POET

900 7th St. NW, Suite 820
Washington, D.C. 20001
Ph: (605) 965-2200
poet.com

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Clerk of the Board
California Air Resources Board
P.O. Box 2815
Sacramento, CA 95812

Submitted electronically via: https://ww2.arb.ca.gov/applications/public-comments

RE: POET COMMENTS ON OCTOBER 1, 2024 PROPOSED LOW CARBON FUEL STANDARD AMENDMENTS

Dear CARB Members:

POET appreciates the opportunity to provide comments on the California Air Resources Board's ("CARB") October 1, 2024, Proposed Low Carbon Fuel Standard ("LCFS") Amendments ("Second Revised Proposed Amendments").[1] POET has participated actively in CARB's ongoing rulemaking and submitted detailed comments on its own behalf and as part of a coalition on February 20, 2024, regarding the Amendments initially proposed in December 2023 ("Original Proposed Amendments"). POET also attended the LCFS rulemaking workshop held on April 10, 2024, and submitted written comments regarding the matters discussed and presented during the workshop. More recently, POET submitted comments in response to the Revised Proposed Amendments published on August 12, 2024, and on October 1, 2024, commented on CARB's Draft Environmental Impact Analysis. Given POET's extensive participation in this rulemaking process and the limited changes embodied in the Second Revised Proposed Amendments, we focus our comments here on the larger implications of CARB's proposed rulemaking on the supply of low carbon liquid transportation fuel to California and emphasize policy alternatives that would better meet LCFS program goals.

For the reasons articulated in our prior written comments, POET remains opposed to the sustainability certification system CARB has proposed for corn ethanol, which is duplicative of existing U.S. state and federal environmental safeguards and undermines LCFS program goals by closing off practical decarbonization pathways for biofuels. POET also remains opposed to many of the implementation features of the proposed sustainability requirements, which impose commercial costs and regulatory penalties that will *almost certainly raise both the carbon intensity*

[1] *See* CARB, *Attachment A-1, Proposed 15-Day Changes and 45-Day Changes Compared to the Current Regulation, Proposed Amendments to the Low Carbon Fuel Standard Regulation*, (Oct. 1, 2024).

and price of ethanol in California. Although we appreciate CARB's revised proposed treatment of corn stover as a "Specified Source Feedstock,"[2] the proposed rule continues to impose unnecessary and costly sustainability requirements on biomass waste feedstocks like corn kernel fiber, which do not threaten any of the alleged environmental impacts that underlie CARB's rulemaking. Here as elsewhere in the proposed rule, requiring certifications and audits around the harvesting of otherwise unused agricultural wastes simply makes it more expensive for POET and other biofuels producers to supply California with low carbon liquid fuel, and serves no discernible public purpose.

POET believes that CARB should abandon the expensive, redundant, and unfounded sustainability requirements it has proposed for corn ethanol. In the alternative, we continue to urge CARB to leverage its proposed sustainability program to encourage the production of low carbon liquid fuel rather than penalize it.

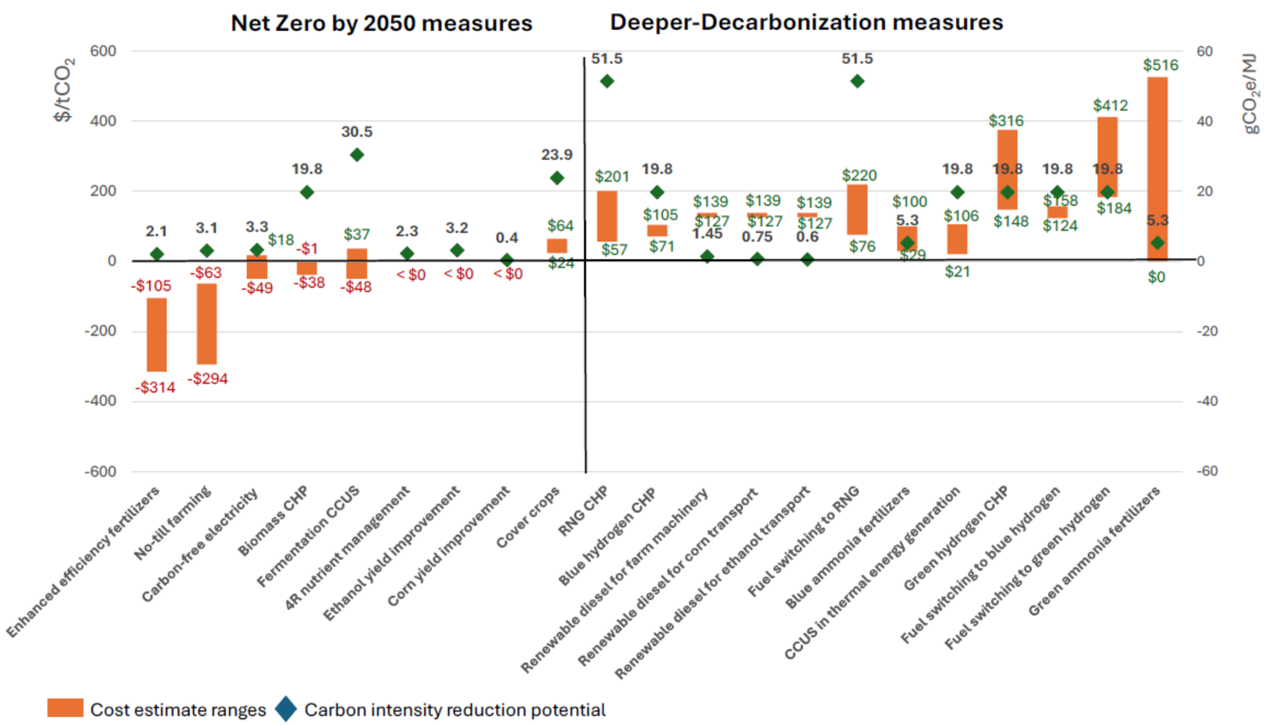
I. CARB's Rulemaking Should Align with Leading-Edge Federal Policymaking on The Regulation of Biofuels

CARB's proposed sustainability requirements come at a time when the Biden Administration has advanced federal climate change policies that are unprecedented in scope and reflect a genuinely technology neutral approach to decarbonizing the economy. Under the Inflation Reduction Act ("IRA"), biofuels, including ethanol, are subject to incentives[3] that are driving investments in new technologies, like carbon capture and sequestration ("CCS"), thermal batteries that can store excess capacity from renewable energy sources, and innovative on-farm practices to lower the carbon intensity of feedstocks. The IRA reflects the understanding that low carbon liquid fuel will continue to play an important role in hard-to-decarbonize sectors such as aviation,[4] and in on-road transportation — even as EVs and other alternative fuel technologies emerge and gain market share. Federal policymaking in this area is well-supported by the latest transportation fuel modeling at Argonne National Laboratories and by the most current climate policy research, which demonstrates the potential of ethanol as a net-zero carbon liquid fuel.

Research published just last month by former Energy Secretary Ernest Moniz makes clear that there are technologies and feedstock production practices available now that, if properly incentivized, allow for the economically feasible production of deeply decarbonized ethanol.[5] The

[2] *Id.* at § 95488.8(g)(1)(A)5.
[3] *See* Clean Fuel Production Credit, 26 U.S.C. § 45Z (2022); Sustainable Aviation Fuel Credit, 26 U.S.C. § 40B (2022).
[4] Department of the Treasury and IRS, *Sustainable Aviation Fuel Credit; Lifecycle Greenhouse Gas Emissions Reduction Percentage and Certification of Requirements Related to the Clean Air Act; Climate Smart Agriculture; Safe Harbors, Notice 2024-37, at Section 4.01 (Apr. 30, 2024),* https://www.irs.gov/pub/irs-drop/n-24-37.pdf ("Notice 2024-37").
[5] Moniz, Ernest et al., *A Strategic Roadmap for Decarbonizing the U.S. Ethanol Industry - EFI Foundation,* at 36

chart below shows that on-farm practices like no-till farming, the planting of cover crops, and more efficient management of nitrogen fertilizers can be implemented now, and can reduce the carbon intensity of ethanol by over 30gCO2e/MJ.[6] Combined with CCS projects under development, ethanol production could achieve a net zero carbon intensity in the coming decades.



A negative cost means that the new measure costs less than the currently adopted measure because of reduced energy or fertilizer inputs (e.g., no-tillage farming, 4R nitrogen management), a lower cost for securing energy (e.g., PPAs), policy incentives (e.g., fermentation CCUS), or additional electricity production (e.g., biomass CHP). Source: EFI Foundation analysis.

CARB's proposed sustainability requirements and its projection that ethanol crediting will be cut in half by 2035[7] is out of step with leading-edge federal climate policies and ignores the role that ethanol could play in the LCFS as producers like POET adapt to federal incentives.

II. CARB Should Allow Qualified Verification Bodies to Certify Carbon Reductions as Part of Sustainability Audits

As POET has previously commented, CARB's proposed amendments not only fail to incentivize the decarbonization of ethanol but promulgate rules likely to have the opposite effect. CARB's proposed sustainability certification scheme will interpose cost and complexity throughout the biofuel supply chain on a massive scale in a short period of time. Biofuel producers will be required

(Sept. 19, 2024), https://efifoundation.org/foundation-reports/a-strategic-roadmap-for-decarbonizing-ethanol-in-the-united-states/.

[6] *Id.* at 7, Fig. ES 3.

[7] Recirculated Draft Environmental Impact Analysis for the Low Carbon Fuel Standard Regulation (Aug. 16, 2024) at 21.

to pay premiums for qualifying feedstock, with the consequence that ethanol costs will rise for blenders and consumers. Given the costs of compliance, the lack of incentives to decarbonize, and the potential for farmers to refuse participation in CARB's certification scheme, there is a real possibility that *higher carbon* ethanol will ship to California, with lower carbon fuel finding more favorable markets.

CARB can avoid the worst outcomes from its proposed sustainability certification program by adopting simple changes to *recognize carbon reductions* as part of the certification process. As POET and other stakeholders have urged repeatedly, CARB could easily adopt Argonne's well-vetted GREET modeling values for carbon-reducing on-farm practices and could verify those practices through the same third-party certification system CARB's proposed rule envisions. Alternatively, CARB could allow third-party verification providers to use established protocols to provide a more granular CI score for California biofuel pathways. Pathway-specific carbon certifications — which seek to measure, among other things, the actual carbon intensity of biofuel feedstock production instead of assigning a default value for the carbon intensity of agriculture — are the norm under the International Sustainability and Carbon Certification (ISCC) program[8] that CARB has enshrined as a qualifying standard in its proposed rule.[9]

CARB's Second Revised Proposed Amendments, which continue to require on-farm audits in which verification bodies must *ignore* the carbon-reducing effects of the sustainable agricultural production that CARB now mandates, undermine any notion of technology neutrality in the LCFS, and will operate to exclude low-carbon biofuels from California's program.

III. CARB Should Encourage, Not Punish, the Production of Waste-Based Biofuels

POET appreciates CARB's responsiveness to our prior comments regarding the treatment of corn stover under the proposed sustainability certification system. Designating corn stover as a "Specified Source Feedstock" under § 95488.8(g), and exempting stover from the more onerous and unnecessary "Sustainability Requirements" of § 95488.9(g), recognizes that corn stover is a low-risk biomass-based waste generated during harvests and can be removed from the field at scale and repurposed as a low-carbon heat source for biofuel production.

Unfortunately, CARB's Second Revised Proposed Amendments continue to assign unwarranted risks to the sustainability of other biomass-based wastes and agricultural residues. In particular, CARB's proposed rule subjects corn kernel fiber to the "Sustainability Requirements" of § 95488.9 — notwithstanding that fiber has long been recognized as a low-carbon waste feedstock under the LCFS. Nothing in CARB's rulemaking documents supports assigning "sustainability"-related risks to corn kernel fiber, which offers no nutritional value in food supply chains, and

[8] *See* Attachment A, ISCC EU 205 Greenhouse Gas Emissions, Version 4.1 (Jan. 2024).
[9] *Supra* Note 1 at § 95502 (c)(3) E.

supplies the lowest carbon component of corn ethanol produced at dry milling facilities. Indeed, the latest proposed version of the CA-GREET model features a simplified CI calculator that models corn kernel fiber as a waste feedstock with *no upstream feedstock or indirect emissions*.[10] By requiring that the fiber component of corn feedstocks satisfy sustainability requirements, CARB is effectively prohibiting any beneficial use of *wastes* generated by non-conforming grain, which will be grown and sold regardless of the market signals embodied in CARB's regulations. This approach abandons carbon reductions, places a premium on the purchase of biofuel waste feedstocks, and will exacerbate the negative impacts of the proposed sustainability requirements by excluding cheaper lower carbon fuel from the California market.

For these reasons, POET urges CARB to remove corn kernel fiber from the "Sustainability Requirements" of § 95488.9(g) and thereby maintain incentives to produce low carbon liquid fuel from proven low-risk waste feedstocks.

IV. CARB Should Make Clear That Qualifying Feedstocks May Be Intermingled and Mass-Balanced with Nonconforming Feedstocks

CARB's Second Revised Proposed Amendments leave uncertain how biofuel producers must account for the carbon intensity of fuel co-produced from both conforming and non-conforming feedstocks under §§ 95488.9(g)(1)-(3). Proposed § 95488.8(g)(4) provides that "if the biomass does not meet the requirements of section 95488.9(g)(1)-(3), the finished fuel developed from the ineligible biomass must be assigned the CARBOB carbon intensity for ethanol produced using uncertified biomass." But POET expects that biofuel producers that ship to California will procure both LCFS-eligible and ineligible feedstock and may intermingle these feedstocks as part of normal supply chain operations. At minimum, CARB should clarify in its regulations that biofuel producers may conduct mass balancing to ensure that biofuel production commensurate with the volume of LCFS-eligible feedstock used at a facility may be assigned a carbon intensity score that aligns with the CI assigned to approved fuel pathways at that facility. This approach is widely accepted and embodied in Canada's Clean Fuel Regulations and in ISCC certification programs.

As POET has commented previously, CARB should authorize even more flexibility in mass balancing, to include mass balancing of feedstocks across the manufacturing facilities of each producer. This approach, adopted under the ISCC PLUS program, allows for the generation of sustainable feedstock credits in circumstances where the volume of qualifying feedstock at a biofuel facility exceeds fuel production in a mass balancing period. Such an approach incentivizes the procurement and use of sustainable feedstocks in areas where farmers have widely adopted

[10] *See* CARB Proposed Tier 1 Simplified Calculators – Starch and Fiber Ethanol (Oct. 1, 2024) available at https://ww2.arb.ca.gov/resources/documents/lcfs-life-cycle-analysis-public-comment.

certified sustainable practices and avoids the carbon emissions associated with transporting eligible feedstocks to production facilities distant from available sustainable biomass.

V. CARB Should Approve E15.

POET again urges CARB to expedite its approval of E15, which has been thoroughly studied in California for years, and which offers material climate and health benefits relative to E10. As noted in previous comments submitted to CARB and the California Energy Commission, E15 will provide immediate economic relief from historically high gas prices while cutting 1.8 million metric tons of GHG emissions annually, equivalent to removing more than 411,000 internal combustion engine vehicles off the road.

CONCLUSION

POET appreciates the opportunity to participate in this rulemaking and has devoted substantial resources to analyzing and offering feedback to the agency as it considers paradigm shifting changes in the regulation and treatment of biofuels under the LCFS program. We must express our disappointment that CARB has not grappled meaningfully with the likely effects of the proposed sustainability certification requirements on the cost, availability, and carbon intensity of the California ethanol supply. We must also express disappointment that CARB, through this rulemaking, appears unwilling to *recognize* carbon reductions in the ethanol supply chain even as CARB is acting to *mandate* these reductions. As Californians continue to purchase, own and operate millions of vehicles that consume liquid transportation fuel, we look forward to future opportunities to work collaboratively to lower emissions from these vehicles. Unfortunately, the agency's proposed rule, as expressed in the Second Revised Proposed Amendments is not a step forward in that direction.

If you have any questions, please contact me at Josh.Wilson@POET.com or (202) 940-6487.

Sincerely,

Joshua P. Wilson
Senior Regulatory Counsel

ATTACHMENT A

ISCC
International Sustainability & Carbon Certification

ISCC EU 205

GREENHOUSE GAS EMISSIONS

Document Title: ISCC EU 205 Greenhouse Gas Emissions

Version 4.1

Valid from: 01 January 2024

Content

Summary of Changes

The following is a summary of the mainchanges to the previous version of the document (ISCC EU System Document 205 v 4.0). covers relevant adjustments based on the Implementing Regulation (EU) 2022/996 on rules to verify sustainability and greenhouse gas emission saving criteria and low indirect land-use change risk criteria (IR). Minor amendments, e.g. corrections of phrasings and spelling mistakes, are not listed.

