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ANNEX

ANNEX

to the

DELEGATED DIRECTIVE

amending Annex V and Annex VI to Directive (EU) 2018/2001 of the European Parliament and of the Council, as regards rules for calculating the greenhouse gas impact of biofuels, bioliquids and biomass fuels and their fossil fuel comparators

ANNEX

Annexes V and VI to Directive (EU) 2018/2011 are amended as follows:

(1) Annex V is amended as follows:

(a) Parts A and B are replaced by the following:

‘***A. TYPICAL AND DEFAULT VALUES FOR BIOFUELS IF PRODUCED WITH NO NET CARBON EMISSIONS FROM LAND-USE CHANGE***

Biofuel production pathway	**Greenhouse gas emissions savings – typical value**	**Greenhouse gas emissions savings – default value**
Ethanol from sugar beet (no biogas from slop), natural gas boiler	69%	65%
Ethanol from sugar beet (with biogas from slop), natural gas boiler	79%	77%
Ethanol from sugar beet (no biogas from slop), cogeneration unit fuelled with natural gas (*)	73%	70%
Ethanol from sugar beet (with biogas from slop), cogeneration unit fuelled with natural gas (*)	79%	77%
Ethanol from sugar cane	66%	66%
Ethanol from all other cereals, natural gas boiler	48%	44%
Ethanol from all other cereals, cogeneration unit fuelled with natural gas (*)	52%	49%
Ethanol from all other cereals, forest residues cogeneration unit (*)	67%	66%
Ethanol from maize, natural gas boiler	54%	49%
Ethanol from maize, cogeneration unit fuelled with natural gas (*)	58%	55%
Ethanol from maize, forest residues cogeneration unit (*)	72%	72%
Ethanol from wheat, natural gas boiler	47%	43%

Ethanol from wheat, cogeneration unit fuelled with natural gas (*)	51%	48%
Ethanol from wheat, forest residues cogeneration unit (*)	66%	66%
Fatty acid methyl ester (**) from rapeseed	56%	54%
Fatty acid methyl ester (**) from sunflower seed	64%	62%
Fatty acid methyl ester (**) from soybean	66%	64%
Fatty acid methyl ester (**) from palm oil, open effluent pond (14% peat)	30%	23%
Fatty acid methyl ester (**) from palm oil, methane captured (14% peat)	50%	48%
Waste cooking oil to Fatty acid methyl ester (**) biodiesel	88%	86%
Fatty acid methyl ester (**) from produced animal fats from rendering plant	82%	79%
Hydrotreated vegetable oil from rapeseed	55%	52%
Hydrotreated vegetable oil from sunflower seed	64%	62%
Hydrotreated vegetable oil from soybean	66%	63%
Hydrotreated vegetable oil from palm oil, 14% peat open effluent pond	30%	23%
Hydrotreated vegetable oil from palm oil, 14% peat methane collected from pond	51%	49%
Hydrotreated oil to waste cooking oil	87%	85%
Hydrotreated oil from produced animal fats from rendering plant (***)	81%	77%
Hydrotreated oil from tall oil	88%	86%

(*) Default values for processes using combined heat and power (CHP) are valid only if all the process heat is supplied by CHP.

(**) When bunkering operations are performed over 150 km from the production plant, the additional greenhouse gas emissions for transport and distribution shall be accounted as actual values.

(***) Applies only to biofuels produced from animal by-products classified as category 1 and category 2 materials in accordance with Regulation (EC) No 1069/2009 of the European Parliament and of the Council ([1]), for which emissions related to hygenisation as part of the rendering are not considered.

*B. **ESTIMATED TYPICAL AND DEFAULT VALUES FOR BIOFUELS FROM LIGNOCELLULOSIC FEEDSTOCKS***

Biofuel production pathway	**Greenhouse gas emissions savings – typical value**	**Greenhouse gas emissions savings – default value**
Ethanol from straw, simultaneous saccharification and co-fermentation (not including carbon debt)	85%	85%
Methanol from waste & residue wood	86%	86%
Methanol from farmed wood	84%	84%
Fischer-Tropsch liquid fuels from waste & residue wood (*)	86%	86%
Fischer-Tropsch liquid fuels from farmed wood (*)	84%	84%
Dimethylether from waste & residue wood (not including carbon debt)	86%	86%
Dimethylether from farmed wood	84%	84%

(*) the value is valid for crude Fischer-Tropsch kerosene before potential upgrading steps. As regards transport and distribution emissions, actual values shall be used, too.’

(b) Part C is amended as follows:

[1] Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (Animal by-products Regulation) (OJ L 300, 14.11.2009, p. 1, ELI: http://data.europa.eu/eli/reg/2009/1069/oj).

(i) the following footnote is added to the title 'Methodology':

'[1] Data source: Hurtig, O., Bouter, A., Besseau, R., Buffi, M. and Scarlat, N., Updating GHG emission values of biofuels and bioliquids in Annex V and biomass fuels in Annex VI of Directive (EU) 2018/2001, European Commission, Ispra, 2023, JRC135651.*[to be published]*';

(ii) in point 3, point (a) is replaced by the following:

'(a) greenhouse gas emissions savings from biofuels:

SAVING = $(E_{F(t)} – E_B)/E_{F(t)}$,

where

E_B = total emissions from the biofuel; and

$E_{F(t)}$ = total emissions from the fossil fuel comparator for transport

For the purpose of Article 27(1), point (a), greenhouse gas emissions savings from biofuels are calculated in absolute terms, i.e. by deducting E_B from $E_{F(t)}$.';

(iii) point 4 is replaced by the following:

'4. Greenhouse gases calculated for the purposes of point 1 shall be CO_2, CH_4 and N_2O. For the purposes of calculating CO_2 equivalence (CO_2eq), those gases shall be valued in accordance with the global warming potential values for a 100-year time horizon (GWP 100) included in Commission Delegated Regulation (EU) 2020/1044[2] (without climate-carbon feedback) relative to CO_2, as follows:

Greenhouse gas	GWP values for a 100-year time horizon (CO_2eq)
CO_2	1
CH_4	28

[2] Commission Delegated Regulation (EU) 2020/1044 of 8 May 2020 supplementing Regulation (EU) 2018/1999 of the European Parliament and of the Council with regard to values for global warming potentials and the inventory guidelines and with regard to the Union inventory system and repealing Commission Delegated Regulation (EU) No 666/2014 (OJ L 230, 17.7.2020, p. 1, ELI: http://data.europa.eu/eli/reg_del/2020/1044/oj).

N_2O	265

;

(iv) point 11 is replaced by the following:

'11. Emissions from processing, e_p, shall include emissions from the processing itself; from waste and leakages; and from the production of chemicals or products used in processing, including the CO_2 emissions corresponding to the carbon content of fossil inputs, whether or not they are actually combusted in the process.

In accounting for the consumption of electricity not produced within the solid or gaseous biomass fuel production plant, the greenhouse gas emissions intensity of the production and distribution of that electricity shall be assumed to be equal to the average emission intensity of the production and distribution of electricity in a defined region. By way of derogation from this rule, producers may use an average value for an individual electricity production plant for electricity produced by that plant, if that plant is not connected to the electricity grid.

Emissions from processing shall include emissions from drying interim products and materials where relevant. Emissions from the processing, e_p, of aviation fuels produced from biofuels suitable for road transport may be calculated by adding all additional emissions that are due to the upgrading of road fuels to aviation fuels to the relevant disaggregated default values for processing of biofuels set out set out in Part D and Part E of this Annex.';

(v) point 14 is replaced by the following:

'14. Where a process for making biofuels or bioliquids produces carbon emissions that are permanently stored in a geological storage site, those carbon emissions (expressed as CO_2eq) may be deducted for those biofuels or bioliquids, as a reduction in emissions under e_{ccs} (in gCO_2eq/MJ fuel). The term e_{ccs} shall include the capture rate of CO_2 from biofuel or bioliquid production, as well as all emissions from operations relating to carbon capture, transport of CO_2 and injection into the permanent storage site, as follows:

$e_{ccs} = cCO_2 - e\ CO_{2-c} - e\ CO_{2-t} - e\ CO_{2-i}$

where:

cCO_2 = CO_2 captured at the carbon capture plant (gCO_2eq/MJ fuel);

$e\ CO_{2-c}$ = emissions associated with all carbon capture, dehydration, compression and liquefaction of CO_2 operations (gCO_2eq/MJ fuel);

$e\ CO_{2-t}$ = emissions from the transport of CO_2 by pipeline, ship, barge, rail or truck from the capture site to the permanent storage site (gCO_2eq/MJ fuel);

$e\ CO_{2-i}$ = emissions from operations relating to the injection of CO_2 into the permanent storage site (gCO_2eq/MJ fuel).

