Standards Document

Instruction Document 6C: Methodology for the calculation of GHG savings

Sustainable Biomass Program
sbp-cert.org

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In the case of inconsistency between translations, the official English language version shall always take precedence.

SBP welcomes comments and suggestions for changes, revisions and/or clarifications on all of its Standards documentation. Please contact: info@sbp-cert.org

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1 Introduction and scope

Compliance with Instruction Document 6C is not mandatory to make SBP claims. Instruction Document 6C is optional within the SBP Framework and only of interest to End-users who need a certified GHG savings calculation, e.g. as a regulatory requirement, to obtain production support for their energy plant.

Instruction Document 6C is a normative document for the certification of that calculation. It describes the principles and methodology for the Certificate Holder to make the calculation and for the CB how to verify it.

The general equations used for the calculation of GHG emissions savings in accordance with the requirements of RED-II Directive 2018-2001 of 11 December 2018 are presented in section 5 of this Instruction Document 6C: Methodology for the calculation of the GHG savings.

Normative requirements for the CB to provide a certification of GHG savings requirements are presented in section 9 of the Instruction Document 6B.

2 Normative references

Related SBP Standards:

[1] SBP Standard 1: Feedstock Compliance Standard;
[2] SBP Standard 2: Verification of SBP-compliant feedstock;
[3] SBP Standard 3: Certification Systems. Requirements for Certification Bodies;
[4] SBP Standard 4: Chain of Custody;
[5] SBP Standard 5: Collection and Communication of Data.
[6] SBP Standard 6: Energy and Carbon Balance Calculation

Related instruction documents

[7] SBP Instruction Document 5E: Collection and Communication of Energy and Carbon Data.

[8] SBP Instruction Document 6B: Biomass Compliance for Flanders

For the calculation of the greenhouse gas savings according to the Fossil Fuel Comparator of the EC, the following references are used:

[9] EC report COM(2010)11 REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT on sustainability requirements for the use of solid and gaseous biomass sources in electricity, heating and cooling[1].

[10] EC SWD(2014)259, COMMISSION STAFF WORKING DOCUMENT, State of play on the sustainability of solid and gaseous biomass used for electricity, heating and cooling in the EU[2].

[1] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0011:FIN:EN:PDF
[2] https://ec.europa.eu/energy/sites/ener/files/2014_biomass_state_of_play_.pdf

3 Default values from JRC

Only reference default values published by JRC can be used for GHG calculations.

The default values can be found in the latest documents published by JRC.

The JRC references are mentioned in footnotes to the values that are mentioned in Table 1 and Table 2.

3.1 Summary tables for the GHG calculations

Table 1 gives the reference low heating values and GHG intensities of the main fuels.

Fuel type	Units	Energy	gCO_2/MJ
HFO[3]	MJ/kg	L1 = 40,5	C1 = 94,2
diesel[4]	MJ/kg	L2a = 43,1	C2 = 95,1
diesel[5]	MJ/litre	L2b = 35,9	C2 = 95,1
gasoline[6]	MJ/litre	L3 = 32,2	C3 = 93,3
natural gas[7,8]	MJ/Nm^3	L4 = 36,1 if not measured	C4 = 66,0
propane[9,10]	MJ/kg	L5 = 46,4	C5 = 78,06
LPG[11,12]	MJ/kg	L6a = 46,0	C6 = 78,06
LPG gas[13,14]	MJ/Nm^3	L6b = 105	C6 = 78,06
butane[15]	MJ/kg	L7 = 45,8	
wood pellets[16]	MJ/tonne	L8 = 16900, if not measured	-
electricity			*CP in Tables 3-7*

Table 1. Lower heating values and GHG values per type of fuel from JRC

[3] JRC (2019 v1d) Definition of input data to assess GHG default emissions from biofuels in EU legislation, p89 and p7, https://op.europa.eu/s/omqH

[4] JRC (2019 v1d) Definition of input data to assess GHG default emissions from biofuels in EU legislation, p254 and p7, https://op.europa.eu/s/omqH

[5] JRC (2019 v1d) Definition of input data to assess GHG default emissions from biofuels in EU legislation, p254 and p7, https://op.europa.eu/s/omqH

