European Commission

Innovation Fund (INNOVFUND)

Methodology for GHG Emission Avoidance Calculation

Version 4.0
15 November 2024

HISTORY OF CHANGES		
Version	**Publication date**	**Changes**
1.0	15.03.2022	▪ Initial version
2.0	01.11.2022	▪ Main table from previous Annex 1 moved to the body of the GHG methodology, clarification for projects with multiple principal products and for hybrid projects, addition of subsection 1.1.2.1. for Net Carbon Removals, previous section 1.15 "GHG emissions from inputs" is now section 1.3.3., Clarifications in table 1.1 on sector classification, addition of a paragraph for principal products of a project replacing the function of a physically different conventional product (section 1.2), Clarifications for projects earning revenues from the sale of multiple products, clarification for manufacturing of components, adding specific data references for projects manufacturing electrolysers (load factor and CAPEX), restructuring of the section related to "Calculation of GHG emission avoidance", added clarification to table 1.3, added paragraph "Simplification for PILOT topic projects", Creation of a subsection 1.3.5. for combustion emissions, addition of 2 example cases for setting the reference scenario for a principal product, addition of elements for Case 3 in section 2.2.4.3., addition of elements for Case 4 in section 2.2.4.4., addition of elements for case 6 in section 2.2.4.6., addition of a reference for methane leakage in section 2.2.5., addition of examples for "Other relevant inputs", addition of element in section 2.2.9.1., reformulation of section 3 "Carbon Credits", clarification of the scope of section 4 and 5, addition of an equation for manufacturing of components of renewable energy systems, addition of examples for auxiliary services, update of the table of contents to the new structure and annex numbering, reworking of sentences for clarity, spelling mistake correction
3.0	01.11.2023	▪ General clarifications, editorial improvements and language streamlining in section 1, 2, 3, 4, and 5. ▪ Editorial improvements on transport emissions in section 1.1.4. ▪ Clarification in section 1.2 on the principal product, and on the selection of the correct sector and methodology. This includes clarifications for CCS projects and manufacturing projects. ▪ Clarifications in section 1.2.2, including clarifications on manufacturing of fuel cells and on manufacturing project duration. ▪ Added section 1.3.6 covering the changes in performance of certain technologies. ▪ Correction and clarifications in Table 2.1. ▪ The need to provide a detailed project diagram has been clarified in section 2.2.2. ▪ Clarifications in section 2.2.4, and changes in the simplifications for PILOTS projects. ▪ Clarifications in section 2.2.4.4, which relates to transport fuel substitutes, including reinstated text of the first three footnotes of section 2.2.4.4, and clarified examples. ▪ Clarifications in the provisions for CCS projects in section 2.2.5.2 and related sections for which cross-references have been provided. ▪ Clarifications in the provisions for CCU projects in section 2.2.5.3, including general editorial improvements and clarifications regarding the system boundaries of CCU projects. ▪ Clarification regarding the End of Life emissions of CCU products in section 2.2.5.3.2

		▪ Amended the provisions concerning heat input emissions in section 2.2.6, second paragraph. ▪ Clarification on reference scenario for waste utilization in section 2.2.6.1, and expanded scope for certain rigid input waste in section 2.2.6.1.1. ▪ Clarification of provisions on upstream emissions in the fossil fuel supply chain, and correction of a related example in section 2.2.6.3.3. ▪ Clarifications in section 2.2.6.3.6 concerning the provisions on timed operations and virtual storage. ▪ Section 3. Clarification and general editorial improvements, including cross-references to other relevant sections for CCS and CCU projects. ▪ Section 3.1. Provisions on splitting the CC credit among multiple projects form the same CCS chain removed. ▪ Section 4. Introduction and scope clarification on renewable sources and direct power connection projects - small scale simplification improved - language harmonisation. ▪ Sections 4.2. and 4.2.1. Clarifications in equation terms. ▪ Removed dedicated provisions for the calculation of the relative GHG emission avoidance for wind, solar and ocean projects in section 4.3. ▪ Clarification on timing conditions for electrical energy storage included in section 5.1 projects ▪ Improved framing of the reference scenario for EV batteries project in equation 5.3 and table 5.2 ▪ Clarification in Table 5.2. EF for hydrogen corrected for using LHV in consistency with other sections, amended description entry for electricity. ▪ Section 2, section 4 and section 5. Several emission factor values updated for consistent application to include CH4 and N2O contributions and to account for LHV and not HHV in H2 in section 5. ▪ Simplification of hierarchy of sources in Appendix 1. ▪ Inclusion of sections 6 and 7 with the provisions for the calculation of GHG emissions avoidance for maritime and aviation projects, respectively. Review of section 1 to account for the inclusion of these new sections.
3.1	01.03.2024	▪ Inclusion of subsection 1.1.6 with guidance for the calculation of GHG emissions avoidance for sectors road transport and buildings. Review of Table 1.1 to include these new sectors. ▪ Correction of the example in section 5.1.2 and of equation 5.4a (Energy Storage). ▪ A leftover reference to footnote 14 has been removed.
4.0	15.11.2024	▪ The entire methodology has been edited for simplicity and clarity. ▪ Emission factors related to the combustion of fuels have been updated to ensure they are inclusive of CO_2 and non-CO_2 GHG emissions, are aligned across the project categories and use the adequate GWP. ▪ Nomenclature reviewed for coherence across the methodology and with other Regulations. ▪ List of main changes to section 1, introduction and general provisions: ○ A list of "Key steps for the calculation of the GHG emissions avoidance" has been added in section 1.1.1.

		○ In section 1.1.3 Equation 1.1 an explicit term has been added for the carbon capture credit, which was previously integrated into the term $Proj_y$. ○ The list of sources generally excluded in section 1.1.7 has been clarified. ○ It has been clarified in section 1.1.7 that the calculation of other GHG savings should be consistent with the principles of the methodology to the extent possible. ○ A bioenergy sector has been created under the RES category, and bioenergy projects shall no longer apply under the EII category (section 1.2). ○ Section 1.2.1 has been added, clarifying the choice of sectors when a principal product may replace more than one reference product. ○ Section 1.2.3 has been added clarifying the choice of principal products and sector for CCU/S projects. ○ In section 1.3 the rules for projects manufacturing innovative technologies and their components have been clarified, including clarifying that the cost share is 1 for projects manufacturing a whole consumer product. ○ In section 1.4.3 guidance has been added relating to the emission factors to be used for heat and hydrogen as project inputs. ○ The emission factor for electricity exported from an EII project has been changed from 0 to 48.8 gCO_2e/MJ (section 1.4.3.1). ○ Section 1.4.4 has been added, clarifying the treatment of biomass-derived fuels and materials. ○ Section 1.5 and Appendix 4, including monitoring and reporting provisions, have been updated, expanded, and harmonised for clarity. ▪ List of main changes to section 2, energy intensive industries (EII): ○ Applicants are no longer permitted to bring within the system boundary input-related upstream processes that are not under their control (section 2.2.3). ○ The rules relating to projects where an innovation applies to only part of the throughput have been clarified (section 2.2.3.1). ○ The requirements in section 2.2.4 relating to the definition of a reference scenario have been clarified, particularly for cases in which a principal product may replace more than one reference products. ○ The requirements in section 2.2.5 relating to carbon capture have been streamlined with the requirements in section 6. ○ For CCU projects, the process in which CO_2 is used must now always be brought within the system boundary of the project (section 2.2.5.3.1). ○ The 'minor' input category has been retired from the methodology; all inputs must be identified as major or de minimis (section 2.2.6.2). The section on inputs (2.2.6) has been reordered and simplified. ○ The requirement to remove upstream emissions associated with the fossil fuel supply chain from the emission factors for inputs, including the simplified option to remove 15% from the supply emissions, has been retired from the methodology. Input emission factors should now be used without this adjustment.

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Rules for rigid inputs have been clarified in section 2.2.6.4, including provisions for waste inputs in section 2.2.6.4.2.
The rules for principal products containing carbon have been clarified in section 2.2.9.1.
An equation has been added in section 2.2.10 to clarify the treatment of non-principal products.

The section dedicated to renewable energy (RES) projects has been renumbered from section 4 to section 3, and streamlined for clarity and simplicity. Main changes include:

Equations have been updated for clarity, and to properly characterize emissions for bioenergy projects (section 3.1.2 and other sections).
Provisions have been included for projects aiming to operate stationary fuel cells (section 3.1.2.1) and to manufacture stationary fuel cells and their components (section 3.1.3.1).
Dedicated sections were created for projects aiming exclusively at consuming renewable energy for activities outside the scope of Annex I to the ETS directive (section 3.1.4 and 3.3.2)
Dedicated sections were created for projects aiming at manufacturing components for renewable energy generation (section 3.1.3 and 3.3.3).

The section dedicated to energy storage (ES) projects has been renumbered from section 5 to section 4, and streamlined for clarity and simplicity. Main changes include:

Auxiliary services are now considered within the boundaries of the GHG calculations also for small-scale projects.
Energy storage technologies for mobility applications are now covered under the new category mobility (MOB) in section 5.
Section 4.1 has been streamlined and aligned with the provisions in section 1. The text now clarifies that the exclusion of simultaneous charging and discharging only applies to the same type of energy.
In section 4.3, the distinction between inputs to energy storage and on-site energy consumption has been clarified by introducing differing subscripts. Equation [4.1] and [4.2] have been adapted to the general provisions on absolute GHG emissions avoidance in section 1.
The methodology for manufacturing of innovative energy storage systems and their components has been separated in the dedicated subsection 4.3.1.2 and aligned with the provisions for manufacturing projects in section 1.
The majority of emission factors in section 4.5 has been revised in line with the changes in other sections. For electricity, heat and hydrogen, a link to the provisions in section 1 has been introduced. The grid losses have been updated based on the latest Eurostat data from 2022.

A dedicated section for mobility projects (MOB) was created as section 5, which replaces the former sections for aviation and maritime projects, and includes also road transport as a sector. The new category covers also manufacturing of innovative aircrafts, maritime vessels, road vehicles and their components, including fuel cells and energy storage components for mobility applications.
The section on CCU/S credit has been renumbered from section 3 to section 6 and has been streamlined and clarified.

Equation 6.1 has been reframed on a single year rather than over the sum of project years (section 6.5).

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		○ Equations have been added in a footnote to section 6.5 to clarify the case that a CC credit must be included in the reference scenario. ▪ A dedicated section for proposals submitted under the INNOVFUND-2024-BATT call has been created as section 7.

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1 Introduction and general provisions

The methodology for the calculation of the GHG emission avoidance for projects submitted under the call "Innovation Fund Call for proposals 2024 Net Zero Technologies" (INNOVFUND-2024-NZT) is described in the following sections and in the appendixes to this document:

Section 1: Introduction and general provisions.

Section 2: Energy intensive industries (EII), including substitute products, carbon capture and utilisation (CCU), and manufacturing of electrolysers and their components.

Section 3: Renewable energy (RES), including manufacturing of components for RES.

Section 4: Energy storage (ES), including manufacturing of components for ES.

Section 5: Mobility (MOB), including manufacturintg of innovative ships, aircraft, road vehicles and their components.

Section 6: Credit for carbon capture and storage or utilisation.

Projects that apply under the call "Innovation Fund Call for proposals 2024 Batteries" (INNOVFUND-2024-BATT) must calculate their GHG emissions following the provisions in Section 7, as the provisions in the rest of this document do not apply to them.

When deciding under which call to submit an application, the applicant should carefully review the eligibility conditions detailed in the call text of each call.

Each methodology section provides the details to be used when:

- calculating the GHG emission avoidance potential of a project at the application stage;
- reporting performance for the purposes of disbursement of the portion of the grant that is linked to GHG emission avoidance verification; and
- reporting performance for the purposes of knowledge-sharing.[1]

Definitions of terms used within the methodology for the INNOVFUND-2024-NZT call are provided in Appendix 5.

1.1 GHG emission avoidance: principles and scope

For the purpose of the Innovation Fund, the GHG emission avoidance of a project is calculated in terms of absolute GHG emission avoidance (section 1.1.3), and relative GHG emission avoidance (section 1.1.4).

The InnovFund grant disbursement depends on verified emission reductions. Therefore, it is important that the emissions reductions described in the application can be delivered. For example, when forecasting operational data, applicants should consider any expected **ramping up period**, e.g., if reduced performance can be expected over the first years of operation due to necessary stops and starts of the production for technical adjustments, this should be reflected in the calculations.

The final split of products and expected functions for those products needs to be clearly identified. If the application claims that a product will be used for a specific purpose this

[1] These parameters will be reported through a dedicated knowledge-sharing report template once projects enter into operation. The detailed knowledge-sharing requirements are specified in the Model Grant Agreement, call text and knowledge-sharing reporting template.

should be credibly demonstrated, for example by providing draft contracts or other relevant supporting documents.

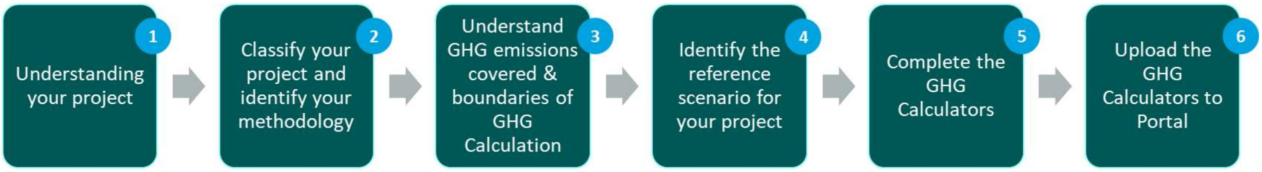
In the case that the share of products or their use during project implementation differs from the products and uses specified in the application, or that other assumptions made at the application stage cannot be demonstrated during project implementation, the project may not be able to reach the GHG emission avoidance claimed at the time of the application, with potential implications on grant disbursement as specified in the Call Text (see also section 1.1.9 and sction 1.5).

It is a fundamental principle of the Methodology for GHG Emission Avoidance Calculation that each GHG emission and each GHG saving shall only be counted once ('no double counting' principle). In any case in which the other provisions in this methodology may seem to call for a given emission or saving to be counted twice, the 'no double counting' principle prevails. If the applicants believes that they have identified such a case, the applicant should consider seeking clarification via the InnovFund helpdesk.

1.1.1 Key steps for the calculation of the GHG emissions avoidance

The following six steps approach outlines the key stages applicants have to go through for calculating the GHG emissions avoidance of a project.

Figure 1.1. The step by step of the GHG GHG calculation



1.1.1.1 Step 1: Understanding your project

The first step for an applicant is to understand their project, what practice or product they intend to replace – does it refer to a change in the process, or a replacement of the final product? What are the parties involved in the implementation?

For instance, a project could propose to produce an innovative fuel for transport applications. Alternatively, a project may focus on the use of an alternative fuel in an innovative vessel or aircraft, or can include both the production and the use of the fuel.

It is very important to have clarity on the scope of the project, and to thoroughly check the eligibility conditions established in the Call Text for each topic.

1.1.1.2 Step 2: Classify your project and identify your methodology

Then, the applicant need to identify the category and sector under which their project falls.

A project must be classified according to the **principal product that is the main aim of the project**, following the provisions in section 1.2. A correct definition of the principal product that is the main aim of the project is the key for a correct identification of the sector under which the application shall be submitted, as well as the category.

Once the project has been classified, the applicant can use Table 1.1 in section 1.2 to identify which section(s) of the GHG methodology they have to follow, in addition to the general guidance provided under section 1 of this document. Each section includes instructions, provisions, and/or readymade equations for applicants to use to calculate the GHG emission avoidance of their project.

Note that some projects may have more than one principal product (section 1.2.2) and some projects may have principal products associated to more than one category (hybrid projects, section 1.2.5).

Refer also to section 1.3.1 for projects aiming at manufacturing innovative technologies and their components and to section 5.1.1 for MOB projects.

1.1.1.3 Step 3: Understand GHG emissions covered & boundaries of GHG Calculation

Once the relevant methodology section(s) has been identified, the applicant must thoroughly review it to understand the provisions that apply to the category and sector of their project.

Then, the applicant must define the project boundaries for the purpose of GHG emission avoidance calculations, in line with the relevant provisions in the Methodology and as a function of the specificities of the proposed project.

The applicant shall take into consideration that the definition of the project boundaries is closely linked to the project classification and principal product definition, so applicants may need to review and confirm the previous steps accordingly, while going through step 3.

Refer to section 1.1.2 to define the time period considered for GHG emission avoidance calculations, to section 1.1.6, 1.1.7, 1.1.8 for GHG emissions and additional non-CO2 climate impacts that are generally included or excluded from the scope of this methodology, and to the relevant sub-sections of the methodology to understand the boundaries of the GHG emission avoidance calculations: section 2.2.3 for EII projects, section **Error! Reference source not found.** for RES projects, section 4.2 for ES projects, s ection 5.2 for MOB projects.

Refer also to section 1.3 for projects aiming at manufacturing innovative technologies and their components, and to section 6 for projects including a component of CCS or CCU.

1.1.1.4 Step 4: Reference Scenario identification

The emission avoidance of a project is calculated in terms of absolute GHG emission avoidance (section 1.1.3), and relative GHG emission avoidance (section 1.1.4) by comparing the emissions in the project scenario to the emissions in the reference scenario.

The reference scenario is a hypothetical scenario that represents what would have occurred in the absence of the project as further detailed in section 1.4.1.

The applicant must select the reference scenario in line with the provisions of the Methodology. Often, the choice of the reference scenario is mandated by the Methodology, and the applicant cannot further adapt the scenario prescribed.

The applicant must thoroughly review and apply the relevant provisions under each section of the methodology as applicable to the category and sector of your project. In particular: section 2.2.4 for EII projects, section 3.2.1 for RES projects, section 4 for ES projects, and section 5.1.2 for MOB projects.

1.1.1.5 Step 5: Complete the GHG Calculators

Once the reference scenario is defined, applicants shall perform their GHG calculations following the relevant section(s) of the methodology adequate for the category and sector of the project, as specified in Table 1.1 in section 1.2, in addition to the general provisions in section 1.

To perform their GHG calculations, the applicant must duly fill-in the relevant GHG calculator(s). GHG calculators are spreadsheet templates available on the Call application webpage, which the applicant must complete and submit as part of their application documents. The applicants must also complete the "data traceability" section of the GHG calculator(s), as part of the Monitoring Reporting and Verification requirements for Innovation Fund projects, as detailed in section 1.5 and Annex 4 to this document.

Since applicants are allowed to upload only one spreadsheet at the application stage, for the case of hybrid projects (section 1.2.5), the applicant needs to combine two or more GHG calculators into one single file, following the instructions in section 1.2.5.1.

In addition to completing the GHG calculator, the applicant must complete the relevant application forms, and provide a detailed explanation of the calculations performed and a credible justification of the assumptions taken. This includes providing adequate justification and explanation as to how the proposed project meets the relevant minimum requirements as specified in the Call Text. The applicant should provide additional supporting documents where relevant and ensure that the information encoded across different application documents are consistent.

It is recommended that applicants review the relevant training materials, tutorials, and examples available on the Innovation Fund webpage.

1.1.1.6 Step 6: Upload GHG calculator to the portal

Once the GHG calculator is completed, the applicant shall upload it on the application portal along with the other application documents.

1.1.2 Time period considered for GHG calculations

The GHG emission avoidance of a project is calculated over a period of 10 years after the entry into operation of the project. **In the case that the project operates for less than 10 years**, operational data will be set to zero for those years in which the project does not operate. As such, both $\Delta \mathrm{GHG}_{\mathrm{abs}}$ and $\Delta \mathrm{GHG}_{\mathrm{rel}}$ shall reflect the reduced period of operation of the project.

The minimum duration of the monitoring and reporting period is specified in the Call Text and depends on the topic under which the project is submitted. Note that the duration of the monitoring and reporting period may be shorter with respect to the period of 10 years over which the GHG emission avoidance of a project is calculated at the application stage.

1.1.3 Absolute GHG emission avoidance

The **absolute GHG emission avoidance** represents the difference, over a defined period, between **all** the emissions that would occur **in the reference scenario**, i.e., in the absence of the proposed project, and **all** the emissions that occur **in the project scenario**.

Note that, in the calculation of the absolute and relative GHG emission avoidance, it is necessary to include all the emissions both in the reference and project scenario. This includes "common" emissions that are the same in both scenarios**.** If "common" emissions would be excluded from both scenarios, then the *relative* emission calculation would be distorted.

The absolute GHG emission avoidance shall be calculated based on the expected emissions avoided in each year from the entry into operation over a 10-year period, as defined in section 1.1.2, using the equation below.

$$\Delta \mathrm{GHG}_{\mathrm{abs}} = \sum_{y=1}^{10} (\mathrm{Ref}_y - \mathrm{Proj}_y + \mathrm{CC}_{\mathrm{credit}_y}) \qquad [1.1]$$

Where:

ΔGHG_{abs}= Net absolute GHG emissions avoided due to operation of the project during the first 10 years of operation, in tCO_2e.

Ref_y = GHG emissions that would occur in the absence of the project in year y, in tCO_2e.

$Proj_y$ = GHG emissions in the project scenario in year y, in tCO_2e.

CC_{credit_y}= credit for storage or utilisation of captured CO_2, calculated in accordance with section 6.

y = year of the operation of the project.

For projects with multiple principal products and for hybrid projects, Ref_y and $Proj_y$ represent the sum of the reference emissions and project emissions across all principal products and categories, respectively. For the case of hybrid projects, this will require adding together reference emissions and project emissions calculated using different sections of this methodology (see section 1.2.5).

1.1.4 Relative GHG emission avoidance

The **relative GHG emission avoidance** potential shall be calculated by dividing the absolute emission avoidance (ΔGHG_{abs}) by the reference emissions (Ref_y) cumulated over a 10-year period, using the equation below, and subject to the additional conditions detailed in this sub-section.

$$\Delta GHG_{rel} = \frac{\Delta GHG_{abs}}{\sum_{y=1}^{10}(Ref_y)} \qquad [1.2]$$

Where:

ΔGHG_{rel} = Relative GHG emissions avoided due to operation of the project over the first 10 years of operation, in percent.

ΔGHG_{abs} = Net absolute GHG emissions avoided due to operation of the project during the first 10 years of operation, in tCO_2e.

Ref_y = GHG emissions that would occur in the absence of the project in year y, in tCO_2e.

The relative GHG emission avoidance of a project cannot be negative. In case the absolute GHG emission avoidance of a project is zero or negative, the relative GHG emission avoidance shall be set to zero. In the unusual case in which a project has zero or negative cumulated reference emissions, but the absolute GHG emission avoidance of the project is positive, equation [1.2] cannot be used and the relative GHG emission avoidance shall be set as 100%. This includes projects that consist only of direct air capture of CO_2, capture of naturally released CO_2, or CO_2 capture at an existing bioenergy plant without expansion of the capacity of the plant, for the purpose of permanent storage.

Note that all the projects must meet the relevant minimum requirement in terms of relative GHG emission avoidance, as specified in the Call Text.

1.1.5 Net carbon removals

To be considered a net carbon removals project, the project must deliver net negative emissions **excluding any credit for timed operation (section 2.2.6.6) and for non-principal products (section 2.2.10)**, i.e. $\sum_{y=1}^{10}\left(Proj_y - CC_{credit_y} - TO_y - Proj_{non-principal_y}\right) < 0$, where TO_y is the emission credit associated with timed operation in year y, and $Proj_{non-principal}$ is the emission credit associated with production of non-principal products in year y.

In order to claim net carbon removal, projects that meet the abovementioned threshold must calculate an adjusted relative GHG emission avoidance by removing any contribution from timed operation. Negative emissions from non-principal products shall be included in calculation of this adjusted relative emissions avoidance score, however, they cannot be the only source of negative emissions for a project claiming net carbon removals. The adjusted relative GHG emission avoidance $\widehat{\Delta \mathrm{GHG}}_{\mathrm{rel}}$ is therefore calculated using the equation below, and subject to the additional conditions detailed in this sub-section.

$$\widehat{\Delta \mathrm{GHG}}_{\mathrm{rel}} = \frac{\Delta \mathrm{GHG}_{\mathrm{abs}} + \sum_{y=1}^{10}(\mathrm{TO}_y)}{\sum_{y=1}^{10}(\mathrm{Ref}_y)} \qquad [1.3]$$

The adjusted relative GHG emission avoidance of a project cannot be negative. In case the value at the numerator is negative, the adjusted relative GHG emission avoidance shall be set to zero. In the unusual case in which a project has zero or negative cumulated reference emissions, but the value at the numerator is positive, equation [1.3] cannot be used and the adjusted relative GHG emission avoidance shall be set as 100%, if the quantity $\sum_{y=1}^{10}\left(\mathrm{Proj}_y - \mathrm{CC}_{\mathrm{credit}_y} - \mathrm{TO}_y - \mathrm{Proj}_{\mathrm{non-principal}_y}\right)$ is positive, or to 200%, if the quantity $\sum_{y=1}^{10}\left(\mathrm{Proj}_y - \mathrm{CC}_{\mathrm{credit}_y} - \mathrm{TO}_y - \mathrm{Proj}_{\mathrm{non-principal}_y}\right)$ is negative. The latter situation includes projects that consist only of direct air capture of CO_2, capture of naturally released CO_2, or CO_2 capture at an existing bioenergy plant without expansion of the capacity of the plant, for the purpose of permanent storage, for which an adjusted relative GHG emission avoidance of 200% always applies.

1.1.6 GHG considered and global warming potentials

The greenhouse gases that must be taken into account in emissions calculations shall be those listed in the EU Emissions Trading System (EU ETS) Directive 2003/87/EC, Annex II: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF_6).

Emission factors for all greenhouse gases shall be expressed in terms of CO_2 equivalent emissions on the basis of 100-year global warming potentials. The global warming potentials (GWPs) to be used are those in the Annex to the Commission Delegated Regulation supplementing Regulation (EU) 2018/1999 of the European Parliament and of the Council with regard to values for GWPs and the inventory guidelines and with regard to the Union inventory system and repealing Commission Delegated Regulation (EU) No 666/2014.[2]

The methodology is structured with the intention of capturing the most common emission sources. However, some GHG emissions are generally excluded from the scope of this methodology (see section 1.1.7).

Examples of emissions that may occur in stages in the lifecycle, and are included within the scope of this methodology (non-exhaustive list):

- Emissions of non-CO_2 greenhouse gases (e.g., methane and nitrous oxide) due to fuel combustion (including from combustion of renewable fuels),
- Emissions of non-CO_2 greenhouse gases resulting from chemical processes such as refrigerant manufacture.

[2] https://eur-lex.europa.eu/legal-content/en/TXT/HTML/?uri=CELEX:32020R1044.

1.1.7 GHG emission sources that are generally excluded and may be considered as "other GHG savings"

Generally, the following emissions are excluded for all projects unless specified otherwise. **These shall not be considered in the calculation** of absolute and relative GHG emissions avoidance.

- Emissions from capital goods (e.g. manufacture of machinery and equipment) and emissions during construction.
- Emissions due to extraction, processing, refining, distribution and storage of fossil fuels that are combusted for energy production by the project (or otherwise consumed to release their chemical energy, e.g. in a fuel cell) are excluded from the calculation in both the reference and project scenario. This allows aligning to the methodology for calculating the EU ETS benchmarks, which considers only combustion emissions of fossil fuels.
- Fugitive CO_2 and CH_4 emissions due to well testing and well bleeding in geothermal power plants.
- Avoidance of methane emissions from alternative disposal of biomass inputs (e.g., their diversion from landfill).
- Indirect land use change (ILUC) emissions from supply of crops, and consideration of carbon debt in forestry.
- Emissions related to decommissioning of the plants and machinery at the end of life.
- Emissions related to employee commuting, business travels and waste generation at the administrative offices.
- Emissions due to the manufacturing process in the case of manufacturing plants for components when they are classified in the sector "Manufacturing of components for production of renewable energy or energy storage".
- Emissions associated with the transport of raw materials, inputs, intermediate products between sites within the system boundary, process waste sent to treatment, and distribution of final products shall not be considered in either the project or reference scenario, unless otherwise specified in section 1.4.5.

Should there be substantial GHG emissions savings from emission sources excluded from the scope of this methodology, the applicant can provide a separate calculation of potential emission savings, which may be claimed separately as "other GHG savings". These shall not be added to the calculation of absolute and relative GHG emissions avoidance.

Note that some emissions are included within the scope of this methodology, even if they are assigned an emission factor equal to zero. In such cases, the applicants cannot claim "other GHG savings" associated to these emission sources. For example, this is the case of biogenic CO2 emissions from biomass-derived fuels and materials as specified in section 1.4.4, and emissions associated to the electricity consumed by a project, as specified in section 1.4.3.

The specific assumptions taken, and the approach used for the calculation of "other GHG savings" should, as far as possible, be consistent with the principles of the Methodology. Applicants shall not selectively choose assumptions and emission factors to inflate emission avoidance claims. Instead, they should use more realistic alternatives that align with the principles of the Methodology.

1.1.8 Additional non-CO_2 climate impacts associated with maritime and aviation activities

Maritime and aviation activities are associated with significant non-CO_2 climate impacts in addition to the non-CO_2 greenhouse gases identified in section 1.1.6. These additional non-CO_2 climate impacts derive mostly from emissions by aircraft of water vapour, formation of contrails (condensation trails) and cloudiness in the wake of aircraft, nitrogen oxides (NOx), soot particles and oxidised sulphur species, and releases of black carbon from vessels.

1.1.6The significance of these additional non-CO_2 climate impacts has been confirmed, and shall be characterised in terms of GWP on a 100-year basis and counted towards absolute GHG emission avoidance for maritime and aviation projects following the provisions in section 5.

1.1.9 Assumptions and data sources

To support the calculation of reference and project emissions, and for those parameters that are not prescribed by this Methodology, applicants may need to adopt assumptions to predict operational performance. Applicants should select assumptions that lead to the most accurate possible estimate of activity data (e.g. energy production or consumption), operational performance and resulting GHG emissions. Every assumption adopted in the calculations shall be justified and underpinned with adequate references to verifiable sources of information. In addition, the operational assumptions adopted for the purposes of GHG calculations shall be consistent with those adopted in the rest of the proposals.

Failure to provide adequate justification, or the use of assumptions that deliberately give an unduly favourable result may adversely affect the quality of the GHG emission avoidance calculations, and the evaluation of the project. In addition, the applicants must propose adequate monitoring measures in their monitoring plan (see section 1.5 and Appendix 4) to ensure adequate monitoring and reporting of the assumptions made at the application stage. Failure to provide an adequate monitoring plan may negatively affect the quality of the GHG calculations, and the resulting evaluation.

During project implementation, failure to demonstrate that the assumptions made at the application stage are representative of the actual operation of the project, may affect the overall GHG emission avoidance that can be achieved, which may have consequences in terms of grant disbursement as specified in the Call Text.

The Methodology provides additional guidance on the selection of relevant assumptions in the following sections, where relevant and depending on the type of project. For example, section 1.3.6 provides specific guidance for projects manufacturing innovative technologies and their components, and section 1.4.4 provides specific guidance on biomass-derived fuels and materials. In addition, Appendix 1 provides specific guidance for the selection of GHG emissions intensities and combustion emissions, when those parameters are not specified in the relevant section of the methodology, and need to be sourced from the literature, which is particularly relevant for the case of Energy Intensive Industry (EII) projects (section 2).

1.2 Principal products and specification of a sector for the purpose of the GHG emission avoidance calculations

When submitting the application, the applicant needs to identify the principal products that the project will produce and choose the sector under which the project falls accordingly (see Table 1.1). Note that this choice may influence the outcome of the evaluation, see the call text for details. The sector shall be determined based on the function of the principal product or service that is the main aim of the project.

Table 1.1 provides an overview of sector classification associated with possible principal products or services and provides an indication of the section of the methodology to follow for the GHG emission avoidance calculation of a given type of project. The sector **must** be chosen from the list provided, but the principal product that is the main aim of the project may not be explicitly listed. The applicant should therefore specify this principal product in the application. For example, a project in the sector 'glass, ceramics and construction material' may specify its principal product as 'shatterproof glass' rather than identifying one of the more generic products listed below.

Table 1.1. Sector classification and methodology section

CATEGORY[3]	**SECTOR**[4]	**PRODUCTS/SERVICES**[5]	**SECTION**
Energy Intensive Industries (EII)	Refineries	fuels (including e-fuels, bio-fuels)	Section 2
	Iron & steel	coke iron iron ore steel cast ferrous metal products other ferrous metal products or substitute products, please specify	Section 2
	Non-ferrous metals	aluminium, precious metals, copper, other non-ferrous metal, cast non-ferrous metal products, other non-ferrous metal products or substitute products, please specify	Section 2
	Cement & lime	cement cement clinker lime, dolime, sintered dolime other cement or lime products or substitute products, please specify	Section 2
	Glass, ceramics & construction material[6]	flat glass container glass glass fibres other glass products tiles, plates, refractory products bricks houseware, sanitary ware other ceramic products mineral wool gypsum and gypsum products other construction materials or substitute products, please specify	Section 2
	Pulp & paper	chemical pulp mechanical pulp paper and paperboard	Section 2

3 Categories are derived from the legal basis – Article 10(a) of the EU ETS Directive
4 To fall in one of the energy intensive industry sectors, the principal product(s) of the project must be or must substitute a product whose conventional production is covered by Annex I of the EU ETS Directive. Substituting a product may include substituting the function of a product.
5 The lists of products given for each sector are non-exclusive and most give 'other products' as an option, where applicant is expected to specify the principal and other product(s) in the GHG calculator.
6 The sector 'Glass, ceramics & construction material' is a combination of the EU ETS activities 'Glass and ceramics', 'Mineral wool' and 'Gypsum'.

CATEGORY[3]	SECTOR[4]	PRODUCTS/SERVICES[5]	SECTION
		sanitary and tissue paper other paper products or substitute products, please specify	
	Chemicals	organic basic chemicals inorganic basic chemicals nitrogen compounds plastics in primary forms synthetic rubber other chemical products or substitute products, including bio-based products, please specify	Section 2
	Hydrogen	hydrogen	Section 2
	Manufacturing of components for energy intensive industries (in case of production of electrolysers)	electrolysers and their components recycling of materials for production of electrolysers and their components other, please specify	Section 2
	Other[7]	Electricity heat other, please specify	Section 2, including for timed-operation projects and for electricity saving projects
Energy Intensive Industries (EII) where CCS is the main aim of the project[8]	Choose an EII sector	choose an EII product	Section 2 and section 6
	EII / Other	CO_2 Transport	Section 2 and section 6
	EII / Other	CO_2 Storage	Section 2 and section 6
Renewable energy (RES)	Wind energy	non-dispatchable electricity heating cooling	Section 3
	Solar energy	non-dispatchable electricity heating cooling	Section 3
	Hydro/Ocean energy	non-dispatchable electricity dispatchable electricity	Section 3

7 The sector 'Other' covers all other activities that fall under the EU ETS. This particularly covers combustion to generate heat and electricity. This could include projects that improve efficiency in conventional combustion plants for electricity generation or make use of CCS in the power sector or electricity and heat produced from biogenic feedstocks. The sector also covers all other combustion for industrial purposes, which falls under the EU ETS. This can apply to many sectors such as food processing or textiles. The list of products therefore also gives 'other' as an option, next to heat and electricity.

8 Full value chain CCU/S projects, i.e. projects capturing CO_2 for geological storage or use, are categorised in the sector where they capture the CO_2. Direct air capture plants or waste-to-energy plants that capture CO_2 for incorporation in substitute products choose the sector of the material product they substitute. Direct air capture plants for geological storage, waste-to-energy plants for geological storage, CO_2 transport and/or CO_2 storage projects are all categorised in sector 'EII / Other'.

CATEGORY[3]	SECTOR[4]	PRODUCTS/SERVICES[5]	SECTION
		heating cooling	
	Geothermal energy (including ambient energy through heat pumps)	dispatchable electricity heating cooling	Section 3
	Bioenergy (also indicated as “bio-electricity”in Part C of the application form)	dispatchable electricity heating cooling	Section 3
	Use of renewable energy outside Annex I[9]	use of renewable energy in water desalination use of renewable energy in wastewater treatment other, please specify	Section 3
	Manufacturing of components for renewable energy	wind plants and their components solar plants and their components hydro/ocean plants and their components geothermal / ambient plants (including heat pumps) and their components recycling of materials for production of RES plants and their components stationary fuel cells using biofuels or RFNBOs, and their components other, please specify	Section 3
Energy storage (ES)	Intra-day electricity storage	electricity[10]	Section 4
	Other energy storage	electricity heating cooling	Section 4
		hydrogen-based energy storage e-fuel-based energy storage	Section 4 (projects producing hydrogen or e-fuels shall only be considered under the Energy Storage category when storage of excess renewable energy is a

9 The sector ‘use of renewable energy outside Annex I’ is aimed at projects whose main innovation is linked to the use rather than production of renewable energy and the final product or service falls outside Annex I activities.

10 For 'Intra-day electricity storage' the only product is electricity, while the products of 'other energy storage' can take different forms, which is accounted for by the different products listed separately and in line with products of other sectors.

CATEGORY[3]	SECTOR[4]	PRODUCTS/SERVICES[5]	SECTION
			primary aim of the project)
	Manufacturing of components for energy storage	batteries and their components recycling of materials for production of batteries and their components other, please specify	Section 4
Mobility (MOB)	Maritime	Transportation of goods/passengers Manufacturing of components for vessels other, please specify	Section 5
	Aviation	Transportation of goods/passengers Manufacturing of components for aircrafts other, please specify	Section 5
	Road transport	Transportation of goods/passengers Manufacturing of components for road vehicles other, please specify	Section 5
Buildings (BIL)	Buildings	Various, please specify	Various. Refer to section 1.2.4.

1.2.1 Choice of a principal product and a reference product

In some cases, the conventional product that will be replaced by a principal product from a project could have uses in more than one sector. For example, some products could be used either as chemicals under sector EII/Chemicals, or could be used as fuel under sector EII/Refineries. In such cases, the applicant must choose the sector associated with the most common use of the principal product that is the main aim of the project unless the project includes specific actions and tasks related to the use of the produced product in less common application. Similarly, in calculating the emissions in the reference scenario for each principal product (see section 1.4.1), the applicant must determine the appropriate emission factor based on the most common use of the product, unless the project includes specific actions and tasks related to the use of the product in a less common application.

> *Example: The sole product of a project is ethanol, and the project does not involve specific actions and tasks, nor investments, related to the use of ethanol as a chemical. The main market for ethanol in the EU is as transport fuel, and therefore the applicant must apply in the sector EII/refineries rather than EII/chemicals. The reference scenario emissions shall be determined in accordance with EII Case 4 (transport fuel substitutes).*

In some cases, a principal product from a project may be physically different (including having a different chemical composition) to the conventional product that it will replace (the reference product). In such cases, the innovative product may not be listed in Table 1.1, but the conventional product that the project aims to replace will often be. In these cases, the relevant sector associated to **the substituted product** shall be chosen for the application. The applicant must clearly specify the principal product and the associated reference product. The reference emissions will be determined by the product that is being replaced. In such cases applicants must credibly demonstrate the claimed use of the product, for example by providing draft contracts, letters of intent from the buyers, or other relevant supporting documents.

> *Example: A project produces a novel biomass-based packaging material and the applicant states that it will replace polystyrene in packaging applications. The category/sector/reference product for the application will be EII/chemicals/polystyrene with a reference scenario based on polystyrene production. The applicant must credibly demonstrate that the packaging product will replace polystyrene in practice.*

In cases where the product that is the main aim of the project could potentially replace either a physically similar[11] conventional product or a physically different conventional product, the applicant must determine the sector based on the sector of the physically similar conventional product unless the project includes specific actions and tasks related to the use of the product to substitute a physically different product. Similarly, in calculating reference scenario emissions for each principal product (see section 1.4.1) the applicant must determine the appropriate emission factor based on production of the physically similar conventional product unless the project includes specific actions and tasks related to the use of the product to substitute a physically different product.

> *Example: A project produces a cardboard product, and the applicant states that it could be used to replace PVC products in a specified application. If the project includes specific actions and tasks and investments related to setting up and operating a manufacturing plant to use the cardboard product in that PVC application, then the application may be submitted in the category/sector EII/Chemicals with a reference scenario based on PVC production. If the project does not include specific actions, tasks, and investments of this sort, then the application must be submitted in the category/sector EII/Pulp & paper.*

During project implementation, copies of contracts will have to be submitted to ensure that the claims made with respect to the intended use of the product and the related GHG emission avoidance are verified. If the project does not reach the expected GHG emissions avoidance due to a change in the use of the product, this may have implications on grant disbursement.

1.2.2 Choice of a sector when there is more than one principal product

The application may only be submitted for one sector. However, some applications may produce multiple products associated to more than one sector, and potentially associated to multiple categories. For such projects, the applicant must therefore choose the appropriate sector for the application based on the principal product or products that represent the main aim of the project, as explained below. The other 'co-principal' products do not affect the choice of sector. Note that projects that include principal products associated to more than one category are referred to as **hybrid projects** (see section 1.2.5).

In case of a project will earn revenues from the sale of a single principal product that substitutes a similar conventional product, it is straightforward to choose the sector according to the single principal product.

[11] A physically similar conventional product is a conventional product with a similar or identical chemical composition and similar or identical physical properties.

> *Example: The sole product of the project is steel produced in an innovative way to substitute traditional steel production. The principal product is steel and the relevant sector to choose is the steel sector under EII/Iron and Steel.*

> *Example: If a project intends to generate electricity through installation of photovoltaic panels, the relevant sector to choose is RES/Solar energy.*

In the case that a project will earn revenues from the sale of **several products**, the applicant shall define as 'principal product(s)' at least the set of products that generate the bulk of the revenues from a project. Other products may be identified as principal or non-principal at the discretion of the applicant. The conventional products substituted by the principal products must be included in the reference scenario for the GHG emissions calculation, whereas non-principal products are included in the project scenario only.

From the set of principal products, one must be chosen that reflects the main aim and innovation of the project. This product will determine the sector for the application. The main aim should be identified primarily by considering the revenues from the products or services that the project will produce or deliver, but the applicant should also consider to which product(s) the main innovation introduced by the project is relateds to. In some cases, the revenue and innovation in a project will be evenly distributed across products in more than one sector – in those cases, the applicant may choose which sector to apply in.

> *Example: A steel producer proposes a project to modify its existing plant in order to produce ethanol from carbon monoxide in the flue gas in addition to steel products. Ethanol will be sold as an alternative transport fuel for blending in gasoline for road transport. Both steel and ethanol are identified as principal products. The applicant must therefore decide whether to apply in the sector 'EII/Iron and steel' or in the sector 'EII/Refineries'.*

In a project of this sort, the produced steel will normally represent a larger revenue stream than the produced ethanol. The main innovation introduced by the project, however, may lay in the conversion of flue gas carbon monoxide to ethanol. In this case, therefore, it may be appropriate for the applicant to identify the ethanol as the product that is the main aim of the project and apply in the sector EII/refineries, even though it does not represent the largest revenue stream for the modified facility. In any case, this choice must be well justified in the application documents.

1.2.3 CCU/S projects

In case of CCS projects that include the facility from which the CO_2 is captured within the system boundary of the project, the principal product must be set as the main output of the facility.

> *Example: A carbon capture unit is added to an existing steel production plant. The principal product and main aim of the project is steel and the relevant sector is EII/Iron and Steel.*

Projects for which the main aim is CCS based on direct air capture or capture of naturally released geological CO_2, in which CO_2 is captured from the atmosphere or from a naturally occurring geological source, rather than from an industrial process, shall apply under category "EII" and sector "other" with the principal product identified as "CO_2 storage" (see also section 2.2.4.7).

Projects that will transport and/or geologically store CO_2 captured outside the system boundary shall apply under category "EII" and sector "other" with the principal product(s) identified as "CO_2 transport" and/or "CO_2 storage" (see also section 2.2.4.8, and section 6.2).

For projects including a CCU component, the sector shall be determined by consideration of the principal product that is the main aim of the project. If both the process from which the CO_2 is captured and the carbon utilisation process are within the system boundary of the project, then at least one of the products from the process from which the CO_2 is captured and at least one CCU product must be identified as principal products of the project, and the applicant must determine from these the product that is the main of the project following the guidance in section 1.2.2 above.

> *Example: A carbon capture unit is added to an existing steel production plant and the captured CO_2 is used in plastic production. Both the steel plant and the plastic production plant are **within the system boundary** of the project. Both steel and plastic must be treated as principal products. The main aim and therefore the sector of the project must be determined by considering the main innovation and sources of revenue for the project.*

If the CO_2 capture occurs outside the boundaries of the project, and the CO_2 is brought in as an input, then one of the CCU products shall be identified as the principal product that is the main aim of the project. In case of multiple CCU products, the guidance in section 1.2.2 above applies.

> *Example: A project sources captured CO_2 from **outside the system boundaries** for it to be used in plastic production. The principal product and main aim of the project is plastic, and the relevant sector is EII/Chemicals.*

Note that in the case that CO_2 is captured for utilisation from a project in the RES or MOB categories , then the CCU product(s) produced will normally fall under the EII category, and a hybrid RES/EII or MOB/EII application may be required (see section 1.2.5).

See section 6 for additional guidance on the calculation of the carbon capture credit. See section 2.2.5.2 for additional guidance on EII projects with a component of CCS, and section 2.2.5.3 for additional guidance on EII projects with a component of CCU.

1.2.4 Buildings

This sub-section applies to projects focusing on innovative solutions that reduce GHG emissions in Buildings (BIL). Such projects shall apply the general provisions outlined in section 1 and in the Annexes as relevant. In addition, such projects should refer to the chapters of the methodology that best correspond to their project activity, namely: EII (section 2), RES (section 3), or ES (section 4).

For example, a project that intends to produce electricity and/or heat for use in buildings should use section 3 of the Methodology if the heat or electricity produced or used is of renewable origin, including bio-origin. Conversely, the project should use section 2 of the methodology if the heat or electricity is of a different origin. In addition, a project that intends to produce innovative construction materials for use in buildings should apply section 2 of the methodology.

The list of examples in this section is not exhaustive.

1.2.5 Hybrid projects

When a project combines activities related to more than one category, such as EII, RES, ES, MOB, this will be considered a hybrid project. In such cases, the applicant shall still choose a main sector and associated principal product that best corresponds to the main aim of the project (see 1.2.2).

> *Example: a hybrid project involves installation of a large wind power generation facility coupled to an electrolyser producing hydrogen. The export of electricity, in excess to the electricity used by the electrolyser, is anticipated to generate ten times as much revenue as the sale of hydrogen and the integration of the two*

installations is innovative in terms of process and technology. The applicant should choose wind energy as the main sector.

If, however, the project's innovation is related only to the electrolyser and is not related to the wind farm, nor the integration between the two facilities, then it would not be appropriate to make a hybrid application. The applicant may instead consider making an application for the electrolyser only under the energy intensive industries or energy storage categories (i.e. considering hydrogen as the principal product and treating electricity production as out of scope).

In cases where the expected revenues for products in different sectors under a potential hybrid project are comparable (i.e. cases where a lower-revenue product would generate at least 70% of the expected revenue of the highest-revenue product) and the innovation is associated with a lower revenue product, the applicant may choose the main sector based on the more innovative product rather than the product with the highest revenue share. The applicant shall then clearly identify the distinct parts in the project relating to the relevant categories so that the calculations follow the respective sections of the methodology.

1.2.5.1 Calculation of GHG emission avoidance for hybrid projects

Hybrid projects may involve elements of any two or more of the categories EII, RES, ES and MOB. Such hybrid projects should combine the various components and clarify the system boundaries for each part. The GHG emissions from each component need to be then summed up while removing double counting. The following sub-sections 1.2.5.2 to 1.2.5.5 provide specific guidance on some more common combinations.

Hybrid projects shall calculate their reference emissions and their project emissions by summing up the single components calculated according to the relevant sections of the methodology (e.g., EII, RES, ES, MOB)while removing double counting of avoidance and/or emissions, if any. Then, the absolute GHG emission avoidance is calculated as the difference between the cumulated reference emissions, and the cumulated project emissions, while the relative GHG emission avoidance is calculated as the cumulated absolute GHG emission avoidance divided by the cumulated reference emissions.

Since applicants are allowed to upload only one spreadsheet at the application stage, for the case of hybrid projects, the applicant needs to combine two or more GHG calculators into one single file. For instance, for an hybrid EII + RES application the applicant shall add a copy of the tabs 'Reference emissions RES', 'Project emissions RES' and "Conversion factors RES" from the RES GHG Calculator into the EII GHG Calculator. If the project involves other categories such as storages or MOB, then the file shall include a copy of the "Reference emissions", "Project emissions" and "Conversion factors" tabs from the corresponding GHG Calculator as well. There is no need to duplicate the remaining tabs, e.g. for 'Assumptions', 'Net carbon removals', etc. Applicants can fill all the required information in one single version of the tab.

Note that, after filling in the project data, calculating the GHG emissions in the reference and project scenario for each of the project categories, and removing any double counted emissions, applicants shall adjust the links to other tabs in the "Summary per year" sheet, to ensure they capture the total reference emissions and project emissions from all the relevant categories. The formulas in the "Net carbon removals" sheet may also need to be adjusted, while the formulas in the "Summary" sheet should not be modified.

1.2.5.2 Energy intensive industries (EII) and renewable energy (RES) projects

For a project including EII and RES parts, the applicant should consider submitting a hybrid application. A typical case could be a project that proposes an innovative EII installation coupled with a RES generation plant, which will both supply power to the EII installation and export excess power to the grid. In this situation, only the portion of electricity exported to the grid can be claimed as part of the RES calculations, and result in additional emission savings.

Projects generating energy from partly biogenic resources (such as waste-to-energy plants where the consumed waste is partly biogenic) must make hybrid applications considering the renewable/biogenic part under RES and the non-renewable/non-biogenic part under EII. For projects involving carbon capture, refer also to the examples provided in section 6.4.

Applicants should pay particular attention to use in the calculation of the correct emission factor for electricity for each part of the project. An applicant should use the appropriate RES EF value from Table 1.3 in section 1.4.3.1 for the net electricity (dispatchable or not) exported from the RES part of the project, even if the hybrid project application is submitted for an EII sector as its main sector. The emissions accounting of EII and RES parts follows the principle of "adding up while removing double counting".

> *Example: A project proposes a hydrogen electrolyser, with principal product hydrogen, combined with an on-site wind energy farm. During wind peaks, the project plans to export half of the power to the grid. The project can be submitted as a hybrid project with an EII part (EII/hydrogen) and a RES part (RES/wind energy). Only the portion of electricity exported to the grid can be included as part of the RES calculations.*
>
> *Conversely, in case all the renewable energy will be used in the production of hydrogen with no electricity export, then the calculation follows only the EII section, and the project does not need to be considered as hybrid.*

For a hybrid EII+RES project, the applicant shall demonstrate that the power from the RES part will be preferentially supplied to local use in the EII part with only the remainder exported.

> *Example: A project intends building a RES facility that supplies 100% of its power to the grid and it is co-located in an EII facility. In such a case the applicant may consider submitting two separate funding applications for the RES and EII facilities, but cannot submit a hybrid application.*

1.2.5.3 Energy intensive industries (EII) and energy storage (ES) projects

A project that includes energy storage in an EII plant should split the GHG calculation into two contributions based on the energy intensive industry section 2 and based on the energy storage section 4. The EII emissions and the ES emissions need to be then summed up while removing double counting.

In case of activities overlapping between the EII and the ES parts, the revenue should be the guiding principle to split production activities between the EII part and the ES part.

> *Example: a project produces steel through the electric-arc method, and has on-site battery storage to take advantage of low electricity prices. During some periods of high electricity price, the plant will release stored electricity to the grid instead of using it for steel production. It is expected that 85% of the revenue comes from steel production (EII part) and 15% from the energy stored (ES part). The applicant should apply in the sector iron and steel and then follow section 2 for the EII part (principal product steel) and section 4 for the ES part (principal product intra-day or other electricity storage).*

1.2.5.4 Renewable energy (RES) and energy storage (ES) projects

Projects that include production of renewable energy and storage of energy should be presented as hybrid projects combining a RES component and an ES component. The application should clarify the system boundaries for the two parts. The RES emissions and the ES emissions need to be then summed up while removing double counting.

The correct emission factors shall be used for the RES and ES component of the project. Refer to the provisions in this section and to section 1.4.3 for the relevant emission factors for dispatchable and non-dispatchable electricity for the RES and ES components.

> *Example: Projects that generate renewable electricity and include a storage component at times when there is an excess of electricity in the grid, e.g., smart grid applications, are an example of hybrid projects. The application should clarify the split for their feed-in of grid electricity into a storage component and the residual uncontrolled feed-in. The emission avoidance of the storage component shall be calculated as in section 4. The emission avoidance of the uncontrolled feed-in shall follow the calculation of section 3.*

For a hybrid RES+ES project, the applicant must demonstrate that the power from the renewable energy facility will be supplied to the energy storage facility when the timing of power generation is consistent with the needs of the storage facility. These projects can claim credit under the RES methodology for any excess power exported. This also means that the combined facility shall never be assumed to store power from the grid at the same time as it is discharging power to the grid.