The term e_{ccs} shall include:

(a) Greenhouse gas emissions per MJ of fuel captured at the carbon capture plant (cCO_2) for the purposes of permanent geological storage in a storage site permitted under Directive 2009/31/EC of the European Parliament and of the Council or under the applicable national law in third countries, provided that:

– the site is not used for enhanced oil and gas recovery;

– the applicable national law governing geological storage sites provides for appropriate monitoring, reporting and verification requirements to detect leaks, and places legal obligations on storage operators to ensure remediation in line with the legal provisions applicable in the Union; and

– the site does not repeatedly leak.

In case of a leak, the equivalent amount of carbon emissions shall not be deducted from emissions under e_{ccs}.

(b) Greenhouse gas emissions per MJ of fuel from CO_2 capture operations ($e\ CO_{2\text{-}c}$) Those emissions shall include emissions from fuel, heat and electricity use and material input use for capture, as well as all material replacements (due to losses or degradation). Those emissions shall be calculated in accordance with Section 21 of Annex IV to Commission Implementing Regulation (EU) 2018/2066*.

(c) Greenhouse gas emissions per MJ of fuel from the transport of CO_2 ($e\ CO_{2\text{-}t}$) by pipeline, ship, rail, truck or other maritime mode of transport from the capture site. Greenhouse gas emissions due to the transportation of CO_2 shall be calculated based on the distance travelled, mode of transport and load. If the injected CO_2 comes via two or more different modes of transport, the emissions totals shall be calculated as a sum for each mode of transport. Transport emissions for multiple sources shall be allocated using the mass-based allocation method. If a pipeline carries CO_2 to multiple geological sites or serves multiple uses, CO_2 transport emissions shall be allocated using the mass-based allocation method. Greenhouse gas emissions from carrying CO_2 by pipeline shall be calculated in accordance with Section 22 of Annex IV to Regulation (EU) 2018/2066.

(d) Greenhouse gas emissions per MJ of fuel from injection ($e\ CO_{2\text{-}i}$) into a permanent geological storage site permitted under Directive 2009/31/EC or under the applicable national law in third countries. Those emissions shall include all fuel combustion emissions from stationary equipment used in CO_2 transport, including emissions from electricity and emissions from fuels used in CO_2 transport by associated booster stations and other combustion activities including on-site power plants. Those emissions shall be calculated in accordance with Section 23 of Annex IV to Regulation (EU) 2018/2066.

Greenhouse gas emissions from fuel, heat and electricity use and material input use for capture, dehydration, compression and liquefaction operations shall be accounted for in all steps in the CO_2 value chain, from capture to storage.

All emissions from venting as well as fugitive emissions and other CO_2 leakages from carbon capture, dehydration, compression and liquefaction, transport of CO_2 and from injection operations shall be calculated.

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* Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012 (OJ L 334, 31.12.2018, p. 1, ELI: http://data.europa.eu/eli/reg_impl/2018/2066/oj)';

(c) Parts D and E are replaced by the following:

'*D.* ***DISAGGREGATED DEFAULT VALUES FOR BIOFUELS AND BIOLIQUIDS***

Disaggregated (cultivation: 'e_{ec}', processing: 'e_p', and transport; 'e_{td}') typical and default values defined in Part C of this Annex, and total typical and default values of greenhouse gas emissions for biofuel and bioliquid pathways (g CO2eq/MJ):

Biofuel and bioliquid pathway			Greenhouse gas emissions– typical values [g CO_2eq/MJ]				Greenhouse gas emissions–default values [g CO_2eq/MJ]			
Biofuel	Feedstock	System	Cultivation	Processing	Transport & distribution	**Total**	Cultivation	Processing	Transport & distribution	**Total**
Ethanol	Sugar beet	No biogas from slop, natural gas boiler	9,9	17,4	2,2	**29,5**	9,9	20,9	2,2	**33,0**
		With biogas from slop, natural gas boiler (*)	9,9	8,1	2,2	**20,2**	9,9	9,7	2,2	**21,8**
		No biogas from slop, cogeneration unit fuelled with natural gas (*)	9,9	13,5	2,2	**25,8**	9,9	16,2	2,2	**28,3**
		With biogas from slop, cogeneration unit fuelled with natural gas	9,9	7,7	2,2	**19,8**	9,9	9,2	2,2	**21,3**
	Sugar cane		22,1	1,2	8,4	**31,7**	22,1	22,1	1,4	**8,4**
	All other cereals	Natural gas boiler	27,7	19,5	2,0	**49,2**	27,7	23,4	2,0	**53,1**
		Cogeneration unit fuelled with natural gas (*)	27,7	15,5	2,0	**45,2**	27,7	18,6	2,0	**48,3**
		Forest residues, cogeneration unit (*)	27,7	1,6	2,0	**31,3**	27,7	1,9	2,0	**31,6**
	Maize	Natural gas boiler	21,9	19,5	2,2	**43,6**	21,9	23,4	2,2	**47,5**
		Cogeneration unit fuelled with natural gas (*)	21,9	15,3	2,1	**39,3**	21,9	18,4	2,1	**42,4**
		Forest residues, cogeneration unit (*)	21,9	1,9	2,1	**25,9**	21,9	2,3	2,1	**26,3**
	Wheat	Natural gas boiler	27,9	19,8	2,0	**49,7**	27,9	23,8	2,0	**53,7**
		Cogeneration unit fuelled with natural gas (*)	27,9	15,7	2,0	**45,6**	27,9	18,8	2,0	**48,7**
		Forest residues cogeneration unit (*)	27,9	1,7	2,0	**31,6**	27,9	2,0	2,0	**31,9**
m et hy -	Rapeseed		29,4	10,5	1,6	**41,5**	29,4	29,4	1,6	**43,6**

	Sunflower seed	21,5	10,4	1,8	**33,7**	21,5	21,5	1,8	**35,8**
	Soybean	14,2	10,9	6,9	**32**	14,2	14,2	6,9	**34,2**
	Palm oil, open effluent pond (14% peat)	28,4	31,7	5,8	**65,9**	28,4	28,4	5,8	**72,2**
	Palm oil, methane captured (14% peat)	28,4	12,4	5,8	**46,6**	28,4	28,4	5,8	**49,1**
	Waste cooking oil	0,0	8,4	2,7	**11,1**	0,0	0,0	2,7	**12,8**
	Animal fats from rendering plant	0,0	15,6	1,4	**17,0**	0,0	0,0	1,4	**20,1**
Hydrotreated vegetable oil (HVO)	Rapeseed	30,7	10,4	1,5	**42,6**	30,7	30,7	1,5	**44,7**
	Sunflower seed	22,2	10,1	1,7	**34,0**	22,2	22,2	1,7	**36,0**
	Soybean	14,7	10,6	7,0	**32,3**	14,7	14,7	7,0	**34,4**
	Palm oil, 14% peat open effluent pond	29,7	30,3	5,9	**65,9**	29,7	29,7	5,9	**72,0**
	Palm oil, 14% peat methane collected from pond	29,7	10,1	5,9	**45,7**	29,7	29,7	5,9	**47,7**
Hydrotreated oil (HO)	Waste cooking oil	0,0	9,8	2,5	**12,3**	0,0	0,0	2,5	**14,3**
	Animal fats from rendering plant (***)	0,0	16,9	1,3	**18,2**	0,0	0,0	1,3	**21,6**
	Tall oil	0,0	9,7	1,5	**11,2**	0,0	0,0	1,5	**13,1**

(*) Default values for processes using CHP are valid only if all the process heat is supplied by CHP.

(**) When bunkering operations are performed over 150 km from the production plant, the additional greenhouse gas emissions for transport and distribution shall be accounted as actual values.

(***) Applies only to biofuels produced from animal by-products classified as category 1 and category 2 materials in accordance with Regulation (EC) No 1069/2009 of the European Parliament and of the Council (1[3]), for which emissions related to hygenisation as part of the rendering are not considered.

[3] Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (Animal by-products Regulation) (OJ L 300, 14.11.2009, p. 1, ELI: http://data.europa.eu/eli/reg/2009/1069/oj).

E. DISAGGREGATED DEFAULT VALUES FOR BIOFUELS FROM LIGNOCELLULOSIC FEEDSTOCKS

Disaggregated (cultivation: 'e_{ec}', processing: 'e_p', and transport; 'e_{td}') typical and default values[4] defined in Part C of this Annex, and total typical and default values of greenhouse gas emissions for biofuel and bioliquid pathways from lignocellulosic feedstocks (g CO2eq/MJ):

Biofuel production pathway	**Greenhouse gas emissions– typical and default values [g CO_2eq/MJ]**			
	Cultivation	Processing	Transport & distribution	**Total**
Ethanol from straw, simultaneous saccharification and co-fermentation (not including carbon debt)	1,8	6,6	5,9	**14,3**
Methanol from waste & residue wood	3,1	0	10,5	**13,6**
Methanol from farmed wood	6,9	0	8,4	**15,3**
Fischer-Tropsch liquid fuels from waste & residue wood (not including carbon debt) (*)	3,1	0,1	9,7	**12,9**
Fischer-Tropsch liquid fuels from farmed wood (*)	7	0,1	7,6	**14,7**
Dimethylether from waste & residue wood (not including carbon debt)	3,1	0	10,5	**13,6**
Dimethylether from short farmed wood	6,9	0	8,4	**15,3**
Fischer-Tropsch liquid fuels (petrol and diesel) from forest residue chips (not including carbon debt) (*)	3,1	0,1	9,7	**12,9**
Fischer-Tropsch liquid fuels (petrol and diesel) from short rotation coppice wood (*)	7	0,1	7,6	**14,7**

(*) The value is valid for crude Fischer-Tropsch kerosene before potential upgrading steps. As regards transport and distribution emissions, actual values shall be used, too.'