[6] JRC (2019 v1d) Definition of input data to assess GHG default emissions from biofuels in EU legislation, p254 and p36, https://op.europa.eu/s/omqH

[7] JRC (2020 v5) Well-to-wheels Analysis of Future Automotive Fuels and Powertrains in the European Context, Appendix 2, p9 https://op.europa.eu/s/olwv

[8] JRC (2019 v1d) Definition of input data to assess GHG default emissions from biofuels in EU legislation, table 47, p36, https://op.europa.eu/s/omqH

[9] JRC (2020 v5) Well-to-wheels Analysis of Future Automotive Fuels and Powertrains in the European Context, Appendix 2, p12, https://op.europa.eu/s/olwv

[10] given that the LHV of propane is higher than that of LPG, the gCO2/MJ of LPG is a conservative estimate for that of propane

[11] JRC (2020 v5) Well-to-wheels Analysis of Future Automotive Fuels and Powertrains in the European Context, Appendix 2, p9, https://op.europa.eu/s/olwv

[12] JRC (2017) Covenant of Mayors for Climate and Energy: Default emission factors for local emission inventories, p35, 0,281 tCO2/MWh = 78,06 gCO2/MJ, https://op.europa.eu/s/omtv

[13] JRC (2020 v5), Well-to-wheels Analysis of Future Automotive Fuels and Powertrains in the European Context Appendix 2, p9, 29,18 kWh/Nm^3 = 105,048 MJ/Nm^3 https://op.europa.eu/s/olwv

[14] JRC (2017) Covenant of Mayors for Climate and Energy: Default emission factors for local emission inventories, p35, 0,281 tCO2/MWh = 78,06 gCO2/MJ, https://op.europa.eu/s/omtv

[15] JRC (2020 v5) Well-to-wheels Analysis of Future Automotive Fuels and Powertrains in the European Context, Appendix 1, p12, https://op.europa.eu/s/olwv

[16] JRC (2017 v2) Solid and gaseous bioenergy pathways: input values and GHG emissions, p181, https://op.europa.eu/s/omql

Note on LPG/propane

LPG (Liquefied Petroleum Gas) is the generic acronym for propane=C3 and butane=C4 hydrocarbons that are gaseous under ambient conditions but can be stored and transported in liquid form at relatively mild pressures (up to about 2.5 MPa for propane). LPG is widely used for heating and cooking as well as petrochemicals. It is also a suitable fuel for spark ignition engines with a good octane rating. LPG is available as a road fuel in a number of European countries.

Table 2 gives the energy intensities of the main transport types as published by JRC.

Transport type	Fuel type	Energy MJ/t.km
sea vessel[17]	HFO	E1 = 0,0656
bulk carrier[18]	diesel	E2 = 0,324
diesel train[19]	diesel	E3 = 0,252
electric train[20]	electricity	E4 = 0,210
truck[21]	diesel	E5 = 0,811

Table 2. Default energy and GHG values per type of transport from JRC

The data referenced in the following Table 3, Table 4, Table 5, Table 6, Table 7 are used to evaluate the GHG intensity for power **CP** in the country of origin for the conversion of electricity consumption into GHG according to the Fossil Fuel Comparator. Those data originate from BioGrace in 201422 as they have not been revised nor by BioGrace nor by JRC since then.

[17] JRC (2017 v2) Solid and gaseous bioenergy pathways: input values and GHG emissions, p34, https://op.europa.eu/s/omqI

[18] JRC (2019 v1d) Definition of input data to assess GHG default emissions from biofuels in EU legislation, p101, https://op.europa.eu/s/omqH

[19] JRC (2019 v1d) Definition of input data to assess GHG default emissions from biofuels in EU legislation, p102, https://op.europa.eu/s/omqH

[20] JRC (2019 v1d) Definition of input data to assess GHG default emissions from biofuels in EU legislation, p102, https://op.europa.eu/s/omqH

[21] JRC (2017 v2) Solid and gaseous bioenergy pathways: input values and GHG emissions, p31, https://op.europa.eu/s/omqI

[22] https://www.biograce.net/img/files/2015-05-12-161933BioGrace-I_GHG_calculation_tool_-_version_4d.zip

