



Department  
for Transport

# **Draft RTFO Guidance: Greenhouse Gas Emissions Methodology and Default Values for Biofuels**

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# 1. Greenhouse gas emission methodology for biofuels

- 1.1 The methodology for calculating greenhouse gas (GHG) emissions outlined in this section applies to all renewable transport fuels that are derived from biomass regardless of state (i.e. both gaseous and liquid biofuels). Such fuels are referred to in this document as 'biofuels'.<sup>1</sup>
- 1.2 GHG emissions for a given consignment of biofuel can be determined by calculating actual values according to the methodology described in this section or by using appropriate default values from Section 2 (Tables 1-3). These default values can only be used to determine the total GHG emissions if the emissions due to land-use change (as calculated in paragraph 1.14) are equal to or less than zero. When calculating actual values it is permissible to use appropriate disaggregated default values from Section 2 (Tables 4-6) and/or default input data provided by the Administrator.
- 1.3 Default values are provided in Section 2 for many of the more commonly used biofuel production pathways. These values may be used when calculating the GHG emissions of biofuels as set out in paragraph 1.2. These defaults are intentionally set conservatively to account for deviation from normal processes. Suppliers should report actual values if they wish to demonstrate higher GHG emission savings, if the default does not meet the required GHG saving, if there have been emissions due to land-use change or where no default has been published for a particular production pathway.
- 1.4 GHG emissions from the production and use of biofuels shall be calculated as follows:

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

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<sup>1</sup> Note that this is different from the methodology outlined in Directive (EU) 2018/2001, whereby gaseous renewable fuels derived from biomass are defined separately from liquid biofuels and have a distinct methodology. Under the RTFO, the GHG emissions from gaseous and liquid biofuels should be calculated using the same methodology, albeit with a credit applied for gaseous biofuels derived from manure, as described in paragraph 1.13.

Where:

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

e<sub>ec</sub> = emissions from the extraction or cultivation of raw materials

e<sub>l</sub> = annualised emissions from carbon stock changes caused by land-use change

e<sub>p</sub> = emissions from processing

e<sub>td</sub> = emissions from transport and distribution

e<sub>u</sub> = emissions from the fuel in use

e<sub>sca</sub> = emission savings from soil carbon accumulation via improved agricultural management

e<sub>ccs</sub> = emission savings from carbon capture and geological storage

e<sub>ccr</sub> = emission savings from carbon capture and replacement

- 1.5 Emissions from the manufacture of machinery and equipment shall not be taken into account.
- 1.6 GHG emissions from biofuels, E, shall be expressed in terms of grams of CO<sub>2</sub> equivalent per MJ of fuel, gCO<sub>2</sub>e/MJ.
- 1.7 Where the GHG emissions from the extraction or cultivation of raw materials, e<sub>ec</sub>, are expressed in unit gCO<sub>2</sub>eq/dry-tonne of feedstock, the conversion to gCO<sub>2</sub>eq/MJ shall be calculated as follows<sup>2</sup>:

$$e_{ec, fuel_a} \left[ \frac{gCO_2eq}{MJ fuel} \right] = \frac{e_{ec, feedstock_a} \left[ \frac{gCO_2eq}{t_{dry}} \right]}{LHV_a \left[ \frac{MJ feedstock}{t_{dry} feedstock} \right]} \times \text{Fuel feedstock factor}_a \times \text{Allocation factor fuel}_a$$

Where:

$$\text{Allocation factor fuel}_a = \left[ \frac{\text{Energy in fuel}}{\text{Energy in fuel} + \text{Energy in co-products}} \right]$$

Fuel feedstock factor<sub>a</sub> = [Ratio of MJ feedstock required to make 1 MJ fuel]

Emissions per dry-tonne feedstock shall be calculated as follows:

$$e_{ec, feedstock_a} \left[ \frac{gCO_2eq}{t_{dry}} \right] = \frac{e_{ec, feedstock_a} \left[ \frac{gCO_2eq}{t_{moist}} \right]}{(1 - \text{moisture content})}$$

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<sup>2</sup> The formula for calculating greenhouse gas emissions from the extraction or cultivation of raw materials e<sub>ec</sub> describes cases where feedstock is converted into biofuels in one step. For more complex supply chains, adjustments are needed for calculating greenhouse gas emissions from the extraction or cultivation of raw materials e<sub>ec</sub> for intermediate products.

