

COMMISSION DELEGATED REGULATION (EU) 2023/1185**of 10 February 2023****supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and by specifying a methodology for assessing greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels**

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Having regard to Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources ⁽¹⁾, and in particular Articles 25(2) and 28(5) thereof,

Whereas:

- (1) Taking into account the need to substantially reduce greenhouse gas emissions in the transport sector and the possibility for each fuel to make significant greenhouse gas emissions savings by applying carbon capture and storage techniques, among other measures, and considering the greenhouse gas saving requirements set for other fuels in Directive (EU) 2018/2001, a minimum greenhouse gas emission saving threshold of 70 % should be set for all types of recycled carbon fuels.
- (2) Clear rules need to be set, based on objective and non-discriminatory criteria, for calculating greenhouse gas emissions savings for renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels and their fossil fuel comparators.
- (3) The greenhouse gas emissions accounting methodology should take into account the full life-cycle emissions from producing renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels and be based on objective and non-discriminatory criteria.
- (4) Credits should not be granted for capturing CO₂ which has already been taken into account under other provisions of Union law. Therefore that kind of captured CO₂ should not be considered as being avoided when determining the emissions from the inputs' existing use or fate.
- (5) The origin of carbon used for the production of renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels is not relevant for determining emission savings of such fuels in the short term, as currently many carbon sources are available and can be captured while making progress on decarbonisation. In an economy on a trajectory towards climate neutrality by 2050, sources of carbon that can be captured should become scarce in the medium- to long-term, increasingly restricted to CO₂ emissions that are hardest to abate. In addition, the continued use of renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels that contain carbon from non-sustainable fuel is not compatible with a trajectory towards climate neutrality by 2050 as it would entail the continued use of non-sustainable fuels and their related emissions. Therefore, capturing of emissions from non-sustainable fuels should not be considered as avoiding emissions indefinitely when determining the greenhouse gas emissions savings from the use of renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels. Captured emissions from the combustion of non-sustainable fuels for the production of electricity should be considered avoided emissions up to 2035, as most should be abated by that date, while emissions from other uses of non-sustainable fuels should be considered avoided emissions up to 2040, as these emissions will remain longer. These dates will be subject to review in light of the implementation in the sectors covered by Directive 2003/87/EC of the European Parliament and of the Council ⁽²⁾ of the Union-wide

⁽¹⁾ OJ L 328, 21.12.2018, p. 82.

⁽²⁾ Directive 2003/87/EC of the European Parliament and of the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC (OJ L 275, 25.10.2003, p. 32).

climate target for 2040. The Union-wide climate target for 2040 is to be proposed by the Commission at the latest within six months of the first global stocktake carried out under the Paris Agreement, in accordance with Regulation (EU) 2021/1119 of the European Parliament and of the Council ⁽³⁾. The implementation of the target in Directive 2003/87/EC will further determine the expected scarcity of emissions in each sector.