Electric emission coefficients		
Europe (EU - 28)		
	Austria	52,4
	Belgium	59,6
	Bulgaria	191,8
	Croatia	112,4
	Cyprus	263,6
	Czech Republic	197,2
	Denmark	116,0
	Estonia	321,3
	Finland	63,9
	France	22,7
	Germany	170,3
	Greece	243,3
	Hungary	120,4
	Ireland	164,4
	Italy	138,3
	Latvia	61,2
	Lithuania	127,8
	Luxemburg	82,6
	Malta	356,7
	the Netherlands	146,7
	Poland	287,0
	Portugal	137,3
	Romania	176,6
	Slovakia	69,6
	Slovenia	122,2
	Spain	107,1
	Sweden	6,1
	United Kingdom	165,5

Table 3. GHG intensity for power CP expressed in gCO_2/MJ and used for the conversion of electricity consumption in the Europe Union and UK into GHG in the calculations of Fossil Fuel Comparator for the calculation of GHG savings.

Europe (Non-EU)		
	Albania	0,4
	Belarus	212
	Bosnia and Herzegovina	274
	FYR Macedonia	307
	Gibraltar	270
	Iceland	0,4
	Kosovo	402,0
	Moldova	199,3
	Montenegro	142
	Norway	3
	Russia	172
	Serbia	275
	Switzerland	3
	Turkey	167
	Ukraine	167

Table 4. GHG intensity for power CP expressed in gCO_2/MJ and for the conversion of electricity consumption in Europe (Non-EU) into GHG in the calculations of Fossil Fuel Comparator for the sake of the calculation of GHG savings.

Africa		
	Algeria	193
	Angola	143
	Benin	272
	Botswana	373
	Cameroon	74
	Congo (DR)	77,7
	Congo (Rep.)	170
	Egypt	1
	Eritrea	156
	Ethiopia	313
	Gabon	3
	Ghana	152
	Ivory Coast	90
	Kenya	81
	Libya	255
	Mauritius	288
	Morocco	244,8
	Mozambique	1
	Namibia	9
	Nigeria	139
	Senegal	227
	South Africa	338
	Sudan	71
	Tanzania	171
	Togo	45
	Tunisia	162,2
	Zambia	290
	Zimbabwe	*339*
	Other Africa	*172*

Table 5. GHG intensity for power CP expressed in gCO_2/MJ and used for the conversion of electricity consumption in Africa into GHG in the calculations of Fossil Fuel Comparator for the calculation of GHG savings.

Asia		
	Armenia	65
	Azerbaijan	184
	Bahrain	263
	Bangladesh	215
	Brunei	271
	Cambodia	190
	China (PR)	263
	Chinese Taipei	191
	Georgia	42
	Hong Kong	297
	India	292
	Indonesia	296
	Iran	256
	Iraq	201
	Israel	270
	Japan	184
	Jordan	232
	Kazakhstan	246
	Korea North	85
	Korea South	194
	Kuwait	270
	Kyrgyzstan	16
	Lebanon	300
	Malaysia	247
	Mongolia	314
	Myanmar	75,2
	Nepal	2
	Oman	211
	Pakistan	150
	Philippines	188
	Qatar	172
	Saudi-Arabia	271
	Singapore	162
	Sri Lanka	182
	Syria	206
	Tajikistan	1,2
	Thailand	184
	Turkey	167
	Turkmenistan	295
	United Arab Emirates	194
	Uzbekistan	198
	Vietnam	149
	Yemen	234
	Other Asia	*112*

Table 6. GHG intensity for power CP expressed in gCO_2/MJ and used for the conversion of electricity consumption in Asia into GHG in the calculations of Fossil Fuel Comparator for the calculation of GHG savings.

Australia/Oceania		
	Australia	294
	New Zealand	55
North America		
	Canada	55
	USA	180
South and Central America		
	Argentina	144
	Bolivia	158
	Brazil	31
	Chile	179
	Colombia	45
	Costa Rica	19
	Cuba	338
	Dominican Republic	206
	Ecuador	112
	El Salvador	86
	Guatemala	99
	Haiti	218
	Honduras	128
	Jamaica	234
	Mexico	165
	Netherlands Antilles	254
	Nicaragua	149
	Panama	108,6
	Paraguay	0
	Peru	102
	Trinidad and Tobago	236
	Uruguay	101
	Venezuela	96
	Other South and Central America	*292*

Table 7. GHG intensity for power CP expressed in gCO_2/MJ and used for the conversion of electricity consumption in Australia/Oceania and America into GHG in the calculations of Fossil Fuel Comparator for the calculation of GHG savings.