Summary of changes made in version 4.1	Chapter
Additions: • "Following the requirements of the recast Renewable Energy Directive (2018/2001/EC), **Article 31(1)-31(3), Annexes V and VI and Implementing Regulation on certification (IR)**, ISCC requires a minimum level of GHG savings for final biofuels, bioliquids and biomass fuels" • "An installation shall be considered to be in operation once the physical production of fuel, heat or cooling, or electricity has started (i.e. once the production of fuels including biofuels, biogas or biofuels, or production of heat, colling or electricity from biomass fuels hast started)." • "Traders with/without storage do not need to calculate GHG emissions. Instead they must provide mode and distance of transportation on the Sustainability Declaration to the next supply chain element." • "For RFNBOs ISCC provides a separate guidance document based on RED II Article 25(2), Article 22 and COM DA referred to in Article 25(2)." • "The following global warming potentials apply: CO_2 =1, CH_4=28, N_2O=265"	2
General: • Update of Figure 2	3, footnotes
Additions: • "The same approach applies for NUTS2 values." • "For transport and distribution it might be acceptable to use disaggregated default values for similar feedstocks if the transported goods can be transported in a similar way and the density is similar."	3.1
Deleted: • "Any updates to the NUTS2 values by Member States which have not been included in the reports published before 2015 (pre-ILUC Directive), or the submission of new "NUTS2 equivalent values" for third countries, requires recognition by the EC." **Addition:** • "…as well as IR Article 20 and Annexes V, VII, IX, Comission Decision 2010/335/EU as of 10 June 2010 (as amended under the RED II). For e_{ec} and e_{sca} specifically Annex V and VII of IR and ISCC's specifications as described in this document apply." • "Only NUTS2 values or values from equivalent regions in third countries that had been subject to an IR can be applied. Furthermore, any values used under REDI are no longer valid due to differences in the GHG emission calculation methodology applied under the REDII methodology." • "They shall be calculated as a sum, taking into account the relative shares of the respective inputs and their emission factors. Therefore, the GHG value must be calculated as a single value for the whole amount of the biogas / biomethane, resulting from the co-digestion"	3.2, footnotes
Deleted: • "Biograce (recognized version)"	

Summary of changes made in version 4.1	Chapter
• "like the "Overview of Standard Calculation Values" table provided by the European Commission or Annex of this document I "List of emission factors and lower heating values (LHVs)""	4.1
Deleted: • "(including the filling station)" **Additions:** • "The emissions of depots and filling stations may be calculated using the data provided by the JRC. The provided values (depot: 0,00084 MJ/MJ fuel, filling station: 0,0034 MJ/MJ fuel) must be multiplied by the appropriate national electricity EF from the Implementing Regulation (EU) 2022/996."	4.2
General: • This summary of changes does not outline the entire new chapter on calculating e_{ec} emissions. Specifications for calculation of e_{ec} were adjusted based on IR Annex VII. • Change from EM_{diesel} to EM_{fuel} • Added specifications for emissions from storage • Amended specifications for $EM_{electricity}$ • Added specifications to calculate emissions from neutralization of fertiliser acidification and soil emissions from liming (aglime) • Added reference to Annex IX of the IR and other sources for emission factors for cultivation • Adjustments to specifications related to calculate crop- and site- specific N_2O emissions based on IR Annex VII. This summary of changes does not outline the entire new chapter on calculating N_2O emissions. • Adjustments of specifications to calculate N input in crop residues **Additions:** • "Amount of aglime in kg aglime ($CaCO_3$)" • "Transportation mode and distance up to the FGP"	4.3.1,
General: • The guidance for calculation and verification of e_{sca} values has been reworked extensively based on the IR Annex V. This summary of changes does not include the full extent of changes to this chapter. **Additions:** • "Regarding penalties relating to farmers operation under a group, ISCC will enforce the penalties and duly inform all other voluntary schemes as well as to publish this information as described in ISCC EU system document 102 "Governance""	4.3.3, footnotes
General: • Section for calculation of transport emissions has been updated to correspond with IR 2022/996. • Clarification of trader responsibilities **Additions:** • "if the empty return ways are attributable to the certified company they must be taken into account. If the return way is not empty and accountable to another company, which can be proven by relevant documentation, return ways can be excluded for transport calculations)" • "The emissions of depots and filling stations may be calculated using the data provided by the JRC . The provided values (depot: 0,00084 MJ/MJ fuel, filling station: 0,0034 MJ/MJ fuel) must be multiplied by the appropriate national electricity EF from the IR 2022/996"	4.3.4

Summary of changes made in version 4.1	Chapter
• “For this purpose a standard factor for grid gas losses of 0.17 g CH4/MJ Natural Gas supplied should be used.”	
General: • EF for grid eletricity must be sourced from the IR on a national level. • Specific requirements for biomass fuels consolidated into 4.3.5.2 **Deleted:** • “If electricity is sourced externally from the grid, the emission factor for electricity from the regional electricity mix shall be used (average emission intensity for a defined region, EFregional electricity mix). In the case of the EU the most logical choice is the whole EU. If electricity from renewable energies is directly consumed (i.e. not connected and supplied from the grid), an adapted EF for the type of renewable electricity may be used (please see chapter 4.3.1.1 for further information).” **Additions:** • “If electricity is consumed from the grid, the EF of the national/country electricity mix (EFelectricity) shall be used. The IR provides country-specific EFs for electricity. “ • “Liquefaction emissions and losses must also be accounted for. If no actual data is available, electricity consumption of 0.06048 MJ (LV) / MJ fuel and LNG losses of 0.13 kJ/MJ fuel shall be considered. The electricity consumption has to be multiplied with the respective national grid mix factor from the IR.”	4.3.5
General: • This summary of changes does not include the full extent of changes made to this chapter **Additions:** • Clarifications of the conditions and audit requirements for the use of CCR and CCS	4.3.6
Deleted: • “Please note that for the calculation of the feedstock factor the LHV per dry ton needs to be applied while for the calculation of the allocation factor LHV values for wet biomass need to be used as this approach was also applied for the calculation of the default values.”	4.3.7
Addition: • Energy producers must apply the respective fossil fuel comparator value for the target market.	4.3.9
General: • Further specifications of verification requirements for both default and actual GHG emission calculations **Additions:** • “If the emissions deviate significantly from typical values (more than 10% deviation), or calculated actual values of emissions savings are abnormally high (more than 30% deviation from default values)” • “Certification bodies must immediately inform the voluntary scheme of such deviations.” • Only values that have been verified and approved by auditors can be passed further in the supply chain. It is not allowed to alter individually	5

Summary of changes made in version 4.1	Chapter
calculated GHG emission values from incoming materials to random numbers for outgoing sustainability documentation. • The System User must clearly communicate all relevant changes and additions made to the CB. • Upon request from the European Commission or responsible national authorities ISCC will provide actual GHG emission calculations to the respective parties. • For CCR and CCS production processes the applied allocation approaches must be clearly documented by the system user and verified by the auditor. •	
General: • Emission factors present in the IR have been removed • Biograce values have been removed as no longer valid • Emission factors from EcoInvent have been updated to newest version	Annex I

1. Introduction

Intention, Applicability. Legal background

The purpose of the document "Greenhouse Gas Emissions" is to explain the options for stating greenhouse gas (GHG) emission values along the supply chain and to provide the methodology, rules and guidelines for calculating and verifying GHG emissions and emission reductions.

The ISCC requirements regarding GHG emissions apply to all relevant supply chain elements from raw material production to the distribution of the final product, including cultivation or extraction, all processing steps, and the transport and distribution of intermediate and final products.

2 Scope and Normative References

GHG emission saving targets

Following the requirements of the recast Renewable Energy Directive (2018/2001/EC) Article 31(1)-31(3), Annexes V and VI and Implementing Regulation on certification (IR[1]), ISCC requires a minimum level of GHG savings for final biofuels, bioliquids and biomass fuels:

- at least 50% for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations in operation on or before 5 October 2015
- at least 60% for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations starting operation from 6 October 2015 until 31 December 2020
- at least 65% for biofuels, biogas consumed in the transport sector, and bioliquids produced in installations starting operation from 1 January 2021
- at least 70% for electricity, heating and cooling production from biomass fuels used in installations starting operation from 1 January 2021 until 31 December 2025, and 80% for installations starting operation from 1 January 2026
- The greenhouse gas emissions savings from the use of renewable liquid and gaseous transport fuels of non-biological origin shall be at least 70%

An installation shall be considered to be in operation once the physical production of biofuels, biogas consumed in the transport sector and bioliquids, and the physical production of heating and cooling and electricity from biomass fuels has started.

Relevant supply chain elements

For the following elements in the supply chain, information on GHG emissions must be provided:

a) Raw material production (extraction or cultivation)

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[1] Specifically the Implementing Regulation on rules to verify sustainability and greenhouse gas emissions saving criteria and low indirect land-use change-risk criteria

b) Processing units (companies that process raw materials/intermediate products and thereby change the physical or chemical properties of the input material)

c) Transport and distribution

The requirements for the calculation of GHG emissions throughout the supply chain and the verification requirements for auditors are explained in this document. The document outlines the use of total and disaggregated default values and how the calculation of actual values is embedded in the ISCC system. Every chapter states the relevant requirements applicable to biofuels, bioliquids and biomass fuels.

Traders with/without storage do not need to calculate GHG emissions. Instead they must provide mode and distance of transportation on the Sustainability Declaration to the next supply chain element.

Types of fuels

Depending on the type of fuel and the market in which it is consumed, different GHG calculation formulas apply:

- *biomass fuels* are gaseous and solid fuels produced from biomass
- *bioliquids* are liquid fuels produced from biomass which are used for purposes other than transport, such as electricity generation and heating and cooling
- *biofuels* are liquid fuels used for transport which are produced from biomass.

For RFNBOs ISCC provides a separate guidance document based on RED Article 25(2), Article 22 and COM DA referred to in Article 25(2).

The following global warming potentials apply: CO_2 =1, CH_4=28, N_2O=265

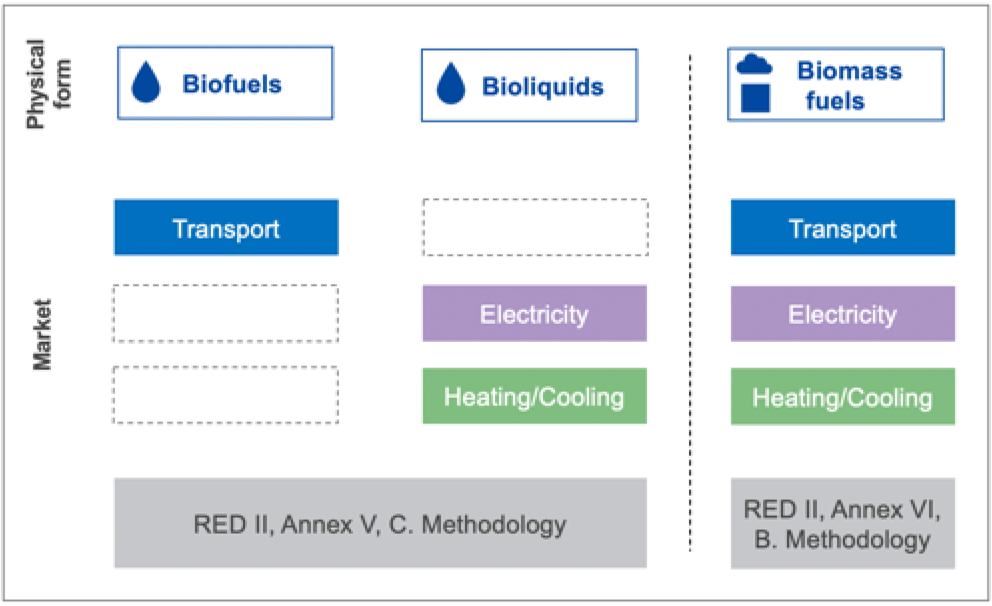

Figure 1: Overview of GHG calculation methodologies for different types of fuels and markets

Definition of feedstock

Figure 1 provides an overview on when which of both GHG calculation methodologies needs to be applied. This depends on the market of the final fuel. Should be supplied in as well as the aggregate condition of the fuel. In the following chapters, "feedstock" is defined as the input material that is processed and hence can either be a raw material or an intermediate product, depending on the scope of the receiving entity.

As a basic principle, all relevant ISCC documents are valid for the scope of the application. The normative references display the documents to which the contents are linked and have to be considered.

3 Options for the provision of GHG information

The RED II[2] allows economic operators to calculate actual GHG emission values, to use total default values or to use a combination of disaggregated default values and calculated actual values.

Within ISCC there are different options for GHG information provision:

3.1. Use of total default values (TDV) OR

Use of disaggregated default values (DDV; which allow a combination of default values and actual values);

3.2. Use of actual values (individually calculated values).

[2] *Annex V and VI of RED II*

GHG calculation formula

Greenhouse gas emissions from the production and use of biofuels, bioliquids and solid biomass fuels shall be calculated as[3] (for gaseous biomass fuels see section 3.2):

$E = e_{ec} + e_{l} + e_{p} + e_{td} + e_{u} – e_{sca} – e_{ccs} – e_{ccr}$

where

E *total emissions from the use of the fuel,*

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 savings from soil carbon accumulation via improved agricultural management,*

e_{ccs} *emission savings from CO_2 capture and geological storage,*

e_{ccr} *emission savings from CO_2 capture and replacement*

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

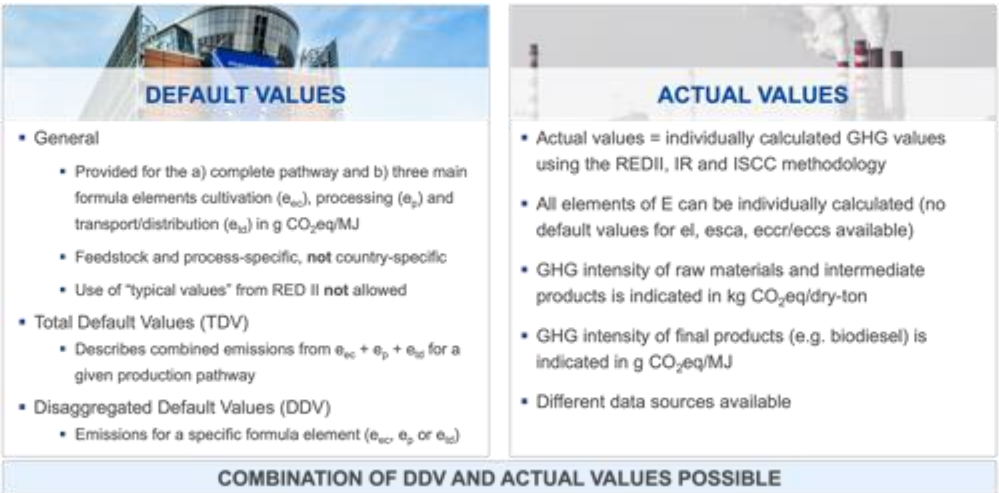

Figure 2: Overview of options to forward GHG values

Figure 2 reflects four options for forwarding GHG information through certified supply chains. The following chapter explains the different approaches in more detail, including practical implications.

[3] *Before conversion of bioliquids and biomass fuels into electricity or for heating/cooling, Annex V, C. Methodology, RED II*

3.1 Use of default values

Source of default values

Total default values (TDV) and disaggregated default values (DDV) are provided by the RED II in Annex V and Annex VI[4].

These default values reflect standardised biofuel, bioliquid and biomass fuel supply chains and processes, and are conservative estimates. Disaggregated default values are available for cultivation (e_{ec}), processing (e_p), and transport and distribution (e_{td}). Default values listed in Annex V and Annex VI can be applied only if the process technology and raw material used for the production of the biofuel match the respective scope of the default value. Certified economic operators can only use (disaggregated) default values if the following criteria are met:

Restrictions for the use of default values

> The TDV for GHG emission savings laid down in part A or B of Annex V and part A of Annex VI of the RED II can only be used if it reflects the production pathway, i.e. the raw material at the beginning of the supply chain and the process of the certified operator and e_l (emissions from land-use change) calculated according to chapter 4.3.2 of this document must equal to or less than zero. It is possible to use a combination of the DDV for cultivation and an individually calculated value for emissions from land-use change (e_l).

Minimum level

> The TDV can only be used if the minimum level of GHG emission savings can be reached (see chapter 2), e.g. the total default value for palm oil biodiesel (with open effluent ponds) cannot be used, as the default GHG emission saving is only 20%.

> The TDV for biodiesel (palm) can be applied for all palm (oil) derivatives as intermediate products.

> Transport of raw material from the farm to the first gathering point (FGP) is included in the DDV element ‘emissions from cultivation’ (e_{ec}). The same approach applies for NUTS2 values.

> Typical values published in the RED II cannot be used for certification.

Forwarding total default values

If the *TDV* is applied, certified economic operators up to the final processing unit do not provide actual numbers for the GHG value but state “Use of total default value” on their Sustainability Declarations. The producer of the biofuel/bioliquid/biomass fuel states the TDV as provided in RED II in g CO_2eq per MJ of biofuel, the GHG emission savings in % and the start date of biofuel operations on the final sustainability declaration (=proof of sustainability “PoS”). The information on GHG emissions can be reported as an aggregate.

[4] The Corrigendum 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 published on 25 September 2020 provides updated default values for some pathways.

During the certification audit, the auditor needs to verify the suitability of the input material and process as well as the correct application of the TDV

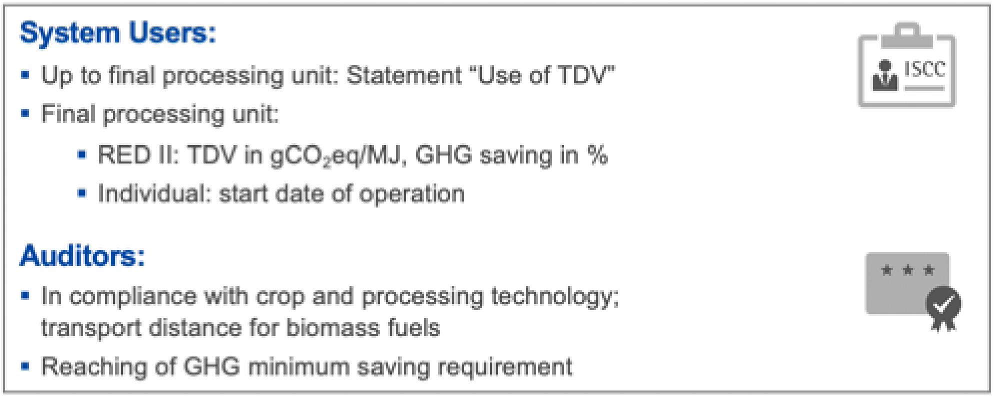

Figure 3: Application of total default values

If an economic operator in the supply chain cannot use the total default value, e.g. because one of the criteria referred to in the above figure 3 is not fulfilled, it may be possible under certain conditions to use individual calculation or disaggregated default values.

Use of disaggregated default values

The *DDVs* are only provided for emissions from cultivation (e_{ec}), processing (e_p) and transport and distribution (e_{td})[5]. Using these values provides the possibility to combine disaggregated default values with actual values from individual GHG calculations. One example would be to use the DDV for the incoming raw material and calculate an individual GHG value for emissions from processing at the operational unit (assuming that the entity is either the first processing unit or an actual GHG value for earlier processing steps has been received). Another option would be to combine an individual calculation for processing but apply the DDV for GHG emissions from transport & distribution. For transport and distribution it might be acceptable to use disaggregated default values for similar feedstocks if the transported goods can be transported in a similar way and the density is similar.

Forwarding disaggregated default values

When using DDVs for one or more elements of the calculation formula, certified economic operators up to the final processing unit have to state "Use of disaggregated default value" on their Sustainability Declarations. Figure 4 below shows key points to take into account when dealing with DDVs.

[5] *In sections D and E of Annex V, as well as Section C of Annex VI of the RED II different disaggregated default values for biofuels, bioliquids and biomass fuels are provided*

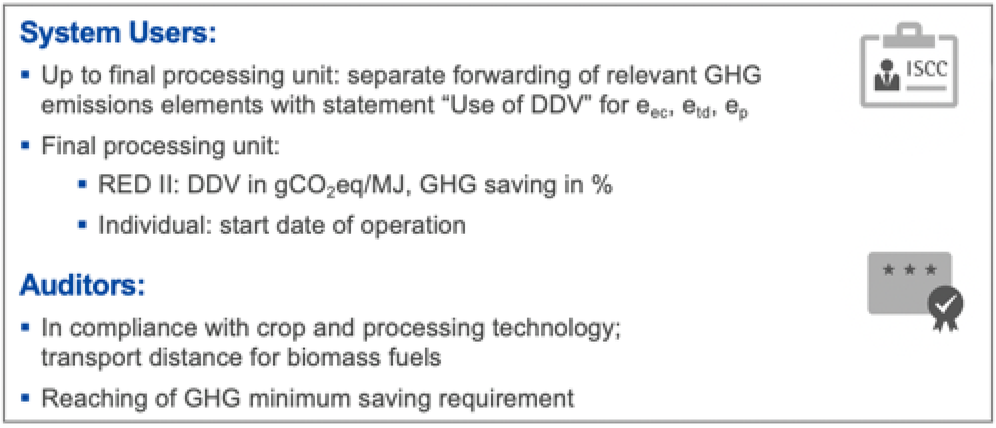

Figure 4: Application of disaggregated default values

Specific requirements for biomass fuels:

The operator can only apply default values for the production of the biomass fuel if the feedstock used, process technology as well as the transport distance (for solid biomass used for electricity/heating/cooling markets) reflect the pathway given in RED II.

Where biomethane is used as compressed biomethane as a transport fuel, a value of 4.6 gCO_2q/MJ biomethane needs to be added to the default values included in RED II, Annex VI.