1.8 The greenhouse gases taken into account for the purposes of the equation in 1.4 and shall be CO<sub>2</sub>, N<sub>2</sub>O and CH<sub>4</sub>. For the purpose of calculating CO<sub>2</sub> equivalence, those gases shall be valued as follows:

- CO<sub>2</sub>: 1
- N<sub>2</sub>O: 298
- CH<sub>4</sub>: 25

1.9 GHG emissions savings percentage from biofuels shall be calculated as follows:

$$\text{GHG Saving (\%)} = \frac{(E_{FF} - E_{RF})}{E_{FF}} \times 100$$

Where:

$E_{RF}$  = total emissions from the biofuel

$E_{FF}$  = total emissions from fossil fuel comparator for transport

1.10 For the purposes of the calculations referred to in paragraph 1.9, the fossil fuel comparator  $E_{FF}$  shall be 94 gCO<sub>2</sub>eq/MJ.

1.11 Emissions from the extraction or cultivation of raw materials,  $e_{ec}$ , shall include emissions from the extraction or cultivation process itself; from the collection, drying and storage of raw materials; from waste and leakages; and from the production of chemicals or products used in extraction or cultivation. Capture of CO<sub>2</sub> in the cultivation of raw materials shall be excluded. Estimates of emissions from agriculture biomass cultivation may be derived from the use of regional averages for cultivation emissions<sup>3</sup> or the disaggregated default values (see Section 2, Tables 4-6), as an alternative to using actual values. In the absence of relevant regional average values it is allowed to calculate averages based on local farming practises based for instance on data of a group of farms, as an alternative to using actual values, although this shall be at the discretion of the Administrator.

1.12 For the purposes of the calculation referred to in paragraph 1.4, GHG emissions savings from improved agriculture management,  $e_{sca}$ , such as shifting to reduced or zero-tillage, improved crop/rotation, the use of cover crops, including crop residue management and the use of organic soil improver (e.g. compost, manure fermentation digestate), shall be taken into account only if solid and verifiable evidence is provided that the soil carbon has increased or that it is reasonable to expect to have increased over the period in which the raw materials concerned were

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<sup>3</sup> The numbers should be based on official statistical data from government bodies when available and of good quality. If not available, statistical data published by independent bodies may be used. As a third option, the numbers may be based on scientifically peer-reviewed work, with the precondition that data used lies within the commonly accepted data range when available. The most recent available data from these sources should be used.

cultivated while taking into account the emissions where such practices lead to increased fertiliser and herbicide use<sup>4</sup>.

1.13 For  $e_{sca}$ , a bonus of 45 gCO<sub>2</sub>eq/MJ manure shall be attributed for improved agricultural and manure management in the case where animal manure is used as a substrate for the production of biogas and biomethane.

1.14 Annualised emissions from carbon stock changes caused by land-use change,  $e_l$ , shall be calculated by dividing total emissions equally over 20 years. These emissions should be calculated as follows<sup>5</sup>:

$$e_l = (CS_R - CS_A) \times 3.664 \times (1/20) \times (1/P) - e_B$$

Where:

$e_l$  = the annualised GHG emissions from carbon stock change due to land-use change (in gCO<sub>2</sub>e/MJ). 'Cropland'<sup>6</sup> and 'perennial cropland'<sup>7</sup> shall be regarded as one land use.

$CS_R$  = the carbon stock associated with the reference land use (i.e. the land use in January 2008 or 20 years before the feedstock was obtained, whichever was later) (in gC/ha).

$CS_A$  = the carbon stock associated with the actual land use (in gC/ha). In cases where the carbon stock accumulates over more than one year, the value attributed to  $CS_A$  shall be the estimated stock per unit area after 20 years or when the crop reaches maturity, whichever was earlier.

$P$  = the productivity of the crop (in MJ/ha/y).

$e_B$  = a bonus of 29 gCO<sub>2</sub>e/MJ if the biofuel feedstock is obtained from restored degraded land (see paragraph 1.15).

1.15 The bonus of 29 g CO<sub>2</sub>eq/MJ shall be attributed if evidence is provided that the land satisfies both of the following criteria:

- it was not in use for agriculture or any other activity in January 2008
- it is severely degraded land, including such land that was formerly in agricultural use

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<sup>4</sup> Measurements of soil carbon can constitute such evidence, e.g. by a first measurement in advance of the cultivation and subsequent ones at regular intervals several years apart. In such a case, before the second measurement is available, increase in soil carbon would be estimated on the basis of representative experiments or soil models. From the second measurement onwards, the measurements would constitute the basis for determining the existence of an increase in soil carbon and its magnitude.