[4] Default values are equivalent to the typical counterparts

(2) Annex VI is amended as follows:

(a) Part A is replaced by the following:

'*A. **Typical and default values of greenhouse gas emissions savings from electricity, heating and cooling from biomass fuels if produced with no net-carbon emissions from land-use change***

A.1 Typical and default values of greenhouse gas emissions savings from electricity, heating and cooling from biomass fuels from wood and woody biomass pathways if produced with no net-carbon emissions from land-use change, under assumed 70% conversion efficiency to heat and cold, and 25% conversion efficiency to electricity, respectively, delivered at the plant gate and with preserved lower heating value until conversion to energy.

Solid biofuel pathways related to wood and woody biomass		**Greenhouse gas emissions savings – typical values**		**Greenhouse gas emissions savings – default values**	
Wood chips, at 30% moisture content, from	**Transport distance in km**	**Heat**	**Electricity**	**Heat**	**Electricity**
Forest residues	< 500	91%	89%	88%	85%
	500 - 2 500	89%	86%	84%	80%
	2 500 - 10 000	79%	74%	70%	64%
	> 10 000	62%	54%	47%	35%
Short Rotation Coppice (Eucalyptus)	2 500 - 10 000	73%	67%	60%	51%
Short Rotation Coppice (Poplar – fertilised)	< 500	87%	84%	80%	75%
	500 - 2 500	84%	81%	76%	71%
	2 500 - 10 000	74%	69%	63%	54%
	> 10 000	57%	47%	38%	24%
Short Rotation Coppice (Poplar – Not	< 500	89%	87%	85%	82%
	500 - 2 500	87%	84%	82%	78%

fertilised)		2 500 - 10 000	77%	72%	68%	61%
		> 10 000	59%	50%	43%	31%
Stemwood		< 500	91%	89%	89%	86%
		500 - 2 500	89%	86%	85%	82%
		2 500 - 10 000	79%	74%	71%	65%
		> 10 000	62%	54%	48%	36%
Wood industry residues		< 500	93%	92%	91%	89%
		500 - 2 500	91%	89%	87%	84%
		2 500 - 10 000	81%	77%	73%	68%
		> 10 000	64%	56%	50%	39%
Wood pellets and briquettes, at 10% moisture content, from (*):						
Forest residues	Case 1	< 500	48%	37%	28%	12%
		500 - 2 500	49%	37%	29%	12%
		2 500 - 10 000	46%	34%	25%	8%
		> 10 000	40%	26%	16%	-3%
	Case 2	< 500	71%	65%	60%	51%
		500 - 2 500	72%	66%	61%	52%
		2 500 - 10 000	69%	62%	57%	47%
		> 10 000	63%	54%	48%	36%
	Case 3	< 500	90%	88%	86%	83%
		500 - 2 500	91%	88%	87%	84%
		2 500 - 10 000	88%	85%	83%	79%

		> 10 000	81%	77%	74%	68%
Short rotation coppice (Eucalyptus)	Case 1	2 500 - 10 000	42%	29%	19%	1%
	Case 2	2 500 - 10 000	64%	56%	50%	39%
	Case 3	2 500 - 10 000	83%	79%	76%	70%
Short rotation coppice (Poplar – fertilised)	Case 1	< 500	46%	33%	24%	7%
		500 - 10 .000	43%	30%	20%	3%
		> 10 000	37%	23%	12%	-8%
	Case 2	< 500	68%	61%	55%	45%
		500 - 10 000	65%	58%	52%	41%
		> 10 000	59%	50%	43%	30%
	Case 3	< 500	86%	83%	81%	76%
		500 - 10 000	84%	80%	77%	72%
		> 10 000	77%	72%	68%	61%
Short rotation coppice (Poplar – not fertilised)	Case 1	< 500	48%	36%	27%	11%
		500 - 10 000	45%	33%	24%	7%
		> 10 000	39%	26%	15%	-4%
	Case 2	< 500	71%	64%	59%	50%
		500 - 10 000	68%	61%	56%	46%
		> 10 000	62%	53%	47%	35%
	Case 3	< 500	89%	87%	85%	81%
		500 - 10 000	87%	84%	82%	77%
		> 10 000	80%	76%	73%	67%
Stemwood	Case 1	< 500	49%	37%	28%	12%
		500 - 2 500	49%	38%	29%	13%

		2 500 - 10 000	46%	34%	25%	8%
		> 10 000	40%	27%	16%	-2%
	Case 2	< 500	72%	65%	60%	52%
		500 - 2 500	72%	66%	61%	52%
		2 500 - 10 000	69%	63%	57%	48%
		> 10 000	63%	55%	48%	37%
	Case 3	< 500	90%	88%	87%	84%
		500 - 2 500	91%	89%	87%	84%
		2 500 - 10 000	88%	85%	83%	80%
		> 10 000	82%	78%	74%	69%
Wood industry residues	Case 1	< 500	69%	62%	57%	47%
		500 - 2 500	70%	63%	58%	48%
		2 500 - 10 000	67%	60%	54%	43%
		> 10 000	61%	52%	45%	33%
	Case 2	< 500	84%	80%	78%	73%
		500 - 2 500	85%	81%	78%	73%
		2 500 - 10 000	82%	78%	74%	69%
		> 10 000	76%	70%	66%	58%
	Case 3	< 500	94%	93%	92%	90%
		500 - 2 500	95%	94%	93%	91%
		2 500 - 10 000	92%	90%	89%	86%
		> 10 000	86%	83%	80%	76%

(*) Case 1 refers to processes in which a natural gas boiler is used to provide the process heat to the pellet mill. Electricity for the pellet mill is supplied from the grid.

Case 2 refers to processes in which a woodchips boiler, fed with pre-dried chips, is used to provide process heat. Electricity for the pellet mill is supplied from the grid.

Case 3 refers to processes in which a cogeneration unit (CHP), fed with pre-dried woodchips, is used to provide electricity and heat to the pellet mill.

A.2 Typical and default values of greenhouse gas emissions savings from electricity, heating and cooling from biomass fuels from agricultural pathways if produced with no net-carbon emissions from land-use change, under assumed 65% conversion efficiency to heat and cold, and 25% conversion efficiency to electricity, respectively, delivered at the plant gate and with preserved lower heating value until conversion to energy

Agricultural residues	**Transport distance in km**	**Greenhouse gas emissions savings – typical values**		**Greenhouse gas emissions savings – default values**	
		Heat	**Electricity**	**Heat**	**Electricity**
Agricultural residues with density < 0,2 t/m³ at 13% moisture content (*)	<500	93%	92%	91%	90%
	500 - 2 500	88%	86%	85%	83%
	2 500 - 10 000	73%	70%	68%	64%
	>10 000	49%	42%	39%	31%
Agricultural residues with density > 0,2 t/m³ at 13% moisture content (**)	<500	93%	92%	91%	90%
	500 - 2 500	92%	91%	90%	89%
	2 500 - 10 000	86%	84%	83%	80%
	>10 000	74%	71%	69%	65%
Straw pellets at 10% moisture content	<500	89%	87%	87%	85%
	500 - 10 000	86%	84%	83%	81%
	>10 000	79%	76%	75%	71%
Bagasse briquettes at 10% moisture content	2 500 - 10 000	91%	90%	89%	88%

	>10 000	84%	82%	81%	78%
Palm kernel meal at 10% moisture content	>10 000	-10%	-25%	-32%	-50%
Palm kernel meal at 10% moisture content (no methane emissions from oil mill)	>10 000	28%	19%	14%	2%

(*) This group of materials includes agricultural residues with a low bulk density, and comprises materials such as straw bales, oat hulls, rice husks and sugar cane bagasse bales (this is not an exhaustive list).

(**) The group of agricultural residues with higher bulk density includes materials such as corn cobs, nut shells, soybean hulls and, palm kernel shells (this is not an exhaustive list).

A.3 Typical and default values of greenhouse gas emissions savings from electricity, heating and cooling and use in transport from gaseous biomass fuels if produced with no net-carbon emissions from land-use change, under standard and best practice and assuming 75% conversion efficiency to heat and cold, and 30% conversion efficiency to electricity, respectively.