> *Example: Consider a hybrid project with a wind farm coupled with a battery storage facility. If the wind farm is generating power during a period during which the battery is being charged, the wind power should be used to charge the battery. Any excess power not required for battery charging may then be exported to the grid. To calculate the GHG emissions avoidance the equations described in sections 3 and 4 should be combined, and any double counted emissions removed.*

1.2.5.5 Fuel production under energy intensive industries (EII) combined with fuel switch under mobility (MOB)

Projects aiming exclusively at producing fuels for transport applications shall apply under the EII category. However, projects that include both the production of the fuel and the use of that fuel in a vessel, aircraft, or road vehiclefor may apply as hybrid projects combining the EII category (for production of the fuel) with the MOB category.

In this way, MOB projects operating in the aviation and maritime sector may claim eventual benefits from using the novel fuel in terms of reduced additional non-CO_2 climate impacts (e.g. black carbon in maritime or contrails in aviation). In such hybrid projects, CO_2, CH_4 and N_2O emissions from fossil fuel combustion that the project avoids by fossil fuel substitution shall be included in the reference scenario for the EII part of the calculation, by using the relevant fossil fuel comparator. Therefore, those terms shall be excluded from the MOB part of the calculation to avoid double counting (i.e. from equation [5.1]).

1.3 Manufacturing of innovative technologies and their components

Some projects involve the **manufacturing of components** to be used in specific renewable energy generation systems, energy storage systems, electrolysers, fuel cells, or mobility systems, including the manufacturing of the entire systems (see Table 1.1, section 1.2).

Such projects that submit an application for the call "Innovation Fund Call for proposals 2024 Net Zero Technologies" (INNOVFUND-2024-NZT) shall follow the rules in this section and calculate emissions reductions based on the intended use of the manufactured components rather than on the manufacturing process itself.

Instead, projects that submit an application under the call "Innovation Fund Call for proposals 2024 Batteries" (INNOVFUND-2024-BATT) shall calculate their GHG emissions following the provisions in Section 7, as the provisions in the rest of the methodology do not apply to them.

When deciding under which call to submit an application, the applicant should carefully review the eligibility conditions detailed in the call text of each call.

1.3.1 Choice of a sector for projects manufacturing innovative technologies and their components

Projects covered under this section shall select the dedicated manufacturing sector under the relevant category **based on the type of component manufactured and its intended use** (see section 1.2):

- electrolysers and their components (EII/Manufacturing of components for energy intensive industries);
- components for renewable energy generation, including heat pumps and fuel cells for stationary applications (RES/Manufacturing of components for renewable energy);
- components for energy storage systems, including batteries for stationary applications (ES/Manufacturing of components for energy storage);
- components for maritime vessels, including batteries and fuel cells for application in maritime vessels (MOB/Maritime).
- components for, aircrafts, including batteries and fuel cells for application in aircrafts (MOB/Aviation).
- components for road vehicles, including batteries and fuel cells for road transport applications (MOB/Road transport).

Eligible projects that manufacture components that are not listed above **may not use the rules in this section, may not apply in a "manufacturing of components" sector** under category EII, RES, and ES, and may not apply the manufacturing methodology under category MOB, but may be permitted to apply in another sector following the relevant provisions as applicable.

1.3.2 Definition of component

Projects covered under this section must produce specialised components, which includes some specialised materials. Projects producing bulk materials shall not apply as "manufacturing of components" projects under category EII, RES and ES, nor apply the manufacturing methodology under category MOB, and they shall not use the provisions in this section. However, they may be permitted to apply in another sector, for example a relevant EII sector, following the relevant provisions as applicable.

For a manufactured product, including a recycled product, to be considered a component, it shall have all the following characteristics distinguishing it from bulk materials:

- It shall be either a part of the energy or mobility system or a specialized material used in the energy or mobility system and could be replaced with a spare part or with replacement material;
- When leaving the manufacturing facility, it already has the intended specialized function relevant to the final purpose of the energy or mobility system;
- It is innovative or produced/recycled in an innovative way;

- It is in a ready to use form, i.e., it can be directly assembled or integrated into the energy or mobility system. Specialised materials must be in their final chemical form for utilisation.

  Example: bulk materials that can be used for manufacturing of batteries, but also for other purposes, are not considered components. Instead, materials to be solely used in batteries can be considered components, e.g., specific battery-grade anode and cathode materials. Other examples of specialised materials are the cooling fluid for a heat pump, and electrolytes.

The methodology for the manufacturing of a component may be applied to the manufacturing of a whole consumer product, with the component being the whole consumer product in this case (see section 1.3.3 and 1.3.5), and it may include the assembling of sub-components procured from a supplier external to the project.

Example: the manufacturing of innovative electric vessels does not require the manufacturing of the electric engines as part of the project but may be limited to the assembly of the innovative vessels with the engines purchased from an external supplier.

1.3.3 Definition of facility and consumer product

Components manufactured by projects covered under this section may be used in facilities which themselves produce product(s) within the scope of the Innovation Fund or may be used in relevant consumer products:

- For projects manufacturing components for electrolysers (EII/manufacturing of components for energy intensive industry), the component shall be considered to be used in a fully functioning electrolyser, which can operate as a facility or can be sold as a consumer product.

  Example: components for electrolysers may be used in large-scale electrolysers for the industrial production of hydrogen (facilities), or in small-scale electrolysers for household or commercial use (consumer products).

- For projects manufacturing components for renewable energy generation, including heat pumps (RES/manufacturing of components for renewable energy), the component may be used in a facility or in a consumer product.

  Example: components for solar panels may be used in solar farms (facilities) or in solar panels for household use (consumer products).

- For projects manufacturing components for energy storage, including batteries for stationary applications (ES/Manufacturing of components for energy storage), the component may be used in a facility or in a consumer product.

  Example: component for batteries may be used in large-scale installations for intra-day electricity storage (facilities) or in batteries for household use (consumer products).

- For projects manufacturing components for aircrafts, vessels, or road transport vehicles, including batteries and fuel cells for transport applications (MOB/Aviation, MOB/Maritime, MOB/Road Transport), the relevant consumer product is a functioning aircraft, vessel or road vehicle.

1.3.4 Calculation of GHG emission avoidance for projects manufacturing innovative technologies and their components

For the purpose of the GHG calculations, applicants shall bring within the system boundary the operation of the facilities or consumer product that will be built using the components manufactured by the project and supplied to the market (subject to the requirements in section 1.3.5 regarding allocation of emissions savings proportionally to the cost share of the component produced with respect to the total cost of the facility or consumer product).

The manufacturing plant producing the components shall be outside the system boundary of the GHG calculation. Any additional GHG emission reduction compared to the traditional processes of components manufacturing is outside of the scope of the GHG avoidance calculations but may be claimed under "Other GHG savings" (see section 1.1.7).

For manufacturing of component projects, the emissions in the project and reference scenarios are calculated considering that the components produced by the project (over the first 10 year of operation of the manufacturing plant) will be installed in relevant facilities and/or consumer products where they will be used for a use period (UP) of 5 years. Unless, the lifetime of the component is expected to be less than five years, in which case the emissions shall be calculated based on the expected lifetime of the component (i.e., the UP shall be set equal to the expected lifetime of the component).

> *Example: A manufacturing plant produces wind turbine blades. The manufacturer expects the blades to remain in service for 20 years. The emission avoidance calculations will consider that the blades produced each year will be used over a period of 5 years, corresponding to the maximum allowed by the methodology.*

> *Example: A manufacturing plant produces an innovative component for road vehicles with an expected lifetime of 3 years. The emission avoidance calculations will consider that the components produced each year will be used over a period of 3 years, corresponding to its lifetime.*

1.3.5 Allocation of emissions avoidance based on the cost share of the component

Applicants can only claim a portion of the emission avoidance generated by the facility or consumer product in which the manufactured component is used. This portion shall be proportional to the cost of the single component as a share of the total capital cost of the relevant facility or of the total retail price of the relevant consumer product ($CS_{component}$). For projects manufacturing a whole consumer product, as defined in section 1.3.3, the $CS_{component}$ shall be equal to 100%.

The relevant facility or consumer product to be used for this purpose is the one in which the component is intended to be used. The same component use must be assumed when calculating the cost share of the component as when determining the sector and when calculating project and reference emissions.

If a manufacturing project will produce components with different possible uses, distinct principal products may be defined for each of the intended use, which need to be well justified.

> *Example: A project will manufacture fuel cells. The fuel cells are specifically designed to be used in road transport vehicles (i.e., the consumer product). The applicant must apply in the sector MOB/Road transport, and must calculate the cost share of the component as the ratio between the cost of the fuel cell and the retail price of a representative fuel cell vehicle. The applicant is not permitted to calculate the cost share based on the use of the fuel cell for stationary applications. The applicant should also justify the intended use of the fuel cells in road transport applications by providing technical specifications, letters of intent and/or other relevant supporting documents.*

> *Example: A project will manufacture fuel cells. Some of the fuel cells are designed to be used in road transport vehicles, while others are designed for use in stationary applications. The applicant must make a hybrid application treating the different*

types of fuel cells as two co-principal products, considering the stationary fuel cells following the RES category rules in section 3 and the fuel cells for vehicles following the mobility category rules in section 5. The sector for the application shall be chosen considering the revenue share and level of innovation for each of the fuel cell types, following the rules in section 1.2.2. A different cost share shall be calculated for each part of the hybrid application, one based on the cost of a fuel cell vehicle as consumer product, and the other based on the cost of a representative stationary fuel cell facility. The applicant should justify the two intended uses of the fuel cells, and the volume of products allocated to each use, by providing technical specifications, letters of intent and/or other relevant supporting documents.

The total capital cost of a facility is the sum of the cost of the manufactured component plus the cost(s) of the remaining components constituting a typical operational facility. For components used in consumer products, the retail price of the consumer product shall be based on a typical use case for the component and shall exclude sales taxes. Applicants must provide appropriate references to justify this cost assessment.

<u>Example</u>: A manufacturing plant produces wind turbine blades. The project shall consider only a share of the reference and project emissions proportional to the share of the capital cost of a wind farm facility spent on the blades. If the applicant presents evidence that the rotor blades represent 25% of the total capital cost of a wind turbine installation, then the project shall include only 25% of the associated reference and project scenario emissions in its GHG calculations.

1.3.6 Assumptions for projects manufacturing innovative technologies and their components

The operating conditions of the facility or consumer product in which the component will be installed shall be estimated based on credible assumptions, and shall be well justified, for example by providing technical specifications, letters of intent and/or other relevant supporting documents. Applicants will have to justify the rationale for the projected performance of the component produced, as well as of other components that will be needed in the operational facility or consumer product, including performance degradation where relevant.

The applicant may not assume that the facility or consumer product equipped with a component manufactured by the project will have better performance or will be operated in a way which increases the resulting emission avoidance with respect to standard practice, unless these are a direct consequence of the installation of the innovative component manufactured by the project.

The intended use of the facility or consumer product equipped with the manufactured component may have an impact on the GHG emission avoidance calculations (see section 1.3.4). Therefore, the choice of the facility or consumer product in which the component will be used must be well justified, for example by providing technical specifications, letters of intent and/or other relevant supporting documents.

In case the actual user of the components produced during project implementation differs from, or is not compatible with, the intended use specified in the application, the project may not be able to reach the expected GHG emission avoidance, with potential implications on grant disbursement.

Applicants shall estimate the number of components manufactured by the project and supplied to the market based on the expected output of the manufacturing plant and the market potential, and in line with the assumptions made in the rest of the proposal concerning the operation of the plant, and including financial calculations. The actual number of components manufactured and provided to the market must be monitored, reported, and demonstrated with relevant supporting documents during project operation.

1.3.6.1 *Default assumptions for projects manufacturing components for electrolysers and hydrogen fuel cells for stationary applications*

Applicants with projects manufacturing electrolyser components (EII/Manufacturing of components for energy intensive industries) may assume that the electrolysers will operate for 5,000 hours a year[12] and may choose to use the following electrolyser capital cost assumptions[13], or may provide their own project specific values:

Electrolyser technology	Alkaline	PEM	Solid oxide	Anion exchange
Capital cost	480 €/kW	700 €/kW	520 €/kW	550 €/kW

Applicants with projects to manufacture hydrogen fuel cell components for stationary applications (RES/Manufacturing of components for renewable energy) may use the following fuel cell capital cost assumptions, or may provide their own project specific values:

Fuel cell technology	< 5 kW	5-50 kW	51-500 kW
Stationary SOFC system (CHP)	8,000 €/kW	7,500 €/kW	7,500 €/kW
Stationary PEMFC system (power generation)	5,500 €/kW	2,150 €/kW	1,550 €/kW

1.4 Calculation of GHG emission avoidance

The calculations of GHG emission avoidance should comprehensively cover the emissions in the reference scenario and in the project scenario. In the following, some general guidance is provided. Detailed calculation guidance is provided by project category in section 2 (EII), section 3 (RES), section 4 (ES), and section 5 (MOB), and in section 6 concerning the calculation of a carbon capture credit.

1.4.1 The reference scenario

The reference scenarios should reflect the production of a quantity of reference products, produced in a way consistent with the current practice in the relevant sectors, that provides an equivalent function to the principal products produced by the project.

Tables 1.2 and Table 1.3 provide examples or reference scenarios for a number of possible principal products. The default values are also given in the spreadsheet-based GHG calculators.

Table 1.2. Examples of reference scenario emissions

Category / Sectors / products	Reference scenario emissions based on:
EII	EU ETS benchmark(s), IF fossil fuel comparators (see Table 2.2), or other cases as specified in section 2.2.4.

[12] Source: Commission Staff Working Document Implementing the Repower EU Action Plan: Investment Needs, Hydrogen Accelerator and Achieving the Bio-Methane Targets,

[13] Source: Strategic Research and Innovation Agenda 2021-2027, Clean Hydrogen Joint Undertaking, Annex to GB decision no. CleanHydrogen-GB-2022-02.

Category / Sectors / products	Reference scenario emissions based on:
EII / Refineries / Biofuels	IF fossil fuel comparators (see Table 2.2)
EII / CCS	CO_2 is released (i.e. not captured) /available in atmosphere
RES / Non-dispatchable renewable electricity	2030 electricity mix
RES / Renewable heat	EU ETS benchmark for heat
RES / Renewable cooling	2030 electricity mix
RES / Dispatchable renewable electricity	Single-cycle natural gas turbine (used for peaking power)
ES / Energy storage	Single-cycle natural gas turbine (used for peaking power)
ES / Electricity grid auxiliary services	Combined-cycle natural gas turbine (partial load)
ES / Heat	EU ETS benchmark for heat production
ES / Hydrogen storage	EU ETS benchmark for hydrogen production
MOB/Maritime	A conventional vessel running on heavy fuel oil
MOB/Aviation	A conventional aircraft running on jet A1 Kerosene
MOB/Road transport	A conventional road vehicle running on conventional diesel

([1]) 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 (Recast), Annexes V and VI.

Source: European Commission internal elaboration.

Example: A project converts biogenic residues into heat and sells the heat for industrial and residential use. The reference scenario for renewable heating is pre-set as the EU ETS benchmark for heat (see Table 1.2).

Example: A project produces hydrogen. The reference scenario is the EU ETS benchmark for hydrogen.

1.4.2 Relationship to the calculation of relevant costs

The GHG emission avoidance calculations and the relevant cost calculations should generally be aligned and based on coherent assumptions, where relevant. For example, in terms of yearly production volumes, plant operation, and quantity of components yearly supplied to the market. However, applicants should be aware that the scope of the relevant costs methodology and the scope of the Methodology for GHG Emission Avoidance Calculation may differ in some cases.

Example: In a CCS project, in the GHG methodology, applicants must consider downstream emissions along the entire CCS chain, including emissions which may fall outside the scope of the project in terms of capital investment.

Example: In a manufacturing facility, the GHG methodology focuses on the emissions during the use of the components, while the relevant cost methodology considers the construction and operation of the manufacturing plant.

1.4.3 GHG emission factors for electricity, hydrogen, and heat

The calculation methodology requires the use of different emission factors for electricity, hydrogen and heat depending on whether they are inputs to, or outputs from a project, and on other contextual factors such as the project category. This section details which emission factors to use in each case.

1.4.3.1 Electricity

The EU is expected to achieve full decarbonisation of grid electricity by 2050. In order to assess Innovation Fund applications based on their long-term potential in a decarbonised economy, the GHG emissions for Innovation Fund projects shall be calculated treating the **grid electricity consumed by a project as having zero associated GHG emissions, which corresponds to the projected average emissions of the 2050 grid electricity mix**[14]. Applicants must still report expected electricity consumption by their projects for knowledge-sharing purposes.

The Innovation Fund also seeks to support projects that will make a contribution to **delivering a fully decarbonised grid**. The GHG emissions for projects that will supply non-dispatchable renewable energy shall be calculated treating the electricity replaced by the project as having the expected average emissions of the 2030 grid electricity mix (with an emission factor of 48.8 gCO_2e/MJ [0.176 tCO_2e/MWh][15]), while the GHG emissions for projects that provide dispatchable renewable electricity or energy storage shall be assessed treating electricity replaced as having the GHG emissions of dispatchable single cycle natural gas power generation (with an emission factor of 140 gCO_2e/MJ [0.505 tCO_2e/MWh][16]).

Example 1: A project produces renewable electricity from an intermittent source, such as wind or solar power. The electricity replaced by the project shall be considered to be non-dispatchable, and the corresponding emission factor is the expected average emission factor of the 2030 grid electricity mix (0.176 tCO_2e/MWh).

Example 2: A project produces renewable electricity from a source that can make the energy output available on demand, such as geothermal or biomass power. The electricity replaced by the project shall be considered to be dispatchable, and the corresponding emission factor is the one corresponding to single cycle natural gas power generation (0.505 tCO_2e/MWh).

Example 3: A project produces renewable electricity from an intermittent source, such as wind or solar power, and is coupled with a battery storage system. The project can apply as a hybrid RES + ES project following the provisions in section 1.2.5.4. The amount of renewable electricity that is fed directly to the grid shall be considered non-dispatchable. In turn, the amount of renewable electricity that is

[14] In contrast, the REDII estimates the "well-to-tank" emissions for fuels produced under current conditions, including current emissions attached to electricity consumption. The objective of this methodology is different from the emission-saving methodology the Commission proposes for renewable fuels of non-biological origin and recycled carbon fuels under REDII.

[15] Source: EU Reference Scenario 2020 https://ec.europa.eu/energy/data-analysis/energy-modelling/eu-reference-scenario-2020_en.

[16] Source: Commission Delegated Regulation (EU) 2018/2066 of 19 December 2018, Annex VI.

used to charge the battery during periods of low demand from the grid, and that is then discharged to the grid during period of high demand, may be considered dispatchable.

The project cannot consider "dispatchable" any amount of electricity that is discharged by the energy storage system while it is simultaneously charging. This means that, for the purposes of GHG calculations, the energy storage system cannot discharge electricity while it is charging at the same time. Also, the project cannot consider "dispatchable" any amount of electricity that is discharged by the energy storage system, while the renewable energy system could have provided the same amount at the same time. This means that the project cannot artificially lower the output of the renewable energy system during period of high demand, to prioritise energy discharge from the battery storage system.

In the energy intensive industries category (EII, section 2), emission avoidance associated with electricity use or generation can be claimed by projects in one of the following three cases:

- EII projects generating electricity for export to the grid can claim related emission avoidance by treating the produced electricity as a co-principal product and including the net amount of electricity exported to the grid as a term in the reference scenario, with an emission factor equal to the expected average emissions of the 2030 grid electricity mix (48.8 gCO_2e/MJ [0.176 tCO_2e/MWh]). Note that in the case that a project both consumes electricity from an external source (such as the grid) and exports electricity, only the net amount of electricity exported can be considered as a product when assessing reference emissions.

  Note that projects that combine an EII component with a component of **renewable** energy generation for net export to the grid should instead apply as hybrid projects following the provisions in section 1.2.5.2.

- EII projects that reduce their electricity consumption with respect to the reference scenario can claim related emission avoidance by identifying the net amount of electricity saved as a term in the reference scenario, with an emission factor equal to the expected average emissions of the 2030 grid electricity mix (48.8 gCO_2e/MJ [0.176 tCO_2e/MWh]).

  This type of project cannot be combined with other emission avoidance measures and shall follow the provisions detailed in section 2.2.6.

- EII projects that use predominantly electricity with low emission factor by timing their electricity demand, thereby increasing absorption of variable renewable electricity and reducing the need for dispatchable fossil power, can claim a credit related to the 'virtual' energy storage service provided by applying the provisions in section 2.2.6.6).

Table 1.3 summarises which emission factors for electricity shall be used in the calculations depending on the type of project and whether the electricity is consumed by or exported from it. These emissions factors apply to both the project and reference scenarios as specified in the table. The treatment of electricity under each project category is detailed in the respective section of this methodology.

Table 1.3. Emission factors for applications involving production, use and/or storage of grid electricity

Context	**Net electricity exported**	**EF**	**Electricity consumed**	**EF**
Energy intensive industry: general	Net amount of electricity exported from the project to the grid	48.8 tCO_2e/TJ [0.176 tCO_2e/MWh] $EF_{electricity,ref}$	Amount of electricity fed from the grid to the project in both the reference and project scenario	0.00 tCO_2e/TJ
Energy intensive industry: electricity-saving projects (see section 2.2.6)	Net amount of electricity saved (i.e. no longer fed from the grid to the system)	48.8 tCO_2e/TJ [0.176 tCO_2e/MWh] $EF_{electricity,ref}$	Amount of electricity fed from the grid to the project in both the reference and project scenario	0.00 tCO_2e/TJ
Energy intensive industry: timed electricity demand (see section 2.2.6.6):	Virtual-stored-energy-release component	140 tCO_2e/TJ [0.505 tCO_2e/MWh]	Constant average consumption component	0.00 tCO_2e/TJ
Renewable energy: non-dispatchable electricity	Net amount of electricity produced in the reference scenario and replaced by non-dispatchable electricity in the project scenario	48.8 tCO_2e/TJ [0.176 tCO_2e/MWh] $EF_{electricity,ref}$	Amount of electricity imported from the grid and consumed at the project site	0.00 tCO_2e/TJ $EF_{electricity,proj}$
Renewable energy: dispatchable electricity	Net amount of electricity produced in the reference scenario and replaced by dispatchable electricity in the project scenario	140 tCO_2e/TJ [0.505 tCO_2e/MWh] $EF_{electricity,ref}$	Amount of electricity imported from the grid and consumed at the project site	0.00 tCO_2e/TJ $EF_{electricity,proj}$
Energy storage	Net amount of dispatchable electricity supplied by the project	140 tCO_2e/TJ [0.505 tCO_2e/MWh] EF_{out}	Amount of electricity consumed by the project (both storage and self-consumption)	0.00 tCO_2e/TJ EF_{in}
Mobility	n/a	n/a	Amount of electricity consumed by the project	0.00 tCO_2e/TJ
Credit for CCU/S	n/a	n/a	Electricity consumed for CO_2 capture, transport and/or injection	0.00 tCO_2e/TJ

Source: European Commission internal elaboration.

1.4.3.2 Hydrogen

Table 1.4 summarises which emission factors for hydrogen shall be used in the calculations depending on the type of project and whether the hydrogen is consumed by or exported from it. These emissions factors apply to both the project and reference scenarios as specified in the table. The treatment of hydrogen under each project category is detailed in the respective section of this methodology.

For EII projects (section 2), the emission factor to be used for the hydrogen that is fed to the project as an input (i.e. sourced from outside the project boundary) is determined by the origin of the hydrogen. If hydrogen is used as an input in both the project and reference scenarios, **the applicant must assume the same origin for the hydrogen in both scenarios**, in line with the provisions in section 2.2.6.1. This includes the case in which the reference scenario is based on an EU ETS benchmark that includes the consumption of generic hydrogen (see example 2 below).

The origin of hydrogen can be classified as:

- Generic hydrogen, for which an emission factor of 6.84 tCO_2e/tH_2 shall be used.
- Renewable hydrogen (i.e. hydrogen as a renewable fuel, RFNBO or of biological origin) as defined in the Renewable Energy Directive 2018/2001 (RED) and its Delegated Regulations, and meeting the greenhouse gas emissions saving criteria set in Article 29 or Article 29a. An emission factor of 0.00 tCO_2e/tH_2 may be used for renewable hydrogen.
- Low-carbon hydrogen as defined in Directive 2024/1788 on common rules for the internal markets for renewable gas, natural gas and hydrogen, for which an emission factor of 0.00 tCO_2e/tH_2 may be used.

The applicant must credibly justify the assumptions made with respect to the origin of the hydrogen, for example by providing letter of supports from potential suppliers or other supporting documents. If the origin of the hydrogen is not known yet at the time of the application, and/or if its renewable or low-carbon origin cannot be credibly justified, then the hydrogen should be considered of "generic" origin.

In addition, the applicant must propose adequate monitoring measures in its monitoring plan (see section 1.5 and Appendix 4) to ensure adequate monitoring and reporting of the assumptions made at the application stage with respect to the origin of the hydrogen.

Failure to provide adequate justification and an an adequate monitoring and reporting plan may affect the quality of the GHG calculations and the resulting evaluation. In addition, failure to demonstrate the actual origin of the hydrogen during project implementation may affect the overall GHG emission avoidance that can be achieved by the project, which may have consequence in terms of grant disbursement as specified in the Call Text.

> *<u>Example 1</u>: A project intends to use direct hydrogen reduction to produce sponge iron instead of a traditional coal-based steel making process. Hydrogen is only used as an input in the project scenario; therefore, the applicant shall choose the relevant emission factor based on the origin of the hydrogen. An emission factor of zero can only be assumed if the applicant is able to credibly justify, and demonstrate during project implementation, the renewable or low-carbon origin of the hydrogen. Otherwise, the hydrogen shall be assumed to be of generic origin.*
>
> *<u>Example 2</u>: An ammonia production project will use hydrogen as an input, and the applicant intends to source RFNBO hydrogen from outside the project boundaries. The ammonia production process is similar to a conventional hydrogen to ammonia process, and the reference scenario is based on the EU ETS benchmark for ammonia production. Since the reference scenario is based on an EU ETS benchmark that includes the consumption of generic hydrogen, then the emissions associated to the*

hydrogen input in the project scenario must be based on the emissions factor for generic hydrogen, irrespective of the actual origin of the hydrogen.

Example 3: An ammonia production project includes within its scope (i.e. includes specific actions, tasks, and investments into) an electrolysis unit to produce electrolytic hydrogen on-site to be fed into the Haber-Bosch process. The hydrogen production process is within the project boundaries. Therefore, hydrogen is not an input to the project, and the rules concerning hydrogen used as an input do not apply. The project can consider an emission factor of zero for the electricity consumed by the electrolyser, and the reference scenario shall be based on the EU ETS benchmark for ammonia.

Table 1.4. Emission factors for applications involving production, use and/or storage of hydrogen

Context	**Net hydrogen exported**	**EF**	**Hydrogen consumed or stored**	**EF**
Energy intensive industry: where the project does not include specific actions and tasks related to a specific hydrogen use (i.e., the use of the hydrogen is within the scope of the project)	Net amount of hydrogen exported	6.84 tCO_2e/tH_2 $EF_{H2,ref}$	Amount of hydrogen (other than renewable or low-carbon hydrogen) fed to the project in both the reference and project scenario	6.84 tCO_2e/tH_2
			Amount of renewable or low-carbon hydrogen fed to the project in both the reference and project scenario	0.00 tCO_2e/tH_2
Energy intensive industry: where the project include specific actions and tasks related to a specific hydrogen use (i.e., the use of the hydrogen is within the scope of the project)	Net amount of hydrogen exported	Case specific depending on equivalent function replaced by produced hydrogen $EF_{H2,ref}$	Amount of hydrogen (other than renewable or low-carbon hydrogen) fed to the project in both the reference and project scenario	6.84 tCO_2e/tH_2
			Amount of renewable or low-carbon hydrogen fed to the project in both the reference and project scenario	0.00 tCO_2e/tH_2
Renewable energy	n/a	n/a	Amount of hydrogen consumed by the project in a renewable energy generation project or amount of hydrogen consumed by the facility or consumer product in a	0.00 tCO_2e/tH_2

Context	Net hydrogen exported	EF	Hydrogen consumed or stored	EF
			manufacturing of components project	
Energy storage	Net amount of hydrogen exported from the project	6.84 tCO_2e/tH_2 EF_{out}	Amount of hydrogen consumed by the project (both storage and self-consumption) or amount of hydrogen consumed by the facility or consumer product in a manufacturing of components project	0.00 tCO_2e/tH_2 EF_{in}
Mobility	n/a	n/a	Amount of hydrogen consumed by the project	0.00 tCO_2e/tH_2
Credit for CCU/S	n/a	n/a	n/a	n/a

Source: European Commission internal elaboration.

1.4.3.3 Heat

Table 1.5 summarises which emission factors for heat shall be used in the calculations depending on the type of project and whether the heat is consumed by or exported from it. These emissions factors apply to both the project and reference scenarios as specified in the table. The treatment of heat under each project category is detailed in the respective section of this methodology.

Table 1.5. Emission factors for applications involving production, use and/or storage of heat

Context	Net heat exported	EF	Heat consumed or stored	EF
Energy intensive industry	Net amount of heat exported	47.3 tCO_2e/TJ $EF_{Heat,ref}$	Amount of heat (other than waste heat) fed to the project from outside the project boundary in the reference and/or project scenario	47.3 tCO_2e/TJ
			Amount of waste heat fed to the project from outside the project boundary in the reference and/or project scenario	Determined following the rules for rigid inputs, see section 2.2.6.4

Context	Net heat exported	EF	Heat consumed or stored	EF
Renewable energy	Net amount of heat exported	47.3 tCO_2e/TJ $EF_{Heat,ref}$	Amount of heat consumed by the project	47.3 tCO_2e/TJ
Energy storage	Net amount of heat exported from the project	47.3 tCO_2e/TJ EF_{out}	Amount of heat fed to the project and stored by the project	0.00 tCO_2e/TJ EF_{in}
			Amount of heat fed to the project and used for self-consumption by a renewable energy generation project or amount of heat consumed by the facility or consumer product in a manufacturing of components project	47.3 tCO_2e/TJ $EF_{on\text{-}site}$
Mobility	n/a	n/a	Amount of heat consumed by the project or amount of heat consumed by the facility or consumer product in a manufacturing of components project	47.3 tCO_2e/TJ
Credit for CCU/S	n/a	n/a	Heat consumed for CO_2 capture, transport and/or injection	47.3 tCO_2e/TJ

Source: European Commission internal elaboration.

1.4.4 Biomass-derived fuels and materials

For the purposes of this methodology, 'biomass-derived fuels' include biomass, biomass fuels, biogas and biomethane, bioliquids, and biofuels, used for energy generation (see Appendix 5). CCU fuels produced using CO_2 of biogenic origin are not considered to be biomass-derived fuels.

For the purposes of this methodology, 'biomass-derived fuels and materials' include biomass-derived fuels and biomass-derived materials (i.e. materials of biogenic origin used for purposes other than energy generation, see Appendix 5). CCU products produced using CO_2 of biogenic origin are not considered to be biomass-derived fuels and materials.

This methodology requires applicants to use an emission factor of zero for biogenic CO_2 emissions from: the combustion of biomass-derived fuels and materials; their decomposition or degradation; and other chemical or biological processes (e.g.

fermentation). This methodology also excludes the avoidance of methane emissions from alternative disposal of biomass-derived fuels and materials entering the project as inputs (e.g. their diversion from landfill).

CO_2 and non-CO_2 emissions associated with the supply of biomass-derived fuels and materials used as an elastic input by an EII project, or used for energy generation by a RES project, are in scope and must be considered in line with section 1.4.4.2.

If biomass-derived fuels and materials are used as rigid inputs by an EII project, for example residual and waste biomass resources, the provisions of section 2.2.6.4 and the other relevant provisions in the EII section of the methodology apply.

Emissions of non-CO_2 greenhouse gases (e.g. CH_4 and N_2O) associated with the combustion or use of biomass-derived fuels and materials, the leakage or venting of biogas and biomethane, decomposition and degradation, and any other chemical or biological process within the system boundary (e.g. fermentation) are in scope, and must be included unless an exception is stated in the methodology sections 2, 3, 4 and 5 as relevant to the type of project (e.g. EII, RES, ES, MOB).

For EII projects, combustion and end-of-life emissions of biomass-derived fuels and materials produced as principal products are covered by the provisions of section 2.2.7 and 2.2.9. For non-principal products, refer to the provisions in section 2.2.10.

1.4.4.1 Sustainability requirements for biomass-derived fuels and materials

Any biomass used in Innovation Fund projects, including residual and waste biomass resources, must conform to the relevant minimum requirement specified in the Call Text.

Any biofuel, bioliquid, and biomass fuel (including biogas and biomethane) used in an Innovation Fund project must comply with the Renewable Energy Directive 2018/2001 (RED) and its Delegated Regulations, and meet the sustainability and greenhouse gas emissions saving criteria set in Article 29 of RED.

The applicant must credibly justify the assumptions made with respect to the classification and origin of a biomass-derived fuel or materials, for example by providing letter of supports from potential suppliers or other supporting documents. In addition, the applicant must propose adequate measures in the monitoring plan (see section 1.5 and Appendix 4) to ensure that the nature and origin of biomass-derived fuels and materials can be adequately reported and monitored.

Failure to provide adequate justification and to propose adequate monitoring measures may affect the quality of the GHG calculations and the resulting evaluation. In addition, failure to demonstrate the actual nature and origin of the biomass-derived fuel or material during project implementation may affect the overall GHG emission avoidance that can be achieved by the project, which may have consequence in terms of grant disbursement as specified in the Call Text.

1.4.4.2 Production and supply of biomass-derived fuels and materials

Where biomass-derived fuels and materials are consumed by a project as an elastic input under the EII category or as fuels for the production of energy under the RES category (in the term $Proj_{bio\ supply}$ in equation 3.8), the GHG emission factor for the production and supply of those biomass-derived fuels and materials, including both CO_2 and non-CO_2 emissions, shall be calculated, in tCO_2e/TJ, following the provisons in this sub-section.

When the biomass-derived fuels and materials utilised are listed in Annex V or VI of the Renewable Energy Directive 2018/2001 (RED), the applicant shall calculate the relevant emission factor by summing together the following terms, as provided in the directive:

- 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_{sca} emission savings from soil carbon accumulation via improved agricultural management.

If the biomass-derived fuels and materials used are not listed in Annex V or VI of the RED, then the applicant shall define an appropriate emission factor following the RED calculation principles and the hierarchy of data sources (Appendix 1).

Emissions associated to the transport of biomass feedstocks are covered by the provisions in section 1.4.5, and should be considered only if the biomass feedstocks are transported for more than 500 km to reach the first point of processing/treatment. When transport emissions must be considered, then they shall be calculated, in tCO_2e/TJ, and added to the emission factor for production and supply of biomass-derived fuels and materials as defined above. Otherwise, transport and distribution emissions may be treated as zero.

Credit for carbon capture and storage or carbon capture and use may only be given to a project by including a carbon capture credit following the rules in section 6. Therefore, a carbon capture term cannot be included in the emission factor for biomass-derived fuels and materials.

1.4.5 Transport emissions

Emissions associated with transport are to be considered in the following cases:

Where a project includes an element of carbon capture and utilisation or carbon capture and storage (CCU/S) the project emissions must include any emissions associated with CO_2 transport. This is to ensure that the net GHG benefits from carbon capture are not unduly undermined by any energy intensive CO_2 handling. Refer to section 6 for dedicated guidance.

Where a project is basing the reference scenario for one or more of its principal products on a physically different product that is used for a comparable function, then the project emissions must include any emissions associated with distributing that principal product to the point of use. This is to ensure that the net GHG benefits from a shift to the use of novel products are not unduly undermined by energy intensive distribution practices.

> *Example: Project scenario: hydrogen supplied for transportation.*
>
> *The project scenario must include in the processes box the emissions associated with distributing the principal product (hydrogen) to the vehicle tank, including any emissions from the transfer of hydrogen by truck, pipeline or other means to a hydrogen refuelling station.*
>
> *Hydrogen refuelling stations may lose hydrogen by boil-off from the liquid hydrogen storage tank, or use energy to re-liquefy the boiled-off hydrogen. Any emissions from re-liquefaction must be included in the processes box, and the amount of energy supplied in the reference scenario should reflect the amount of hydrogen that is finally supplied to vehicles if this is less than the amount of hydrogen leaving the hydrogen production facility.*
>
> *The reference scenario emissions shall be calculated based on the relevant fossil fuel comparator.*

Where a project uses biomass or waste materials as feedstock/inputs, the project emissions must include any additional emissions associated with gathering those materials and transporting them to the first point of processing/treatment when the transport range exceeds 500 km. This is to ensure that the net GHG benefits associated with utilising biomass or resources that would otherwise be wasted are not unduly undermined by the emissions associated with their transport, given that they may be transported over potentially long distances.

To calculate GHG emissions from the transportation of biomass or waste feedstock which are input to or are used as fuels in the system, applicants shall either use:

- Primary data: actual fuel consumption figures in the calculation submitted when data can be tracked from the distribution/logistics companies, or;
- Secondary data: estimated fuel consumption, based on distance between sites, and volume transported multiplied by the emission factors presented in Table 1.6 or other similar values that the applicant could duly justify.

If applicants' data is available per trip, applicants should calculate the emissions for each trip, using the average distance in each leg, and the amount of material transported in that exact leg, which can be derived from the estimate capacity of the truck. Otherwise, an approximated estimate of the total distance travelled in the year and the total emissions transported in the year is allowed as a proxy.

Table 1.6. GHG emissions (g $CO_2e/(t*km)$) from the transportation of biomass

Mode of transportation	Type of vehicle	Emission Factor
Rail transport	Freight electric train	Refer to InnovFund assumptions for electricity consumption
	Freight diesel train	18.68 gCO_2e /(t*km)
Road	40 t diesel truck (includes return trip)	60.03 gCO_2e/(t*km)
Inland/coastal waterway	1.2 kt diesel tanker	37.38 gCO_2e/(t*km)
	8.8 kt diesel bulk carrier	24.10 gCO_2e/(t*km)
Sea	12.6 kt HFO tanker	9.29 gCO_2e/(t*km)
	26 kt HFO bulk carrier Handysize	15.48 gCO_2e/(t*km)

Source: Internal elaboration of data from JEC WTW v5 Annexes, UBA ProBAS database, GEMIS v. 4.9

1.4.6 Combustion emissions

Emissions from combustion of fuels or other materials within the system boundary must be included in the emissions avoidance calculation. This must include the amount of non-CO_2 greenhouse gases (in particular CH_4 and N_2O) produced under the expected combustion conditions, on a CO_2 equivalent basis.

CO_2 emitted from the combustion of biomass-derived fuels and materials may be treated as having an emission factor of zero, but other greenhouse gases emitted in the combustion of biomass-derived fuels and materials shall be considered.

Where materials containing carbon atoms are used or produced by a project, the methodology requires in some specific cases that the applicant must consider the 'stoichiometric combustion emissions' of CO_2 for that material. The stoichiometric emissions shall be calculated as the amount of CO_2 that would be produced if all of the carbon in the material were to be oxidised to CO_2. Where the guidance asks for stoichiometric combustion emissions to be included, it is not necessary to consider the potential generation of other greenhouse gases under real-world combustion conditions.

1.4.7 Changes in performance over the period of a project

Some projects will be subject to predictable changes in production over the course of the first ten years of operation. For example, solar panels are subject to a degree of degradation that can be expected to reduce electricity output per installed solar cell over the time. The effects of such degradation or other changes should be reflected in the calculation of the reference scenario emissions or project scenario emissions as relevant. If likely changes in performance have not been properly considered in the GHG calculation, this may affect the assessment of the quality of the GHG calculation.

1.5 Monitoring, reporting and verification of performance for disbursement and knowledge-sharing

During operation, beneficiaries will have to demonstrate the GHG emission avoidance achieved by the project, and demonstrate that the assumptions made at the application stage are representative of the actual operation of the project. Additional requirements are introduced for the purpose of knowledge-sharing (KS).

In general, beneficiaries shall obtain, record, compile, analyse and document monitoring data, including assumptions, references, activity data and calculation factors in a transparent manner that enables the checking of performance achieved during the operation of the project. Beneficiaries shall ensure that the operational data determination is neither systematically nor knowingly inaccurate[17] and avoid bias in the selection of assumptions. In selecting a monitoring methodology, the improvements from greater accuracy shall be balanced against additional costs.

At the application stage, failure to provide an adequate monitoring plan may negatively affect the quality of the GHG calculations, and the resulting evaluation.

During project implementation, failure to demonstrate that the assumptions made at the application stage are representative of the actual operation of the project, may affect the overall GHG emission avoidance that can be achieved, which may have consequences in terms of grant disbursement as specified in the Call Text.

The GHG emission avoidance achieved by a project over the entire monitoring period will need to be verified by an independent GHG verifier. This includes a verification that the assumptions made at the application stage are representative of the actual operation of the project. A verified GHG emission avoidance report over the entire monitoring period must be provided at the end of the last year of operation, as specified in the Call Text. The general conditions on monitoring, reporting and verification (MRV) of performance, disbursement of the grant, and knowledge-sharing are described in the Call Text. The duration of the monitoring and reporting period is also specified in the Call Text.

Appendix 4 provides details on the specific requirements for reporting for the purposes of grant disbursement and for knowledge-sharing purposes for the different project categories and sectors.

[17] Commission Implementing Regulation (EU) 2018/2067 on the verification of data and on the accreditation of verifiers pursuant to Directive 2003/87/EC of the European Parliament and of the Council (Text with EEA relevance).

2 Energy intensive industry (EII), including substitute products, and carbon capture and utilisation (CCU)

2.1 Scope

This section deals with the methodology to estimate GHG emission avoidance in the proposed projects concerning activities falling in the energy intensive industry category and sectors (see section 1.2).

Projects that **produce a CCU product as one of their principal products** must follow the rules in this section. Projects concerned with innovative processing of biomass feedstock to produce biomass-derived fuels and/or materials in bio-refineries also must follow the provisions in this section.

Some guidance on cases where a sector choice might be less obvious is given in Table 2.1.

Table 2.1. Examples of sector choices

Projects	Choice of sector
Bio-refineries	Depending on the final products, bio-refinery projects need to choose either: refineries if predominantly producing fuels; or chemicals if predominantly producing chemicals; or pulp and paper if predominantly producing pulp and paper products. In some cases (such as a bio-based substance with both fuel and chemical applications) applicants will have to choose between refineries and chemicals referring to the guidance in section 1.2.
Direct air capture with CCS (DACCS) Waste-to-energy with CCS	EII / Other
DAC with CCU CCU	Such projects must produce in substitute products for the products listed in Annex I of the ETS Directive. The sector to choose is the sector of the substitute product.
Wastewater treatment	If biofuels are produced, then refineries can be chosen. If there is no EII relevant product produced but the treatment of wastewater uses renewable energy, then the sector is "Use of renewable energy outside Annex I" under the RES category (section 3).
Water desalination	If using renewable energy, then the sector is "Use of renewable energy outside Annex I" in the RES category. Otherwise, the sector can be EII / Other.
Production of hydrogen from electricity	Such projects generally fall under the sector EII/hydrogen. If the project includes specific actions and tasks related to ensure the use of the hydrogen in a specific application, then the sector may be determined by that application in which hydrogen will be used. For example, a project including actions and tasks related to setting up and operating hydrogen refuelling stations could apply in the sector EII/refineries. If the main aim of the project is the production of hydrogen as a mean of storage of excess renewable electricity (e.g. the electricity consumed is limited to periods of high renewable energy production, which result in a particularly low load factor) the project could apply in the sector Energy Storage/Other energy storage Following the provisions in section 4.

Source: *European Commission internal elaboration.*

2.2 GHG emissions avoidance

2.2.1 Absolute and relative GHG emissions avoidance

Applicants have to calculate both the absolute and relative emissions avoidance expected from the project. For the general formulas, refer to sections 1.1.3 and 1.1.4. The **absolute emissions** avoided by the project are the emissions of the reference scenario minus the emissions of the project scenario. The **relative emissions avoidance** is then calculated by dividing the absolute emissions avoided by the emissions of the reference scenario.

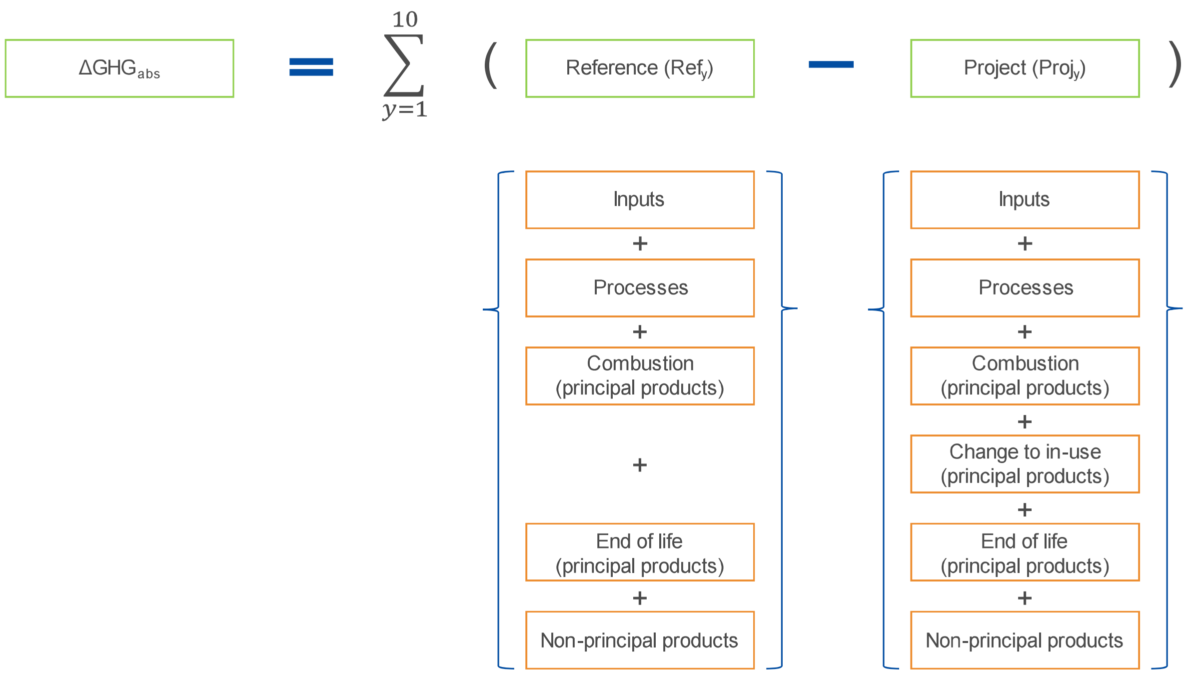
2.2.2 Life-cycle stages

The GHG emissions for each life-cycle stage shall be included in the calculations for the reference scenario and the project scenario, as illustrated in Figure 2.1.

The reference scenario provides the same functions as principal product(s) provide(s) in the project scenario. As explained in the section 1.2: the principal product(s) should reflect the main aim and innovation of the project; the reference scenario should reflect the current state-of-the-art in the given sector.

The applicants shall provide a detailed process diagram for the project and reference scenarios, indicating all the sub-processes, inputs, and products for both scenarios. The diagram should include quantities of the material and energy flows, when relevant. The applicants may use Figure 2.1 for guidance.

Figure 2.1. Diagram of GHG emission avoidance related to InnovFund EII projects



Source: *European Commission internal elaboration.*

Both scenarios shall include any relevant emissions in the boxes corresponding to "inputs", "processes", "combustion (principal products)", "end of life (principal products)", and "non-principal products"**.** The emission sources (positive emission terms) and credits (negative emission terms) to be considered in each life-cycle stage ("box") are explained in further detail in this section.

The "change to in-use (principal products)" emissions box appears only in the project scenario. If an innovative product reduces GHG in-use emissions compared to the reference scenario, then this change should be recorded only in the box for the project scenario with a negative term. The in-use emissions shall not be reported in the reference scenario.

Applicants shall differentiate "change to in-use (principal products)" box from the case of fuels or other combusted products, where combustion emissions are included in the "combustion (principal products)" box.

2.2.3 System boundary

In the context of the GHG emission calculations for an Innovation Fund project, the system boundary defines the set of processes to be assessed.

At the minimum the system boundary for the project scenario must include the parts of an installation at which **innovative practices** are being introduced by the project and any processes **downstream of those innovative practices** that are required to produce the principal products from the project. These processes must be included in the "processes" box of the project scenario (see section 2.2.5).

Processes **upstream of the innovative processes** may also be brought within the system boundary if they are under the control of the applicants and within the scope of the project. Otherwise, the outputs of those upstream processes shall be treated as inputs to the project and included in the "inputs" box (see section 2.2.6).

Note for applicants familiar with earlier versions of the methodology: This provision has changed with respect to previous versions of the methodology, in which applicants were allowed to expand the system boundary to include any number of upstream processes, even when they were not under their control and outside the scope of the project – this is no longer permitted.

The reference scenario is defined by the principal product(s) being produced by the project. The system boundary for the reference scenario will depend on the type of reference scenario that is appropriate to the project in question. The different cases for construction of a reference scenario are detailed in section 2.2.4.

Proposals may be submitted jointly by more than one entity that have formed a consortium. The methodology calculates the emissions savings for the whole project, not for each individual entity within the consortium. Therefore, there is no need to split the emission reduction between members of a consortium.

2.2.3.1 <u>System boundary in the case of an innovation applied to only part of a plant's throughput</u>

In some cases, an innovative element of a process may be introduced that reduces the emissions of only a fraction of the overall throughput of an existing industrial plant. In such cases, the GHG calculations shall be undertaken as follows:

- If the innovation could, in principle, be extended (i.e. scaled up) to cover the entire throughput of the plant then the system boundary must be drawn around a part of the plant proportional to the amount of throughput to which the innovation is applied. If, for example, the innovation applies to 30% of the throughput, then the GHG calculations may include that 30% of the throughput only. The project scenario shall include only the portion of the throughput to which the innovation is applied, and the reference scenario shall include the conventional production of an equivalent amount of reference product.

  <u>Example</u>: an ammonia production plant that currently consumes 100 thousand tonnes of hydrogen and produces 550 thousand tonnes of ammonia per year applies to the Innovation Fund for support to add an electrolysis unit (powered by electricity from RES) capable of producing 10 thousand tonnes of green hydrogen per year (one tenth of the input hydrogen). In principle it would be possible to add additional

electrolysis units to produce enough green hydrogen to supply the entire facility. The applicant may set the system boundary to include only a tenth of the whole facility, so that the project scenario would be based on 100% green hydrogen use and 55 thousand tonnes of ammonia output. The reference scenario would be based on the EU ETS ammonia benchmark for 55 thousand tonnes of production.

- If there are technical reasons that prevent the innovation from being scaled up to cover the entire throughput of the plant, then the project scenario must include the whole throughput of the plant, including the portion to which the innovation is applied and the portion to which the innovation is not applied. The reference scenario should include the conventional production of an amount of reference product equivalent to the total throughput of the plant.

  Example: *a glass production project will produce new glass by a combination of waste glass recycling and additional raw materials, recycling 20 thousand tonnes of waste glass a year and producing 40 thosuand tonnes of new glass. For technical reasons, the project limits the use of waste glass to 50% of the input stream. The whole facility must be placed within the system boundary, and the project must include the emissions associated with sourcing and processing the non-waste raw materials. The reference scenario would be based on the EU ETS benchmark for glass making for 40 thousand tonnes of output.*

If the system boundary is set to anything other than the size of the full facility, and the GHG calculations consider anything than the entire throughput of the plant, applicants must justify this decision. Failure to do so may negatively impact the credibility of the GHG emission avoidance calculations, and the resulting evalution.

2.2.4 Choice and construction of a reference scenario

The reference scenario includes emissions of conventional "processes" that would produce products that provide equivalent function(s) to the project's principal product(s). An "**equivalent function**" is usually the same quantity of a physically similar conventional product(s). If the principal product does not have a physically similar conventional alternative, then the reference scenario would be based on the production of the conventional product, or combination of conventional products, that would fulfil an equivalent function as the produced product.

In any cases where there is more than one possible reference scenario, the reference scenario must be based on the conventional products most likely to fulfil the function in the absence of the project, unless the project includes specific actions and tasks to use the product to substitute a physically different product (refer to section 1.2.1).

If the application is based on an inappropriate reference scenario (e.g., by choosing a reference scenario with higher emissions in preference to a reference scenario that would be more likely in the absence of the project) then this may affect the quality of the GHG emission avoidance calculations and the resulting evaluation.

Sum of individual reference scenarios: the **full reference scenario** of the project will consist of the sum of the individual reference scenarios for each of the principal products identified for the project. This may involve summing reference scenario emissions calculated following more than one of the nine cases detailed below.

> Example: *A project with two principal products: hydrogen and synthetic diesel fuel. A reference scenario consists of the sum of a reference scenario based on the EU ETS product benchmark for hydrogen production, and a reference scenario based on the InnovFund fossil fuel comparator for diesel.*

One 'combined' reference scenario: in some cases, it may be possible to identify for two or more principal products in the project scenario just one 'combined' production process in the reference scenario, provided that it is possible to match the quantity of each principal product in the project scenario to the quantity of each product from the reference scenario.