- (6) Emissions from activities listed in Annex I to Directive 2003/87/EC, namely from industrial processes or from the combustion of non-sustainable fuels, should be prevented, even if they could be captured and used to produce renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels. These emissions are subject to carbon pricing to incentivise abating the emissions from non-sustainable fuels in the first place. Therefore, where such emissions are not taken into account upstream through an effective carbon pricing, those emissions must be accounted for and should not be considered as being avoided.
- (7) Renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels can be produced in various processes, which may yield a mixture of different types of fuels. The methodology to assess the greenhouse gas emissions savings should therefore be able to derive the actual emission savings from those processes, including processes that yield both renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels.
- (8) To determine the greenhouse gas emissions intensity of renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels it is necessary to calculate the share of the energy content of such fuels in the output of a process. For this purpose, the fraction of each type of fuel should be determined by dividing the relevant energy input for the type of fuel in question by the total relevant energy inputs into the process. In case of the production of renewable liquid and gaseous transport fuels of non-biological origin, it is necessary to determine whether the relevant electricity input should be considered as fully renewable. The relevant electricity input should be counted as fully renewable if the provisions under Article 27(3) fifth and sixth subparagraph of Directive (EU) 2018/2001 are fulfilled. Otherwise, the average share of electricity from renewable sources in the country of production, as measured two years before the year in question, should be used to determine the share of renewable energy. In case of the production of recycled carbon fuels, only liquid or solid waste streams of non-renewable origin which are not suitable for material recovery in accordance with Article 4 of Directive 2008/98/EC of the European Parliament and of the Council ⁽⁴⁾ and waste processing gas and exhaust gas of non-renewable origin which are produced as an unavoidable and unintentional consequence of the production process in industrial installations can be considered as relevant energy input for the production of recycled carbon fuels.
- (9) The fossil fuel comparator for renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels should be set at 94 gCO₂eq/MJ in line with the value set out for biofuels and bioliquids in Directive (EU) 2018/2001.
- (10) The main objective of promoting recycled carbon fuels is to reduce greenhouse gas emissions by improving the efficiency of use of eligible feedstock compared to present uses. Given that feedstock that can be used to produce recycled carbon fuels may already have been in use to produce energy, it is appropriate to take the greenhouse gas emissions resulting from the diversion of the use of those rigid inputs from its current use into account when calculating greenhouse gas emissions. The same should apply for rigid inputs obtained from incorporated processes and used to produce renewable liquid and gaseous transport fuels of non-biological origin.
- (11) If the electricity used to produce renewable liquid and gaseous transport fuels of non-biological origin is taken from the electricity grid and is not considered as fully renewable, the average carbon intensity of electricity consumed in the Member State where the fuel is produced should be applied, given that that best describes the greenhouse gas intensity of the whole process. Alternatively, electricity taken from the electricity grid that is used in the production process of renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels that does

⁽³⁾ Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 401/2009 and (EU) 2018/1999 (OJ L 243, 9.7.2021, p. 1).

⁽⁴⁾ Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (OJ L 312, 22.11.2008, p. 3).

not qualify as fully renewable according to Article 27(3) of Directive (EU) 2018/2001, could be attributed greenhouse gas emissions values depending on the number of full load hours the installation producing renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels is operating. If the electricity used to produce renewable liquid and gaseous transport fuels of non-biological origin is considered fully renewable according to the rules set out in Article 27 of Directive (EU) 2018/2001, a carbon intensity of zero should be applied to this electricity supply,

HAS ADOPTED THIS REGULATION:

Article 1

This Regulation establishes a minimum threshold for greenhouse gas emissions savings of recycled carbon fuels and specifies the methodology to calculate the greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels.

Article 2

The greenhouse gas emissions savings from the use of recycled carbon fuels shall be at least 70 %.

Article 3

The greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels shall be determined in accordance with the methodology set out in the Annex.

Article 4

This Regulation shall enter into force on the twentieth day following that of its publication in the *Official Journal of the European Union*.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Brussels, 10 February 2023.

For the Commission
The President
Ursula VON DER LEYEN

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ANNEX

Methodology for determining greenhouse gas emissions savings from renewable liquid and gaseous transport fuels of non-biological origin and from recycled carbon fuels

A. METHODOLOGY

1. Greenhouse gas emissions from the production and use of renewable liquid and gaseous transport fuels of non-biological origin or recycled carbon fuels shall be calculated as follows:

$$E = e_i + e_p + e_{td} + e_u - e_{ccs}$$

where:

E =	total emissions from the use of the fuel (gCO ₂ eq/MJ fuel)
e _i =	e _i elastic + e _i rigid – e _{ex-use} : emissions from supply of inputs (gCO ₂ eq/MJ fuel)
e _i elastic =	emissions from elastic inputs (gCO ₂ eq/MJ fuel)
e _i rigid =	emissions from rigid inputs (gCO ₂ eq/MJ fuel)
e _{ex-use} =	emissions from inputs' existing use or fate (gCO ₂ eq/MJ fuel)
e _p =	emissions from processing (gCO ₂ eq/MJ fuel)
e _{td} =	emissions from transport and distribution (gCO ₂ eq/MJ fuel)
e _u =	emissions from combusting the fuel in its end-use (gCO ₂ eq/MJ fuel)
e _{ccs} =	emission savings from carbon capture and geological storage (gCO ₂ eq/MJ fu)

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

The greenhouse gas emissions intensity of renewable liquid and gaseous transport fuels of non-biological origin or recycled carbon fuels shall be determined by dividing the total emissions of the process covering each element of the formula by the total amount of fuel stemming from the process and shall be expressed in terms of grams of CO₂ equivalent per MJ of fuel (gCO₂eq/MJ fuel). If a fuel is a mix of renewable liquid and gaseous transport fuels of non-biological origin, recycled carbon fuels and other fuels, all (fuel) types shall be considered to have the same emission intensity.

