ANNEX 1

Methodology for the calculation of greenhouse gas emission savings

1. Greenhouse gas emissions from the production and use of transport fuels, biofuels and bioliquids shall be calculated as:

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

where,

E - total emissions from the use of fossil fuel (EF) or biofuel (EB),
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_{sca} - emission saving from soil carbon accumulation via improved agricultural management;
e_{ccs} - emission saving from carbon capture and geological storage;
e_{ccr} - emission saving from carbon capture and replacement;
e_{ee} - emission saving from excess electricity from cogeneration.

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

2. Greenhouse gas emissions from fuels E from item 1 of this methodology, shall be expressed in terms of grams of CO_2 equivalent per MJ of fuel, gCO_2eq/MJ.

3. By derogation from point 2, for transport fuels, values calculated in terms of gCO2eq/MJ may be adjusted to take into account differences between fuels in useful work done, expressed in terms of km/MJ. Such adjustments shall be made only where evidence of the differences in useful work done is provided.

4. Greenhouse gas emission saving from biofuels and bioliquids shall be calculated as:

$$SAVING = \frac{(EF - EB)}{EF}$$

where:
EB - total emissions (E) from biofuel,
EF - total emission (E) for fossil fuel comparator.
The value of EB shall be calculated in one of the following ways:

1) by using default values for the biofuel production as defined in this Annex in the section Typical and default values for biofuel, provided that the value of e_l, calculated in line with item 7 of this methodology, is equal to or less than zero, or

2) as actual value calculated in accordance with the formula from item 1 of this methodology, or

3) by using the formula from item 1 of this methodology, where disaggregated default values from the part Disaggregated default and set values are used for some factors; when there

are no default values for the formula factors from item 1 of this methodology, their actual values shall be used.

For fossil fuels, for the purpose of calculation of the EF value, the latest available actual average emissions from the fossil part of petrol and fossil part of gas oil consumed in the EU shall be used.

If no such data are available, the value used shall be 83,8 gCO_2eq/MJ.

For bioliquids used for electricity production, for the purposes of calculation of the EF value, the value used shall be 91 gCO_2eq/MJ.

For bioliquids used for heat production, for the purposes of calculation of the EF value, the value used shall be 77 gCO_2eq/MJ.

For bioliquids used for cogeneration, for the purposes of calculation of the EF value, the value used shall be 85 gCO_2eq/MJ.

5. The greenhouse gases taken into account for the purpose of point 1 of this methodology shall be CO_2, N_2O и CH_4. For the purpose of calculating CO_2 equivalence, those gases shall be valued as follows:

CO_2: 1

N_2O: 296

CH_4: 23

6. Emissions from the extraction or cultivation of raw materials, e_{ec}, shall take into account emissions from: the extraction or cultivation process itself; the collection of raw materials; from waste and leakages; the production of chemicals or products used in extraction or cultivation. Capture of CO_2 in the cultivation of raw materials shall be excluded. Certified reductions of greenhouse gas emissions from flaring at oil production sites anywhere in the world shall be deducted. Estimates of emissions from cultivation may be derived from the use of averages calculated for smaller geographical areas than those used in the calculation of the default values, as an alternative to using actual values.

7. Annualized emissions from carbon stock changes caused by land-use change, e_l, shall be calculated by dividing total emissions equally over 20 years. For the calculation of those emissions the following rule shall be applied:

$$e_l = (CS_R - CS_A) \times 3{,}664 \times 1/20 \times 1/P - eB,$$

where,

e_l - annualised greenhouse gas emissions from carbon stock change due to land-use change, measured as mass of CO_2 - equivalent expressed in g, per unit biofuel energy expressed in MJ. Cultivated land and land used for permanent cultures shall be considered as identically used land,

CS_R - the carbon stock per unit area associated with the reference (prior) land-use, measured as mass of carbon in tones per unit area, including both soil and vegetation. The reference land use shall be the land use in January 2008 or 20 years before the raw material was obtained, whichever was the latter,

CS_A – the carbon stock per unit area associated with the actual (current) land use, measured as mass of carbon per unit area expressed in tons, including both soil and vegetation. In cases where the carbon stock accumulates over more than one year, the value attributed to CS_A CSA shall be the estimated stock per unit area after 20 years or when the crop reaches maturity, whichever the earlier;

3,664 - coefficient obtained by dividing the molecular mass of CO_2 (44,010/mol) with carbon molecular mass (12,011 g/mol),

P - the productivity of the crop (measured as biofuel energy per unit area per year),

eB - bonus of 29 gCO_2eq/MJ biofuel if biomass is obtained from restored degraded land under the conditions provided for in point 8 of this methodology.