> *Example: An innovative process produces ethylene and propylene as principal products. Ethylene and propylene are co-products of the conventional steam cracking process, for which there is an EU ETS benchmark. The EU ETS benchmark for steam cracking may be used as a combined reference provided that the outputs of ethylene and propylene from the project are consistent with the benchmark specifications. The description of the benchmark (definition of products covered) reads: "Mix of high value chemicals (HVC) [...] with an ethylene content in the total product mix of at least 30 mass-percent and a content of HVC, fuel gas, butenes and liquid hydrocarbons of together at least 50 mass-percent of the total product mix".*

Nine cases for setting the reference scenario for a principal product:

The following nine cases (discussed in detail in sub-section 2.2.4.1 through 2.2.4.9) shall be used to define a reference scenario for each of the principal products of the project.

1. If there is an EU ETS product benchmark corresponding to production of the principal product, that benchmark shall be the basis for the reference scenario.

2. If there is no EU ETS product benchmark available that directly corresponds to production of a principal product, it may be possible to construct an appropriate reference scenario by combining EU ETS heat, fuel and/or process sub-installations with an existing EU ETS product benchmark.

3. If the project is a modification of an existing production system, the applicant may choose to use the existing production system as the reference scenario, subject to conditions detailed in sub-section 2.2.4.3.

4. If the principal product is a transport fuel substitute, then the reference scenario for that product shall be based on the InnovFund fossil fuel comparator values.

5. If the principal product is a natural gas substitute, then the reference scenario shall be based on the combustion emissions intensity of natural gas.

6. If the principal product can be synthesised from natural gas (e.g., methanol) and an emission value is available in the inputs data hierarchy (Appendix 1) for production of that principal product with natural gas as the primary feedstock[18], then the applicant shall base the reference scenario on that emission value.

7. If the project is for CCS from direct air capture, the reference scenario is zero emissions.

8. If the project is to transport and/or store CO_2 captured outside the system boundary, the reference emission is the quantity of CO_2 entering the system boundary.

9. Where it is not possible to construct a reference scenario for the production of one or more of the principal products from a project in the ways identified above, then the applicant may propose an appropriate reference scenario, subject to the conditions detailed in sub-section 2.2.4.9 This option can only be used for situation that are not covered by any of the previous cases, and the choice to use this option must be credibly justified by the applicant. In addition, the applicant must provide

[18] If it is not clear whether a pathway value contained in the data hierarchy assumes a natural gas feedstock, then the applicant should instead propose a reference scenario following the requirements of case 9.

clear justifications of the proposed approach and a robust characterisation of the emissions associated with the reference system proposed.

2.2.4.1 Case 1: A relevant EU ETS product benchmark (or benchmarks) exists

For projects producing principal products for which an EU ETS product benchmark is defined in Annex I of the applicable Benchmarking Decision[19] at the time of the submission of the application, the reference scenario shall be based on that EU ETS product benchmark. The EU ETS benchmark emissions **for the production of the relevant amount of the principal product** shall be included in the "processes" box of the reference scenario.

For projects **producing heat as a principal product**, the EU ETS heat benchmark shall be used to calculate the emissions in the "processes" box of the reference scenario.

For projects **producing hydrogen as a principal product**, the EU ETS hydrogen benchmark shall be used to calculate the emissions in the "processes" box of the reference scenario unless the project includes specific actions and tasks related to the use of the hydrogen produced in a specified application (section 1.2.1).

> *Example: A project produces hydrogen at a new facility to be used in an industrial application. The EU ETS benchmark value for hydrogen (2021 Benchmarking Decision: 6.84 tCO_2e/tH_2) shall be applied to all the hydrogen production as the reference.*
>
> *Example: A project produces hydrogen at a new facility to be supplied to hydrogen refuelling stations for use in fuel cell vehicles, but the project **does not include any action or task related to the construction and operation of the hydrogen refuelling stations, nor associated investments**. The EU ETS benchmark value for hydrogen (2021 Benchmarking Decision: 6.84 tCO_2e/tH_2) shall be applied to all the hydrogen production as the reference.*
>
> *Example: A project produces hydrogen at a new facility to be supplied to hydrogen refuelling stations for use in fuel cell vehicles, and the project includes relevant actions and tasks related to the construction and operation of a sufficient number of refuelling stations to supply the entire volume of hydrogen produced for the intended application. The applicant may choose to set the reference scenario emissions based on Case 4: Transport Fuel Substitutes instead of using Case 1 based on the EU ETS benchmark value for hydrogen, provided that this choice is credibly justified.*

Benchmark values for refinery units and processes included in Annex II of Commission Delegated Regulation (EU) 2019/331 **shall not be used to set reference scenario emissions**. If no relevant benchmark value is available in Annex I of the applicable Benchmarking Decision[20], then the reference scenario shall be determined following one of the other cases below.

In some cases, the processes producing a principal product in the reference scenario may correspond to **a combination of multiple EU ETS product benchmarks**.

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[19] The applicable EU act is Commission Implementing Regulation (EU) 2021/447 of 12 March 2021 determining revised benchmark values for free allocation of emission allowances for the period from 2021 to 2025 pursuant to Article 10a(2) of Directive 2003/87/EC of the European Parliament and of the Council, available at https://eur-lex.europa.eu/eli/reg_impl/2021/447. All the guidance documents are here: https://ec.europa.eu/clima/policies/ets/allowances_en#tab-0-1 (make sure to scroll down to 2021-2030).

[20] The applicable EU act is Commission Implementing Regulation (EU) 2021/447 of 12 March 2021 determining revised benchmark values for free allocation of emission allowances for the period from 2021 to 2025 pursuant to Article 10a(2) of Directive 2003/87/EC of the European Parliament and of the Council, available at https://eur-lex.europa.eu/eli/reg_impl/2021/447. All the guidance documents are here: https://ec.europa.eu/clima/policies/ets/allowances_en#tab-0-1 (make sure to scroll down to 2021-2030).

> *Example: A project producing hot metal.*
>
> *Constructing the appropriate reference scenario may require the applicant to combine the benchmarks for coke, sintered ore, and hot metal as all are part of the conventional hot metal production process. It will be necessary to provide in the calculation the expected consumption per unit of output of the intermediate products (in this case coke and sintered ore) that are used in the production of the final product (hot metal).*

The reference scenario shall include emissions in additional boxes that **the EU ETS product benchmark(s) do(es) not cover**[21]:

"Inputs". The EU ETS benchmarks do not include emissions associated with the production and supply of inputs used by the process. The applicant shall identify the quantities of inputs to be used in the conventional production process associated with the ETS benchmark in the reference scenario.

> *Example: the EU ETS benchmark for 'bottles and jars of colourless glass' does not include upstream emissions associated to the production of the material inputs to the conventional glass making process, such as sand, soda ash, and limestone. Therefore, the applicant shall identify appropriate emission factors for sand, soda ash, and limestone in the input data hierarchy (Appendix 1) and include the relevant input emissions in the "inputs" box or the reference scenario.*
>
> Note that, in the definition of the reference and project scenario, and the calculation of reference and project emissions, it is necessary to include also emissions that are the same in both scenarios as their exclusion would alter the relative emissions savings result. This is applicable to the case that some of the inputs are the same in the reference and project scenarios in terms of volumes and associated emissions.

"Non-principal products" associated with the reference scenario. In some cases, non-principal products must be included in the "non-principal products" box of the reference scenario.

> *Example: The EU ETS benchmark for short fibre kraft pulp reflects a process that generates tall oil as a non-principal product. An emission credit associated with the production of the associated quantity of tall oil must be included in the "non-principal products" box of the reference scenario.*

If the same non-principal product is produced in both the reference and project scenarios, then the credit should be included in both scenarios.

"Combustion (principal products)" where combustion of principal products occurs in the reference scenario, related emissions must be included in the "Combustion (principal products)" box of the reference scenario.

> *Example: A project will produce a coke substitute for use in iron production as a principal product. The reference scenario includes emissions in the "processes" box based on the EU ETS benchmark value for producing coke, and emissions in the "combustion (principal products)" box based on combustion emissions for the coke.*

[21] The processes and emissions covered by the EU ETS product benchmarks can be found in the "Guidance Document n°9 on the harmonized free allocation methodology for the EU-ETS post 2020 Sector-specific guidance" available at https://ec.europa.eu/clima/system/files/2019-07/p4_gd9_sector_specific_guidance_en.pdf

"End of life (principal products)". The EU ETS benchmarks do not include emissions associated with the end of life of principal products. These should be included in the dedicated box following the provisions in section 2.2.9.

> *Example: For a project producing ethylene glycol, emissions calculated using the EU ETS benchmark value will be included in the "processes" box of the reference scenario, but this does not include end of life emissions associated with the carbon contained in the product. The emissions from conversion of the carbon in the ethylene glycol to carbon dioxide at end of life should be included in the "end of life (principal products)" box.*

2.2.4.2 *Case 2: An appropriate reference scenario can be constructed from a combination of EU ETS product benchmarks and other benchmarks sub-installation*

Where the conventional processes required to provide the same functions as the principal product(s) do not correspond directly to an EU ETS product benchmark, it may be possible to construct an appropriate reference scenario by combining the existing product benchmark with the EU ETS fallback benchmarks sub-installations. In other words, when the boundaries of the project scenario do not coincide with an EU ETS product benchmark in the reference scenario, other EU ETS fallback sub-installations can be added to the "processes" box in the reference scenario to balance the scenarios.

In these cases, the relevant EU ETS product benchmark plus additional fallback sub-installation(s) shall be added to the "processes" box in the reference scenario to properly reflect the set of processes required to provide the same or equivalent function(s).

There are three types of other EU ETS fallback benchmarks sub-installations[22]:

- heat benchmark sub-installations.
- fuel benchmark sub-installations.
- process emissions sub-installations.

Heat benchmark sub-installations shall be added to the "processes" box of the reference scenario to account for additional heat used to produce an equivalent quantity of principal products in the reference scenario, beyond the amount of heat already covered by any of the EU ETS product benchmark required.

Fuel benchmark sub-installations shall be added to the "processes" box of the reference scenario to account for additional fuel use to produce an equivalent quantity of principal products in the reference scenario, beyond the fuel use already covered by any of the EU ETS product benchmark required.

Process emissions sub-installations may be added to cover any emissions occurring in the "processes" box of the reference scenario not already covered by any of the EU ETS product benchmark required.

> *Example: A project manufacturing cold drawn steel bars may be able to construct a reference scenario in which the "processes" box is based on combination of the product benchmark for hot metal and a fuel benchmark sub-installation reflecting additional fuel consumption for the drawing process.*

[22] The applicable EU act is Commission Implementing Regulation (EU) 2021/447 of 12 March 2021 determining revised benchmark values for free allocation of emission allowances for the period from 2021 to 2025 pursuant to Article 10a(2) of Directive 2003/87/EC of the European Parliament and of the Council, available at https://eur-lex.europa.eu/eli/reg_impl/2021/447. All the guidance documents are here: https://ec.europa.eu/clima/policies/ets/allowances_en#tab-0-1 (make sure to scroll down to 2021-2030).

> *<u>Example</u>: A project manufacturing sodium bicarbonate may be able to construct a reference scenario in which the "processes" box is based on the combination of the EU ETS benchmark for soda ash and a fuel benchmark sub-installation reflecting additional fuel consumption for reacting soda ash with water and CO_2 to produce sodium bicarbonate.*

All assumptions made in the characterisation of these additional sub-installations should be clearly stated and justified (for example in determining whether to assume that additional energy is supplied as heat, fuel or electricity), and the applicant should provide a reasonable characterisation of normal practice in the conventional production process.

When a decision must be made between two alternatives that are both equally representative of the current practice, the reference scenario should always reflect the lower GHG emissions option (i.e., the most conservative).

> *<u>Example</u>: If there is a choice between assuming that an additional process would be powered with electricity from the grid (zero emissions under the InnovFund calculation methodology for energy-intensive industry projects) or by adding an additional fuel benchmark sub-installation, then it should be assumed that power would be taken from the grid.*

Electricity consumption (see Table 1.3) is treated as having zero GHG emissions in energy intensive industry projects. Therefore, any additional electricity consumption not covered by the EU ETS product benchmark sub-installations should be included with zero emission factor for transparency.

The reference scenario shall include emissions in additional boxes that the EU ETS product benchmarks and other benchmarks sub-installation do not cover, such as "inputs", "Non-principal products", "Combustion (principal products)", and "End of life (principal products)". See related guidance in section 2.2.4.1.

2.2.4.3 <u>Case 3: Modifications to existing production systems</u>

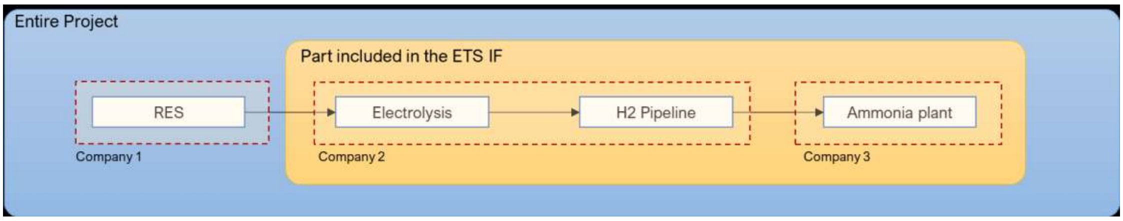
A project may be treated as a modification of an existing production system if emissions reductions are delivered by modifying one or more units or processes in an existing system in an innovative way, without simply replacing the main processes of the system and without changing the principal product that is produced by the system, and that is used to determine the sector of the application.

Projects that add carbon capture units to existing installations without changing the products from those installations **must be treated as modifications to the existing system**.

If the CAPEX associated with a project is more than a third of the CAPEX that would be required to develop a whole new production facility, then the project **cannot be treated as a modification of an existing system**.

A project in which only inputs are changed **does not qualify as a modification to an existing system**.

> *<u>Example</u>: In the diagram below Companies 2 and 3 jointly submit a project to use additional renewable electricity to produce hydrogen (the intermediate product) for making ammonia (the principal product), replacing hydrogen from an existing steam methane reformer in the existing ammonia plant.*



In a joint application, the project can be defined as a modification to the ammonia plant, as the hydrogen production unit is only a part of the production system. Therefore, the reference scenario may be taken to be the existing ammonia production plant, subject to the rules for modified plants detailed above.

Alternatively, company 3 could propose the project alone. The hydrogen coming out of the pipe from the electrolyser (company 2) would now be treated as an input (from 'outside' the system boundary). Company 3 would therefore not be permitted to treat this project as a modification to an existing production system, unless there were other innovative changes being made to the ammonia production system. The reference scenario would be the EU ETS benchmark for ammonia (see case 1 in section 2.2.4.1 above)), and the relevant emission factor for the hydrogen used as an input in the project scenario is 6.84 tCO2e/tH2 (see also example 2 in section 1.4.3.2). Note that this option prevents the applicant from claiming emission avoidance associated to the production of hydrogen, since it occurs outside the project boundaries.

Finally, if company 2 applied alone, then the principal product is hydrogen. In this case it would also not be possible to treat the project as a modification of an existing plant, and the reference scenario would be the EU ETS benchmark for hydrogen (see case 1 in section 2.2.4.1 above).

In some cases, identifying a project as a modification will depend on the choice of principal product.

<u>Example</u>: if a steam methane reformer at an oil refinery is replaced with an electrolyser and the principal product is identified as hydrogen, this could not be treated as a modification as the main element of the hydrogen production system is entirely replaced.

If, however, refined hydrocarbon fuels were treated as the principal product then the project could be treated as a modification in the context of this wider production system, which should then be included within the project boundaries in both the reference and project scenario.

Applicants **must provide justification** to support the decision to treat a project as a modification to an existing production system. If the applicant incorrectly identifies a project as a modification of an existing production system, or does not provide sufficient justification, this may affect the assessment of the quality of the GHG calculations.

Rules for modified production systems: When a project is identified as a modification of an existing production system, the applicant **may be permitted** to take the unmodified processes as the reference scenario, rather than the relevant EU ETS benchmark(s), under the following conditions:

- The emissions in the project scenario must be lower than the emissions in the reference scenario, otherwise the modification would not make sense from the GHG emissions avoidance perspective.

- Where modifications are made to at least one sub-process of a process corresponding to an EU ETS product benchmark, then the total of emissions for that modified process should be lower than the respective EU ETS product benchmark emissions.[23]
- If a project produces only one principal product and it is associated with an EU ETS product benchmark, then the GHG emissions from the modified production system must be below the EU ETS product benchmark emissions for the relevant quantity of that principal product. This requirement is not relevant to cases where there is not a corresponding EU ETS product benchmark for at least one principal product of the project.
- When comparing the "processes" emissions in a modification project to an EU ETS product benchmark, the benchmark must be chosen based on the modified plant, which may be different to the relevant EU ETS benchmark for the unmodified plant.

  Example: the existing, unmodified facilities operate a blast furnace steel production. The project would replace the blast furnace capacity with electric arc furnace (EAF) capacity. EAF processes only scrap steel, not iron ore, and therefore is a fundamentally less CO_2 intensive technology (hence the total of emissions for the modified process EAF has a much lower EU ETS benchmark than 'hot metal'). For the benchmark comparison: the project "processes" emissions should be below those for a benchmark EAF facility.

  Note that this project modification would also cause a change in the inputs from iron ore to scrap steel. Scrap steel should be assessed as a rigid input (see section 2.2.6.4), which may result in additional emissions being assigned in the "inputs" box following the modification.

- When defining the reference scenario based on an existing production system, the applicant shall identify inputs in the "inputs" box. The other boxes shall also be used as required.

  Note that, in the definition of the reference and project scenario, and the calculation of reference and project emissions, it is necessary to include also emissions that are the same in both scenarios as their exclusion would alter the relative emissions savings result. This applies also to the case in which some of the inputs are the same in the reference and project scenarios in terms of volumes and associated emissions.

2.2.4.4 Case 4: Transport fuel substitutes

For projects with a principal product that replaces (i.e. provides an equivalent function to) a conventional transport fuel, the reference scenario shall be based on the "IF fossil fuel comparator"[24] (emission factors) of the substituted fuel(s) defined in Table 2.2. This includes projects producing novel transport fuels falling under the definition of biofuels, renewable fuels of non-biological origin (RFNBOs), or recycled carbon fuels (RCFs) under REDII.

Proposals must credibly justify the intended use of the product as a substitute transport fuel, for example by providing draft contracts with distributors, letters of intent, or other relevant supporting documents.

For projects producing fuels for which transport is not the most common application, such as hydrogen, electricity, natural gas, natural gas substitutes, etc., a reference scenario

[23] Summed in both cases for the years of operation of the project.

[24] For fuels that are blended into fossil transport fuel or used as their direct replacements in existing unmodified vehicle engines, the equivalent quantity of the substituted fuel is that with an equal lower heating value (LHV; = net calorific value, NCV). For fuels (such as hydrogen) used in heavily modified vehicles, the equivalent quantity of substituted fuel is that which provides the same transport function (i.e. delivers the same kilometres x tonne of load), derived from v5 of the JEC-WTW report.

based on a fossil fuel comparator can only be chosen if the project includes specific actions and tasks to supply the fuel produced to the final user for the intended application, for example through the construction and operation of hydrogen refuelling stations that will supply the hydrogen produced to fuel cell vehicles. See section 1.2 for further guidance.

The emissions for the equivalent quantity of substituted conventional fuel(s) shall be included in the **"combustion (principal products)"** box of the reference scenario and based on the relevant IF fossil fuel comparators[25]. In this case **no emissions need to be included in the processes box of the reference scenario** as the relevant processing emissions are already included in the fossil fuel comparators. This approach also applies to projects producing synthetic crude oil as a principal product, for which a specific fossil fuel comparator is provided in Table 2.2.

For projects using a fossil fuel comparator as the reference scenario, the combustion emissions of the novel fuel (if any) must be included in the "combustion (principal products)" box of the project scenario. This must include any CH_4 or N_2O emissions associated with combustion of the fuel in a relevant vehicle. Lower Heating Values (LHV), also called Net Calorific Values (NCV), shall be used for the different fuels as provided in Table 2.2.

Table 2.2. "InnovFund fossil fuel comparators (FFC)"[26] and the lower heating values (net calorific values) for fossil fuels displaced by InnovFund projects.

Substituted fossil transport fuel	**InnovFund fossil fuel comparator (tCO_2e/TJ)**	**LHV = NCV (MJ/kg)**
Diesel	80.4	43.0
Gasoline	78.9	44.3
LPG	65.4	47.3
Aviation kerosene	78.3	44.1
Aviation gasoline	78.9	44.3
Marine reference fuel oil	78.0	42.8
Synthetic crude oil	75.5	42.0

Source: JRC elaboration of data from JEC-WTW report v5.

For fuels used in highly modified vehicles, such as hydrogen for fuel cell cars, the applicant shall take into account a change in vehicle efficiency based on typical vehicle efficiencies documented in JEC-WTW report v.5 (matching the function provided as detailed above).

If the fuel or transport mode (e.g., maritime, aircraft) is not dealt with in JEC-WTW report v.5, the relative efficiency compared to fossil fuels in conventional vehicles is found from the hierarchy of data sources in Appendix 1. If the fuels will be used in vessels or aircraft

[25] Note that the InnovFund fossil fuel comparator differs from comparator values used in the REDII because the InnovFund methodology (in order to align with EU ETS) does not consider the emissions from extraction and transport of crude oil, nor the transport and distribution of the final fuel. Specifically in the InnovFund methodology, the FFCs include: Combustion emissions + Transformation near market (crude refining). The FFCs do not include: production and conditioning at source (crude oil production), transformation at source, transportation to market (crude oil transport), conditioning and distribution (distribution and dispensing at retail site). FFCs include CO2, N2O and CH4 emissions.

[26] The FFCs are not to be used as emissions factors for these fuels when combusted for process energy – in that case, combustion-only emission factors should be used, as stated in section 2.2.5.

and the applicant wants to include other non-CO_2 climate impacts (e.g., black carbon), then the applicant may submit a hybrid application as detailed in section 1.2.5.5.

When the novel fuel is physically different with respect to the relevant fossil fuel comparator, the project shall include in the "processes" box emissions associated to the distribution of the novel (unblended) fuel to the vehicles, as detailed in section 1.4.5.

No inputs nor non-principal products shall be included in the reference scenario for this case. No additional emissions shall be recorded in the "combustion (principal products)" or "end of life (principal products)" boxes of the reference scenario.

Simplification for PILOTS topic **projects:** For the purposes of GHG calculations, PILOTS projects are not expected to submit letters of intent or other supporting documents when claiming the intended use of their product. However, applicants shall credibly justify their claim at the application stage, and will need to demonstrate the actual use of the product as a transport fuel substitute during project implementation.

2.2.4.5 Case 5: Natural gas substitutes

For projects producing natural gas substitute products (e.g., biomethane, synthetic methane), unless the project includes specific actions and tasks to use the product in a specific application, the emissions for the equivalent quantity of substituted natural gas, calculated as equal energy content on a lower heating value basis, shall be included in the "processes" box of the reference scenario based on the combustion emissions intensity (i.e. emission factor) of natural gas (56.2 gCO_2e/MJ).

If the project involves specific actions or tasks to use the natural gas substitute to fulfil an identified function (e.g. to enable supply for natural gas vehicles replacing the function of liquid fossil fuels or for an identified industrial use replacing the function of a different fuel), then a different case may be used so that the reference scenario reflects emissions associated with providing that equivalent function. The emission factor for this function may be **different from a natural gas combustion reference**. The choice of a reference scenario and emission factor different than the standard one, subject to the conditions detailed above, must be credibly justified by the applicant.

> *Example: A project produces renewable gas fed into the natural gas grid with no specific actions and tasks related to, nor investments in, a specific product use. The reference for the natural gas fed into the gas grid would be the general combustion emissions intensity of 56.2 gCO_2e/MJ.*
>
> *Example: A project produces renewable gas and supplies it to a steel plant. The applicant does not foresee action and tasks, nor investments, related to the steel making process. The reference would be the general natural gas combustion emissions intensity of 56.2 gCO_2e/MJ.*
>
> *Example: A project produces renewable gas and includes specific actions and tasks related to the construction and operation of fuelling stations to supply the gas for heavy duty transport. The applicant may use Case 4: Transport Fuel Substitutes and use the diesel fossil fuel comparator as the reference (80.4 gCO_2e/MJ, Table 2.2), taking into account the relative efficiency of natural gas and diesel heavy duty engines. The project scenario shall include emissions associated with distribution of the produced gas to the fuelling station.*

No inputs nor non-principal products shall be included in the reference scenario for this case. No additional emissions shall be recorded in the "combustion (principal products)" or "end of life (principal products)" boxes of the reference scenario.

2.2.4.6 Case 6: The principal product can be synthesised from natural gas and a life-cycle emissions value is available in the data hierarchy

For projects where the principal product provides a function that replaces conventional carbon-based fuels or chemicals for which reference scenarios cannot be proposed under cases 1, 3, 4 or 5[27] it is allowed to take as a reference scenario a life-cycle[28] emission factor drawn from the hierarchy of data sources in Appendix 1, provided that the emission factor is based on a process with natural gas as the main feedstock (e.g., synthesis of methanol, formaldehyde, acetic acid).

In general, life-cycle emission factors from the data hierarchy may be expected to include the carbon contained within the product. If a value does not include carbon contained within the product, then that amount of carbon shall be added to the emission value from the data hierarchy on a stoichiometric basis. The resulting value can be used as a single emission factor associated to the production of the relevant principal product in the "processes" box of the reference scenario.

No inputs nor non-principal products shall be included in the reference scenario for this case. No additional emissions shall be recorded in the "combustion (principal products)" or "end of life (principal products)" boxes of the reference scenario, because release of the carbon contained in the product shall be included in the emission factor in the "processes" box.

Several chemicals that can be produced by steam cracking of natural gas liquids fall on the 'high value chemicals' (HVC) list in the ETS[29]. However, they may be produced in ratios that do not meet the HVC definition, and therefore the EU ETS HVC benchmark may not be used to define the relevant reference scenario. In that case, the applicants shall propose a reference scenario based on a lifecycle emission value for the relevant chemical from the hierarchy of data sources (Appendix 1) and operate under case 6. The value proposed must be based on steam cracking of natural gas liquids. For example, it is not permissible to propose a reference scenario under case 6 based on steam cracking of naphtha.

> *Example: A project will produce propylene as the sole principal product.*
>
> *The EU ETS benchmark for "Steam cracking (high value chemicals)" states that it applies to processes, "with an ethylene content in the total product mix of at least 30 mass-percent and a content of HVC, fuel gas, butenes and liquid hydrocarbons of together at least 50 mass-percent of the total product mix". As the project produces no ethylene, this benchmark may not be used as a reference.*
>
> *The applicant shall look through sources in the data hierarchy (Appendix 1) to find a lifecycle emission value for propylene production from steam cracking of natural gas liquids and use that value as their reference scenario.*

Note that the reference scenario shall consider the function of the principal products of the project. For example, a fossil fuel comparator may still be the correct reference scenario even for a chemically distinct principal product, if that product will be used as a transport fuel, if applicable under the conditions detailed in sub-section 2.2.4.4.

> *Example: If methanol will be supplied for use as a transport fuel in maritime applications, under the conditions set in sub-section 2.2.4.4, the reference scenario shall be based on the fossil fuel comparator for maritime fuel (section 2.2.4.4), and not on methanol production. Applicants must convincingly establish that the*

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[27] I.e. the principal product does not replace any of: natural gas; fuels with fossil fuel comparator values (such as gasoline or diesel); or products with EU ETS product benchmarks.

[28] A life-cycle emission factor includes emissions associated with the production of the product. The stoichiometric combustion emission factors given in IPCC 2006 Guidelines for National Greenhouse Gas Inventories do not constitute life-cycle emission values.

[29] Acetylene, ethylene, propylene, butadiene, benzene.

methanol willl be used for maritime transport, and the project shall include emissions associated to the methanol distribution to the vessels.

2.2.4.7 Case 7: Direct air capture or capture of naturally occurring CO_2 for CCS

Where a project consists solely of the installation of a direct air capture facility, with the captured CO_2 sent for permanent storage, then the reference scenario emissions shall be set to zero. For such projects, it is not possible to use equations 1.2 and 1.3. Therefore, the relative GHG emission avoidance shall be set equal to 100% as specified in section 1.1.4, and the adjusted relative GHG emission avoidance shall be set equal to 200% as specified in section 1.1.5.

Where a project consists solely of the installation of a facility to capture naturally released geological CO_2 (e.g. from a geyser), with the captured CO_2 sent for permanent storage, then the reference scenario emissions shall be set to zero. For such projects, it is not possible to use equations 1.2 and 1.3. Therefore, the relative GHG emission avoidance shall be set equal to 100% as specified in section 1.1.4, and the adjusted relative GHG emission avoidance shall be set equal to 200% as specified in section 1.1.5. This case does not apply if the emission of CO_2 was stimulated by human intervention. If geological CO_2 is released due to a project to generate geothermal energy, then a project to capture that CO_2 should apply in category/sector RES/geothermal energy and follow the provisions of section 3.

See section 2.2.5.2, section 2.2.5.3 and section 6 for additional guidance on CCU/S.

2.2.4.8 Case 8: Storage and/or transport of captured CO_2

For projects that involve only the storage and/or transport of CO_2 that is captured outside the boundary for the project, the reference emissions shall be set as the quantity of CO_2 entering the system boundary, appearing as a positive emission term.

No distinction shall be made between CO_2 of fossil, atmospheric or biogenic origin in this case. For an applicant to gain recognition within the GHG calculation for the biogenic origin of the CO_2, then the capture of that CO_2 must be within the project scope and system boundary, and this reference case would not apply.

See section 2.2.5.2.2 and section 6 for additional guidance on projects that involve only the storage or transport of CO_2 that is captured outside the boundary for the project.

2.2.4.9 Case 9: The applicant proposes a reference scenario

Only for projects whose principal products cannot be given reference scenarios using any of the cases detailed above, the applicant may propose a reference scenario based on either a life-cycle analysis sourced from appropriate literature or based on a life-cycle analysis undertaken or commissioned by the applicants themselves.

The applicant must credibly justify the choice to resort to Case 9, and why the other cases described above could not be applied. In general, the applicant must select an appropriate reference scenario which delivers the **same quantity or function** as the principal product in the project scenario, and credibly justify and present the assumptions and calculations made.

When defining the reference scenario, the applicant shall identify relevant inputs in the "inputs" box and use the other boxes as appropriate. In the definition of the reference and project scenario, and in the calculation of reference and project emissions, it is necessary to include also emissions that are the same in both scenarios. This applies also to the case in which some of the inputs are the same in the reference and project scenarios in terms of volumes and associated emissions. The emissions of biogenic CO_2 from combustion of biofuels shall not be considered.

In applying Case 9, the applicant must apply the provisions of the hierarchy of data sources (Appendix 1) to select appropriate emission factors and references. Deviations from the hierarchy, for example the choice of a value from a source lower in the hierarchy when a value is available at a higher source, must be well justified.

The specific sources should, as far as possible, be consistent with the principles of EU ETS benchmarking. Applicants shall not define a reference scenario with artificially high emissions when lower-emission alternatives are available that are also more consistent with the principles of EU ETS benchmarking and more realistic.

The applicants should calculate **the direct GHG emissions for the combination of processes in the project scenario** using calculation methods which are in line with the Monitoring and Reporting Regulation (MRR)[30]. The derogations in Article 27(a) of the EU ETS Directive and Article 47 of the MRR relating to installations with low emissions are not relevant in the context of the Innovation Fund.

2.2.5 Emissions from processes

For the **project scenario**, the applicant must include in the "processes" box all the emissions expected within the system boundary of the project associated with the processes required to produce the chosen **principal product(s)** or delivering its function (section 1.2). The set of processes to be assessed in the "processes" box are defined by the system boundary (section 2.2.3).

- The "processes box" must include **all emissions of CO_2 or other greenhouse gases occurring due to fuel combustion or other chemical or biological processes** within the project boundary, remembering that any emission of biogenic CO_2 should be recorded, but shall be treated as having a zero emission factor, while emissions of non-CO_2 greenhouse gases (e.g. CH_4 and N_2O) must be considered with the appropriate emission factor.

- When fuels are combusted in the project scenario (or otherwise consumed to release their chemical energy e.g. in a fuel cell) an emission term must be included, based on the relevant reference indicated in the hierarchy of sources. For the case of fossil fuels, this generally means combustion emissions for a relevant case documented in tables 2.2 and 2.3 of Vol.2 Energy of the IPCC 2006 Guidelines for National Greenhouse Gas Inventories.[31] The combustion emissions must include expected generation of CH_4 and N_2O.

- The "processes box" must also include **any expected biogas or methane leakage occurring within the project boundary.** Leakages should be predicted based on standard rates for the type of facility/equipment proposed. See also section 1.1.7 and section 1.4.6

- Emissions associated with transport must be considered and included in the "processes" box in the cases specified in section 1.4.5.

- GHG emissions associated with any processes that produce non-principal products from the project should also be included in the "processes" box, as they are within the system boundary. The credit for supplying non-principal products is dealt with separately in the "non-principal products" box (section 2.2.10).

- Inputs from processes that are outside the system boundary are to be dealt with in the "inputs" box (section 2.2.6).

[31] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf.

The **reference scenario** includes in the "processes" box emissions from all processes associated with producing the same quantity of the principal product(s) or meeting the same functions as the principal product(s). Refer also to section 2.2.4 for relevant provisions concerning the definition of an appropriate reference scenario.

Note for applicants familiar with earlier versions of the methodology: The credit for carbon capture has been moved from the processes box and is now included in the calculation through Equation 1.1 (see section 1.1.3).

2.2.5.1 Changes in emissions from waste processing

If a process produces waste, emissions from the processing of waste – waste handling emissions belong to the "processes" box.

Example: An innovative process (project scenario) may eliminate a waste stream that conventionally (reference scenario) requires energy -intensive treatment.

2.2.5.2 Projects with an element of CCS

Projects that involve capture of CO_2 for storage, transport of CO_2 to a storage site, and/or storage of CO_2 in a permanent storage site can calculate a carbon capture credit in accordance with section 6.

In the case that CO_2 capture and storage occur in the reference scenario (this may occur, for example, under Case 3: Modification to an existing production system), this must also be taken into account by the inclusion of an appropriate separate carbon capture credit for the reference scenario (See section 6 for more guidance on calculating this credit).

2.2.5.2.1 Projects that capture CO_2 from within the system boundary, for storage

Projects that capture some or all of the CO_2 produced by processes within the system boundary and transfer it for storage **must include the full amount of CO_2 produced by those processes as an emission term within the processes box of the project scenario even though some of this CO_2 is to be captured**. Credit for the capture and subsequent storage of the CO_2 is then given by the separate calculation of a carbon capture credit following the rules in section 6 (cf. Equation [1.1]).

Fossil CO_2 will appear as a positive emission term, while biogenic CO_2 shall be reported with an emission factor of zero.

The reference emissions shall be calculated as for any EII project using the methodology as detailed in this section 2, and choosing the appropriate case as detailed in section 2.2.4.

- Projects that add carbon capture units to existing installations without changing the products from those installations **must be treated as modifications to the existing system** (Case 3, section 2.2.4.3).

- Projects consisting of CCS based on direct air capture (DACCS), in which CO_2 is captured from the atmosphere rather than from an industrial process, shall apply under category "EII" and sector "other" with the principal product identified as "CO_2 storage"**.** The reference scenario emissions for a DACCS project shall be zero (Case 7, section 2.2.4.7).

- Projects consisting of CO_2 capture for geological storage from natural geological sources (e.g. a geyser) shall apply under category "EII" and sector "other" with the principal product identified as "CO_2 storage"**.** The reference scenario emissions for such a project shall be zero (Case 7, section 2.2.4.7).

  If, however, a project causes the release of geological CO_2 which would otherwise have stayed underground (e.g., by sourcing geothermal steam from a reservoir where the steam is mixed with CO_2), and then captures the released CO_2, then the CO_2 that is released as a result of the project activities must appear as a positive term in the project scenario, including the portion of CO_2 that will later be captured.

If geological CO_2 is released due to a project to generate geothermal energy, then a project to capture that CO_2 should apply in category/sector RES/geothermal energy and follow the provisions of section 3.

2.2.5.2.2 Projects that transport and/or store CO_2 that was captured outside the system boundary

Projects that transport and/or geologically store CO_2 captured outside the system boundary of the project **shall include the full amount of CO_2 being brought into the system boundary as a positive emission term in the processes box of both the reference and project scenario**. This applies even though this CO_2 will not be emitted in the project scenario (excepting any fugitive, vented or leaked emissions). Credit for storage of the CO_2 is then given by the separate calculation of a carbon capture credit following the rules in section 6 (cf. Equation [1.1]).

Irrespectively of its origin (e.g., fossil, biogenic, geological, or atmospheric), the captured CO_2 will appear as a positive emission term in both the reference and project scenario. Additional credit associated to the biogenic origin of the CO_2 cannot be claimed if the CO_2 is captured outside of the system boundaries of the project. In this case, the origin of the CO_2 or the nature of the processes from which it is captured makes no difference to the GHG calculations.

In line with the approach described above, the emissions in the processes box of the reference scenario shall be set according to Case 8: Storage or transport of captured CO_2 (section 2.2.4.8) as the amount of CO_2 entering the project boundary (i.e. the reference scenario is set as if the CO_2 would be released in the absence of the project).

2.2.5.3 Projects with an element of CCU

Projects that will use captured CO_2 by incorporating it in a product can calculate a carbon capture credit in accordance with section 6. The CO_2 may be captured within the system boundary of the project or brought in from outside the boundaries of the project.

In the case that CO_2 capture and utilisation occur in the reference scenario (this may occur, for example, under Case 3: Modification to an existing production system), this must also be taken into account by the inclusion of an appropriate separate carbon capture credit for the reference scenario (See section 6 for more guidance).

2.2.5.3.1 Projects that capture CO_2 from within the system boundary, for use

Projects that capture some or all of the CO_2 produced by processes within the system boundary and utilise it or transfer it for utilisation **must include the full amount of CO_2 produced by those processes as an emission term within the processes box of the project scenario even though some of this CO_2 is to be captured and utilised**. Credit for the capture and subsequent utilisation of the CO_2 is then given by the calculation of a separate carbon capture credit following the rules in section 6 (cf. Equation [1.1]).

Fossil CO_2 will appear as a positive emission term,while biogenic CO_2 shall be reported with an emission factor of zero. As with CCS (see section 2.2.5.2.1), if the source of the captured CO_2 is atmospheric carbon or naturally released geological carbon, there is no requirement to include a positive emission term, unless the project causes the release of geological CO_2 which would otherwise have stayed underground. The reference emissions shall be calculated as for any EII project using the methodology as detailed in this section 2, and choosing the appropriate case as detailed in section 2.2.4.

Both the process from which the CO_2 is captured and the process in which CO_2 is used shall be included within the system boundary of the project: both processes must be included in the GHG calculations, and the applicant must provide a full characterization of both. At least one of the products of the process from which the CO_2 is captured, and one of the CCU products, must be set as a co-principal product of the project, and the principal product which is the main aim of the project shall be identified following the provisions in section 1.2.3. Non-principal CCU products, if any, may be included in the project scenario following the provisions in section 2.2.10.

> _Example_: *A project will add carbon capture to an existing steel plant, the steel plant is within the system boundary of the project and steel is set as one of the principal products of the project. The captured CO_2 will be used in an e-fuel production facility built and operated by the applicant as part of the project.*
>
> *The CO_2 generated by the steel plant is included as an emission term in the processes box of the project scenario even though part of it will be captured, and a carbon capture credit will be included in Equation [1.1] based on the amount of carbon incorporated in the e-fuel, following the rules in section 6.*
>
> *The applicant must include the e-fuel plant within the system boundary and fully characterise it as part of the GHG calculations. The produced e-fuel must be set as a co-principal product of the project, and the principal product which is the main aim of the project must be identified following the provisions in section 1.2.3.*

In the case in which CO_2 is captured by the applicant within the project scope, and it is then transferred to a third party for use purposes, outside the project scope, the applicant must include the CO_2 utilisation process within the boundaries of its calculations, including inputs to the CO2 utilisation process, and the combustion or end-of-life emissions of CCU products, following the provisions in this and other relevant sub-sections.

> _Example_: *A project will add carbon capture to an existing steel plant, the steel plant is within the system boundary of the project and steel is set as one of the principal products of the project. The captured CO_2 will be used in an e-fuel production facility built and operated by a third party and outside the scope of the project.*
>
> *The CO_2 generated by the steel plant is included as an emission term in the processes box of the project scenario even though part of it will be captured, and a carbon capture credit will be included in Equation [1.1] based on the amount of carbon incorporated in the e-fuel, following the rules in section 6.*
>
> *The applicant must include the e-fuel plant within the system boundary and fully characterise it as part of the GHG calculations. The produced e-fuel must be set as a co-principal product of the project, and the principal product which is the main aim of the project must be identified following the provisions in section 1.2.3.*

2.2.5.3.2 Projects that use CO_2 that was captured outside the system boundary

If the CO_2 is brought in from outside the project boundaries, then all the processes used to produce the CCU products and their associated emissions must be included within the system boundary of the project scenario. At least one of the products of the CCU process must be set as a principal product of the project.

In this case, there is no need to include a positive emission term for CO_2 production in the “processes” box. This means that **for CO_2 produced outside the system boundary it makes no difference to any part of the calculation whether the source of the CO_2 is biogenic, fossil, atmospheric or geological.**

<u>Example</u>: A project will use CO_2 captured from a steel plant for e-fuel production. Both the steel plant and the carbon capture unit are outside of the system boundary: they are operated by a third party (not part of the consortium) from whom the applicant purchases the CO_2 that enters the project as an input.

*The CO_2 generated by the steel plant **is not included** as an emission term in the processes box of the project scenario. The applicant must include the e-fuel plant within the system boundary and set the produced e-fuel as a principal product. A carbon capture credit may be included in Equation [1.1] based on the amount of carbon incorporated in the e-fuel, following the rules in section 6.*

The reference emissions shall be calculated as for any EII project using the methodology as detailed in this section 2, and choosing the appropriate case following the provisions in section 2.2.4, based on which reference product is replaced by the CCU product produced by the project.

Non-principal CCU products, if any, may be included in the project scenario following the provisions in section 2.2.10.

2.2.5.3.3 Combustion / end of life emissions of CCU fuels and products

If CCU principal products are to be combusted for energy (e.g. in the case of e-fuels produced using captured CO_2), then the emissions from this combustion shall be included in the project scenario just as they would be for non-CCU products (section 2.2.7). This provision applies also in the cases in which a third-party CO_2 utilisation process has been brought within the system boundaries of the project (see section 2.2.5.3.1).

Similarly, if CCU principal products are not combusted for energy, then the emission at end of life shall be included in the project scenario just as they would be for non-CCU products (section 2.2.9).

Combustion and end-of-life emissions for CCU products are **not affected by the original fossil or biogenic status of the captured CO_2,** i.e. combustion and end of life emissions for CCU products shall not be treated as zero even if the CO_2 was originally captured from a biogenic source.

<u>Example</u>: a project aims to produce methanol using CO_2 captured from waste gasification, with a waste composition of 70% biogenic carbon and 30% fossil carbon. The methanol is a principal product.

If the methanol is supplied as a fuel, then the release of the contained carbon shall be recorded as an emission under "combustion (principal products)". The original status of the captured CO_2 as partly biogenic does not affect the calculation of this emission term, which shall be equal to the full GHG emissions from combustion of the methanol.

If the methanol is supplied as a chemical, then the release of the contained carbon shall be recorded as an emission under "end of life (principal products)". The original status of the captured CO_2 as partlybiogenic does not affect the calculation of this emission term, which shall be equal to the full CO_2 emissions from stoichiometric combustion of the methanol.

2.2.6 Emissions from inputs

The applicant must specify the inputs that enter the system boundary (see section 2.2.3) and are used by processes in the "processes" box of the project or the reference scenarios. This shall include all **energy and material inputs, with the following exceptions**:

- Fossil fuels combusted (or otherwise consumed to release their chemical energy e.g. in a fuel cell) within the system boundary are an exception, as emissions due to extraction, processing, refining, distribution and storage of fossil fuels that are combusted for energy production by the project (or otherwise consumed to release their chemical energy e.g. in a fuel cell) are excluded from the calculation in line with section 1.1.7, and emissions from the combustion of fuels are included in the **"processes" box** (see 2.2.5). Fossil fuels shall therefore only be included in the "inputs" box if they are used as a non-combusted chemical input.

- In cases where solid materials are reshaped, reformed or assembled into a product by the project but remain largely unchanged in their chemical composition or structure they may not be treated as inputs. Such cases need to be well justified by the applicant.

  <u>Example</u>*: A project consists of working steel into parts for machinery. The steel used shall not be treated as an input, and therefore emissions associated to the production of the steel that is reshaped by the project will not be included in either the project or reference scenario.*

  <u>Example</u>*: A project consists of applying a coating to steel components. The steel component to which the coating is applied shall not be treated as an input, since it is simply the support to which coating is applied, and therefore steel production emissions will not be included in either the project or reference scenario.*

The emissions factors for **electricity, hydrogen and heat** used as inputs are stated in section 1.4.3. Electricity consumed in either the project or reference scenario shall be assigned an emission factor of zero, with the following two exceptions:

- Projects in which an existing production system is modified by means of specific innovative technologies that **reduce electricity consumption**, and this reduction in electricity consumption is the only change (i.e. there is no change to the products of the system, to the use of non-electrical energy or to the consumption of inputs other than those associated with the reduced electricity consumption).

  In this case the reference emissions related to electricity shall be obtained by multiplying the project net electricity savings by the expected 2030 electricity grid mix emission factor (48.8 gCO_2e/MJ [0.176 tCO_2e/MWh]).

  The electricity-saving projects shall be submitted under the EII sector determined based on the principal product as normal (section 1.2). It is not permitted to combine electricity-saving projects with other type of projects under any category or hybrid projects in a single InnovFund application.

- Projects that **time their operation** to coincide with periods in which the GHG intensity of grid electricity is low. This exception is explained in section 2.2.6.6.

Emissions for **water provision** as an input should be neglected unless water provision involves desalination, purification, or additional pumping. If one of these is required, then an emission factor should be chosen from the data hierarchy that reflects the specific water supply case. For example, if the water is supplied by desalination, then an emission factor for desalinated water should be found in the data hierarchy.

Other inputs in both scenarios are to be divided into three categories:

Elastic inputs (Section 2.2.6.3) are inputs for which overall production is variable (flexible), i.e. inputs for which production would be expected to increase as demand increases, and must be assigned emission factors from the data hierarchy (Appendix 1).

Rigid inputs (Section 2.2.6.4) are inputs for which overall availability is fixed, i.e. inputs for which production would not be expected to increase even if demand increases. Using rigid inputs is expected to result in displacement effects due to changes in current use or **disposition** of those rigid inputs.

Semi-elastic inputs (Section 2.2.6.5) are inputs that fall between these cases. Rigid inputs are never directly assigned emission factors from the data hierarchy – instead the applicant must identify the displacement effects of consuming those rigid (and semi-elastic) inputs. This may include an increase in demand for an associated elastic input, in which case an emission factor from the data hierarchy must be identified for that elastic input.

2.2.6.1 Treatment of inputs in the project and reference scenario

The emission factors used for inputs in the GHG emission avoidance calculations should represent current typical practices. As a fundamental principle, when a project uses the same or similar inputs in the reference and project scenario, these inputs should be given the same treatment as *elastic*, *rigid*, or *semi-elastic*, and must be assigned the same emission factor. A project cannot claim the benefits associated to procuring inputs from a less carbon-intensive source by assuming a different origin of the same or similar inputs between the reference and project scenario. Similarly, applicants are not permitted to adjust emission factors by making alternative assumptions about the upstream emissions for production of an input or product even if they are able to identify specific details to more closely represent the process used by their supplier.

In the **project scenario**, some inputs may be identified as de minimis and disregarded. as detailed in section 2.2.6.2.

For the **reference scenario only**, the applicant may choose to **simplify the calculation by ignoring the (positive) emissions of any number of inputs**. Note, however, that ignoring some inputs in the reference scenario would reduce the reportable absolute and relative GHG emissions avoidance of the project.

Where the reference scenario under 'Case 1' (see 2.2.4.1) or 'Case 2' (see 2.2.4.2) is based on one or more EU ETS benchmarks, it includes the emissions covered by EU ETS direct emissions calculations, but it does not include embedded emissions associated with any inputs used in those benchmarked processes. The applicant should therefore identify inputs that would be used in the conventional production system and include them in the "inputs" box of the reference scenario. In general, the EU ETS benchmark documents do not specify the quantities of all inputs used in each process, in which case the applicant must provide a reasonable and well justified estimate. This estimate of inputs quantity may be based on engineering principles and/or appropriate sources taken from the data hierarchy. The applicant must explicitly detail the basis for assumptions on quantities of inputs used in the reference scenario and provide references.

2.2.6.2 Materiality of inputs

The levels of materiality in this section are directly relevant only to elastic inputs in the project scenario. Rigid inputs and the rigid fraction of semi-elastic inputs are replaced in the calculations with associated quantities of elastic inputs (which should then be given a level of materiality) and/or with defined emissions from changed **disposition** which do not need to be further adjusted.

The level of materiality of elastic inputs can be *major* or *de minimis*. Major inputs must always be included in the emissions calculations with emission factors derived from reference literature, according to the method and hierarchy in Appendix 1.

De minimis inputs

De minimis inputs are elastic inputs that make such a small contribution to the overall emissions of the project scenario that they may be ignored when assessing emissions avoidance. Inputs used in very small quantities that would obviously not make a significant contribution to the GHG emissions profile of the relevant scenario may be stated generically, e.g., "maintenance materials", and assigned zero emissions. Any input estimated as having total associated annual emissions of 10 tCO_2e or lower during full project operation may be treated as *de minimis* and ignored.

The applicant may also select from the list of inputs a subset whose emissions jointly amount to less than 5 % of the total emissions ascribed to the inputs for the whole project and treat them as de minimis inputs.

For monitoring and reporting for disbursement the selection of de minimis inputs must be restricted so that their emissions jointly amount to less than 5% of the total emissions ascribed to the inputs; for monitoring and reporting for knowledge-sharing to less than 2% of the total emissions ascribed to the inputs.

The emissions of *de minimis* inputs may be disregarded.

For projects submitted in a Small-Scale or Pilots topic:

The applicant may select from the list of inputs a subset whose emissions jointly amount to less than 15 % of the total emissions ascribed to the inputs for the whole project and treat them as de minimis inputs.

2.2.6.3 ELASTIC inputs

If the supply of the input can be increased in order to meet the change in the demand, then the input is considered "elastic", and its emission factor is based on the emissions involved in supplying the extra quantity of that input. The full definition of an elastic input is given in Appendix 2. Emissions factors for elastic inputs used should be drawn from the data hierarchy in Appendix 1.

Note that the **EU ETS benchmark emission factors may not be used for inputs** as the scope of the EU ETS benchmark calculation is not appropriate for this purpose.

As explained in section 2.2.6.4.1 below, the emissions intensity of a rigid input is based on identifying the elastic input that replaces the rigid input in its existing use. The provisions in this section also apply to elastic inputs identified in this way as substitutes for diverted rigid inputs or diverted semi-elastic inputs.

2.2.6.3.1 Biomass-derived fuels and materials as elastic inputs

The emissions for biomass-derived fuels and materials as elastic inputs are calculated following the rules in section 1.4.4.

Non-CO_2 greenhouse gas emissions (CH_4 and N_2O) associated to the combustion or use of any biomass-derived fuels and materials that is combusted or used as part of the project must be included in the "processes" box or "combustion (principal products)" box as appropriate.

Refer to section 2.2.6.4.2 for the treatment of residual and waste biomass resources, which typically should be treated as rigid inputs.

2.2.6.3.2 Other relevant inputs

For other inputs, GHG emission intensity values must be taken from the reference literature according to the method and hierarchy in Appendix 1. The applicant must reference and justify all the literature values that are used for the emissions factors, so the evaluators can check them.

If several emission factors are available at the same level of the hierarchy, representing different processes for obtaining the same product, the applicant shall select the process that best describes the **marginal** source (otherwise known as the "swing producer") of the input, and must explain the choice.

For inputs containing carbon compounds, life cycle and well-to-wheel databases will often show total carbon intensity, which is the sum of the stoichiometric carbon content of the material and all emissions from processes in the supply chain (i.e. the carbon intensity of the product assuming that its carbon is entirely converted to CO_2 during use/end of life phases). However, including stoichiometric CO_2 release in the emission intensity of the input as well as in the "combustion (principal products)" or "end of life (principal products)" boxes for the products would **result in double counting** of those carbon emissions. For carbon-containing inputs, where the emission factor selected includes the stoichiometric carbon content, the appropriate emission factors to be used can therefore be found by subtracting from the total carbon intensity the carbon content of the input converted to mass of CO_2 using the molar weight ratio 44/12.