The exception to this rule is the case of co-processing where renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels are only partially replacing a conventional input in a process.

In such a situation it shall be distinguished in the calculation of the greenhouse gas emissions intensity on a proportional basis of the energetic value of inputs between:

- the part of the process that is based on the conventional input, and
- the part of the process that is based on renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels assuming that the process parts are otherwise identical.

An analogous distinction between processes shall be applied where renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels are processed together with biomass.

The greenhouse gas emissions intensity may be calculated as an average for the entire production of fuels occurring during a period of at most one calendar month but may also be calculated for shorter time intervals. Where electricity qualifying as fully renewable according to the methodology set out in Directive (EU) 2018/2001 is used as input that enhances the heating value of the fuel or intermediate products, the time interval shall be in line with the requirements applying for temporal correlation. Where relevant, greenhouse gas emissions intensity values calculated for individual time intervals may then be used to calculate an average greenhouse gas emissions intensity for a period of up to one month, provided that the individual values calculated for each time period meet the minimum savings threshold of 70 %.

2. Greenhouse gas emission savings from renewable liquid and gaseous transport fuels of non-biological origin or from recycled carbon fuels shall be calculated as follows:

$$\text{Savings} = (E_F - E)/E_F$$

where:

E = total emissions from the use of renewable liquid and gaseous transport fuel of non-biological origin or recycled carbon fuel.

E_F = total emissions from the fossil fuel comparator.

For all renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels, the total emissions from the fossil fuel comparator shall be 94 gCO₂eq/MJ.

3. If the output of a process does not fully qualify as renewable liquid and gaseous transport fuels of non-biological origin or recycled carbon fuel, their respective shares in the total output shall be determined as follows:

(a) the fraction of renewable liquid and gaseous transport fuels of non-biological origin shall be determined by dividing the relevant renewable energy input into the process by the total relevant energy inputs into the process;

(b) the fraction of recycled carbon fuel shall be determined by dividing the relevant energy input qualifying as a source for the production of recycled carbon fuels into the process by the total relevant energy inputs into the process.

The relevant energy for material inputs is the lower heating value of the material input that enters into the molecular structure of the fuel ⁽¹⁾.

For electricity inputs that are used to enhance the heating value of the fuel or intermediate products the relevant energy is the energy of the electricity.

For industrial off-gases, it is the energy in the off-gas based on their lower heating value. In case of heat that is used to enhance the heating value of the fuel or intermediate product, the relevant energy is the useful energy in the heat that is used to synthesise the fuel. Useful heat is the total heat energy multiplied by the Carnot efficiency, as defined in Annex V, part C, point (1)(b) of Directive (EU) 2018/2001. Other inputs are only taken into account when determining the emission intensity of the fuel.

4. When determining emissions from supply of inputs, it shall be distinguished between elastic inputs and rigid inputs. Rigid inputs are those whose supply cannot be expanded to meet extra demand. Thus, all inputs qualifying as a carbon source for the production of recycled carbon fuels are rigid, as well as outputs produced in fixed ratio by an incorporated process ⁽²⁾ and which represent less than 10 % of the economic value of the output. If it represents 10 % or more of the economic value, it shall be treated as elastic. In principle, elastic inputs are those whose supply can be increased to meet extra demand. Petroleum products from refineries fall into this category because refineries can change the ratio of their products.
5. Electricity qualifying as fully renewable according to Article 27(3) of Directive (EU) 2018/2001, shall be attributed zero greenhouse gas emissions.
6. One of the three following alternative methods shall be applied during each calendar year to attribute greenhouse gas emissions values to the electricity taken from the grid that does not qualify as fully renewable according to Article 27(3) of Directive (EU) 2018/2001 and is used to produce renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels:
- (a) greenhouse gas emissions values shall be attributed according to part C of this Annex. This is without prejudice to the assessment under State aid rules;

⁽¹⁾ For material inputs containing water, the lower heating value is taken to be the lower heating value of the dry part of the material input (i.e. not taking into account the energy needed to evaporate the water). Renewable liquid and gaseous transport fuels of non-biological origin used as intermediate products for the production of conventional fuels are not considered.