BIOMETHANE[5] (*)			**Greenhouse gas emissions saving (***)**	
Practice	**Process**	**Feedstock**	**Typical value**	**Default value**
Standard (**)	Anaerobic digestion	Biowaste	35%	23%
		Manure[1]	124%	104%
		Sewage sludge[2]	21%	5%
		Crop silage[3]	16%	4%
	Gasification and methanation	Short rotation coppice, <500 km transport distance	77%	74%
		Waste wood, 500- 2 500 km transport distance	77%	75%

5 Biomethane means biogas that has been upgraded to a quality and methane content similar to fossil natural gas.

Best (***)	Anaerobic digestion	Biowaste	88%	86%
		Manure	217%	215%
		Sewage sludge	73%	68%
		Crop silage	67%	66%
	Gasification and methanation	Short rotation coppice, <500 km transport distance	77%	74%
		Waste wood, 500-2 500 km transport distance	77%	75%

BIOGAS (*)			**Greenhouse gas emissions saving (****) – typical values**		**Greenhouse gas emissions saving (****) – default values**	
Practice	**Process**	**Feedstock**	**Heat**	**Electricity**	**Heat**	**Electricity**
Standard (**)	Anaerobic digestion	Biowaste	49%	39%	49%	39%
		Manure[1]	120%	102%	120%	102%
		Sewage sludge[2]	49%	39%	49%	39%
		Crop silage[3]	33%	23%	33%	23%
Best (***)		Biowaste	86%	83%	86%	83%
		Manure	197%	194%	197%	194%
		Sewage sludge	86%	83%	86%	83%
		Crop silage	68%	65%	68%	65%

(*) All settings assume that process energy is supplied from own biogas/biomethane production. Other practices should be calculated with actual values.

(**) The standard practice was reflected in the values that were valid in accordance with Annex VI to Directive (EU) 2018/2001 as applicable on…..[OP please insert a date - one day before the entry into force of this delegated directive].

(***) To improve 'standard practice' and in order to achieve 'best practice', the corresponding methane emissions improvement factor $e_{me,i}$ (Point 15a in Part B) is to be subtracted from the default values of the respective standard practice

(****) The values for biogas production from manure include negative emissions for emissions saved from raw manure management. The value of e_{sca} considered is equal to – 45 g CO2eq/MJ manure used in anaerobic digestion.

[1] **Manure** (also known as livestock manure) refers to organic matter, mostly derived from animal faeces and urine, but normally also containing plant material (often straw), that has been used as bedding for animals and has absorbed the faeces and urine. It includes cattle manure and mixtures of manure from different origins. The values for biogas production from manure include negative emissions for emissions saved from raw manure management. The value of e_{sca} considered is equal to – 45 g CO2eq/MJ manure used in anaerobic digestion.

[2] **Sewage sludge** refers to the accumulated settled solids separated from various types of wastewater, and which are either moist or partly liquefied as a result of natural or artificial processes (from JECv5 Well-to-Tank as OWCG3).

[3] **Crop silage** refers to silage made up of maize, wheat, triticale, barley, sorghum or a mix thereof. If such crops are cultivated using different practices than those used for standard crop silage (e.g. non-conventional crop rotations) or using different soil inputs than the default case (e.g. fossil-based N-fertilisers), actual values shall be used.

Actual values shall be calculated for all feedstocks not fitting into the categories of the default values, including but not limited to agricultural residues left on the field, cover crops and intermediate crops.

When accounting for emissions from the increase of soil organic carbon where advanced agricultural practices are applied, the methodology set out in the Implementing Regulation (EU) 2022/996 shall be applied.

If biomethane is transportedin either its compressed or liquefied form, an additional disaggregated value of 2.4 or 4.9 g CO_2eq/MJ shall be added, respectively. The liquefaction value is only applicable if liquefaction takes place in the EU and is powered by electricity. In all other cases, actual values shall be calculated. In addition, emissions from the transport and distribution of such biomethane shall be added as actual values.'

(b) Part B is amended as follows:

(i) point 1 is amended as follows:

(1) points (a) and (b) are replaced by the following:

'(a) Greenhouse gas emissions from the production and use of biomass fuels before conversion into electricity, heating and cooling, shall be calculated as:

$$E = (e_{ec} + e_l + e_p + e_{td} + e_u - e_{me,i} - e_{sca} - e_{ccs} - e_{ccr}) \times C_{stor}$$

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;

$e_{me,i}$ = the improvement factor due to a reduction in methane emissions

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

e_{ccs} = emission savings from CO_2 capture and geological storage;

e_{ccr} = emission savings from CO_2 capture and replacement; and

C_{stor} = the correction factor reflecting the preservation of lower heating value of feedstock delivered at the gate.

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

‘(b) In the case of co-use of different solid biomass fuels in conversion to bioenergy for heating, cooling or electricity, the typical and default values of greenhouse gas emissions shall be calculated as:

$$E = \sum_{l}^{n} S_n \times E_n$$

where:

E = greenhouse gas emissions per MJ of heating or cooling or kWh of electricity produced from the co-use of a defined mixture of solid biomass fuels

S_n = share of solid biomass fuel *n* in energy content

E_n = emissions in g CO_2/MJ for pathway *n* as provided in Part D of this Annex

$$S_n = \frac{LHV_n \times W_n}{\sum_{I}^{n} W_n}$$

where:

LHV_n = lower heating value [MJ] per kilogram of solid biomass fuel as defined in the European standards (EN)

W_n = weighting factor of solid biomass fuel *n* defined as:

$$W_n = \frac{I_n}{\sum_I^n I_n} \times \frac{C_{stor}}{\sum_I^n C_{stor}}$$

where:

I_n = annual input to energy conversion technology of solid biomass fuel *n* [tonne of dry matter]

C_{stor} = the correction factor reflecting the preservation of a lower heating value of feedstock delivered at the gate.

As regards existing installations, E can include technological additions to increase greenhouse gas emissions savings through energy efficiency measures (e.g. waste heat utilisation to produce additional electricity or heat or cooling), energy system integration (e.g. a combination of the existing bioenergy plant with non-combustible renewables), or changing from feedstock in table A.1 to A.2 as defined in Part B, point 1, point 15a of Annex VI.'

(2) the following point (ba) is inserted:

'(ba) In the case of co-digestion of different substrates in a biogas plant for the production of biogas or biomethane, the typical and default values of greenhouse gas emissions shall be calculated as:

E = $\sum_l^n S_n \times E_n$

where:

E = greenhouse gas emissions per MJ biogas or biomethane produced from co-digestion of the defined mixture of substrates;

S_n = share of feedstock n in energy content;

E_n = emissions in g CO_2/MJ for pathway n as provided in Part D of this Annex (*)

$$S_n = \frac{P_n \cdot W_n}{\sum_1^n P_n \cdot W_n}$$

where:

P_n = energy yield [MJ] per kilogram of wet input of feedstock n (**);

W_n = weighting factor of substrate n defined as:

$$W_n = \frac{I_n}{\sum_1^n I_n} \cdot \left(\frac{1 - AM_n}{1 - SM_n}\right)$$

where:

I_n = annual input to digester of substrate n [tonne of fresh matter]

AM_n = average annual moisture of substrate n [kg water/kg fresh matter]

SM_n = standard moisture for substrate n (***).

(*) For animal manure used as substrate, a bonus of 45 g CO_2eq/MJ manure (– 54 kg CO_2eq/t fresh matter) is added for improved agricultural and manure management.

(**) The following values of P_n shall be used for calculating typical and default values:

P(Crop silage): 4,16 [$MJ_{biogas}/kg_{wet\ maize\ @\ 65\ \%\ moisture}$]

P(Manure): 0,50 [$MJ_{biogas}/kg_{wet\ manure\ @\ 90\ \%\ moisture}$]

P(Biowaste) 3,41 [$MJ_{biogas}/kg_{wet\ biowaste\ @\ 76\ \%\ moisture}$]

P(Sewage sludge) 0,13 [$MJ_{biogas}/kg_{wet\ sewage\ sludge\ @\ 97\ \%\ moisture}$]

(***) The following values of the standard moisture for substrate SM_n shall be used:

SM(Crop silage): 0,65 [kg water/kg fresh matter]

SM(Manure): 0,90 [kg water/kg fresh matter]

SM(Biowaste): 0,76 [kg water/kg fresh matter]

SM(Sewage sludge): 0,97 [kg water/kg fresh matter]'

(3) point (c) is replaced by the following:

'(c) In the case of co-digestion of n substrates in a biogas plant for the production of electricity or biomethane, actual greenhouse gas emissions of biogas and biomethane are calculated as follows:

$$E = \sum_{1}^{n} S_n \left(e_{ec,n} + e_{td,feedstock,n} + e_{l,n} - e_{sca,n}\right) + e_p + e_{td,product} + e_u - e_{ccs} - e_{ccr} - e_{mei}$$

where:

E	=	total emissions from the production of the biogas or biomethane before energy conversion;
S_n	=	share of feedstock n, in fraction of input to the digester;
$e_{ec,n}$	=	emissions from the extraction or cultivation of feedstock n;
$e_{td,feedstock,n}$	=	emissions from transport of feedstock n to the digester;
$e_{l,n}$	=	annualised emissions from carbon stock changes caused by land-use change, for feedstock n;
e_{sca}	=	emission savings from improved agricultural management of feedstock n (*);
e_p	=	emissions from processing;
$e_{td,product}$	=	emissions from transport and distribution of biogas and/or biomethane;
e_u	=	emissions from the fuel in use, that is greenhouse gases emitted during combustion;

e_{ccs} = emission savings from CO_2 capture and geological storage;

e_{ccr} = emission savings from CO_2 capture and replacement; and

$e_{me,i}$ = the improvement factor due to a reduction in methane emissions.