<sup>5</sup> The quotient obtained by dividing the molecular weight of CO<sub>2</sub> (44,010 g/mol) by the molecular weight of carbon (12,011 g/mol) is equal to 3,664.

<sup>6</sup> Cropland as defined by IPCC.

<sup>7</sup> Perennial crops are defined as multi-annual crops, the stem of which is usually not annually harvested such as short rotation coppice and oil palm.

The bonus of 29 g CO<sub>2</sub>eq/MJ shall apply for a period of up to 20 years from the date of conversion of the land to agricultural use, provided that a steady increase in carbon stocks as well as a sizable reduction in erosion phenomena are ensured.

- 1.16 'Severely degraded land' means land that, for a significant period of time, has either been significantly salinated or presented significantly low organic matter content and has been severely eroded.
- 1.17 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<sub>2</sub> emissions corresponding to the carbon contents of fossil inputs, whether or not actually combusted in the process.

In accounting for the consumption of electricity not produced within the fuel production plant, the GHG 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 of interim products and materials where relevant.

- 1.18 Emissions from transport and distribution,  $e_{td}$ , shall include emissions from the transport of raw and semi-finished materials and from the storage and distribution of finished materials. Emissions from transport and distribution to be taken into account under paragraph 1.11 shall not be covered by this paragraph.
- 1.19 Emissions of the fuel in use,  $e_u$ , shall be taken to be zero for biofuels.
- 1.20 Emission savings from CO<sub>2</sub> capture and geological storage,  $e_{ccs}$ , that have not already been accounted for in  $e_p$ , shall be limited to emissions avoided through the capture and storage of emitted CO<sub>2</sub> directly related to the extraction, transport, processing and distribution of the biofuel.
- 1.21 Emission savings from CO<sub>2</sub> capture and replacement,  $e_{ccr}$ , shall be related directly to the production of the biofuel they are attributed to, and shall be limited to emissions avoided through the capture of CO<sub>2</sub> of which the carbon originates from biomass and which is used to replace fossil-derived CO<sub>2</sub> in production of commercial products and services.
- 1.22 Where a cogeneration unit – providing heat and/or electricity to a biofuel production process for which emissions are being calculated – produces excess electricity and/or excess useful heat, the GHG emissions shall be divided between the electricity and the useful heat according to the temperature of the heat (which reflects the usefulness (utility) of the heat). The useful part of the heat is found by multiplying its energy content with the Carnot efficiency,  $C_h$ , calculated as follows:

$$C_h = \frac{T_h - T_0}{T_h}$$



Where:

$T_h$  = Temperature, measured in absolute temperature (kelvin), of the useful heat at point of delivery.

$T_0$  = Temperature of surroundings, set at 273.15 kelvin (equal to 0 °C).

If the excess heat is exported for heating of buildings, at a temperature below 150 °C (423.15 kelvin),  $C_h$  can alternatively be defined as follows:

$C_h$  = Carnot efficiency in heat at 150 °C (423.15 kelvin), which is: 0.3546

For the purposes of this calculation, the actual efficiencies shall be used, defined as the annual mechanical energy, electricity and heat produced respectively divided by the annual energy input.

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

- 'cogeneration' shall mean the simultaneous generation in one process of thermal energy and electrical and/or mechanical energy
- 'useful heat' shall mean heat generated to satisfy an economical justifiable demand for heat, for heating or cooling purposes
- 'economically justifiable demand' shall mean the demand that does not exceed the needs for heat or cooling and which would otherwise be satisfied at market conditions

1.23 Where a biofuel production process produces, in combination, the fuel for which emissions are being calculated and one or more other products ('co-products'), GHG emissions shall be divided between the fuel or its intermediate product and the co-products in proportion to their energy content (determined by lower heating value in the case of co-products other than electricity and heat). The GHG intensity of excess useful heat or excess electricity is the same as the GHG intensity of heat or electricity delivered to the biofuel production process and is determined from calculating the GHG intensity of all inputs and emissions, including the feedstock and CH<sub>4</sub> and N<sub>2</sub>O emissions, to and from the cogeneration unit, boiler or other apparatus delivering heat or electricity to the biofuel production process. In the case of cogeneration of electricity and heat, the calculation is performed following paragraph 1.22.