⁽²⁾ Incorporated processes include processes that take place in the same industrial complex, or that supply the input via a dedicated supply infrastructure, or that supply more than half of the energy of all inputs to the production of the renewable liquid and gaseous transport fuel of non-biological origin or recycled carbon fuel.

- (b) greenhouse gas emissions values shall be attributed depending on the number of full load hours the installation producing renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels is operating. Where the number of full load hours is equal or lower than the number of hours in which the marginal price of electricity was set by installations producing renewable electricity or nuclear power plants in the preceding calendar year for which reliable data are available, grid electricity used in the production process of renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels shall be attributed a greenhouse gas emissions value of zero gCO₂eq/MJ. Where this number of full load hours is exceeded, grid electricity used in the production process of renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels shall be attributed a greenhouse gas emissions value of 183 gCO₂eq/MJ; or
- (c) the greenhouse gas emissions value of the marginal unit generating electricity at the time of the production of the renewable liquid and gaseous transport fuels of non-biological origin in the bidding zone may be used if this information is publicly available from the national transmission system operator.

If the method set in point (b) is used, it shall also be applied to electricity that is used to produce renewable liquid and gaseous transport fuels of non-biological origin and recycled carbon fuels and qualifies as fully renewable according to Article 27(3) of Directive (EU) 2018/2001.

7. GHG emissions of elastic inputs that are obtained from an incorporated process shall be determined based on data from their actual production process. This shall include all emissions arising due to their production over the whole supply chain (including emissions arising from the extraction of the primary energy required to make the input, processing of the input and transportation of the input). Combustion emissions related to the carbon content of fuel inputs shall not be included ⁽³⁾.

However, GHG emissions from the elastic inputs that are not obtained from an incorporated process shall be determined based on the values included in Part B of this Annex. If the input is not included in the list, information of the emission intensity may be drawn from the latest version of the JEC-WTW report, the ECOINVENT database, official sources such as the IPCC, IEA or government, other reviewed sources such as the E3 and GEMIS database and peer reviewed publications.

8. The supplier of each input, excluding those where the values are taken from part B of this Annex, shall calculate the emissions intensity ⁽⁴⁾ of the input following the procedures in this document, and report the value to the next production step or final fuel producer. The same rule applies to the suppliers of inputs further back in the supply chain.
9. Emissions from rigid inputs shall include the emissions resulting from the diversion of those inputs from a previous or alternative use. These emissions shall take into account the loss of production of electricity, heat or products that were previously generated using the input as well as any emissions due to additional treatment of the input and transport. The following rules shall apply:
- (a) Emissions attributed to the supply of rigid inputs shall be determined by multiplying the lost production of electricity, heat or other products with the relevant emission factor. In case of lost electricity production, the emission factors to consider are for grid electricity generation in the country where the displacement occurred determined according to the appropriate methodology set out under points 5 or 6. In case of diverted material, the emissions to be attributed to the replacement material are calculated as for material inputs in this methodology. For the first 20 years after the start of production of renewable liquid and gaseous transport fuels of non-biological origin or recycled carbon fuels, the loss of production of electricity, heat and material shall be determined based on the average amount of electricity and heat that was produced from the rigid input over the last three years before the start of production of renewable liquid and gaseous transport fuels of non-biological origin or recycled carbon fuels. After 20 years of production, the loss of production of electricity, heat or other products shall be determined based on the minimum energy performance standards assumed in pertinent best available technology (BAT) conclusions. Where the process is not covered by a BAT, the estimation of lost production shall be based on a comparable process applying state of the art technology.

⁽³⁾ If carbon intensities are taken from the table in part B, combustion emissions shall not be considered. This is because combustion emissions are counted in processing or in the combustion emissions of the final fuel.

⁽⁴⁾ Consistent with section 6 the emissions intensity shall not include the emissions embedded in the carbon content of the supplied input.