4 Calculation of the GHG reduction

The methodology in the EC report COM(2010)11, supplemented by EC SWD(2014)259, and the fossil fuel comparator from the European Joint Research Centre - or the updated version of those documents – must be used to calculate greenhouse gas emissions from solid and gaseous biomass for the production of electricity and heat.

5 General equation for the calculation of emissions of the biomass production pathway

For the calculation of greenhouse gas emissions from solid and gaseous biomass for electricity and heat production, the methodology as laid down in the EC report COM(2010)11, complemented by EC SWD(2014)259, is applied in combination with the fossil fuel comparator of the European Joint Research Centre. EC SWD(2014)259 contains recommendations for the application of RED-I to solid (and gaseous) biomass. Methodology for solid biomass is RED II, Annex VI, or COM(2010)11, Annex I – formula has not changed.

5.1 EQUATION 1

Greenhouse gas emissions from the production of solid and gaseous biomass fuels, before conversion into electricity, heating and cooling, shall be calculated as:

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

where

E = total emissions from the production of the fuel before energy conversion;

e_{ec} = emissions from the extraction or cultivation of raw materials;

e_l = annualised emissions from carbon stock changes caused by land use change;

e_p = emissions from processing;

e_{td} = emissions from transport and distribution;

e_u = emissions from the fuel in use, that is greenhouse gases emitted during the combustion of solid and gaseous biomass;

e_{sca} = emission savings from soil carbon accumulation via improved agricultural management;

e_{ccs} = emission savings from carbon capture and geological storage, and;

e_{ccr} = emission savings from carbon capture and replacement.

Emissions from the manufacture of machinery and equipment shall not be taken into account.

5.2 EQUATION 2

From those GHG emissions, GHG savings can be calculated against the references states by the Joint Research Centre (JRC) of the European Commission.

Greenhouse gas emission savings from biofuels and bioliquids shall be calculated as:

$$SAVING = (E_F - E_B)/E_F,$$

where

E_B = total emissions from the biofuel or bioliquid; and

E_F = total emissions from the fossil fuel comparator.

For electricity, the current Fossil fuel comparator E_F has been set by JRC to 183 gCO_2/MJ and E_B must include electric efficiency of the energy plant ($E_B = E/\eta_{el.}$).

This electric efficiency of the energy plant is calculated as the net electricity produced during the period of the past 12 months divided by the total fuel consumption during that same period, where all quantities are taken from official production reporting.

5.3 GHG emissions for wood cultivation e_{ec}

JRC publication in 2017[23] delivers default GHG emission factors used to cover some sources of emissions for which no individual calculation is intended. Those values were evaluated on the basis of

- In Table 8, GHG values in gCO_{2eq}/MJ pellets cover extraction and cultivation of wood (i.e. forestry and harvesting): e_{ec}, must include default emissions from the extraction or cultivation process itself; from the collection and storage of raw materials; from waste and leakages; and from the production of chemicals or products used in extraction or cultivation but capture of CO_2 in the cultivation of feedstock must be excluded.
- In Table 8, where necessary GHG values in gCO_{2eq}/MJ pellets cover non-CO_2 emissions from final combustion at the plant.
- In Table 9,GHG value in gCO_{2eq}/MJ wood chips when chips are used as fuel for the dryer/CHP inside the pellet plant (the default values cover, where appropriate : cultivation of wood fuel, processing of wood fuel, transport and distribution of wood fuel, and non CO_2 emissions generated by the combustion of wood fuel in the pellet plant).