(*) For e_{sca} a bonus of 45 g CO_2eq/MJ manure shall be attributed for improved agricultural and manure management in the case of animal manure that is used as a substrate for the production of biogas and biomethane.';

(4) in point (d), the following point (v) is added:

'(v) Existing installations using solid biomass fuels can meet the increasing greenhouse gas emissions thresholds by refurbishing the installation with technological solutions that increase overall efficiency by improving energy efficiency (e.g. by producing additional useful heat, cooling and/or electricity from waste heat or flue gases), using agricultural feedstock instead of forest biomass or by improving renewable energy system integration through the use of non-combustion renewable energy technologies. Produced heat should be included in the formula in points (i) and (ii) only if that heat is used for an economically justified purpose. Where heat pumps are combined with bioenergy, the weighted average of produced energy should be calculated using the formula in Annex VII to this Directive.

For the purposes of that calculation, the following definitions apply:

'energy efficiency improvement' means energy efficiency improvement as defined in Article 2, point (10), of Directive (EU) 2023/1791 of the European Parliament and of the Council*;

'economically justifiable demand' means economically justifiable demand as defined in Article 2, point (37), of Directive (EU) 2023/1791;

'useful heat' means useful heat as defined in Article 2, point (38), of Directive (EU) 2023/1791;

'overall efficiency' means overall efficiency as defined in Article 2, point (41), of Directive (EU) 2023/1791.

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* Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955, OJ L 231, 20.9.2023, p. 1, http://data.europa.eu/eli/dir/2023/1791/oj).';

(ii) in point 3, point (a) is replaced by the following:

‘(a) greenhouse gas emissions savings from biomass fuels used as transport fuels:

$$SAVING = \frac{(E_{F(t)} - E_{B})}{E_{F(t)}}$$

where:

E_B = total emissions from the biomass fuel; and

$E_{F(t)}$ = total emissions from the fossil fuel comparator for transport.

For the purposes of Article 27(1), point (a), greenhouse gas emissions savings from biofuels are calculated in absolute terms, i.e. by deducting E_B from $E_{F(t)}$.’;

(iii) point 4 is replaced by the following:

‘4. Greenhouse gases calculated for the purposes of point 1 shall be CO_2, CH_4 and N_2O. For the purposes of calculating CO_2 equivalence (CO_2eq), those gases shall be valued in accordance with the global warming potential values for a 100-year time horizon (GWP 100) included in the Commission Delegated Regulation (EU) 2020/1044* (without climate-carbon feedback) relative to CO2, as follows:

Greenhouse gas	GWP values for 100-year time horizon (CO_2eq)
CO_2	1
CH_4	28
N_2O	265

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* Commission Delegated Regulation (EU) 2020/1044 of 8 May 2020 supplementing Regulation (EU) 2018/1999 of the European Parliament and of the Council with regard to values for global warming potentials and the inventory guidelines and with regard to the Union inventory system and repealing Commission Delegated Regulation (EU) No 666/2014 (OJ L 230, 17.7.2020, p. 1, ELI: http://data.europa.eu/eli/reg_del/2020/1044/oj).’;

(iv) point 14 is replaced by the following:

’14. Where a process for making biomass fuel produces carbon emissions that are permanently stored in a geological storage site, that carbon (expressed as CO_2eq) may be deducted from the products of the process as a reduction in emissions under $\mathbf{e_{ccs}}$ (in gCO_2eq/MJ fuel). The term e_{ccs} shall include the capture rate of CO_2 from biomass fuel production, all emissions from carbon capture and transport of CO_2 operations, and emissions from injection into the permanent storage site as follows:

$$e_{ccs} = cCO_2 - eCO_{2-c} - eCO_{2-t} - eCO_{2-i}$$

where:

cCO_2 = CO_2 captured at the carbon capture plant (gCO_2eq/MJ fuel);

$e\,CO_{2-c}$ = emissions associated with all carbon capture, dehydration, compression and liquefaction of CO_2 operations (gCO_2eq/MJ fuel);

$e\,CO_{2-t}$ = emissions from the transport of CO_2 by pipeline, ship, barge, rail or truck from the capture site to the permanent storage site (gCO_2eq/MJ fuel);

$e\,CO_{2-i}$ = emissions from operations involving the injection operations of CO_2 into the permanent storage site (gCO_2eq/MJ fuel).

The term e_{ccs} shall include:

(a) Greenhouse gas emissions per MJ of fuel captured at the carbon capture plant (cCO_2) for the purposes of permanent geological storage in a storage site permitted under Directive 2009/31/EC of the European Parliament and of the Council or under the applicable national law in third countries, provided that:

– the site is not used for enhanced oil and gas recovery;

– the applicable national law governing geological storage sites provides for appropriate monitoring, reporting and verification requirements to detect leaks, and places legal obligations on storage operators to ensure remediation in line with the legal provisions applicable in the Union;

– the site does not repeatedly leak.

In case of a leak, the equivalent amount of carbon emissions shall not be deducted from emissions under e_{ccs}.

(b) Greenhouse gas emissions per MJ of fuel from CO_2 capture operations ($e\,CO_{2-c}$). Those emissions shall include emissions from fuel, heat and electricity use and material input use for capture, as well as all material replacements (due to losses or degradation). Those emissions shall be calculated in accordance with Section 21 of Annex IV to Implementing Regulation (EU) 2018/2066.

(c) Greenhouse gas emissions per MJ of fuel from the transport of CO_2 ($e\,CO_{2-t}$) by pipeline, ship, rail, truck or other maritime mode of transport from the capture site. Greenhouse gas emissions due to the transportation of CO_2 shall be calculated based on the distance travelled, mode of transport and load. If the injected CO_2 comes via two or more different modes of transport, the emissions totals shall be calculated as a sum for each mode of transport. Transport emissions for multiple sources shall be allocated using the mass-based allocation method. If a pipeline carries CO_2 to multiple geological sites or serves multiple uses, CO_2 transport emissions shall be allocated using the mass-based allocation method. Greenhouse gas emissions from carrying CO_2 by pipeline shall be calculated in accordance with Section 22 of Annex IV to Regulation (EU) 2018/2066.

(d) Greenhouse gas emissions per MJ of fuel from injection (e $CO_{2\text{-}i}$) into a permanent geological storage site permitted under Directive 2009/31/EC or under the applicable national law in third countries. Those emissions shall include all fuel combustion emissions from stationary equipment used in CO_2 transport, including emissions from electricity and emissions from fuels used in CO_2 transport by associated booster stations and other combustion activities including on-site power plants. Those emissions shall be calculated in accordance with Section 23 of Annex IV to Regulation (EU) 2018/2066.

Greenhouse gas emissions from fuel, heat and electricity use and material input use for capture, dehydration, compression and liquefaction operations shall be accounted for in all steps in the CO_2 value chain, from capture to storage.

All emissions from venting as well as fugitive emissions and other CO_2 leakages from carbon capture, dehydration, compression and liquefaction, transport of CO_2 and from injection operations shall be calculated.'

(v) the following points 15a and 15b are inserted:

'15a. Where best practice is applied to one or more sources of methane leakages at a biogas or biomethane plant, the improvement factor '$e_{me,i}$ ' can be deducted from the standard practice default emissions values set out in Part D. TOTAL TYPICAL AND DEFAULT VALUES FOR GASEOUS BIOMASS FUELS PATHWAYS, for the best practice applied:

Source of methane leakages	**Type**	**Improvement factor, $e_{me,i}$ [g CO_2eq/MJ]**
Biogas processing	Piping, maintenance, overpressure events, leaks	25,2
Digestate management	Digestate composting or airtight storage with biogas recuperation	11,8 [silage], 13,4 [biowaste and sewage sludge], 55,4 [manure]
	Storage with remaining methane potential (RMP) measurement below the proposed default emission factor for (open) digestate storage	Equation (*) shall be used: $e_{me,i} = (X – 0,1) x 5,6$ where: X for best practice is calculated as RMP x 0,25 X for standard practice is calculated as RMP x 0,75
Biogas upgrading to biomethane	Any technology	16,8
	Technologies certified or measured to have < 0,2% of produced methane in the off-gas	15,7
	Technologies certified or measured to have < 1% of produced methane in the off-gas	11,2
Biogas use in CHP	Slippage of methane in the exhaust gas	0

15b. The sum of all greenhouse gas emissions along the wood pathways referred to in table A.1 of Part.A of this Annex are multiplied by the C_{stor} factor to calculate the total greenhouse gas emissions for the production and use of biomass fuels before conversion into electricity, heating and cooling. In this case, C_{stor} shall be 115% where there is no suitable storage facility, or 100% where there is a suitable storage facility or delivery log to confirm the balance between delivery and conversion of solid biomass fuel to energy.’;

(vi) point 19 is replaced by the following:

’19. For biomass fuels used for the production of electricity, for the purposes of the calculation referred to in point 3, the fossil fuel comparator $EC_{F(el)}$ shall be 183 g CO_2eq/MJ electricity, or 212 g CO_2eq/MJ electricity for the outermost regions. For biomethane injected into the gas grid for the purposes of the calculation referred to in point 3, the fossil fuel comparator $EF_{(t)}$ shall be 94 g CO_2eq/MJ.