3.2 Use of actual values

Individual calculation of GHG emissions

Individually calculated GHG values or *"actual values"* are calculated based on the RED II methodology (according to the methodology laid down in part C of Annex V and as well as part B of Annex VI) as well as IR Article 20 and Annexes V, VII, IX, Commission Decision 2010/335/EU of 10 June 2010 (as amended under the RED II). For e_{ec} and e_{sca} specifically Annex V and VII of IR and ISCC's specifications as described in this document apply. Individual calculations of emissions must always be conducted at the point in the supply chain where they originate (e.g. emissions from cultivation can only be determined at the farm/plantation or the central office or the FGP of a group of farmers if all data is available there). It is not possible to calculate actual values retrospectively for elements of the upstream supply chain. For the calculation of "actual values" all relevant inputs of an economic operator must be considered.

Forwarding actual values

Certified economic operators who conduct an individual GHG calculation must always state the GHG values calculated for raw materials and intermediate products in kg CO_2eq/dry-ton of output on Sustainability Declarations[6]. The RED II requires information on actual GHG emission values to be provided for all relevant elements of the GHG emission calculation formula. It is therefore required that e_{ec}, e_l, e_p, e_{td}, e_u, e_{sca}, e_{ccs} and e_{ccr} are reported separately. Figure

[6] *Please see chapter 4.3.9 for specific requirements of final biofuel/bioliquid/biomass fuel producers*

5 summarizes the methodology how to forward actual values in the supply chain.

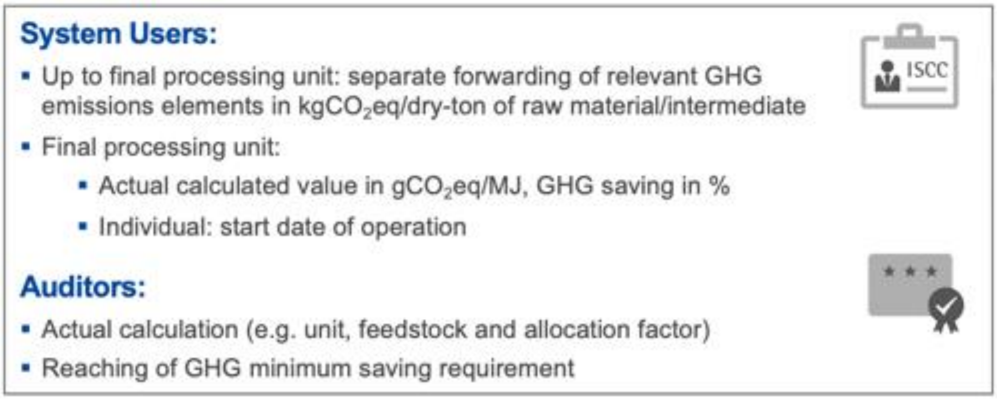

Figure 5: Application of actual values

Use of NUTS2 GHG values

For agricultural production, Member States or the competent authorities in third countries may have submitted reports to the Commission including data on typical emissions from the cultivation of feedstocks calculated on a regional level (NUTS2 or NUTS2 consistent region for non-EU countries). As laid out under Article 31(2) of the RED II, values from the "NUTS 2" reports submitted to the Commission by the Member States in accordance with Regulation (EC) No 1059/2003 of the European Parliament and of the Council can be used as an alternative to actual values. Once the calculation of these values has been scrutinised by the Commission and approved by the EC through an Implementing Act, ISCC system users are allowed to apply these values provided they have been published in gCO2eq/kg of dry feedstock. It is possible to use either the respective GHG value for the specific NUTS2 region (or the region in the third country) from which the raw material originates or to use the highest emission value from the Member State's NUTS2 report (or the third country report) for specific raw material coming from that country. Only NUTS2 values or values from equivalent regions in third countries that had been subject to an IR can be applied. Furthermore, any values used under REDI are no longer valid due to differences in the GHG emission calculation methodology applied under the REDII methodology.

Forwarding of NUTS2 values

Companies (farmers or FGPs/Central offices) using the emission values for cultivation provided in Member State Reports must provide the specific value in kg CO_2eq/dry-ton of raw material on their Sustainability Declarations as available on the Commission website.

Use of average GHG values

In the absence of relevant information on NUTS2 values in non-EU country reports[7] or information on disaggregated default values for cultivation emissions of agricultural biomass in the RED II Annex V and VI, it is permitted to calculate averages based on local farming practices based on, for example, data from a group of farms, as an alternative to using actual values.

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[7] *Reports referred to in the RED II Article, 31(4) or information on disaggregated default values for cultivation emissions in the RED II Annex V,*

Calculation and data

Estimates of emissions from cultivation and harvesting of forestry biomass may be derived from the use of averages for cultivation and harvesting emissions calculated for geographical areas at national level, as an alternative to using actual values. The methodology for calculating average GHG values can be the same as described in the chapter 4 “Requirements for individual GHG emission calculations”. The data should be updated over time unless there is no significant variability in the data over time. For emissions from agrochemical use, the typical type and quantity of agrochemical product used for the raw material in the region concerned may be utilised. Emissions from the production of agrochemicals should either be based on measured values or on the technical specifications of the production facility. When the range of emissions values for a group[8] of agrochemicals production facilities to which the facility concerned belongs is available, the most conservative emission number (highest) of that group shall be used. When a measured value for yields is used (as opposed to an aggregated value) for the calculations, a measured value for agrochemical input must also be used and vice versa.

Switching GHG information

A switch between different GHG information approaches is only possible if all relevant information and data can be verified by the auditor. Therefore, conducting an individual calculation for upstream processes at a later stage of the supply chain is not permitted, because the relevant input data would not be verifiable. Switching to a disaggregated default value or a total default value is possible as long as the relevant information has been delivered by certified economic operators and a default value is provided in the RED II.

Other recognised certification schemes

Options other than those described are not accepted under the RED II. All deliveries, including those from other recognised voluntary certification schemes, must comply with these requirements, otherwise they cannot be accepted.

Specific requirements for biomass fuels:

RED II, Annex VI. Part B. point 1 (b) and (c) outlines the methodology market operators must apply in the case of co-digestion of different (n) substrates in a biogas plant for the production of electricity or biomethane. They shall be calculated as a sum, taking into account the relative shares of the respective inputs and their emission factors. Therefore, the GHG value must be calculated as a single value for the whole amount of the biogas / biomethane, resulting from the co-digestion.

The formula for actual greenhouse gas emissions of biogas and biomethane is as follows:

[8] *It refers to for example a situation where an economic operator knows that a certain company in a certain country produced the fertiliser. That company has a number of fertiliser production facilities in that country for which the range of processing emissions are known; an economic operator can claim the most conservative number of emissions from those group of fertiliser production facilities.*

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

GHG calculation methodology for biomass fuels

where

E = *total emissions from the production of the biogas or biomethane before energy conversion;*

S_n = *Share of feedstock n, as a fraction of input to digester (*);*

$e_{ec,n}$ = *emissions from the extraction or cultivation of feedstock n;*

$e_{td,feedstock,n}$ = *emissions from transport of feedstock n to the digester;*

$e_{l,n}$ = *annualised emissions from carbon stock changes caused by land-use change, for feedstock n;*

e_{sca} = *emission savings from improved agricultural management of feedstock n (**);*

e_p = *emissions from processing;*

$e_{td,product}$ = *emissions from transport and distribution of biogas and/or biomethane;*

e_u = *emissions from the fuel in use, that is greenhouse gases emitted during combustion*

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

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

(*) For detailed Information on the Sn factor, see REDII, Annex VI, Part B.
(**) For e^{sca} a bonus of 45 g CO_2eq/MJ manure shall be attributed for improved agricultural and manure management in the case animal manure is used as a substrate for the production of biogas and biomethane.

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

Specific requirements for bioliquids and biomass fuels:

Energy installations delivering heat/electricity

Greenhouse gas emissions from the production and use of **bioliquids** shall be calculated in the same way as for biofuels (E), but with an extension necessary for including the energy conversion to electricity and/or for use for heating and cooling. Hence, energy installations using bioliquids to deliver only heat, only electricity, or (useful) heat together with electricity and/or mechanical energy need to apply the methodology provided in the RED II, Annex V, C. Methodology, point b in addition to the formula stated above (E).

Greenhouse gas emissions from the use of **biomass fuels** for producing electricity, or used for heating and cooling, including the energy conversion to electricity and/or for use for heating or cooling shall be calculated according to the methodology as provided in the RED II, Annex VI, B. Methodology, point d.

For energy installations delivering **only heat**:

$$EC_h = \frac{E}{\eta_h}$$

For energy installations delivering **only electricity**:

$$EC_{el} = \frac{E}{\eta_{el}}$$

For the electricity or mechanical energy coming from energy installations delivering useful heat together with electricity and/or mechanical energy:

$$EC_{el} = \frac{E}{\eta_{el}} \left(\frac{C_{el} \cdot \eta_{el}}{C_{el} \cdot \eta_{el} + C_h \cdot \eta_h} \right)$$

For the useful heat coming from energy installations delivering heat together with electricity and/or mechanical energy:

$$EC_h = \frac{E}{\eta_h} \left(\frac{C_h \cdot \eta_h}{C_{el} \cdot \eta_{el} + C_h \cdot \eta_h} \right)$$

where:

$EC_{h,el}$ = *Total greenhouse gas emissions from the final energy commodity*

E = *Total greenhouse gas emissions of the fuel before end-conversion*

η_{el} = *The electrical efficiency, defined as the annual electricity produced divided by the annual energy input, based on its energy content*

η_h = *The heat efficiency, defined as the annual useful heat output divided by the annual energy input, based on its energy content*

C_{el} = *Fraction of exergy in the electricity, and/or mechanical energy, set to 100 % (C_{el}= 1)*

C_h = *Carnot efficiency (fraction of exergy in the useful heat)*

The Carnot efficiency, C_h , for useful heat at different temperatures is defined as:

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

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 that calculation, the following definitions apply.

cogeneration shall mean the simultaneous generation in one process of thermal energy and electricity and / or mechanical energy;

useful heat shall mean heat generated to satisfy an economical justifiable demand for heat, for heating or cooling purposes;

economical 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.

4 Requirements for individual GHG emission calculation

The following chapters describe how an individual calculation shall be conducted in the different steps of the supply chain. Chapter 4.1 describes the general requirements for data gathering and the type of data to be used in an individual calculation. Chapter 4.2 defines the relevant supply chain elements for an individual GHG calculation. In chapter 4.3 the calculation methodologies for the following elements are introduced in detail:

4.3.1: Emissions from the extraction or cultivation of raw materials (e_{ec})

4.3.2: Emissions from carbon stock changes caused by land-use change (e_l)

4.3.3: Emission saving from soil carbon accumulation via improved agricultural management (e_{sca})

4.3.4: Emissions from transport and distribution (e_{td})

4.3.5: Emissions from processing (e_p)

4.3.6: Emission savings from CO_2 capture and replacement (e_{ccr}) and CO_2 capture and geological storage (e_{ccs})

4.3.7: Adjusting incoming emission values

4.3.8: Allocation of emissions to main products and co-products

4.3.9: Further requirements for the producers of final biofuels, bioliquids and biomass fuels

4.1 Data gathering

The GHG calculation methodology for individual calculations differentiates between the different elements in the supply chains, i.e. between agricultural producers (cultivation) and processing units. The calculation formula consists of actual data gathered from the individual (to be) certified company and data gathered from databases and literature.

Audit data gathering for individual calculation

Certification audit data gathering is relevant for actual input data, e.g. electricity or heat consumption, chemicals or fertilisers and for output data like wastewater production. Actual data measured and gathered at the system user must be documented and provided to the auditor for the verification. This can include field record systems, production reports, production information systems, delivery notes, weighbridge protocols, contracts, invoices and others. The calculation period should cover a full twelve-month period (in case of agricultural crops the growing season must be included). It must be as up to date as possible. As an alternative, it must cover the previous calendar or financial year. In cases of exceptional maintenance measures and unstable production conditions a shorter period (for inputs and respective outputs) may be considered if it better reflects the relevant timeframe. This can also be the case if within one year two crops are cultivated of which only one is unambiguously supplied in the biofuel sector. The respective period for data gathering and thus for the calculation of GHG emissions must be transparently displayed in the calculation. If, at the initial certification audit, no actual data is available (i.e. at the beginning of the production), “design data” can be used to conduct the individual calculation. Six months after the date of certificate issuance, certified economic operators must prove to their Certification Bodies that the values based on design data are appropriate. In case of deviations, new actual GHG values must be calculated, verified and used. After one year, the company has to switch from design data to actual data. This change is subject to the general recertification audit.

Inputs with little or no effect

If an input has little or no effect for the emission element of the calculation formula, it can be excluded from the emission calculation. Inputs with little or no effect are those that have an impact on the overall emissions of the respective calculation formula element (e.g. cultivation e_{ec}) that is lower than 0.5%.

Data sources for EF and LHVs

Published data includes the emission factors (EF), with which the respective input data are multiplied, and lower heating values. These have to be gathered from official sources. Whenever available, the standard values published in Annex IX of the IR 2022/996 shall be used. Alternative values may be used but must be duly justified and flagged in the calculation documentation in order to facilitate verification by auditors. They can be based on LCA Databases such as Ecoinvent or individually calculated or measured (e.g. LHV could be measured through laboratory analyses) as long as the methodology for the GHG calculation complies with the methodology set in the RED II and is verifiable during the audit or the supplier of the EF/LHV is ISCC/ISO certified. If not available, other scientifically peer-reviewed literature or official statistical data from government bodies can be used. All data gathered from databases or literature shall be based on the most recent available sources and shall be updated over time. The source and the date of data collection shall be documented. EFs chosen or calculated shall also reflect the specific situation and set-up, e.g. if a process-specific input was produced in Europe then the EF for this input shall also reflect the European situation. It is the responsibility of the CB to confirm that a given EF can be used by the System User.

4.2 Supply chain elements

System boundaries

An individual GHG emission calculation is not performed for the whole supply chain but only within the system boundary of a certified supply chain element. The following figure shows the supply chain elements responsible for calculating the individual elements of the calculation formula. Figure 6 shows at which step in the supply chain what kind of emissions can arise at the example of an agricultural supply chain:

> For agricultural supply chains the minimum requirements to be forwarded up to the final biofuel processor are e_{ec}, e_l (in case emissions from land use change in compliance with ISCC requirements took place), e_p and e_{td}

> For waste/residue supply chains the minimum requirements to be forwarded up to the final biofuel processor are e_p and e_{td}

> e_{sca}, e_{ccr} and e_{ccs} are voluntary additional savings and can only be forwarded if they are actually implemented and verified at the respective supply chain element

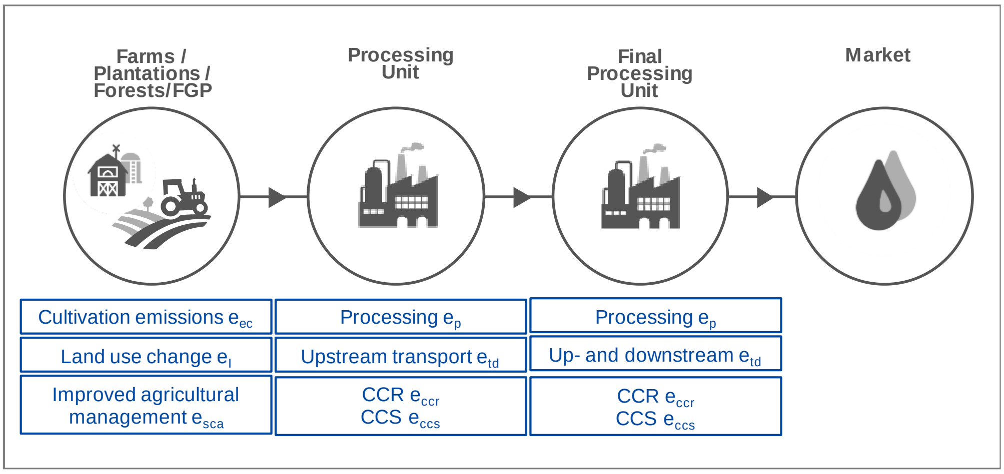

Figure 6: Relevant supply chain elements for an individual calculation for biofuels of the different elements of the calculation formula in an agricultural supply chain

Individual calculation for cultivation

Actual values of emissions from the extraction or cultivation of raw materials e_{ec} can only be determined at the origin of the chain of custody on the farm/ plantation level and for forestry biomass at the forest sourcing area level. Farmers and agricultural producers or FGPs/groups' central offices (on behalf of the farmers belonging to the group) can conduct an individual GHG emission calculation for e_{ec}. If, additionally, land-use change (e_l) has occured (that did not violate ISCC Principle I) or improved agricultural management (e_{sca}) is applied, these emissions (or savings in the case of e_{sca}) also need to be calculated at this step. If farms or plantations belong to a group, they can either conduct an individual GHG emission calculation for each farmer or one GHG emission calculation for the whole group. As highlighted in the EC Communication 2010/C160/01, group certification for the purpose of calculating GHG emissions is acceptable if the units have similar production systems and products.[9] The data basis for an individual calculation of a group is based on a sample of relevant individual input data. Data is gathered from the square root of all farms/plantations belonging to a group. The data gathering samples must take into account the different crops cultivated, regional specifics and the size of the individual farms. Sampling for the purpose of individual calculations must also be risk-based. This means that farms applying an individual calculation for GHG emissions need to be represented accordingly in the sample. The highest GHG emission value can be used for the whole group. Using the average of different GHG emission values is not permitted.

If during the validity of a certificate and prior recertification:

> further farmers are added to the supply base, the already calculated highest actual value can be used for the complete supply base. It is the responsibility of the FGP in the framework of the self assessment and internal audit to ensure that individual calculations comply with

[9] *For all requirements on on group certification see ISCC EU System Document 203 "Traceability and Chain of Custody"*

ISCC requirements. Samples of the individual calculations need to be verified latest in the upcoming recertification audit. The CB is responsible to choose farmers that become part of this sample (for more guidance please see the requirements as outlined in ISCC EU System Documents 203 “Traceability and Chain of Custody” and 204 “Risk Management”).

> farmers would like to switch from a group certification setup the highest value is applied for all farmers to individual farm calculations it is the responsibility of the CB to decide if a respective switch can be allowed (i.e. because relevant GHG documentation is established, clear and traceable). It is the responsibility of the CB to decide if an on-site visit is necessary to verify compliance with ISCC requirements.

> in case all group members use the default value and would like to switch to an actual calculation, relevant requirements for group certification of this chapter need to be applied.

> any changes in the GHG methodology must be clearly documented by the economic operator and must be reported to the certification body before the adjustment.

Above stated adaptions should be reflected in the risk assessment of the System User and the CB, i.e. potentially leading to a higher risk in the next audit.

Individual calculation for processing units

If the certified economic operator is a processing unit, the emissions from processing (e_p) may be calculated. Actual values of emissions from processing can only be determined if emissions from all processing steps are recorded and transmitted through the chain of custody. During this step further emission savings such as CO_2 capture and geological storage (e_{ccs}) or CO_2 capture and replacement (e_{ccr}) are calculated if applicable.