- (b) In case of rigid inputs that are intermediate streams in industrial processes, such as coke oven gas, blast furnace gas in a steelworks, or refinery gas in an oil refinery, if the effect of diverting it for fuel production cannot be measured directly, the emissions due to the diversion of inputs shall be determined based on simulations of the plant operation before and after it is modified to produce recycled carbon fuels. If the modification of the plant caused a reduction of output of some products, the emissions attributed to the rigid input shall include the emissions associated with replacing the lost products.
- (c) Where the process makes use of rigid inputs from new installations such as a new steelworks that uses its blast furnace gas for making recycled carbon fuels, the impact of diverting the input from the most economic alternative use shall be taken into account. Then the emission implications are calculated according to the minimum energy performance standards assumed in the pertinent BAT conclusions. For industrial processes which are not covered by a BAT, the saved emissions shall be calculated on the basis of the comparable process applying state of the art technology.
10. Emissions from existing use or fate include all emissions in the existing use or fate of the input that are avoided when the input is used for fuel production. These emissions shall include the CO₂ equivalent of the carbon incorporated in the chemical composition of the fuel that would have otherwise been emitted as CO₂ into the atmosphere. This includes CO₂ that was captured and incorporated into the fuel provided that at least one of the following conditions is fulfilled:
- (a) the CO₂ has been captured from an activity listed under Annex I of Directive 2003/87/EC and has been taken into account upstream in an effective carbon pricing system and is incorporated in the chemical composition of the fuel before 2036. This date shall be extended to 2041 in other cases than CO₂ stemming from the combustion of fuels for electricity generation; or
- (b) the CO₂ has been captured from the air; or
- (c) the captured CO₂ stems from the production or the combustion of biofuels, bioliquids or biomass fuels complying with the sustainability and greenhouse gas saving criteria and the CO₂ capture did not receive credits for emission savings from CO₂ capture and replacement, set out in Annex V and VI of Directive (EU) 2018/2001; or
- (d) the captured CO₂ stems from the combustion of renewable liquid and gaseous transport fuels of non-biological origin or recycled carbon fuels complying with the greenhouse gas saving criteria, set out in Article 25(2) and Article 28(5) of Directive (EU) 2018/2001 and this Regulation; or
- (e) the captured CO₂ stems from a geological source of CO₂ and the CO₂ was previously released naturally.
- Captured CO₂ stemming from a fuel that is deliberately combusted for the specific purpose of producing the CO₂ and CO₂, the capture of which has received an emissions credit under other provisions of the law shall not be included.
- Emissions associated with the inputs like electricity and heat and consumable materials used in the capture process of CO₂ shall be included in the calculation of emissions attributed to inputs.
11. The dates established in point 10(a) will be subject to review considering the implementation in the sectors covered by Directive 2003/87/EC of the Union-wide climate target for 2040 established in accordance with Article 4(3) of Regulation (EU) 2021/1119.
12. Emissions from processing shall include direct atmospheric emissions from the processing itself, from waste treatment and from leakages.
13. Emissions from combustion of the fuel refer to the total combustion emissions of the fuel in use.
14. The greenhouse gases taken into account in emissions calculations, and their carbon dioxide equivalents, shall be the same as specified in Annex V, part C, point 4 of Directive (EU) 2018/2001.

15. Where a process yields multiple co-products such as fuels or chemicals, as well as energy co-products such as heat, electricity or mechanical energy exported from the plant, greenhouse gas emissions shall be allocated to these co-products applying the following approaches in the following manner:
- The allocation shall be conducted at the end of the process that produces the co-products. The emissions allocated shall include the emissions from the process itself, as well as the emissions attributed to inputs to the process.
 - The emissions to be allocated shall be e_i plus any fractions of e_p , e_{td} and e_{ccs} that take place up to and including the process step at which the co-products are produced. If an input into the process is itself a co-product of another process, the allocation at the other process shall be done first to establish the emissions to be attributed to the input.
 - If any installation inside the project boundary treats only one of the project's co-products, then the emissions from that installation shall be ascribed entirely to that co-product.
 - Where the process allows to change the ratio of the co-products produced, the allocation shall be done based on physical causality by determining the effect on the process' emissions of incrementing the output of just one co-product whilst keeping the other outputs constant.
 - Where the ratio of the products is fixed and the co-products are all fuels, electricity or heat, the allocation shall be done by energy content. If allocation concerns exported heat on the basis of the energy content, only the useful part of the heat may be considered, as defined in Annex V, part C, point 16 of Directive (EU) 2018/2001.
 - Where the ratio of the products is fixed and some co-products are materials with no energy content, the allocation shall be done by the economic value of the co-products. The economic value considered shall be the average factory-gate value of the products over the last three years. If such data is not available, the value shall be estimated from commodity prices minus the cost of transport and storage ^(?).
16. Emissions from transport and distribution shall include emissions from the storage and distribution of the finished fuels. Emissions attributed to inputs e_i shall include emissions from their associated transport and storage.
17. Where a process for making renewable liquid and gaseous transport fuels of non-biological origin or recycled carbon fuels produces carbon emissions that are permanently stored in accordance with Directive 2009/31/EC on the geological storage of carbon dioxide, this may be credited to the products of the process as a reduction in emissions under e_{ccs} . Emissions arising due to the storage operation (including transport of the carbon dioxide) will also need to be taken into account under e_p .