1.24 For the purposes of the calculation referred to in paragraph 1.23, the emissions to be divided shall be  $e_{ec} + e_l + e_{sca}$  + those fractions of  $e_p$ ,  $e_{td}$ ,  $e_{ccs}$ , and  $e_{ccr}$  that take place up to and including the process step at which a co-product is produced. If any allocation to co-products has taken place at an earlier process step in the life-cycle, the fraction of those emissions assigned in the last such process step to the intermediate fuel product shall be used for those purposes instead of the total of those emissions.

All co-products shall be taken into account for the purposes of that calculation. No emissions shall be allocated to wastes and residues. Co-products that have a negative energy content shall be considered to have an energy content of zero for the purposes of the calculation.

Wastes and residues, including tree tops and branches, straw, husks, cobs and nut shells, and residues from processing, including crude glycerine (glycerine that is not refined) and bagasse, shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials irrespectively of whether they are processed to interim products before being transformed into the final product.

In the case of fuels produced in refineries, other than the combination of processing plants with boilers or cogeneration units providing heat and/or electricity to the processing plant, the unit of analysis for the purposes of the calculation referred to in paragraph 1.23 shall be the refinery.

## 2. Default values

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## Default values for biofuels

**Table 1** Default values for biofuels (excluding biomethane and those not on the market in 2016) if produced with no net carbon emissions from land-use change as calculated in accordance with paragraph 1.14.

Biofuel production pathway	Default GHG emissions (gCO <sub>2</sub> eq/MJ)	Default GHG emission saving <sup>8</sup>
Sugar beet ethanol (no biogas from slop, natural gas as process fuel in conventional boiler)	38.2	59%
Sugar beet ethanol (with biogas from slop, natural gas as process fuel in conventional boiler)	25.5	73%
Sugar beet ethanol (no biogas from slop, natural gas as process fuel in CHP plant*)	30.4	68%
Sugar beet ethanol (with biogas from slop, natural gas as process fuel in CHP plant *)	22.5	76%
Sugar beet ethanol (no biogas from slop, lignite as process fuel in CHP plant*)	50.2	47%
Sugar beet ethanol (with biogas from slop, lignite as process fuel in CHP plant*)	33.9	64%
Corn (maize) ethanol (natural gas as process fuel in conventional boiler)	56.8	40%
Corn (maize) ethanol, (natural gas as process fuel in CHP plant *)	48.5	48%
Corn (maize) ethanol (lignite as process fuel in CHP plant*)	67.8	28%
Corn (maize) ethanol (forest residues as process fuel in CHP plant*)	30.3	68%
Other cereals** excluding maize ethanol (natural gas as process fuel in conventional boiler)	58.5	38%
Other cereals** excluding maize ethanol (natural gas as process fuel in CHP plant*)	50.3	46%
Other cereals** excluding maize ethanol (lignite as process fuel in CHP plant*)	71.7	24%
Other cereals** excluding maize ethanol (forest residues as process fuel in CHP plant*)	31.4	67%
Sugar cane ethanol	28.6	70%
The part from renewable sources of ethyl-tertio-butyl-ether (ETBE)	Equal to the ethanol production pathway used	Equal to that of the ethanol production pathway used
The part from renewable sources of tertiary-amyl-ethyl-ether (TAEE)	Equal to that of the ethanol production pathway used	Equal to that of the ethanol production pathway used
Rape seed biodiesel	50.1	47%
Sunflower biodiesel	44.7	52%
Soybean biodiesel	47	50%
Palm oil biodiesel (open effluent pond)	75.5	20%
Palm oil biodiesel (process with methane capture at oil mill)	51.4	45%
Waste cooking oil biodiesel	14.9	84%
Animal fats from rendering biodiesel***	20.7	78%
Hydrotreated vegetable oil from rape seed	50.1	47%

<sup>8</sup> GHG savings relative to the fossil fuel comparator for transport of 94 gCO<sub>2</sub>eq/MJ.