[23] JRC (2017 v2) Solid and gaseous bioenergy pathways: input values and GHG emissions, tables 92-93 p120-122, https://op.europa.eu/s/omql

Biomass fuel production system	Cultivation gCO_{2eq}/MJ	Non CO_2 gCO_{2eq}/MJ
Wood briquettes or pellets from forest residues	0,0	0,3
Wood briquettes or pellets from stemwood	1,4	0,3
Wood briquettes or pellets from wood industry residues	0,0	0,3

Table 8. GHG emissions resulting from the cultivation and non CO_2 emissions for briquettes and pellets made out of forest residues, stemwood and industry residues

Biomass fuel production system	Cultivation	Processing	Transport on less than 500 km	Non CO_2
	gCO_{2eq}/MJ	gCO_{2eq}/MJ	gCO_{2eq}/MJ	gCO_{2eq}/MJ
Wood chips from forest residues	0,0	1,9	3,6	0,5
Wood chips from stemwood	1,1	0,4	3,6	0,5
Wood chips from SRC (eucalyptus)	4,4	0,0	13,2	0,5
Wood chips from SRC (poplar, fertilised)	3,9	0,0	4,2	0,5
Wood chips from SRC (poplar, non-fertilised)	2,2	0,0	4,2	0,5

Table 9. GHG emissions resulting from the cultivation, processing, transport and non CO_2 emissions for the wood chips used for drying the feedstock for the pellets

The transport values in Table 9 must only be used when the average weighted transport distance is shown to be less than 500 km. Otherwise the corresponding value from Table 91 in the JRC publication in 2017[24] must be used.

[24] JRC (2017 v2) Solid and gaseous bioenergy pathways: input values and GHG emissions, tables 92-93 p120-122, https://op.europa.eu/s/omql

5.4 GHG emissions for land use change e_l.

The bonus for repaired degraded land must be calculated as stipulated in RED-I and when applicable RED-II.

The factor for emission reduction through carbon storage in the soil applicable must be calculated as stipulated in RED-I and when applicable RED-II.

5.5 GHG emissions for processing e_p

5.5.1 Power consumption for making the pellets

The GHG emissions for the specific power consumption of the BP e_p in gCO_2/ton pellet is given by

$$e_{p,1} = 3{,}6\,.\,CP.\,P1$$

where

CP is the GHG intensity of power in gCO_2/MJ in the country of origin as given in Tables 3 to 7.

P1 is the specific consumption of the BP in [kWhe/tonne pellets].

P1 is estimated in the SAR based on 12 months operation, if documented records are available. When the power consumption and the related pellet production are not available for 12 months operation, other approaches (such as test periods, extrapolations, and design values) can be used. This is particularly relevant for new plants.

If the electricity comes from the grid, invoices from the supplier covering the whole reference period are also cross-checked by the CB, unless there is a specific reason why those documents are not available (newly commissioned plants) or not relevant (several production lines sharing the same meters).

If the electricity comes from an energy plant on site, possibly a combined heat and power plant, a detailed calculation is made according to net electricity and the net heat produced by the plant, used respectively. as a source of power and as a source of heat for drying.

5.5.2 Use of fossil fuels for the preparation of the biomass

The quantification methods for fossil fuel used on site depend on the available information. It can be based on a monitoring operated by the producer, sometimes supported by supplier invoices, but not always. As far as possible it should be referred to 12 months operation.

Sometimes there is no relevant monitoring, so the CB needs to validate some estimation.

The **diesel oil** annually used in the pellet plant (to fuel pay loader or other machinery) is generally reported in volume (litres per ton pellets) PV_2.

$$e_{p,2} = PV_2.\,C2.\,L2b$$

- $e_{p,2}$ in gCO_2/ton pellet from diesel,
- C2 is the GHG intensity of diesel in gCO_2/MJ as given in Table 1,
- L2b is the heating value per litre of diesel in MJ/litre as given in Table 1.

In the cases that **gasoline** is used and not diesel, then C2 and L2b must be respectively substituted with C3 and L3.

If any natural gas is used in the process, it can be monitored either as primary energy (in kWhp or MJp) or as volume (in Nm³ per ton pellets). If the natural gas consumption is reported in primary energy in MJ per tonne pellets PV4', the specific GHG emission is calculated as

$$e_{p,4} = PV_4{}'.C4$$

- $e_{p,4}$ in gCO_2/ton pellet from Natural Gas,
- C4 is the GHG intensity of natural gas in gCO_2/MJ as given in Table 1,