B. 'STANDARD VALUES' FOR GREENHOUSE GAS EMISSION INTENSITIES OF ELASTIC INPUTS

The GHG intensities of inputs other than electricity are shown in the table below:

	Total emissions gCO ₂ eq/MJ	Upstream emissions gCO ₂ eq/MJ	Combustion emissions gCO ₂ eq/MJ
Natural gas	66,0	9,7	56,2
Diesel	95,1	21,9	73,2
Gasoline	93,3	19,9	73,4
Heavy fuel oil	94,2	13,6	80,6
Methanol	97,1	28,2	68,9
Hard coal	112,3	16,2	96,1
Lignite	116,7	1,7	115,0

^(?) Note that it is the relative values of the co-products that matters, so general inflation is not an issue.

	gCO ₂ eq/kg
Ammonia	2 351,3
Calcium chloride (CaCl ₂)	38,8
Cyclohexane	723,0
Hydrochloric acid (HCl)	1 061,1
Lubricants	947,0
Magnesium sulphate (MgSO ₄)	191,8
Nitrogen	56,4
Phosphoric acid (H ₃ PO ₄)	3 124,7
Potassium hydroxide (KOH)	419,1
Pure CaO for processes	1 193,2
Sodium carbonate (Na ₂ CO ₃)	1 245,1
Sodium chloride (NaCl)	13,3
Sodium hydroxide (NaOH)	529,7
Sodium methoxide (Na(CH ₃ O))	2 425,5
SO ₂	53,3
Sulphuric acid (H ₂ SO ₄)	217,5
Urea	1 846,6

C. GHG EMISSION INTENSITY OF ELECTRICITY

The greenhouse gas emission intensity of electricity shall be determined at the level of countries or at the level of bidding zones. The greenhouse gas emission intensity of electricity may be determined at the level of bidding zones only, if the required data are publicly available. The calculation the carbon intensity of electricity, expressed as gCO₂eq/kWh electricity, shall consider all potential primary energy sources for electricity generation, type of plant, conversion efficiencies and own electricity consumption in the power plant.

The calculation shall consider all carbon equivalent emissions, associated with the combustion and supply of the fuels used for electricity production. This relies on the amount of different fuels used in the electricity production facilities and the emission factors from fuel combustion and the upstream fuel emission factors.

Greenhouse Gases other than CO₂ shall be converted to CO₂eq by multiplying their Global Warming Potential (GWP) relative to CO₂ over the 100-year time horizon as set out in Annex V, part C, point 4 to Directive (EU) 2018/2001. Because of their biogenic origin, CO₂ emissions from the combustion of biomass fuels are not accounted for, but emissions of CH₄ and N₂O shall be accounted for.

For the calculation of the GHG emissions from fuels combustion, the IPCC default emission factors for stationary combustion in the energy industries shall be used (IPCC 2006). The upstream emissions shall include emissions from all the processes and phases required to make the fuel ready to supply the power production; they result from the extraction, refining and transport of the fuel used for electricity production.

In addition, all the upstream emissions from the cultivation, harvesting, collection, processing and transport of biomass shall be considered. Peat and the components of waste materials that are from fossil origins shall be treated as a fossil fuel.