For biomass fuels used for the production of useful heat, and for the production of heating and/or cooling, for the purposes of the calculation referred to in point 3, the fossil fuel comparator $EC_{F(h)}$ shall be 80 g CO_2eq/MJ heat.

For biomass fuels used for the production of useful heat, in which a direct physical substitution of coal can be demonstrated, for the purposes of the calculation referred to in point 3, the fossil fuel comparator $EC_{F(h)}$ shall be 124 g CO_2eq/MJ heat.

For biomass fuels used as transport fuels and biomethane injected in the fossil gas grid, for the purposes of the calculation referred to in point 3, the fossil fuel comparator $EF_{(t)}$ shall be 94 g CO_2eq/MJ.’;

(c) Parts C and D are replaced by the following:

‘*C.* ***DISAGGREGATED DEFAULT VALUES FOR SOLID BIOMASS FUELS PATHWAYS***

Biomass fuel production system		**Greenhouse gas emissions– typical values [g CO_2eq/MJ]**				**Greenhouse gas emissions– default values [g CO_2eq/MJ]**			
Wood chips from:	**Transport distance in km**	**Cultivation**	**Processing**	**Transport**	**Non-CO2 emissions from fuel use**	**Cultivation**	**Processing**	**Transport**	**Non-CO2 emissions from fuel use**
Forest residues	< 500	0,0	1,6	3,0	0,4	0,0	2,2	4,2	0,6
	500 - 2 500	0,0	1,6	4,4	0,4	0,0	2,2	6,2	0,6
	2 500 - 10 000	0,0	1,6	9,9	0,4	0,0	2,2	13,8	0,6
	> 10 000	0,0	1,6	19,3	0,4	0,0	2,2	27,0	0,6
Short rotation coppice (Eucalyptus)	2 500 - 10 000	4,2	0,0	10,4	0,4	7,3	0,0	14,5	0,6
Short rotation coppice (Poplar – fertilised)	< 500	3,5	0,0	3,5	0,4	5,9	0,0	4,8	0,6
	500 - 2 500	3,5	0,0	4,9	0,4	5,9	0,0	6,9	0,6
	2 500 - 10 000	3,5	0,0	10,4	0,4	5,9	0,0	14,5	0,6
	> 10 000	3,5	0,0	20,2	0,4	5,9	0,0	28,3	0,6
Short rotation coppice (Poplar – Not fertilised)	< 500	2,1	0,0	3,5	0,4	2,8	0,0	4,8	0,6
	500 - 2 500	2,1	0,0	4,9	0,4	2,8	0,0	6,9	0,6
	2 500 - 10 000	2,1	0,0	10,4	0,4	2,8	0,0	14,5	0,6
	> 10 000	2,1	0,0	20,2	0,4	2,8	0,0	28,3	0,6
Stemwood	< 500	1,1	0,3	3,0	0,4	1,1	0,4	4,2	0,6
	500 - 2 500	1,1	0,3	4,4	0,4	1,1	0,4	6,2	0,6
	2 500 -	1,1	0,3	9,9	0,4	1,1	0,4	13,9	0,6

		10 000								
		> 10 000	1,1	0,3	19,3	0,4	1,1	0,4	27,0	0,6
Wood industry residues		< 500	0,0	0,3	3,0	0,4	0,0	0,4	4,2	0,6
		500 - 2 500	0,0	0,3	4,4	0,4	0,0	0,4	6,2	0,6
		2 500 - 10 000	0,0	0,3	9,9	0,4	0,0	0,4	13,9	0,6
		> 10 000	0,0	0,3	19,3	0,4	0,0	0,4	27,0	0,6
Wood pellets and briquettes from:										
Forest residues	Case 1	< 500	0,0	25,8	2,8	0,2	0,0	36,1	4,0	0,3
		500 - 2 500	0,0	25,8	2,5	0,2	0,0	36,1	3,6	0,3
		2 500 - 10 000	0,0	25,8	4,1	0,2	0,0	36,1	5,8	0,3
		> 10 000	0,0	25,8	7,6	0,2	0,0	36,1	10,6	0,3
	Case 2	< 500	0,0	12,8	3,0	0,2	0,0	17,9	4,1	0,3
		500 - 2 500	0,0	12,8	2,7	0,2	0,0	17,9	3,7	0,3
		2 500 - 10 000	0,0	12,8	4,3	0,2	0,0	17,9	6,0	0,3
		> 10 000	0,0	12,8	7,8	0,2	0,0	17,9	10,9	0,3
	Case 3	< 500	0,0	2,3	3,0	0,2	0,0	3,3	4,2	0,3
		500 - 2 500	0,0	2,3	2,7	0,2	0,0	3,3	3,8	0,3
		2 500 - 10 000	0,0	2,3	4,3	0,2	0,0	3,3	6,0	0,3
		> 10 000	0,0	2,3	7,9	0,2	0,0	3,3	11,0	0,3
Short rotation coppice (Eucalyptus)	Case 1	2 500 - 10 000	3,7	24,3	4,1	0,2	5,2	34,0	5,8	0,3
	Case 2	2 500 - 10 000	4,7	10,9	4,3	0,2	6,6	15,2	6,0	0,3
	Case 3	2 500 - 10 000	4,9	0,3	4,3	0,2	6,9	0,5	6,0	0,3
ice (P	Case	< 500	3,1	24,3	2,8	0,2	4,4	34,0	4,0	0,3

	1	500 - 10 000	3,1	24,3	4,1	0,2	4,4	34,0	5,8	0,3
		> 10 000	3,1	24,3	7,6	0,2	4,4	34,0	10,6	0,3
	Case 2	< 500	4,0	10,9	3,0	0,2	5,6	15,2	4,1	0,3
		500 - 10 000	4,0	10,9	4,3	0,2	5,6	15,2	6,0	0,3
		> 10 000	4,0	10,9	7,8	0,2	5,6	15,2	10,9	0,3
	Case 3	< 500	4,2	0,3	3,0	0,2	5,9	0,5	4,2	0,3
		500 - 10 000	4,2	0,3	4,3	0,2	5,9	0,5	6,0	0,3
		> 10 000	4,2	0,3	7,9	0,2	5,9	0,5	11,0	0,3
Short rotation coppice (Poplar – not fertilised)	Case 1	< 500	1,9	24,3	2,8	0,2	2,6	34,0	4,0	0,3
		500 - 10 000	1,9	24,3	4,1	0,2	2,6	34,0	5,8	0,3
		> 10 000	1,9	24,3	7,6	0,2	2,6	34,0	10,6	0,3
	Case 2	< 500	2,4	10,9	2,9	0,2	3,4	15,2	4,1	0,3
		500 - 10 000	2,4	10,9	4,3	0,2	3,4	15,2	6,0	0,3
		> 10 000	2,4	10,9	7,8	0,2	3,4	15,2	10,9	0,3
	Case 3	< 500	2,5	0,3	3,0	0,2	3,5	0,5	4,2	0,3
		500 - 10 000	2,5	0,3	4,3	0,2	3,5	0,5	6,0	0,3
		> 10 000	2,5	0,3	7,9	0,2	3,5	0,5	11,0	0,3
Stemwood	Case 1	< 500	1,1	24,6	2,8	0,2	1,5	34,4	4,0	0,3
		500 - 2 500	1,1	24,6	2,6	0,2	1,5	34,4	3,6	0,3
		2 500 - 10 000	1,1	24,6	4,1	0,2	1,5	34,4	5,8	0,3
		> 10 000	1,1	24,6	7,6	0,2	1,5	34,4	10,6	0,3
	Case 2	< 500	1,3	11,3	3,0	0,2	1,9	15,8	4,1	0,3
		500 - 2 500	1,3	11,3	2,7	0,2	1,9	15,8	3,8	0,3
		2 500 - 10 000	1,3	11,3	4,3	0,2	1,9	15,8	6,0	0,3
		> 10 000	1,3	11,3	7,8	0,2	1,9	15,8	10,9	0,3
	Case	< 500	1,4	0,8	3,0	0,2	2,0	1,1	4,2	0,3