Individual calculation for transport

Actual values of emissions from transport and distribution (e_{td}) can only be determined if emissions from all transport steps are recorded and transmitted through the chain of custody. Any recipient of physical material has to determine the upstream transport emissions (e_{td}) and has to transmit these values to the recipient of the material. The final processing unit also has to determine the downstream transport and distribution emissions to the final market.

The emissions of depots and filling stations may be calculated using the data provided by the JRC[10]. The provided values (depot: 0,00084 MJ/MJ fuel, filling station: 0,0034 MJ/MJ fuel) must be multiplied by the appropriate national electricity EF from the Implementing Regulation (EU) 2022/996.

Moisture factor

All elements need to provide emissions in $kgCO_2eq$/dry-ton throughout the supply chain up to the final biofuel producer. Therefore, the emissions are

[10] *European Commission, Joint Research Centre, Padella, M., O’Connell, A., Giuntoli, J. et al., Definition of input data to assess GHG default emissions from biofuels in EU legislation – Version 1d - 2019, Publications Office, 2019, https://data.europa.eu/doi/10.2760/69179*

either divided by the amount of dry feedstock or they are calculated by applying a moisture factor:

$$e_{feedstock}\left[\frac{kg\ CO_2eq}{ton_{dry}}\right] = \frac{e_{feedstock}\left[\frac{kg\ CO_2eq}{ton_{moist}}\right]}{(1 - moisture\ content)}$$

The moisture content should be the value measured after delivery, or, if this is not known, the maximum value allowed by the delivery contract. The moisture contents of suppliers and recipients of sustainable material need to be consistent (e.g. between a farm/plantation and oil mill). If this is not measured after delivery, industry-wide accepted values e.g. derived from scientific databases can be applied as an alternative.

If at any point of the chain of custody emissions have occurred and are not recorded, so that the calculation of an actual value is no longer feasible for operators downstream in the chain of custody, this must be clearly indicated in the Sustainability Declarations.

4.3 Calculation methodology

4.3.1 Emissions from the extraction or cultivation of raw materials (e_{ec})

Applicability of e_{ec}

Emissions from the extraction or cultivation of raw materials apply to all agricultural raw materials, such as rapeseed/canola, palm, soybean, wheat, corn/maize and sugarcane. If wastes or residues (e.g. straw, crude glycerine) are used as a raw material in a process, the GHG emissions of extraction or cultivation of the raw material are considered to be zero and emissions at the point of origin of the waste or residue are zero.

4.3.1.1 Calculation formula for extraction or cultivation of raw materials

Sum of emissions from cultivation or extraction

The GHG emission formula for extraction or cultivation of raw materials e_{ec} includes all emissions (EM) from the extraction or cultivation process itself; including emissions 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. The capture of CO_2 in the cultivation of raw materials is excluded:

$$e_{ec}\left[\frac{kg\ CO_2eq}{ton}\right] = \frac{\left(EM_{fertiliser} + EM_{N2O} + EM_{inputs} + EM_{fuel} + EM_{electricity}\right)\left[\frac{kg\ CO_2eq}{ha * yr}\right]}{yield\ raw\ material\ \left[\frac{ton}{ha * yr}\right]}$$

Division by yield

The sum of GHG emissions from fertilisers, further inputs like plant protection products[11,] seeding material, fuel diesel and electricity (EM, here in kg CO_2eq per ha and year) is divided by the yield of raw material in tons per ha and year in order to receive the specific GHG emission per ton of raw material. For all

[11] *Plant protection product or pesticide includes herbicides, insecticides, fungicides, etc.*

types of raw materials, the yield shall refer to the dry matter content. If not calculated per dry ton directly a correction is required (please find the formula in chapter 4.2).

Emissions of individual inputs (EM)

The emissions of the different inputs (EM) are calculated by multiplying the input data with the respective EFs. Care must be taken that units of on-site gathered data and data used from recognised sources are the same.

$$EM_{fuel} = fuel\ consumption\ \left[\frac{l}{ha * yr}\right] * EF_{fuel}\left[\frac{kg\ CO_2 eq}{l}\right]$$

EM_{fuel}

For calculating fuel emissions from the use of farm machinery (EM_{fuel}) the fuel consumption of all activities during field-preparation, seeding, fertiliser and pesticide application, harvesting and collection must be determined, documented and multiplied with the EF for the respective fuel type e.g. diesel, gasoline, heavy fuel oil, biofuels. Emissions from the collection of raw materials include also transport to storage (this includes transport to and storage at the FGP). Appropriate EFs to be used can be found in Annex IX of the IR. Where biofuels are used, the default GHG emissions set out in RED II must be used.

Emissions from storage

The cultivation emissions shall include emissions from drying before storage as well as from storage and handling of biomass feedstock. Data on energy use for drying before storage shall include actual data on the drying process used to comply with the requirements of storage, depending on the biomass type, particle size, moisture content, weather conditions, etc. Appropriate emission factors, including upstream emissions, shall be used to account for the emissions from the use of fuels to produce heat or electricity used for drying. Emissions for drying include only emissions for the drying process needed to ensure adequate storage of raw materials and does not include drying of materials during processing.

$$EM_{electricity} = electricity\ consumption\ \left[\frac{kWh}{ha * yr}\right] * EF_{electricity}\left[\frac{kg\ CO_2 eq}{kWh}\right]$$

$EM_{electricity}$

For **electricity** used in farming operations the emission intensity shall be that of a defined region, which can be at a NUTS2 region (if available and recognized by the European Commission) or a national level. In case national electricity emission coefficients are used, the values from Annex IX of the IR shall be used. The producer may also use an average value for an individual electricity production plant for electricity produced by that plant if it is not connected to the electricity grid and sufficient information are available to derive an emission factor.

$$EM_{input} = input\left[\frac{kg}{ha * yr}\right] * EF_{input}\left[\frac{kg\ CO_2 eq}{kg}\right]$$

EM_{input} refers to for example seeding material (seeds or seedlings) and all types of plant protection products. *EM_{input}*

The calculation of emissions from **seeding material** production shall be based on actual data on the seeding material used. If EFs are being used to account for the emissions from production and supply of the seeding material the standard values set out in Annex IX of the IR must be used. If the appropriate EF for the respective seeding material cannot be found, literature values from the following hierarchy must be used:

> version 5 of JEC-WTW report,

> EcoInvent database,

> “official” sources, such as Intergovernmental Panel on Climate Change (IPCC), International Energy Agency (IEA) or governments,

> Other reviewed sources of data, such as E3 database, GEMIS database,

> Peer-reviewed publications.

> Duly documented own estimates.

Emissions from pesticides

For **plant protection products** the unit for EM_{input} is always kg active ingredient of the used pesticide.

$$EM_{fertiliser} = fertiliser\ input\left[\frac{kg\ nutrient}{ha * yr}\right] * EF_{production}\left[\frac{kg\ CO_2 eq}{kg\ nutrient}\right]$$

The amount of fertiliser used always refers to the main nutrient/active ingredient (e.g. nitrogen). *$EM_{fertiliser}$*

- For *synthetic fertilisers* (e.g. P_2O_5, K_2O, CaO) $EF_{production}$ is relevant and must be applied.
- For *synthetic nitrogen fertilisers*, in addition to $EF_{production}$, N_2O-field emissions have to be calculated.

Emissions from fertilizer acidification

For *nitrogen fertilisers*, next to on-field N_2O emissions also emissions from the neutralisation of fertiliser acidification in the soil have to be included based on the amount used. For nitrate fertilisers, the emissions from neutralisation shall be 0.783 kg CO_2/kg N; for urea fertilisers, the neutralisation emissions shall be 0.806 kg CO_2/kg N.

If *agricultural lime (aglime)* is used and applied on the field additional soil emissions from liming shall be accounted for.

N_2O-field emissions

For *synthetic nitrogen fertilisers*, in addition to $EF_{production}$, N_2O-field emissions have to be calculated. For *organic nitrogen fertilisers* and *crop residues* left on the field **N_2O-field emissions** must be calculated as well.

The IPCC methodology shall be applied to ensure that N_2O emissions from managed soils are taken into account, including what are described as both “direct” and “indirect” N_2O emissions of synthetic and organic nitrogen fertilisers and crop residues.[12]

$$N_2O_{Total} - \mathrm{N} = [N_2O_{Direct} - N + N_2O_{Indirect} - N]$$

For mineral soils, direct N_2O emissions shall be calculated as:

$$N_2O_{Direct} - N = [(F_{\mathrm{SN}} + F_{\mathrm{ON}}) * EF_1] + [F_{\mathrm{CR}} * EF_1]$$

While for organic soils the formula to be applied is as follows:

$$N_2O_{Direct} - N = [(F_{\mathrm{SN}} + F_{\mathrm{ON}}) * EF_1] + [F_{\mathrm{CR}} * EF_1] + \left[F_{\mathrm{OS,CG,Temp}} * EF_{2\mathrm{CG,Temp}}\right] + \left[F_{\mathrm{OS,CG,Trop}} * EF_{2\mathrm{CG,Trop}}\right]$$

For both mineral and organic soils, the calculation of indirect N_2O emissions shall follow the following equation:

$$N_2O_{Indirect} - N = [(F_{\mathrm{SN}} * Frac_{\mathrm{GASF}}) + (F_{\mathrm{ON}} * Frac_{\mathrm{GASM}})] * EF_4] + \left[(F_{\mathrm{SN}} + F_{\mathrm{ON}} + F_{\mathrm{CR}}) * Frac_{\mathrm{Leach-(H)}} * EF_5\right]$$

Where:

$N_2O_{Total} - \mathrm{N}$	Direct and Indirect annual N_2O-N emissions produced from managed soils, kg N_2O-N ha^{-1} a^{-1}
$N_2O_{Direct} - \mathrm{N}$	Annual direct N_2O-N emissions produced from managed soils, kg N_2O-N ha^{-1} a^{-1}
$N_2O_{Indirect} - \mathrm{N}$	Annual indirect N_2O-N emissions, (that is to say, the annual amount of N_2O–N produced from atmospheric deposition of N volatilised from managed soils and annual amount of N_2O–N produced from leaching and run-off of N additions to managed soils in regions where leaching/run-off occurs), kg N_2O-N ha^{-1} a^{-1}
F_{SN}	Annual synthetic nitrogen fertilizer input, kg N ha^{-1} a^{-1}
F_{ON}	Total organic N-fertilizer input, kg N ha^{-1} a^{-1}
F_{CR}	Total crop residues N-input, kg N ha^{-1} a^{-1}
$F_{OS,CG,Temp}$	Annual area of managed/drained organinc soils under cropland in temperate climate, ha^{-1} a^{-1}
$F_{OS,CG,Trop}$	Annual area of managed/drained organinc soils under cropland in tropical climate, ha^{-1} a^{-1}

[12] *IPCC guidelines for National Greenhouse Gas Inventories, Volume 4, Chapter 11, http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_11_Ch11_N2O&CO2.pdf and “2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories”*

$Frac_{GASF}$	**0,10** (kg N volatilised) (kg of N applied)$^{-1}$. Fraction of applied synthetic N fertiliser that volatilises as NH_3 and NO_x,
$Frac_{GASM}$	**0,20** (kg N volatilised) (kg of N applied or deposited)$^{-1}$. Fraction of applied organic N fertiliser that volatilises as NH_3 and NO_x.
$Frac_{LEACH-(H)}$	**0,30** (kg N) (kg of N additions)$^{-1}$. Fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff,
EF_1	**0,01** (kg N_2O-N) (kg N input)$^{-1}$. Emission factor for N_2O emissions from N inputs
$EF_{2CG,Temp}$	**8** kg N ha^{-1} a^{-1} for temperate organic crop and grassland soils
$EF_{2CG,Trop}$	**16** kg N ha^{-1} a^{-1} for tropical organic crop and grassland soils
EF_4	**0,01** (kg N_2O-N) (kg NH_3–N + NO_x–N volatilised)$^{-1.}$ Emission factor for N_2O emissions from atmospheric deposition of N on soils and water surfaces
EF_5	**0,0075** (kg N_2O–N) (kg N leached and runoff)$^{-1}$. Emission factor for N_2O emissions from N leaching and runoff

Crop- and site-specific emission factor

Economic operators shall use disaggregated crop-specific emission factors for different environmental conditions (corresponding to Tier 2 of the IPCC methodology) to calculate the N_2O emissions resulting from crop cultivation. Economic operators shall use crop and site-specific emission factors for the calculation of N_2O emissions from synthetic and organic fertilizers application (EF_1 of the above equation). N_2O emissions from soils under agricultural use, in different agricultural fields under different environmental conditions and agricultural land use classes can be determined following the statistical model developed by Stehfest and Bouwman (2006) ('the S&B model'). The crop- and site- specific emission factor calculated, according to the S&B model (EF1ij), can be used to substitute the IPCC EF_1 factor in the calculation of direct N_2O emissions from fertilizer input.

The $EF1_{ij}$ for the crop i at location j is calculated, according to the S&B model as:

$$EF_{1ij} = \left[\left(E_{fert,ij} - E_{unfert,ij}\right)/N_{appl,ij}\right]$$

Where:

$E_{fert,ij}$	N_2O emission, based on S&B, where fertilizer input is the actual N application rate (mineral fertilizer and manure) to the crop i at location j (kg N_2O-N ha^{-1} a^{-1})
$E_{unfert,ij}$	N_2O emission of the crop i at location j (kg N_2O-N ha^{-1} a^{-1}), based on S&B. The N application is set to 0 and all the other parameters are kept the same

$N_{appl,ij}$ N input from mineral fertiliser and manure (kg N ha^{-1} a^{-1}) to the crop i at location j

$E_{fert,ij}$ and $E_{unfert,ij}$ are calculated through the basic formula of the S&B model which combines the effect of different drivers such as soil organic content, pH, soil texture, climate and vegetation and N input, in the following equation:

$$E = exp\,(-1.516 + \sum ev)$$

Where:

E annual N_2O emission (kg N_2O-N ha^{-1} a^{-1})

- 1.516 constant value

ev effect value for different drivers (i.e. (Table 1)

Table 1 should be used to derive the effect value according to the specific crop and site conditions of crop i grown at location j.

Constant value	-1.516	
Parameter	**Parameter class or unit**	**Effect value (ev)**
Fertilizer input		0.0038 * N application rate in kg N ha^{-1} a^{-1}
Soil organic C content	<1 %	0
	1-3 %	0.0526
	>3 %	0.6334
pH	<5.5	0
	5.5-7.3	-0.0693
	>7.3	-0.4836
Soil texture	Coarse	0
	Medium	-0.1528
	Fine	0.4312
Climate	Subtropical climate	0.6117
	Temperate continental climate	0
	Temperate oceanic climate	0.0226
	Tropical climate	-0.3022
Vegetation	Cereals	0
	Grass	-0.3502
	Legume	0.3783
	None	0.5870
	Other	0.4420
	Wetland rice	-0.8850
Length of experiment	1 yr	1.9910

Table 1 – Constant and effect values for the S&B model

Crop residues N input

The nitrogen input provided to the soil with the crop residues left on the field, shall also be taken into account as a contribution to N_2O emissions from managed soils. The crop residues N input shall be calculated as follows:

For sugar beet and sugar cane, N input should be calculated not considering below-ground residues and with the addition of input from vignasse and filter cake respectively. This is done, through the following formula, in accordance with IPCC (2006) Vol. 4 Chapter 11, Eq. 11.6:

$$F_{CR} = Yield * DRY * \left(1 - Frac_{Burnt} * C_f\right) * [R_{AG} * \ N_{AG} * (1 - Frac_{Remove})] + F_{VF}$$

For coconut and oil palm plantations a fixed N input is applied based on literature, because the IPCC (2006) provides no default calculation method for standard emission factors, pursuant to Annex IX of the IA.

For all the other crops, calculations should be done, according to IPCC (2006) Vol. 4 Chapter 11 Eq. 11.7a, 11, 12, as:

$$F_{CR} = \left(1 - Frac_{Burnt} * C_f\right) * AG_{DM} * N_{AG} * (1 - Frac_{Remove}) + (AG_{DM} + Y * DRY) * R_{BG-BIO} * N_{BG}$$

Where:

F_{CR} Amount of N in crop residues (kg N ha^{-1} yr^{1})

Yield Annual fresh yield of the crop (kg ha^{-1})

DRY Dry matter fraction of harvested product [kg d.m. (kg fresh weight)$^{-1}$] (table 2)

$Frac_{Burnt}$ Faction of crop area burnt annually [ha (ha)$^{-}$1]

C_f Combustion factor [dimensionless] (table 2)

R_{AG} Ration of above-ground residues, dry matterto harvested dry matter yield, for the crop [kg d.m. (kg d.m.)$^{-1}$] (table 2)

N_{AG} N content of above-ground residues [kg N (kg d.m.)-1] (table 2)

$Frac_{Remove}$ Fraction of above-ground residues removed from field [kg d.m. (kg AG_{DM})$^{-1}$] (table 2)

F_{VF} Annual amount of N in sugar cane vignasse and filter cake returned to the field kg N ha^{-1}

AG Above-ground residues dry matter (kg d.m. ha^{-1})

Crop	Calculation method	DRY	LHV	N_{AG}	slope	intercept	R_{BG_BIO}	N_{BG}	Cf	R_{AG}	Fixed amount of N in crop residues (kg N ha^{-1})	Data sources*
Barley	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.865	17	0.007	0.98	0.59	0.22	0.014	0.8			1, 2
Cassava	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.302	16.15	0.019	0.1	1.06	0.2	0.014	0.8			1, 2
Coconuts	Fixed N from crop residues	0.94	32.07								44	1, 3
Cotton	No inform. on crop residues	0.91	22.64									
Maize	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.86	17.3	0.006	1.03	0.61	0.22	0.007	0.8			1, 2
Oil palm fruit	Fixed N from crop residues	0.66	24								159	1, 4
Rapeseed	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.91	26.976	0.011	1.5	0	0.19	0.017	0.8			1, 5
Rye	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.86	17.1	0.005	1.09	0.88	0.22	0.011	0.8			1, 6
Safflower seed	No inform.on crop residues	0.91	25.9									
Sorghum (grain)	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.89	17.3	0.007	0.88	1.33	0.22	0.006	0.8			1, 7
Soybeans	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.87	23	0.008	0.93	1.35	0.19	0.087	0.8			1, 8
Sugar beets	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.6	0.25	16.3	0.004					0.8	0.5		1, 9
Sugar cane	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.6	0.275	19.6	0.004					0.8	0.43		1, 10
Sunflower seed	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.9	26.4	0.007	2.1	0	0.22	0.007	0.8			1, 11
Triticale	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.86	16.9	0.006	1.09	0.88	0.22	0.009	0.8			1, 2
Wheat	IPCC (2006) Vol. 4 Ch. 11 Eq. 11.7a	0.84	17	0.006	1.51	0.52	0.24	0.009	0.9			1, 2

Table 2 – Crop-specific parameters to calculate N input from crop residues

N_2O-N to N_2O conversion

Finally, the results of the calculation of N_2O emission from managed soil shall be converted from $N_2O - N$ to N_2O according to the following equation:

$$N_2O = N_2O - N * 44/28$$

As stated in the Implementing Regulation (EU) 2022/996, 1 g N_2O is equal to 265 g CO_2eq for the purposes of calculating CO_2 equivalence.