> *Example: A project uses hydrochloric acid (HCl) as an input. An emissions intensity value of 1061.1 gCO₂e/kg is provided for HCl in the document "Definition of input data to assess GHG default emissions from biofuels in EU legislation" at level 3 of the data input hierarchy.*

> *Example: A project uses methanol (CH_3OH) as an input. An emissions intensity value of 97.1 gCO_2e/MJ is provided for methanol in the document "Definition of input data to assess GHG default emissions from biofuels in EU legislation", and this value is subdivided into supply emissions of 28.2 gCO_2e/MJ and combustion emissions of 68.9 gCO_2e/MJ. For methanol used as an input, only the supply emissions shall be considered so the emission factor to use is 28.2 gCO_2e/MJ.*

Note for applicants from previous calls: previous versions of the methodology included a requirement to reduce input emission factors by 15% to approximately remove upstream fossil fuel supply emissions. **This requirement has been removed** as part of the simplification of the methodology.

2.2.6.3.3 Attribution of emissions between co-products in the supply of elastic inputs

In some circumstances, it may be necessary to attribute emissions between co-products of a process in order to determine the GHG emissions intensity of an elastic input. This would include the case that a major elastic input is one co-product from a process that has only an overall GHG emissions intensity available in the data hierarchy.

For the purposes of the calculation of attribution of emissions to co-products, the emissions to be shared shall be all the considered emissions that take place up to, and including, the process step at which the co-products are produced. If an input to the process is itself a co-product of another process, the attribution of emissions at the earlier process must be done first to establish the emissions to be attributed to the input.

ISO 14044 (2006) provides a framework for such an attribution and for calculating the emissions intensities for the supply of elastic inputs that are co-products of another process as illustrated in Appendix 3.

2.2.6.4 RIGID inputs

If the input has a fixed supply, which cannot be increased to accommodate additional demand, then it is considered "rigid". This means that it can only be supplied to a new InnovFund project by **diverting** it from another use or **disposition**.

The emission intensity of a rigid input is calculated considering the impact of diverting it from its existing use (rather than any emissions associated with the generation of the rigid input itself), plus the emissions associated with any additional treatment and transport. This means that a rigid input shall never be directly allocated an emission factor from the data hierarchy. The emissions intensity may be negative (i.e., avoidance of GHG emissions) if the input was releasing emissions in its existing use/disposition, or positive (i.e., additional GHG emissions) if the input was avoiding emissions in its existing use (for example by reducing demand for other materials).

A product that represents less than 10% of the value of the total products of the supplier shall be treated as rigid. A product that represents between 10 and 50% of the value of the total products of the supplier shall be treated as semi elastic, see 2.2.6.5. This is discussed further in Appendix 2.

Examples of rigid inputs are provided below.

> *Example: Municipal waste, used plastics, used lubricating oil. For example, taking municipal waste as an input will not affect the generation of municipal waste, and therefore it is considered a rigid input. Applicants shall duly document the use or disposition from which the waste used by the project is diverted from, and shall calculate the associated emissions following the provisions in section 2.2.6.4.2.*
>
> *Example: Intermediate streams from existing processes. For example, blast furnace gas, black liquor. Using industrial off-gases from an existing process will not affect the generation of off-gases by that process, and therefore it is considered a rigid input.*
>
> *Example: Process heat or waste heat[32] taken from an existing process. For example, using excess process heat from an existing process will not affect the generation of excess heat by that process, and therefore it is considered a rigid input.*

2.2.6.4.1 Assessment: diversion emissions

The emissions intensity of a rigid input should consider the impact of diverting it from its existing use based on one of the following four cases. The applicant should clearly and explicitly detail in the application the assumptions that have been made with regard to any rigid inputs.

1. **Case 1: The diversion of the rigid input is expected to increase demand for one or more elastic inputs**. In this case, the rigid input should be replaced in the list of inputs in the "inputs" box with the relevant quantities of these elastic materials, which should be treated as any other elastic input.

> *Example: A project uses heat recovered from an existing process, and as a result extra heat needs to be produced to maintain the supply of heat to other processes. In this case, the emissions intensity of the heat used is determined by the emission factor for "heat fed to the project" specified in section 1.4.3.*
>
> *Example: A project takes as an input industrial off-gas that would otherwise be combusted to produce process heat. Then the applicant shall consider, in the project scenario, the emissions incurred to replace the heat lost by diverting the off-gas from its current use to the project. This can be done by considering the production of an equivalent amount of heat and using the emission factor for "heat fed to the project" specified in section 1.4.3.*

[32] REDII Directive, Article 2 (9):'waste heat and cold' means unavoidable heat or cold generated as by-product in industrial or power generation installations, or in the tertiary sector, which would be dissipated unused in air or water without access to a district heating or cooling system, where a cogeneration process has been used or will be used or where cogeneration is not feasible.

As emissions for electricity used are set to zero, there are no additional emissions associated to diverting off-gases from electricity production.

2. **Case 2: The diversion of the rigid input is expected to increase demand for other inputs that are rigid or semi-elastic**. In this case, the results of diversion of those other rigid inputs (or the rigid fraction of semi-elastic inputs) should be assessed in the same way. This should continue until the emissions implications of diverting the original rigid input have been fully characterised as a combination of increased demand for elastic inputs and emissions changes due to changes in disposition.

   Example: The project used sugar beet molasses as an input. The applicant determines that molasses should be considered a semi-elastic input (see section 2.2.6.5) as the value of the molasses is estimated by the applicant at 17% of the overall value from sugar beet processing. The input emission factor will therefore be calculated as a weighted average of the emissions of producing and processing additional sugar beet to molasses (elastic part) and the emissions of producing one or more substitutes (rigid part) in the ratio 7:33[33] (see Appendix 2). The molasses are to be diverted from a yeast production facility controlled by the applicant and will be replaced by corn steep liquor. Corn steep liquor is a by-product of corn starch extraction, and is itself considered a rigid input. The applicant identifies glucose syrup as an elastic substitute for corn steep liquor, and so the final emission factor for the use of the molasses as an input is a weighted average of the emissions for molasses production from sugar beet and the emissions for production of glucose syrup, which should be sourced from the data hierarchy (see Appendix 1).

3. **Case 3: The diversion of the rigid input is expected to create no additional demand for other inputs** (i.e. the rigid input would otherwise have been disposed without productive use). Any change in emissions due to changing the disposition of the input should be counted as the emissions intensity of the input.

   Example: A project uses waste heat as defined by RED. The waste heat was not previously recovered and is not diverted from a current use. Therefore, it can be considered as having an emission factor of zero. However, the nature of the heat must be well characterised and justified by the applicant.

4. **Case 4: A combination of the first three outcomes**. In this case, the emissions implications associated with each outcome should be assessed as above, and combined to give the overall emissions implication of use of the rigid input.

Where a reference scenario includes use of a rigid input, then the logic of the assessment is reversed. Rather than assessing the expected impacts of diverting an additional amount of the rigid input, the applicant must assess the expected impacts if the supply of the rigid input were made available to other uses. In such a case, the result of the assessment will be some combination of reduced demand for other elastic inputs and emissions that would result from increased alternative disposition of the input.

2.2.6.4.2 Waste as an input and application of the Waste Framework Directive

Typically, project that involve the use of waste materials (e.g., municipal waste, industrial waste, used plastics, used lubricating oil) should consider them as rigid inputs, considering that the additional demand for waste material generated by the project will not increase the production of waste. Instead, the waste materials used by a project will be diverted from their current use or disposal, being it landfilling, incineration with or without energy recovery, recycling, reuse, or other.

[33] This ratio is derived as [17%-10%]:[50%-17%].

Projects that involve the use of "waste" materials must respect the waste hierarchy in the Waste Framework Directive[34], which puts top priority on material recycling (e.g., recycling used plastic as plastic). Converting waste to a fuel is specifically excluded from the definition of "recycling" in the Waste Framework Directive, and does not count towards recycling targets for Member States. It is classified as "recovery", on a lower level of the waste hierarchy, along with burning for electricity and/or heat production. Therefore, projects that use as feedstock materials covered in the Waste Framework Directive, such as used plastics, must precisely define the "waste" they are intending to use, and justify why it cannot be given a higher-priority treatment under the Waste Framework Directive during the lifetime of the project.

Applicants shall duly document the use or disposition from which the waste used by the project is diverted from, and shall calculate the associated emissions following the provisions in section 2.2.6.4.1, and the additional guidance below:

If waste is diverted from a **current use** (i.e., the waste used by the project is not currently landfilled or incinerated without energy recovery), then the diversion of the waste is expected to increase demand for one or more elastic, rigid, or semi-elastic inputs.

> *Example (Case 1): A project is using municipal waste as an input, which is diverted from being burnt to provide district heating. The project shall consider, in the "inputs" box of the project scenario, the additional positive emissions incurred to replace that district heat by considering the production of an equivalent amount of heat and using the emission factor for "heat fed to the project" specified in section 1.4.3.*

> *Example (Case 1): The project diverts waste steel (scrap) from other recycling operators rather than identifying additional sources of scrap for recycling. Then the displacement of steel scrap from its current use results in the need to produce more steel from iron ore. To account for this, the project shall consider, in the "inputs" box of the project scenario, the additional **positive** emissions associated to the production of the additional amount of steel from iron ore.*

If the existing fate of the waste is **incineration without energy recovery** (condition that the applicants must duly justify and document), then the emissions from incineration are avoided. This means that the emissions attributed to the waste used as an input are typically negative resulting in a credit for its novel use.

Emissions associated to the incineration of waste should be calculated based on the stoichiometric CO_2 emissions from combustion of that amount of waste. However, the **CO_2 emissions of any biogenic waste must be counted with an emission factor of zero**, so the biogenic fraction of carbon-containing waste would be given an emission factor of zero when diverted from incineration without energy recovery.

> *Example (Case 3): If the existing fate of municipal waste is incineration without energy recovery, then the emissions from the incineration are avoided. This means the emissions attributed to using the non-biogenic fraction of the waste are negative (i.e. avoiding the original fate saves emissions, so there is a CO2 credit for its novel use), while the emissions attributed to using the biogenic fraction of the waste are zero.*

> *Example (Case 3): If a stream of industrial off-gas containing fossil carbon monoxide (CO) is diverted from flaring with release of the CO_2 to the atmosphere,*

[34] Directive 2008/98/EC on waste and its amendments.

and is used as an input in the project, the emission attributed to that input is negative, equal in magnitude to the CO_2 release that is avoided.

If carbon-containing waste is diverted from **landfill** (condition that the applicants must duly justify and document), the carbon emissions shall be assumed equal to those for incineration without energy recovery, meaning that the emission factor attributed to carbon-containing waste at the point of collection will tipically be negative. Although in practice landfill sequesters part of the carbon on a long-term basis, it is not desirable to encourage landfill for other environmental reasons.

Any additional avoided greenhouse gas emissions from avoided methane production due to diversion of material from landfill or other disposition are considered out of scope of the main GHG calculation, but may be included in the calculation of "other GHG savings" (cf. section 1.1.7).

When carbon-containing waste is diverted from either landfill or from incineration without energy recovery and used as an input for novel fuel or consumable chemical production, this will result in a project scenario with a negative emission term for the non-biogenic carbon-containing waste as a rigid input in the "inputs" box and, a positive emission term in the "combustion (principal products)" or "end of life (principal products)" boxes (see section 2.2.7 and 2.2.9 respectively). If the number of carbon atoms in the non-biogenic waste input is identical or close to the number of carbon atoms in the produced fuel, these terms would exactly cancel each other out or be very similar. In such cases, the applicants should still include both terms in the calculations for transparency and to aid the evaluators in understanding the project.

Projects using exclusively biomass waste or residues to produce heat or electricity as a product are typically classified as renewable energy projects (see section 1.2) and should apply the RES methodology (section 3). Projects using a mixed biomass/fossil waste or residual input to produce heat or electricity as a product should refer to the provisions of section 1.2.5.2 on hybrid EII + RES projects. Projects involving a component of carbon capture should refer to the examples in section 6.4.

In some projects, a material waste stream may be taken as an input and only partly utilised (for example if a project involves utilisation of some subset of plastics in a municipal waste stream with the remnant waste returned for other disposal). In such cases, the emission in the input box should be based on the change in emissions for only the fraction of the municipal waste actually utilised.

Transport emissions for waste inputs should be considered only if waste feedstocks are transported for more than 500 km to reach the first point of processing/treatment (see section 1.3.4).

Any biomass used in InnovFund projects, including biomass wastes or residues, must conform to the relevant minimum requirements specified in the Call Text.

2.2.6.5 SEMI-ELASTIC inputs

Some inputs are one of several co-products produced in fixed ratios from an existing process, but with less value than other co-products. In such cases, it may not be clear whether the input should be characterised as rigid or elastic. To simplify the assessment of these cases, any input that represents less than 10% of the economic value of products from a process is considered rigid, any input that represents more than half of the economic value of products from a process is considered elastic, and **any input with a value from 10% to 50% of the economic value of products from a process is considered semi-elastic**. The emissions of a semi-elastic material shall be assessed as the weighted combination of the emissions if it was entirely rigid and the emissions if it was entirely elastic. This calculation is described fully in Appendix 2.

2.2.6.6 Timing operations to lower grid electricity emissions

A plant using electricity (such as an electrolyser) can reduce the emissions of the grid electricity it consumes by operating only at times when the emissions of the electricity supply are below average. This approach helps grid stability in a similar way to electricity storage, and this can be considered by calculating a 'virtual storage' credit following the provisions in this section.

Virtual storage can only be claimed in the case that a project is **grid connected**. No virtual storage term shall be included if a project is directly connected to a renewable power facility without grid connection. The credit allowed for virtual storage in energy intensive industries recognises that while the long-term trajectory (2050) is for full grid decarbonisation, in the short-term the EU electricity grid still includes fossil power generation, and that additional climate benefit can be delivered if an electricity-consuming project times its operation to preferentially consume power when the GHG intensity of grid electricity is below average.

To claim a virtual storage credit the applicant must provide details of the plan to manage grid electricity consumption to coincide with times when the emissions of the electricity supply are below average. For example, if an applicant claims that a PPA is used to determine when electricity is consumed they must provide convincing evidence that using this PPA is a reasonable basis to ensure that electricity consumption is **preferentially** reduced during periods of high grid carbon intensity. If a credible plan to time operation is not provided, this may affect the assessment of the quality of the GHG calculations.

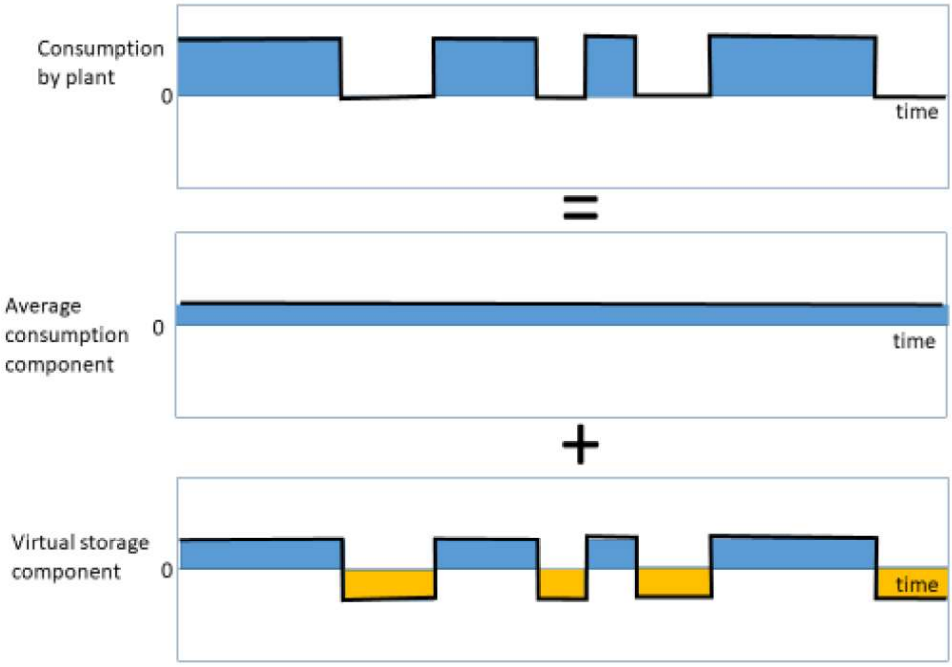
Credit may only be claimed for periods of lower electricity consumption where the reduction in consumption results from a decision by the applicant based on data about the supply of high GHG emissions electricity to the grid. This could include the instantaneous fraction of renewable power from intermittent sources supplied to the grid, the instantaneous price of grid electricity as a proxy for the level of renewable power supply, or other similar metrics. Credit may not be claimed based on the expectation of reduced electricity consumption during periods of necessary maintenance, emergency shutdowns or shutdowns due to a lack of market demand for either principal or non-principal products, unless it can be demonstrated that such shutdowns can be purposefully timed to coincide with periods of higher-than-average grid electricity GHG emissions intensity.

The virtual storage credit shall be calculated by resolving the time-dependent electricity demand into a **virtual storage component** plus a constant average consumption. This is illustrated in the example diagram below (Figure 2.2) for a case where the plant consumes zero power in its reduced operation mode. A timed operation credit may also be calculated for a plant that reduces power consumption in its reduced operation mode, but not all the way to zero.

The emission avoidance of the virtual storage component of the project shall be calculated as indicated in the section on energy storage (see section 4). This additional avoidance should be included as a credit term (negative emission) in the processes box equal to the absolute emissions avoidance calculated for the virtual storage component. The applicant must include details of the virtual storage calculation in their application. The relevant emission factors for electricity in EII projects timing their operation are indicated in section 1.4.3.1 (Table 1.3).

Some projects using timed operation **may show negative project emissions**. because of the associated emission credit. However, such projects should not be understood as delivering net carbon removals. Refer to section 1.1.5 for the calculation of adjusted project emissions and adjusted relative GHG emission avoidance for the purpose of claiming net carbon removals.

Figure 2.2. Calculation example of emissions from projects using electricity when marginal emissions are low



Source: *European Commission internal elaboration.*

2.2.7 Emissions from combustion (principal products)

Some projects will produce one or more principal products that will be combusted for energy purposes. This includes projects producing novel transport fuels, fuel additives, solid fuels and natural gas substitutes as principal products. In such cases the emissions from combustion of these principal products shall be included in the "combustion (principal products)" box. This must include the emissions of CO_2, CH_4 and N_2O, expressed in tonnes of carbon dioxide equivalent.

In the case of transport fuels, this will normally be done through the use of InnovFund fossil fuel comparators (Table 2.2) in the reference scenario and by including the combustion emissions for the novel fuel in the "combustion (principal products)" box of the project scenario.

> *Example: A project produces a drop-in diesel fuel substitute. The reference scenario will include emissions in the "combustion (principal products)" box based on the InnovFund fossil fuel comparator for diesel. The project scenario will include in the "combustion (principal products)" box combustion emissions for the novel fuel.*

Where an InnovFund fossil fuel comparator is not available, then the combustion emissions for the reference product should be included in the "combustion (principal products)" box of the reference scenario, using combustion emission factors from the data hierarchy in Appendix 1.

In the case of fuels produced using captured or recycled carbon, the combustion emissions must still be included in the "combustion (principal products)" box of the project scenario. Any emissions savings associated with the use of captured or recycled carbon are characterised in the carbon capture credit (see section 6) for captured carbon, or in the "inputs" box for recycled carbon.

2.2.7.1 Combustion emissions of carbon of biogenic origin

Note that, while CO_2 emissions from the combustion of biomass-derived fuels and materials may be treated as zero, non-CO_2 emissions such as N_2O and CH_4 emissions stemming from the combustion of biomass-derived fuels and materials must be considered.

Attention: An emission factor of zero does not apply to the carbon incorporated into a fuel through the utilisation of CO_2 originally captured from a biogenic source. All the carbon incorporated into a CCU product or fuel shall be treated as fossil carbon for the purpose of calculating combustion emissions.

2.2.8 Emissions from change in use (principal products)

The methodology does not require applicants to include all emissions associated with the use of principal products. However, in some cases **the characteristics of innovative products may save emissions in the use phase of the principal product**, for instance by allowing more efficient operation. The "change to in-use" emissions box allows credit to be given in the project scenario for such emissions savings. Wherever such savings are claimed they must be well justified and based on a realistic use case.

> *Example: A project produces an innovative nitrogen compound to use as a fertiliser, and the applicant provides convincing evidence that its use will reduce nitrous oxide (N_2O) emissions compared to conventional nitrogen fertilisers when applied to the soil. Credit may be given in the "change to in-use (principal products)" box for the CO_2 equivalent emissions that can be avoided by use of the new compound.*

Applicants will need to demonstrate the delivery of the reported emission reductions. Therefore, they shall propose appropriate monitoring arrangements.

Applicant may include in-use savings from the changed properties of the various materials to be produced with the principal product.

> *Example: A project produces a new material that enables improved tire dynamics (e.g., light-weighting benefit and reduced rolling resistance) when the tires are in-use. Credit may be given in the "change to in-use (principal products)" box for the associated reduction in fuel use through the life of a tire.*

Savings from changes to in-use emissions may only be claimed where they are enabled directly by the properties of the produced product: it is not enough to state that the produced product may be used as an input for the production of a second product which would then deliver in-use emissions reductions.

> *Example: A project produces steel with an innovative process, but the steel itself has comparable properties to steel from conventional processes. The applicant states that the steel will be sold to another company and used in a manufacturing process that has a lower carbon intensity than the state of the practice. The use of the steel in the manufacturing process is not enabled by any particular property of the produced steel, and therefore no additional credit may be given.*

In some cases, the use of an innovative product will enable in-use emissions savings only when coupled with one or more additional innovative products of practices. In such cases, the applicant should record in the "change to in-use" emissions box a fraction of the emissions saved proportional to the ratio of the cost of the innovative product to the cost of the entire innovative system.

> *Example: A project produces an innovative polymer that can be combined with a second innovative polymer (not produced by the project) and used to produce lightweight packaging material, allowing reductions in fuel consumption by delivery vehicles. If the costs of the two polymer components are equal, then the applicant*

may record a credit in the "change to in-use" emissions box equivalent to half of the expected emissions saving due to reduced fuel use by delivery vehicles.

Unlike the other boxes, the in-use emissions in the project scenario focus on changes in emissions rather than including all use-phase emissions. There is therefore no need to record in-use emissions in the reference scenario. This leaves the "change to in-use (principal products)" emissions box for project scenario only.

The emission avoidance in use is first estimated per tonne of product. Then the scale of production assumed in the calculation of total emission avoidance is limited to the **quantity** that the applicant is confident to be able to sell into the market within which in-use savings are achievable. During the monitoring and reporting stage, applicants will be required to prove the amount of products sold into that market in addition to monitoring and reporting of the parameters related to the production of the product.

Some emission reductions associated with use of the principal products are dealt with outside of the "change to in-use (principal products)" emissions box. If the use of a novel product replaces a larger quantity of a conventional product (for example 1 tonne of a novel product replaces 1.2 tonnes of a conventional product) this is dealt with by including 1.2 tonnes of conventional production in the reference scenario for every 1 tonne of novel production in the project scenario.

Attention: If a principal product replaces fossil fuels, then the difference in combustion emissions are dealt with via the "combustion (principal products)" box, and not in the "change to in-use" emissions box.

2.2.9 Emissions from end of life (principal products)

End of life emissions refer to the emissions associated with the disposal or recycling of a principal product after the end of its useful life. Applicants are not permitted to include end of life emissions for non-principal products, except in the case described in section 2.2.10. Innovation Fund applications are not required to provide full end of life emissions estimates, but shall include end of life emissions for principal products in two cases:

1. If a principal product (either the innovative product from the project scenario or the conventional product performing the equivalent function in the reference scenario) **contains carbon,** then the applicant must include any emissions associated with the fate of that carbon in the "end of life (principal products)" box**.** These emissions must be included even if they are identical between the project and reference scenarios.

Attention: Failure to consider the fate of carbon at end of life would result in distortion of the emissions avoidance calculation and may affect the quality of the GHG calculation.

2. If a principal product produced by the project scenario will **deliver** emission **reductions** in its end of life compared to the equivalent conventional product in the reference scenario, then the calculated reduction in end of life emissions **may be** included as a credit (negative emission term) in the "end of life (principal products)" box of the project scenario.

These two cases are further explained below.

2.2.9.1 Principal product containing carbon

Where carbon is incorporated into principal products and is not released during product use or through combustion of those products as fuels, the applicant must consider the expected fate of this **carbon** at the end of life. This fate may differ between project and reference scenarios, but any assumed differences shall be well justified.

2.2.9.1.1 Natural decomposition, incineration, landfilling

In cases where the likely fate would be any combination of natural decomposition, incineration (with or without energy recovery) or landfilling, then an emission term shall be included in the "end of life (principal products)" box based on CO_2e emissions from stoichiometric combustion of all the carbon contained in the principal products (i.e. complete oxidation to CO_2 of all carbon atoms).

> *Example: methanol is produced as a principal product.*
>
> *If the methanol is used as a transport fuel and the reference scenario is based on a fossil fuel comparator (sections 2.2.4.4 and 2.2.4.6), then no additional emissions need to be included in the "end of life (principal products)" box. Instead, combustion emissions need to be included in the "Emissions from combustion (principal products)" box (see section 2.2.7).*
>
> *If instead the methanol is used as a chemical product and is expected to decompose, be landfilled or be incinerated after use the applicant shall include stoichiometric combustion emissions for the produced quantity of methanol in the "end of life (principal products)" box for both the project and reference scenarios.*

If some fraction of the carbon in the principal products is of biogenic origin, then the stoichiometric combustion emissions for that fraction of the product may be treated as having zero associated CO_2 emissions (section 1.1.7). An emission factor of zero does not apply to the carbon incorporated into a product through the utilisation of CO_2 originally captured from a biogenic source. All the carbon incorporated into a CCU product shall be treated as fossil carbon for the purpose of calculating end of life emissions.

2.2.9.1.2 Recycling

If the likely fate (i.e. expected for at least 90% of material produced) of the carbon in the product materials would be recycling into new products, which must be credibly justified by the applicant, then this term in the "end of life (principal products)" box shall be set to zero (this should still be explicitly recorded in the GHG calculation). If the likely fate is a combination of some recycling (less than 90% of the material produced) and other fates, then an emission factor of zero should be used only for the fraction of carbon that is recycled.

If an applicant claims that the product of the project scenario will be recycled but the conventional product in the reference scenario would not be recycled, then this assumption must be well justified by reference to the physical characteristics of the products (for instance replacing a plastic that is not normally recycled with one that is), or to actions within the power of the applicant (e.g., if the business model included collection of used items for recycling). Applicants shall not take credit for assumed increases in recycling rates that are not directly related to the project. Recycling rates assumed for principal products in either scenario must be credibly justified. For example, an applicant would not be permitted to assume 100% recycling of a material that was recyclable in principle if it is not normally recycled in practice.

There is no additional credit permitted in the GHG emission calculation of the Innovation Fund for avoiding primary material use by enabling recycling.

> *Example: A project produces recyclable plastic bottles as a principal product, and they will replace conventional plastic bottles that are not recyclable. The applicant provides evidence that the typical disposition of non-recyclable bottles in their region is to be sent to landfill, but that 70% of recyclable bottles are sent for recycling.*

Landfilled material may be treated as if it would be combusted without energy recovery, therefore the applicant includes emissions term in the "end of life (principal product)" box of the reference scenario based on stoichiometric combustion emissions for 100% of the conventional bottles, and an emission term in the "end of life (principal product)" box of the project scenario based on stoichiometric combustion emissions for only 30% of the innovative bottles (the 30% that it is assumed are not sent for recycling).

2.2.9.1.3 Carbon incorporation into products on a long-term basis

In cases where the applicant can show that most of the carbon in the principal product(s) will remain incorporated in the material on a long-term basis, defined as a useful lifetime of 50 years or more before the product is disposed, then the applicant may **include in the "end of life (principal products)" box only 50% of the CO_2 emissions from stoichiometric combustion** of that product. This may be appropriate in the case of **building materials**, for example.

It is the responsibility of the applicant to convincingly demonstrate that it is reasonable to assume that the carbon will normally remain incorporated for at least 50 years. The applicant must be consistent in the consideration of long-term carbon utilisation in the reference and project scenarios, and the applicant must treat carbon incorporated in the principal products in the project and reference scenarios equally when considering the potential for long-term incorporation.

In general, if physically similar products are produced in the two scenarios, then the assumptions about long-term carbon utilisation should be identical. Applicants are not permitted to treat more than 50% of the carbon as long-term incorporated.

<u>Example</u>: A project produces polystyrene beads from fossil resources as a principal product, and the material will be used in building insulation. The product from the project is chemically identical to conventionally produced polystyrene beads (the reference product) but produced in a more efficient manner. The applicant shows that the insulation can be expected to remain in place for at least 50 years. The applicant therefore includes an emission term in the "end of life (principal products)" box in both the project and reference scenarios equivalent to the emissions from stoichiometric combustion of only 50% of the carbon from the material.

This does not affect the absolute emission saving from the project as the terms are the same in both scenarios. The end of life emissions are lower in both scenarios than they would be for a project producing polystyrene for short term use, so because the reference scenario emission will be lower this will result in a higher reportable relative GHG emission reduction than if the material were used in an application where it was expected to go to landfill immediately after use.

2.2.9.1.4 End of life emissions of carbon of biogenic origin

Attention: When calculating end-of-life emissions carbon in a product that is from a CCU process **shall be treated as fossil carbon** irrespectively of its origin. In other words, where carbon in a principal product is derived from CO_2 captured from a biogenic source, this shall not be treated as biogenic carbon at end of life. The credit for the biogenic characteristics of the captured carbon is already given in the "processes" box where appropriate, and cannot be given a second time in the "end of life" box (see section 2.2.5.3 and section 6.3).

In other cases, when the carbon incorporated in the product or being recycled is of biogenic origin (i.e. derived from biomass-derived inputs to the project), then the end-of-life emission of this carbon is set to zero, and therefore the emissions are unaffected by the likely fate of this carbon.

Recognition may therefore be given to projects delivering recycling or long-term incorporation of carbon of biogenic origin through the inclusion of a credit (negative emission term) in the "end of life (principal products)" box for the extended useful life of that biogenic carbon. This credit should be equivalent to 50% of the stoichiometric combustion emissions for the amount of biogenic carbon that will remain incorporated.

> *Example: A project produces biochar as a principal product which is to be used as a soil improver. The applicant provides convincing evidence that the application of biochar to the soil can improve nitrogen retention and thereby reduce nitrogen fertiliser use, and therefore the reference product is set as nitrogen fertiliser, in the sector chemicals, on an equivalent function basis. The quantity of nitrogen fertiliser in the reference is calculated as the reduction in nitrogen fertiliser consumption to be delivered over the first 10 years of operation of the project. The applicant provides references to support the claim that the biochar will remain incorporated in the soil for a period of more than 50 years. This would normally allow the applicant to discount the end-of-life emissions from carbon release by 50%, but because biochar is a biogenic product the end of life emissions are zero whether or not the biochar remains in the soil. The applicant therefore includes a credit in the "end of life (principal products)" box equivalent to the stoichiometric combustion emissions for 50% of the carbon in the biochar.*

> *Example: A project produces bio-PET bottles to replace conventional fossil PET bottles. Both types of bottle are recyclable and the applicant shows that the recycling rate in the relevant region is over 90%. A zero-emission term is included in the "end of life (principal product)" box of the reference scenario, while an emission credit (negative emission term) is included in the "end of life (principal product)" box of the project scenario equivalent to 50% of the stoichiometric combustion emissions for the carbon in the PET.*

2.2.9.2 Other reductions in end of life emissions

If a project **delivers** further **reductions** in "end of life" emissions compared to the reference scenario, these **may** also be included in the calculation. This could be relevant in cases where a principal product replaces a chemically different conventional product and can be **disposed of in a more energy efficient way**, or if an innovative product **avoids end-of-life** emissions or non-CO_2 greenhouse gases (expressed as CO_2e).

> *Example: Innovative refrigerants could replace conventional refrigerants with higher global warming potential. This could avoid emissions associated with potential leakage of the conventional refrigerants at "end of life" (some leakage could occur during proper disposal of refrigerators, and some fraction of refrigerators may not be properly disposed of).*

Furthermore, some projects may enable more efficient recycling due to **changes in the physical characteristics of products.** In such cases, changes in "end of life" emissions should be estimated and added to the emissions avoidance calculations. Any such credits should be clearly justified, and in general such credits will only be considered where they relate to fundamental **physical properties** of the materials at "end of life" (such as a different global warming potential for refrigerant gases) and not where reductions at "end of life" are conditional on behaviour changes outside of the control of the applicant (such as changed recycling practices that are predicated on very specific waste sorting protocols that may not be adopted).

2.2.10 Emissions from non-principal products

A project may produce a number of products. At least one must be a principal product, and any other products produced must be identified as either co-principal or non-principal products, following the provisions in section 1.2.

The processes in both the project and reference scenarios shall produce the same **quantity** of the principal products ("processes" box), or, where the principal product and reference product, are physically different shall produce the quantities required to deliver an equivalent **function**. However, there may be changes in non-principal product(s) (i.e., co-products of the principal products that are supplied for use outside the project boundary) associated with the adoption of innovative processes. To balance the scenarios, the emissions associated to non-principal products must be considered, **but only in the scenario in which they are produced**.

The emission avoidance of the project will generally be increased by the production of non-principal products in the **project scenario**, while it will generally be reduced by the production of non/principal products in the reference scenario.

A credit (negative emission term) proportional to the quantity of each non-principal product produced should be included in the "non-principal products" box. Similarly, if non-principal products are produced in the **reference scenario**, a credit (negative emissions term) should be included in the "non-principal products" box of the reference scenario. This means that, for **both the reference and project scenarios**, the term in the "non-principal products" box shall be calculated as:

$$C_{NPP} = -1 * Q_{RP} * EF_{RP}$$

Where:

$C_{NPP} =$ Credit for non-principal product.

Q_{RP} = Quantity of conventional replaced product substituted by the non-principal product.

EF_{RP} = Emission factor of the conventional replaced product, produced in a conventional way.

The credit should be based on an emission factor for a 'conventional replaced product' that could be replaced in the market by the non-principal product. In many cases, the appropriate conventional replaced product will be a physically identical product produced in a conventional way. In some cases, however, the appropriate conventional replaced product will be a physically different product that serves a similar function. The choice of a conventional replaced product is discussed further below.

The emissions factors needed for this calculation are to be taken from the data hierarchy in Appendix 1 following the method in the section on other relevant inputs (section 2.2.6.3.3), with the exception of natural gas as a conventional replaced product for which specific rules are stated in section 2.2.10.2 below. **Allocation approaches should not be used** to deal with the emissions associated to non-principal products.

2.2.10.1 Accounting for carbon in non-principal products

Attention: Carbon in a non-principal product that is from a CCU process **shall be treated as fossil carbon** irrespectively of its origin. In other words, where carbon in a principal product is derived from CO_2 captured from a biogenic source, this shall not be treated as biogenic carbon at end of life. The credit for the biogenic characteristics of the captured carbon is already given in the "processes" box where appropriate, and cannot be given a second time (see section 2.2.5.3 and section 6.3).

It is important when accounting for non-principal products to ensure that any carbon embedded in the product and/or its conventional alternative is properly accounted for. This affects the way in which the emission factor for the conventional replaced product shall be chosen. There are two cases:

1. The non-principal product is physically the same as the conventional product it replaces, and all of the carbon in the non-principal product is non-biogenic. **In this case, the emission factor shall exclude the carbon contained in the conventional replaced product.** The carbon released through combustion/use/end of life of the non-principal product is the same as would be released through combustion/use/end of life of the conventional replaced product.

   <u>Example</u>: methanol is produced as a non-principal product using captured carbon, which is not biogenic, and will be supplied for use as a chemical. The conventional replaced product is conventionally produced methanol, which is physically similar. *The document "Definition of input data to assess GHG default emissions from biofuels in EU legislation" from the data hierarchy states that the emissions associated with methanol use are 28.2 gCO_2e/MJ for methanol supply and 68.9 gCO_2e/MJ for methanol combustion. The combustion emissions **shall not** be included, so the correct emission factor for the conventional replaced product is 28.2 gCO_2e/MJ.*

2. The non-principal product is physically different with respect to the conventional product it replaces, and/or some of the carbon in the non-principal product is biogenic. In this case, the carbon released through combustion/use/end of life of the non-principal product **may not be the same** as would be released through combustion/use/end of life of the conventional replaced product, and therefore any difference must be calculated. The emission factor for the conventional replaced product shall be calculated as its supply emissions plus its carbon content (converted to CO_2 on a stoichiometric basis, equivalent to the combustion emissions for that material), minus the non-biogenic carbon content of the non-principal product.

   <u>Example 1</u>: methanol is produced as a non-principal product using biogenic carbon. The conventional replaced product is conventionally produced methanol, which is physically similar. *The document "Definition of input data to assess GHG default emissions from biofuels in EU legislation" from the data hierarchy states that the emissions associated with methanol use are 28.2 gCO_2e/MJ for methanol supply and 68.9 gCO_2e/MJ for methanol combustion. The combustion emissions **shall** be included. There is no non-biogenic carbon in the non-principal product methanol, so no further term needs to be subtracted. The correct emission factor for the conventional replaced product is calculated as the supply emissions plus the combustion emissions, which gives 97.1 gCO_2e/MJ.*

   <u>Example 2</u>: methanol is produced as a non-principal product using carbon from waste gasification that is 40% biogenic, and it will be supplied for use as a chemical. The conventional replaced product is conventionally produced methanol, which is physically similar. *The document "Definition of input data to assess GHG default emissions from biofuels in EU legislation" from the data hierarchy states that the emissions associated with methanol use are 28.2 gCO_2e/MJ for methanol supply and 68.9 gCO_2e/MJ for methanol combustion. The combustion emissions **shall** be included. The non-principal product methanol has 60% fossil carbon content carbon in the non-principal product methanol so a term equal to 60% of methanol combustion emissions must be subtracted (41.3 gCO_2e/MJ). The correct emission factor for the conventional replaced product is calculated as the supply emissions plus the combustion emissions for the conventional replaced product, minus the non-biogenic combustion emissions for the non-principal product methanol. This gives: (28.2 + 68.9 – 41.3) = 55.8 gCO_2e/MJ*

2.2.10.2 <u>Correctly identifying the conventional product replaced by a non--principal product</u>

In some cases, it may not be obvious what the appropriate conventional replaced product is and therefore what **emission factor** from the data hierarchy should be used to calculate the credit for a non-principal product. This is especially likely in cases: where a non-principal product is itself innovative so that there is no data in the data hierarchy to characterise 'conventional' production of that material; where a non-principal product could equally replace one of a number of conventional products; or where the non-principal product is to be used in an innovative way.

The following principles shall be followed in choosing appropriate emission factors for non-principal products in the data hierarchy, and the choices made must be well justified:

- Where several possible conventional products could be considered functionally interchangeable with a non-principal product, the applicant shall use **the lower** of the associated emission factors. The applicant must not inflate the emission credit from non-principal products by cherry picking an alternative product with very high associated emissions.

- If a non-principal product is expected to be combusted for energy, then in general the conventional replacement product shall be taken to be **natural gas**, even if the non-principal product is more physically similar to other fossil fuels. In this case, the upstream supply emission for natural gas shall be treated as zero and the stoichiometric combustion emissions as 56.2 gCO_2e/MJ for consistency with the natural gas comparator value in section 2.2.4.5. An exception may be made to this principle if the applicant can demonstrate that a non-principal product is likely to be used to substitute a known fuel other than natural gas in a specific application in which a higher-carbon-content fuel is required for physical reasons, for example replacing fossil coke used in steel manufacture.

  Example: if biochar[35] is produced as a non-principal product and expected to be used as a fuel, then the credit in the "non-principal products" box shall generally be calculated taking natural gas as the conventional replacement product rather than a solid fuel such as coal. The emission factor for the replacement product is calculated as the supply emissions (taken to be 0 gCO_2e/MJ) plus the combustion emissions (56.2 gCO_2e/MJ) minus the non-biogenic carbon content of the biochar (0 gCO_2e/MJ), which gives 56.2 gCO_2e/MJ.

If a non-principal product containing biogenic carbon will not be combusted and will not replace the function of a conventional product but is expected to provide useful incorporation of its constituent carbon on a long-term basis (50 years or more expected lifetime, other than in landfill), then, the applicant may calculate a negative emission terms for medium term carbon incorporation calculated as 50% of the biogenic carbon content.

Attention: Carbon in a non-principal product that is from a CCU process **shall be treated as fossil carbon** irrespectively of its origin. In other word, where carbon in a principal product is derived from CO_2 captured from a biogenic source, this shall not be treated as biogenic carbon at end of life.

> *Example: if biochar is produced as a non-principal product and will be sold as a soil improver with the primary purpose of storing its constituent carbon in the soil (i.e. not directly replacing the use of conventional products such as compost or fertilisers). The applicant is able to provide evidence that the expected carbon incorporation time is 50 years or more. A credit (negative emission term) may be included in the "non-principal products" box equivalent to 50% of the CO_2 emissions from stoichiometric combustion of the biochar.*

If the non-principal product will not be combusted and will be used for an innovative function that will enable more efficient use of other materials, thenthe applicant may

[35] "Char" is the general product of the slow pyrolysis, "charcoal" is the product of the woody biomass slow pyrolysis, "biochar" is char produced from biomass sources that is used for example in soil application, beware of contaminants (tar) generated in certain quick industrial processes.

propose (with a well-founded justification) a calculation of the avoided emissions and include these additional avoided emissions as a credit (negative emission term) in the "non-principal product box". In such cases, the applicant should avoid overstating the potential benefits. Failure to provide a convincing justification for the calculation of this credit may affect the quality of the GHG calculation.

> *Example: A non-principal product from a biorefining process is to be used as a cattle feed additive, and the applicant is able to provide evidence that this will reduce the formation of methane through enteric fermentation. A credit may be calculated based on the amount of methane emissions to be avoided by use of the feed additive.*

2.3 Data and parameters

Each project will identify the parameters that will remain constant throughout the duration of the project and consequently shall not be monitored by choosing the sources of data as explained in section 2. These will include all emission factors, combustion emissions, and lower heating values (net calorific values).

3 Renewable energy (RES)

3.1 Scope

This section describes the calculation of GHG emission avoidance for projects covered under the renewable energy (RES) category. These projects produce electricity, heat and/or cooling from renewable energy sources, or use renewable energy in activities that are not covered by Annex I of the ETS directive. This section also covers the manufacturing of components to be used in renewable energy facilities or consumer products, including stationary fuel cells.

Electricity produced from renewable sources may be dispatchable or non-dispatchable, depending on the nature of the source, and may be supplied to a grid or directly to an end user. Renewable energy sources include wind energy, solar energy, hydro/ocean energy, geothermal energy (including ambient energy through heat pumps), and bioenergy.

Renewable energy projects that include a CCS or CCU component, shall calculate the CC credit based on the guidance described in section 6.

Projects that include both the production and storage of renewable energy shall apply as hybrid projects following the provisions in section 1.2.5.4, and correctly applying the relevant emission factors for the RES and ES component of the project as specified in section 1.4.3.

This section also covers projects aiming at the retrofitting, repowering, rehabilitation, refurbishment, replacement, or capacity addition of an existing renewable energy plant. For these projects, only the added capacity, or the capacity affected by the retrofitting, shall be accounted for in the GHG calculations (See section 3.2.1).

3.1.1 Products and sectors

Products and sectors covered under the RES category are defined in section 1.2, with additional guidance provided in sections 3.1.2, 3.1.3, and 3.1.4 below.

3.1.2 Bioenergy projects

Bioenergy can be generated from biomass-derived fuels as defined in section 1.4.4. Any project using biomass-derived fuels must comply with the relevant sustainability requirement as specified in section 1.4.4.1, and must follow the relevant provisions in that section, including providing adequate justifications and an adequate monitoring plan.

Bioenergy projects must consider the emissions associated to the supply of biomass-derived fuels under project emissions ($Proj_{bio\ supply}$) as specified in section 1.4.4.2, and in equation [3.8], section 3.3. Emissions of biogenic CO_2 associated to the combustion of a biomass-derived fuel are attributed a zero-emission factor. However, emissions of non-CO_2 greenhouse gases associated to the combustion of biomass-derived fuels must be considered in the project scenario ($Proj_{bio\ use}$) as specified in equation [3.6], section 3.3. No emissions associated to other uses of biomass-derived fuels, nor leakage or venting or other chemical or biological process, shall be included.

Projects aiming exclusively at producing biomass-derived fuels and materials shall follow the rules for Energy Intensive Industry (EII) projects in section 2. If the project includes both the production of biomass-derived fuels and their consumption for the purpose of generating electricity, heat, or cooling as a principal product, then the project shall be treated as a hybrid EII + RES project and follow the provisions in section 1.2.5.2.

Similarly, projects producing heat or electricity as a product from feedstocks that are partly biogenic (for example mixed municipal waste with both biogenic-carbon and fossil-carbon content), shall refer to the provisions of section 1.2.5.2 on hybrid EII + RES projects. When such projects also involve a component of carbon capture, applicants should also refer to the examples in section 6.4.

3.1.2.1 Projects operating stationary fuel cells

Projects aiming at operating stationary fuel cells using biomass-derived fuels and having electricity, heating, or cooling as their principal product should apply under sector RES/bioenergy and refer to the provisions in section 3.1.2.

Projects aiming at operating stationary hydrogen fuel cells and having electricity, heating, or cooling as their principal product should also apply under sector 'bioenergy', and use the emission factors for hydrogen for renewable energy generation projects as specified in section 1.4.3.2. Emissions associated to the supply ($Proj_{bio\ supply}$) or use ($Proj_{bio\ use}$) of hydrogen shall be disregarded.

Projects aiming at operating stationary fuel cells using RFNBOs other than hydrogen, and having electricity, heating, or cooling as their principal product should also apply under sector 'bioenergy' and follow the provisions in this sub-section. Emissions associated to the supply ($Proj_{bio\ supply}$) or use ($Proj_{bio\ use}$) of the RFNBO shall be disregarded.

For such projects, renewable fuels of non-biological origin (RFNBOs) are considered as defined in the Renewable Energy Directive 2018/2001 (RED) and its Delegated Regulations, and meeting the greenhouse gas emissions saving criteria set in Article 29a of RED.

The applicant must credibly justify the assumptions made with respect to the renewable origin of the fuel. Failure to provide adequate justification may affect the quality of the GHG calculations and the resulting evaluation. In addition, the applicants must propose adequate monitoring measures in their monitoring plan (see section 1.5 and Appendix 4) to ensure adequate monitoring and reporting of the assumptions made at the application stage. Failure to provide an adequate monitoring plan may negatively affect the quality of the GHG calculations, and the resulting evaluation.

During project implementation, failure to demonstrate the actual renewable nature of the fuel(s) used during project implementation may affect the overall GHG emission avoidance that can be achieved by the project, which may have consequence in terms of grant disbursement as specified in the Call Text (see also section 1.1.9).

Projects aiming at operating fuel cells using non-renewable fuels shall follow the provisions for Energy Intensive Projects (EII, section 2). Projects aiming at operating fuel cells using a mix of renewable and non-renewable fuels, shall refer to the provisions of section 1.2.5.2 on hybrid EII + RES projects. When such projects also involve a component of carbon capture, applicants should also refer to the examples in section 6.4.

3.1.3 Manufacturing of components for renewable energy generation

Projects that aim at manufacturing components for renewable energy generation shall refer to the provisions in section 1.3, in addition to those detailed in this section. The applicant should refer to the relevant provisions in section **Error! Reference source not found.** f or the definition of the system boundary, and section 3.3.3 for relevant equations.

3.1.3.1 Projects manufacturing stationary fuel cells

Projects aiming at manufacturing fuel cells for mobility applications, and their components, shall refer to the provisions for mobility projects (MOB, section 5). Projects aiming at manufacturing fuel cells for stationary applications, and their components, shall refer to this sub-section, and the other relevant provisions in section 3.

Applicants must credibly justify the assumptions made with respect to the operation of the facility or consumer product in which the component is installed based on credible operational assumptions and technical specifications. The operational assumptions made, must be representative of the expected use of the component, facility, and consumer product. This includes the type of fuel used by a fuel cell.

The applicant shall not assume that the facility or consumer product equipped with a component manufactured by the project will have better performance resulting in increased GHG emission avoidance with respect to standard practice, unless this is a direct consequence of the installation of the innovative component manufactured by the project.

For the case of fuel cells which can run on a variety of different fuel mixes, credible assumptions shall be taken with respect to the expected fuel mix, and period over which the fuel cell will operate on renewable fuels as opposed to fossil fuels. Only the operation of the manufactured fuel cells on biomass-derived fuels, hydrogen and RFNBO can be considered as part of the GHG calculations, and a hybrid application cannot be made for the manufacturing of fuel cells operating on a mix of renewable and non-renewable fuels. This means that the reference emissions shall be representative only of the portion of energy displaced by the operation of the fuel cell on biomass-derived fuels, hydrogen, or RFNBO.

Failure to provide adequate justification may affect the quality of the GHG calculations and the resulting evaluation. In case the actual user of the innovative components produced during project implementation differs from, or is not compatible with, the intended use specified in the application, the project may not be able to reach the expected GHG emission avoidance, with potential implications on grant disbursement (see also section 1.3.6).

3.1.4 Use of renewable energy in activities not covered under Annex I of the EU ETS directive

Projects aiming to use renewable energy in activities not covered under Annex I of the EU ETS directive must consume solely electricity, heating and/or cooling that are wholly renewable. See relevant provisions in section 3.2 for the definition of the system boundary, and section 3.3.2 for relevant equations for such projects.

The applicant must credibly justify the assumptions made with respect to the renewable origin of the energy used by the project. Failure to provide adequate justification may affect the quality of the GHG calculations and the resulting evaluation. In addition, the applicants must propose adequate monitoring measures in their monitoring plan (see section 1.5 and Appendix 4) to ensure adequate monitoring and reporting of the assumptions made at the application stage. Failure to provide an adequate monitoring plan may negatively affect the quality of the GHG calculations, and the resulting evaluation.

During project implementation, failure to demonstrate the actual renewable nature of the energy used during project implementation may affect the overall GHG emission avoidance that can be achieved by the project, which may have consequences in terms of grant disbursement as specified in the Call Text (see also section 1.1.9).

3.2 System boundary

The emission sources that shall be included within the boundaries of the calculations for RES projects are shown in Table 3.1.

Table 3.1. Emission sources included in or excluded from the boundaries of the GHG emission avoidance calculation for RES projects

Source		**Included in any topic except small-scale**	**Included in small-scale topic**
Reference (Ref)	**Projects that intend to produce renewable energy (electricity, heating or cooling):** GHG emissions for the net[36] generation of dispatchable or non-dispatchable electricity ($Ref_{elec,prod}$ and $Ref_{elec,prod,unit}$), heating ($Ref_{heat,prod}$ and $Ref_{heat,prod,unit}$) or cooling ($Ref_{cool,prod}$ and $Ref_{cool,prod,unit}$) using the conventional technologies, which will be replaced due to the project activity	Yes	Yes
	Projects that intend to consume renewable energy (electricity, heating or cooling) in activities not covered under Annex I of the EU ETS directive: GHG emissions for the generation of dispatchable or non-dispatchable electricity ($Ref_{elec,use}$), heating ($Ref_{heat,use}$) or cooling ($Ref_{cool,use}$) using the conventional technologies, which will be replaced by the renewable energy used in the project activity	Yes	Yes
Project (Proj)	GHG emissions due to consumed electricity, heat, and fuels for the operation of the renewable energy generation plant, in stationary machinery and on-site vehicles ($Proj_{on\text{-}site}$ and $Proj_{on\text{-}site,unit}$)	Yes	No
	GHG emissions due to leakage during the operation of geothermal power plants ($Proj_{geo}$ and $Proj_{geo,unit}$)	Yes	Yes
	GHG emissions from the production and supply of biomass-derived fuels consumed in stationary machinery and on-site vehicles at the project site ($Proj_{bio\ supply}$ and $Proj_{bio\ supply,unit}$)	Yes	Yes

Source: European Commission internal elaboration.

In terms of emissions in the project scenario, sources of GHG emissions depend on the technology and supporting infrastructure for the operation of the plant. Normally, emissions from wind, solar and ocean energy generation are relatively limited. However, the same may not be true for other renewables, such as geothermal or bioenergy.

Applicants shall quantify all GHG emissions associated to electricity, heat and fuel use in stationary machinery and on-site vehicles for the operation of the renewable energy plant in the project scenario ($Proj_{on\text{-}site}$). This includes (but is not limited to) emissions of non-CO_2 greehouse gases from the combustion of biomass-derived fuels in the project scenario, for example, for the case of bioenergy projects.

For projects producing renewable energy from geothermal power plants, leakage during operation shall be accounted for under project emissions ($Proj_{geo}$).

[36] Only the energy generated for external usage, i.e. fed into the grid or directly to another party, and not directly related to the operation of the renewable energy plant, shall be accounted for. Any on-site usage or losses occurring during the renewable energy production shall be deducted from the calculation. For the situations where the project involves retrofit or capacity added to an existing plant, only the added capacity shall be accounted for.