The total mass of **propane** used, expressed in kg, is denoted PV_5. If propane annually used in the pellet plant (to fuel pay loader or other machinery) is reported in volume of gaseous propane PV_{5a} (Nm³), the conversion to kg PV_5 is performed based on the following density[25]: 1,91 kg/Nm³ (1.013 bar and 15°C (59°F)). If the use is reported in the volume of liquid propane PV_{5b} (m³), the conversion in kg PV_5 is performed based on the following density[26]: 584,8 kg/m³. Then the total mass of propane used, expressed in kg, is denoted PV_5, the specific GHG emission in [g_{CO2}/ton pellets] is

$$e_{p,5} = PV_5.C5.L5$$

- $e_{p,7}$ in gCO_2/ton pellet from propane,
- C5 is the GHG intensity of propane in gCO_2/MJ as given in Table 1,
- L5 is the heating value per kg of propane in MJ/kg as given in Table 1.

Propane can be monitored either as primary energy (in kWhp or MJp) or as volume (in Nm³ per ton pellets).

The sum corresponding to the usage of **any additional fossil fuels** like LPG (6), butane (7), and other (N). is converted in a similar way to the corresponding quantity $e_{p,6}$, $e_{p,7}$, …, $e_{p,N}$ according to PV_N and expressed in gCO_2 per ton pellets. In case the fuel N is not described in Table 1 or in Table 2, adequate JRC references for CN and LN parameters should be found and mentioned in the calculation sheet.

[25] http://encyclopedia.airliquide.com/Encyclopedia.asp?GasID=53#GeneralData
[26] https://rapidn.jrc.ec.europa.eu/substance/propane

5.5.3 GHG emissions for the processing of the wood pellets

$$e_p = \frac{e_{p,1} + e_{p,2} + e_{p,3} + e_{p,4} + e_{p,5} + \cdots + e_{p,N}}{L8}$$

- e_p is the GHG emissions for processing in gCO_2/MJ pellets,
- $e_{p,1}$, $e_{p,2}$, $e_{p,3}$, $e_{p,4}$, $e_{p,5}$, …, $e_{p,N}$ are the GHG emissions for the use of electricity, diesel, gasoline, propane, natural gas, and all other fossil fuels, as calculated in [gCO_2/tonne pellets],
- L8 is the low heating value of the wood pellets in MJ/tonne pellets and is measured together with the moisture content of the final product and reported in the SAR.

5.6 Emissions for transport e_{td}

5.6.1 Road transport by truck

In case of transport of the feedstock by diesel trucks:

$$e_{f,5} = K1 \, . \, C2 . \, E5$$

In case of transport of the pellets by diesel trucks:

$$e_{t,5} = K2 \, . \, C2 . \, E5$$

with

K1 weighted average distance between the origins per Feedstock Groups in the SAR and the BP in [km] for the transport by diesel trucks,
K2 weighted average distance for the transport by diesel trucks of the pellets in [km],
E5 energy intensity for the transport by diesel trucks as defined in Table 2 in MJ/t.km,
C2 GHG intensity for the transport by diesel trucks in gCO_2/MJ as specified by JRC in Table 1.

5.6.2 Transport by bulk carriers

In case of transport of the feedstock by diesel bulk carriers:

$$e_{f,2} = K3 \, . \, C2 . \, E2$$

In case of transport of the pellets by diesel bulk carriers:

$$e_{t,2} = K4 \, . \, C2 . \, E2$$

with:

K3 weighted average distance between the origins per Feedstock Groups in the SAR and the BP in [km] for the transport by diesel bulk carriers,
K4 weighted average distance for the transport by diesel bulk carriers of the pellets in [km],
E2 energy intensity for the transport by diesel bulk carriers as defined in Table 2 in MJ/t.km,
C2 GHG intensity for the transport by diesel bulk carriers in gCO_2/MJ as specified by JRC in Table 1.

5.6.3 Transport by diesel train

In case of transport of the feedstock by diesel trains:

$$e_{f,3} = K5 \, . \, C2 . \, E3$$

In case of transport of the pellets by diesel-fueled trains, the energy consumption is given in [kWh/tonne pellets] by the following formula:

$$e_{t,3} = K6 \, . \, C2 . \, E3$$

with

K5 weighted average distance between the origins per Feedstock Groups in the SAR and the BP in [km] for the transport by diesel trains,
K6 weighted average distance for the transport by diesel trains of the pellets in [km],
E3 energy intensity for the transport by diesel trains as defined in Table 2 in MJ/t.km,

C2 GHG intensity for the transport by diesel trains in gCO_2/MJ as specified by JRC in Table 1.