Soil emissions from liming (aglime)

The real amount of aglime used shall be duly documented and emissions from its application calculated as follows:

> On acid soils, where pH is less than 6.4, a factor of 0.44 kg CO_2/ kg $CaCO_3$ equivalent aglime shall be used.
> If soil pH is greater or equal to 6.4, an EF of 0.079 kg CO_2/ kg ($CaCO_3$ equivalent) aglime shall be used in addition to the emissions due to the neutralisation of fertilizer acidity.
> If the liming emissions calculated in (1) and (2) are greater than the fertilizer neutralization emissions, the latter may be subtracted from the calculated liming emissions to avoid double counting.
> If the fertilizer neutralization emissions exceed those attributed to liming, the net liming emissions shall be counted zero to avoid negative emissions. However, emissions from fertilizer neutralization shall be maintained.

If no data is available on actual aglime use, the amount recommended by the Agricultural Lime Association shall be assumed and reflect the crop type, measured soil pH, soil type and type of lime material. Respective CO_2 emissions shall be calculated based on step (1) and (2) above. However, the subtraction specified in point 3 shall not be applied in this case, since the recommended use of aglime does not include aglime used to neutralize fertilizer applied in the same year, so there is no possible double counting of fertilizer neutralization emissions.

EFs production

The EFs for both chemical fertilisers and pesticides shall include all related emissions from the manufacture of those pursuant to Annex IX of the IR. For fertilisers also transport emissions shall be included, using the emissions from transport modes listed in Annex IX of the IA.

> If the economic operator knows the factory producing the fertiliser and it falls under the EU Emissions Trading System (ETS), then the economic operator can use the production emissions declared under ETS, adding the upstream emissions for natural gas etc. Transport of the fertilizers shall also be included, using the emissions from transport modes listed in Annex IX of the IR
> If the economic operator does not know the factory supplying the fertiliser, it should use the standard values provided for in Annex IX of the IR

When calculating GHG emissions on cultivation level emissions from replanting activities and from activities on immature areas must also be taken into account.

Replanting activities

4.3.1.2 Data basis

On-site data gathering

The following data for the calculation of GHG emissions from cultivation must be gathered on-site. They will form the basis for the calculation of GHG emissions for an individual crop. All input values must be gathered for the same reference area and time period. In the example below the time period of 1 year (yr) and the reference area of 1 hectare (ha) are used.

Relevant input data for cultivation

> Amount of seeding material in kg per ha and yr

> Amount of plant protection products (PPP) in kg active ingredient per ha and year (e.g. kg glyphosate/(ha*yr))

> Amount of synthetic fertilisers: phosphorus (P_2O_5), potassium (K_2O), lime (CaO), and nitrogen (N) fertiliser in kg nutrient per ha and year (e.g. kg nitrogen/(ha*yr))

> Amount of organic nitrogen (N) fertilisers in kg N/(ha*yr)

> Amount of aglime in kg aglime ($CaCo_3$)

> Amount of crop residues in kg N /(ha*yr)

> For the calculation of N_2O-field emissions specifically:

- o Amount of N_2O-N produced from atmospheric deposition of N (ATD)
- o Amount N_2O-N produced from leaching, runoff of N (L)

> Diesel consumption, electricity consumption and other energy consumption (for any work related to the cultivation, collection and drying of biomass).

> If biomass is dried and stored in an external warehouse, these emissions also need to be taken into account.

> Transportation mode and distance up to the FGP

> Yield of the raw material in ton/(ha*yr) moist and moisture content to determine yield of dry matter. If moisture content or yield of dry matter are not known, emissions can be calculated based on moist yield and adapted by applying a moisture factor (see 4.2). Therefore, the moisture content should be measured after delivery to the first gathering point or be based on the maximum value allowed by the delivery contract with the first gathering point

In the case that further emission-relevant inputs are used during cultivation, the relevant amounts per ha and time period must be documented and included in the calculation.

Published data

Relevant emission factors

The following data for the calculation of GHG emissions are normally gathered from literature or other officially recognised or certified sources:

> EFs for seeding material in kg CO_2eq/kg seeding material

> EFs for plant protection products in kg CO_2eq/kg active ingredient

> EFs for synthetic fertilisers reflecting the emissions of production, extraction and processing of the fertilisers in kg CO_2eq/kg nutrient (to be applied for P_2O_5, K_2O, CaO, and synthetic N fertiliser)

> EFs for field emissions of all nitrogen fertilisers including synthetic and organic N fertiliser and crop residues in kg CO_2eq/kg N (EF_{field})

> EFs for diesel, electricity or other energy source in kg CO_2eq per unit of energy used

Forwarding of e_{ec}

After calculating the GHG emissions per dry-ton of raw material, the certified agricultural producers or FGPs/Central offices (on behalf of the farmers belonging to the group) forward the GHG information for e_{ec} in kg CO_2eq/dry-ton raw material together with the agricultural raw material itself to the recipient.

4.3.2 Emissions from carbon stock changes caused by land-use change (e_l)

Definition and reference year land use change

Land-use change is a change from one of the following IPCC land cover categories: forest land, grassland, wetlands, settlements, or other land, to cropland or perennial cropland[13]. 'Cropland' and 'perennial cropland' shall be regarded as one land use. GHG emissions from land-use change (e_l) between the five land categories to cropland or perennial cropland taking place after the cut-off date of 1 January 2008 and in compliance with ISCC sustainability principle 1 (see ISCC EU System Document 202-1 “Agricultural Biomass – ISCC Principle 1”) must be taken into account. A change in cropland structure, management activities, tillage practices, or manure input practices is not considered land-use change.

For calculating emissions in kg CO_2eq/dry-ton of raw material, the carbon stock of the actual land use (CS_A) is subtracted from the carbon stock of the reference land use (prior to the land-use change) (CS_R). The result is divided by the yield of raw material (which is measured as dry matter or by adapting the emissions value by applying a moisture factor (see 4.2)) and annualised over 20 years. In order to convert the carbon (C) to CO_2eq-emissions, the

[13] *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.*

conversion factor of 3.664 must be applied. The following formula needs to be applied:

Formula for e_l

$$e_l\left[\frac{kg\ CO_2eq}{ton}\right] = \left(\frac{CS_R\left[\frac{kg\ C}{ha}\right] - CS_A\left[\frac{kg\ C}{ha}\right]}{yield\ raw\ material\left[\frac{ton}{ha * yr}\right] * 20\ [yr]} * 3.664\right) - eB$$

As the total carbon stock change is annualised over 20 years, the GHG emissions from land-use change must be considered for a period of 20 years after the land-use change took place. The reference land use (CS_R) and the actual land use (CS_A) are defined by the mass of carbon in the soil and vegetation per unit of land:

CS_R= The carbon stock per unit area associated with the reference land use (land carbon stock before conversion into agricultural land) measured as mass (tons) of carbon 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 is more recent;

CS_A= the carbon stock per unit area associated with the actual land use (carbon stock per unit of land after conversion into agricultural land) measured as mass (tons) of carbon per unit area, including both soil and vegetation. 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 is earlier;

The carbon stock (CS) of land use i (reference or actual) per unit area takes into account the soil organic carbon as well as the carbon of the vegetation:

Formula for CS

$$CS_i = (SOC + C_{veg}) * A$$

A is referring to the converted area (is 1 if whole area is subject to conversion).

C_{veg} is zero fro cropland

C_{veg} is the above and below ground carbon stock of the vegetation. The vegetation value for cropland is zero[14]. The soil organic carbon (SOC) consists of four factors, which depend on climate, soil type, management practice and C-input practice: the standard soil organic carbon in the 0-30 cm topsoil layer (SOC_{ST}), the land use factor (F_{LU}), the management factor (F_{MG}) and the input factor (F_i):

Formula for SOC

$$SOC = (SOC_{ST} * F_{LU} * F_{MG} * F_i)$$

Forwarding of e_l

[14] *EC Communication 2010/C160/02 from the Commission on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels. Brussels.*

Together with the batch of the respective agricultural raw material, the supplier forwards the actual GHG value for land-use change e_l in kg CO_2eq/dry-ton raw material to the recipient.

The RED II also provides the option for a GHG bonus if degraded land is restored:

Bonus "severely degraded land"

e_B= bonus of 29 g CO_2eq/MJ for biofuel, bioliquid, biomass fuel if biomass is obtained from restored degraded land

The bonus of 29 g CO_2eq/MJ can only be applied and attributed if evidence is provided that the land:

> was not in use for agriculture or any other activity in January 2008; and

> is severely degraded land, including land that was formerly in agricultural use.

The bonus of 29 g CO_2eq/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 for land falling under severely degraded land are ensured. *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 (e.g. characterised by soil erosion, significant loss of soil quality or biodiversity).

Forwarding of e_b

Auditors need to verify on farm/plantation level during the farm audit if the requirements stated above are fulfilled so that the bonus can be applied. If a farm/plantation is compliant with these requirements, the respective information needs to be forwarded through the supply chain via Sustainability Declarations and the final biofuel producer can deduct the bonus from the total GHG value of the final product in the final biofuel proof of sustainability (PoS).

4.3.3 Emission saving from soil carbon accumulation via improved agricultural management (e_{sca})

The RED II allows the use of emissions savings, e_{sca}, due to carbon accumulation in soil driven by the adoption of improved agricultural management. According to the Annex V of the IR improved agricultural management practices accepted for the purpose of achieving emission savings from soil carbon accumulation include:

> Shifting to reduced or zero-tillage.

> Improved crop rotation.

> The use of cover crops, including crop residues management.

> The use of organic soil improver (e.g. compost, manure fermentation digestate, biochar etc.).

How to calculate e_{sca}

According to the Annex V of the IR, e_{sca} value has to be calculated according to the following formula:

$$e_{sca}\left[\frac{gCO_2eq}{MJ}\right] = (CS_A - CS_R) * 3.664 * 10^6 * \frac{1}{n} * \frac{1}{P} - e_f$$

Where:

$\mathbf{CS_R}$ is the mass of soil carbon stock per unit area associated with the reference crop management practice in Mg of C per ha.

$\mathbf{CS_A}$ is the mass of soil estimated carbon stock per unit area associated with the actual crop management practices after at least 10 years of application in Mg of C per ha.

$\mathbf{3,664}$ is the quotient obtained by dividing the molecular weight of CO_2 (44,010 g/mol) by the molecular weight of carbon (12,011 g/mol) in g CO_2eq/g C.

$\boldsymbol{n}$ is the period (in years) of the cultivation of the crop considered.

$\boldsymbol{P}$ is the productivity of the crop (measured as MJ biofuel or bioliquid energy per ha per year).

$\boldsymbol{e_f}$ emissions for the increased fertilizer or herbicide use.

Under ISCC the following formula applies aligned to the concept of forwarding other emission values up to the final biofuel producer on mass-basis:

$$e_{sca}\left[\frac{kg\ CO_2eq}{ton}\right] = \left(\frac{CS_A\left[\frac{kg\ C}{ha}\right] - CS_R\left[\frac{kg\ C}{ha}\right]}{yield\ raw\ material\left[\frac{ton}{ha * yr}\right] * \mathrm{n}\ [yr]} * 3.664\right) - ef$$

The calculation of the actual values of CS_R and CS_A shall be based on measurements of soil carbon stocks.

The entire area for which CS_R and CS_A are calculated shall have a similar climate and soil type as well as similar management history in terms of tillage and carbon input to soil. If the improved management practices are only applied to part of the farm, the GHG emissions savings can only be claimed for the area covered by them. If different improved management practices are applied on a single farm, a claim of GHG emission savings shall be calculated and claimed individually for each e_{sca} practice.

To ensure reduced year-to-year fluctuations in the measured soil carbon stocks and to reduce associated errors, fields that have the same soil and climate characteristics, similar management history in terms of tillage and carbon input to soil and that will be subject to the same improved management practice may be grouped, including those fields belonging to different farmers.

If e_{sca} is calculated, information on the e_{sca} methodology has to be provided[15].

Two options for e_{sca} calculation

The e_{sca} calculation shall be based on field measurements. However, the integration between the field measurement and soil/crop modelling may be possible under certain conditions.

Calculation approach

The calculation of carbon stocks and the e_{sca} shall follow the following steps:

1. The measurement of CS_R shall be carried out at the farm level before the improved management practice is applied, in order to establish a baseline. In the absence of such a reference, it will not be possible to detect any potential soil carbon accumulation and the respective magnitude.
2. Once the baseline is established, the CS_A shall be measured at regular intervals no later than 5 years apart.
3. After the first measurement of CS_A and the establishment of the baseline, the increase in soil carbon can be estimated based on representative experiments or soil models, before a second measurement of the increase in carbon stock is made. The requirements for the integration of soil carbon stock measurements and modelling estimates are as follows:
   a. The models used shall take into account the different soil, climate and field management history to simulate carbon dynamics in soil.
   b. From the second measurement onwards, the measurements shall constitute the ultimate basis for determining the actual values of the increase in soil carbon stock.

Field measurement rules

In order to claim the e_{sca}, field measurements of soil carbon stocks shall be performed by certified laboratories and samples shall be retained for a period of at least 5 years for auditing purposes.The measurement of carbon stocks in the field shall follow the rules described below to ensure the representativeness of soil sampling and to secure that the relevant parameters are measured and properly determined.

Sampling rules

Representative sampling method:

> Sampling shall be made for each plot or field.

> At least one grab sample of 15 well distributed sub-samples per every 5 hectares or per field, whichever is smaller (taking into account the heterogeneity of the plot's carbon content), shall be taken.

> Smaller fields with the same climatic conditions, soil type, reference farming practice, and e_{sca} practice can be grouped.

> Sampling shall be done either in spring before soil cultivation and fertilization or in autumn, a minimum of 2 months after harvest.

[15] *ISCC will provide statistical information and qualitative feedback on the esca methodology in the annual activity report as described in the EU 102 Governance document.*

> Direct measurements of soil carbon stock changes shall be taken for the first 30 cm of soil.

> The points of the initial sampling to measure the baseline of soil carbon stocks shall be used under identical field conditions (especially soil moisture).

> The sampling protocol shall be well documented.

Measurement of the soil carbon content

> Soil samples shall be dried, sieved, and, if necessary, grounded.

> If the combustion method is used, inorganic carbon shall be excluded.

Determination of dry bulk density

> Changes in bulk density over time shall be taken into account.

> Bulk density should be measured using the tapping method, by mechanically tapping a cylinder into the soil, which greatly reduces any errors associated with bulk density measurement.

> If the tapping method is not possible, especially with sandy soils, another reliable method shall be used instead.

> Samples should be oven-dried before weighing.

Integration with modelling

After the second measurement, economic operators may use modelling to estimate the annual increase in soil carbon stocks. This is possible only until the next measurement becomes available and only if the models used have been calibrated, based on the real values measured. Only modelling estimates obtained by ISCC-validated models described below, can be accepted for the integration with field measurement values. However, the final actual values that are established based on the soil carbon measurements results, shall be used to adjust the annual claims of e_{sca}, made on the basis of modelling.

Validated soil models

According to the Annex V of the IR, models used to estimate soil carbon increase between the baseline and the second measurement, and in between successive measurements after the second one, shall take into account the different soil types, climate conditions and field management history. On this basis, ISCC has assessed and validated for such use the soil models listed below. Economic operators which intend to use soil modelling integrated with field measurement shall use one of those. Any other model outside the models validated by ISCC will not be accepted for the purpose of e_{sca} estimate.

RothC model

RothC is a well-established and robust model for the turnover of organic carbon in non-waterlogged topsoils that allows for the effects of soil type, temperature, moisture content and plant cover on the turnover process. RothC was developed by the Institute of Arable Crops Research-Rothamsted (IACR) (formerly known as Rothamsted Experimental Station) in the UK. RothC was originally developed and parameterized to model the turnover of organic C in arable topsoils from the Rothamsted Long Term Field Experiments - hence the name. Later, it was extended to model turnover in grassland and woodland and operate in different soils and climates.

RothC structure

The model is structured to consider four active compartments of soil plus a small amount of inert inorganic matter. The soil organic carbon in tonnes/ha at the start of the RothC simulation is divided into decomposable plant material (DPM) and resistant plant material (RPM), both of which decompose, by first-order processes to give CO_2 (lost from the system), microbial biomass (BIO) and humified organic matter (HUM). Both BIO and HUM decompose at their characteristic rates by first-order processes to give more CO_2, biomass and humified matter. The soil is also assumed to contain a small organic compartment that is inert to biological attack which is known as IOM (inert organic matter).[16]

RothC input

It uses a monthly time step to calculate total organic carbon (t ha -1), microbial biomass carbon (t ha -1) and ∆14C (from which the equivalent radiocarbon age of the soil can be calculated) on years to centuries timescale[17] .

The input information required to run the model are:

> average monthly rainfall (mm),
> average monthly open pan evaporation (mm),
> average monthly air temperature (°C),
> clay content of the soil (%),
> an estimate of the decomposability of the incoming plant material,
> soil cover for each month (between 0 = bare and 1 = vegetated),
> monthly input of plant residues (t C/ha),
> monthly input of farmyard manure (FYM) (t C/ha) (if applicable)
> the depth of soil sample (cm).

Applicability and limitations

RothC model can be applied to simulate and estimate soil carbon accumulation in arable crops in different soils and climates. It can also be used with reliable results on grassland and woodlands. However, it should be used cautiously on subsoils, soils developed on recent volcanic ash, soils from the tundra and taiga and not at all on soils that are permanently waterlogged.

'Forward' mode

RothC runs in two modes 'forward' and 'inverse'. In the former, known inputs are used to calculate changes in soil organic matter, while in the latter, inputs are calculated from known changes in soil organic matter. For the purpose of

[16] Jenkinson et al., 1991
[17] Jenkinson et al. 1987; Jenkinson, 1990; Jenkinson et al. 1991; Jenkinson et al. 1992; Jenkinson and Coleman, 1994

e_{sca} estimate, only the results obtained by ROTHC model, run in 'forward' mode, will be accepted.

Century model

CENTURY model

The CENTURY model is another option that can be accepted by ISCC for e_{sca} estimate purposes. It is a plant-soil ecosystem model that has been developed by Parton et al. (1987) to simulate C, N, P, and S dynamics through an annual cycle over different time scales. The primary purpose of the model is to provide a tool for ecosystem analysis to evaluate the effect of changes in management and climate on ecosystems. The model was specially developed to deal with a wide range of cropping system rotations and tillage practices for system analysis of the effects of management and global change on the productivity and sustainability of agroecosystems.

The CENTURY model has a long application history in the simulation of ecosystem dynamics for all the major agroecosystems and dominant cropland of the world. It has been used to simulate the response of these ecosystems to changes in environmental driving variables (e.g., maximum, and minimum air temperature, precipitation, and atmospheric CO_2 levels) and changes in the management practices (grazing intensity, forest clearing practices, burning frequency, fertilizer rates, crop cultivation practices etc.) for grasslands, crop, forest, and savanna ecosystem. In addition, CENTURY has been successfully applied to a variety of scales, including national, regional, and plot-level experiments for a range of long-term experiments (Ogle et al., 2010). Such a wide applicability and proven robustness makes this model suitable for the e_{sca} purposes.

CENTURY structure

The structure of CENTURY model comprises a series of submodels simulating plant growth, nutrient cycling, and soil organic matter (SOM) dynamics for grassland, agricultural (i.e., cropland), forest, and savanna system. The major structural components of the CENTURY model are:

> Plant production: the submodel calculates potential plant production and nutrient demand as a function of monthly average soil temperature and precipitation, it reduces plant protection, based on available soil nutrients and allocates new C, N, and P to the different live plant compartments.