For projects consuming biomass-derived fuels in stationary machinery and on-site vehicles, including projects using biomass-derived fuels to produce bioenergy, the GHG emissions from the production and sourcing of the biomass-derived fuels consumed by the project shall be accounted for in the calculations, under project emissions ($Proj_{bio\ supply}$).

Simplification for SMALL-SCALE topic: Projects submitted under the small-scale topic can disregard $Proj_{on\text{-}site}$ emissions.

3.2.1 Reference scenario for renewable energy projects

For the sake of simplification and to enable a fair competition between projects, the reference scenario has been pre-defined for all projects, despite the regional differences that may be observed in real life.

For RES projects, and in line with the provisions of section 1.4.3:

- The emission factor attributed to non-dispatchable electricity and to cooling in the reference scenario is the typical EU grid emissions in 2030 according to the Commission's EU Reference Scenario 2020, i.e. $EF_{electricity,ref}$ = 48.8 tCO_2e/TJ (0.176 tonnes CO_2e/MWh).
- The emission factor attributed to dispatchable electricity in the reference scenario corresponds to the emissions from dispatchable power generation by a single cycle gas turbine plant with 40% electrical efficiency, i.e. 140 tCO_2e/TJ (0.505 tonnes CO_2e/MWh).
- The emission factor attributed to heat in the reference scenario is the EU ETS benchmark for heat, i.e. 47.3 tCO_2e/TJ.

In the calculation of reference emissions, the following provisions shall apply:

- **Projects aiming at generating renewable energy (section 3.3.1):** In the calculation of reference emissions, the applicant shall always consider the net amount of energy that is delivered by the project for external usage (i.e., fed into the grid or directly to another party). This means that the amount of energy generated by the project and used for internal consumption cannot be included in the reference scenario.

- **Projects that use renewable electricity, heating and cooling in activities not covered under Annex I of the EU ETS directive (section 3.3.2):** In the calculation of reference emissions, the applicant shall consider the amount of energy that is displaced by the renewable energy used by the project.

- **Manufacturing of components projects under the RES category (section 3.3.3):** In the calculation of reference emissions, the applicant shall always consider the net amount of renewable energy that is delivered by the facility or consumer product, equipped with the component manufactured by the project, for external usage (i.e., fed into the grid or directly to another party). This means that the amount of energy generated by the facility or consumer product and used for internal consumption cannot be included in the reference scenario.

For the situations where the project involves retrofit of an existing plant, the project shall consider only the part of the plant that is affected by the retrofit. For example, in the case of a retrofit at a wind farm that affects 10% of the wind turbines, only the energy generated by those 10% of the wind turbines would be considered in the reference scenario and only the emissions associated with operating those 10% of the wind turbines would be considered in the project scenario.

For the situations where the project involves capacity added to an existing plant, only the added capacity shall be accounted for. This means, for example, that in the case of the addition of a carbon capture unit to a bioenergy facility without any increase of the energy output of the facility, the reference emissions will be zero.

In some projects, an increase in the output of one product may be delivered at the expense of a reduction in the output of another product. For example, a project introducing carbon capture to a bioenergy facility may consume some of its produced electricity to run the carbon capture unit, but increase heat output by a combination of increased biomass intake and heat recovery from the carbon capture unit. In the case that the output of one type of energy is reduced by a project but others increase then the reference emissions should include a negative value for the term where there is 'negative displacement' by the project activity. The sum of the emissions in the reference scenario may, however, never be less than zero. For example, if a carbon capture unit consumed energy and thereby reduces total energy output from a facility, the Ref_y term should be reported as zero, not as a negative number.

3.3 Calculation of project and reference emission

The equation to be applied for the calculation of the emissions in the reference and project scenario for renewable energy projects are described as follows:

- For projects that intend to produce renewable electricity, heating or cooling, refer to section 3.3.1.
- For projects that intend to use renewable energy in activities not covered under Annex I of the EU ETS directive, refer to section 3.3.2.
- For projects involving the manufacturing of renewable energy systems or their components, refer to section 3.3.3.

3.3.1 Projects that intend to produce renewable electricity, heating or cooling

Parameter	=	Equation	
Ref_y	=	$Ref_{elec,prod,\,y} + Ref_{heat,prod,\,y} + Ref_{cool,prod,\,y}$	[3.1]
$Proj_y$	=	$Proj_{on\text{-}site,y} + Proj_{geo,y} + Proj_{bio\ supply,y}$	[3.2]

Where:

$Ref_{elec,prod,y}$ = GHG emissions for the generation of dispatchable or non-dispatchable electricity using the conventional technologies, which will be displaced by the project activity in year y, in tonnes CO_2e. Calculated according to Equation [3.3].

$Ref_{heat,prod,y}$ = GHG emissions for the generation of heating using the conventional technologies, which will be displaced due to the project activity, in year y, in tonnes CO_2e. Calculated according to Equation [3.4].

$Ref_{cool,prod,y}$ = GHG emissions for the generation of cooling using the conventional technologies, which will be displaced due to the project activity, in year y, in tonnes CO_2e. Calculated according to Equation [3.5].

$Proj_{on\text{-}site,y}$ = GHG emissions due to fuel, heat and electricity consumption at the project site in year y, in tonnes CO_2e. Calculated according to Equation [3.6]. Projects submitted under the small-scale topic may omit this parameter.

$Proj_{geo,y}$ = GHG emissions from the operation of the geothermal power plant in year y, in tonnes CO_2e. Calculated according to Equation [3.7].

$Proj_{bio\ supply,y}$= GHG emissions from the production and supply of biomass-derived fuels consumed in stationary machinery and on-site vehicles at the project site, in year y, in tonnes CO_2e. Calculated according to Equation [3.8].

y = year of the operation.

3.3.1.1 Reference emissions sub-equations

Parameter	=	Equation			
$Ref_{elec,prod,y}$	=	$(EG_{elec,disp,y} * EF_{elec,disp,ref}) + (EG_{elec,nondisp,y} * EF_{elec,nondisp,ref})$	=	$(P_{elec,disp,y} * PLF_{elec,disp,y} * T_{elec,disp,y}) * EF_{elec,disp,ref} + (P_{elec,nondisp,y} * PLF_{elec,nondisp,y} * T_{elec,nondisp,y}) * EF_{elec,nondisp,ref}$	[3.3]
$Ref_{heat,prod,y}$	=	$EG_{heat,y} * EF_{heat}$	=	$(P_{heat,y} * PLF_{heat,y} * T_{heat,y}) * 0.0036 * EF_{heat}$	[3.4]
$Ref_{cool,prod,y}$	=	$EG_{cool,y} * EF_{elec,\ nondisp,ref}$	=	$(P_{cool,y} * PLF_{cool,y} * T_{cool,y}) * EF_{elec,\ nondisp,ref}$	[3.5]

Where:

$EG_{elec,disp,y}$ = Net amount of dispatchable electricity to be generated by the renewable technology in year y and delivered to the grid, in MWh.

$EG_{elec,nondisp,y}$ = Net amount of non-dispatchable electricity to be generated by the renewable technology in year y and delivered to the grid or directly to an end user, in MWh.

$EG_{heat,y}$ = Net amount of heat to be delivered by the renewable technology in year y, in TJ.

$EG_{cool,y}$ = Net amount of cooling to be delivered by the renewable technology in year y, in MWh.

$P_{out,y}$ = Power plant capacity for energy output type "out", i.e. net maximum power output also taking into account technology degradation, in year y, in Watts.

$PLF_{out,y}$ = Plant Load Factor, i.e. plant's capacity utilisation, for each energy output type "out", in year y, in %.

$T_{out,y}$ = operating hours for each energy output type "out", in year y , in hours.

$EF_{elec,disp,ref}$ = Emissions factor for the generation of dispatchable electricity in the reference scenario, in tonnes CO_2e/MWh. The appropriate EF presented in Table 3.2 Parameters not to be monitored shall be applied.

$EF_{elec,nondisp,ref}$ = Emissions factor for the generation of non-dispatchable electricity in the reference scenario, in tonnes CO_2e/MWh. The appropriate EF presented in Table 3.2 Parameters not to be monitored shall be applied.

EF_{heat} = Emission factor due to the generation of heat in the reference scenario, in tonnes CO_2e/TJ. The EF presented in Table 3.2 Parameters not to be monitored shall be applied.

out = dispatchable electricity ("elec,disp"), non-dispatchable electricity ("elec,nondisp"), heating ("heat") or cooling ("cool").

y = year of operation.

3.3.1.2 *Project emissions sub-equations*

Parameter	=	Equation			
$Proj_{on\text{-}site,y}$	=	$Proj_{FF,y} + Proj_{bio\ use,y} + Proj_{elec,y} + Proj_{heat,y}$	=	$(Q_{FF,y} * EF_{FF}) + (Q_{bio,f,y} * EF_{bio\ use,f}) + (Q_{elec,y} * EF_{elec,proj}) + (Q_{heat,y} * EF_{heat})$	[3.6]
$Proj_{geo,y}$[37]	=	$Proj_{dry\_flash,y} + Proj_{binary,y}$	=	$(0.00544695$[38] $* M_{steam,y}) + ((M_{inflow,y} - M_{outflow,y}) * 0.00544695 + M_{working\ fluid,y} * GWP_{working\ fluid})$	[3.7]
$Proj_{bio\ supply,y}$	=	$Q_{bio.f,y} * EF_{bio\ supply,f}$			[3.8]

Where:

$Proj_{FF,y}$ = GHG emissions from fossil fuel consumption in stationary machinery and on-site vehicles at the project site in year y, in tonnes CO_2e. This includes fuel consumed for generation of electric power and heat, and from auxiliary loads and vehicles used for regular maintenance.

$Proj_{bio\ use,y}$ = GHG emissions due to the consumption of biomass-derived fuels in stationary machinery and on-site vehicles at the project site in year y, in tonnes CO_2e. This includes use of biomass-derived fuels for renewable energy generation purposes, for the case of bioenergy projects.

$Proj_{elec,y}$ = GHG emissions due to the electricity imported from the grid and consumed at the project site, in year y, in tonnes CO_2e.

$Proj_{heat,y}$ = GHG emissions due to the heat purchased from third parties and consumed at the project site, in year y, in tonnes CO_2e.

$Q_{FF,y}$ = Quantity of fossil fuel type FF consumed in stationary or mobile sources at the project site in year y, in TJ.

$Q_{bio,f,y}$ = Quantity of biomass-derived fuel type f consumed in stationary or mobile sources at the project site in year y, in TJ. For the case of fuel cells using RFNBOs or hydrogen, this includes/corresponds to the quantity of RFNBO or hydrogen used in the fuel cell. This should be reported for transparency, even if an emission factor of zero shall be used for hydrogen and RFNBO used in a fuel cell.

EF_{FF} = Emission factor due to the combustion of the fossil fuel type FF, in tonnes CO_2e/TJ. The applicable EF presented in Table 3.2 should be applied.

$EF_{bio\ use,f}$ = Emission factor due to the combustion of the biomass-derived fuel type f, in tonnes CO_2e/TJ. The applicable EF presented in Table 3.2 should be applied.

$Q_{elec,y}$ = Amount of electricity imported from the grid and consumed at the project site in year y, in MWh.

$EF_{elec,proj}$ = Average EU electricity emissions factor in the project scenario, in tonnes CO_2e/MWh. The appropriate EF presented in Table 3.2 shall be applied.

$Q_{heat,y}$ = Amount of heat imported and consumed at the project site in year y, in TJ.

[37] When estimating leakage emissions for geothermal plants, the applicant may also consider using standard ratios for parameters like the mass of steam per MWh generated, steam losses and working fluid per tonne of steam, based on industry benchmarks, if available.

[38] Based on IPCC AR5 and CDM benchmarks. Assumes: Average mass fraction of methane in the produced steam = 0.00000413 tonnes CH_4/ tonne steam; Average mass fraction of CO_2 in the produced steam = 0.00533144 tonnes CO_2/tonne steam.

EF_{heat} = Emission factor for the consumption of imported heat in the project scenario, in tonnes CO_2e/TJ. The appropriate EF presented in Table 3.2 shall be applied.

$Proj_{dry\_flash}$ = GHG emissions due to release of non-condensable gases from produced steam during the operation of dry steam or flash steam geothermal power plants in year y, in tonnes CO_2e.

$Proj_{binary}$ = GHG emissions due to physical leakage of non-condensable gases and working fluid during the operation of binary geothermal power plants in year y, in tonnes CO_2e.

$M_{steam,y}$ = Quantity of steam produced in year y, in tonnes steam.

$M_{inflow,y}$ = Quantity of steam entering the geothermal plant in year y, in tonnes steam.

$M_{outflow,y}$ = Quantity of steam leaving the geothermal plant in year y, in tonnes steam.

$M_{working\ fluid,y}$ = Quantity of working fluid consumed in year y, in tonnes of working fluid.

$GWP_{working\ fluid}$ = Global Warming Potential for the working fluid used in the binary geothermal power plant.

$EF_{bio\ supply,f}$ = Emission factor for the supply of biomass-derived fuel '*f*', in tonnes CO_2e/TJ. To be calculated following the provisions in section 1.4.4.

y = year of operation.

3.3.2 Projects that intend to use renewable electricity, heating or cooling in activities not covered under Annex I of the EU ETS directive

Parameter	=	Equation	
Ref_y	=	$Ref_{elec,use,\ y} + Ref_{heat,use,\ y} + Ref_{cool,use,\ y}$	[3.9]
$Proj_y$	=	0	[3.10]

Where:

$Ref_{elec,use,y}$ = GHG emissions for the generation of dispatchable or non-dispatchable electricity using conventional technologies, which will be displaced by the renewable energy used in project activity in year y, in tonnes CO_2e. Calculated according to Equation [3.11].

$Ref_{heat,use,y}$ = GHG emissions for the generation of heating using conventional technologies, which will be displaced by the renewable energy used in the project activity, in year y, in tonnes CO_2e. Calculated according to Equation [3.12].

$Ref_{cool,use,y}$ = GHG emissions for the generation of cooling using conventional technologies, which will be displaced by the renewable energy used in the project activity, in year y, in tonnes CO_2e. Calculated according to Equation [3.13].

y = year of the operation.

3.3.2.1 <u>Reference emissions sub-equations</u>

Parameter	=	Equation	
$Ref_{elec,use,y}$	=	$Q_{elec,y} * EF_{elec,nondisp,ref}$	[3.11]
$Ref_{heat,use,y}$	=	$Q_{heat,y} * EF_{heat}$	[3.12

Parameter	=	Equation	
$Ref_{cool,use,y}$	=	$Q_{cool,y} * EF_{elec,nondisp,ref}$	[3.13]

Where:

$Q_{elec,y}$ = Amount of renewable electricity to be consumed by the project in non-Annex I activities, in year y, in MWh.

$Q_{heat,y}$ = Amount of renewable heating to be consumed by the project in non-Annex I activities in year y, in TJ.

$Q_{cool,y}$ = Amount of renewable cooling to be consumed by the project in non-Annex I activities in year y, in MWh.

$EF_{elec,nondisp,ref}$ = Emissions factor for the generation of non-dispatchable electricity in the reference scenario, in tonnes CO_2e/MWh. The appropriate EF presented in Table 3.2 shall be applied.

EF_{heat} = Emission factor due to the generation of heating in the reference scenario, in tonnes CO_2e/TJ. The EF presented in Table 3.2 shall be applied.

3.3.3 Manufacturing of components for renewable energy generation

In addition to the equations detailed below, equations [3.3 $Ref_{elec,prod}$],[3.4 $Ref_{heat,prod}$],[3.5 $Ref_{cool,prod}$] and [3.6 $Proj_{on-site}$],[3.7 $Proj_{geo}$],[3.8 $Proj_{bio\ supply}$] presented in section 3.2.1, shall be used as guidance for the calculation of reference and project emissions per year for a facility or consumer product equipped with the component produced by a manufacturing projects.

Parameter	=	Equation	
Ref_y	=	$N_y * UP * CS * (Ref_{elec,prod,unit,y} + Ref_{heat,prod,unit,y} + Ref_{cool,prod,unit,y})$	[3.14]
$Proj_y$	=	$N_y * UP * CS * (Proj_{on-site,unit,y} + Proj_{geo,unit,y} + Proj_{bio\ supply,unit,y})$	[3.15]

Where:

$Ref_{elec,prod,unit,y}$ = Specific GHG emissions for the generation of dispatchable or non-dispatchable electricity using conventional technologies, which will be displaced by the renewable electricity generated by a facility or consumer product equipped with an innovative component produced by the manufacturing project in year y, per unit and per year of use of the component, in tonnes CO_2e/(unit * year of use of the component). Refer to Equation [3.3] for general guidance.

$Ref_{heat,prod,unit,y}$ = Specific GHG emissions for the generation of heating using conventional technologies, which will be displaced by the renewable heating generated by a facility or consumer product equipped with an innovative component produced by the manufacturing project in year y, per unit and per year of use of the component, in tonnes CO_2e/(unit * year of use of the component). Refer to Equation [3.4] for general guidance.

$Ref_{cool,prod,unit,y}$ = Specific GHG emissions for the generation of cooling using conventional technologies, which will be displaced by the renewable cooling generated by a facility or consumer product equipped with an innovative component produced by the manufacturing project in year y, per unit and per year of use of the component, in tonnes CO_2e/(unit * year of use of the component). Refer to Equation [3.5] for general guidance.

$Proj_{on-site,unit,y}$ = Specific GHG emissions due to fuel, heat and electricity consumption by a facility or consumer product equipped with an innovative component produced by the manufacturing project in year y, per unit and per year of use of the component, in tonnes CO_2e/(unit * year of use of the component). Refer to Equation [3.6] for general guidance. Projects submitted under the small-scale topic may omit this parameter.

$Proj_{geo,unit,y}$ = Specific GHG emissions from the operation of a geothermal power plant equipped with an innovative component produced by the manufacturing project in year y, per unit and per year of use of the component, in tonnes CO_2e/(unit * year of use of the component). Refer to Equation [3.7] for general guidance.

$Proj_{bio\ supply,unit,y}$= Specific GHG emissions from the production and supply of biomass-derived fuels consumed in a facility or consumer product equipped with an innovative component produced by the manufacturing project in year y, per unit and per year of use of the component, in tonnes CO_2e/(unit * year of use of the component). Refer to Equation [3.8] for general guidance.

CS = cost share of the innovative component as a fraction of the total capital cost of the relevant facility or retail price of the consumer product, as defined in section 1.3.5. Applicants must provide appropriate references and justifications to substantiate this cost assessment.

N_y = number of innovative renewable energy components produced and supplied to the market in year y by the proposed manufacturing project. The applicant shall estimate this based on the expected output of the manufacturing plant and the market potential, and in line with the assumptions made in the rest of the proposal concerning the operation of the plant, and including financial calculations.

UP = Applicable use period of the manufactured innovative component, as defined in section 1.3.4. The use period is equal to a maximum of 5 years, or to the lifetime of the component, if the lifetime of the component is shorter than five years.

y = year of operation of the manufacturing project.

3.4 Relative GHG emission avoidance

Refer to section 1.1.4 for Guidance on the calculation of ΔGHG_{rel}.

In the specific case of the addition of CCS to an existing bioenergy facility without increasing the energy output of the facility, the reference emissions are zero. For such projects, it is not possible to use equations 1.2 and 1.3. Therefore, the relative GHG emission avoidance shall be set equal to 100% as specified in section 1.1.4, and the adjusted relative GHG emission avoidance shall be set equal to 200% as specified in section 1.1.5.

3.5 Data and parameters

Table 3.2 presents the parameters that will be deemed as constant throughout the duration of the project, unless otherwise stated. For emission or conversion factors not listed here, refer to the hierarchy of sources in Appendix 1.

Table 3.2 Parameters not to be monitored

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
Energy	0.0036	TJ/MWh	Conversion factor		Applies to all types of energy
Energy	0.001	GJ/MJ	Conversion factor		Applies to all types of energy

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
EF_{heat}	47.3	tonnes CO_2e/TJ	GHG emission factor for heat	Commission Implementing Regulation (EU) 2021/447 of 12 March 2021	
EF_{NG}	59.5	tonnes CO_2e/TJ	GHG emission factor for the combustion of natural gas in stationary or mobile sources	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2. (EF) and IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (GWP)	Based on the most conservative EFs for CH_4 and/or N_2O among stationary and mobile use
EF_{LPG}	64.90	tonnes CO_2e/TJ	GHG emission factor for the combustion of liquefied petroleum gas in stationary or mobile sources	Same as above	Same as above
$EF_{heavyoil}$	77.8	tonnes CO_2e/TJ	GHG emission factor for combustion of heavy fuel oil in stationary sources	Same as above	Same as above
$EF_{gasoline}$	73.2	tonnes CO_2e /TJ	GHG emission factor for the combustion of gasoline in stationary or mobile sources	Same as above	Same as above
EF_{diesel}	75.2	tonnes CO_2e /TJ	GHG emission factor for the combustion of diesel in mobile or stationary sources	Same as above	

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
$EF_{bio\ use}$	0.4	tonnes CO_2e /TJ	Emission factor for the non-CO_2 GHG emissions from the combustion of biomass-derived fuels in stationary or mobile sources	Same as above	
$EF_{elec,nondisp,ref}$	0.176	tonnes CO_2e / MWh	Emissions of electricity production in 2030	EU Reference Scenario 2020	Base year 2030. Combustion only.
$EF_{elec,disp,ref}$	0.505	tonnes CO_2e / MWh	Emissions of electricity production with single cycle natural gas turbine	Based on the EF for combustion of natural gas according to COMMISSION IMPLEMENTING REGULATION (EU) 2018/2066 and a gas turbine with efficiency of 40 %	The value should be applied in all years *y*.
$EF_{elec,proj}$	0.000	tonnes CO_2e / MWh	Emissions of electricity production in 2050	Assumption	Base year 2050. Combustion only.
$EF_{bio\ supply}$	To be calculated following the requirements in section 1.4.4.	tonnes CO_2e/TJ	GHG emission factor for the production and supply of the biomass-derived fuel used to generated electricity, heat or cooling	To be calculated following the requirements in section 1.4.4.	

Source: see the column "Source data".

4 Energy storage (ES)

The GHG emission avoidance of an energy storage (ES) project is calculated as the difference between the project emissions and the emissions in the reference scenario (i.e., in the absence of the project) following the provisions in this section.

Emissions in the reference scenario correspond to the emissions associated to the energy displaced by the output of the energy storage system, whereas project emissions are those associated with the input to the energy storage system during operation, plus emissions associated to the operation of the energy storage facility.

If the services delivered by the project are useful from a system perspective, additional emissions avoidance associated with the delivery of the services may be claimed under certain conditions. In this respect, the energy storage methodology distinguishes various services that contribute to the GHG emission avoidance delivered by energy storage units, as specified in section 4.1.

The energy stored may be sourced from an energy grid or directly from a plant, and it can be delivered to an energy grid or directly to a plant. For electricity, heat, and hydrogen, default emission factors depending on the source and intended use must be applied as specified in section 1.4.3, and no deviations are allowed. Other standard emission factors are provided in Table 4.2 and must be used, unless the applicant provides evidence and credibly justify alternative assumptions made. Refer to section 1.1.9 for relevant provisions concerning assumptions.

During operation, projects will be required to maintain records of measurements, quality assurance and quality control procedures, and calculations used in the development of data reported, along with copies of reported data and forms submitted. During the monitoring period, beneficiaries will need to prove, based on the same methodology, that the GHG emission avoidance is delivered. In addition, the project operators will be asked to deliver hourly load profiles for knowledge sharing purposes. See also section 1.5 and Appendix 4 for relevant provisions.

4.1 Scope

This section applies to projects in the energy storage (ES) category (see section 1.2). These projects can include the construction and operation of a greenfield energy storage plant, or the extension of an existing plant by adding an energy storage unit.

An energy storage unit or plant can stores any type of energy (e.g. electricity, heat, cold, hydrogen, gaseous or liquid fuels) from the time at which it was originally generated or supplied, to a later moment of use. It is not allowed to claim emission avoidance for an energy storage system during any period during which it is simultaneously charged and discharged with the same type of energy (e.g. electricity).

The storage of energy may include the conversion of one energy type into another. In the case of projects converting electricity into fuel, such as hydrogen or other synthetic fuels, the application should generally be made under the Energy Intensive Industry (EII) category and follow the provisions in section 2. Such projects may only apply under the ES category and follow the provisions in this section if the storage of excess renewable energy in another form is the primary aim of the project. For such projects, the electricity consumed must be limited to periods of high renewable electricity production that result in a particularly low load factor, condition that must be credibly justified by the applicant, and demonstrated during project implementation.

This section is also to be used to calculate emissions savings from timed operation in EII projects as detailed in section 2.2.6.6.

If a project includes an element of energy storage alongside EII activities, renewable energy generation, or other activities falling under other categories, then the applicant shall submit a hybrid application, following the provisions of section 1.2.5.

4.1.1 Services, products and sectors

Products and sectors covered under the ES category are defined in section 1.2 with some examples provided below:

- **Intra-day electricity storage**, covering: arbitrage, reserve power, ramping, auxiliary services to electricity grids (including reactive power, synchronous inertia), and avoidance of renewable energy curtailment.
- **Other energy storage**, such as storage of hydrogen and storage of heat.
- **Manufacture of components** for energy storage, such as batteries and other components for stationary energy storage applications.

Note for applicants familiar with earlier versions of the methodology: Components for energy storage used in mobility applications, including road transport, are now covered under the MOB category, section 5.

4.1.2 Constructing a reference for auxiliary services

The reference scenario for auxiliary services may be more complex to identify with respect to other cases, because it may involve a change in the efficiency at which a service is delivered, rather than a change in the quantity of the service delivered.

Applicants must propose an appropriate reference scenario for their project by taking into account the specificities of the auxiliary service provided and the local context for providing such service. This is explained in additional detail and in relation to equation [4.4] in the example below.

> *Example: A project provides reactive power services with a rating of* **X** *MVAr. For the reference, it is assumed that an equivalent reactive power service could be delivered by running combined cycle gas turbines (CCGTs) below optimal efficiency (e.g. running two turbines at 45% thermal efficiency instead of a single turbine at 55% thermal efficiency). The applicant identifies that* **Z** *MW of power generation would need to run in this lower efficiency mode to provide the* **X** *MVAr of reactive power, and that the reactive power service will be used by the grid for* **Y** *hours per year. The additional natural gas consumption by CCGTs in the reference scenario, expressed in MWh of natural gas, is equal to (55% - 45%)/(55% x 45%)* x **Z** x **Y**, *and the reference emissions in tonnes CO_2e would therefore be (55%-45%)/(55% x 45%)* x **Z** x **Y** x 0.202 *(the natural gas emission factor 56.2 gCO_2e/MJ is equivalent to 0.202 tCO_2e/MWh).*

4.2 System boundary

The system boundary for an ES project includes the energy storage plant/unit and all facilities that the energy storage plant/unit is connected to, and that are not metered separately. In well justified cases, such as for the management of distributed renewable energy, the condition for a single metering point may not be applicable.

The greenhouse gases and emission sources included in, or excluded from, the system boundary are shown in Table 4.1.

Table 4.1. Emission sources included in the system boundary

Source		Included in any topic except small-scale	Included in small-scale topic
Reference scenario (Ref)	Ref_{energy}: Emissions related to the provision of energy in the absence of the project activity. This includes direct emissions from the use of fossil fuels and generation of heat, indirect emissions from the use of grid electricity, hydrogen and heat, process-related emissions from the production of hydrogen, and from transmission losses associated with the transport network.	Yes	Yes
	$Ref_{services}$: Emissions related to the provision of auxiliary services to the grids in the absence of the project activity. This includes direct emissions from the use of fossil fuels and generation of heat, in particular from inefficient operation of fossil-fuelled plants, indirect emissions from the use of grid electricity, hydrogen and heat and from transmission losses associated with the grid transport.	Yes	Yes
Project (Proj)	$Proj_{energy}$: Emissions related to the provision of energy caused by the project activity. This includes direct emissions from the use of fossil fuels and generation of heat, indirect emissions from the use of grid electricity, hydrogen and heat, process-related emissions from the production of hydrogen and from transmission losses associated with the energy transport.	Yes	Yes
	$Proj_{on\text{-}site}$: On-site emissions of fugitive GHGs and emissions from energy use other than energy storage. This includes emissions from combustion in vehicles or stationary machinery, emissions from other processes at installations functionally connected to the transport network, including booster stations, and fugitive and vented emissions from the transport network.	Yes	No

Source: European Commission internal elaboration.

Simplification for SMALL-SCALE topic: Projects submitted under the small-scale topic can disregard $Proj_{on\text{-}site}$ for the purpose of GHG calculations. These will need to be reported only for knowledge sharing purposes.

4.3 Calculation of project and reference emissions

As explained in section 1.1.3, the absolute GHG emission avoidance is given by the difference of the emissions in the reference scenario Ref_y and the project scenario $Proj_y$, possibly adjusted by a credit for carbon capture.

The equations to be applied for calculating Ref_y and $Proj_y$ by projects intending to operate energy storage plants are described in section 4.3.1. The equations to be applied for calculating Ref_y and $Proj_y$ by projects manufacturing innovative energy storage systems or their components are described in section 4.3.2.

4.3.1 Projects that intend to operate innovative energy storage systems

For projects that intend to operate innovative energy storage systems, Ref_y and $Proj_y$ shall be calculated according to Equation [4.1] and [4.2].

Parameter	=	Equation	
Ref_y	=	$Ref_{energy,y} + Ref_{services,y}$	[4.1]
$Proj_y$	=	$Proj_{energy,y} + Proj_{on\text{-}site,y}$	[4.2]

Where:

$Ref_{energy,y}$ = Energy-related GHG emissions present in the reference scenario in year y that will not occur due to the energy storage plant put in place, in tonnes CO_2. This includes direct emissions from the use of fossil fuels and generation of heat, indirect emissions from the use of grid electricity, hydrogen and heat, process-related emissions from the production of hydrogen as well as from transmission losses associated with the energy transport. It shall be calculated according to Equation [4.3] below.

$Ref_{services,y}$ = Auxiliary-services-related GHG emissions present in the reference case in year y that will not occur due to the energy storage plant put in place, in tonnes CO_2. This includes direct emissions from the use of fossil fuels and generation of heat, in particular from inefficient use of primary energy, indirect emissions from the use of grid electricity, hydrogen and heat as well as from transmission losses associated with the energy transport. It shall be calculated according to Equation [4.4] below. In the case that a service could alternatively be delivered by running some amount of power generation with CCGTs at reduced efficiency (45% rather than 55%) then Equation [4.4a] may be used.

$Proj_{energy,y}$ = Energy-related GHG emissions not present in the reference scenario in year y that will occur due to the provision of energy by the energy storage plant, in tonnes CO_2. This includes direct emissions from the use of fossil fuels and generation of heat, indirect emissions from the use of grid electricity , hydrogen and heat, process-related emissions from the production of hydrogen as well as from transmission losses associated with the energy transport. It shall be calculated according to Equation [4.5] below.

$Proj_{on\text{-}site,y}$ = Emissions from storage of energy carriers and their transport by pipelines, road or maritime modals in year *y,* in tonnes CO_2e. This includes emissions from combustion at the vehicles, and other processes at installations functionally connected to the transport network including booster stations; fugitive and vented emissions from the transport network. It shall be calculated according to Equation [4.6] below and its [4.6a], [4.6b], [4.6c] sub-equations.

y = year of operation.

Parameter	=	Equation	
$Ref_{energy,y}$	=	$\sum_{x=1}^{X} EF_{out,x,y} * E_{out,x,y} / (1 - \Theta_x)$	[4.3]

Where:

X = number of energy types considered. This includes all energy types replaced, in particular all kinds of energy carriers as well as energy types with associated indirect GHG emissions such as electricity and heat.

$E_{out,x,y}$ = secondary energy supplied to energy grids or final energy delivered to end user of energy type *x*, in year *y*, in terajoules (TJ). For the application, this shall be estimated by the applicant based on the foreseen operation of the energy storage plant in line with the planned storage capacity, storing cycles as well as the rated input and output power; those planned parameters shall account for technology degradation, where applicable (e.g. batteries). For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, it shall be estimated based on forecasted capacity, load factor, forecasted degradation and operating hours that the innovative technology(ies) or component(s) will be able to generate when implemented.

$EF_{out,x,y}$ = emission factor for the energy displaced by the output of the energy storage plant of energy type *x*, in year *y*, in tonnes CO_2e/TJ. For the emission factors, the values presented in Table 4.2.

Parameters not to be monitored shall be applied as the default case. If the energy is delivered to a pre-defined set of end users with a reference emission intensity deviating from the default case, the applicant shall use an emission intensity tied to the specific case, providing verifiable information on it. Given the high interconnectivity of the European electricity markets, it does not apply to grid electricity.

Θ_x = mean losses from transport of energy type *x*, in percent. As long as no regulation prescribes the use of certain values for transport losses, the EU default values presented in Table 4.2 should be applied.

Parameter	**=**	**Equation**	
$Ref_{services,y}$	=	$\sum_{a=1}^{A} \Delta EF_{service,a} * T_{services,a,y} * R_{services,a,y}$	[4.4]
$Ref_{services,y}$	=	$\sum_{a=1}^{A} EF_{out,\ natural\ gas} * [0.1 / (0.55 * 0.45)] * CCGT_{services,a} * T_{services,a,y} * R_{services,a,y}$	[4.4a]

Where:

A = number of services considered.

$\Delta EF_{service,a}$ = mean increase of the emission intensity of grid electricity due to the need for the auxiliary service *a*, in tonnes CO_2e per hours of service delivery and per unit of service (MW, MVAr, GVAs). This is to be estimated by the applicant based on the local grid conditions. The reference case to be considered is the provision of the auxiliary service *x* by running fossil fuel plants at a less-than-optimal efficiency.

$T_{services,a,y}$ = the amount of hours that the provision of the auxiliary service *a* is required in year *y*, in hours (h). This is to be estimated by the applicant based on the local grid conditions and the current local grid regulation. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, it shall be estimated based on forecasted operating hours that the innovative technology(ies) or component(s) will be able to generate when implemented.

$R_{services,a,y}$ = rating of the energy storage plant with respect to the service *a*, in year *y*, in a unit depending on the service (MW, MVAr, GVAs). This is to be provided by the applicant based on the technical documentation of the foreseen energy storage plant. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, it shall be estimated based on forecasted total rating that the innovative technology(ies) or component(s) will be able to generate when implemented.

$CCGT_{services,a}$ = capacity of CCGTs required to run at 45% instead of 55% efficiency in MW per unit of service *a*.

Parameter	**=**	**Equation**	
$Proj_{energy,y}$	=	$\sum_{x=1}^{X} EF_{in,x,y} * E_{in,x,y} / (1 - \Theta_x)$	[4.5]

Where:

X = number of energy types considered. The applicant needs to include all energy types used, in particular all kinds of energy carriers as well as energy types with associated indirect GHG emissions such as electricity and heat.

$EF_{in,x,y}$ = emission factor of energy type *x* for the energy used by the energy storage plant, in year *y*, in terajoules (TJ). For the emission factors, the values presented in Table 4.2. Parameters not to be monitored shall be applied as the default case. If the energy is supplied by a pre-defined set of suppliers with a reference emission intensity deviating from the default case, the applicant shall use an emission intensity tied to the specific case, providing verifiable information on it.

$E_{in,x,y}$ = energy used by the energy storage plant of energy type *x*, in year *y*, in terajoules (TJ). This includes both the energy stored in the energy storage plant and its self-consumption of energy. For the proposal, this shall be estimated by the applicant based on the foreseen operation of the energy storage unit in line with the planned storage capacity, storage efficiency, storing cycles and the rated input power. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, it shall be estimated based on forecasted capacity, load factor and operating hours that the innovative technology(ies) or component(s) will be able to generate when implemented.

θ_x = mean losses from transport of energy type *x*, in percent. As long as no regulation prescribes the use of certain values for transport losses, the EU default values presented in Table 4.2. Parameters not to be monitored should be applied.

Parameter	=	Equation	
$Proj_{on\text{-}site,y}$	=	$Proj_{stat,y} + Proj_{mob,y} + Proj_{fug,y}$	[4.6]
$Proj_{stat,y}$	=	$EF_{in,x} * E_{stat,x,y}$	[4.6a]
$Proj_{mob,y}$	=	$EF_{in,x} * E_{mob,\ x,y}$	[4.6b]
$Proj_{fug,y}$	=	$M_{fug,z,y} * GWP_{fug,z}$	[4.6c]

Where:

X = number of energy types considered. The applicant needs to include all energy types used, in particular all kinds of energy carriers as well as energy types with associated indirect GHG emissions such as electricity and heat.

Z = number of GHGs considered (see section 1.1.6).

$Proj_{stat,y}$ = GHG emissions from energy consumption in stationary machinery (except for the energy storage units) at the project site in year y, in tonnes CO_2e. This should include fuel consumed for processing of materials, generation of electric power and heat, and from auxiliary loads. It shall be calculated according to Equation [4.6a] above.

$Proj_{mob,y}$ = GHG emissions from energy consumption from on-site vehicles and other transportation at the project site, in year y, in tonnes CO_2e. This includes vehicles used for regular maintenance. It shall be calculated according to Equation [4.6b] above.

$Proj_{fug,y}$ = GHG emissions from fugitive greenhouse gas emissions at the project site in year y, in tonnes CO_2e. It shall be calculated according to Equation [4.6c] above.

$E_{stat,y,x}$ = Quantity of energy type *x* used in stationary sources at the project site in year y, in TJ. For the proposal, this shall be estimated by the applicant based on the foreseen operation of the energy storage unit in line with the planned storage capacity, storage efficiency, storing cycles and the rated input power. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, it shall be estimated based on forecasted energy use that the innovative technology(ies) or component(s) will require when implemented.

$E_{mob,y,x}$ = Quantity of energy type *x* used in mobile sources at the project site in year y, in TJ. For the proposal, this shall be estimated by the applicant based on the foreseen operation of the energy storage unit in line with the planned storage capacity, storage efficiency, storing cycles and the rated input power. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, it shall be estimated based on forecasted energy use that the innovative technology(ies) or component(s) will require when implemented.

$EF_{on\text{-}site,x}$ = Emission factor due to the use of the energy type *x*, in tonnes CO_2e/ TJ. The applicable EF presented in Table 4.2. Parameters not to be monitored should be applied.

$M_{fug,y,z}$ = Amount of the fugitive emissions of greenhouse gas *z* at the project site in year y, in tonnes. For the proposal, this shall be estimated by the applicant based on the foreseen operation of the energy storage unit in line with the planned storage capacity, storage efficiency, storing cycles and the rated input power. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, it shall be estimated based on forecasted fugitive emissions that the innovative technology(ies) or component(s) will result in when implemented.

$GWP_{fug,z}$ = Global Warming Potential of the fugitive greenhouse gas *z* (see section 1.1.6).

4.3.2 Manufacturing of innovative energy storage systems or their components

For a manufacturing project that produces energy storage units, Ref_y and $Proj_y$ shall be calculated according to Equation [4.7] and [4.8].

See also section 1.3 for other provisions relevant for the case of manufacturing projects.

Parameter	=	Equation	
Ref_y	=	$UP * N_y * CS_{component} * (Ref_{energy,y} + Ref_{services,y})$	[4.7]
$Proj_y$	=	$UP * N_y * CS_{component} * Proj_{energy,y}$	[4.8]

Where:

$Ref_{energy,y}$ = Energy-related GHG emissions in the reference scenario that will not occur due to the use of one energy storage facility or consumer product equipped with the component produced by the proposed manufacturing project in year y, per unit and per year of use of the component. Expressed in tonnes CO_2 / (unit * year of use of the component). This includes direct emissions from the use of fossil fuels and generation of heat, indirect emissions from the use of grid electricity, hydrogen and heat, process-related emissions from the production of hydrogen as well as from transmission losses associated with the energy transport. It shall be calculated according to Equation [4.3] above.

$Ref_{services,y}$ = Auxiliary-services-related GHG emissions present in the reference scenario that will not occur due to the use of one energy storage facility or consumer product equipped with the component produced by the proposed manufacturing project in year y, per unit and per year of use of the component. Expressed in tonnes CO_2 / (unit * year of use of the component). This includes direct emissions from the use of fossil fuels and generation of heat, in particular from inefficient use of primary energy, indirect emissions from the use of grid electricity, hydrogen and heat as well as from transmission losses associated with the energy transport. It shall be calculated according to Equation [4.4] above. In the case that a service could alternatively be delivered by running some amount of power generation with CCGTs at reduced efficiency (45% rather than 55%) then Equation [4.4a] may be used.

$Proj_{energy,y}$ = Energy-related GHG emissions not present in the reference scenario that will occur due to the provision of energy by the proposed manufacturing project in year y, per unit and per year of use of the component. Expressed in tonnes CO_2 / (unit * year of use of the component). This includes direct emissions from the use of fossil fuels and generation of heat, indirect emissions from the use of grid electricity, hydrogen and heat, process-related emissions from the production of hydrogen as well as from transmission losses associated with the energy transport. It shall be calculated according to Equation [4.5] above.

N_y = number of components produced and supplied to the market by the proposed manufacturing project in year y. The applicant shall estimate this based on the expected output of the manufacturing plant and the market potential, and in line with the assumptions made in the rest of the proposal concerning the operation of the manufacturing plant, and including financial calculations.

$CS_{component}$ = innovative components' cost as a share of the total capital cost of the relevant facility or retail price of the relevant consumer product, as defined in section 1.3.5. Applicants must provide appropriate references and justifications to substantiate this cost assessment.

UP = Applicable use period of the manufactured component, as defined in section 1.3.4. The use period is equal to a maximum of 5 years, or to the lifetime of the component, if the lifetime of the component is shorter than five years.

y = year of operation of the manufacturing project.

4.4 Relative GHG emission avoidance

The relative GHG emission avoidance (ΔGHG_{rel}) by an energy storage plant shall be calculated according to section 1.1.2.

4.5 Data and parameters

The Table 4.2 presents the parameters that will be deemed as constant throughout the duration of the project, unless otherwise stated.

For emission or conversion factors not listed here, refer to the hierarchy of sources in Appendix 1.

Table 4.2 Parameters not to be monitored

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
$EF_{out,H2}$	57.0 (6.84)	tCO_2e/TJ (tCO_2e/tH_2)	See section 1.4.3.2 Emission benchmark for generating hydrogen under the ETS	See section 1.4.3.2 Commission Implementing Regulation (EU) 2021/447 of 12 March 2021	Value to be used for all the years y
$EF_{in,H2}$ / $EF_{on\text{-}site,H2}$	0	tCO_2e/TJ (tCO_2e/tH_2)	See section 1.4.3.2	See section 1.4.3.2	Value to be used for all the years y
$EF_{on\text{-}site,heat}$ / $EF_{out,heat}$	47.3	tCO_2e/TJ	See section 1.4.3.3 Emission benchmark for generatin	See section 1.4.3.3 Commission Implementing Regulation (EU) 2021/447	Value to be used for all the years y

			g heat under the ETS	of 12 March 2021	
$EF_{in, heat}$	0	tCO_2e/TJ	See section 1.4.3.3	See section 1.4.3.3	Value to be used for all the years y
$EF_{in, natural gas}$ / $EF_{on-site, natural gas}$ / $EF_{out, natural gas}$	59.5	tCO_2e/TJ	GHG emission factor for the combustion of natural gas	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2. (EF) and IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (GWP)	To be used for storage and combustion of natural gas in all stationary and mobile applications for all the years y.
$EF_{in, diesel}$ / $EF_{on-site, diesel}$ / $EF_{out, diesel}$	75.2	tCO_2e/TJ	GHG emission factor for the combustion of diesel fuel	Same as above	To be used for combustion of diesel in all stationary and mobile applications for all the years y.
$EF_{in, gasoline}$ / $EF_{on-site, gasoline}$ / $EF_{out, gasoline}$	73.2	tCO_2e/TJ	GHG emission factor for the combustion of gasoline	Same as above	To be used for combustion of gasoline in all stationary and mobile applications.
$EF_{in, heavy fuel oil}$ / $EF_{on-site, heavy fuel oil}$ / $EF_{out, heavy fuel oil}$	77.8	tCO_2e/TJ	GHG emission factor for the combustion of heavy fuel oil	Same as above	To be used for combustion of heavy fuel oil in all stationary and mobile applications.

			(residual fuel oil)		
$EF_{in, other fossil fuels}$ / $EF_{on-site, other fossil fuels}$ / $EF_{out, other fossil fuels}$	look up in TABLE 2.2 of the source of data	tCO_2e/TJ	Combustion emissions many fossil fuels	IPCC 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	If not in that table, use the literature hierarchy in Appendix 1
$EF_{in, electricity}$ / $EF_{on-site,electricity}$	0	tCO_2e/TJ (tCO_2e/MWh)	See section 1.4.3.1	See section 1.4.3.1	Value to be used for all the years y
$EF_{out,electricity}$	140 (0.505)	tCO_2e/TJ (tCO_2e/MWh)	See section 1.4.3.1 Emissions for dispatchable electricity generation.	See section 1.4.3.1 Based on the EF for combustion of natural gas according to COMMISSION IMPLEMENTING REGULATION (EU) 2018/2066 and a gas turbine with efficiency of 40 %	Value to be used for all the years y
$\theta_{electricity}$	6.74	%	Mean losses due to transport of electricity to consumers via the grid in the EU in 2022	EUROSTAT	Use default only, if no country-specific prescription exists.
θ_{heat}	11.25	%	Mean losses due to transport of heat to consumers via heat networks in the EU in 2022	EUROSTAT	Use default only, if no country-specific prescription exists.

Θ_{gas}	0.64	%	Mean losses due to transport of gaseous fuel s to consumer s via the grid in the EU in 2022	EUROSTAT	Use default only, if no country-specific prescription exists.
$\Delta EF_{service,a}$	Individual calculation by the applicant	t CO_2e per unit depending on service (MW/GVAs /MVAr)	mean increase of the emission intensity of grid electricity due the need for the auxiliary service a	No source available	Where relevant the reference case shall consider the provision of the service by a CCGT plant running at a less than optimal electrical efficiency of 45% instead of 55%.

Source: see the column "Source data".

5 Mobility (MOB)

This section covers projects under the mobility (MOB) category. These projects can contribute to the reduction of GHG emissions (see section 1.1.6) from aviation, maritime, and road transportation activities within the scope of the EU ETS, and to the reduction of additional non-CO_2 climate impacts from aviation and maritime activities within the scope of the EU ETS (see section 1.1.8).

This section includes provisions on how to calculate the impacts that will be avoided in operating journeys as a result of the implementation of innovative projects. The absolute GHG emissions avoidance of the project is defined by the difference between the amount of emissions from GHGs and other non-CO_2 climate impacts, expressed in terms of CO_2 equivalent, that would occur for the delivery of the same transport services using a conventional technology in the reference scenario, and those associated to the project activity in the project scenario.

5.1 Scope

Projects under the MOB category include projects that aim to provide transportation services, and projects that aim to manufacture innovative aircrafts, maritime vessels, road vehicles and their components.

- **Projects that aim to provide transportation services** as their principal product may envisage a reduction in energy use per functional unit, e.g. per km, per journey), or a reduction in the emissions per unit of energy through, for example, the adoption of a less carbon intensive energy source, e.g. use of electricity, hydrogen, or biomass-derived fuels.
- **For projects that aim to manufacture innovative aircrafts, maritime vessels, road vehicles or their components**, the project emissions shall be defined by the emissions that the manufactured aircraft, vessel, or vehicle will emit when in use, which shall be estimated based on credible assumptions about the projected performance of all components of the finished vehicle, and underpinned with robust evidence. Refer also to section 1.3 for general provisions for manufacturing projects.

Examples of such projects include, but are not limited to:

- Projects that reduce energy use per functional unit (e.g. new vehicles/airframes, reduced weight, replacement of fleet with more efficient vehicles/aircraft/vessels).
- Fuel switch (e.g. use of sustainable biofuels or blends, electricity, hydrogen or recycled carbon fuels or renewable fuels of non-biological origin or alternative fuels with lower content of other pollutants associated with climate forcing effects, e.g. aromatics and sulphur, instead of the conventional fossil fuel).
- Projects that envisage a modal shift (e.g. new mode of transportation, or a combination or various modes); Manufacturing of electric or hydrogen-fuelled aircraft or their components.
- Manufacturing of innovative vessels and their components (e.g. new hull designs, wind propulsion technologies, energy saving propulsors, power train hull appendage and other hull technologies).
- Manufacturing of innovative vehicles and their components (e.g. electric vehicles, fuel cell vehicles, batteries for mobility applications, fuel cells for mobility applications).

- Solutions to reduce GHG emissions from on-board ship systems (e.g. fuel cells for vessels, batteries for vessels).
- Wind propulsion technologies and power take-in from propulsors (e.g. Flettner rotors, sail rigs, other wind propulsion devices).
- Projects involving the decarbonisation of the supporting infrastructure (e.g. at the ports and airports).
- Projects that contribute to the reduction of non-CO_2 climate impacts.
- Projects combining the above.

5.1.1 Choice of a sector for mobility projects

For projects classified under the MOB category, the sector shall be defined as specified in section 1.2, i.e. it shall be determined based on the function of the principal product or service that is the main aim of the project.

> *Example: A project that involves the manufacturing of innovative maritime vessels shall be classified under sector MOB/maritime.*

> *Example: A project that intends to provide transportation services for passengers with an innovative aviation solution shall be classified under sector MOB/aviation.*

The general rule above applies also to the case of modal switch projects:

> *Example: A project intends to replace road freight transport with maritime shipping. The project aims to provide maritime transportation services; therefore, it shall be classified under sector MOB/maritime.*

Only in case a modal switch project aims to provide a transportation service in the project scenario different than aviation, maritime, or road transport, then the sector shall be chosen based on the transport service replaced in the reference scenario (which must be either aviation, maritime, or road transport) following the provisions in section 1.2.1 and the other relevant provisions in section 1.2

> *Example: A project intends to replace road freight with rail transport. The project aims to reduce emissions in the road transport sector by replacing road travels with transportation services in a sector different than road transport, maritime, or aviation. Then, the sector is determined by the transport service replaced, and the project shall be classified under sector MOB/road transport.*

Projects aiming exclusively at producing fuels shall apply under the EII category (section 2). However, projects that envisage both the production and use of such fuels may apply as hybrid EII + MOB projects, where the GHG emissions avoided are calculated separately for each component and added up while removing any double counting. See section 1.2.5.5 for specific guidance.

5.1.2 Reference scenario for mobility projects

The reference scenario for mobility projects shall be the delivery of the same transport services provided by the innovative project. This means that for a project delivering freight and passenger transport services, the delivered transport service in terms of tonne-kilometres and/or person-kilometres must be the same, respectively, while the number of vehicle, vessels and/or aircrafts may (in some cases within the provisions of section 5.1.2.1) differ between the reference and the project scenario, if the typical size of the innovative technology differs from the conventional one.

The emissions in the reference and project scenario shall be calculated following the provisions and equations in section 5.3. The reference scenario shall be based on a representative mode of transport as specified in section 5.1.2.1, and on the use of a relevant conventional fossil fuel and relevant average vehicle fuel consumptions as specified in section 5.1.2.2.

5.1.2.1 *Mode of transport in the reference scenario*

As a general rule, the mode of transport assumed in the reference scenario shall be the same as in the project scenario. For a project aiming to deliver transport services, if section 5.3.1 allows for the selection of one out of multiple reference vehicles within the same mode of transport, the applicant shall match the project scenario by selecting the one most representative of the transportation service provided by the project.

This means that the reference scenario should typically be built by considering the same number of vehicles as in the project scenario, travelling the same distances and transporting the same volumes of passengers or goods as in the project scenario, and thus providing the same transport service in terms of tonne-kilometres and/or person-kilometres as in the project scenario.

> *Example: the reference scenario for a project delivering aviation transportation services is an equivalent fleet of conventional aircrafts operating on the relevant conventional fuel as specified in section 5.1.2.2. The number of reference aircrafts should be the same as in the project scenario, and the type of reference aircraft should be selected as the one most representative for the type of service provided by the project among the options available, in terms of distance travelled and volumes of passengers or goods transported. The transport service provided in the reference scenario shall be the same as in the project scenario in terms of tonne-kilometres and/or person-kilometres.*

Two exceptions are allowed for specific **projects that aim to provide a transport service**:

- When it is not possible to build a reference scenario for the delivery of the same transportation service as in the project scenario (in tonne-kilometres and/or person-kilometres) by considering the same number of vehicles in the two scenarios, then the applicant may deviate from the standard approach in terms of number and type of vehicles and distance travelled. However, the mode of transport considered must be the same as in the project scenario.
- In situations in which the transport service provided by the project in the project scenario is typically provided through other modes of transport in the reference scenario, then the applicant can select the most common mode of transport used for such services in the reference scenario, among those available within the provisions in section 5.3.1. This is typically the case of projects that aim at reducing emissions through modal shift, where nonetheless the reference scenario shall provide the same transport service in terms of tonne-kilometres and/or person-kilometres as in the project scenario.

These situations must be well justified by the applicants, for example by providing relevant supporting documents. Deviating from the standard reference scenario without providing a credible justification may negatively impact the credibility of the GHG calculations and the resulting evaluation. In any case, the emissions in the reference and project scenario shall be calculated following the provisions of section 5.3.1, and the transport service provided in the reference scenario shall be equal to the transport service provided in the project scenario in terms of tonne-kilometres and/or person-kilometres.