5.6.4 Transport by electric trains

In case the feedstock is transported by electric train:

$$e_{f,4} = K7\,.\,E4\,.\,CP$$

In case the pellets are transported by electric train, the energy consumption of the transport is given by the following formula:

$$e_{t,4} = K8\,.\,E4\,.\,CP$$

with

K7 weighted average distance between the origins per Feedstock Groups in the SAR and the BP in [km] for the transport by electric trains,
K8 weighted average distance for the transport by electric trains of the pellets in [km],
E4 energy intensity for the transport by electric trains in MJ/t.km as defined in Table 2

CP the GHG intensity in gCO_2/MJ of electricity given in Tables 3-7 per country.

5.6.5 Marine transport of the pellets

For the route that the sea vessel uses and for evaluating the corresponding distance, the CB uses https://sea-distances.org/ specifying Port or origin and Port of destination. Those data are collected by the BP or the trader and stored into the Data Transfer System of SBP.

If Port is not in the list, the closest Port in the list is used. This delivers sometimes several possible routes, like via Suez Canal or via Panama Canal. To select the right route, the Certificate Holder makes sure what will be the real route that the sea transport company will usually take, as mentioned in an SREG of SBP.

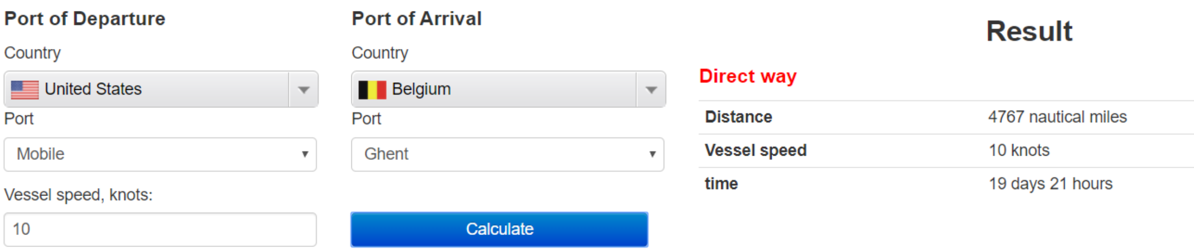

Table 10. Distance for route between the port of Mobile, USA and Ghent, BE is 4767 nautical miles, D=8828,5km