Hydrotreated vegetable oil from sunflower	43.6	54%
Hydrotreated vegetable oil from soybean	46.5	51%
Hydrotreated vegetable oil from palm oil (open effluent pond)	73.2	22%
Hydrotreated vegetable oil from palm oil (process with methane capture at oil mill)	47.9	49%
Hydrotreated oil from waste cooking oil	16	83%
Hydrotreated oil from animal fats from rendering***	21.8	77%
Pure vegetable oil from rape seed	40	57%
Pure vegetable oil from sunflower	34.3	64%
Pure vegetable oil from soybean	36.9	61%
Pure vegetable oil from palm oil (open effluent pond)	65.5	30%
Pure vegetable oil from palm oil (process with methane capture at oil mill)	40.3	57%
Pure oil from waste cooking oil	2.2	98%

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

\*\* "Other cereals" can be barley, wheat, triticale or rye.

\*\*\* Applies only to biofuels produced from animal by-products classified as category 1 and 2 material (see [guidance issued by the Department for Environment, Food & Rural Affairs](#) for more details on the categorisation of animal by-products). Emissions related to hygenisation as part of the rendering are not considered.

**Table 2** Default values for future biofuels that were not on the market or were on the market only in negligible quantities in 2016, if produced with no net carbon emissions from land-use change as calculated in accordance with paragraph 1.14.

Biofuel production pathway	Default GHG emissions (gCO <sub>2</sub> eq/MJ)	Default GHG emission saving <sup>9</sup>
Wheat straw ethanol	15.7	83%
Waste wood Fischer-Tropsch diesel in free-standing plant	15.6	83%
Farmed wood Fischer-Tropsch diesel in free-standing plant	16.7	82%
Waste wood Fischer-Tropsch petrol in free-standing plant	15.6	83%
Farmed wood Fischer-Tropsch petrol in free-standing plant	16.7	82%
Waste wood dimethylether (DME) in free-standing plant	15.2	84%
Farmed wood dimethylether (DME) in free-standing plant	16.2	83%
Waste wood methanol in free-standing plant	15.2	84%
Farmed wood methanol in free-standing plant	16.2	83%
Fischer – Tropsch diesel from black-liquor gasification integrated with pulp mill	10.2	89%
Fischer – Tropsch petrol from black-liquor gasification integrated with pulp mill	10.4	89%
Dimethylether (DME) from black-liquor gasification integrated with pulp mill	10.2	89%
Methanol from black-liquor gasification integrated with pulp mill	10.4	89%
The part from renewable sources of methyl-tertio-butyl-ether (MTBE)	Equal to that of the methanol production pathway used	Equal to that of the methanol production pathway used

<sup>9</sup> GHG savings relative to the fossil fuel comparator for transport of 94 gCO<sub>2</sub>eq/MJ.

**Table 3** Typical and default values for compressed biomethane used in transport if produced with no net carbon emissions from land-use change as calculated in accordance with paragraph 1.14.

Biomethane production pathway	Default GHG emissions (gCO <sub>2</sub> eq/MJ)	Default GHG emission saving <sup>10</sup>
Wet manure (Open digestate, no off-gas combustion*)	26.4	72%
Wet manure (Open digestate, off-gas combustion**)	5.4	94%
Wet manure (Close digestate, no off-gas combustion*)	-74.7	179%
Wet manure (Close digestate, off-gas combustion**)	-95.7	202%
Maize whole plant (Open digestate, no off-gas combustion*)	78.1	17%
Maize whole plant (Open digestate, off-gas combustion**)	57.1	39%
Maize whole plant (Close digestate, no off-gas combustion*)	55.5	41%
Maize whole plant (Close digestate, off-gas combustion**)	34.5	63%

\* This category includes the following categories of technologies for biogas upgrade to biomethane: Pressure Swing Adsorption (PSA), Pressure Water Scrubbing (PWS), Membranes, Cryogenic, and Organic Physical Scrubbing (OPS). It includes an emission of 0.03 MJCH<sub>4</sub>/MJ biomethane for the emission of methane in the off-gases.

\*\* This category includes the following categories of technologies for biogas upgrade to biomethane: Pressure Water Scrubbing (PWS) when water is recycled, Pressure Swing Adsorption (PSA), Chemical Scrubbing, Organic Physical Scrubbing (OPS), Membranes and Cryogenic upgrading. No methane emissions are considered for this category (the methane in the off-gas is combusted, if any).

<sup>10</sup> GHG savings relative to the fossil fuel comparator for transport of 94 gCO<sub>2</sub>eq/MJ.