For **projects aiming at manufacturing innovative aircraft, maritime vessels, or road vehicles** (section 5.3.2), deviating from the standard reference scenario is not allowed. For such projects, the mode of transportation to be considered in the reference scenario shall always match the one in the project scenario. For example, should the project involve the manufacturing of a certain number of innovative maritime vessel, then the applicant shall assume that these vessels will replace the same number of representative conventional maritime vessel, thus providing the same transport service in terms of tonne-kilometres and/or person-kilometres as in the project scenario.

5.1.2.2 Type of fuel and specific fuel consumption in the reference scenario

In terms of fuel types to be used in the reference scenario, the following shall apply:

- The conventional jet kerosene type A1 shall be used when the reference scenario is based on **aviation** as a mode of transport;
- The maritime reference fuel oil, composed by a mix of sulphur fuel oil, marine diesel oil (MDO)/marine gas oil (MGO) and Liquefied Natural Gas (LNG) shall be used when the reference scenario is based on **maritime** as a mode of transport.
- Diesel B0 shall be used when the reference scenario is based on road transport.

With regards to specific fuel consumption (i.e. fuel use per functional unit, $SC_{ref,t,y}$) applicants shall adopt the default values or estimate those based on the provided references as indicated in section 5.3.2.1, unless the average consumption of the reference aircraft, maritime vessel or road vehicle is expected to differ significantly from such standard values. In this case, applicants must provide appropriate references to justify all assumptions adopted and include this parameter in the monitoring plan.

Deviations in the specific fuel consumption in the reference scenario, must be duly justified and underpinned with robust evidence at the application stage. Failure to provide adequate justification may negatively impact the credibility of the GHG calculations and the resulting evaluation.

5.1.3 GHG emissions and additional non-CO_2 climate impacts for mobility projects

The methodology for mobility projects considers the greenhouse gases (GHGs) covered by section 1.1.6, including non-CO_2 GHGs. In addition, the methodology for mobility projects considers the additional non-CO_2 climate impacts covered by section 1.1.8.

With respect to GHGs, the methodology for mobility projects accounts predominantly for the CO_2, CH_4 and N_2O emissions due to the combustion of fossil fuels, and for the CH_4 and N_2O emissions due to the combustion of biomass-derived fuels, renewable fuels of non-biological origin (RFNBOs), and low-carbon fuels.

With respect to additional non-CO_2 climate impacts, the methodology for mobility projects considers the warming impact associated with black carbon emissions from maritime transport and other non-CO_2 climate impacts from aviation, such as emissions by aircraft of water vapour, formation of contrails (condensation trails) and cloudiness in the wake of aircraft, nitrogen oxides (NOx), soot particles, and oxidised sulphur species.

5.1.3.1 Renewable fuels and low-carbon fuels

The mobility methodology allows projects to consider a zero-emission factor for the CO_2 emitted when combusting or using biomass-derived fuels, renewable fuels of non-biological origin (RFNBOs), and low-carbon fuels.

However, the emissions of non-CO_2 greenhouse gases (e.g. CH_4 and N_2O) associated to the combustion of such fuels must be considered within the term $Proj_{t,ene,y}$ (or $Proj_{t,ene,unit,y}$). following the provisions in sections 5.3.1.2 and 5.3.2.2. Furthermore, leakeage of fuels with a direct GHG impact, such as methane, must be considered within the term $Proj_{t,fug,y}$

(or $Proj_{t,fug,unit,y}$), following the provisions in section sections 5.3.1.2 and 5.3.2.2. No other emissions associated to the use of these fuels should be included in the calculations.

Concerning the definition of biomass-derived fuels, RFNBOs, and low-carbon fuels:

- For projects intending to use biomass-derived fuels, refer to section 1.4.4, and in particular to the sustainability requirements specified in section 1.4.4.1.
- RFNBOs are considered as defined in the Renewable Energy Directive 2018/2001 and its Delegated Regulations, and meeting the greenhouse gas emissions saving criteria set in Article 29a of RED.
- Low-carbon fuels are considered as defined in Directive 2024/1788 on common rules for the internal markets for renewable gas, natural gas and hydrogen.

For **projects that aim to provide a transportation service** (section 5.3.1), the applicant must credibly justify the assumptions made with respect to the classification of a fuel as biomass-derived fuel, RFNBO, or low-carbon fuel, for example by providing letter of supports from potential suppliers or other supporting documents. If the origin of the fuel is not known at the time of the application, and/or if its origin cannot be credibly justified, then the fuel should be considered of fossil origin. Failure to provide adequate justification may affect the quality of the GHG calculations and the resulting evaluation. In addition, the applicants must propose adequate monitoring measures in their monitoring plan (see section 1.5 and Appendix 4) to ensure adequate monitoring and reporting of the assumptions made at the application stage. Failure to provide an adequate monitoring plan may negatively affect the quality of the GHG calculations, and the resulting evaluation. During project implementation, failure to demonstrate that the assumptions made at the application stage are representative of the actual operation of the project, may affect the overall GHG emission avoidance that can be achieved, which may have consequences in terms of grant disbursement as specified in the Call Text (see also section 1.1.9).

For **projects that aim at manufacturing innovative aircraft, maritime vessels, road vehicles, or their components**, the applicant must credibly justify the assumptions made with respect to the fuel used by the aircraft, vessel, or vehicle based on credible operational assumptions and technical specifications. The applicant shall not assume that the consumer product equipped with a component manufactured by the project will have better performance, consume less fuel, or consume a fuel different than the reference fuels mix, unless this is a direct consequence of the installation of the innovative component manufactured by the project. The operation assumptions made, must be representative of the expected use of the component and consumer product. For example, for the case of dual-fuel engines, credible assumptions should be taken with respect to the expected fuel mix, and period over which the engine will operate on biomass-derived fuels, RFNBOs, and low-carbon fuels as opposed to fossil fuels. Failure to provide adequate justification may affect the quality of the GHG calculations and the resulting evaluation. In case the actual user of the innovative components produced during project implementation differs from, or is not compatible with, the intended use specified in the application, the project may not be able to reach the expected GHG emission avoidance, with potential implications on grant disbursement as specified in the Call Text (see also section 1.3.6).

The provisions in this sub-section are not relevant for the case of hydrogen used as a fuel by a mobility project, for which an emission factor of zero applies, as specified inTable 1.4 section 1.4.3.2.

5.1.3.2 Additional non-CO_2 climate impacts for aviation activities

For aviation, the approach for the calculation of non-CO_2 climate impacts, detailed in section 5.3, is aligned to an overall climate impact in the range from 2 to 4 times the radiative forcing from CO_2 alone, recognised by the IPCC in its special report on Aviation and Global Atmosphere.

In the reference scenario, the additional non-CO_2 climate impacts from aviation shall be assumed equal to 2 times the CO_2 emissions from jet A1 fuel combustion, corresponding to an overall climate impact equal to 3 times the radiative forcing from CO_2 alone. Applicants may opt to decouple the calculation of additional non-CO_2 climate impacts from aviation from the single factor of fuel use if, and only if, they rely on data monitored according to the Monitoring, Reporting, and Verification (MRV) framework for additional non-CO_2 climate impacts from aviation under the EU ETS, should that be available at the time of their application.

In the project scenario, applicants must calculate this term using a well-justified approach based on scientific literature, or by modelling global near surface temperature change. Alternatively, applicants can use data compliant with the MRV framework for additional non-CO_2 climate impacts from aviation under the EU ETS, should that be available at the time of their application, and if the same approach is used also for the reference scenario.

Any claimed reduction of additional non-CO_2 climate impacts from aviation activities must be a direct consequence of the innovation proposed by the project. This means that applicants are not allowed to claim a reduction in additional non-CO_2 climate impacts that only result from the adoption of a different calculation method between the reference and the project scenario. Similarly, for the case of projects aiming at manufacturing aircrafts and their components, the applicant shall not assume that the aircraft equipped with a component manufactured by the project will have better performance in terms of additional non-CO_2 climate impacts with respect to the reference scenario, unless the use of the component is part of the IF project and/or savings in terms of additional non-CO2 climate impacts are a direct consequence of the installation of the innovative component manufactured by the project.

5.2 System boundaries

The emission sources that shall be included within the boundaries of the calculations for mobility projects, and those that shall not be considered, are specified in Table 5.1.

Table 5.1. Emission sources included in or excluded from the boundaries of the GHG emission avoidance calculation for aviation, maritime and road transport activities

Source		Included in any topic except small-scale	Included in small-scale topic
Reference (Ref)	GHG emissions due to the use of one or more sources of energy in the various modes of transportation, for the delivery of the same transport services provided by the innovative project. ($Ref_{t,ene}$ or $Ref_{t,ene,unit}$).	Yes	Yes
	Fugitive GHG emissions due to intentional (venting) or non-intentional (leakage) releases of gases, such of as methane, that will occur in the absence of the project activity due to maritime or road transportation activities ($Ref_{t,fug}$ or $Ref_{t,fug,unit}$)	Yes	Yes
	Additional non-CO_2 climate impacts from aviation and maritime activities that would occur in the absence of the project ($Ref_{t,AddnonCO2}$ or $Ref_{t,AddnonCO2,unit}$). .	Yes	Yes

Source		Included in any topic except small-scale	Included in small-scale topic
	GHG emissions due to the energy use in the supporting infrastructure for aviation and maritime activities, for the delivery of the same transport services provided by the innovative project. This includes combustion of fossil or other fuels, use of electricity, that in the absence of the project activity would be consumed in the infrastructure that support the operation of the journeys covered by the project ($Ref_{infra,ene}$).	Optional[39]	Optional[39]
	GHG emissions due to the energy use in the supporting infrastructure for road transport activities, in the reference scenario, for the delivery of the same transport services provided by the innovative project.	No	No
Project (Proj)	GHG emissions due to the energy use that will be consumed in aviation, maritime or road transportation activity proposed by the project ($Proj_{t,ene}$ or $Proj_{t,ene,unit}$) This includes (including their share in blends): ▪ Fossil fuels ▪ Biomass-derived fuels ▪ RFNBOs ▪ Low-Carbon Fuels ▪ Heat ▪ Electricity ▪ Hydrogen	Yes	Partial[40]
	Fugitive emissions due to intentional (venting) or non-intentional (leakage) releases of gases, such of as methane, that will occur in the proposed in the project activity due to maritime or road transportation activities ($Proj_{t,fug}$ or $Proj_{t,fug,unit}$)	Yes	Yes
	Additional non-CO_2 climate impacts from aviation and maritime activities that will occur in the project scenario ($Proj_{t,nonCO2}$. or $Proj_{t, nonCO2,unit}$).	Yes	Yes
	GHG emissions due to the energy use in the supporting infrastructure for aviation and maritime activities, in the innovative project. This includes combustion of fossil or other fuels, use of electricity, that is proposed to be consumed in the infrastructure in the project activity to support the operation of the journeys covered by the project ($Proj_{infra,ene}$)	Optional[39]	Optional[39]

[39] Should the applicant wish to include emissions from aviation and maritime infrastructure in the calculation of absolute GHG avoidance, these shall be included in both the reference and project scenarios, and the corresponding parameters shall be included in the MRV plan. Emissions from transport infrastructure shall not be included.

[40] **Projects submitted under the small-scale topic** are exempted from considering emissions from biomass-derived fuels, RFNBOs, and low-carbon fuels.

Source		Included in any topic except small-scale	Included in small-scale topic
	GHG emissions due to the energy use in the supporting infrastructure for road transport activities, in the innovative project.	No	No

Source: European Commission internal elaboration.

5.3 Calculation of reference and project emissions

The equations to be applied for the calculation of the reference and project emissions of **projects that aim to provide a transport service as their principal product** are specified in section 5.3.1.

Projects aiming to build a plant for the **manufacturing of innovative aircraft, vessels, road vehicles or their components** shall calculate their absolute GHG emission avoidance according to section 5.3.2.

5.3.1 Projects that aim to provide a transport service as their principal product.

Equations [5.1] and [5.2] define the parameters that shall be included in the calculation of the Absolute GHG emissions avoidance for projects that aim to provide a transport service as their principal product.

Projects envisaging a combination of one or more modes of transport shall calculate the emissions associated to each mode individually, before adding them up. In case the project involves more than one type of aircraft, maritime vessel, or road vehicle within the same transport mode, applicants shall calculate the emissions associated to each type of aircraft, maritime vessel, and road vehicle individually, before adding them up.

The number and type of transport mode considered, and the number and type of aircrafts, maritime vessels, and road vehicles considered, may be different in the project scenario and in the reference scenario, when allowed by the provisions in section 5.1.2.1.

Parameter	=	Equation	
Ref_y	=	$\sum_{t=1}^{T} (Ref_{t,ene,y} + Ref_{t,fug,y} + Ref_{t,AddnonCO2,y}) + Ref_{infra,y}$	[5.1]
$Proj_y$	=	$\sum_{t=1}^{T} (Proj_{t,ene,y} + Proj_{t,fug,y} + Proj_{t,AddnonCO2,y}) + Proj_{infra,y}$	[5.2]

Where:

$Ref_{t,ene,y}$ = GHG emissions due to the use of one or more sources of energy in mode of transportation type t, for the delivery of the same transport services provided by the innovative project, that in the absence of the project activity would be consumed for the operation of the journeys covered by the project, in year y, in tonnes CO_2e. Calculated according to equation [5.3].

$Ref_{t,fug,y}$ = Fugitive GHG emissions due to intentional (venting) or non-intentional (leakage) releases of gases in road transport or maritime modes of transportation, that will occur in the absence of the project activity for the delivery of corresponding transportation services, in year y, in tonnes CO_2e. Calculated according to equation [5.4].

$Ref_{t,AddnonCO2,y}$ = additional non-CO_2 climate impacts that would occur in the absence of the project activity in maritime and/or aviation transportation for the delivery of corresponding transportation services, in year y, in tonnes CO_2e. Calculated according to equation [5.5]. This includes black carbon emissions from maritime transport and other non-CO_2 climate impacts from aviation.

$Ref_{infra,y}$ = GHG emissions due to the use of one or more sources of energy in the supporting infrastructure for aviation or maritime transport, for the delivery of the same transport services provided by the innovative project, in year y, in tonnes CO_2e. Calculated according to equation [5.6].

$Proj_{t,ene,y}$ = GHG emissions due to the use of one or more sources of energy in mode of transportation type t, proposed by the project activity and which, alone or in combination with other modes of transportation, replaces corresponding services, in year y, in tonnes CO_2e. Calculated according to equation [5.7].

$Proj_{t,fug,y}$ = Fugitive GHG emissions due to intentional (venting) or non-intentional (leakage) releases of gases, such of as methane, that will occur in the operation of road or maritime transportation in the project activity, in year y, in tonnes CO_2e. Calculated according to equation [5.8]. Projects not envisaging the use of these modes of transportation may omit this parameter.

$Proj_{t,AddnonCO2,y}$ = additional non-CO_2 climate impacts that will occur in the project activity due to the operation of air and/or water transportation, in year y, in tonnes CO_2e. Calculated according to equation [5.9]. This includes black carbon emissions from maritime transport and other non-CO_2 climate impacts from aviation.

$Proj_{infra,y}$ = GHG emissions due to use or one of more sources of energy in the infrastructure that supports the operation of the aviation or maritime journeys covered by the project, in year y, in tonnes CO_2e. Calculated according to equation [5.10].

t = mode of transportation type t used, including aviation (t=a), maritime (t=m), and road transport (t=r).

T = number of transport modes considered. The number and types of modes of transportation may differ between reference and project scenarios, when allowed by the provisions in section 5.1.2.1.

y = year of the operation of the project.

5.3.1.1 Reference emissions sub-equations

Parameter	=	Equation	
$Ref_{t,ene,y}$	=	Defined for each mode of transport t in the equations below: aviation (t=a), maritime (t=m), road (t=r).	[5.3]
$Ref_{a,ene,y}$	=	$Q_{ref,a,y} * EF_{jetA1}$	[5.3a]
$Ref_{m,ene,y}$	=	$Q_{ref,m,y} * EF_{MRF}$	[5.3b]
$Ref_{r,ene,y}$	=	$Q_{ref,r,y} * EF_{diesel}$	[5.3c]
$Ref_{t,fug,y}$	=	$\sum_{z=1}^{Z} Q_{ref,t,fug,z,y} * GWP_z$	[5.4]
$Ref_{t,AddnonCO2,y}$	=	Defined for each mode of transport t in the equations below: aviation (t=a), maritime (t=m).	[5.5]
$Ref_{a,AddnonCO2,y}$	=	$2 * Q_{ref,a,FF,y} * EF_{CO2,jetA1}$	[5.5a]
$Ref_{m,AddnonCO2,y}$	=	$Q_{ref,m,BC,y} * GWP_{BC}$	[5.5b]

Parameter	=	Equation	
$Ref_{infra,y}$	=	$\sum_{x=1}^{X} (Q_{ref,infra,x,y} * EF_x)$	[5.6]

Where:

$Q_{ref,t,y}$ = Quantity of energy used in mode of transportation type t consumed for the operation of journeys that will be reduced and/or replaced with other energy sources in the project activity, in year y, in TJ. For the proposal, this shall be estimated by the applicant based on the total transport distances and volumes of goods and passengers and the planned operation of the corresponding reference transport fleet in the reference scenario.

EF_{jetA1} = Emission factor due to the consumption of jet kerosene type A1, in tonnes CO_2e/TJ. The appropriate EF presented in Table 5.2 shall be applied.

EF_{MRF} = Emission factor due to the consumption of the maritime reference fuel oil, in tonnes CO_2e/TJ. The appropriate EF presented in Table 5.2 shall be applied.

EF_{diesel} = Emission factor due to the consumption of diesel, in tonnes CO_2e/TJ. The appropriate EF presented in Table 5.2 shall be applied.

$Q_{ref,t,fug,z,y}$ = Quantity of fugitive emissions due to intentional (venting) or non-intentional (leakage) releases of greenhouse gas type z in year y in the reference scenario for the delivery of the same transport services as provided by the innovative project, in tonnes. In particular, this covers slippage of methane and nitrous oxide. For the proposal, this shall be estimated by the applicant based on the total transport distances and volumes of goods and passengers and the planned operation of the corresponding reference transport fleet in the reference scenario.

GWP_z = Global Warming Potential of the fugitive greenhouse gas z in tonnes CO_2e/tonne. For all GWPs covered by EU regulation, see section 1.1.6.

$Q_{ref,a,FF,y}$ = Quantity of conventional aviation fuel consumed for the operation of flights that will be reduced and/or replaced with other energy sources in the project activity, in year y, in TJ. Applicants may opt to decouple the calculation of non-CO_2 effects of flights from the single factor of fuel use if, and only if, actual data monitored according to the Monitoring, Reporting, and Verification (MRV) framework for additional non-CO_2 climate impacts for aviation under the EU ETS is available at the time of their application. Not applicable to modes of transportation other than aviation.

$EF_{CO2,jetA1}$ = CO_2 emission factor due to the combustion of the jet A-1, in tCO_2/TJ. The applicable EF presented in Table 5.2 shall be applied. Not applicable to modes of transport other than aviation.

$Q_{ref,m,BC,y}$ = Quantity of emissions of black carbon from maritime vessels in the reference scenario for the delivery of the same transport services as provided by the innovative project in year y, in tonnes of black carbon. This shall be estimated by the applicant using the Fourth IMO GHG Study[41] as a reference. Not applicable to modes of transportation other than maritime.

GWP_{BC} = Global Warming Potential of black carbon, in tonnes CO_2e/tonne of black carbon. The applicable GWP is presented in Table 5.2. The GWP provided in Table 5.2 is a global average, which is used to provide a level-playing field between potential applicants, in spite of the potential diverging impacts due to, for instance, shipping routes.

$Q_{ref,infra,x,y}$ = Quantity of energy type x used at infrastructure facilities that are replaced by the innovative project in year y, in TJ. This may include fuels consumed at the supporting infrastructure (e.g. airports, ports). For the proposal, this shall be estimated by the applicant based on the total transport distances and volumes of goods and passengers and the planned operation of the infrastructure that serves the corresponding reference transport fleet in the reference scenario, evidenced by information from credible sources. Not applicable for road transport infrastructure.

[41] The Fourth IMO GHG Study is available online at: https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Fourth%20IMO%20GHG%20Study%202020%20-%20Full%20report%20and%20annexes.pdf

EF_x = Emission factor due to the consumption of the energy source type x, in tonnes CO_2e/TJ. The applicable EF presented in Table 5.2 shall be applied.

t = mode of transportation type t used, including aviation (t=a), maritime (t=m), and road transport (t=r).

x = type of energy source used in the reference scenario. This includes any of the energy sources specified in section 5.2.

z = type of fugitive greenhouse gases considered in the reference scenario.

X = number of energy types considered in the reference scenario. This includes all energy types being used in the reference scenario, independently of their use in the project scenario.

Z = number of fugitive greenhouse gases considered in the reference scenario.

5.3.1.2 Project emissions sub-equations

Parameter	=	Equation	
$Proj_{t,ene,y}$	=	$\sum_{x=1}^{X} (Q_{proj,t,x,y} * EF_x)$	[5.7]
$Proj_{t,fug,y}$	=	$\sum_{z=1}^{Z} Q_{proj,t,fug,z,y} * GWP_z$	[5.8]
$Proj_{t,AddnonCO2,y}$	=	Defined for each mode of transport t in the equations below: aviation (t=a), maritime (t=m).	[5.9]
$Proj_{a,AddnonCO2,y}$	=	Refer to section 5.1.3.2	[5.9a]
$Proj_{m,AddnonCO2,y}$	=	$Q_{proj,m,BC,y} * GWP_{BC}$	[5.9b]
$Proj_{infra,x,y}$	=	$\sum_{x=1}^{X} (Q_{proj,infra,x,y} * EF_x)$	[5.10]

Where:

$Q_{proj,t,x,y}$ = Quantity of energy source type x used in mode of transportation type t consumed for the operation of journeys as part of the project activity, in year y, in TJ.

EF_x = Emission factor due to the consumption of the energy source type x, in tonnes CO_2e/TJ. The applicable EF presented in Table 5.2 shall be applied, even if (some of) the CO_2 from fuel combustion will be captured – credit for carbon capture is given through the CC_{credit} term in equation [1.1].

$Q_{proj,t,fug,z,y}$ = Quantity of fugitive emissions due to intentional (venting) or non-intentional (leakage) releases of greenhouse gas type z estimated to occur in the project scenario, in year y, in tonnes. In particular, this covers slippage of methane and nitrous oxide. For the proposal, this shall be estimated by the applicant based on the total transport distances and volumes of goods and passengers and the planned operation of the corresponding vehicle fleet in the reference scenario. For fugitive emissions lower than in the reference case, the applicant needs to provide sufficient evidence for their mitigation by the project.

GWP_z = Global Warming Potential of the fugitive greenhouse gas type GHG in tonnes CO_2e/tonne. For all GWPs covered by EU regulation, see section 1.1.6.

$Proj_{a,AddnonCO2,y}$ = Additional non-CO_2 climate impacts for aviation activities, in year y, refer to section 5.1.3.2.

$Q_{proj,m,BC,y}$ = Quantity of emissions of black carbon from maritime vessels in the project scenario in year y, in tonnes of black carbon. This shall be estimated by the applicant using the Fourth IMO GHG Study[42] as a reference. Not applicable to modes of transport other than maritime.

GWP_{BC} = Global Warming Potential of black carbon, in tonnes CO_2e/tonne of black carbon. The applicable GWP is presented in Table 5.2. The GWP provided in Table 5.2 is a global average, which is used to provide a level-playing field between potential applicants, in spite of the potential diverging impacts due to, for instance, shipping routes.

$Q_{proj,infra,x,y}$ = Quantity of energy type x used at infrastructure facilities that will be used in the project scenario in year y, in TJ. This shall include fuels consumed at the supporting infrastructure (e.g. airports and ports). Not applicable for road transport infrastructure.

t = mode of transportation type t used, including aviation (t=a), maritime (t=m), and road transport (t=r).

x = type of energy source used in the project scenario. This includes include energy sources specified in section 5.2.

z = type of fugitive greenhouse gases considered in the project scenario.

X = number of energy types used in the project scenario.

Z = number of fugitive greenhouse gases considered in the project scenario.

5.3.2 Manufacturing of innovative aircraft, maritime vessels, road vehicles or their components

Projects aiming at manufacturing innovative aircraft, maritime vessels, road transport vehicles, or their components, shall calculate their GHG emissions avoidance based on the use phase of the manufactured aircraft, maritime vessel, road vehicle or component. As such, project emissions will be based on the emissions that the innovative aircraft, maritime vessel or road transport vehicle will emit when in operation.

These emissions shall be estimated based on credible assumptions and underpinned with robust justification on the projected performance of the component produced as well as of other components that will be needed for the final assembly of the aircraft, maritime vessel, or road transport vehicle. Refer to section 1.3 for general provisions for manufacturing projects, and to section 1.3.6 for further guidance on related assumptions.

Equations [5.11] and [5.12] below define the parameters that shall be included in the calculation of the Absolute GHG emissions avoidance for projects aiming at manufacturing innovative aircraft, maritime vessels, road transport vehicles, or their components.

Projects envisaging a combination of one or more modes of transport shall calculate the emissions associated to each mode individually, before adding them up. In case the project involves more than one type of aircraft, maritime vessel, or road vehicle within the same transport mode, applicants shall calculate the emissions associated to each type of aircraft, maritime vessel, and road vehicle individually, before adding them up.

The number and type of transport modes considered, and the number and type of aircrafts, maritime vessels, and road vehicles considered, must be the same in the reference and project scenario for manufacturing projects, as specified in section 5.1.2.1.

[42] The Fourth IMO GHG Study is available online at: https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Fourth%20IMO%20GHG%20Study%202020%20-%20Full%20report%20and%20annexes.pdf

Parameter	=	Equation	
Ref_y	=	$\sum_{t=1}^{T}$ $N_{t,y}$ * UP * CS_t * $D_{ref,t}$ * ($Ref_{t,ene,unit,y}$ + $Ref_{t, fug,unit,y}$ + $Ref_{t,AddnonCO2,unit,y}$)	[5.11]
$Proj_y$	=	$\sum_{t=1}^{T}$ $N_{t,y}$ * UP * CS_t * $D_{proj,t}$ * ($Proj_{t,ene,unit,y}$ + $Proj_{t,fug,unit,y}$ + $Proj_{t,AddnonCO2,unit,y}$)	[5.12]

Where:

$Ref_{t,ene,unit,y}$ = GHG emissions due to the use of one or more types of energy in mode of transportation type t, for the operation of a corresponding conventional aircraft, maritime vessel or road transport vehicle that will be replaced by an innovative aircraft, maritime vessel or road vehicle manufactured by the project in year y, or replaced by an aircraft, maritime vessel, or road vehicle equipped with an innovative component manufactured by the project in year y. In tonnes CO_2e / (km * year of use of the innovative technology). Calculated according to equation [5.13].

$Ref_{t,fug,unit,y}$ = Fugitive GHG emissions due to intentional (venting) or non-intentional (leakage) releases of gases, that will occur in the operation of a corresponding conventional vessel or road transport vehicle that will be replaced by an innovative aircraft, maritime vessel or road vehicle manufactured by the project in year y, or replaced by an aircraft, maritime vessel, or road vehicle equipped with an innovative component manufactured by the project in year y. In tonnes CO_2e / (km * year of use of the innovative technology). Calculated according to equation [5.14].

$Ref_{t,AddnonCO2,unit,y}$ = additional climate impacts due to the non-CO_2 effects that would occur for the operation of a corresponding conventional aircraft or maritime vessel that will be replaced by an innovative aircraft, maritime vessel or road vehicle manufactured by the project in year y, or replaced by an aircraft, maritime vessel, or road vehicle equipped with an innovative component manufactured by the project in year y. In tonnes CO_2e / (km * year of use of the innovative technology). Calculated according to equation [5.15]. This includes black carbon emissions from maritime transport and other non-CO2 climate impacts from aviation.

$Proj_{t,ene,unit,y}$ = GHG emissions due to the use of one or more sources of energy in an innovative aircraft, maritime vessel or road vehicle manufactured by the project in year y, or in an aircraft, maritime vessel or road vehicle equipped with an innovative component manufactured by the project in year y. In tonnes CO_2e / (km * year of use of the innovative technology). Calculated according to equation [5.16].

$Proj_{t,fug,unit,y}$ = Fugitive GHG emissions due to intentional (venting) or non-intentional (leakage) releases of gases in an innovative maritime vessel or road vehicle manufactured by the project in year y, or in a maritime vessel or road vehicle equipped with an innovative componentmanufactured by the project in year y. In tonnes CO_2e / (km * year of use of the innovative technology). Calculated according to equation [5.17]. Projects not envisaging the manufacturing of road vehicles or maritime vessels, or their components, may omit this parameter.

$Proj_{t,AddnonCO2,unit,y}$ = additional non-CO_2 climate impacts due to the use of an innovative aircraft or maritime vessel manufactured by the project in year y, or due to the use of an aircraft of maritime vessel that is equipped with an innovative component manufactured by the project in year y. In tonnes CO_2e / (km * year of use of the innovative technology). Calculated according to equation [5.18]. This includes black carbon emissions from maritime transport and other non-CO_2 climate impacts from aviation.

CS_t = cost share of the innovative component for the mode of transport of type "t" to be manufactured as a fraction of the total capital cost cost or retail price of the entire aircraft, maritime vessel or road vehicle, as defined in section 1.3.5. Applicants must provide appropriate references and justifications to substantiate this cost assessment. A cost share of 100% should be applied for projects aiming to manufacture an entire fully operational aircraft, maritime vessel or road vehicle.

$N_{t,y}$ = number of innovative aircrafts, maritime vessels road vehicles, or their components manufactured and supplied to the market by the proposed manufacturing project in year y. Estimates shall be based on the expected output of the manufacturing plant and the market potential, and must be consistent with the assumptions adopted in other parts of the application, such as those used to support the financial calculations.

UP = Applicable use period of the aircraft, maritime vessel, road vehicle, or component manufactured by the project, as defined in section 1.3.4. The use period is equal to a maximum of 5 years, or to the lifetime of the aircraft, maritime vessel, road vehicle, or component manufactured by the project, if its lifetime is shorter than five years.

$D_{ref,t}$ = annual average distance travelled by a conventional aircraft, maritime vessel or vehicle (i.e. mode of transport of type t) in the reference scenario. In km per year of use of the innovative technology. The value presented in Table 5.2 shall be applied. Deviations from the default values require a clear and credible justification and sufficient evidence of why this is necessary.

$D_{proj,t}$ = annual average distance travelled by an innovative aircraft, maritime vessel or road vehicle manufactured by the project (i.e. mode of transport of type t), or one that is equipped with an innovative component manufactured by the project. In km per year of use of the innovative technology. Applicants shall adopt the same values used for $D_{ref,t}$.

t = mode of transport of type t used, including aviation (t=a), maritime (t=m), and road transport (t=r).

T = number of modes of transport considered. It must be the same in the reference and project scenario.

y = year of operation of the manufacturing project.

5.3.2.1 *Reference emissions sub-equations*

Parameter	=	Equation	
$Ref_{t,ene,unit,y}$	=	Defined for each mode of transport t in the equations below: aviation (t=a), maritime (t=m), road transport (t=r).	[5.13]
$Ref_{a,ene,unit,y}$	=	$SC_{ref,a,y} * EF_{jetA1}$	[5.13a]
$Ref_{m,ene,unit,y}$	=	$SC_{ref,m,y} * EF_{MRF}$	[5.13b]
$Ref_{r,ene,unit,y}$	=	$SC_{ref,r,y} * EF_{diesel} = SC_{proj,r,y} * EER * EF_{diesel}$	[5.13c]
$Ref_{t,fug,unit,y}$	=	$\sum_{z=1}^{Z} SE_{ref,t,fug,z,y} * GWP_z$	[5.14]
$Ref_{t,AddnonCO2,unit,y}$	=	Defined for each mode of transport t in the equations below: aviation (t=a), maritime (t=m).	[5.15]
$Ref_{a,AddnonCO2,unit,y}$	=	$2 * SC_{ref,a,FF,y} * EF_{CO2,jetA1}$	[5.15a]
$Ref_{m,AddnonCO2,unit,y}$	=	$SE_{ref,m,,BC,y} * GWP_{BC}$	[5.15b]

Where:

$SC_{ref,t,y}$ = Specific consumption of energy in mode of transportation type t for the operation of one conventional aircraft (a), maritime vessel (m) or road vehicle (r) that will be replaced by an innovative aircraft, maritime vessel, or road vehicle manufactured by the project in year y, or one equipped with an innovative component manufactured by the project in year y, in TJ /km. Should the project scenario involve the manufacturing of innovative road vehicles or their components, then $SC_{ref,r,y} = SC_{proj,r,y} * EER$, with both terms defined below. For all other cases, refer to Table 5.2 for the applicable specific consumption to be applied or guidance for its calculation.

$SC_{proj,r,x,y}$ = Specific consumption of energy for the operation of one road vehicle equipped with an innovative component produced by the project in year y, in TJ / km. Estimated based on forecasted energy use that the entire vehicle will require.

EER = Energy Efficiency Ratio, which accounts for change in vehicle energy efficiency. For the energy efficiency ratio, the value presented in Table 5.2 shall be applied as the default case.

EF_{jetA1} = Emission factor due to the consumption of jet kerosene type A1, in tonnes CO_2e/TJ. The appropriate EF presented in Table 5.2 shall be applied.

EF_{MRF} = Emission factor due to the consumption of the maritime reference fuel oil, in tonnes CO_2e/TJ. The appropriate EF presented in Table 5.2 shall be applied.

EF_{diesel} = Emission factor due to the consumption of diesel, in tonnes CO_2e/TJ. The appropriate EF presented in Table 5.2 shall be applied.

$SE_{ref,t,fug,z,y}$ = Specific fugitive emissions due to intentional (venting) or non-intentional (leakage) releases of greenhouse gas type "z" for the operation of one conventional maritime vessel or road vehicle that will be replaced by the project activity in year y, in tonnes of gas / km.

GWP_z = Global Warming Potential of the fugitive greenhouse gas "z" in tonnes CO_2e/ tonne of gas. For all GWPs covered by EU regulation, see section 1.1.6.

$SC_{ref,a,FF,y}$ = Specific consumption of conventional aviation fuel for the operation of one conventional aircraft that will be replaced with an innovative aircraft, maritime vessel or road vehicle manufactured by the project in year y, or one equipped with an innovative component manufactured by the project in year y, in TJ / km. Applicants shall use the values indicated in Table 5.2. Applicants may opt to decouple the calculation of non-CO_2 effects of flights from the single factor of fuel use if, and only if, actual data monitored according to the Monitoring, Reporting, and Verification (MRV) framework for additional non-CO_2 climate impacts for aviation under the EU ETS is available at the time of their application. Not applicable to modes of transport other than aviation.

$EF_{CO2,jetA1}$ = CO_2 emission factor due to the combustion of the jet A-1, in tonnes CO_2/TJ. The applicable EF presented in Table 5.2 shall be applied.

$SE_{ref,m,BC,y}$ = Specific emissions of black carbon from the operation of one conventional maritime vessel that will be replaced by an innovative aircraft, maritime vessel or road vehicle manufactured by the project in year y, or by one equipped with an innovative component manufactured by the project in year y, in tonnes of black carbon / km. This shall be estimated by the applicant using the Fourth IMO GHG Study[43] as a reference. Not applicable to modes of transport other than maritime.

GWP_{BC} = Global Warming Potential of black carbon, in tonnes of CO_2e/tonne of black carbon. The applicable GWP is presented in Table 5.2. The GWP provided in Table 5.2 is a global average, which is used to provide a level-playing field between potential applicants, in spite of the potential diverging impacts due to, for instance, shipping routes.

t = mode of transportation type t used, including aviation (t=a), maritime (t=m), and road transport (t=r).

z = type of fugitive greenhouse gases considered in the reference scenario.

Z = number of greenhouse gases considered.

5.3.2.2 *Project emissions sub-equations*

Parameter	=	Equation	
$Proj_{t,ene,unit,x,y}$	=	$\sum_{x=1}^{X} (SC_{proj,t,x,y} * EF_x)$	[5.16]

[43] The Fourth IMO GHG Study is available online at: https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Fourth%20IMO%20GHG%20Study%202020%20-%20Full%20report%20and%20annexes.pdf

Parameter	=	Equation	
$Proj_{t,fug,unit,y}$	=	$\sum_{z=1}^{Z} SE_{proj,t,fug,z,y} * GWP_{z\ y}$	[5.17]
$Proj_{t,AddnonCO2,unit,y}$	=	Defined for each mode of transport t in the equations below: aviation (t=a), maritime (t=m).	[5.18]
$Proj_{a,AddnonCO2,unit,y}$	=	Refer to section 5.1.3.2	[5.18a]
$Proj_{m,AddnonCO2,unit,y}$	=	$SE_{proj,m,BC\ ,y} * GWP_{BC}$	[5.18b]

Where:

$SC_{proj,t,x,y}$ = Specific consumption of energy source type x in mode of transportation type t for the operation of one innovative aircraft, maritime vessel or road vehicle manufactured by the project in year y, or one equipped with an innovative component manufactured by the project in year y, in TJ / km. Estimated based on forecasted energy use that the innovative technology(ies) or component(s) will require when implemented, which shall be duly justified and underpinned with robust evidence.

EF_x = Emission factor due to the consumption of the energy source type x, in tonnes CO_2e/TJ. The applicable EF presented in Table 5.2 shall be applied.

$SE_{proj,t,fug,z,y}$ = Specific fugitive emissions due to intentional (venting) or non-intentional (leakage) releases of greenhouse gas type z for the operation of one innovative maritime vessel or road vehicle manufactured by the project in year y, or one equipped with an innovative componentmanufactured by the project in year y, in tonnes of gas / km. Estimated based on forecasted fugitive emissions that the innovative technology(ies) or component(s) will result in when implemented, which shall be duly justified and underpinned with robust evidence.

GWP_z = Global Warming Potential of the fugitive greenhouse gas z in tonnes CO_2e/tonne of gas. For all GWPs covered by EU regulation, see section 1.1.6.

$Proj_{a,AddnonCO2,unit,y}$ = additional non-CO_2 climate impacts from the use of one innovative aircraft manufactured by the project in year y, or one equipped with an innovative component manufactured by the project in year y, in tonnes CO_2e / km. Refer to section 5.1.3.2.

$SE_{proj,m,BC,y}$ = Specific emissions of black carbon from one innovative vessel manufactured by the project in year y, or one equipped with an innovative component produced by the project in year y, in tonnes of black carbon / km. This shall be estimated by the applicant using the Fourth IMO GHG Study[44] as a reference. Not applicable to modes of transport other than maritime.

GWP_{BC} = Global Warming Potential of black carbon, in tonnes CO_2e/tonne of black carbon. The applicable GWP is presented in Table 5.2. The GWP provided in Table 5.2 is a global average, which is used to provide a level-playing field between potential applicants, in spite of the potential diverging impacts due to, for instance, shipping routes.

t = mode of transportation type t used, including aviation (t=a), maritime (t=m), and road transport (t=r).

x = type of energy source used in the project scenario. This includes include energy sources specified in section 5.2.

z = type of fugitive greenhouse gases considered in the project scenario.

X = number of energy types used in the project scenario.

Z = number of fugitive greenhouse gases considered.

[44] The Fourth IMO GHG Study is available online at: https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Fourth%20IMO%20GHG%20Study%202020%20-%20Full%20report%20and%20annexes.pdf

5.4 Relative GHG emissions avoidance

Refer to section 1.1.4 for Guidance on the calculation of ΔGHG_{rel}.

5.5 Data and parameters

Table 5.2 presents the parameters that will be deemed as constant throughout the duration of the project, unless otherwise stated. Emission factors are on a NCV basis and have been rounded to the fourth decimal.

For emission or conversion factors not listed here, refer to the hierarchy of sources in Appendix 1.

Table 5.2. Parameters not to be monitored

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
Energy	0.0036	TJ/MWh	Conversion factor		Applies to all fuels
Energy	0.001	GJ/MJ	Conversion factor		Applies to all fuels
EF_{MRF}	77.50	tonne CO_2e/TJ	GHG emission factor for combustion of maritime reference fuel oil	Calculation based on data reported for the year 2020 under Regulation 2015/757 on the monitoring, reporting and verification of carbon dioxide emissions from maritime transport	
EF_{jetA1}	72.0	tonne CO_2e/TJ	GHG emission factor due to the combustion of jet A-1 kerosene	2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2. (EF) and IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (GWP)	

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
$EF_{CO2,jetA1}$	71.5	tonne CO_2e/TJ	CO_2 emission factor for the combustion of jet A-1 kerosene	Same as above	For use in the calculation of additional non-CO_2 climate impacts only
EF_{avgas}	70.5	tonne CO_2e/TJ	GHG emission factor for the combustion of aviation gasoline	Same as above	
EF_{NG}	59.50	tonne CO_2e/TJ	GHG emission factor for combustion of natural gas	Same as above	Based on the most conservative EF for CH_4 and/or N_2O
EF_{LPG}	64.90	tonne CO_2e/TJ	GHG emission factor for combustion of liquefied petroleum gas	Same as above	Based on the most conservative EF for CH_4 and/or N_2O
$EF_{gasoline}$	73.20	tonne CO_2e/TJ	GHG emission factor for the combustion of gasoline	Same as above	Based on the most conservative EF for CH_4 and/or N_2O
EF_{diesel}	75.20	tonne CO_2e/TJ	GHG emission factor for combustion of diesel B0	Same as above	Based on the most conservative EF for CH_4 and/or N_2O
EF_{bio}	0.70	tonne CO_2e/TJ	Non-CO_2 GHG emission factor for the combustion of biomass-derived fuels	Same as above	Based on the most conservative values for combustion of biomass-derived fuels in mobile sources
EF_{H2}	0.00	tonne CO_2e/TJ	GHG emission factor for consumption of hydrogen	See Table 1.4	See Table 1.4
EF_{elec}	0.00	tonne CO_2e/TJ	GHG emission factor for electricity from the grid for both EU and non-EU countries	See Table 1.3	

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
EF_{RFNBO}	1.10	tonne CO_2e/TJ	Non-CO_2 GHG emission factor for combustion of renewable fuels of non-biological origin (RFNBO) other than hydrogen	EU Regulation on the use of renewable and low-carbon fuels in maritime transport	See section 5.1.3.1 for the definition of RFNBOs under the MOB category
$EF_{low\text{-}carbon\ fuel,y}$	1.10	tonne CO_2e/TJ	Non-CO_2 GHG emission factor for combustion of low-carbon fuels	Same as above	See section 5.1.3.1 for the definition of low-carbon fuels under the MOB category
$EF_{other\ ammonia}$	104.80	tonne CO_2e/TJ	GHG emission factor for combustion of ammonia not qualifying as biomass-derived fuel, RFNBO, or low-carbon fuel	Commission implementing Regulation (EU) 2021/447 of 12 March 2021	Benchmark value for 2021-2025
$EF_{other\ methanol}$	102.90	tonne CO_2e/TJ	GHG emission factor for combustion of methanol not qualifying as biomass-derived fuel, RFNBO, or low-carbon fuel	Regulation (EU) on the use of renewable and low-carbon fuels in maritime transport	Including the WtT emissions for natural-gas-based methanol and the defaults for non-CO_2 combustion emissions provided for e-methanol.
$EF_{other\ LNG}$	56.70	tonne CO_2e/TJ	GHG emission factor for combustion of liquefied natural gas not qualifying as low-carbon gas	Same as above	LNG slippage not included. The applicant needs to take the slippage into account under Ref_{other} and $Proj_{other}$.

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
EF_{MDO}	76.20	tonne CO_2e/TJ	GHG emission factor for combustion of marine diesel oil	Same as above	Calculated as the sum of CO_2, N_2O and CH_4 emissions using the GWP from the Annex to the Commission Delegated Regulation supplementing Regulation (EU) 2018/1999
EER_{BEV}	3	-	Energy efficiency ratio for a battery and catenary electric vehicle compared to a diesel ICE	By assumption, assuming a three times higher efficiency of battery electric vehicles compared to combustion engines	For hybrid engines, the efficiency ratio and the corresponding data source should be provided by the applicant and credibly justified and referenced.
EER_{FCEV}	1.75	-	Energy efficiency ratio for a fuel-cell electrical vehicle compared to a diesel ICE	By assumption, assuming a 1.75 times higher efficiency of fuel-cell electric vehicles compared to combustion engines.	For other types of innovative hydrogen engines, the efficiency ratio and the corresponding data source should be provided by the applicant and credibly justified and referenced.
GWP_{BC}	900	tonnes CO_2e/ tonne BC	100-year global warming potential of black carbon	Bond et al. (2013): Bounding the role of black carbon in the climate system: A scientific assessment. Journal of Geo-physical Research: Atmospheres, 118, 5380–5552, doi:10.1002/jgrd.50 171,	No official EU regulation on black carbon in place. Therefore, the scientific source usually referenced (for instance by the Fourth IMO GHG Study and the

Data / Parameter	**Value to be applied**	**Data unit**	**Description**	**Source of data**	**Assumption / Comment**
					ICCT) is used here.
$D_{ref,avi}$ (General Aviation)	68,714	km / year	Annual average distance travelled by an aircraft submodel "general aviation", in km.	European Union Aviation Safety Agency. Environmental Labelling for Aviation. Product Environmental Footprint Category Rules v1 and v2	Estimated based on the product of the Average annual number of flights (taking into account assumed operations, forecasted maintenance, and expected downtime) and the average flight distance (taking into account average historical scheduled flights distance for this type of aircraft). Reference aircraft C208
$D_{ref,avi}$ (Turboprop)	671,282	km / year	Annual average distance travelled by an aircraft submodel "turboprop", in km.	Same as above	As above. Reference aircraft AT75
$D_{ref,avi}$ (Regional jet)	969,550	km / year	Annual average distance travelled by an aircraft submodel "regional", in km.	Same as above	As above. Reference aircraft E190
$D_{ref,avi}$ (Single-Aisle or narrow-body)	2,093,381	km / year	Annual average distance travelled by an aircraft submodel "single-aisle or narrow-body", in km.	Same as above	As above. Reference aircraft A320
$D_{ref,avi}$ (Twin-Aisle or wide body)	5,461,404	km / year	Annual average distance travelled by an aircraft submodel "twin-aisle or wide body", in km.	Same as above	As above. Reference aircraft B77W

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
$D_{ref,mar}$	To be derived from table 81 in the Annex of the Fourth IMO GHG Study	Km / year	Average distance sailed by ships per year for various maritime transportation options	See table 81 (pp. 446ff) in the Annex of the Fourth IMO GHG Study. Available at https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Fourth%20IMO%20GHG%20Study%202020%20-%20Full%20report%20and%20annexes.pdf	To be used in reference calculation and as default for project calculation
$D_{ref,car}$	14,300	km / year	Average distance driven by cars in the EU per year		For other types of vehicles, individual data and data source should be provided by the applicant and duly justified and referenced.
$SC_{ref,r}$ (on-road passenger cars)	0.0000022	TJ / km	Average fuel consumption per distance for passenger cars	IEA, 2021. Global Fuel Economy Initiative 2021. Fuel economy in the European Union.	
$SC_{ref,r}$ (on-road light duty trucks)	0.0000054	TJ / km	Average fuel consumption per distance for on-road light duty trucks	Assumption	
$SC_{ref,r}$ (on-road HDV)	0.0000121	TJ / km	Average fuel consumption per distance for on-road heavy duty vehicles	JRC, 2021. CO2 emissions of the European heavy-duty vehicle fleet and ICCT, 2018. Comparison of fuel consumption and emissions for representative heavyduty vehicles in Europe	
$SC_{ref,m}$	[to be derived from table 81 in the	TJ / km	Average fuel consumption per distance for various maritime	See table 81 (pp. 446ff) in the Annex of the Fourth IMO GHG Study.	

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
	Annex of the Fourth IMO GHG Study by the applicant]		transportation options	Available at https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/Fourth%20IMO%20GHG%20Study%202020%20-%20Full%20report%20and%20annexes.pdf	
$SC_{ref,a}$ (general aviation)	0.00018	TJ / km	Average fuel consumption per distance for aircraft submodel “general aviation”	Small emitters tool - For traffic emissions 2023	Reference aircraft type C208. 95km added.
$SC_{ref,a}$ (turboprop)	0.00029	TJ / km	Average fuel consumption per distance for aircraft submodel “turboprop”	Same as above	Reference aircraft type AT75. 95km added.
$SC_{ref,a}$ (regional jet)	0.00050	TJ / km	Average fuel consumption per distance for aircraft submodel “regional jet”	Same as above	Reference aircraft type E190. 95km added.
$SC_{ref,a}$ (single aisle or narrow body)	0.00054	TJ / km	Average fuel consumption per distance for aircraft submodel “single aisle or narrow body”	Same as above	Reference aircraft type A320. 95km added.
$SC_{ref,a}$ (twin aisle or wide body)	0.00129	TJ / km	Average fuel consumption per distance for aircraft submodel “twin aisle or wide body”	Same as above	Reference aircraft type B77W. 95km added.

6 Credit for Carbon Capture and Storage or Utilisation

This section explains how a carbon capture credit (CC_{credit}) can be calculated when a project includes an element of carbon capture and storage or utilisation. Guidance on the selection of the category and sector for CCU/S projects is provided in section 1.2.2.

In the case that following the rules below for the assessment of the GHG emissions credit would result in double counting of any GHG emission (source or sink) already included in the assessment of project scenario emissions following the rules for EII, RES, or MOB projects, this double counting shall be removed.

In the unusual case that the reference scenario includes an element of carbon capture and storage or utilisation(e.g. modification of an existing EII facility that captures or utilises CO_2), then a carbon capture term for the reference scenario shall be calculated following the rules in this section, and an overall carbon capture credit shall be defined as the difference between the carbon capture credit in the project scenario and the carbon credit in the reference scenario.[45]

6.1 Scope

This section applies to projects that involve capturing CO_2 from point sources or directly from the ambient air for injection in storage sites permitted under Directive 2009/31/EC on the geological storage of CO_2 or for incorporation into products. This includes projects that involve capturing CO_2, projects that involve transporting captured CO_2 for storage or use or utilisation, projects that involve storing captured CO_2, and projects that involve utilising captured CO_2. A given project may include one or several of these steps.

A carbon capture credit cannot be claimed based on the capture of CO_2 that is produced as a by-product of hydrocarbon extraction (such as CO_2 produced from natural gas wells).

A carbon capture credit cannot be claimed based on the capture of CO_2 that is produced intentionally for the purpose of capturing it (for example through extraction from a natural CO_2 reservoir or through additional combustion of fuels).

6.2 Carbon Capture and Storage (CCS)

CCS is characterised by the capture of CO_2 to be transported, injected and permanently stored in a storage site permitted under Directive 2009/31/EC.

If the full CCS chain is not part of the application, the applicant should demonstrate the provision of the remaining services in the CCS chain by third parties, for example by providing letters of intent, draft contracts, or other relevant supporting documents. In addition, since the InnovFund grant disbursement is dependent on verified emission reductions, i.e. the amount of CO_2 stored in a site permitted under Directive 2009/31/EC, copies of contracts and other relevant documents will have to be provided during project implementation to ensure the intended emissions savings are taking place.

6.3 Carbon Capture and utilisation (CCU)

An emission reduction by CCU can only be claimed by **projects that will demonstrate that the captured carbon will be used** by incorporation into a product. Projects that include a CCU component shall identify at least one of the CCU products as a principal product under the EII category (see section 2.2.5.3). Projects that capture CO_2 from a source in a sector that falls under the RES category (e.g. a bioenergy plant) or the MOB category (e.g. a ship) shall submit a hybrid application (see section 1.2.5), and cover the production of the CCU product(s) in the EII part of the calculations.

A project can only claim an emission reduction because of CCU if the intended use represents an additional utilisation of CO_2. No carbon capture credit can be claimed for supplying captured CO_2 to established markets, such as the production of carbonated beverages, or greenhouse plant growth enhancement. No carbon capture credit may be claimed for supplying CO_2 to a third-party facility that is already operational and where the CO_2 supplied would replace an existing source of CO_2.

Even if the CO_2 utilisation phase is not part of the application and is carried out by a third party, the CO_2 utilisation processes, inputs, and the combustion and/or end-of-life emissions from the CCU product(s) must be included as part of the GHG calculations, in line with section 2.2.5.3.1, 2.2.5.3.3, and other relevant provisions.

If the full CCU chain is not part of the application, the applicant should demonstrate the provision of the remaining services in the CCU chain by third parties, for example by providing letters of intent, draft contracts, or other relevant supporting documents. In addition, since the InnovFund grant disbursement is dependent on verified emission reductions, copies of contracts and other relevant documents will have to be provided during project implementation to ensure the intended emissions savings are taking place.