8. The bonus of 29 gCO_2eq/MJ shall be attributed if evidence is provided that the land:

а) was not in use for agriculture or any other activity in January 2008;

б) falls into one of the following categories:

- severely degraded land, including such land that was formerly in agricultural use,
- heavily contaminated land.

This rule shall also apply to the land that is the subject of recovery and improvement measures for degraded or highly contaminated land, in accordance with the regulation governing land protection.

9. The calculation of land carbon stocks shall be based on the United Nations Framework Convention on Climate Change - Guidelines for National Greenhouse Gas Inventories - volume 4, International Panel for Climate Change 2006.

10. 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. In accounting for the consumption of electricity not produced within the fuel production plant, the greenhouse gas emission 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 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.

11. Emissions from transport and distribution, e_{td}, shall include emissions from the transport and storage 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 point 6 shall not be covered by this point.

12. Emissions from the fuel in use, e_u, shall be taken to be zero for biofuels.

13. Emission saving from carbon 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 sequestration of emitted CO_2 directly related to the extraction, transport, processing and distribution of fuel.

14. Emission saving from carbon capture and replacement, e_{ccr}, hall be limited to emissions avoided through the capture of CO_2 of which the carbon originates from biomass and which is used to replace fossil-derived CO_2 used in commercial products and services.

15. Emission saving from excess electricity from cogeneration, e_{ee}, shall be taken into account in relation to the excess electricity produced by fuel production systems that use cogeneration except where the fuel used for the cogeneration is a co-product other than an agricultural crop residue. In accounting for that excess electricity, the size of the cogeneration unit shall be assumed to be the minimum necessary for the cogeneration unit to supply the heat that is needed to produce the fuel. The greenhouse gas emission saving associated with that excess electricity shall be taken to be equal to the amount of greenhouse gas that would be emitted when an equal amount of electricity was generated in a power plant using the same fuel as the cogeneration unit.

16. Where a fuel production process produces, in combination, the fuel for which emissions are being calculated and one or more other products (co-products), greenhouse gas 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).

17. For the purposes of the calculation referred to in point 15 of this methodology, the emissions to be divided shall be ecc+el, plus those fractions of e_p, e_{td} и e_{ee}, 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 this purpose instead of the total of those emissions.

In the case of emissions for biofuels, all co-products, including electricity that does not fall under the scope of point 16, shall be taken into account for the purposes of that calculation, except for agricultural crop residues, including straw, bagasse, husks, cobs and nut shells. Co-products that have a negative energy content shall be considered to have an energy content of zero for the purpose of the calculation. Wastes, agricultural crop residues, including straw, bagasse, husks, cobs and nut shells, and residues from processing, including crude glycerine (glycerine that is not refined), shall be considered to have zero life-cycle greenhouse gas emissions up to the process of collection of those materials.

18. In the case of fuels produced in refineries, the unit of analysis for the purposes of the calculation referred to in point 16 shall be the refinery.

Typical and default values for biofuels

Table 1. Typical and default values for biofuels if produced with no net carbon emission form land-use change

Biofuel and bioliquid production pathway	Typical greenhouse gas emission saving	Default greenhouse gas emission saving
sugar beet ethanol	61%	52%
wheat ethanol (process fuel not specified)	32%	16%
wheat ethanol (lignite as process fuel in CHP plant)	32%	16%
wheat ethanol (natural gas as process fuel in conventional boiler)	45%	34%
wheat ethanol (natural gas as process fuel in CHP plant)	53%	47%
wheat ethanol (straw as process fuel in CHP plant)	69%	69%
corn (maize) ethanol, Community produced (natural gas as process fuel in CHP plant)	56%	49%
sugar cane ethanol	71%	71%

the part from renewable sources of ethyl-tertio-butyl-ether (ETBE)	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	
rape seed biodiesel	45%	38%
sunflower biodiesel	58%	51%
soybean biodiesel	40%	31%
palm oil biodiesel (process not specified)	36%	19%
palm oil biodiesel (process with methane capture at oil mill)	62%	56%
waste vegetable or animal oil biodiesel[1]	88%	83%
hydrotreated vegetable oil from rape seed	51%	47%
hydrotreated vegetable oil from sunflower	65%	62%
hydrotreated vegetable oil from palm oil (process not specified)	40%	26%
hydrotreated vegetable oil from palm oil (process with methane capture at oil mill)	68%	65%
pure vegetable oil from rape seed	58%	57%
biogas from municipal organic waste as compressed natural gas	80%	73%
biogas from wet manure as compressed natural gas	84%	81%
biogas from dry manure as compressed natural gas	86%	82%