## Disaggregated default values for biofuels

**Table 4** Disaggregated default values for biofuels (excluding biomethane and those not on the market in 2016). All values are in gCO<sub>2</sub>eq/MJ.

Biofuel production pathway	Cultivation, e <sub>ec</sub> (incl. N <sub>2</sub> O)	Cultivation, e <sub>ec</sub> (N <sub>2</sub> O only)	Processing, e <sub>p</sub>	Processing, e <sub>p</sub> (Oil extraction only)	Transport, e <sub>td</sub>	Transport, e <sub>td</sub> (final fuel only)
Sugar beet ethanol (no biogas from slop, natural gas as process fuel in conventional boiler)	9.6	4.9	26.3	0	2.3	1.6
Sugar beet ethanol (with biogas from slop, natural gas as process fuel in conventional boiler)	9.6	4.9	13.6	0	2.3	1.6
Sugar beet ethanol (no biogas from slop, natural gas as process fuel in CHP plant*)	9.6	4.9	18.5	0	2.3	1.6
Sugar beet ethanol (with biogas from slop, natural gas as process fuel in CHP plant*)	9.6	4.9	10.6	0	2.3	1.6
Sugar beet ethanol (no biogas from slop, lignite as process fuel in CHP plant*)	9.6	4.9	38.3	0	2.3	1.6
Sugar beet ethanol (with biogas from slop, lignite as process fuel in CHP plant*)	9.6	4.9	22	0	2.3	1.6
Corn (maize) ethanol (natural gas as process fuel in conventional boiler)	25.5	13.7	29.1	0	2.2	1.6
Corn (maize) ethanol, (natural gas as process fuel in CHP plant*)	25.5	13.7	20.8	0	2.2	1.6
Corn (maize) ethanol (lignite as process fuel in CHP plant*)	25.5	13.7	40.1	0	2.2	1.6
Corn (maize) ethanol (forest residues as process fuel in CHP plant*)	25.5	13.7	2.6	0	2.2	1.6
Other cereals** excluding maize ethanol (natural gas as process fuel in conventional boiler)	27	14.1	29.3	0	2.2	1.6
Other cereals** excluding maize ethanol (natural gas as process fuel in CHP plant*)	27	14.1	21.1	0	2.2	1.6
Other cereals** excluding maize ethanol (lignite as process fuel in CHP plant*)	27	14.1	42.5	0	2.2	1.6
Other cereals** excluding maize ethanol (forest residues as process fuel in CHP plant*)	27	14.1	2.2	0	2.2	1.6
Sugar cane ethanol	17.1	2.1	1.8	0	9.7	6
The part from renewable sources of ETBE	Equal to that of the ethanol production pathway used					
The part from renewable sources of TAAE	Equal to that of the ethanol production pathway used					
Rape seed biodiesel	32	17.6	16.3	4.2	1.8	1.3
Sunflower biodiesel	26.1	12.2	16.5	4	2.1	1.3
Soybean biodiesel	21.2	13.4	16.9	4.4	8.9	1.3
Palm oil biodiesel (open effluent pond)	26	16.5	42.6	29.2	6.9	1.3
Palm oil biodiesel (process with methane capture at oil mill)	26	16.5	18.5	5.1	6.9	1.3
Waste cooking oil biodiesel	0	0	13	0	1.9	1.3
Animal fats from rendering biodiesel***	0	0	19.1	6.1	1.6	1.3
Hydrotreated vegetable oil from rape seed	33.4	18	15	4.4	1.7	1.2
Hydrotreated vegetable oil from sunflower	26.9	12.5	14.7	4.1	2	1.2
Hydrotreated vegetable oil from soybean	22.1	13.7	15.2	4.6	9.2	1.2



Hydrotreated vegetable oil from palm oil (open effluent pond)	27.3	16.9	38.9	30.7	7	1.2
Hydrotreated vegetable oil from palm oil (process with methane capture at oil mill)	27.3	16.9	13.6	5.4	7	1.2
Hydrotreated oil from waste cooking oil	0	0	14.3	0	1.7	1.2
Hydrotreated oil from animal fats from rendering***	0	0	20.3	6	1.5	1.2
Pure vegetable oil from rape seed	33.4	17.6	5.2	4.4	1.4	0.8
Pure vegetable oil from sunflower	27.2	12.2	5.4	4.2	1.7	0.8
Pure vegetable oil from soybean	22.2	13.4	5.9	4.7	8.8	0.8
Pure vegetable oil from palm oil (open effluent pond)	27.1	16.5	31.7	30.5	6.7	0.8
Pure vegetable oil from palm oil (process with methane capture at oil mill)	27.1	16.5	6.5	5.3	6.7	0.8
Pure oil from waste cooking oil	0	0	0.8	0	1.4	0.8

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

\*\* "Other cereals" can be barley, wheat, triticale or rye.