> Soil organic matter: through multiple components, the submodel simulates the dynamics of carbon and soil nutrients for the different inorganic and organic SOM pools. Decomposition of the SOM pools results in the release of soil nutrients from the SOM pools which are then available for plant uptake. Dead plant material from the plant production submodel flows into the surface and belowground litter pools, which are inputs to the SOM model.

> Soil water and temperature sub-models: Monthly precipitation, stored soil water, and soil temperature control the rate of decomposition of

the soil organic matter pools and the release of nutrients from the SOM pools.

CENTURY input

The input required to run the CENTURY model refers to soil texture and type, climate, and agricultural management practices. Those are available for most natural and agricultural ecosystems and can generally be estimated from existing literature. Table 3 shows in detail the input variables requested by the model.

Input Variables		
Soil	**Climate**	**Agricultural practices (if applicable)**
Mandatory: -Texture (fraction 0-1): sand, silt, and clay - Lignin, N, S and P content of plant material - Soil and atmospheric N inputs - Initial soil carbon, nitrogen (phosphorous and sulfur optional) **Optional:** - Bulk density - pH - Soil drainage class - Soil layers and thickness: the rooting zone depth (depth above which most fine roots are found) - Stream flow calibration - Field capacity and wilting point - External nutrient input parameters - Forest soil: initial forest floor and soil carbon storage	- Monthly precipitation - Temperature (minimum and maximum) - Monthly average maximum and minimum air temperature	- Type of crop in use - Date of crop planting - Type of harvest - The First month of growth for crops - Last month of growth for crops - Months of senescence for crops - Fertilization event in the current month - Cultivation event in the current month - Organic matter addition event in the current month. - Irrigation event in the current month - Grazing event in the current month - Erosion event in the current month - Fire in the current month - Tree type - Tree removal - The first month of growth of the forest - The last month of growth of the forest

Table 3 – Detailed input for the CENTURY model

Applicability

The CENTURY model can be used to simulate soil organic carbon dynamics across a variety of ecosystems including grassland, croplands, savanna, and forests, for a range of timescales from years to centuries. Simulation of complex agricultural management systems including crop rotations, tillage practices, fertilization, irrigation, grazing, and harvest methods is also possible. CENTURY model can be applied to a variety of scales from national, to regional and down to farm and plot scale.

DAYCENT model

Alongside the CENTURY model, the DAYCENT model exists and represents a third accepted option for the e_{sca} estimate purpose. DAYCENT (Parton et al. 1998, DelGrosso et al. 2001, Kelly et al. 2000) is the daily time step version of the CENTURY ecosystem model. It includes submodels for plant productivity, decomposition of dead plant material and SOM, soil water and temperature dynamics, and trace gas fluxes which requires a finer time scale resolution. In addition to modelling decomposition, nutrient flow, soil water and temperature on a finer time scale than CENTURY, DAYCENT also uses spatial resolution for soil layers.

General provisions must be considered for the calculation of carbon stocks and of the e_{sca}:

Cut-off date

> Emission savings from such improvements can be considered if evidence is provided that the above-mentioned practices were adopted **after January 2008**.

> Setting the baseline

> CS_R must be set before the improved agriculture management is applied. In absence of that, changes in soil organic carbon (and their magnitude) cannot be detected.

> Evidence required

> **Solid and verifiable evidence for each individual farmer who claims e_{sca}** must be provided that the improved agricultural management practices giving right to e_{sca} claim are implemented in best practice so that an increase in soil carbon can be expected over the period in which the raw materials concerned were cultivated. ISCC reserves the right to reject certain improved agricultural practices if scientific evidence shows that these practices will not sequester the SOC in the long run.

> e_{sca} actual value

> The actual values for e_{sca} have to be calculated at the individual farm level, i.e. it is not allowed to use a regional approach. This can result **in different e_{sca} values per farmer.** The area for which the soil carbon stocks are calculated shall have a similar climate and soil type as well as similar management history in terms of tillage and carbon input to soil. In case of non-homogenous soil, climate or management practice(s), soil organic carbon values have to be estimated for every single field the farmer owns, or rents and e_{sca} has to be calculated at the farm level.

> Different e_{sca} values for different practices

> In a single farm where different improved management practices are applied, a claim of GHG emission savings shall be calculated, claimed and forwarded individually for each e_{sca} practice.

Averaging is not possible

> **Averaging** emission values from farmers applying e_{sca} and farmers not applying e_{sca} **is not allowed**, and only those farmers who apply e_{sca} measures are allowed to forward respective values together with the batch of sustainable material.

> Increased inputs

> **Increased use of fertilisers or agrochemicals for pest control (e.g. herbicides), due to the application of improved agricultural practices must be considered** in terms of overall GHG emissions from cultivation (e_f). For example, shifting from conventional to no-tillage prevents the mechanical control of weeds through tillage. Also, leaving crop residue in the field, without post-harvest incorporation in soil, may significantly increase the risk of spreading plant diseases to the next crop in rotation. To avoid such problems, the switch to no-tillage practices will most likely result in an increase in agro-chemicals input that must be accounted for. Additionally, for organic fertilisers

N_2O emissions must be calculated. The implementation of nitrogen fixation crops used to reduce the additional fertilisers can be considered in the calculation. For this purpose, adequate evidence shall be provided on the historic use of fertilisers or herbicide that shall be counted as the average for the 3 years before the application of the new agricultural practices.

Annual caps for e_{sca} claim

The maximum possible total value or the annual claim for e_{sca} is 25 g CO_2eq/MJ biofuel or bioliquids per year, for the entire period of application of the e_{sca} practice. If biochar is used as organic soil improver alone or in combination with other eligible e_{sca} practices, the maximum possible value for the annual e_{sca} claim is raised to 45 g CO_2eq/MJ biofuel or bioliquids.

Rules for previously engaged operators

Primary producers or economic operators, who are already engaged in eligible e_{sca} practices and have made respective e_{sca} claims before the entry into force of the Implementing regulation, may apply a cap of 45 g CO2eq/MJ biofuel or bioliquid in a transition period until the first measurement of the carbon stock is made at the 5th year. In this case, the measured carbon stock increase during the 5th year will become a cap for the annual claims to be made in the following period of 5 years.

Conceding that the first measurement if the carbon stock increase at the 5th year and it shows higher total annual carbon stock increase, compared to the annual claims made, the annual difference can be claimed by primary producers or economic operators in subsequent years to compensate for lower carbon stock increases. If the first measurement of the carbon stock increase at the 5th year shows lower total annual soil carbon stock increase, compared to the annual claims made, the annual difference has to be deducted accordingly by farmers or economic operators from their claims in the subsequent five years.

Retroactive e_{sca} claim

In case that the eligible e_{sca} improved agricultural management practices application started in the past, but no previous e_{sca} claims were made, annual retroactive e_{sca} claims can be made, provided that economic operators provide adequate evidence about the start of the application of the improved farming practices. In such a case, the estimate of the CS_R value can be based on a comparative measurement of a neighboring or other field with similar climatic and soil conditions as well as similar field management history. If there is no available data from such a field, the CS_R estimated value can be based on modelling. In that case, a first measurement shall be done immediately, at the moment of commitment. The next measurement of carbon stock increase will have to be made 5 years later.

A retroactive e_{sca} claim is possible for no longer than 3 years prior to the moment of e_{sca} certification.

Long-term commitment

In contrast to a direct avoidance of GHG emissions, the increase of SOC as a climate protection measure is only effective if carbon storage is long-term and the corresponding amount of CO_2 is thus removed from the atmosphere for the foreseeable future. Changes in agricultural practices can completely reverse the positive effect of the SOC build-up. Hence, **a long-term commitment by the farmer or economic operator is requested** to continue applying the improved management practice for a minimum of 10 years for GHG emission savings to be taken into consideration. **The long-term commitment may be implemented as a 5-years renewable commitment.** Failure to meet this criterion will lead to all e_{sca} values of the current year for the farmer or economic operator being added as emissions to the overall GHG emissions of the energy crop delivered, instead of being deducted as GHG emissions savings. Additionally, including an e_{sca} value in the GHG calculations will be prohibited for 5 years. In case a long-term commitment is signed in the name of an economic operator on behalf of several farmers and one of these farmers withdraws early, the above-mentioned 5-years penalty shall apply only to the farmer concerned and not to all the commitments of the economic operator. Once the 5-years penalty is over, farmers will be requested to set a new CS_R baseline and to follow entirely the rules defined above for the e_{sca} calculation, to be entitled again for e_{sca} claims. Regarding penalties[18] relating to farmers` operation under a group, ISCC will enforce the penalties and duly inform all other voluntary schemes as well as publish this information as described in the ISCC EU system document 102 “Governance”.

Long-term commitment failure and penalties

3 years minimum period

Additionally, the improved agricultural management practices shall be applied **continuously** for at least three years successively if the economic operators would like to account for e_{sca}. This means that it is not allowed to switch management practices every year when e_{sca} is claimed.

Forwarding of e_{sca}

Together with the batch of the respective agricultural raw material, the supplier forwards the actual GHG value for soil carbon accumulation via improved agricultural management e_{sca} in kg CO_2eq/dry-ton raw material to the recipient.

Specific requirements for biomass fuels:

For e_{sca} a bonus of 45 g CO_2eq/MJ manure shall be attributed for improved agricultural and manure management in the case animal manure is used as a substrate for the production of biogas and biomethane. Auditors need to verify during the audit at the biogas plant if the bonus can be applied. In case of compliance, respective information needs to be forwarded throughout the supply chain via Sustainability Declarations and the final biofuel producer can deduct the bonus in the final biofuel proof of sustainability (PoS). Auditors need to verify at the processing unit if the above stated requirement is fulfilled so that the bonus can be applied. In case of compliance, respective information needs to be forwarded throughout the supply chain via Sustainability Declarations and the final biofuel producer can deduct the bonus in the final biofuel proof of sustainability (PoS) from the total GHG value of the final product.

[18] *For penalties refer to sanctions as it is described in the ISCC System Document 102 “Governance”.*

4.3.4 Emissions from transport and distribution (e_{td})

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.

4.3.4.1 Calculation formula for transport emissions

Formula for e_{td}

GHG emissions from upstream transport of the feedstock or downstream transport of the product e_{td} can be calculated based on the following formula:

$$e_{td}\left[\frac{kg\ CO_2eq}{ton}\right] = \frac{T_{needed} * \left(d_{loaded}[km] * K_{loaded}\left[\frac{l}{km}\right] + d_{empty}[km] * K_{empty}\left[\frac{l}{km}\right]\right) * EF_{fuel}\left[\frac{kg\ CO_2eq}{l}\right]}{amount\ transported\ material\ [ton]}$$

In order to find out how often a transport system was used for the transported amount, T_{needed} must be calculated. If e.g. amount is received in wet-ton, this value is calculated by dividing the amount of transported goods (wet) by the loading weight of the transport system used, e.g. if 100 tons of input material is transported by trucks which can carry 20 tons, 5 trucks ($T_{needed} = 5$) would be needed to transport all the feedstock. The sum of the fuel consumption of loaded transport and empty transport (if applicable) is multiplied with the number of times this transport system is being used and the EF of the fuel. Afterwards emissions are adapated to dry-matter.

Alternative formula for e_{td}

As an alternative, the methodology for ton-km may also be used:

$$e_{td}\left[\frac{kg\ CO_2eq}{ton}\right] = Distance[km] * Transport\ Efficiency\left[\frac{MJ}{tkm}\right] * EF_{fuel\ type}\left[\frac{gCO_2eq}{MJ}\right] * \frac{moist\ weight\ transported\ [ton]}{dry\ weight\ transported\ [ton]}$$

To calculate the emissions of transport per ton of feedstock, the distance of transportation is multiplied with the transport efficiency of that transportation type, the emission factor of the used fuel and the ratio of moist and dry weight of the transported materials.

After replicating this approach for each different transport type along the transportation route the emissions are summed up to yield the final result.

Upstream and downstream transport

As processing units calculate upstream transport emissions in kg CO_2eq/dry-ton feedstock but have to provide GHG values in terms of the output they deliver, emissions need to be adapted to determine kg CO_2eq/dry-ton of product by applying the feedstock factor. In chapter 4.3.7 and 4.3.8 the methodologies for converting and allocating upstream emissions are described.

Responsibilities of traders:

Paper traders do not calculate emissions from transport but simply forward information on GHG emissions on outgoing sustainability declarations as received.

Traders with storage do not calculate emissions from transport but communicate the transport distance(s) and transport type(s) towards their storage site on the outgoing sustainability declaration. The receiving down stream supply chain unit must account for the emissions from that transport in their GHG calculation.

Traders after the final fuel producer do not calculate, nor amend GHG emission values, as it is the responsibility of the final biofuel/bioliquid/biomass producer responsible to take the complete downstream transport inot account under e_{td}

4.3.4.2 Data basis

On site data gathering

Relevant input data for transport

For the calculation of e_{td} the following information needs to be provided through on-site data gathering. All input values must be gathered for the same time period.

> Transport distance (d) loaded/empty respectively (if the empty return ways are attributable to the certified company they must be taken into account. If the return way is not empty and accountable to another company, which can be proven by relevant documentation, return ways can be excluded for transport calculations),

> Mode of transport (e.g. diesel truck, 40t) and,

> Amount of product transported.

Published data

Relevant published data

Input data for various transportation types may be found in the Annex IX of the IR 2022/996.

As an alternative to using transport efficiency data from literature, these data can also be measured by the logistics providers and provided to the economic operator who is in charge of calculating emissions from transport. The reports from the logistics provider must be verified.

Forwarding of e_{td}

Together with the batch of the respective material, the supplier forwards the actual GHG value for transport and distribution e_{td} in kg CO_2eq/dry-ton product to the recipient.

The emissions of depots and filling stations may be calculated using the data provided by the JRC[19]. The provided values (depot: 0,00084 MJ/MJ fuel, filling station: 0,0034 MJ/MJ fuel) must be multiplied by the appropriate national electricity EF from the IR 2022/996

Emissions from depots and filling stations

Specific requirements for biomass fuels:

Gas losses occurring from the transport of gas in the transmission and distribution infrastructure (gas grid) must be included in the scope of the GHG emissions savings calculation. For this purpose a standard factor for grid gas losses of 0.17 g CH_4/ MJ NG supplied should be used[20].

4.3.5 Emissions from processing (e_p)

Emissions from processing, e_p, shall include emissions from the processing itself, from waste and leakages, and from the production of chemicals or products used in processing, including the CO_2 emissions corresponding to the carbon content of fossil inputs, whether or not actually combusted in the process. Emissions from processing shall include emissions from drying of interim products and materials where relevant.

4.3.5.1 Calculation formula for processing emissions

The calculation must be based on the following formula:

Sum of emissions from processing

$$e_p\left[\frac{kg\ CO_2eq}{ton}\right] = \frac{\left(EM_{electricity} + EM_{heat} + EM_{inputs} + EM_{wastewater}\right)\left[\frac{kg\ CO_2eq}{yr}\right]}{\text{yield product}\left[\frac{ton}{yr}\right]}$$

For all types of products, the yield shall refer to the dry matter content. If not calculated per dry ton directly a correction needs to take place (please find the formula in chapter 4.2).

The emissions of the different inputs (EM) must be calculated according to the formulas below and divided by the yield of the main product.

Emissions of individual inputs (EM)

Formula components for calculating EM are:

$$EM_{electricity} = electricity\ consumption\left[\frac{kWh}{yr}\right] * EF_{regional\ electricity\ mix}\left[\frac{kg\ CO_2eq}{kWh}\right]$$

$EM_{electricity}$

If **electricity** is consumed from the grid, the EF of the national/country electricity mix ($EF_{electricity}$) shall be used. The IR provides country-specific EFs for electricity. If electricity from renewable energies is directly consumed (i.e. not supplied from the grid), an adapted EF for the type of renewable electricity

[19] European Commission, Joint Research Centre, Padella, M., O'Connell, A., Giuntoli, J. et al., *Definition of input data to assess GHG default emissions from biofuels in EU legislation – Version 1d - 2019*, Publications Office, 2019, https://data.europa.eu/doi/10.2760/69179

[20] JRC report (Version 1d - 2019), Definition of input data to assess GHG default emissions from biofuels in EU legislation

may be used if that plant is not connected to the electricity grid. In the case that an electricity production plant is connected to the grid (e.g. a waste incineration plant), using the average emission value for electricity from that individual electricity production plant in the biofuel production process is permitted if it is guaranteed that there is a direct connection between the biofuel plant and the individual electricity production plant and that it is possible to validate the amount of electricity used with a suitable meter.

EM_{heat}

For calculating the emissions from heat production, two different formulas can be used, based on the available units of the provided heat:

$$EM_{heat} = fuel\ consumption\ \left[\frac{kg\ or\ l}{yr}\right] * EF_{fuel}\left[\frac{kg\ CO_2eq}{kg\ or\ l}\right]$$ or

$$EM_{heat} = heat\ produced\ from\ fuel\ \left[\frac{MJ}{yr}\right] * EF_{fuel/heat\ system}\left[\frac{kg\ CO_2eq}{MJ}\right]$$

As the EFs for heat production differ for the fuel and the heating system, both data must be documented. For calculating EM_{heat} the consumed heat or the fuel consumption for producing the heat for all activities during processing must be determined and multiplied with the respective EF. If heat and electricity are consumed from a combined heat and power system (CHP), two EFs exist, one for the produced heat and the other for the produced electricity. One can either determine the total fuel consumed in the CHP and multiply that with the EF for the fuel or determine electricity and heat production and apply the different EFs for heat and electricity.

EM_{inputs}

$$EM_{inputs} = inputs\ consumption\ \left[\frac{kg\ or\ l}{yr}\right] * EF_{inputs}\left[\frac{kg\ CO_2eq}{kg\ or\ l}\right]$$

EM_{inputs} refers to all other types of inputs required as e.g. consumed chemicals (e.g. hydrogen), other production goods, process water, or diesel or other fuel used in the production process (e.g. natural gas).

$EM_{wastewater}$

$$EM_{wastewater} = wastewater\ \left[\frac{cbm}{yr}\right] * EF_{wastewater}\left[\frac{kg\ CO_2eq}{cbm}\right]$$

All wastewater that is generated during the activities of processing must be documented and multiplied with the respective EF.

4.3.5.2 Data basis

System boundaries

Every processing unit in the supply chain must guarantee that all GHG emissions from processing, GHG emissions from wastes (wastewater), and from process-specific inputs are included in the emissions calculation. Annual average figures can be used.

Emissions allocation to different products

Emissions from processing need to be allocated to main products and co-products. The methodology for doing so is described in chapter 4.3.7 “Working with incoming emission values” and 4.3.8 “Allocation of emissions to main products and co-products”.

For the calculation of GHG emissions from processing (e_p) as a minimum, the following data shall be determined i.e. the respective quantities must be extracted from respective operating documents for the previous year and must be verified by the auditors.

On-site data gathering

On-site data always needs to be gathered for the whole process and not purely for biofuel-relevant processes. The following data for the calculation of GHG emissions must be gathered on-site. All input values must be gathered for the same time period.