Table 2. Estimated typical and default values for future biofuels that were not on the market or were on the market only in negligible quantities in January 2008, if produced with no net carbon emissions from land-use change

Biofuel production pathway	Typical greenhouse gas emission saving	Default greenhouse gas emission saving
wheat straw ethanol	87%	85%
waste wood ethanol	80%	74%

[1] Not including animal oil produced from animal by-products classified as category 3, in line with the regulation prescribing the manner of sorting and treatment of animal by-products.

farmed wood ethanol	76%	70%
waste wood Fischer-Tropsch diesel	95%	95%
farmed wood Fischer-Tropsch diesel	93%	93%
waste wood dimethylether (DME)	95%	95%
farmed wood DME	92%	92%
waste wood methanol	94%	94%
farmed wood methanol	91%	91%
the part from renewable sources of methyl-tertio-butyl-ether (MTBE)	Equal to that of the methanol production pathway used	

Disaggregated typical and default values

Табела 1. Disaggregated typical and default values for cultivation e_{ec}

Biofuel production pathway	Typical greenhouse gas emissions (gCO_2eq/MJ)	Default greenhouse gas emissions (gCO_2eq/MJ)
sugar beet ethanol	12	12
wheat ethanol	23	23
corn (maize) ethanol, Community produced	20	20
sugar cane ethanol	14	14
the part from renewable sources of ETBE	Equal to that of the ethanol production pathway used	
the part from renewable sources of TAEE	Equal to that of the ethanol production pathway used	
rape seed biodiesel	29	29
sunflower biodiesel	18	18
soybean biodiesel	19	19
palm oil biodiesel	14	14
waste vegetable or animal oil biodiesel [2]	0	0
hydrotreated vegetable oil from rape seed	30	30
hydrotreated vegetable oil from sunflower	18	18
hydrotreated vegetable oil from palm oil	15	15

[2] Not including animal oil produced from animal by-products classified as category 3, in line with the regulation prescribing the manner of sorting and treatment of animal by-products.

pure vegetable oil from rape seed	30	30
biogas from municipal organic waste as compressed natural gas	0	0
biogas from wet manure as compressed natural gas	0	0
biogas from dry manure as compressed natural gas	0	0

Table 2. Disaggregated typical and default values for processing (including excess electricity): e_p-e_{ee}

Biofuel production pathway	Typical greenhouse gas emissions (gCO_2eq/MJ)	Default greenhouse gas emissions (gCO_2eq/MJ)
sugar beet ethanol	19	26
wheat ethanol (process fuel not specified)	32	45
wheat ethanol (lignite as process fuel in CHP plant)	32	45
wheat ethanol (natural gas as process fuel in conventional boiler)	21	30
wheat ethanol (natural gas as process fuel in CHP plant)	14	19
wheat ethanol (straw as process fuel in CHP plant)	1	1
corn (maize) ethanol, Community produced (natural gas as process fuel in CHP plant)	15	21
sugar cane ethanol	1	1
the part from renewable sources of ETBE	Equal to that of the ethanol production pathway used	
the part from renewable sources of TAEE	Equal to that of the ethanol production pathway used	
rape seed biodiesel	16	22
sunflower biodiesel	16	22
soybean biodiesel	18	26
palm oil biodiesel (process not specified)	35	49
palm oil biodiesel (process with methane capture at oil mill)	13	18

waste vegetable or animal oil biodiesel	9	13
hydrotreated vegetable oil from rape seed	10	13
hydrotreated vegetable oil from sunflower	10	13
hydrotreated vegetable oil from palm oil (process not specified)	30	42
hydrotreated vegetable oil from palm oil (process with methane capture at oil mill)	7	9
pure vegetable oil from rape seed	4	5
biogas from municipal organic waste as compressed natural gas	14	20
biogas from wet manure as compressed natural gas	8	11
biogas from dry manure as compressed natural gas	8	11

Table 3. Disaggregated typical and default values for transport and distribution: e_{td}

Biofuel production pathway	Typical greenhouse gas emissions (gCO_2eq/MJ)	Default greenhouse gas emissions (gCO_2eq/MJ)
sugar beet ethanol	2	2
wheat ethanol	2	2
corn (maize) ethanol, Community produced	2	2
sugar cane ethanol	9	9
the part from renewable sources of ETBE	Equal to that of the ethanol production pathway used	
the part from renewable sources of TAEE	Equal to that of the ethanol production pathway used	
rape seed biodiesel	1	1
sunflower biodiesel	1	1
soybean biodiesel	13	13
palm oil biodiesel	5	5
waste vegetable or animal oil biodiesel	1	1
hydrotreated vegetable oil from rape seed	1	1
hydrotreated vegetable oil from sunflower	1	1

hydrotreated vegetable oil from palm oil	5	5
pure vegetable oil from rape seed	1	1
biogas from municipal organic waste as compressed natural gas	3	3
biogas from wet manure as compressed natural gas	5	5
biogas from dry manure as compressed natural gas	4	4