\*\*\* Applies only to biofuels produced from animal by-products classified as category 1 and 2 material (see [guidance issued by the Department for Environment, Food & Rural Affairs](#) for more details on the categorisation of animal by-products). Emissions related to hygenisation as part of the rendering are not considered.

**Table 5** Estimated disaggregated default values for future biofuels that were not on the market or were only on the market in negligible quantities in 2016. All values are in gCO<sub>2</sub>eq/MJ.

Biofuel production pathway	Cultivation, e <sub>ec</sub> (incl. N <sub>2</sub> O)	Cultivation, e <sub>ec</sub> (N <sub>2</sub> O only)	Processing, e <sub>p</sub>	Transport, e <sub>td</sub>	Transport, e <sub>td</sub> (final fuel only)
Wheat straw ethanol	1.8	0	6.8	7.1	1.6
Waste wood Fischer-Tropsch diesel in free-standing plant	3.3	0	0.1	12.2	1.2
Farmed wood Fischer-Tropsch diesel in free-standing plant	8.2	4.4	0.1	8.4	1.2
Waste wood Fischer-Tropsch petrol in free-standing plant	3.3	0	0.1	12.2	1.2
Farmed wood Fischer-Tropsch petrol in free-standing plant	8.2	4.4	0.1	8.4	1.2
Waste wood dimethylether (DME) in free-standing plant	3.1	0	0	12.1	2
Farmed wood dimethylether DME in free-standing plant	7.6	4.1	0	8.6	2
Waste wood methanol in free-standing plant	3.1	0	0	12.1	2
Farmed wood methanol in free-standing plant	7.6	4.1	0	8.6	2
Fischer Tropsch diesel from black-liquor gasification integrated with pulp mill	2.5	0	0	7.7	2
Fischer Tropsch petrol from black-liquor gasification integrated with pulp mill	2.5	0	0	7.9	2
Dimethylether (DME) from black-liquor gasification integrated with pulp mill	2.5	0	0	7.7	2
Methanol from black-liquor gasification integrated with pulp mill	2.5	0	0	7.9	2
The part from renewable sources of MTBE	Equal to that of the methanol production pathway used				

**Table 6** Disaggregated default values for biomethane. All values are in gCO<sub>2</sub>eq/MJ.

Biomethane production pathway	Cultivation	Processing	Upgrading	Transport	Compression at filling station	Manure credits
Wet manure (Open digestate, no off-gas combustion*)	0	117.9	27.3	1	4.6	-124.4
Wet manure (Open digestate, off-gas combustion**)	0	117.9	6.3	1	4.6	-124.4
Wet manure (Close digestate, no off-gas combustion*)	0	4.4	27.3	0.9	4.6	-111.9
Wet manure (Close digestate, off-gas combustion**)	0	4.4	6.3	0.9	4.6	-111.9
Maize whole plant (Open digestate, no off-gas combustion*)	18.1	28.1	27.3	0	4.6	-
Maize whole plant (Open digestate, off-gas combustion**)	18.1	28.1	6.3	0	4.6	-
Maize whole plant (Close digestate, no off-gas combustion*)	17.6	6	27.3	0	4.6	-
Maize whole plant (Close digestate, off-gas combustion**)	17.6	6	6.3	0	4.6	-

\* This category includes the following categories of technologies for biogas upgrade to biomethane: Pressure Swing Adsorption (PSA), Pressure Water Scrubbing (PWS), Membranes, Cryogenic, and Organic Physical Scrubbing (OPS). It includes an emission of 0.03 MJCH<sub>4</sub>/MJ biomethane for the emission of methane in the off-gases.

\*\* This category includes the following categories of technologies for biogas upgrade to biomethane: Pressure Water Scrubbing (PWS) when water is recycled, Pressure Swing Adsorption (PSA), Chemical Scrubbing, Organic Physical Scrubbing (OPS), Membranes and Cryogenic upgrading. No methane emissions are considered for this category (the methane in the off-gas is combusted, if any).