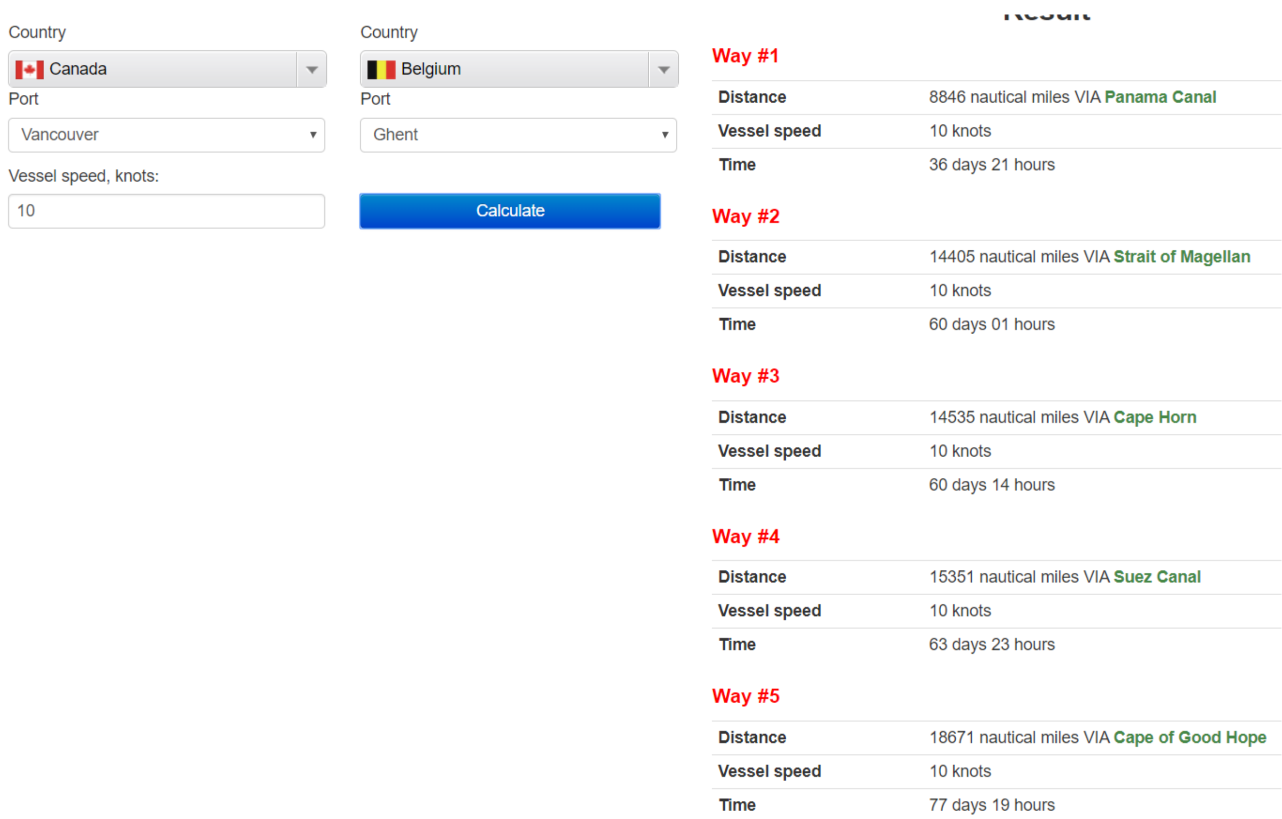

Table 11. Distance for the route between the port of Vancouver, BC, Canada and Ghent, BE via Panama Canal is 8846 nautical miles, D = 16383km

The fuel consumption during marine transport per ton of pellets is given by the following formula:

$$e_{t,1} = D \,.\, E1 . C1$$

with

D	Distance in km = (nautical miles x 1,852)
E1	energy intensity for the transport by sea vessel in MJ/t.km as defined in Table 2
C1	GHG intensity in gCO_2/MJ as specified in Table 1.

5.6.6 GHG emissions for the transport of the feedstock and the biomass

However, because transport of feedstock is evaluated in [kWh/tonne feedstock] a conversion rate, CR, needs to be applied to have a value expressed in [kWh/tonne pellets]. The reduction in weight between raw material and pellets is caused by the drying process. Hence, this conversion rate is given by following formula:

$$CR = \frac{1 - IM_{wet}}{1 - FM_{wet}}$$

with the following values as stated in “3.3. Moisture content and drying” of the SAR:

FM_{wet}	Final moisture (wet basis)
IM_{wet}	Initial moisture (wet basis)

For the initial moisture, the CB has to specify the origin of the figure (it can be a rough estimation based on the typical moisture contents of the raw material, it can be based on a couple of punctual measurements, and, when available, it can be based on the weighted average of all moisture measurements performed of each entering batch of raw material during the reference period). The final moisture is based on specs, and the values are as stated in “3.3. Moisture content and drying” of the SAR. Typical range is 5-8%.

Finally, the GHG emissions due to the transport of the feedstock is given by

$$e_f = \frac{e_{f,5} + e_{f,4} + e_{f,3} + e_{f,2} + e_{f,1}}{CR}$$

and the GHG emissions due to the transport of the pellets is given by

$$e_t = e_{t,5} + e_{t,4} + e_{t,3} + e_{t,2} + e_{t,1}$$

And the total contribution for transport expressed in g_{CO2}/MJ is then:

$$e_{td} = \frac{e_f + e_t}{L8}$$

where

e_{td} is the GHG emissions for processing in gCO_2/MJ,

e_f, e_t, are the GHG emissions for the transport of the feedstock and the pellets calculated in [gCO_2/ton pellets].

L8 is the lower heating value of wood pellets, expressed as MJ/tonne pellets, as measured together with moisture of final product and reported in the SAR, when this actual measurement is not available the value from Table 1 must be used.