Table 4. Total values for cultivation, processing, transport and distribution

Biofuel production pathway	Typical greenhouse gas emissions (gCO_2eq/MJ)	Default greenhouse gas emissions (gCO_2eq/MJ)
sugar beet ethanol	33	40
wheat ethanol (process fuel not specified)	57	70
wheat ethanol (lignite as process fuel in CHP plant)	57	70
wheat ethanol (natural gas as process fuel in conventional boiler)	46	55
wheat ethanol (natural gas as process fuel in CHP plant)	39	44
wheat ethanol (straw as process fuel in CHP plant)	26	26
corn (maize) ethanol, Community produced (natural gas as process fuel in CHP plant)	37	43
sugar cane ethanol	24	24
the part from renewable sources of ETBE	Equal to that of the ethanol production pathway used	
the part from renewable sources of TAEE	Equal to that of the ethanol production pathway used	
rape seed biodiesel	46	52
sunflower biodiesel	35	41
soybean biodiesel	50	58
palm oil biodiesel (process not specified)	54	68
palm oil biodiesel (process with methane capture at oil mill)	32	37

waste vegetable or animal oil biodiesel	10	14
hydrotreated vegetable oil from rape seed	41	44
hydrotreated vegetable oil from sunflower	29	32
hydrotreated vegetable oil from palm oil (process not specified)	50	62
hydrotreated vegetable oil from palm oil (process with methane capture at oil mill)	27	29
pure vegetable oil from rape seed	35	36
biogas from municipal organic waste as compressed natural gas	17	23
biogas from wet manure as compressed natural gas	13	16
biogas from dry manure as compressed natural gas	12	15

Table 5. Estimated disaggregated default values for cultivation e_{ec} for biofuels that were not on the market or were only on the market in negligible quantities in January 2008.

Biofuel production pathway	Typical greenhouse gas emissions (gCO_2eq/MJ)	Default greenhouse gas emissions (gCO_2eq/MJ)
wheat straw ethanol	3	3
waste wood ethanol	1	1
farmed wood ethanol	6	6
waste wood Fischer-Tropsch diesel	1	1
farmed wood Fischer-Tropsch diesel	4	4
waste wood DME	1	1
farmed wood DME	5	5
waste wood methanol	1	1
farmed wood methanol	5	5
the part from renewable sources of MTBE	Equal to that of the methanol production pathway used	

Table 6. Estimated disaggregated default values for processing (including excess electricity): e_p-e_{ee}, for biofuels that were not on the market or were only on the market in negligible quantities in January 2008.

Biofuel production pathway	Typical greenhouse gas emissions (gCO_2eq/MJ)	Default greenhouse gas emissions (gCO_2eq/MJ)
wheat straw ethanol	5	7
wood ethanol	12	17
wood Fischer-Tropsch diesel	0	0
wood DME	0	0
wood methanol	0	0
the part from renewable sources of MTBE	Equal to that of the methanol production pathway used	

Table 7. Estimated disaggregated default and typical values for transport and distribution: e_{td}, for biofuels that were not on the market or were only on the market in negligible quantities in January 2008

Biofuel production pathway	Typical greenhouse gas emissions (gCO_2eq/MJ)	Default greenhouse gas emissions (gCO_2eq/MJ)
wheat straw ethanol	2	2
waste wood ethanol	4	4
farmed wood ethanol	2	2
waste wood Fischer-Tropsch diesel	3	3
farmed wood Fischer-Tropsch diesel	2	2
waste wood DME	4	4
farmed wood DME	2	2
waste wood methanol	4	4
farmed wood methanol	2	2
the part from renewable sources of MTBE	Equal to that of the methanol production pathway used	

Table 8. Estimated total values for cultivation, processing, transport and distribution

Biofuel production pathway	Typical greenhouse gas emissions (gCO_2eq/MJ)	Default greenhouse gas emissions (gCO_2eq/MJ)
wheat straw ethanol	11	13
waste wood ethanol	17	22
farmed wood ethanol	20	25
waste wood Fischer-Tropsch diesel	4	4
farmed wood Fischer-Tropsch diesel	6	6
waste wood DME	5	5
farmed wood DME	7	7
waste wood methanol	5	5
farmed wood methanol	7	7

the part from renewable sources of MTBE	Equal to that of the methanol production pathway used