The fuels used for gross electricity production in electricity only plants are determined based on the electricity production and the efficiency of conversion to electricity. In the case of Combined Heat and Power (CHP), the fuels used for heat produced in CHP shall be counted by considering alternative heat production with average overall efficiencies of 85 %, while the rest shall be attributed to electricity generation.

For nuclear power plants, the conversion efficiency from nuclear heat shall be assumed to be 33 % or data provided by Eurostat or a similar, accredited source.

No fuels are associated with electricity production from renewables that include hydro, solar, wind and geothermal. The emissions from the construction and decommissioning and waste management of electricity producing facilities are not considered. Thus, the carbon equivalent emissions associated with the renewable electricity (wind, solar, hydro and geothermal) production are considered to be equal to zero.

The CO₂ equivalent emissions from gross electricity production shall include upstream emissions from JEC WTW v5 (Prussi et al, 2020) listed in Table 3 and the default emission factors for stationary combustion from IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 2006) listed in Tables 1 and 2. The upstream emissions for supplying the fuel used shall be calculated applying the JEC WTW v5 upstream emission factors (Prussi et al, 2020).

The calculation of the carbon intensity of electricity shall be done following the formula:

$$e_{\text{gross.prod}} = \sum_{i=1}^k (c_{i-\text{ups}} + c_{i-\text{comb}}) \times B_i$$

where:

$e_{\text{gross.prod}}$ = CO₂ equivalent emissions [gCO_{2eq}]

$c_{i-\text{ups}}$ = upstream CO₂ equivalent emission factors $\left[\frac{\text{gCO}_{2\text{eq}}}{\text{MJ}} \right]$

$c_{i-\text{comb}}$ = CO₂ equivalent emission factors from fuels combustion $\left[\frac{\text{gCO}_{2\text{eq}}}{\text{MJ}} \right]$

B_i = fuel consumption for electricity generation [MJ]

$i = 1 \dots k$ = fuels used for electricity production

The amount of net electricity production is determined by the gross electricity production, own electricity consumption in the power plant and the electricity losses in pump storage.

$$E_{\text{net}} = E_{\text{gross}} - E_{\text{own}} - E_{\text{pump}}$$

where: net electricity production [MJ]

E_{net} =

E_{gross} = gross electricity production [MJ]

E_{own} = own internal electricity consumption in power plant [MJ]

E_{pump} = electricity for pumping [MJ]

The carbon intensity of net produced electricity shall be the total gross GHG emissions for producing or using the net electricity:

$$CI = \frac{e_{\text{gross.prod}}}{E_{\text{net}}}$$

where: CI = CO₂ equivalent emissions from electricity production $\left[\frac{\text{gCO}_{2\text{eq}}}{\text{MJ}} \right]$

Electricity production and fuel consumption data

Data on electricity production and fuel consumption shall be sourced from IEA Data and statistics that provides data on energy balances and electricity produced using various fuels, e.g. from IEA website, Data and Statistic section ('Energy Statistics Data Browser')⁽⁶⁾.

⁽⁶⁾ Example: <https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser?country=GERMANY&energy=Coal&year=202>.

For EU Member States, Eurostat data are more detailed and can be used instead. Where the greenhouse gas emission intensity is established at the level of bidding zones, data from official national statistics of the same level of detail as the IEA data shall be used. Fuel consumption data shall include available data at the highest level of detail available from national statistics: solid fossil fuels, manufactured gases, peat and peat products, oil shale and oil sands, oil and petroleum products, natural gas, renewables and biofuels, non-renewable waste and nuclear. Renewables and biofuels include biofuels, renewable municipal waste, hydro, ocean, geothermal, wind, solar and heat pumps.

Input data from literature sources

Table 1

Default emissions factors for stationary combustion [g/MJ fuel on a net calorific value]