6.4 CO_2 capture from biogenic sources

There is **no difference** when calculating the CC credit between CO_2 captured from fossil sources and from biogenic sources. The CC credit is calculated based solely on the quantity of CO_2 permanently stored or used, and it is not affected by the origin of the CO_2. When adding a CCS/CCU element to a project in the EII or RES categories that involves CO_2 from biogenic sources, any additional benefit to the project from the use of biogenic resources is assessed under the EII or RES component of the calculations.

> *Example (fossil CO_2): A carbon capture unit is added to an existing natural-gas-fired power plant. The captured CO_2 will be geologically stored. The carbon capture credit shall be calculated following section 6.5 as the amount of CO_2 stored, minus any emissions associated with the capture, transport and storage of the CO_2. The project shall apply with category/sector/product EII/Other/Dispatchable electricity. Following the EII rules in section 2.2.5.2 an emission shall be recorded in the processes box of the project scenario equal to the full amount of CO_2 generated by the power plant, even though some of it will be captured. This emission term will be partly offset by the carbon capture credit term.*

> *Example (biogenic CO_2): A carbon capture unit is added to an existing biomass-fired power plant. The captured CO_2 will be geologically stored. The carbon capture credit shall be calculated following section 6.5 as the amount of carbon stored, minus any emissions associated with the capture, transport and storage of the CO_2. The project shall apply with category/sector/product RES/Bioenergy/Dispatchable electricity. As the output of the renewable energy plant is not expanded by the project, and all the innovation relates to the carbon capture unit, the applicant cannot claim reductions due to the renewable energy generation. As such, the terms* $Ref_{elec,prod,y}$ *and* $Ref_{heat,prod,y}$ *shall be set to zero in Equation [4.1] when calculating the reference emissions for the project.*

> *Example (mixed CO_2 stream): A carbon capture unit is added to an existing waste-to-energy combined heat and power (CHP) plant with 60% of the waste being of biogenic origin. The captured CO_2 will be geologically stored. As the project has elements of renewable and non-renewable energy generation it must apply as a hybrid RES/EII project. As the waste is primarily of biogenic origin the application may be made in the category/sector RES/Bioenergy. The carbon capture credit shall be calculated following section 6.5 as the amount of carbon stored (including both the fossil and biogenic fractions), minus any emissions associated with the capture, transport, and storage of the CO_2. In the EII part of the calculation, the fossil CO_2 emissions from the waste to energy plant must be included as an emission term in the processes box of the project scenario, even though they will be captured. The*

reference emissions for the EII part of the project will be based on Case 3: Modifications to existing production systems and include the fossil CO_2 emissions prior to the addition of the carbon capture unit. The reference emissions for the RES part of the project will be zero unless the output of renewable energy is increased alongside the addition of the carbon capture unit, in which case, the reference emissions for the RES part of the project shall be based on the increased capacity only (see section 3.2.1).

6.5 Calculation of the credit

The equation to be applied for the calculation of the carbon capture credit is described in the following.

GHG emission credit	**=**	**Sinks**	**–**	**Sources**	
$CC_{credit,y}$	=	$(CC_{storage,y} + CC_{use,y})$	–	$(CC_{capture,y} + CC_{injection,y} + CC_{EHR,y} + CC_{pipeline,y} + CC_{transport,y})$	[6.1]

Where:

y = year of operation.

$CC_{credit,y}$ = carbon capture credit. It defines the net GHG benefit delivered by a project through CO_2 storage or utilisation in year y. It is calculated as a positive term for inclusion in equation [1.1][45].

$CC_{storage,y}$ = Amount of CO_2 that is injected for permanent storage in year y, in tonnes CO_2, determined in accordance with Commission Implementing Regulation (EU) 2018/2066 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council and amending Commission Regulation (EU) No 601/2012, especially Articles 40 to 46 and Article 49 and Annex IV, Section 21. This term is therefore equal to the amount of CO_2 captured, minus any CO_2 lost to fugitive emissions, leakage or venting between the point of capture (inclusive) and the point of permanent storage.

$CC_{use,y}$ = Amount of CO_2 that is incorporated into products in year y, in tonnes CO_2e. This amount may be calculated as 44/12 multiplied by the mass of carbon atoms from captured CO_2 incorporated in the products. This amount excludes any CO_2 lost to fugitive emissions, leakage or venting between the point of capture and the point of incorporation.

$CC_{capture,y}$ = GHG emissions from CO_2 capture activities in year y, in tonnes CO_2e. This includes emissions from fuel and input material used for compression and liquefaction of the CO_2, but does not include CO_2 lost to fugitive emissions, leakage or venting during the capture process. It shall be calculated according to Regulation (EU) 2018/2066, Annex IV, Section 21. If the CO_2 is bought off the industrial gas market from a **producer who does not provide data**, the estimated emissions for the capture and transport must be included by the project applicant based on appropriate referenced sources.

$CC_{injection,y}$ = For CCS projects, GHG emissions from injection and geological storage of CO_2 in a storage site permitted under Directive 2009/31/EC in year y, in tonnes CO_2e. This includes emissions from fuel use by associated booster stations and other combustion activities including on-site power plants; venting from injection or enhanced hydrocarbon recovery operations; fugitive emissions during injection; breakthrough CO_2 from enhanced hydrocarbon recovery operations; and leakages

[45] In the unusual case in which the reference scenario includes an element of carbon capture and storage or utilisation, the overall carbon capture credit is defined as the difference between the carbon capture credit in the project scenario and the carbon credit in the reference scenario ($CC_{credit,y} = CC_{credit_{Proj,y}} - CC_{credit_{Ref,y}}$), with $CC_{credit_{Proj,y}}$ and $CC_{credit_{Ref,y}}$ first calculated separately following the provisions of section 6.

during or after injection. It shall be calculated according to Regulation (EU) 2018/2066, Annex IV, Section 23.

$CC_{EHR,y}$ = For projects in which CO_2 injection and storage is associated with enhanced hydrocarbon recovery (EHR), emissions consistent with stoichiometric combustion of the associated fraction of the produced hydrocarbons. This is to be calculated as $CC_{EHR,y} = (CC_{storage,y} / EHR_{storage,y}) * HC_y * \%C_y * 44/12$,

where $EHR_{storage,y}$ is the total amount of CO_2 stored at the EHR location in year y, HC_y is the total mass of hydrocarbons in tonnes produced at the EHR location in year y, and $\%C_y$ is the carbon fraction in the produced hydrocarbons.

$CC_{pipeline,y}$ = GHG emissions from transport of CO_2 by pipelines in year y, in tonnes CO_2e. This includes emissions from combustion and other processes at installations functionally connected to the transport network including booster stations, but does not include CO_2 lost to fugitive emissions, leakage or venting during the transport process via pipeline. It shall be calculated according to Regulation (EU) 2018/2066, Annex IV, Section 22.

$CC_{transport,y}$ = GHG emissions from transport of CO_2 via road, rail or maritime modals in year y, to be calculated based on distance travelled, type of modal and load according to Equation [3.2] in section 6.5.1 and relevant sub equations, in tonnes CO_2e.

6.5.1 GHG emissions from transportation of CO_2 via road, rail, or maritime modals

This methodology assumes the transportation of the CO_2 will be done through heavy good vehicles (HGVs) when via road, and by sea tankers for maritime journeys. Related emissions are calculated according to equation [6.2] and relevant sub-equations.

Note that the more detailed and broken-down is the information available on distance between sites, and volume transported, the more accurate will be the calculation of $CC_{transport,y}$. Therefore, if applicants' data is available per trip, applicants should calculate the emissions for each trip, using the average distance in each leg, and the amount of CO_2 transported in that exact leg (which can be derived from the estimate capacity of the truck), and add them up, as described in the equations below. Otherwise, an approximated estimate of the total distance travelled in the year and the total emissions transported in the year is allowed as a proxy.

For projects submitted to the InnovFund in a small scale topic: emissions due to transportation by road, rail and maritime modals can be disregarded from the calculation of the GHG emissions avoidance, if the total distance travelled between the point of capture and the point of storage is less than 5,000 kilometres.

Parameter	=	Equation	
$CC_{transport,y}$	=	$CC_{transport,road,y} + CC_{transport,rail,y} + CC_{transport,maritime,y}$	[6.2]
$CC_{transport,road,y}$	=	$\sum_{L=1}^{T} (K_{road,L} * CO_{2road,L} * EF_{road} * 10^{-3})$	[6.2a]
$CC_{transport,rail,y}$	=	$\sum_{L=1}^{T} (K_{rail,L} * CO_{2rail,L} * EF_{rail} * 10^{-3})$	[6.2b]
$CC_{transport,maritime,y}$	=	$\sum_{L=1}^{T} (K_{maritime,L} * CO_{2maritime,L} * EF_{maritime} * 10^{-3})$	[6.2c]

Where:

$CC_{transport,road,y}$ = GHG emissions due to the transportation of CO_2 in tank trucks or other road modals, in year y, in tonnes CO_2e.

$CC_{transport,rail,y}$ = GHG emissions due to the transportation of CO_2 by rail, in year y, in tonnes CO_2e.

$CC_{transport,maritime,y}$ = GHG emissions due to the transportation of CO_2 in sea tankers or other maritime modals, in year y, in tonnes CO_2e.

$K_{road,L}$ = distance of one-way trip travelled by road vehicles, in kilometres.

$CO_{2road,L}$ = amount of CO_2 transported in each one-way trip in road modals, in tonnes.

EF_{road} = emission factor for road vehicles, in kg CO_2e / tonne.km. The default EF is presented in section 6.6.

$K_{rail,L}$ = distance of one-way trip travelled by rail, in kilometres.

$CO_{2rail,L}$ = amount of CO_2 transported in each one-way trip by rail, in tonnes.

EF_{rail} = emission factor for rail transportation, in kg CO_2e / tonne.km. The default EF is presented in section 6.6.

$K_{maritime,L}$ = distance of one-way trip travelled by maritime transportation, in kilometres.

$CO_{2maritime,L}$ = amount of CO_2 transported in each one-way trip in maritime transportation, in tonnes.

$EF_{maritime}$ = emission factor for maritime transportation, in kg CO_2e / tonne.km. The default EF is presented in section 6.6.

L = outbound trip by the modal.

T = total number of outbound trips by the modal in year y.

6.6 Data and parameters

Table 6.1 presents the parameters that will be deemed as constant throughout the duration of the project for the calculation of $CC_{transport}$. Should applicants wish to adopt emission and conversion factors different from those proposed, a justification must be provided and the corresponding parameter(s) shall be included in the monitoring plan. The emissions attributed to electricity consumed for injection, transport, and/or capture shall be zero.

Refer to Regulation (EU) 2018/2066, Annex IV, Section 23 for conversion factors to be used for the calculation of $CC_{capture}$, $CC_{pipeline}$ and $CC_{injection}$. For other emission or conversion factors not listed here, refer to the hierarchy of sources in Appendix 1.

Table 6.1. Parameters not to be monitored (fixed ex-ante)

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
EF_{road}	0.108	kg CO_2e / tonne.km	Emission factor for liquid CO_2 transport by heavy truck.	JRC based on M.L. Perez et al. *Low Carbon Economy, 2012, 3, 21-33.* *http://dx.doi.org/10.4236/lce.2012.31004*	40 tonne articulated truck carrying 20 m3 pressurised cryotank. Includes empty return trip.

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
EF_{rail}	0.065	kg CO_2e / tonne.km	Emission factor for freight by rail modals	M.L. Perez et al. Low Carbon Economy, 2012, 3, 21-33. *http://dx.doi.org/10.4236/lce.2012.31004*	Transport in liquid form. Includes necessary boil-off of CO_2
$EF_{maritime}$	0.030	kg CO_2e / tonne.km	Emission factors for freight by maritime modals	IPCC special report on Carbon Capture and Storage, chapter 4. https://www.ipcc.ch/site/assets/uploads/2018/03/srccs_chapter4-1.pdf	Lower end of IPCC range. Includes fuel combustion and boil-off of CO_2 and empty return trip.

Source: see the column "Source data".

7 Methodology for projects applying under the INNOVFUND-2024-BATT call

This section deals with the methodology to calculate the GHG emission avoidance of projects applying under the call "Innovation Fund Call for proposals 2024 Batteries" (INNOVFUND-2024-BATT).

Note that projects applying under the call "Innovation Fund Call for proposals 2024 Net Zero Technologies" (INNOVFUND-2024-NTZ) shall NOT refer to this section, as the provisions in this section do not apply to them.

This section provides the details to be used when:

- calculating the GHG emission avoidance potential of a project at the application stage;
- reporting performance for the purposes of disbursement of the portion of the grant that is linked to GHG emission avoidance verification; and
- reporting performance for the purposes of knowledge-sharing.[46]

7.1 Methodological scope

The underlying calculation model is designed to determine two key figures for the emission reduction of battery cell manufacturing projects. Two calculation models are used for this purpose (see Figure 7.1):

1. **Manufacturing carbon footprint reduction:** The project's manufacturing emissions are calculated against a standardised battery manufacturing reference, considering emissions from raw materials to battery cell production (see section 7.3).
2. **Absolute and relative GHG emission avoidance:** The project's GHG emission avoidance is the sum of the battery manufacturing carbon footprint reduction and emissions associated to the Electric Vehicle (EV) use case, including end of life treatment, calculated against the simplified diesel reference scenario (see sections 7.4 and7.5)

The methodology for the manufacturing carbon footprint takes into account aspects of the entire value chain, including raw material related emissions, precursors and battery components, and the production of the battery cells. It includes life cycle stages as defined by the EU batteries regulation (annex II)[47]: (a) raw materials and pre-processing, (b) main product / cell manufacturing, (c) distribution of batteries is excluded, (d) EoL and recycling.

The calculation model is oriented towards the materials and the process chain for Li-ion battery (LIB) cells. The model can also be applied to the production of other battery chemistries and types. This will however require the allocation of battery technology specific production steps to the set of pre-defined production steps for LIB cells.

The methodology for determining the absolute and relative GHG emission avoidance is based on the assumption of an EV use case, i.e. battery pack production and the use of the battery cells in electric vehicles for a use period of 10 years. In addition, end-of-life

[46] These parameters will be reported through a dedicated knowledge-sharing report template once projects enter into operation. The detailed knowledge-sharing requirements are spelled out in the Model Grant Agreement, INNOVFUND-2024-BATT call text and knowledge-sharing reporting template.

[47] Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC, http://data.europa.eu/eli/reg/2023/1542/oj

treatment is considered. The reference scenario assumes the use of diesel-powered vehicles for comparison.

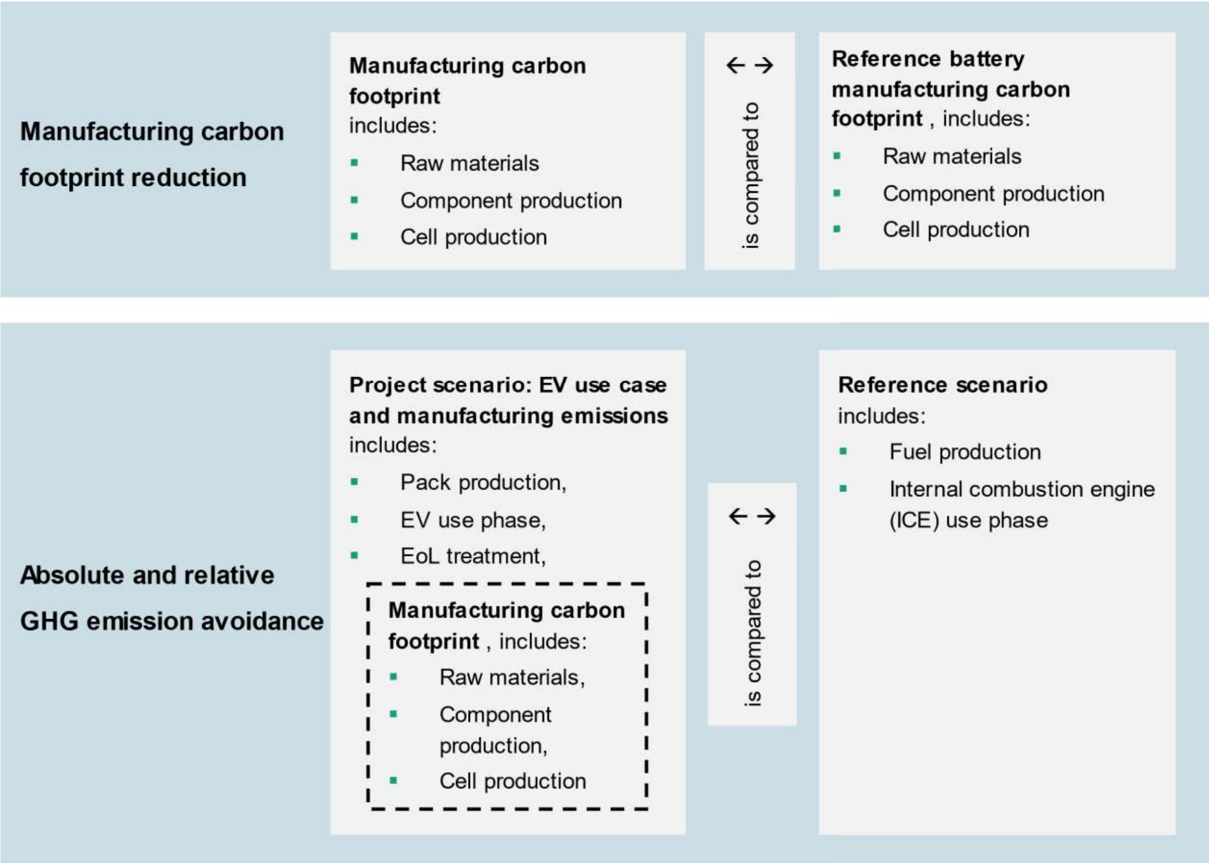


Figure 7.1. Calculation of project emissions as (1) Manufacturing carbon footprint reduction and (2) Absolute and Relative GHG emission avoidance

The Manufacturing carbon footprint reduction (1) is a subset of the GHG emission avoidance of the project, including the EV use case (2).

7.2 System boundary

7.2.1 Steps within the project scope

The scope of projects includes manufacturing steps of battery cells that can be used in EV. The manufacturing steps are defined below on the basis of inputs and outputs.

In addition to battery cell production, certain upstream steps can also be part of the project’s GHG avoidance claims, provided their outputs serve as input for the project's battery cell production. The project's battery cell production inputs can also be supplied by external suppliers (project's own upstream outputs < 100% battery cell production inputs).

7.2.1.1 Battery cell production

Battery cell production is measured in energy storage capacity and is defined in MWh battery cell output (quality units, successful end of line test).

Battery cell production includes electrode production (material mixing, coating, drying, calendering) and electrode and cell assembly (slitting, vacuum drying, stacking/winding, assembly, electrolyte filling, formation, aging, testing).

It does not include any further processing of battery cells to modules or battery packs.

Inputs	• Battery active materials CAM and AAM (such as NMC, NCA, LFP, Graphite, Silicon) ready for electrode production • Additive materials such as binders, conductive additives • Current collector foils and separator materials ready for coating • Electrolytes such as mixtures of organic solvents and Li-salts ready to be filled in assembled cells • Other components such as cell housings, connectors • Net energy (to be specified in the methodology distinguished by energy carrier) • NMP, water, other auxiliary materials
Outputs	• Sealed, finished and tested battery cells, test passed and approved. • Production scrap (does not have to be specified in the calculation)

Note for alternative battery systems: *For battery cells whose production differs from LIB, a system boundary for cell production should be selected that is as comparable as possible to the LIB process. In any case, cell production should include all processes and components necessary to produce a functional electrochemical unit. This includes the capability to store energy, sealing, safety and transportability. The system boundary between cell production and material and component production should be selected in such a way that, if possible, all essential processes that change the chemical composition of the input materials are not part of cell production. This applies to both passive and active materials. There may be exceptions, e.g. in the case of solid-state batteries, where the production of the solid-state electrolyte takes place in-situ on the cell production line.*

7.2.1.2 Optional: Battery cathode active material (CAM) production

This step includes mixing of pCAM materials with a Li-source, firing, post-treatment such as washing, milling, coating. May include blending of different CAM.

Does not include purification of input materials. Does not include production of Li sources (e.g. LiOH, Li_2CO_3), neither refinement of Li sources to battery grade.

Inputs	• Precursor CAM materials (pCAM powder) at battery grade; Li-source such as Li_2CO_3, LiOH-H_2O or others at battery grade • Net energy (e.g. electricity, heat, fossil fuels, hydrogen, others) • Water, other auxiliary materials
Outputs	• Cathode active materials (powder) ready for further processing in cell production. • Production scrap (does not have to be specified in the calculation)

Note for alternative battery systems: *Some alternative battery concepts do not use classic cathode materials such as those found in LIBs. These include, for example, metal-air batteries or redox flow batteries. The subdivision into pCAM and CAM production is also specific to LIB (and possibly sodium-ion battery (SIB)). In alternative battery systems,* *there may well be single-stage synthesis routes. In any case, the output of CAM production should be selected so that it is directly available as input for cell production. It is important to ensure that, apart from transportation, there is no gap between active material production and cell production.*

The system boundaries for cell production should be selected so that all essential synthesis processes and changes to the chemical composition of active components take place BEFORE cell production. The system boundaries for pCAM production should be selected in such a way that possible degrees of freedom in the chemical composition of active materials (e.g. ratio of individual metals) are already defined in the pCAM production step.

7.2.1.3 Optional: Precursor battery cathode active material (pCAM) production

This step includes mixing of materials and precipitation of pCAM (e.g. NMC-$(OH)_2$, $FePO_4$). May include further steps such as milling, washing, coating or others.

Does not include purification of input materials.

Inputs	• Precursor materials such as metal-oxides, -sulphates, -oxalates, -phosphates or others at battery grade • Net energy (e.g. electricity, heat, fossil fuels, hydrogen, others) • Water, other auxiliary reagents such as NaOH
Outputs	• Precursor cathode active materials (powder) ready for further processing in cathode active material production. • Production scrap (does not have to be specified in the calculation)

Note for alternative battery systems: *Some alternative battery concepts do not use classic cathode materials such as those found in LIBs. These include, for example, metal-air batteries or redox flow batteries. The subdivision into pCAM and CAM production is also specific to LIB (and possibly Sodium-ion batteries SIB). In alternative battery systems, there may well be single-stage synthesis routes.*

The system boundaries for pCAM production should be selected in such a way that possible degrees of freedom in the chemical composition of active materials (e.g. ratio of individual metals) are already defined in the pCAM production step and not in the subsequent CAM production step.

The system boundaries to all other upstream processes should be selected in such a way that no significant purification steps (separation of input materials) are located in pCAM production. pCAM production includes processes that change the essential properties of the input materials such as particle size and morphology, chemical composition and particle aggregation.

7.2.1.4 Optional: Anode active material (AAM) production

This step includes production of graphites, silicons, LTO, metallic Li foils or other anode active materials from precursors as well as all post-processing steps such as milling, coating, blending, etc. The final product of anode active material production is a material or component ready for further processing in cell production.

This step does not include the production of raw materials.

For natural graphite, this means: no mining of graphite, no separation of graphite from other mining products. But mechanical, thermal and chemical purification steps.

For synthetic graphite this means: No production of basic feedstock such as petroleum coke, tar or other precursors. But calcination, graphitization and purification steps.

For silicon this means: No production of metallurgical grade silicon (e.g. melt reduction), no production of silane gas or other Si precursors. But the purification of Si to battery grade or the synthesis of Si particles or layers from Si precursors.

For LTO this means: No production of Li sources (e.g. LiOH, Li_2CO_3). No refinement of Li sources. No production of titanium precursors such as TiO_2. But the production of lithiated titanate powder.

For metallic Li-anode this means: No production of Li sources (e.g. LiCl solution). But the reduction of Li compounds to metallic Li, purification, coating onto substrate foils, coating with protective layers.

Inputs	• Basic feedstock such as raw natural graphite, petroleum coke or tar, metallurgical grade silicon or other Si-compounds, transition metal compounds at battery grade, Li-compounds at battery grade • Net energy (e.g. electricity, heat, fossil fuels, hydrogen, others) • Water, solvents and other auxiliary reagents such as acids and bases
Outputs	• Anode active materials (powder) ready for further processing in cell production. • Production scrap (does not have to be specified in the calculation)

Note for alternative battery systems: *Some alternative battery concepts do not use classic anode materials such as those found in LIBs. These include, for example, systems with a Li-metal anode or other conversion type anodes (e.g. transition metal oxides) or redox flow batteries.*

The system boundaries for anode production should be selected in such a way that the output is a material or component ready for further processing in cell production. All essential chemical characteristics of the anode active material should be determined in the anode active material production step.

The system boundary upstream for graphite and silicon should be defined in such a way that the input materials can in principle also be used for non-battery applications (e.g. other graphite qualities can be produced from raw graphite for other applications (e.g. for electric arc furnace)). The system boundary upstream for Li-compounds and other metal compounds should be set at battery grade.

7.2.1.5 Optional: Separator production

This step includes production of polymer-based or fiber-based separator sheets (e.g. extrusion, stretching, drying, weaving) ready for further processing in cell production. May include additional treatment such as coating.

Does not include the production of the polymer (polyethylene (PE), polypropylene (PP), others), plasticizers or fiber.

Inputs	• Polymers (PE, PP, others), fibers (glass, aramid, others), plasticizers • Inorganic coating materials • Net energy (e.g. electricity, heat, fossil fuels, hydrogen, others) • Water, solvents, other auxiliary materials
Outputs	• Separator foil ready for further processing in cathode active material production. • Production scrap (does not have to be specified in the calculation)

7.2.1.6 Optional: Electrolyte production

This step includes purification and mixing of solvents (ethylene carbonate (EC), dimethyl carbonate (DMC), diethyl carbonate (DEC), others), purification and solvation of Li-salts ($LiPF_6$, others)

Does not include production of solvents (e.g. production from CO_2 and cyclic ethers), does not include the production of Li-electrolyte salts (e.g. from LiF and phosphorous/fluorine/chlorine compounds).

Inputs	• Solvents (EC, DMC, DEC, others) • Electrolyte salts ($LiPF_6$, others) • Net energy (e.g. electricity, heat, fossil fuels, hydrogen, others) • Water, solvents, other auxiliary materials
Outputs	• Electrolyte solution ready to be further processed in cell production. • Production scrap (does not have to be specified in the calculation)

Note for alternative battery systems: *In solid-state batteries, the boundaries between separator and electrolyte can easily become blurred, as both functions (electrical insulation, ionic conduction) are performed by the same material. In this case, it is recommended to allocate all emissions associated with production to "electrolyte production" and to calculate "separator production" as zero.*

Most alternative battery systems use electrolytes that are comparable to LIB electrolytes (solvent and dissolved salt), so that direct transferability is given. Redox-flow batteries are a drastic exception. It is recommended to declare the production of the electrolytes of redox flow batteries as the production of the cathode and anode active materials and to calculate the "electrolyte production" as zero in the GHG calculation.

7.2.2 Steps outside the project scope but within manufacturing carbon footprint calculations

7.2.2.1 Raw material extraction and refining

The cell chemistry and material efficiency of the battery cell product define the bill of materials. The raw materials necessary (tonnes) and the amounts required per energy storage capacity (kg / kWh) are therefore considered in the definition of the project's manufacturing carbon footprint. In addition, the share of recycled raw materials is considered in the project calculations.

Default and fixed assumptions are made for the GHG footprint associated with the extraction of raw materials, refinement and the production of battery precursors. This means that specific emissions per ton of a metal or element are defined. The defined values represent average values for different mining regions, different feedstocks (e.g. brine or ore) and different precursors (e.g. LiOH or Li_2CO_3). These emission factors are constant across all projects and years.

The proportion of recycled materials can be specified in the manufacturing carbon footprint calculation. Literature-based emission factors are defined for recycled materials, which differ from the values for the primary extraction of raw materials. These emission factors are constant across all projects and years.

The total raw materials used by the project must be specified in the GHG calculation model as elemental equivalent (e.g. 1 kg of Li_2CO_3 has the elemental equivalent of 0.188 kg lithium). This number corresponds in principle to the sum of the bill of materials (BoM) of the battery cells produced in the project and the unavoidable production scrap (see 7.3.3.2).

7.2.2.2 Production of Cu-current collector and Al-current collector foils and their pre-products

Standard processes and corresponding emission factors are assumed for the production of copper and aluminum current collector foils.

7.2.3 Steps outside the project scope but within absolute GHG emission avoidance and relative GHG emission avoidance calculations

7.2.3.1 Battery pack production

The emissions from the production of battery packs results from the energy required for the process and the materials used (excluding battery cells).

Battery pack production is considered in the GHG calculations with a simplified approach, which assumes constant emission factors for all projects alike. A battery pack made of aluminum, plastic and steel is assumed.

7.2.3.2 End of life (EoL) treatment

The 'End-of-life' life-cycle stage begins when the product in scope (or the EV where the battery is incorporated) is disposed of or discarded by the user and ends when the product in scope is returned to nature as a waste product or enters another product's life-cycle (i.e., as a recycled input).

EoL treatment in the methodology includes battery collection and dismantling only. All thermal or mechanical pre-treatment, separation and conversion steps (e.g., pyrometallurgical and hydrometallurgical treatment) for the production of battery material precursors are allocated to the input phase of battery production (cut-off approach). For this purpose, the emission factors for recyclates as input materials for battery material production have a value greater than 0.

EoL recycling is considered in the GHG emission balance with a simplified approach, which assumes constant emission factors for all projects alike.

7.2.4 Steps outside the project scope and outside GHG emission balance

The following production steps remain outside the manufacturing carbon footprint and GHG emission avoidance calculations:

- All petrochemical processes through to products that could also be used for applications other than battery components. (Non-exclusivity of materials for battery production) (e.g. solvents like EC, DMC, DEC, N-methyl-2-pyrrolidone (NMP)).
- Production of basic polymers or plastics (e.g. PP, PE).
- Production of auxiliary reagents or materials such as NaOH.
- Production of battery material binders (e.g. PVDF, CMC/SBS).
- Production of conductive electrode additives (e.g. carbon blacks, CNTs).
- Production of battery cell housing components.
- Battery application production.
- Transport of materials, components, batteries, and applications.
- Manufacturing of equipment for battery material, battery cell, battery module, battery pack or battery system production.
- Auxiliary inputs to the manufacturing plant that are not directly related to the battery production process (such as heating and lighting of associated office rooms, secondary services, sales processes, administrative and research departments, etc.).

7.3 Manufacturing carbon footprint reduction

The calculation of the manufacturing carbon footprint reduction follows the logic of project and reference process emissions. The result of this calculation will be assessed under the award criterion of "Manufacturing carbon footprint reduction". In the following, the formal mathematical approach is described.

Term	=	Emissions	
ΔGHG_{manuf}	=	$\sum_{y=1}^{10} (Ref_{manuf,y} - Proj_{manuf,y}) / (\sum_{y=1}^{10} Ref_{manuf,y})$	[7.1]
$Ref_{manuf,y}$	=	$Ref_{direct,y} + Ref_{upstream,y} + Ref_{rawmaterial,y}$	[7.2]
$Proj_{manuf,y}$	=	$Proj_{direct,y} + Proj_{upstream-outside,y} + Proj_{rawmaterial,y}$	[7.3]

Where:

ΔGHG_{manuf} = GHG emissions avoidance of battery cell production in year y, calculated as percentage value.

$Ref_{manuf,y}$ = GHG emissions of battery cell production in the reference scenario in year y, in tonnes CO_2e (see section 7.3.1).

$Proj_{manuf,y}$ = GHG emissions of battery cell production in the project scenario in year y, in tonnes CO_2e (see section 7.3.2).

$Ref_{direct,y}$ = Direct GHG emissions of battery cell production in the reference scenario in year y, in tonnes CO_2e. Calculated according to Equation [4] (see section 7.3.1).

$Ref_{upstream,y}$ = GHG emissions from components upstream of cell production in the reference scenario in year y, in tonnes CO_2e. Calculated according to Equation [5] (see section 7.3.1).

$Ref_{rawmaterial,y}$ = GHG emissions from raw materials in the reference scenario in year y, in tonnes CO_2e. Calculated according to Equation [6] (see section 7.3.1).

$Proj_{direct,y}$ = Direct GHG emissions of battery cell production and upstream components within project boundary in year y, in tonnes CO_2e. Calculated according to Equation [7] (see section 7.3.2).

$Proj_{upstream\text{-}outside,y}$ = GHG emissions from components upstream of cell production not within project boundary in year y, in tonnes CO_2e. Calculated according to Equation [8] (see section 7.3.2).

$Proj_{rawmaterial,y}$ = GHG emissions from raw material in the project scenario in year y, in tonnes CO_2e. Calculated according to Equation [9] (see section 7.3.2).

y = year of the operation.

7.3.1 Reference battery manufacturing carbon footprint

The reference life cycle and the underlying production processes and assumptions are based on the production and use of LIBs for EVs and are briefly explained below.

7.3.1.1 Raw material and precursor production

The reference scenario values are based on a 80/20 mixture of NMC622/Graphite and LFP/Graphite prismatic (Al case) battery cells where Graphite is a 50/50 mixture of natural and synthetic graphite.

The default recycled content of the materials is 0 until 2031 and 6 % for Li, 16 % for Co and 6 % for Ni in line with the requirements specified in the EU battery regulation.

The reference BoM for the production of battery cells in the reference manufacturing scenario, is given in the Table below.

Table 7.1. Reference bill of raw materials for the production of battery cells in the reference manufacturing scenario

Element	Value (t / MWh)
Li	0.11
Al	0.6
Mn	0.155
Fe	0.142
Co	0.166
Ni	0.495
Cu	0.49
F	0.123
Carbon	1.1

7.3.1.2 pCAM, CAM and AAM production

A two-stage process (pCAM, CAM) is assumed for the production of cathode active materials. This comprises a precipitation reaction for the Li-free pCAM and firing with a Li source for the CAM. Emission factors per unit of weight for pCAM and CAM are defined for the calculation of the GHG contribution. These are based on the production of LFP (via Li_2CO_3 and $FePO_4$ pCAM) and NMC (via LiOH and $NMC(OH)_2$ pCAM).

A multi-step process was assumed for the production of anode materials, as is typical for the production or preparation of graphite. For synthetic graphite, three thermal steps of calcination, carbonization and graphitization were assumed. For natural graphite, the mechanochemical steps of flotation, spheronization, purification and coating were assumed. The reference scenario process energy intensity and non-energy emissions are given in section 7.6.

The bill of material is based on a 80/20 mixture of NMC622/Graphite and LFP/Graphite battery cells where Graphite is a 50/50 mixture of natural and synthetic graphite.

The reference BoM for the production of battery cells in the reference scenario is given in the Table below.

Table 7.2. Reference bill of materials in the reference manufacturing scenario

Material	Value (t/MWh)
pCAM	1.70
CAM	1.78
AAM	0.91
Electrolyte	0.76
Separator	0.1
Al current collector	0.195
Cu current collector	0.49

7.3.1.3 <u>Production of other components</u>

For all other components, manufacturing processes for PP/PE separators, $LiPF_6$-based electrolytes, Cu and Al current collector foils were assumed.

The reference BoM for the production of battery cells in the reference scenario, is given in the Table above.

7.3.1.4 <u>Cell production</u>

The emissions from cell production in the reference result from the energy input for the manufacturing processes and for the infrastructure such as the clean and dry room. Electricity was assumed as energy carrier for cell production. A global average emission factor was used.

The reference scenario energy intensity and non-energy emissions given in the Table below.

Table 7.3. Energy intensity of battery cell production in the reference manufacturing scenario

	Unit	**Value**	**Sources**
Energy consumption cell production	kWh / kWh_cell	35	Degen et al. 2022 (https://doi.org/10.1016/j.jclepro.2021.129798), Degen et al. 2023 (https://doi.org/10.1038/s41560-023-01355-z), Dai et al. (https://www.mdpi.com/2313-0105/5/2/48), Kurland (http://dx.doi.org/10.1088/2515-7620/ab5e1e), von Drachenfels et al. (https://doi.org/10.1002/ente.202200673)
Emissions not originating from energy consumption cell production	kg CO_2e / kWh_cell	0.25	Ecoinvent DB, 24576, 24741

7.3.1.5 Reference battery manufacturing carbon footprint sub-equations

Parameter	**=**	**Equation**	
$Ref_{direct,y}$	=	$\sum_{i=1}^{I} (E_{Ref,i} * EF_i) + Proj_{production,y} * EF_{non\text{-}energy,y}$	[7.4]
$Ref_{upstream,y}$	=	$\sum_{j=1}^{J} (Ref_{up,j} * EF_j) * Proj_{production,y}$	[7.5]
$Ref_{rawmaterial,y}$	=	$\sum_{k=1}^{K} [s_{ref,recy,k,y} * EF_{recy,k} + (1 - s_{ref,recy,k,y}) * EF_{raw,k}] * Ref_{raw,k} * Proj_{production,y}$	[7.6]

Where:

$Proj_{production,y}$ = Quantity energy storage capacity produced in year y, in MWh.

$EF_{non\text{-}energy}$ = Emission factor of non-energy emissions from cell production in the reference scenario in year y in tonnes CO_2e / MWh.

$E_{Ref,i}$ = Amount of energy sourced from energy carrier i in the reference scenario in year y in TJ.

EF_i = Emission factor of energy carrier i in tonnes CO_2e / TJ.

$Ref_{up,j}$ = Specific use of upstream component j in the reference scenario in year y in kg/kWh.

EF_j = Emission factor for the production of upstream component j in the reference scenario in year y in kg CO_2e / kg.

$s_{ref,recy,k,y}$ = Share of recycled raw material k used in the reference scenario in year y.

$EF_{recy,k}$ = Emission factor of recycled material k.

$EF_{raw,k}$ = Emission factor of raw material k.

$Ref_{raw,k}$ = Specific use of raw material k in the reference scenario in year y in kg/kWh.

i = Energy carriers considered in the reference scenario, including electricity.

j = Upstream components considered (pCAM, CAM, AAM, electrolyte, separator, Al-current collector foils, Cu-current collector foils)

k = Raw materials considered

I = Total number of energy carriers

J = Total number of upstream components

K = Total number of raw materials

7.3.2 Project manufacturing carbon footprint

The project manufacturing carbon footprint is divided into two parts:

1. Emissions directly caused by the project's activities and associated with the project's battery cell output (e.g. from energy use or direct process emissions).

2. Emissions from the project's upstream chain from raw materials to key cell components.

Projects must include the manufacturing of battery cells that can be used in EVs. Projects may additionally include the manufacturing of key battery cell components. For this reason, the boundary between 1. (project) and 2. (upstream chain) is project-dependent and must be specified in the calculation methodology (see section 7.3.2.2).

To quantify the emissions associated with the upstream chain, the project's bill of materials needs to be specified (see section 7.3.2.1).

If the upstream components or parts of the upstream components are not produced within the project boundary, their emissions are accounted for by default values, unless the project can provide evidence justifying a divergence from the default value (see section 7.3.2.3).

All energy consumption and direct emissions from the project's production processes must be included in the calculation (see section 7.3.2.4).

The calculation formulas for determining the manufacturing carbon footprint and the manufacturing carbon footprint reduction are given in section 7.3.2.5.

7.3.2.1 The project's bill of materials

By specifying the BoM, the battery chemistry and raw material emissions have an influence on the manufacturing carbon footprint of the project.

Absolute values for the raw material requirement need to be specified in elemental equivalents (GHG Calculator: *Manufacturing: Raw materials: Project bill of materials*). The default emission factors for raw materials are fixed and cannot be deviated from. Projects must state the proportion of raw materials sourced from secondary sources (recycling, GHG Calculator: *Manufacturing: Raw materials: Project recycled content*). These are factored in with their own emission factors.

The bill of materials with regard to the direct upstream components of cell production (expressed as relative BoM in kg/kWh, GHG Calculator: *Manufacturing: Project bill of materials*) must be provided.

- CAM, AAM: This only includes the electrochemically active material used in the project. Weight fractions of conductive additives, binders or other electrode additives that are not directly involved in electrochemical energy storage can be neglected.

- Separators: This includes the total quantity of separator foils (incl. cut-offs) used in the project. In the case of pre-coated current collector foils (e.g. ceramics), the total weight of the separator foil must be taken into account.

- Electrolyte: This includes the total quantity of electrolyte used in the project.

- Current collectors: This includes the total quantity of current collector foils (incl. cut-offs) used in the project. In the case of pre-coated current collector foils (e.g. carbon), the total weight of the current collector foils must be taken into account. The weight of additional Cu, Al or Ni tabs and conductor bars in the battery cell can be neglected.

7.3.2.2 Upstream components produced by the project

The share of the upstream components *produced* by the project of all upstream components *consumed* by the project needs to be specified in the calculation (GHG Calculator: *Manufacturing: Project bill of materials: Production share within project scope*). The upstream components produced within the project boundary may not exceed the amount required by the cell production within the project boundary. The maximum is 100%.

The energy demand and emissions of upstream component production are directly considered as project manufacturing emissions, see section 7.3.2.4 (GHG Calculator: *Manufacturing: Project energy: Energy carriers and non-energy emissions*).

7.3.2.3 Upstream components not produced by the project and emission factors

For the share of upstream components sourced from external suppliers to the project, default emission factors for component production are assumed.

The default emission factors for any imported upstream components may be customized by the project if the project can provide evidence that components intended to be imported into the project will have a lower-than-default GHG footprint. Customized emission factors can be entered in the GHG Calculator in *Manufacturing: Upstream components: Emission factors of components not produced as part of the project*.

Any customised emission factors must be based on the process boundaries of the predefined manufacturing steps for upstream components (as defined by inputs and outputs in section 7.2.1). The GHG balance underlying the customized emission factors must cover at least the predefined scope of the respective manufacturing steps. I.e. it is not permissible to use a customized emission factor, e.g. for the production of cathode material, if the process on which the factor is based does not cover the full processing of inputs to outputs as specified in section 7.2.1.

Customised emission factors should be calculated in following the Global Battery Alliance GHG Rulebook[48] (e.g. for emission factor calculation of upstream materials based on company activity data). The Global Battery Alliance GHG Rulebook is being developed in alignment with the EU battery passport rules, the Product Environmental Footprint (PEF) approach, and the Product Environmental Footprint Category Rules (PEFCR).

- **At application stage**, projects need to provide adequate evidence. For example, MoUs with suppliers, indicating that more sustainable components will be purchased or Heads of Terms with the relevant component supplier and carbon footprint claims by that supplier. In addition, the applicants must propose adequate monitoring measures in their monitoring plan to ensure adequate monitoring and reporting of the assumptions made at the application stage. Failure to provide adequate evidence, and an adequate monitoring plan, may affect the quality of the GHG calculations and the resulting evaluation.

- **During project implementation**, failure to demonstrate the assumptions made at the application stage, may affect the overall GHG emission avoidance or manufacturing carbon footprint reduction that can be achieved by the project, which

[48] in its currently valid version, right now: Greenhouse gas rulebook, Generic rules – Version 1.5

may have consequences in terms of grant disbursement as specified in the INNOVFUND-2024-BATT Call Text.

The assumptions adopted at the application stage with respect to the origin of the imported upstream components and the emission factors adopted must be confirmed as part of the **verified GHG emission avoidance report** to be provided at the end of the project, as specified in the INNOVFUND-2024-BATT Call Text.

7.3.2.4 Energy used within the project boundary (and emissions not originating from energy production and use)

No default activity data shall be used for the declaration of the energy consumption and the energy sources which entails that company-specific activity data are required.

Energy consumed within the project boundary is rated with fixed emission factors provided for the different energy sources. The default emission factors for imported energy may be altered (customized emission factors) by the project:

If a MoU or other precontractual agreement with the renewable energy provider can be presented with the application. In the case of electricity, the MoU or other precontractual agreement must mention the additional nature of the electricity.

- If the project provides proof of the energy purchase during the monitoring phase as claimed in the application.

Failure to provide adequate evidence may affect the quality of the GHG calculations and the resulting evaluation. In addition, failure to demonstrate, during project implementation, the assumptions made at the application stage may affect the overall GHG emission avoidance or manufacturing carbon footprint reduction that can be achieved by the project, which may have consequences in terms of grant disbursement as specified in the INNOVFUND-2024-BATT Call Text.

The assumptions adopted at the application stage with respect to the origin of the energy, the additional nature of the electricity, and the corresponding emission factor must be confirmed as part of the verified GHG emission avoidance report to be provided at the end of the project.

Electricity:

Electricity consumed within the project boundary is rated with a fixed emission factor based on the average emissions of the 2030 EU grid electricity mix with an emission factor of 48.8 t CO_2e / TJ, based on the EU Reference Scenario 2020[49], independent of the geographical location of the project.

If a project can prove electricity consumption through a direct line to (an) additional[50] renewable electricity source(s) or (a) PPA(s) with (a) provider(s) of additional50 renewable electricity, the corresponding share of electricity can be rated with an emission factor of zero. The MoU or other precontractual agreement provided at application stage must contain a statement that the electricity source will be additional.

Heat:

Heat consumed by the project is accounted for using a default emission factor (EF_{heat}). If a project can prove heat consumption and sourcing of heat with a purchase agreement,

[49] Data available from https://ec.europa.eu/energy/data-analysis/energy-modelling/eu-reference-scenario-2020_en

[50] Renewable electricity shall be considered as additional if the installation generating the renewable electricity comes into operation not earlier than 36 months before the entry into operation of the manufacturing project.

the project can deviate from the default value. The share of the energy sourced under the purchase agreement and the verifiable emission factor must be specified annualy.

Hydrogen:

Hydrogen consumed by the project is accounted for using a default emission factor (EF_{H2}). If a project can prove hydrogen consumption and sourcing of hydrogen with a purchase agreement, the project can deviate from the default value. The share of the energy sourced under the purchase agreement and the verifiable emission factor must be specified annualy.

(Natural) gas:

Natural gas consumed by the project is accounted for using a default emission factor (EF_{NG}). If a project can prove decarbonized gas consumption and sourcing of decarbonized gas with a purchase agreement, the project can deviate from the default value. The share of the energy sourced under the purchase agreement and the verifiable emission factor must be specified annualy.

Other forms of energy:

For other forms of energy imported by the project, the base value for energy consumption in TJ and an appropriate emission factor must be given. The emission factor (t CO_2e / TJ) must be well justified and referenced, and representative of the type of energy.

Customized emission factors can be entered in the GHG Calculator in (*Manufacturing: Project energy: Zero-rated RE share and other energy emission factors*).

Emissions not related to energy generation or consumption:

Project emissions not originating from energy generation or energy consumption are also considered and need to be specified as tonnes CO_2e per year.

7.3.2.5 Project manufacturing carbon footprint sub-equations

Parameter	=	Equation	
$Proj_{direct,y}$	=	$E_{Proj,elect,y} * (1 - s_{PA,elec,y}) * EF_{electricity}$ $+ E_{Proj,heat,y} * ((1 - s_{PA,heat,y}) * EF_{heat} + s_{PA,heat,y} * EF_{PA,heat,y})$ $+ E_{Proj,h2,y} * ((1 - s_{PA,heat,y}) * EF_{H2} + s_{PA,H2,y} * EF_{PA,H2,y})$ $+ E_{Proj,dc\text{-}gas,y} * ((1 - s_{PA,dc\text{-}gas,y}) * EF_{NG} + s_{PA,dc\text{-}gas,y} * EF_{PA,dc\text{-}gas,y})$ $\sum_{i=5}^{I_{proj}} (E_{Proj,i,y} * EF_i)$ $+ E_{Proj,non\text{-}energy,y}$	[7.7]
$Proj_{upstream\text{-}outside,y}$	=	$\sum_{j=1}^{J} (1 - s_{up\text{-}in,Proj,j,y}) * Proj_{up,j} * EF_{up,Proj,j,y}) * Proj_{production,y}$	[7.8]
$Proj_{rawmaterial,y}$	=	$\sum_{k=1}^{K} (s_{Proj,recy,k,y} * EF_{recy,j} + (1 - s_{Proj,recy,k,y}) * EF_{raw,k}) * Proj_{raw,k,y} * Proj_{production,y}$	[7.9]

Where:

$E_{Proj,i,y}$ = Amount of energy sourced from energy carrier i in the project scenario in year y in TJ, tonnes or litres.

$EF_{electricity}$, EF_{heat}, EF_{H2}, EF_{NG} = Default emission factors for electricity, heat, hydrogen and natural gas in the project scenario in kg CO_2e / kWh or t CO_2e / TJ.

$EF_{PA,heat,y}$ = Emission factor for heat sourced via a qualified PA in year y in t CO_2e / TJ.

$EF_{PA,H2,y}$ = Emission factor for hydrogen sourced via a qualified PA in year y in t CO_2e / TJ.

$EF_{PA,dc\text{-}gas,y}$ = Emission factor for decarbonized gas sourced via a qualified PA in year y in t CO_2e / TJ.

$s_{PA,elect,y}$ = Share of electricity sourced from direct line to renewable energy or via a qualified PPA in year y.

$s_{PA,heat,y}$ = Share of heat sourced via a qualified PA in year y with an emission factor that verifiably differs from the default value.

$s_{PA,H2,y}$ = Share of hydrogen sourced via a qualified PA in year y with an emission factor that verifiably differs from the default value (e.g. green hydrogen).

$s_{PA,dc\text{-}gas,y}$ = Share of decarbonized gas sourced via a qualified PA in year y with an emission factor that verifiably differs from the default value for natural gas.

$E_{non\text{-}energy,y}$ = Non-energy related emissions in the project scenario in tonnes CO_2e.

I_{proj} = Energy carriers considered in the project scenario, excluding electricity, heat, hydrogen and natural gas.

$s_{up\text{-}in,Proj,j,y}$ = Share of upstream component j produced within project boundary in year y in percent. $s_{up\text{-}in,Proj,Al\text{-}CC,y}$ = $s_{up\text{-}in,Proj,Cu\text{-}CC,y}$ = 0 per default.

$Proj_{up,j,y}$ = Specific use of upstream component j in the project in year y in kg / kWh.

$EF_{up,Proj,j,y}$ = Emission factor for the production of upstream components by external suppliers (not within project boundaries) j in the project scenario in year y in kg CO_2e / kg; different to reference value if third party verified data can be provided.

J = Upstream components considered in the project scenario.

$Proj_{raw,k,y}$ = Specific use of raw material k in the project in year y in kg / kWh.

$s_{ref,recy,k,y}$ = Share of recycled raw material k used in the project scenario in year y.

$EF_{raw,j}$ = Emission factor for the extraction and provision of raw materials in kg CO_2e / kg elemental equivalent.

$EF_{recy,j}$ = Emission factor for the processing and provision of secondary raw materials from recycling in kg CO_2e / kg elemental equivalent.

K = Raw materials considered in the project scenario.

7.3.3 Dealing with additional output and scrap

7.3.3.1 Dealing with additional output

A process or facility may provide more than one function, i.e., it delivers goods and/or services apart from the product of interest defined by the project (i.e. battery cells, including selected upstream components as defined in the INNOVFUND-2024-BATT Call Text). All data in the GHG calculation must refer exclusively to the product of interest.

7.3.3.2 Dealing with production scrap

Battery cell production produces unavoidable scrap (e.g. cuttings, coating at the start of a new coil, residues in mixing vessels, etc.) and scrap due to faulty production that is in principle avoidable.

For the purposes of GHG calculations, the reject rate due to faulty production shall be assumed to be 0%.

For the purposes of GHG calculations, the unavoidable scrap shall be assumed to be 0%.

7.4 Absolute GHG emission avoidance

Term	=	Emissions	
ΔGHG_{abs}	=	$\sum_{y=1}^{10}$ $Ref_y - Proj_y$	[7.10]
$Proj_y$	=	$Proj_{manuf,y} + Proj_{pack,y} + Proj_{use,y} + Proj_{EoL,y}$	[7.11]

Where:

Ref_y = GHG emissions due to the use of diesel in the reference scenario internal combustion fuel, attributed to the year of production in year y, in tonnes CO_2e. Calculated according to Equation [12].

$Proj_{manuf,y}$ = GHG emissions due to manufacturing of battery cells in year y, in tonnes CO_2e. Calculated according to Equation [3] (see section 7.3).

$Proj_{pack,y}$ = GHG emissions due to battery pack manufacturing in year y, in tonnes CO_2e. Calculated according to Equation [13].

$Proj_{use,y}$ = GHG emissions of the use phase of the battery cell attributed to the year of production in year y, in tonnes CO_2e. Calculated according to Equation [14].

$Proj_{EoL,y}$ = GHG emissions of the end of life recycling of the battery cell attributed to the year of production in year y, in tonnes CO_2e. Calculated according to Equation [15].

7.4.1 Reference scenario

For the reference scenario, the same basic assumptions on car life within project duration and usage of the car as for the project scenario are made (see section 7.4.2).

In addition, it is assumed that an internal combustion engine powered by diesel uses three times as much energy as an EV. This way, the diesel consumed by the conventional vehicle is calculated. The emission factor for diesel applied considers the lifecycle emissions of production and combustion of the diesel. This ensures consistency with the approach taken for battery cells here, which also considers the production phase of the battery cell.

7.4.1.1 Reference emissions sub-equations

Parameter	**=**	**Equation**	
$Ref_{t,y}$	=	$10 * Proj_{production,y} / EV_{capacity} * BEV_{consumption} * EER * BEV_{distance} * EF_{Diesel}$	[7.12]

Where:

$Proj_{production,y}$ is defined in section 7.3.1.5

$EV_{capacity}$ = Assumed EV battery pack storage capacity of 100 kWh.