Relevant input data for processing

> Amount of main product and co-products in tons per year. Either refers to dry matter or emissions must be adapted by applying a moisture factor (see formula in 4.2)

> Amount of process-specific inputs used (e.g. methanol, NaOH, HCl, H2SO4, hexane, citric acid, fuller’s earth, alkali, process water, diesel or other fuel) in kg per year or litres per year

> Combustion emissions

> Combustion emissions of fossil methanol or other process catalysts containing methanol (e.g. potassium methylate) must also be taken into account and need to be reflected in the relevant EF and must be verified by the Certification Body

> Electricity consumption in kWh/yr and source of electricity (e.g. grid)

> Heat consumption in MJ/yr, fuel for heat production (e.g. natural gas) and type of heating system (e.g. boiler or combined heat and power system)

> Amount of wastes (e.g. palm oil mill effluent (POME), wastewater) in kg/yr

Published data

Relevant published data

The following data for the calculation of GHG emissions can be gathered from recognised/certified sources:

> EFs for process specific inputs in kg CO_2eq/kg and fuels used in kg CO_2eq/l

> EFs for electricity consumption based on the source of electricity in kg CO_2eq/kWh

> EFs for heat consumption based on the fuel and the type of heating system in kg CO_2eq/MJ.

Forwarding of e_p

The actual GHG value for an intermediate product must be provided to the recipient of the product in the unit kg CO_2eq/dry-ton product. The total GHG emissions are calculated per dry-unit mass of the main product (e.g. kg CO_2eq-emissions/dry-ton of sunflower oil). If a processing unit has received actual values and also conducts an individual calculation, emissions produced at the processing unit have to be added by applying a feedstock and allocation factor (see chapter 4.3.7 and 4.3.8).

Specific requirements for bioliquids and biomass fuels:

Allocation to substrate quantities

For the individual calculation of GHG emissions for biogas and biomethane plants the substrate quantities documented in the operations journal and the assigned GHG values must be taken into account for the calculation. The total biogas and/or biomethane yield will be allocated to the individual substrates. An exact allocation of substrate quantity and gas yield is not possible. Therefore, the allocation of gas yields is done via literature values such as methane yields (in m3 per ton of fresh mass) that can be found for instance in the German Biomass Ordinance (BiomasseV) or in scientific documents (e.g. KTBL values "Typical values for agriculture").

Additional Emission Sources

Biogas plants must consider emissions occurring during the storage of the digestate for the GHG calculation. At the biomethane plant, diffuse methane emissions from the fermentation process must be taken into account when calculating GHG emissions. Methane emissions of 1% of the biomethane quantity produced are assumed. Lower values must be proven by corresponding measurements. Liquefaction emissions and losses must also be accounted for. If no actual data is available, electricity consumption of 0.06048 MJ (LV) / MJ fuel and LNG losses of 0.13 kJ/MJ fuel shall be considered. The electricity consumption has to be multiplied with the respective national grid mix factor from the IR.

Cogeneration units

Where a cogeneration unit which provides heat and/or electricity to a fuel 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.

<u>The following methodologies need to be applied:</u>

For bioliquids: RED II Annex V, C.Methodology, point 16

For biomass fuels: RED II Annex VI, B.Methodology, point 16

The greenhouse gas intensity of excess useful heat or excess electricity is the same as the greenhouse gas intensity of heat or electricity delivered to the fuel production process and is determined by calculating the greenhouse gas intensity of all inputs and emissions, including the feedstock and CH4 and N_2O emissions, to and from the cogeneration unit, boiler or other apparatus delivering heat or electricity to the biomass fuel production process. In the case of cogeneration of electricity and heat, the calculation is performed following the two above stated references[21].

4.3.6 Emission savings from CO_2 capture and replacement (e_{ccr}) and CO_2 capture and geological storage (e_{ccs})

Emission savings from CO_2 capture and replacement (e_{ccr}):

"CO_2 Replacement"

The RED II sets out that emission savings from carbon capture and replacement, e_{ccr}, shall be limited to emissions avoided through the capture of CO_2 of which the carbon originates from biomass. e_{ccr} can only be taken into account if it can be proven that the CO_2 replaces fossil-derived CO_2 which is used in the production of commercial products and services. Therefore, the recipient should provide information on how the CO_2 that is replaced was generated previously and declare, in writing, that due to the replacement, emissions are avoided. The auditor is responsible for deciding whether the requirements of the RED II are met on a case-by-case basis, including deciding whether emissions are actually avoided. It is not required to conduct audits on the premises of the recipient as the recipient of the CO_2 is not part of the chain of custody related to the biofuel production. Good examples for a replacement which can be expected to avoid CO_2 emissions are cases where the CO_2 that is replaced was previously produced in a dedicated process aiming at the production of CO_2.

Auditors shall verify that the estimate of emissions saving from capture and replacement of CO2 is 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. That verification requires access to the following information:

> the purpose for which the captured CO2 is used;

> the origin of the CO2 that is replaced;

> the origin of the CO2 that is captured;

> information on emissions due to capturing and processing of CO2.

For the purposes to proof the origin of the CO_2 that is replaced economic operators using captured CO_2 may state how the CO_2 that is replaced was previously generated and declare, in writing, that emissions equivalent to that quantity are avoided as a consequence of the replacement. That evidence shall be considered sufficient to verify compliance with the requirements of Directive (EU) 2018/2001 and the avoidance of emissions.

Emission savings from CO_2 capture and geological storage (e_{ccs}):

"CO_2 Storage"

CCS savings can only be taken into account in e_{ccs} if the emissions have not already been accounted for in e_p. Valid evidence needs to be provided that

[21] *For biofuels and bioliquids: RED II Annex V, C. Methodology, point 16; For biomass fuels: RED II Annex VI, B.Methodology, point 16*

CO_2 was effectively captured and safely stored in compliance with Directive 2009/31/EC of the European Parliament and of the Council on the geological storage of carbon dioxide[22]. Where the CO_2 is geologically stored, CBs shall verify the evidence provided on the integrity of the storage site and the volume of the CO_2 stored and report compliance in the respective audit documentation. If the CO_2 is directly stored it should be verified whether the storage is in good condition, that there are no leakages, and that the existing storage guarantees that the leakage does not exceed the current state of technology. Where a third party carries out the transport or geological storage, proof of storage may be provided through the relevant contracts with and invoices of that third party.

The following formula shall be used to calculate e_{ccr} and e_{ccs} (in g CO_2eq per MJ fuel):

$$e_{ccr/ccs}\left[\frac{g\ CO_2eq}{MJ}\right] = \frac{\left(produced\ CO_2[kg] - energy\ consumed\ [MWh] * EF\left[\frac{kg\ CO_2eq}{MWh}\right] - input\ materials\ [kg] * EF\left[\frac{kg\ CO_2eq}{kg}\right]\right) * 1000}{produced\ quantity\ of\ biofuel\ [t] * 1000 * lower\ heating\ value\ biofuel\left[\frac{MJ}{kg}\right]}$$

System boundaries

For both elements, the emissions saved must relate directly to the production of the biofuel or its intermediates that they are attributed to. All biofuels/intermediates originating from the same process must be treated equally, i.e. the allocation of arbitrarily different amounts of savings to biofuels obtained from the same process is not permitted. If the CO_2 is not captured continuously, it might be appropriate to deviate from this approach and to attribute different amounts of savings to biofuel obtained from the same process. However, in no case should a higher amount of savings be allocated to a given batch of biofuel than the average amount of CO_2 captured per MJ of biofuel in a hypothetical process where the entire CO_2 stemming from the production process is captured. Emissions related to the capture and processing of CO_2 have to be taken into account in the calculation by applying the appropriate EFs for the energy consumed and the inputs used.

On-site data gathering

Relevant input data for CO_2 capture

For the calculation of e_{ccr} and e_{ccs} the following information needs to be gathered on-site:

Amount of biofuel, bioliquid and biomass fuel produced

e_{ccr}: Quantity of biogenic CO_2 captured for replacement of fossil CO_2 during the biofuel, bioliquid and biomass fuel production process

22 Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide and amending Council Directive 85/337/EEC, European Parliament and Council Directives 2000/60/EC, 2001/80/EC, 2004/35/EC, 2006/12/EC, 2008/1/EC and Regulation (EC) No 1013/2006 (OJ L 140, 5.6.2009, p. 114).

e_{ccs} : Quantity of CO_2 captured and stored for storage during the biofuel, bioliquid and biomass fuel production process

Origin of the (biogenic) CO_2 (extraction, transport, processing and distribution of fuel)

Quantity of energy consumed for the capturing and the processing of CO_2 (e.g. compression and liquefaction)

Other input materials consumed in the process of CO_2 capture and processing

Published data

Relevant published data

The following information needs to be gathered from recognised/certified sources:

GHG EFsfor all inputs and their sources (e.g. for input materials, energy consumption etc.)

LHV of the main product in MJ per kg

4.3.7 Working with incoming emission values

As referred to in chapter 3.1, "Use of default values" and 3.2, "Use of actual values" certified economic operators must state the calculated GHG value or DDV for all relevant elements of the calculation formula on the Sustainability Declaration of their product if the TDV is not applied.

Aggregation of different input values

If an ISCC System User receives different GHG values, the aggregation of GHG values from incoming input materials is only possible if the product identities and GHG values are the same. As an alternative to using single values for each incoming batch, the highest GHG value (of the least performing batch) can also be used for all incoming batches of the same kind of input material.

Requirements for incoming and own GHG values

Incoming GHG emission values need to be adjusted from kg CO_2eq/dry-ton of feedstock to kg CO_2eq/ton of product. In order to do so, emissions of input materials are multiplied by a fuel **feedstock factor (FF)**. For some of the received actual GHG values, like processing emissions or transport emissions, actual values need to be added at each step of the chain of custody by the respective operational unit.

4.3.7.1 Feedstock factor for intermediates

A feedstock factor (FF) needs to be applied for all incoming emissions (e_{ec}, e_{sca}, e_l, e_p, e_{td}, e_{ccr} and e_{ccs}) as they are expressed in terms of the input material and need to be converted to the respective outgoing product of the certified unit. Hence, the FF represents the ratio of dry input material required to make one ton of dry output. For intermediate products the FF is *mass-based* and is calculated by dividing the total amount of feedstock (in this case raw material) by the total amount of the intermediate main product. The following formula must be applied when processing intermediate products:

Feedstock factor for intermediates

$$FF = Ratio\ of\ X\ ton\ dry\ feedstock\ required\ to\ make\ 1\ ton\ dry\ intermediate\ product$$

$$= \frac{Total\ amount\ of\ feedstock\ (ton_{dry})}{Total\ amount\ of\ output\ (ton_{dry})}$$

The formula below shows an example how the feedstock factor has to be applied when a company has received a GHG value for emissions from cultivation for its input material (e_{ec} of feedstock a), processes the material into an intermediate product (e.g. vegetable oil) and needs to forward an adapted individual value for emissions from cultivation on the outgoing Sustainability Declaration (for the certified vegetable oil):

$$e_{ec}interm.product_a \left[\frac{kg\ CO_2eq}{ton_{dry}}\right] = e_{ec}feedstock_a \left[\frac{kg\ CO_2eq}{ton_{dry}}\right] * Fuel\ feedstock\ factor_a$$

Adding own emissions

After converting the GHG emissions of the incoming input material to the GHG emissions of the intermediate product, the additional emissions of the recipient need to be added to the emissions accordingly. For instance, in figure 7, processing unit P2 has to add its actual GHG values for upstream e_{td} and apply the FF. While incoming emissions of e_p will also be multiplied by the FF, the processing unit's own processing emissions will not, but will only be added to the calculated value of e_p.

4.3.7.2 Feedstock factor for final fuels

As for intermediates, the FF also needs to be applied for all incoming emissions (e_{ec}, e_{sca}, e_{l}, e_p, e_{td}, e_{ccr} and e_{ccs}) for final products as they are expressed in terms of the feedstock (in this case a raw material or an intermediate product depending on the type of plant) and need to be converted to the respective outgoing product of the certified unit. An example would be when a final biofuel producer, which has received a GHG value for emissions from extraction and cultivation together with the delivery of the feedstock (e_{ec} of vegetable oil), processes the material into a final product (e.g. biodiesel) and needs to forward an adapted individual value for emissions from cultivation on the outgoing Sustainability Declaration for the biodiesel. For final biofuels the FF is calculated on an *energetic basis* by dividing the total energy content of the feedstock by the total energy content of the final biofuel main-product. The following formula must be applied when processing final biofuels:

Feedstock factor for final fuels

$$Final\ fuel\ feedstock\ factor = [Ratio\ of\ X\ MJ\ feedstock\ required\ to\ make\ 1\ MJ\ final\ fuel]$$

$$FF = \frac{Total\ energy\ content\ of\ feedstock\ (MJ)}{Total\ energy\ content\ of output\ (MJ)}$$

The energy content is calculated based on the lower heating value (LHV) of the materials.

4.3.8 Allocation of emissions to main- and co-products

General requirements

Only emissions up to and including the production of the intermediate product and co-products can be included in the allocation via an allocation factor (AF). Downstream processing or transport and distribution emissions of an intermediate product cannot be added prior to allocation, as those emissions are not related to the co-products. The allocation of GHG emissions to any products that are considered a waste or residue (including agricultural residues like straw) is not permitted. The emissions to be divided are 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.

Relevant data

Yields of intermediates/final fuels and co-products shall be measured on-site, while relevant lower heating values can come from published sources. Co-products that have a negative energy content shall be considered to have an energy content of zero for the purpose of the calculation.

Forwarding of GHG information

After applying the FF and AF, the certified company passes on the GHG emission information in kg CO_2eq/dry ton intermediate product or g CO_2eq/MJ final biofuel together with the product itself on the Sustainability Declaration.

4.3.8.1 Allocation factor for intermediates

Allocation of intermediates

Allocation is done based on the AF, which reflects the relation of the total energy content of the intermediate main product to the total energy content of all products. The energy content is calculated from the lower heating value and the yield of the respective product. The lower heating value shall always refer to the moisture content of the material. The following formula must be applied to all emissions from received materials and emissions produced at the respective certified unit (e_{ec} + e_l + e_{sca}, e_p, e_u e_{td}, e_{ccr} and e_{ccs}) when calculating the AF:

$$AF\ intermediate\ product = \frac{Energy\ content_{interm.product}[MJ]}{Total\ energy\ content\ \left(energy\ content_{interm.product}[MJ] + energy\ content_{co-product}[MJ]\right)}$$

with

$$Energy\ content_{interm.product}[MJ] = yield_{interm.product}\left[\frac{kg_{dry}}{year}\right] * LHV_{inter.product}\left[\frac{MJ}{kg}\right]$$

and

$$Energy\ content_{co-product}[MJ] = yield_{co-product}\left[\frac{kg_{dry}}{year}\right] * LHV_{co-product}\left[\frac{MJ}{kg}\right]$$

The following formula is used for the calculation of allocated emissions when processing intermediate products:

AF formula applied

$$e_{ec}interm.product_a\ allocated \left[\frac{kg\ CO_2eq}{ton_{dry}}\right] = e_{ec}interm.product_a\ non-allocated \left[\frac{kg\ CO_2eq}{ton_{dry}}\right] * Allocation\ factor\ interm.product_a$$

4.3.8.2 Allocation factor for final fuels

Allocation is done based on the AF, which reflects the relation of the total energy content of the final biofuel main product to the total energy content of all products. The energy content is calculated from the lower heating value and the yield of the respective product. The following formula needs to be applied when calculating the AF:

Allocation factor final fuels

$$AF\ fuel = \frac{Energy\ content_{biofuel}[MJ]}{Total\ energy\ content\ (energy\ content_{ibiofuel}[MJ] + energy\ content_{co-product}[MJ])}$$

with

$$Energy\ content_{biofuel}[MJ] = yield_{biofuel}\left[\frac{kg_{dry}}{year}\right] * LHV_{fuel}\left[\frac{MJ}{kg}\right]$$

and

$$Energy\ content_{co-product}[MJ] = yield_{co-product}\left[\frac{kg_{dry}}{year}\right] * LHV_{co-product}\left[\frac{MJ}{kg}\right]$$

For final fuels the following formula is applicable for the relevant elements in the calculation methodology (shown for the example of e_{ec}, but all other values need to be similarly adjusted):

AF formula applied

$$e_{ec}fuel_a\left[\frac{g\ CO_2eq}{MJ\ biofuel}\right]_{ec} = \frac{e_{ec}feedstock_a\left[\frac{g\ CO_2eq}{kg_{dry}}\right]}{LHV_a\left[\frac{MJ\ feedstock}{kg\ dry\ feedstock}\right]} * fuel\ feedstock\ factor_a * Allocation\ factor\ fuel_a$$

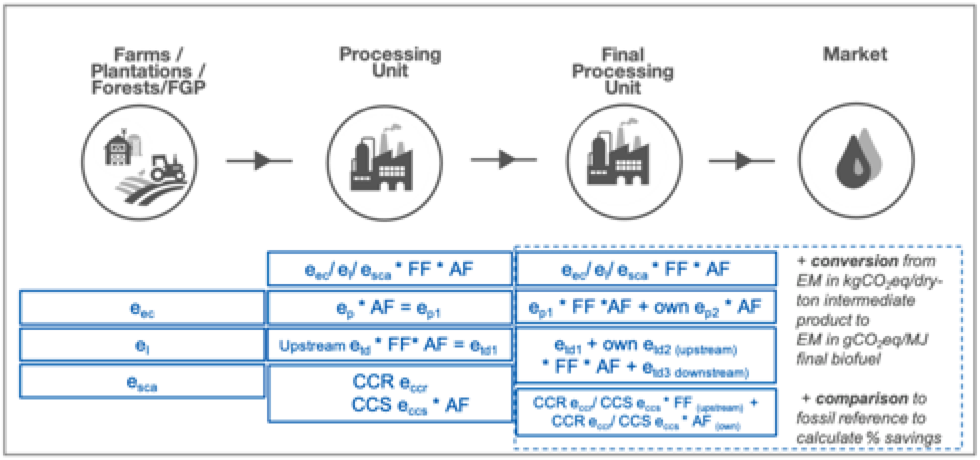

Figure 8: Summary of steps required for incoming and own emissions with actual values in an agricultural supply chain for a biofuel

Emissions delivered with the incoming feedstock and the upstream transport emissions, which are given in kg CO_2eq/dry-ton feedstock must be multiplied by the feedstock factor (FF) in order to calculate the emissions in kg CO_2eq /dry- ton of output product. In a second step, for incoming and own emissions the allocation factor (AF) need to be applied (except for downstream transport).

Specific requirements for biomass fuels:

In the case of biogas and biomethane, all co-products shall be taken into account for the purposes of that calculation.

4.3.9 Further requirements for the producers of final biofuels, bioliquids and biomass fuels

Downstream transport and distribution

A biofuel, bioliquid or biomass fuel is considered to be final if no further processing of the material takes place. The producers of final biofuels, bioliquids and biomass fuels (hereafter called final processing units) must also include emissions from the downstream transport and distribution (up to and including the filling station). Should the exact distance for downstream transport and distribution not be known to the final processing unit, conservative assumptions must be made (e.g. transport distance to Europe and throughout Europe). As those emissions relate only to the biofuel transport, no allocation is possible.

Disaggregated default values for transport and distribution are provided in sections D and E of Annex V and Annex VI of the RED II for certain final fuels. If a final fuel is produced for which no such values are available a conservative approach can be used and the highest value of the most logical choice from these tables can be used (please see chapter 3.1 for further specifications)..