Fuel	CO ₂	CH ₄	N ₂ O
Solid fossil fuels			
Anthracite	98,3	0,001	0,0015
Coking coal	94,6	0,001	0,0015
Other bituminous coal	94,6	0,001	0,0015
Sub-bituminous coal	96,1	0,001	0,0015
Lignite	101	0,001	0,0015
Patent fuel	97,5	0,001	0,0015
Coke oven coke	107	0,001	0,0015
Gas coke	107	0,001	0,0001
Coal tar	80,7	0,001	0,0015
Brown coal briquettes	97,5	0,001	0,0015
Manufactured gases			
Gas works gas	44,4	0,001	0,0001
Coke oven gas	44,4	0,001	0,0001
Blast furnace gas	260	0,001	0,0001
Other recovered gases	182	0,001	0,0001
Peat and peat products	106	0,001	0,0015
Oil shale and oil sands	73,3	0,003	0,0006
Oil and petroleum products			
Crude oil	73,3	0,003	0,0006
Natural gas liquids	64,2	0,003	0,0006
Refinery feedstocks	73,3	0,003	0,0006
Additives and oxygenates	73,3	0,003	0,0006
Other hydrocarbons	73,3	0,003	0,0006
Refinery gas	57,6	0,001	0,0001
Ethane	61,6	0,001	0,0001
Liquefied petroleum gases	63,1	0,001	0,0001
Motor gasoline	69,3	0,003	0,0006

Aviation gasoline	70	0,003	0,0006
Gasoline-type jet fuel	70	0,003	0,0006
Kerosene-type jet fuel	71,5	0,003	0,0006
Other kerosene	71,5	0,003	0,0006
Naphtha	73,3	0,003	0,0006
Gas oil and diesel oil	74,1	0,003	0,0006
Fuel oil	77,4	0,003	0,0006
White spirit and SBP	73,3	0,003	0,0006
Lubricants	73,3	0,003	0,0006
Bitumen	80,7	0,003	0,0006
Petroleum coke	97,5	0,003	0,0006
Paraffin waxes	73,3	0,003	0,0006
Other oil products	73,3	0,003	0,0006
Natural gas	56,1	0,001	0,0001
Waste			
Industrial waste (non-renewable)	143	0,03	0,004
Non-renewable municipal waste	91,7	0,03	0,004

Note: values have to be multiplied with GWP factors set out in Annex V, part C, point 4 to Directive (EU) 2018/2001.
Source: IPCC, 2006.

Table 2

Default emissions factors for stationary combustion of fuels of biomass origin [g/M] fuel on a net calorific value]

Fuel	CO ₂	CH ₄	N ₂ O
Primary solid biofuels	0	0,03	0,004
Charcoal	0	0,2	0,004
Biogases	0	0,001	0,0001
Renewable municipal waste	0	0,03	0,004
Pure biogasoline	0	0,003	0,0006
Blended biogasoline	0	0,003	0,0006
Pure biodiesels	0	0,003	0,0006
Blended biodiesels	0	0,003	0,0006
Pure bio jet kerosene	0	0,003	0,0006
Blended bio jet kerosene	0	0,003	0,0006
Other liquid biofuels	0	0,003	0,0006

Source: IPCC, 2006.

Table 3

Fuel upstream emission factors [gCO₂eq/M] fuel on a net calorific value]

Fuel	Emission factor
Hard coal	15,9
Brown coal	1,7
Peat	0
Coal gases	0
Petroleum Products	11,6
Natural gas	12,7
Solid biofuels	0,7
Liquid biofuels	46,8
Industrial Waste	0
Municipal waste	0
Biogases	13,7
Nuclear	1,2

Source: JEC WTW v5.

Table A includes the values for the GHG emission intensity of electricity at country level in the European Union. If the greenhouse gas emission intensity of electricity is determined at country level, these values shall be used for electricity sourced in the European Union until more recent data becomes available to determine the emission intensity of electricity (?).

Table A

Emission intensity of electricity in the European Union 2020

Country	Emission intensity of generated electricity (gCO ₂ eq/MJ)
Austria	39,7
Belgium	56,7
Bulgaria	119,2
Cyprus	206,6
Czechia	132,5
Germany	99,3
Denmark	27,1
Estonia	139,8
Greece	125,2
Spain	54,1
Finland	22,9
France	19,6
Croatia	55,4

(?) Updated data will be made available by the European Commission on a regular basis.

Hungary	72,9
Ireland	89,4
Italy	92,3
Latvia	39,4
Lithuania	57,7
Luxembourg	52,0
Malta	133,9
Netherlands	99,9
Poland	196,5
Portugal	61,6
Romania	86,1
Slovakia	45,6
Slovenia	70,1
Sweden	4,1

Source: JRC, 2022.