	3	500 - 2 500	1,4	0,8	2,7	0,2	2,0	1,1	3,8	0,3
		2 500 - 10 000	1,4	0,8	4,3	0,2	2,0	1,1	6,0	0,3
		> 10 000	1,4	0,8	7,9	0,2	2,0	1,1	11,0	0,3
Wood industry residues	Case 1	< 500	0,0	14,2	2,7	0,2	0,0	19,9	3,8	0,3
		500 - 2 500	0,0	14,2	2,4	0,2	0,0	19,9	3,4	0,3
		2 500 - 10 000	0,0	14,2	4,0	0,2	0,0	19,9	5,6	0,3
		> 10 000	0,0	14,2	7,4	0,2	0,0	19,9	10,3	0,3
	Case 2	< 500	0,0	5,9	2,8	0,2	0,0	8,3	3,9	0,3
		500 - 2 500	0,0	5,9	2,5	0,2	0,0	8,3	3,5	0,3
		2 500 - 10 000	0,0	5,9	4,1	0,2	0,0	8,3	5,7	0,3
		> 10 000	0,0	5,9	7,5	0,2	0,0	8,3	10,5	0,3
	Case 3	< 500	0,0	0,2	2,8	0,2	0,0	0,3	3,9	0,3
		500 - 2 500	0,0	0,2	2,5	0,2	0,0	0,3	3,5	0,3
		2 500 - 10 000	0,0	0,2	4,1	0,2	0,0	0,3	5,7	0,3
		> 10 000	0,0	0,2	7,5	0,2	0,0	0,3	10,5	0,3
Agricultural residues										
Agricultural residues, < 0,2 t/m³ density (*)		<500	0,0	0,9	2,5	0,2	0,0	1,1	3,0	0,3
		500 - 2 500	0,0	0,9	5,2	0,2	0,0	1,1	6,3	0,3
		2 500 - 10 000	0,0	0,9	12,7	0,2	0,0	1,1	15,3	0,3
		>10 000	0,0	0,9	25,3	0,2	0,0	1,1	30,4	0,3
Agricultural residues > 0,2 t/m³ density (**)		<500	0,0	0,9	2,5	0,2	0,0	1,1	3,0	0,3
		500 - 2 500	0,0	0,9	3,1	0,2	0,0	1,1	3,7	0,3
		2 500 - 10 000	0,0	0,9	6,4	0,2	0,0	1,1	7,6	0,3
		>10 000	0,0	0,9	12,2	0,2	0,0	1,1	14,7	0,3

Straw pellets	<500	0,0	2,6	2,9	0,2	0,0	3,2	3,5	0,3
	500 - 10 000	0,0	2,6	4,4	0,2	0,0	3,2	5,2	0,3
	>10 000	0,0	2,6	8,0	0,2	0,0	3,2	9,6	0,3
Bagasse briquettes	2 500 - 10 000	0,0	0,3	3,9	0,4	0,0	0,4	4,7	0,5
	>10 000	0,0	0,3	7,5	0,4	0,0	0,4	9,0	0,5
Palm kernel meal	>10 000	23,0	23,6	10,1	0,2	27,6	28,3	12,2	0,3
Palm kernel meal (no methane emissions from oil mill)	>10 000	23,0	3,9	10,1	0,2	27,6	4,6	12,2	0,3

(*) This group of materials includes agricultural residues with a low bulk density, and comprises materials such as straw bales, oat hulls, rice husks and sugar cane bagasse bales (this is not an exhaustive list).

(**) The group of agricultural residues with higher bulk density includes materials such as corn cobs, nut shells, soybean hulls, and palm kernel shells (this is not an exhaustive list).

Case 1 refers to processes in which a natural gas boiler is used to provide the process heat to the pellet mill. Process electricity is purchased from the grid.

Case 2 refers to processes in which a boiler fuelled with wood chips is used to provide the process heat to the pellet mill. Process electricity is purchased from the grid.

Case 3 refers to processes in which a CHP plant, fuelled with wood chips, is used to provide heat and electricity to the pellet mill.

DISAGGREGATED DEFAULT VALUES FOR GASEOUS BIOMASS FUELS PATHWAYS

Biogas and biomethane (*)				Greenhouse gas emissions savings –typical values [g CO_2eq/MJ]				Greenhouse gas emissions savings –default values [g CO_2eq/MJ]			
Renewable gas	**Practice**	**Process**	**Feedstock**	Emissions saved from raw manure management (****)	Cultivation	Processing	Transport & distribution	Emissions saved from raw manure management	Cultivation	Processing	Transport & distribution
Biomethane	**Standard (**)**	Anaerobic digestion	Biowaste	0,0	0,0	58,5	2,3	0,0	0,0	70,2	2,3
			Manure[1]	-120,5	0,0	95,2	2,7	-120,5	0,0	114,24	2,7
			Sewage sludge[2]	0,0	0,0	72,7	1,9	0,0	0,0	87,24	1,9
			Crop silage[3]	0,0	19,4	56,9	2,3	0,0	19,4	68,28	2,3
		Gasification and methanation	Short rotation coppice, <500 km transport distance	0,0	5,2	10,5	6,3	0,0	5,2	12,6	6,3
			Waste wood, 500 - 2 500 km transport distance	0,0	0,0	10,5	10,7	0,0	0,0	12,6	10,7

	Best(***)	Anaerobic digestion	Biowaste	0,0	0,0	9,0	2,3	0,0	0,0	10,8	2,3
			Manure	-120,5	0,0	8,2	2,7	-120,5	0,0	9,84	2,7
			Sewage sludge	0,0	0,0	23,2	1,9	0,0	0,0	27,84	1,9
			Crop silage	0,0	19,4	8,9	2,3	0,0	19,4	10,68	2,3
		Gasification and methanation	Short rotation coppice, <500 km transport distance	0,0	5,2	10,5	6,3	0,0	5,2	12,6	6,3
			Waste wood, 500 - 2 500 km transport distance	0,0	0,0	10,5	10,7	0,0	0,0	12,6	10,7
Biogas for heat and power	**Standard**	Anaerobic digestion	Biowaste	0,0	0,0	47,7	0,3	0,0	0,0	57,24	0,3
			Manure	-104,9	0,0	85,2	0,7	-104,9	0,0	102,24	0,7
			Sewage sludge	0,0	0,0	47,7	0,0	0,0	0,0	57,24	0,0
			Crop silage	0,0	16,8	46,2	0,4	0,0	16,8	55,44	0,4
	Best	Anaerobic digestion	Biowaste	0,0	0,0	13,2	0,3	0,0	0,0	15,84	0,3
			Manure	-104,9	0,0	13,2	0,7	-104,9	0,0	15,84	0,7
			Sewage sludge	0,0	0,0	13,2	0,0	0,0	0,0	15,84	0,0
			Crop silage	0,0	16,8	13,2	0,4	0,0	16,8	15,84	0,4

(*) all settings assume that process energy is supplied from own biogas/biomethane. Other solutions should be calculated with actual values.

(**) The standard practice was reflected in the values that were valid in accordance with Annex VI to Directive (EU) 2018/2001 as applicable on…..[OP please insert a date - one day before the entry into force of this delegated directive].

(***)To improve 'standard practice' and in order to achieve 'best practice', the corresponding methane emission improvement factor $e_{me,i}$ (Point 15a in Part B) is to be subtracted from the default values of the respective standard practice

(****) The values for biogas production from manure include negative emissions for emissions saved from raw manure management. The value of e_{sca} considered is equal to – 45 g CO2eq/MJ manure used in anaerobic digestion.

[1] **Manure** (also known as livestock manure) refers to organic matter, mostly derived from animal faeces and urine, but normally also containing plant material (often straw), that has been used as bedding for animals and has absorbed the faeces and urine. It includes cattle manure and mixtures of manure from different origins. The values for biogas production from manure include negative emissions for emissions saved from raw manure management. The value of e_{sca} considered is equal to – 45 g CO2eq/MJ manure used in anaerobic digestion.

[2] **Sewage sludge** refers to the accumulated settled solids separated from various types of waste water, and which are either moist or partly liquefied as a result of natural or artificial processes (from JECv5 Well-to-Tank as OWCG3).

[3] **Crop silage** refers to silage made up of maize, wheat, triticale, barley, sorghum or a mix thereof. If such crops are cultivated using different practices than those used for standard crop silage (e.g. non-conventional crop rotations) or using different soil inputs than the default case (e.g. fossil-based N-fertilisers), actual values shall be used.

Where best practice is followed in the production of biogas and biomethane, the corresponding methane emission improvement factor $e_{me,i}$ shall be applied, as referred to in Part B, point 15a of this Annex. In those cases, the best practice methane emission improvement factor is deducted from the default values of the respective standard practice pathway.

