	
	Agricultural residues – density < 200 kg/m³ [12]	N/A	1 - 500 km	0.0	1.1	3.1	0.3	4
			500 - 2.500 km	0.0	1.1	4.2	0.3	
			2.500 - 10.000 km	0.0	1.1	8.0	0.3	
			In excess of 10,000 km	0.0	1.1	15.4	0.3	
	Straw pellets	N/A	1 - 500 km	0.0	6.1	3.5	0.3	4
			500 - 10.000 km	0.0	6.1	5.4	0.3	
			In excess of 10,000 km	0.0	6.1	9.9	0.3	
	Bagasse briquettes	N/A	500 - 10.000 km	0.0	0.4	5.1	0.5	4
			In excess of 10,000 km	0.0	0.4	9.4	0.5	
	Palm kernel meal	N/A	In excess of 10,000 km	22.1	25.4	13.3	0.3	4
	Palm kernel meal (no CH_4 emissions from oil mill)	N/A	In excess of 10,000 km	22.1	4.2	13.3	0.3	4