Calculating emissions in g CO_2eq/MJ fuel

Additionally, the final processing unit must calculate the GHG emissions of all elements of the calculation formula in g CO_2eq/MJ fuel and the GHG saving potential of the final fuel. After the conversion (via feedstock factor) and allocation of all GHG emissions, as referred to in chapter 4.3.7 “Working with incoming emission values” and 4.3.8 “Allocation of emissions to main- and co-products”, the final GHG emissions (of e.g. cultivation/extraction of the raw material, processing and transport & distribution) are displayed in kg CO_2eq/dry-ton of fuel. In order to determine the GHG emissions per MJ biofuel, the respective lower heating value of the fuel has to be used.

Sum emissions biofuel

For comparing the emissions to the fossil reference, the sum of all emissions has to be build based on the formula:

Total emissions from the production of the fuel before energy conversion =

$$e_{ec} + e_l + e_p + eu + e_{td} - e_{sca} - e_{ccs} - e_{ccr}$$

GHG saving formulas for transport market

The GHG saving potential **for transport fuels** compared to the fossil reference is calculated according to the following formula:

<u>Biofuels:</u>

$$\text{GHG saving potential}[\%] = \frac{GHG\ emission\ from\ fossil\ fuel\ comparator\ for\ transport - GHG\ emission\ from\ biofuel}{GHG\ emission\ from\ fossil\ fuel\ comparator\ for\ transport} * 100$$

<u>Biomass fuels:</u>

$$\text{GHG saving potential}[\%] = \frac{GHG\ emission\ from\ fossil\ fuel\ comparator\ for\ transport - GHG\ emission\ from\ biomass\ fuel\ used\ in\ transport}{GHG\ emission\ from\ fossil\ fuel\ comparator\ for\ transport} * 100$$

GHG saving formula for heating/cooling/ electricity markets

Energy producers must apply the respective fossil fuel comparator value for the target market. The GHG saving potential generated **from heating and cooling**, **and electricity** compared to the fossil reference is calculated according to the following formula:

<u>Bioliquids and biomass fuels:</u>

$$\text{GHG saving potential}[\%] = \frac{GHG\ emission\ fossil\ \ from\ \ fossil\ fuel\ comparator\ for\ uselful\ heat\ or\ electricity - GHG\ emission\ from\ heat\ or\ electricity}{GHG\ emission\ fossil\ \ from\ \ fossil\ fuel\ comparator\ for\ uselful\ heat\ or\ electricity} * 100$$

Fossil references

The following emission values shall be used for fossil references:

Biofuels for transport[23]: 94 g CO_2eq/MJ fossil fuel[24],

[23] *Including biomass fuels used as transport fuels*

Bioliquids used for electricity, and production of energy for heating and/or cooling: 183 g CO_2eq/MJ,

Bioliquids used for the production of useful heat, as well as for the production of heating and/or cooling: 80 g CO_2eq/MJ

For biomass fuels used for the production of electricity the fossil fuel comparator shall be 183 g CO_2eq/MJ electricity or 212 g CO_2eq/MJ electricity for the outermost regions[25]

For biomass fuels used for the production of useful heat, as well as for the production of heating and/or cooling the fossil fuel comparator shall be 80 g CO_2eq/MJ heat

For biomass fuels used for the production of useful heat, in which a direct physical substitution of coal can be demonstrated, the fossil fuel comparator shall be 124 g CO_2eq/MJ heat

Forwarding of GHG emissions for final fuels

After applying the FF and AF, the certified company passes on the GHG emission information in g CO_2eq/MJ final fuel product together with the information on GHG savings as well as the start date of biofuel/ bioliquid/ biomass fuel production on the Sustainability Declaration.

Specific requirements for bioliquids and biomass fuels

Fuel in use

The final producer also needs to take into account the emissions from the fuel in use (e_u). Emissions of CO_2 from fuel in use, e_u, are given as zero for biofuels, bioliquids and biomass fuels, but emissions of non-CO_2 greenhouse gases (CH_4 and N_2O) from the fuel in use shall be included in the e_u factor for bioliquids and biomass fuels. RED II, Annex VI outlines default value information on "non-CO_2 emissions from the fuel in use" for some biomass fuels. For all other biomass fuels and bioliquids which are not mentioned there but for which this additional information needs to be provided, System Users can use a conservative approach and apply the highest value given for e_u from the reference table mentioned above or values from recognised published literature[26] can be applied. The information on emissions from "e_u" needs to be forwarded together with the batch of sustainable material on the Sustainability Declaration.

5 Documentation and verification requirements

Depending on the type of GHG information an economic operator is using, different evidence must be kept for audit verification.

[25] *Outermost regions according to Article 349 TFEU are Guadeloupe, French Guiana, Martinique, Mayotte, Réunion and Saint Martin (France), the Canary Islands (Spain) and the Azores and Madeira (Portugal)*

[26] *E.g. JRC Science for Policy Report "Solid and gaseous bioenergy pathways: input values and GHG emissions: Calculated according to methodology set in COM(2016) 767: Version 2"*

Verification of default values

Verification of total or disaggregated default values:
When default values are used, the auditor must verifiy that following requirements are met:

> Does the upstream supply chain fulfil the requirements for using (disaggregated) default values. This can be verified by checking the Sustainability Declarations of the incoming input material.

> Does the economic operator fulfil the requirements for using (disaggregated) default values. This can be verified by checking the feedstock, production pathway and produced fuel and compare it with the data provided in the REDII.

Verification of individually calculated values:
The following verification approach is required for all individual calculations:

Verification approach of actual values

> Every Certification Body that verifies individual GHG emission calculations needs to have at least one GHG expert auditor who is responsible for verifying the methodology and the input data prior to the audit. In order to become a GHG expert, the auditor has to participate in an ISCC GHG training[27]

> The ISCC System User has to make the GHG emission calculation of the planned audit available to the Certification Body (e.g. in Excel) in a verifiable format (without sheet protection) in sufficient time in advance prior to the audit. The GHG calculation sheet should have a clear structure with a setup overview, process details and detailed references to enhance verification efficiency. That information shall include input data and any other relevant evidence, information on the emission and conversion factors and standard values applied and their reference sources, GHG emission calculations and evidence relating to the application of GHG emission saving credits. Further helpful information to be provided includes summarized results of emissions, as well as translations. Links to other documents and assumptions (e.g. for design data) must be indicated.

> The GHG expert checks information (e.g. methodology, EFs, LHVs, other standard values etc.) prior to the on-site certification audit. If they have any questions and/or require any corrections, the CB must contact the client for clarification

> During the on-site certification audit, the auditor verifies all relevant information concerning the calculation of actual GHG values (e.g. type of heat, types of inputs, consumption amounts etc.)

> The auditor has to document emissions occurring at the audited site. For the processing of final fuels, the auditor shall record the emissions after allocation and the achieved savings. If the emissions deviate

[27] *Please also see ISCC EU System Document 103 "Requirements for Certification Bodies and Auditors*

significantly from typical values (more than 10% deviation), or calculated actual values of emissions savings are abnormally high (more than 30% deviation from default values), then the report must also include information that explains the deviation. Certification bodies must immediately inform the voluntary scheme of such deviations.

> If the Certification Body requests any corrections, System Users must provide an updated file to the CB so that a final confirmation can take place

> ISCC System Users are only allowed to use the actual value after the CB has explicitly confirmed that it is correct. Only values that have been verified and approved by auditors can be passed on in the supply chain. It is not allowed to alter individually calculated GHG emission values from incoming materials to random numbers for outgoing sustainability documentation.

> Additionally, CBs need to provide GHG calculations together with other certification documents to ISCC. This is in order to facilitate a prompt investigation by ISCC in case of alleged non-compliance of actual GHG emission values. These documents (preferably in non-protected Excel) must be complete, transparent and include the methodology, formulas, input values, EFs and respective sources

> The procedure above also applies if a System User would like to switch from default to individually calculated values

> If an actual calculation which has already been verified is updated, the System User must contact the CB. The System User must clearly communicate all relevant changes and additions made to the CB. It is the responsibility of the CB to decide if an on-site audit is necessary to verify compliance with ISCC requirements

> In any case, the CB needs to provide ISCC with updated certification documents (annex, audit procedures, GHG calculations)

> System Users need to send the first three Sustainability Declarations issued after the recertification audit to their CB so that the auditor responsible can verify that the correct default value or, in case of actual values, the approved GHG value is used and applied correctly. All sustainability documentation necessary for verification must be provided in addition (e.g. respective incoming sustainability declarations)

> Upon request from the European Commission or **national bodies/authorities responsible for supervision of the certification bodies** ISCC will provide actual GHG emission calculations to the respective parties.

If an individual calculation was conducted, the economic operator has to keep records and evidence of the following data which will be verified during the audit:

Data to be provided

- Evidence of all data for all relevant in- and outputs and feedstock factors of the production process (e.g. production reports, Sustainability Declarations, invoices)
- Sources of EFs (standard values list of European Commission, ISCC list of emission factors or other scientifically peer-reviewed literature/databases) including the year of publication and their applicability (with respect to time period and region)
- For external suppliers (e.g. of steam), individual EFs must be provided. It must be possible to verify the EF and the data/methodology used for the calculation within the scope of the audit or the EF must be certified under ISCC
- Sources for the used lower heating values for main- and co-products (e.g. RED II, ISCC list of EFs and lower heating values (LHVs), scientifically peer-reviewed literature/ databases, documents from laboratory test results)
- The methodology used for the individual calculation and the calculation itself must be transparent. The calculation itself must be done in a way that allows the auditor to verify the calculation
- For CO_2 Capture and Replacement (CCR), the auditor has to check if the emission saving from CCR is limited to emissions of which the carbon originates from biomass, and which is used to replace fossil-derived CO_2. This requires access to information such as a declaration from the recipient of the CO_2, in writing, that fossil-derived CO_2 is avoided due to the CO_2 coming from CCR. The declaration should include information on the purpose for which the captured CO_2 is used
- For CO_2 Capture and Storage (CCS), the auditor has to check if the emission saving from CCS are limited to emissions avoided through the capture and sequestration of emitted CO_2 and directly relate to the extraction, transport, processing and distribution of the fuel. Valid evidence that CO_2 was effectively captured and safely stored in compliance with Directive 2009/31/EC needs to be provided.
- For CCR and CCS production processes the applied allocation approaches must be clearly documented by the system user and verified by the auditor.

Verification in case a methane capture device is installed:

If a methane capture device that can guarantee actual methane capture is operated by the unit, e.g. for pre-treatment of wastewater, the following aspects need to be checked and fulfilled:

Verification of methane capture devices at palm oil mills

> The methane capture technology at the palm oil mill must ensure that the methane is captured in an efficient manner similar to what has been assumed in the calculation of the default values.

> Absorption of all wastewater in a closed system (only short-term storage of fresh wastewater) and supply to a methane capture device.

> Use of the biogas produced for energy purposes or, in the worst case, flaring of the biogas.

> The methane capture device is in good condition, leakages are non-existent, and the producer provides a guarantee about the maximum methane leakage that does not exceed the current state of the technology.

Annex I

List of emission factors and lower heating values (LHVs)

The choice of emission and energy factors has an impact on the results of the GHG emissions calculation. It must always be verified that a chosen emission factor is suitable for the process/input it is applied to.

Relevant parts of emission factors

Emission factors describe the relationship between the amount of released GHG emissions and the amount of input material. They are needed in order to calculate the CO_2eq emissions related to a specific input material. Emission factors for energy supply must include direct and indirect effects. Direct effects are atmospheric emissions from combustion, waste, effluents and electricity use. They mainly depend on the carbon content of the fuel. Indirect effects are the upstream emissions of a material. They include e.g. emissions from extraction or processing steps. Both factors – direct and indirect – must be considered in the emission factor used.

Lower heating values are needed for the calculation of feedstock factors (FF) and allocation factors.

Possible sources

The variance of individual emission factors may be large and for some inputs emission factors might not be available or just an approximation can be used. However, to avoid cherry picking and to support objective, transparent and verifiable Individual calculations and audits, whenever possible, system users should use the values provided by the IR 2022/996. Secondly, ISCC has developed a list of emission factors. The list is mainly based on the list of standard calculation values published on the Commission website or LCA

Databases such as Ecoinvent (Version 3.9.1 (2022), Allocation cut-off; IPCC 2021; GWP 100a). Alternative values might be used but must be duly justified and flagged in the documentation of the calculations in order to facilitate the verification by auditors (see chapter 4).

The following overview can be updated by ISCC on a continuous base as soon as databases provide new published values.

Table 1: List of emission factors, lower heating values (LHVs) and their respective sources

Input	Unit	Standard factor	Source, description
A) Emission factors for cultivation			
Fertiliser			
Ammonium nitrate phosphate	kg CO_2eq/kg N	RER: 1.541 RoW: 2.0635	Ecoinvent v. 3.9.1, 2022: ammonium nitrate phosphate production
Glyphosate	kg CO_2eq/kg	11.691	Ecoinvent v. 3.9.1 2022: market for glyphosate (GLO)
Seeds			
Seeds corn	kg CO_2eq/kg seed	1.9935	Ecoinvent v. 3.9.1, 2022: maize seed production, for sowing, max. water content of 12% (GLO)
Seeds soybean	kg CO_2eq/kg seed	3.0472	Ecoinvent v. 3.9.1, 2022: market for soybean seed, for sowing (GLO)
B) Emission factors for processing			
Process inputs			
Deionised water	kg CO_2eq/kg	Europe without CH: 0.00043346 RoW: 0.00046746	Ecoinvent v. 3.9.1, 2022: market for water, deionised
Magnesium oxide	kg CO_2eq/kg	2.0728	Ecoinvent v. 3.9.1, 2022: market for magnesium oxide (GLO)
Process water	kg CO_2eq/kg	Europe without CH: 0.00030884 RoW: 0.0012409	Ecoinvent v. 3.9.1, 2022: market for tap water
Electricity consumption from grid (electricity mix)			

Input	Unit	Standard factor	Source, description
Argentina	kg CO_2eq/kWh_{el}	0.38912	Ecoinvent v. 3.9.1,2022: electricity, high voltage, production mix (AR)
Brazil	kg CO_2eq/kWh_{el}	0.15704	Ecoinvent v. 3.9.1,2022: market group for electricity, high voltage (BR)
China	kg CO_2eq/kWh_{el}	0.94077	Ecoinvent v. 3.9.1,2022: electricity, high voltage, production mix (CN)
Indonesia	kg CO_2eq/kWh_{el}	1.1202	Ecoinvent v. 3.9.1,2022: electricity, high voltage, production mix (ID)
Malaysia	kg CO_2eq/kWh_{el}	0.80353	Ecoinvent v. 3.9.1,2022: electricity, high voltage, production mix (MY)
Thailand	kg CO_2eq/kWh_{el}	0,765	Ecoinvent v. 3.9.1,2022: electricity, high voltage, production mix (TH)
Energy consumption from internal production			
Heat/electricity from CHP (diesel)	kg CO_2eq/MJ kg CO_2eq/kWh	heat: 0.035576 electricity: 0.78164	Ecoinvent v. 3.9.1,2022: Heat and power co-generation, diesel, 200kW electrical, SCR-NOx reduction (RoW)
Heat/electricity from CHP (NG)	kg CO_2eq/MJ kg CO_2eq/kWh kg CO_2eq/MJ kg CO_2eq/kWh	RoW heat: 0.027909 RoW electricity: 0.59214 Europe without CH heat: 0.029527 Europe without CH electricity: 0.62646	Ecoinvent v. 3.9.1,2022: Heat and power co-generation, natural gas, 1MW electrical, lean burn
Heat from boiler (hard coal)	kg CO_2eq/MJ_{th}	0.13182	Ecoinvent v. 3.9.1, 2022: heat production, at hard coal industrial furnace 1-10MW (Europe without CH)
Heat from boiler (light fuel oil)	kg CO_2eq/MJ_{th}	0.098862	Ecoinvent v. 3.9.1, 2022: heat production, light fuel oil, at industrial furnace 1MW (RoW)

Input	Unit	Standard factor	Source, description
Heat from boiler (lignite)	kg CO_2eq/MJ_{th}	0.17958	Ecoinvent v.3.9.1, 2022: heat production, lignite briquette, at stove 5-15kW (Europe without CH)
Heat from boiler (NG)	kg CO_2eq/MJ_{th}	Europe without CH: 0.075656 RoW: 0.074026	Ecoinvent v. 3.9.1, 2022: heat production, natural gas, at industrial furnace >100kW
Liquefied petroleum gas (LPG)	kg CO_2eq/kg	Europe without CH: 1.0537 RoW: 0.98469	Ecoinvent v. 3.9.1, 2022: market for liquefied petroleum gas
Solar electricity	kg CO_2eq/kWh_{el}	0.073504	Ecoinvent v. 3.9.1, 2022: Electricity production, photovoltaic, 3kWp flat-roof install. multi-Si (RoW)
Waste wood	kg CO_2eq/kg	0.048037	Ecoinvent v. 3.9.1, 2022: treatment of waste wood, post-consumer, sorting and shredding (RoW)
Wind electricity	kg CO_2eq/kWh_{el}	0.014748	Ecoinvent v. 3.9.1, 2022: Electricity production, wind, 1-3MW turbine, onshore (RoW)
Electricity production in conventional power plants			
Electricity (heavy fuel oil)	kg CO_2eq/kWh_{el}	1.0022	Ecoinvent v. 3.9.1, 2022: electricity production, oil (RoW)
Lignite in Steam Turbine	kg CO_2eq/kWh_{el}	1.29	Ecoinvent v. 3.9.1, 2022: electricity production, lignite (RoW)
NG in Combined Cycle Gas Turbine	kg CO_2eq/kWh_{el}	0.47	Ecoinvent v. 3.9.1, 2022: electricity production, NG (RoW)
Waste treatment			
EFB and POME Co-composting	kg CO_2eq/kg CPO	0.03	Stichnothe et al. 2010 doi: 10.1007/s11367-010-0223-0
	kg CO_2eq/kg POME	0.01	
	kg CO_2eq/kg CPO[29]	0.51	BLE, 2010, Guideline Sustainable Biomass Production

[29] CPO: Crude Palm Oil

Input	Unit	Standard factor	Source, description
POME[28] treatment in open ponds	kg CO_2eq/kg POME	0.16	BLE, 2010, Guideline Sustainable Biomass Production. 3.25 kg POME per kg CPO
POME treatment in closed ponds and flaring of emissions	kg CO_2eq/kg CPO	0	Biogenic CO_2 set to zero, No CH4, N_2O if pond appropriately covered without any leakages, methane is properly captured
POME treatment in open ponds with belt press	kgCO2eq/kg CPO	EF open ponds (kg CO_2eq/kg CPO) – (Carbon belt press cake (kg C//kg belt press cake) * Annual average belt press cake production (kg) * 30.59 (kgCO_2eq)/ Annual average CPO production (kg))	Enström et al., 2018, doi: 10.1007/s10668-018-0181-4
Wastewater treatment	kg CO_2eq/cbm	Europe without CH: 0.36367 RoW: 0.27207	Ecoinvent v. 3.9.1, 2022: market for wastewater, average

[28] *POME: Palm Oil Mill Effluent*