If biomethane is transported in either its compressed or liquefied form, an additional disaggregated value of 2,4 or 4,9 g CO_2eq/MJ shall be added, respectively. The liquefaction value is only applicable if liquefaction takes place in the EU and is powered by electricity. In all other cases, actual values shall be calculated. In addition, emissions from the transport and distribution of such biomethane shall be added as actual values.

D. TOTAL TYPICAL AND DEFAULT VALUES FOR SOLID BIOMASS FUELS PATHWAYS

Biomass fuel production system	**Greenhouse gas emissions– typical values** **[g CO_2eq/MJ]**	**Greenhouse gas emissions–default values** **[g CO_2eq/MJ]**

Wood chips from:		Transport distance in km	Total	Total
Forest residues		< 500	4,9	6,9
		500 - 2 500	6,4	8,9
		2 500 - 10 000	11,9	16,6
		> 10 000	21,3	29,8
Short rotation coppice (Eucalyptus)		2 500 - 10 000	14,9	22,4
Short rotation coppice (Poplar – fertilised)		< 500	7,4	11,3
		500 - 2 500	8,8	13,3
		2 500 - 10 000	14,3	20,9
		> 10 000	24,2	34,8
Short rotation coppice (Poplar – Not fertilised)		< 500	6,0	8,2
		500 - 2 500	7,4	10,3
		2 500 - 10 000	12,9	17,9
		> 10 000	22,8	31,8
Stemwood		< 500	4,8	6,3
		500 - 2 500	6,2	8,3
		2 500 - 10 000	11,7	16,0
		> 10 000	21,1	29,2
Wood industry residues		< 500	3,7	5,2
		500 - 2 500	5,1	7,2
		2 500 - 10 000	10,6	14,9
		> 10 000	20,0	28,0
Wood pellets & briquettes from:				
Forest residues	Case 1	< 500	28,9	40,4
		500 - 2 500	28,6	40,0

		2 500 - 10 000	30,2	42,3
		> 10 000	33,6	47,1
	Case 2	< 500	16,0	22,4
		500 - 2 500	15,7	22,0
		2 500 - 10 000	17,3	24,2
		> 10 000	20,9	29,2
	Case 3	< 500	5,6	7,8
		500 - 2 500	5,3	7,4
		2 500 - 10 000	6,9	9,6
		> 10 000	10,5	14,6
Short rotation coppice (Eucalyptus)	Case 1	2 500 - 10 000	32,4	45,3
	Case 2	2 500 - 10 000	20,1	28,1
	Case 3	2 500 - 10 000	9,8	13,7
Short rotation coppice (Poplar – fertilised)	Case 1	< 500	30,5	42,7
		500 - 10 000	31,8	44,5
		> 10 000	35,2	49,3
	Case 2	< 500	18,1	25,3
		500 - 10 000	19,4	27,1
		> 10 000	22,9	32,1
	Case 3	< 500	7,7	10,8
		500 - 10 000	9,0	12,7
		> 10 000	12,6	17,7
Short rotation coppice (Poplar – not fertilised)	Case 1	< 500	29,2	40,9
		500 - 10 000	30,5	42,8
		> 10 000	34,0	47,6
	Case 2	< 500	16,4	23,0

		500 - 10 000	17,8	24,9
		> 10 000	21,3	29,8
	Case 3	< 500	6,0	8,5
		500 - 10 000	7,4	10,3
		> 10 000	10,9	15,3
Stemwood	Case 1	< 500	28,7	40,2
		500 - 2 500	28,5	39,8
		2 500 - 10 000	30,0	42,1
		> 10 000	33,5	46,9
	Case 2	< 500	15,8	22,1
		500 - 2 500	15,6	21,8
		2 500 - 10 000	17,1	24,0
		> 10 000	20,7	28,9
	Case 3	< 500	5,4	7,5
		500 - 2 500	5,1	7,2
		2 500 - 10 000	6,7	9,4
		> 10 000	10,3	14,4
Wood industry residues	Case 1	< 500	17,2	24,1
		500 - 2 500	16,9	23,7
		2 500 - 10 000	18,5	25,9
		> 10 000	21,9	30,6
	Case 2	< 500	9,0	12,5
		500 - 2 500	8,7	12,1
		2 500 - 10 000	10,3	14,4
		> 10 000	13,7	19,1
	Case 3	< 500	3,2	4,5

		500 - 2 500	3,0	4,2
		2 500 - 10 000	4,5	6,4
		> 10 000	7,9	11,1
Agricultural residues				
Agricultural residues, < 0,2 t/m³ density (*)		<500	3,7	4,4
		500 - 2 500	6,4	7,6
		2 500 -10 000	13,9	16,6
		>10 000	26,5	31,7
Agricultural residues, >0,2 t/m³ density (**)		<500	3,7	4,4
		500 - 2 500	4,2	5,1
		2 500 -10 000	7,5	9,0
		>10 000	13,4	16,0
Straw pellets		<500	5,8	7,0
		500 - 10 000	7,2	8,7
		>10 000	10,9	13,1
Bagasse briquettes		2 500 -10 000	4,7	5,6
		>10 000	8,2	9,9
Palm kernel meal		>10 000	57,0	68,4
Palm kernel meal (no methane emissions from oil mill		>10 000	37,2	44,7

(*) This group of materials includes agricultural residues with a low bulk density and comprises materials such as straw bales, oat hulls, rice husks and sugar cane bagasse bales (this is not an exhaustive list).

(**) The group of agricultural residues with higher bulk density includes materials such as corn cobs, nut shells, soybean hulls, and palm kernel shells (this is not an exhaustive list).

Case 1 refers to processes in which a natural gas boiler is used to provide the process heat to the pellet mill. Process electricity is purchased from the grid.

Case 2 refers to processes in which a boiler fuelled with wood chips is used to provide the process heat to the pellet mill. Process electricity is purchased from the grid.

Case 3 refers to processes in which a CHP plant, fuelled with wood chips, is used to provide heat and electricity to the pellet mill.

TOTAL TYPICAL AND DEFAULT VALUES FOR GASEOUS BIOMASS FUELS PATHWAYS

Biogas and biomethane (*)				Greenhouse gas emissions– typical values [g CO_2eq/MJ]	Greenhouse gas emissions– default values [g CO_2eq/MJ]
Renewable gas	**Practice**	**Process**	**Feedstock**		
Biomethane	**Standard (**)**	Anaerobic digestion	Biowaste	60,8	72,5
			Manure[1] (****)	-22,6	-3,6
			Sewage sludge[2]	74,6	89,1
			Crop silage[3]	78,6	90,0
		Gasification and methanation	Short rotation coppice, <500 km transport distance	22,0	23,3
			Waste wood, 500 - 2 500 km transport distance	21,2	24,1
	Best(***)	Anaerobic digestion	Biowaste	11,3	13,1
			Manure	-109,6	-108,0
			Sewage sludge	25,1	29,7
			Crop silage	30,6	32,4
		Gasification and methanation	Short rotation coppice, <500 km transport distance	22,0	24,1
			Waste wood, 500 - 2 500 km transport distance	21,2	23,3
Biogas for heat and power	**Standard**	Anaerobic digestion	Biowaste	48,0	57,5
			Manure	-19,0	-2,0
			Sewage sludge	47,7	57,2

			Crop silage	63,4	72,6
	Best	Anaerobic digestion	Biowaste	13,5	16,1
			Manure	-91,0	-88,4
			Sewage sludge	13,2	15,8
			Crop silage	30,4	33,0

[1]**Manure** (also known as livestock manure) refers to organic matter, mostly derived from animal faeces and urine, but normally also containing plant material (often straw), that has been used as bedding for animals and has absorbed the faeces and urine. includes cattle manure and mixtures of manure from different origins. The values for biogas production from manure include negative emissions for emissions saved from raw manure management. The value of e_{sca} considered is equal to – 45 g CO_2eq/MJ manure used in anaerobic digestion.

[2]**Sewage sludge** refers to the accumulated settled solids separated from various types of waste water, and which are either moist or partly liquefied as a result of natural or artificial processes (from JECv5 Well-to-Tank as OWCG3).

[3]**Crop silage** refers to silage made up of maize, wheat, triticale, barley, sorghum or a mix thereof. If such crops are cultivated using different practices than those used for standard crop silage (e.g. non-conventional crop rotations) or using different soil inputs than the default case (e.g. fossil-based N-fertilizers), actual values shall be used.

(*) all settings assume that process energy is supplied from own biogas/biomethane. Other solutions should be calculated with actual values.

(**) The standard practice was reflected in the values that were valid in accordance with Annex VI to Directive (EU) 2018/2001 as applicable on…..[OP please insert a date - one day before the entry into force of this delegated directive].

(***) To improve 'standard practice' and in order to achieve 'best practice', the corresponding methane emissions improvement factor $e_{me,I}$ (Point 15a in Part B) is to be subtracted from the default values of the respective standard practice

(****) The values for biogas production from manure include negative emissions for emissions saved from raw manure management. The value of e_{sca} considered is equal to – 45 g CO2eq/MJ manure used in anaerobic digestion.

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