$BEV_{consumption}$ = Assumed EV electricity consumption of 19 kWh / 100 km.

EER = Energy efficiency ratio for electrical vehicle compared to diesel internal combustion enginge (ICE) of 3.

$BEV_{distance}$ = Assumed annual mileage of 14,300 km.

EF_{Diesel} = Emission factor for the combustion of diesel of 2.68 kg CO_2e / L.

7.4.2 Project scenario / EV use case

It is assumed that the battery cells are mounted into EVs and that each EV carries a battery of 100 kWh capacity. For this purpose, fixed emission factors are assumed for the production of the battery packs. These cannot be changed.

It is further assumed that each EV runs 14,300 km per year and uses 19 kWh/100km. Electricity consumed during the EV use phase is rated with a fixed emission factor based on the average emissions of the 2030 EU grid electricity mix, independent of the geographical location of the project.

The use period of the EV in the calculation methodology is set as 10 years. This corresponds at least to the current warranty periods of the automobile manufacturers. This assumption is independent of a possibly longer real lifetime of EV batteries and cannot be changed.

The emissions of the use phase are calculated with a fixed emission factor and are attributed to the years in which the battery cells are produced. No battery replacement during the use phase of the EV is assumed.

The EoL recycling of batteries in the EV use case is considered by fixed emission factors and cannot be changed.

7.4.2.1 Project emissions sub-equations

Parameter	**=**	**Equation**	
$Proj_{pack,y}$	=	$Proj_{production,y} / EV_{capacity} * EF_{pack}$	[7.13]
$Proj_{use,y}$	=	$10 * Proj_{production,y} / EV_{capacity} * BEV_{consumption} * BEV_{distance} * EF_{electricity}$	[7.14]
$Proj_{EoL,y}$	=	$Proj_{production,y} * EF_{EoL}$	[7.15]

Where:

$Proj_{production,y}$ is defined in section 7.3.1.5.

$EV_{capacity}$, $BEV_{consumption}$ and $BEV_{distance}$ are defined in section 7.4.1.1.

EF_{pack} = Emission factor for the production of EV battery packs in kg CO_2e / unit.

EF_{EoL} = Emission factor for the end of life (EoL) treatment of battery packs.

7.5 Relative GHG emission avoidance

Term	=	Emissions	
ΔGHG_{rel}	=	$\sum_{y=1}^{10} (Ref_y - Proj_y) / (\sum_{y=1}^{10} Ref_y)$	[7.16]

The terms are explained in section 7.4.

7.6 Reference data and parameters

The calculation of the manufacturing carbon footprint and the EV use case emissions are based on assumptions and data taken from the literature.

Where possible, this methodology uses peer-reviewed global data. If only regional data were available, data for Europe or Asia were used.

In some cases, different process options differ greatly in terms of resulting emission factors. For example, there are several possible processes for producing battery-grade cobalt sulphate from primary cobalt sources. In general, the data sets that were selected were those closest to current production processes in the battery value chain. In some cases, several transforming activities from the Ecoinvent database have been linked or mean values of different processes, raw materials or end products were calculated.

For the reference manufacturing process, the production of battery cells using 2023 state-of-the-art technology was assumed. The bill of materials is based on a mix of 20% lithium iron phosphate cells (LFP) and 80% nickel-manganese-cobalt-oxide cells (NMC622).

Table 7.4 and Table 7.5 present the parameters that will be deemed as constant throughout the duration of the project, unless otherwise stated.

Table 7.4. Standard factors

Data / Parameter	Proposed value	Data unit	Description	Source of data	Assumption / Comment
$EF_{electricity}$	48.9	t CO_2e / TJ	Emissions for electricity generation within the EU	EU Reference Scenario 2020 - European Commission	
$EF_{electricity,global}$	161.1	t CO_2e / TJ	Emissions for electricity generation for reference	Value of global value chain by assumption	
EF_{H2}	57	t CO_2e / TJ	Emission benchmark for generating hydrogen under the ETS	COMMISSION IMPLEMENTING REGULATION (EU) 2021/447 of 12 March 2021	Starting point for determination of annual reduction rate for benchmark value update not yet defined
EF_{heat}	47.3	t CO_2-eq / TJ	Emission benchmark for generating heat under the ETS	COMMISSION IMPLEMENTING REGULATION (EU) 2021/447 of 12 March 2021	Starting point for determination of annual reduction rate for benchmark value update not yet defined
EF_{NG}	56.2	t CO_2e / TJ	Emission factor for combustion of natural gas	COMMISSION DELEGATED REGULATION (EU) 2018/2066 of 19 December 2018, annex VI	
EF_{NG}	0.00215	t CO_2e / m^3	Emission factor for combustion of natural gas	COMMISSION DELEGATED REGULATION (EU) 2018/2066 of 19 December 2018, annex VI	Assumes density of 800 g / m^3

$EF_{gasoline}$	0.00228	t CO_2e / L	Emission factor for the combustion of gasoline	COMMISSION DELEGATED REGULATION (EU) 2018/2066 of 19 December 2018, annex VI	No biofuel blend. Motor gasoline. Assumes density of 742 g / L. gasoline EF is 69.3 gCO2/MJ. LHV is 44.3 MJ/kg
$EF_{gasoline}$	69.3	t CO_2e / TJ	Emission factor for the combustion of gasoline	COMMISSION DELEGATED REGULATION (EU) 2018/2066 of 19 December 2018, annex VI	LHV = 44,3 TJ/tonne or MJ/kg
EF_{diesel}	0.00268	t CO_2e / L	Emission factor for the combustion of diesel	Based on EF and NCV from 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2. Energy. Available at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	No biofuel blend. Diesel oil. Assumes density of 840 g / L
EF_{diesel}	74.3	t CO_2e /TJ	Emission factor for the combustion of diesel	COMMISSION DELEGATED REGULATION (EU) 2018/2066 of 19 December 2018, annex VI	
$EF_{heavyoil}$	77.6	t CO_2e/TJ	Emission factor for combustion of heavy fuel oil	Based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Available at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	
$EF_{heavyoil}$	3.12	t CO2e / t	Emission factor for combustion of heavy fuel oil	Based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Available at: https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	Assumes NCV = 40.2 GJ/tonne
	0.0000036	TJ / kWh	Energy unit conversion factor	Fundamental unit definition	

Table 7.5. Battery specific factors

Data / Parameter	Proposed value	Data unit	Description	Source of data	Assumption / Comment
Battery methodology factors					
$EV_{capacity}$	100	kWh	Battery capacity in a BEV	By assumption	
$BEV_{consumption}$	0.19	kWh / km	BEV electricity consumption	By assumption	
EER	3	kWh / kWh	Energy efficiency ratio for electrical vehicle compared to diesel ICE	By assumption	Assuming a three times higher efficiency of electric motors compared to combustion engines.
$BEV_{distance}$	14300	km / year	distance driven by car per year	By assumption	
EF_{Diesel}	80.4	t CO_2e / TJ	Diesel reference with diesel production	By assumption	
Manufacturing: Reference bill of materials					
$S_{pCAM-CAM}$	1.05	kg / kg	pCAM/CAM weight ratio in kg/kg	Typical CAM precursor for NMC and LFP materials	
$Ref_{raw,Li}$	0.115	t / MWh	Reference BoM Li	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{raw,Al}$	0.600	t / MWh	Reference BoM Al	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{raw,Mn}$	0.155	t / MWh	Reference BoM Mn	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{raw,Fe}$	0.142	t / MWh	Reference BoM Fe	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{raw,Co}$	0.166	t / MWh	Reference BoM Co	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	

$Ref_{raw,Ni}$	0.495	t / MWh	Reference BoM Ni	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{raw,Cu}$	0.490	t / MWh	Reference BoM Cu	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{raw,F}$	0.123	t / MWh	Reference BoM F	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{raw,Carbon}$	1.030	t / MWh	Reference BoM Carbon	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{up,pCAM}$	1.700	t / MWh	Reference BoM pCAM	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{up,CAM}$	1.780	t / MWh	Reference BoM CAM	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{up,AAM}$	0.910	t / MWh	Reference BoM AAM	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{up,Electrolyte}$	0.760	t / MWh	Reference BoM electrolyte	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{up,Separator}$	0.100	t / MWh	Reference BoM separator	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{up,Al\text{-}CC}$	0.195	t / MWh	Reference BoM Al current collector	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
$Ref_{up,Cu\text{-}CC}$	0.490	t / MWh	Reference BoM Cu current collector	Mix of 20% LFP cells and 80% NMC622 cells, 2023 technology	
Manufacturing: Energy consumption and emission factors					
Energy consumption cell production	kWh / kWh_cell	35	Reference energy consumption for production of the defined reference cells.	Degen et al. 2022 (https://doi.org/10.1016/j.jclepro.2021.129798), Degen et al. 2023 (https://doi.org/10.1038/s41560-023-01355-z), Dai et al. (https://www.mdpi.com/2313-0105/5/2/48), Kurland (http://dx.doi.org/10.1088/2515-7620/ab5e1e), von Drachenfels et al. (https://doi.org/10.1002/ente.202200673)	

Emissions not originating from energy consumption cell production	kg CO_2e / kWh_cell	0.25	Reference direct emissions during cell production	Ecoinvent DB, 24576, 24741	
EF_{pack}	6	kg CO_2e / kWh	Emissions battery pack assembly	Estimation based on Sun et al. (https://doi.org/10.1016/j.jclepro.2020.123006)	
EF_{EoL}	0	kg CO_2e / kWh	Emissions end of life recycling of battery packs		Cut-off approach
E_{pCAM}	9	kWh / kg	Energy consumption pCAM production	Averaged values for NMC and LFP taken from Sun et al. (https://doi.org/10.1016/j.jclepro.2020.123006), Dai et al. (https://www.mdpi.com/2313-0105/5/2/48) / Ecoinvent DB 24661 and Quan et al. (https://doi.org/10.1016/j.scitotenv.2022.153105)	
$EF_{pCAM-non-energy}$	0.8	kg CO_2e / kg	Emissions not originating from energy consumption pCAM production	Averaged values for NMC and LFP taken from Sun et al. (https://doi.org/10.1016/j.jclepro.2020.123006), Dai et al. (https://www.mdpi.com/2313-0105/5/2/48) and Quan et al. (https://doi.org/10.1016/j.scitotenv.2022.153105)	
E_{CAM}	8	kWh / kg	Energy consumption CAM production	Averaged values for NMC and LFP taken from Sun et al. (https://doi.org/10.1016/j.jclepro.2020.123006), Dai et al. (https://www.mdpi.com/2313-0105/5/2/48) / Ecoinvent DB 24710 and Quan et al. (https://doi.org/10.1016/j.scitotenv.2022.153105)	
$EF_{CAM-non-energy}$	0.18	kg CO_2e / kg	Emissions not originating from energy consumption CAM production	Averaged values for NMC and LFP taken from Sun et al. (https://doi.org/10.1016/j.jclepro.2020.123006), Dai et al. (https://www.mdpi.com/2313-0105/5/2/48) / Ecoinvent DB 24710, Quan et al. (https://doi.org/10.1016/j.scitotenv.2022.153105) and Ecoinvent DB 27232	

E_{AAM}	12	kWh / kg	Energy consumption AAM production	Averaged values for NG and SG taken from Iyer et al. (https://doi.org/10.2172/1891640) / GREET2022, Falcone et al. (https://doi.org/10.3390/batteries8080076) and Ecoinvent DB 24786	
$EF_{AAM\text{-}non\text{-}energy}$	0.9	kg CO_2e / kg	Emissions not originating from energy consumption AAM production	Averaged values for NG and SG taken from Iyer et al. (https://doi.org/10.2172/1891640) / GREET2022 and Ecoinvent DB 24786	
$EF_{Electrolyte}$	5.6	kg CO_2e / kg	Emissions electrolyte production	Ecoinvent DB, 24889	
$EF_{Separator}$	34	kg CO_2e / kg	Emissions separator production	Ecoinvent DB, averaged values of 3764 and 8842	
$EF_{Al\text{-}CC}$	12.3	kg CO_2e / kg	Emissions Al current collector foil production	Averaged values from Falcone et al. (https://doi.org/10.3390/batteries8080076) and Ecoinvent DB 24698	
$EF_{Cu\text{-}CC}$	6.45	kg CO_2e / kg	Emissions Cu current collector foil production	Averaged values from Falcone et al. (https://doi.org/10.3390/batteries8080076) and Ecoinvent DB 24660	
Raw material emission factors, secondary materials					
$EF_{recy,Li}$	15.8	kg CO_2e / kg	Emissions from secondary production of lithium	Ali et al. 2024, https://doi.org/10.1016/j.resconrec.2023.107384	
$EF_{recy,F}$	1.33	kg CO_2e / kg	Emissions from secondary production of fluorine	n/a, as primary	
$EF_{recy,Na}$	1.53	kg CO_2e / kg	Emissions from secondary production of sodium	n/a, as primary	

$EF_{recy,Al}$	2.5	kg CO_2e / kg	Emissions from secondary production of aluminium	Calculation based on Mohr et al. 2020, https://onlinelibrary.wiley.com/doi/pdf/10.1111/jiec.13021	
$EF_{recy,Si}$	30.8	kg CO_2e / kg	Emissions from secondary production of silicon	n/a, as primary	
$EF_{recy,P}$	2.18	kg CO_2e / kg	Emissions from secondary production of phosphorus	n/a, as primary	
$EF_{recy,S}$	0	kg CO_2e / kg	Emissions from secondary production of sulfur	n/a, as primary	
$EF_{recy,Cl}$	0	kg CO_2e / kg	Emissions from secondary production of chlorine	n/a, as primary	
$EF_{recy,Ti}$	93	kg CO_2e / kg	Emissions from secondary production of titanium	n/a, as primary	
$EF_{recy,V}$	3.78	kg CO_2e / kg	Emissions from secondary production of vanadium	n/a, as primary	
$EF_{recy,Mn}$	8.1	kg CO_2e / kg	Emissions from secondary production of manganese	Ali et al. 2024, https://doi.org/10.1016/j.resconrec.2023.107384	
$EF_{recy,Fe}$	0.24	kg CO_2e / kg	Emissions from secondary production of iron	n/a, as primary	

$EF_{recy,Co}$	7.8	kg CO_2e / kg	Emissions from secondary production of cobalt	Ali et al. 2024, https://doi.org/10.1016/j.resconrec.2023.107384	
$EF_{recy,Ni}$	7.8	kg CO_2e / kg	Emissions from secondary production of nickel	Ali et al. 2024, https://doi.org/10.1016/j.resconrec.2023.107384	
$EF_{recy,Cu}$	1.7	kg CO_2e / kg	Emissions from secondary production of copper	Ecoinvent DB, 1138	
$EF_{recy,Zn}$	0.0038	kg CO_2e / kg	Emissions from secondary production of zinc	Ecoinvent DB, 21545	
$EF_{recy,Ge}$	151.00	kg CO_2e / kg	Emissions from secondary production of germanium	Secondary production from Robertz et al. 2015, DOI: 10.1007/s11837-014-1267-6	
$EF_{recy,Zr}$	26.18	kg CO_2e / kg	Emissions from secondary production of zirconium	n/a, as primary	
$EF_{recy,La}$	31.14	kg CO_2e / kg	Emissions from secondary production of lanthanum	n/a, as primary	
$EF_{recy,Pb}$	0.38	kg CO_2e / kg	Emissions from secondary production of lead	Ecoinvent DB, 9161	
$EF_{recy,Carbon}$	4.9	kg CO_2e / kg	Emissions from secondary production of basic carbon materials	n/a, as primary	
Raw material emission factors: Primary materials					

$EF_{raw,Li}$	31.95	kg CO_2e / kg	Emissions from primary production of lithium	Ecoinvent DB, 2085, 24583 (50/50 mix of brine and spodumene)	
$EF_{raw,F}$	1.33	kg CO_2e / kg	Emissions from primary production of fluorine	Ecoinvent DB, 19069	
$EF_{raw,Na}$	1.53	kg CO_2e / kg	Emissions from primary production of sodium	Ecoinvent DB, 27939	
$EF_{raw,Al}$	11.62	kg CO_2e / kg	Emissions from primary production of aluminum	IEA 2021, Al mining and processing https://www.iea.org/data-and-statistics/charts/average-ghg-emissions-intensity-for-production-of-selected-commodities	
$EF_{raw,Si}$	30.8	kg CO_2e / kg	Emissions from primary production of silicon	Ecoinvent DB, 3823	
$E_{Fraw,P}$	2.18	kg CO_2e / kg	Emissions from primary production of phosphorus	Belboom et al. 2015 http://dx.doi.org/10.1016/j.jclepro.2015.06.141	
$EF_{raw,S}$	0	kg CO_2e / kg	Emissions from primary production of sulfur	n/a	
$EF_{raw,Cl}$	0	kg CO_2e / kg	Emissions from primary production of chlorine	n/a	
$EF_{raw,Ti}$	93	kg CO_2e / kg	Emissions from primary production of titanium	Ecoinvent DB, 13572, 24518	
$EF_{raw,V}$	3.78	kg CO_2e / kg	Emissions from primary production of vanadium	Ecoinvent DB, 24768	

$EF_{raw,Mn}$	6.2	kg CO_2e / kg	Emissions from primary production of manganese	Falcone et al. 2022, https://doi.org/10.3390/batteries8080076	
$EF_{raw,Fe}$	0.236	kg CO_2e / kg	Emissions from primary production of iron	Ecoinvent DB, 7544	
$EF_{raw,Co}$	18.42	kg CO_2e / kg	Emissions from primary production of cobalt	Kallitsis et al. 2024 https://doi.org/10.1016/j.jclepro.2024.141725	
$EF_{raw,Ni}$	14.86	kg CO_2e / kg	Emissions from primary production of nickel	Kallitsis et al. 2024 https://doi.org/10.1016/j.jclepro.2024.141725	
$EF_{raw,Cu}$	15.4	kg CO_2e / kg	Emissions from primary production of copper	Econinvent DB, 21253, 23772	
$EF_{raw,Zn}$	2.5	kg CO_2e / kg	Emissions from primary production of zinc	Ecoinvent DB, 13957	
$EF_{raw,Ge}$	698.00	kg CO_2e / kg	Emissions from primary production of germanium	Primary production from Robertz et al. 2015, DOI: 10.1007/s11837-014-1267-6	
$EF_{raw,Zr}$	26.18	kg CO_2e / kg	Emissions from primary production of zirconium	Ecoinvent DB, 5657, 26331	
$EF_{raw,La}$	31.14	kg CO_2e / kg	Emissions from primary production of lanthanum	Ecoinvent DB, 22675, 23500	
$EF_{raw,Pb}$	3.08	kg CO_2e / kg	Emissions from primary production of lead	Ecoinvent DB, 10760, 21163	

$EF_{raw,Carbon}$	4.9	kg CO_2e / kg	Emissions from primary production of basic carbon material	ANL-22/74 2022, Iyer et al., Updated production inventory for Lithium-Ion Battery Anodes for the GREET Model, and Review of Advanced Battery Chemistries, Argonne National Lab	

7.7 Monitoring reporting and verification requirements for projects applyingunder the INNOVFUND-2024-BATT call

When submitting their proposal, applicants shall include a detailed monitoring plan consisting of a complete and transparent documentation of the parameters used in GHG calculations and data sources. This can be done by completing the dedicated "Data traceability" section in project emissions tab the GHG calculators, which are provided as templates in spreadsheet format.

At the reporting stage, during project operation, all measurements should be conducted with calibrated measurement equipment according to industry standards and in line with relevant EU ETS requirements, as applicable.

Each parameter monitored shall be accompanied with the following information, which shall be included in the dedicated "Data traceability" section in the GHG calculators, provided as templates in spreadsheet format:

Area / Department responsible for collection and archiving.

Data source.

Equipment used for monitoring, including details on accuracy and calibration.

Monitoring frequency

QA/QC Procedures

Brief description, including measurement methods and procedures.

Reliability.

Parameters to be monitored shall include to a minimum:

Table 7.6. Parameters for monitoring for a battery manufacturing project

Data / Parameter	Data unit	Description	Comment
$E_{in,x}$	TJ	Energy used by the project of type *x*, *x* includes the energy source as well as the energy sourcing, e.g. purchase agreement and the associated emission factors	Hourly data required for knowledge sharing purposes.
$E_{Proj,x}$	TJ	Allocation of consumed energy to all co-products in compliance with allocation rules.	Yearly figures

Data / Parameter	Data unit	Description	Comment
$E_{Proj,non-energy,z}$	tonnes	Amount of process-inherent emissions of greenhouse gas z at the project site	Yearly figures
$M_{comp-up,x}$	tonnes / m² for separator	Amount of upstream components defined in section 7.2.1, 7.2.2.2 and consumed by the project	Yearly figures
$M_{Proj,comp-up,x}$	tonnes / m² for separator	Amount of upstream components defined in section 7.2.1 and 7.2.2.2 produced and consumed by the project	Yearly figures
EF_x	kg CO_2e / ton	List of emission factors for upstream component sourcing and the sources of the data (section 7.3.2.3).	Yearly figures
$M_{comp-raw,x}$	tonnes	Amount of raw materials as elemental equivalent contained in the upstream components consumed by the project (section 7.3.2.1)	Yearly figures
$Q_{cell,x}$	MWh	Amount of battery storage capacity produced by the project and supplied by the project to customers of battery cell type x	Yearly figures. Justify the sale volumes with adequate supporting documents, such as invoices
$C_{cell,x}$	MWh	Machine / facility capacity for battery cell production of battery cell type x	Yearly figures.
$M_{scrap,x}$	tonnes	Amount of production scrap of type x (e.g. AAM, CAM, electrodes, finished cells) produced by the project	Yearly figures

Source: European Commission internal elaboration.

In addition to the parameters listed above, further parameters will be monitored for knowledge-sharing purposes: check the knowledge sharing report template available on the Funding and Tenders Portal.

7.8 Definitions specific to methodology for projects applying under the INNOVFUND-2024-BATT call

For the purpose of this methodology, the following definitions apply:

(1) 'activity data' means data on the amount of fuels or materials consumed or produced by a process relevant for the calculation-based monitoring methodology, expressed in

terajoules, mass in tonnes or (for gases) volume in normal cubic metres, as appropriate.

(2) 'battery grade': Quality and purity grade for chemicals and components making them suitable for battery (component) production without any further refinement or purification steps.

(3) 'calculation factors' means net calorific value, emission factor, oxidation factor, conversion factor, carbon content or biomass fraction.

(4) 'combustion emissions' means greenhouse gas emissions occurring during the exothermic reaction of a fuel with oxygen. Used for calculating the direct carbon emissions for processes in *EU ETS* benchmarks.

(5) 'co-product': All products of a process or facility that provides more than one function, i.e., it delivers several goods and/or services.

(6) 'decarbonized gas': Gas (e.g. methane) either produced from renewable resources, such as biomass, natural waste or water (hydrogen electrolysis) or natural gas combined with a carbon capture process, either before its use (pre-combustion) or post-combustion.

(7) 'elemental equivalents': Total mass of a chemical compound multiplied by the mass fraction of a particular element in chemical compounds

(8) 'direct emissions' from the use of fossil fuels and generation of heat.

(9) 'emission factor' means the average emission rate of a greenhouse gas relative to the activity data of a source stream assuming complete oxidation for combustion and complete conversion for all other chemical reactions.

(10) 'indirect emissions' from the use of grid electricity and grid heat.

(11) 'fugitive emissions' means irregular or unintended emissions from sources that are not localised, or too diverse or too small to be monitored individually.

(12) 'tonnes of CO_2e' means metric tonnes of CO_2 or CO_2e.

(13) 'upstream components': All components that can be used directly as input materials for battery cell production.

(14) 'waste' means waste as defined in point (1) of Article 3 of Directive 2008/98/EC, excluding substances that have been intentionally modified or contaminated in order to meet this definition.

Appendix 1

Hierarchy of data sources for inputs and products in industrial projects, including projects with CCS

The GHG emissions intensity and combustion emissions of inputs or products, **that are not specified elsewhere in the relevant section of the methodology, such as section 2 for energy intensive industries (EII),** and need to be sourced from literature, will be taken from the sources listed below. Emission factors that are taken from sources in the hierarchy should **represent the typical emissions intensity for that specific input or product**.

Emissions values for heat, electricity and hydrogen are provided in the methodology and therefore must never be taken from sources in the data hierarchy. In addition, The EU ETS benchmark emission factors **may not be used** as emissions factors for inputs or products, as the scope of the EU ETS benchmark calculation is not appropriate for this purpose.

Note that the **emissions intensities** are not the same as **combustion emissions** (which are used for calculating the direct carbon emissions for processes in EU ETS). Emissions intensities, which are also known for transport fuels as well-to-wheels emissions, comprises combustion emissions and also all the "upstream" emissions from the supply chain extraction of raw materials, all steps in the processing, transport and distribution.

Applicants should generally use values taken from the highest level at which a value is available, looking at the hierarchyfrom the top to the bottom . If an applicant deviates from the hierarchy (i.e. chooses to use a value from a source lower in the hierarchy when a value is available at a higher source) the applicant must credibly justify why the value from the lower source is a better characterisation of the typical emissions intensity of that input.

Since the values used in the GHG emission avoidance calculations should represent current typical practices, a deviation from the hierarchy may not be justified by arguing that the chosen value more closely represents the situation of the applicant's supplier. Similarly, applicants are **not permitted** to adjust values from the hierarchy by making alternative assumptions about the upstream emissions for production of an input or product even if they are able to identify specific details about the process used by their supplier. Applicants are also **not permitted** to adjust values from the hierarchy to reflect the zero emission intensity for electricity consumption that is used elsewhere in the calculations.

If using values for different inputs from more than one source at the same level of the hierarchy, the application should explain why this was necessary; cherry-picking favourable values is not allowed.

The hierarchy of data sources is provided below:

1. Typical emissions for production of a number of forms of **biomass, biogas, biomethane, bioliquid and biofuels** are provided in Annexes V and VI of 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 (Recast).

2. Stoichiometric combustion emissions for a wide range of **fuels** are provided in 2019 Refinement to the IPCC 2006 Guidelines for National Greenhouse Gas Inventories. More precisely, this information can be found in tables 2.2 and 2.3 of Vol.2 Energy of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories.[51]

[51] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf.

3. Emissions intensity for most widely-used process **chemicals** are provided in Table 47 of the Report "Definition of input data to assess GHG default emissions from biofuels in EU legislation" (European Commission 2019).[52]

4. If the data is not available at a higher level of the hierarchy, coherent data for a different range of inputs/products may be found in JEC-WTW v.5, WTT Annexes[53], which shares the same input database as the calculations in Annex V of REDII.

5. a. Calculations using input data from **ECOINVENT 3.5**, or more recent versions. Calculations in ECOINVENT should use the "cut-off system model". An equivalent calculation may also be made in proprietary software packages (e.g., GABI, open LCA) using the same input data. If the calculation calls for allocation of emissions between multiple products, allocation by economic value should be selected (the database includes the cost of products).

   b. "Official" sources, such as IPCC, IEA or governments (noting however that most IPCC and IEA tables show combustion emissions, not lifecycle emissions intensity).

   c. Other reviewed sources of data, such as E3 database, GEMIS database.

   d. Peer-reviewed publications. The applicant should properly reference the source used so that the evaluator is able to check against it, but does not have to provide a review of the methodology adopted by the chosen source (the GHG methodology is not prescriptive about specific LCA decisions when peer reviewed sources are used). Note that the use of LCA-derived values is only allowed within the provisions regulating the application of the hierarchy of data sources. It is not acceptable to simply take a value without developing the GHG emission avoidance calculations in full alignment with the methodology.

6. Duly documented and justified own-estimates.

7. "Grey literature": unreviewed sources, such as commercial literature and websites. It is not acceptable to simply take a calculated value for an entire process from the literature without developing the GHG emission avoidance calculations in full alignment with the methodology.

[52] https://ec.europa.eu/jrc/en/publication/definition-input-data-assess-ghg-default-emissions-biofuels-eu-legislation.

[53] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC119036/jec_wtt_v5_119036_annexes_final.pdf.

Appendix 2

Processes with a fixed ratio of outputs: definition of rigid, elastic and semi-elastic products

Some inputs may be products of processes that produce a fixed ratio of outputs. Consider a process that produces various outputs (principal products, non-principal products, residues or wastes) in fixed ratios and with different prices. If the incentive for a company to increase the production of the whole plant is proportional to the sum of the economic value of all the outputs; the fraction of the incentive from one output is proportional to its value-fraction in the "total value of all the products produced by the process".

For example, if one output is a waste with zero value, its value-fraction is zero and there is no incentive to increase overall production to supply more of it. This means the waste has a rigid supply. At the opposite extreme, if the process only has one output, then it represents the entire incentive to increase production, so the supply of that output will increase with demand, its supply is elastic.

In order to reduce the administrative burden of the calculation for products that are in between these extremes, the following simplification is applied:

A product that represents less than 10% of the value of the total products of the supplier are treated as rigid, and their emissions calculated accordingly.

A product that represents more than 50% of the total value of the products of the supplier are treated as elastic, and their emissions calculated accordingly.

The emissions attributed to a product that represent between 10% and 50% of the total value of the products of the production process shall be:

$$\frac{(emissions\ assuming\ elastic\ source\ ) * (VF - 0.1) + (emissions\ assuming\ rigid\ source) * (0.5 - VF)}{(0.5 - 0.1)}$$

where:

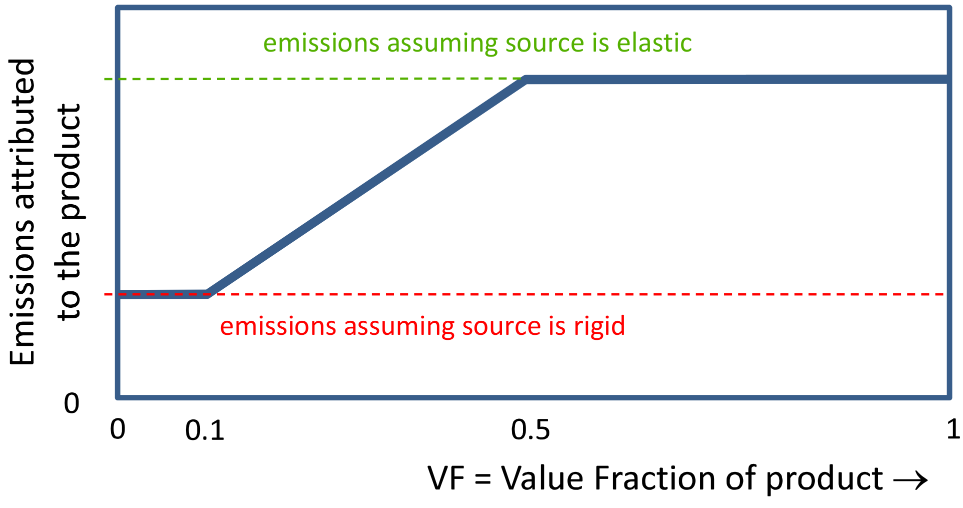
VF = Value Fraction of the product =

$$\frac{(value\ of\ the\ product)}{(total\ value\ of\ all\ the\ products\ produced\ by\ the\ process)}$$

This relation is represented in the graph in Figure A2.1. This graph is only schematic; the emissions calculated assuming the result is elastic are not necessarily higher than those assuming that it is rigid, and calculated emissions can also be negative.

In calculating VF, the prices should be the average of the data for the last 3 years.

Figure A2.1. Determining emissions for semi-elastic inputs



Source: *European Commission internal elaboration.*

In practice, it is expected that the great majority of inputs fall into either the "elastic" or "rigid" category, so the simplification is considerable in most cases.

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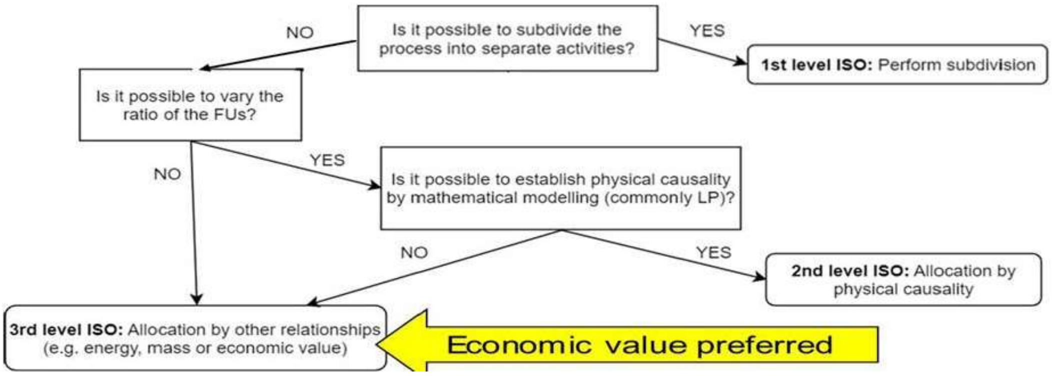
Appendix 3

Attribution of emissions to co-products in emissions calculations for InnovFund projects

In some cases, it may be necessary to attribute emissions associated with production of an input between the input and its co-products. This will generally only be necessary if a source in the data hierarchy provides a characterisation of the production process but does not provide disaggregated emission factors for the co-products. In such cases, a simplified version of the ISO 14044 (2006) multifunctionality framework is used to attribute emissions to co-products, as shown in Figure A3.1.

Figure A3.1. Simplification of the ISO 14044 (2006) hierarchy for sharing emissions between co-products [54]



Source: *European Commission internal elaboration.*

In the flow chart "**allocation by physical causality**" at the second level requires analysis showing the emissions consequences of changing the output of the product without changing the output of co-products, and will often require process modelling.

At the third level, allocation shall generally be made by the **economic value** of the co-products. In general, allocation by any other property (e.g., mass, chemical energy) will only be justified in the case that the specific emissions being allocated are directly related to that property. For example, transport emissions may be largely determined by **mass or volume** of a good rather than its value.

A lack of comprehensive value data shall generally not be considered an adequate reason to use an alternative allocation method. Where value data for a specific input is not readily available, it should be inferred by reference to comparable inputs for which prices are available. Alternative allocation choices would need to be well justified and should only be used as a last analytical resort.

If any installation involved in the process to produce the input treats only one input and no other co-products, then obviously the emissions from that installation can be ascribed entirely to the input. Similarly, if any installation treats only the other co-products, then its emissions may be disregarded.

If that does not completely solve the problem, the next question is whether the process allows one to change the ratio of the co-products produced (as it is possible, for example in a "complex" oil refinery) or whether the ratio is fixed, for example by the stoichiometry of a chemical reaction. If the ratio of outputs is variable, allocation of emissions between

[54] The option in ISO 1044 (2006) to "enlarge the system boundaries to include all the co-functions" does not exist in this case, because we must find the emissions attributable to the "principal product(s)", which are already fixed. Also the option in ISO 1044 (2006) to apply substitution to by-products has been eliminated in order to simplify calculations. Note: LP: linear programming, FU: functional unit.

products is made, if possible, by "physical causality" (level 2 of the ISO hierarchy): calculating the effect on the process' emissions of incrementing the output of just one product whilst keeping the other outputs constant. **This is not the same as allocating using an arbitrary physical property** of the products.

If it is impossible to make the incremental calculation just described, or if the ratio of the products, is fixed, the 3rd level of the hierarchy is invoked. In an industrial process, the motivation for making different products is the market value of the products. So, at this 3rd level, allocation by the economic value[55] of the products is the preferred choice. Allocation by other properties, such as weight or volume, of the different products may only be done where it can be shown that they are the "cause of the limit" of the function.

The point in the supply chain where the allocation is applied shall be at the output of the process that produces the co-products. The emissions allocated shall include the emissions from the process itself, as well as the emissions attributed to inputs to the process.

[55] The average price over the previous 3 years should be used; any other assumption must be justified. Objections that "the price varies" will not be considered: it is better to have a method that is approximately correct than one which is exactly wrong.

Appendix 4

Overview of the Monitoring Reporting and Verification requirements for Innovation Fund projects

Overview

This appendix presents an overview of the Innovation Fund Monitoring Reporting and Verification (MRV) requirements concerning GHG emission avoidance.

When submitting their proposal, applicants shall include a detailed monitoring plan, consisting of a complete and transparent documentation of the parameters and data sources used in GHG calculations, and how they will be monitored during project implementation. This can be done by completing the dedicated "Data traceability" section in the GHG calculators, which are provided as templates in spreadsheet format.

The monitoring plan should be in line with the Commission Implementing Regulation (EU) 2024/2493 of 23 September 2024 (amending Implementing Regulation (EU) 2018/2066) on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council.

MRV specific provisions for InnovFund projects

At the reporting stage, during project operation, all measurements should be conducted with calibrated measurement equipment according to industry standards and in line with relevant EU ETS MRV requirements as applicable.

Each parameter monitored shall be accompanied with the following information, which shall be included in the dedicated "Data traceability" section in the GHG calculators, provided as templates in spreadsheet format:

- Area / Department responsible for collection and archiving.
- Data source.
- Equipment used for monitoring, including details on accuracy and calibration.
- Monitoring frequency.
- QA/QC Procedures.
- Brief description, including measurement methods and procedures.
- Reliability.

Specific MRV provisions for the different InnovFund project categories are given in the following sub-sections.

1. Energy Intensive Industries (EII)

Considering the high heterogeneity of the sectors covered under the EII category, the detailed list of the parameters required to be monitored is a function of the type of project. Parameters that may not need to be monitored are listed in section 2.3, while parameters to be monitored and reported shall include at a minimum:

- The quantities of inputs used by the project, including identification of "de minimis" and "major inputs" following section 2.2.6.2.
- The quantities of principal and non-principal products produced by the project.

- The quantities of fuels consumed to provide energy for the processes of the project.
- The emissions of greenhouse gases associated with the operation of the project. Either from direct measurement, of calculated from other parameters to be monitored, as listed here, or deemed constant, as specified in section 2.3.
- Emission factors associated with biomass-derived inputs to the project.
- Origin of hydrogen used as an input by the project (see section 1.4.3.2).

For projects using biomass-derived fuels and/or materials as inputs, the applicant must monitor the origin and type of the input for each utilised batch, demonstrate that it meets the sustainability requirements (see section 1.4.4), and report the associated emission factor. The emission factor must be calculated following the calculation rules of the RED. Where available, the project may report default emission factors as detailed in Part A or Part B of Annex V or Annex VI of the RED. Where default emission factors are not used, the project shall either report actual emission factors calculated in accordance with the methodology laid down in Part C of Annex V or Annex VI of the RED, or shall report typical emission factors for the relevant input sourced from the data hierarchy, in either case considering only the lifecycle stages specified in section 1.4.4.2.

For projects involving the manufacturing of components (section 1.3), the beneficiary shall monitor and report the number of components manufactured and sold each year. In addition, the beneficiary shall justify the sale volumes, cost assumptions, use period of the component, and the performance of the relevant component, facility, or consumer product with adequate supporting documents, such as invoices and test results.

As an example, Table A4.1 shows the parameters to be monitored for a sample project producing e-methanol from captured CO_2 and hydrogen electrolysis.

Table A4.1. Example of parameters for monitoring a project producing e-methanol

Data / Parameter	**Data unit**	**Description**
Electricity	MWh	Amount of electricity consumed for hydrogen production
Electricity	MWh	Amount of electricity consumed by the utilities
Water	tonnes	Amount of water consumption by the electrolysis installation and e-methanol synthesis
Catalyst	tonnes	Amount of catalyst consumed by the process
Natural gas input to process	tonnes	Amount of natural gas consumed for process heat
CO_2 captured	tonnes	Amount of CO_2 captured for input to e-methanol synthesis reactor
Off-gases	tonnes	Amount and type of off-gases produced by the processes
Hydrogen production	tonnes	Amount of hydrogen produced for input to e-methanol synthesis
e-methanol production	tonnes	Amount of e-methanol produced

Source: European Commission internal elaboration.

In addition to the parameters listed above, the following parameters will be monitored and reported for **knowledge sharing purposes** for projects using grid electricity, where applicable:

- Hourly profiles for use and feed-in of grid electricity.
- Hourly profiles for generation of electricity delivered to the project from PPAs.
- Hourly profiles for avoided curtailment based on final physical notifications of co-located RES plants or grid operator instructions.

Further details on the parameters to be monitored for knowledge-sharing purpose are provided in the Knowledge sharing report template available on the Funding and Tenders Portal.

2. Renewable energy

Parameters that may not need to be monitored are listed in section 3.5, while Table A4.2 presents the parameters that, at minimum, shall be monitored on an annual basis and throughout the monitoring period of the project, and be part of the project's monitoring and reporting plan.

For projects using biomass-derived fuels, including bioenergy projects, the applicant must monitor the origin and type of the input for each utilised batch, demonstrate that it meets the sustainability requirements (see section 1.4.4), and report the associated emission factor. The emission factor must be calculated following the calculation rules of the RED. Where available, the project may report default emission factors as detailed in Part A or Part B of Annex V or Annex VI of the RED. Where default emission factors are not used, the project shall either report actual emission factors calculated in accordance with the methodology laid down in Part C of Annex V or Annex VI of the RED, or shall report typical emission factors for the relevant input sourced from the data hierarchy, in either case considering only the lifecycle stages specified in section 1.4.4.2.

For projects operating stationary fuel cells consuming RFNBOs, the beneficiary shall document the renewable origin of the fuel, and demonstrate that it meets the relevant sustainability requirements (see section 3.1.2.1).

For projects involving the manufacturing of components (section 1.3, 3.1.3, 3.3.3), the beneficiary shall monitor and report the number of components manufactured and sold each year. In addition, the beneficiary shall justify the sale volumes, cost assumptions, use period of the component, and the performance of the relevant component, facility, or consumer product with adequate supporting documents, such as invoices and test results.

Table A4.2. Parameters for monitoring for a renewable energy project

Type of project	Emission source	Data / Parameter	Data unit	Description	Comment
Projects that intend to produce renewable electricity, heating or cooling	$Ref_{elec,prod}$	$EG_{elec,disp}$	MWh	Net amount of dispatchable electricity to be generated by the renewable technology and delivered to the grid	
		$EG_{elec,nondisp}$	MWh	Net amount of non-dispatchable electricity to be generated by the renewable technology and delivered to the grid	
	$Ref_{heat,prod}$	EG_{heat}	TJ	Net amount of heat to be delivered by the renewable technology	
	$Ref_{cool,prod}$	EG_{cool}	MWh	Net amount of cooling to be delivered by the renewable technology	
	$Proj_{on\text{-}site}$	Q_{FF}	TJ	Quantity of fossil fuel type FF combusted in stationary or mobile sources at the project site	If derived from volume (i.e. litres or m^3) or mass (i.e. kg or tonnes), include the density and/or NCV used for the conversion
		$Q_{bio,f}$	TJ	Quantity of biomass-derived fuel type f consumed by the project in stationary or mobile sources	As above
		Q_{elec}	MWh	Amount of electricity imported from the grid and consumed at the project site	
		Q_{heat}	TJ	Amount of heat imported and consumed at the project site	
	$Proj_{geo}$	M_{steam}	tonnes steam	Quantity of steam produced	When estimating leakage emissions for geothermal plants, the applicant may also consider the adoption of standard ratios for parameters like the mass of steam per MWh TJ generated, steam losses and

Type of project	Emission source	Data / Parameter	Data unit	Description	Comment
					working fluid per tonne of steam, based on industry benchmarks, should these be available.
		M_{inflow}	tonnes steam	Quantity of steam entering the geothermal plant	As above
		$M_{outflow}$	tonnes steam	Quantity of steam leaving the geothermal plant	As above
		$M_{working\ fluid}$	tonnes workin g fluid	Quantity of working fluid leaked/reinjected	As above
		$GWP_{working\ fluid}$	tonnes CO_2e / tonnes workin g fluid	Global Warming Potential for the working fluid used in the binary geothermal power plant	
	$Proj_{bio}$	$EF_{bio\ supply.f}$	tonnes CO_2e / TJ	Emission factor due to the production and supply of biomass-derived fuel f consumed at the project site, whether for energy generation or other purposes.	
Projects that intend to consume renewable electricity, heating or cooling in activities not covered under Annex I of the EU ETS directive	$Ref_{elec,use}$	Q_{elec}	MWh	Amount of renewable electricity to be consumed by the project in non-Annex I activities	
	$Ref_{heat,use}$	Q_{heat}	TJ	Amount of renewable heating to be consumed by the project in non-Annex I activities	
	$Ref_{cool,use}$	Q_{cool}	MWh	Amount of renewable cooling to be consumed by the project in non-Annex I activities	
Manufacturing of innovative renewable facilities or their components	n/a	N	units	Number of components supplied to markets by the manufacturing project	Based on relevant supporting documents, such as invoices
	n/a	UP	Years	Applicable use period of the manufactured component	The use period is equal to a maximum of 5 years, or to the lifetime of the component if

Type of project	Emission source	Data / Parameter	Data unit	Description	Comment
					lower than five years
	n/a	CS	%	Cost share of the innovative component as a fraction of the total capital cost of the relevant facility or of the retail price of the consumer product	
	$Ref_{elec,prod,unit}$	Refer to data requirements described for $Ref_{elec,prod}$, then pro-rate the activity data to a single facility or consumer product			
	$Ref_{heat,prod,unit}$	Refer to data requirements described for $Ref_{heat,prod}$, then pro-rate the activity data to a single facility or consumer product			
	$Ref_{cool,prod,unit}$	Refer to data requirements described for $Ref_{cool,prod}$, then pro-rate the activity data to a single facility or consumer product			
	$Proj_{on\text{-}site,unit}$	Refer to data requirements described for $Proj_{on\text{-}site}$, then pro-rate the activity data to a single facility or consumer product			
	$Proj_{geo,unit}$	Refer to data requirements described for $Proj_{geo}$, then pro-rate the activity data to a single component			
	$Proj_{bio\ supply,unit}$	Refer to data requirements described for $Proj_{bio\ supply}$, then pro-rate the activity data to a single facility or consumer product			

Source: European Commission internal elaboration.

In addition to the parameters listed above, further parameters will be monitored for knowledge-sharing purposes: check the Knowledge sharing report template available on the Funding and Tenders Portal.

3. Energy storage

Parameters that may not need to be monitored are listed in section 4.5, while Table A4.3 presents the parameters that, at minimum, shall be monitored on an annual basis and throughout the operation of the project, and be part of the project's monitoring and reporting plan.

The reporting of achieved GHG emission avoidance will be based on the annual aggregation of the hourly output profiles, using the same equations and default parameters as during the proposal stage.

At entry into operation, the applicant will need to provide technical documentation of the energy storage plant and its connections to end users and energy grids, including the current local grid conditions with respect to renewable energy, grid congestions and auxiliary service requirements.

For projects involving the manufacturing of components (section 1.3, 4.3.2), the beneficiary shall monitor and report the number of components manufactured and sold each year. In addition, the beneficiary shall justify the sale volumes, cost assumptions, use period of the component and the performance of the relevant component, facility, or consumer product with adequate supporting documents, such as invoices and test results.

Table A4.3. Parameters for monitoring for an energy storage project

		Data / Parameter	Data unit	Description	Comment
Both, projects that intend to operate innovative energy storage systems and manufacturing of innovative energy storage systems or their components	n/a	P_{in}	MW	Input power rating	
		P_{out}	MW	Output power rating	
		E_{stor}	TJ	Maximum storage capacity including degradation	
	$Ref_{services}$	$R_{services,gen}$	MW	Generator rating	Only for intra-daily electricity storage
		$R_{services,var}$	MVAr	Reactive power rating	Only for intra-daily electricity storage
		$R_{services,Inert}$	GVAs	Inertia capability rating	Only for intra-daily electricity storage
	n/a	η	%	Input-output efficiency including storage losses	To be derived from stock, input and output
	$Proj_{energy}$	$E_{in,x}$	TJ	Energy stored by the project of type *x*	Hourly data required for knowledge sharing purposes
	$Proj_{energy}$	$E_{stat,x}$	TJ	Energy consumed by the project in stationary applications of type *x*	
	$Proj_{energy}$	$E_{mob,x}$	TJ	Energy consumed by the project in mobile applications of type *x*	
	Ref_{energy}	$E_{out,x}$	TJ	Energy supplied by the project of type *x*	Hourly data required for knowledge sharing purposes
Only projects that intend to operate innovative	$Proj_{on-site}$	$E_{stat,x}$	TJ	Energy of type x used in stationary sources (except in the energy storage	

		Data / Parameter	Data unit	Description	Comment
energy storage systems				units) at the project site	
		$E_{mob,x}$	TJ	Energy of type x used in mobile sources at the project site	
		$T_{services,a}$	h	Duration of delivery of service a by the project	
		$M_{fug,z}$	tonnes	Amount of the fugitive emissions of greenhouse gas z at the project site	All types of GHGs from section 1.1.6 to be included
Only manufacturing of innovative energy storage systems or their components	n/a	N	Units	Number of renewable energy system units supplied to markets by the proposed manufacturing plant of renewable energy systems	Based on relevant supporting documents, such as invoices
		UP	Years	Applicable use period of the manufactured component	The use period is equal to a maximum of 5 years, or to the lifetime of the component if lower than five years
		CS	%	Cost share of the innovative component as a fraction of the total capital cost of the relevant facility or of the retail price of the consumer product	

TSource: European Commission internal elaboration.

In addition to the parameters listed above, further parameters will be monitored for knowledge-sharing purposes: check the Knowledge sharing report template available on the Funding and Tenders Portal.

4. Mobility

Parameters that may not need to be monitored are listed in section 5.5, while Table A4.4 presents the parameters that, at minimum, shall be monitored on an annual basis and throughout the operation of the project, and be part of the project's monitoring and reporting plan.

For projects consuming biomass-derived fuels, RFNBOs, and low-carbon fuels the beneficiary shall document the renewable origin of the fuel, and demonstrate that it meets the relevant sustainability requirements (see section 5.1.3.1).

For projects involving the manufacturing of components (section 1.3, 5.3.2), the beneficiary shall monitor and report the number of components manufactured and sold each year. In addition, the beneficiary shall justify the sale volumes, cost assumptions, and the performance of the relevant component, facility, or consumer product with adequate supporting documents, such as invoices and test results.

Table A4.4. Parameters for monitoring for mobility projects

Type of project	Emission source	Data / Parameter	Data unit	Description	Comment
Projects that reduce energy use per functional unit, fuel switch projects and projects that envisage a shift of modes of transportation, or their combination	$Ref_{t,ene}$	$Q_{ref,m}$	TJ	Quantity of energy consumed in maritime transportation for the operation of journeys reduced and/or replaced with other energy sources in the project activity	The MRV plan shall include entries for each energy type used in this mode of transportation
		$Q_{ref,a}$	TJ	Quantity of energy consumed in air transportation for the operation of journeys reduced and/or replaced with other energy sources in the project activity	The MRV plan shall include entries for each energy type used in this mode of transportation
		$Q_{ref,r}$	TJ	Quantity of energy consumed in road transportation for the operation of journeys reduced and/or replaced with other energy sources in the project activity	The MRV plan shall include entries for each energy type used in this mode of transportation
	$Ref_{t,fug}$	$Q_{ref,fug,z}$	tonnes	Quantity of fugitive emissions due to intentional (venting) or non-intentional (leakage) releases of greenhouse gas type "z" in the reference scenario for the delivery of the same transport services as provided by the innovative project	
	$Ref_{t,AddnonCO2}$	$Q_{ref,a,FF}$	TJ	Quantity of conventional aviation fuel consumed for the operation of flights reduced and/or replaced with other energy sources in the project activity	Applicants who opt to adopt actual data monitored according to the Monitoring,

Type of project	Emission source	Data / Parameter	Data unit	Description	Comment
					Reporting, and Verification (MRV) framework for aviation non-CO2 effects under the EU ETS shall include the corresponding parameters in their MRV plan
		$Q_{ref,m,BC}$	tonnes	Quantity of emissions of black carbon of mode of maritime transportation type "m" in the reference scenario for the delivery of the same transport services as provided by the innovative project	
	Ref_{infra}	$Q_{ref,infra,x}$	TJ	Quantity of energy type x used at infrastructure facilities that are replaced by the innovative project	
	$Proj_{,ene}$	$Q_{proj,t,x}$	TJ	Quantity of energy source type x used in mode of transportation type t consumed for the operation of journeys proposed in the project activity	The MRV plan shall include entries for each energy type used in each mode of transportation occurring in the project activity
	$Proj_{t,fug}$	$Q_{proj,fug,z}$	tonnes	Quantity of fugitive emissions due to intentional (venting) or non-intentional (leakage) releases of greenhouse gas type GHG occurring in the innovative project	
	$Proj_{t,AddnonCO2}$	Parameters used for the calculation $Proj_{a,AddnonCO2}$	To be defined by the applicant	Parameters used for the calculation of additional non-CO_2 climate impacts from aviation activities in the project scenario	Applicants who opt to adopt actual data monitored according to the Monitoring, Reporting, and Verification (MRV) framework for aviation non-CO2 effects under the EU ETS shall include the corresponding parameters in their MRV plan

Type of project	Emission source	Data / Parameter	Data unit	Description	Comment
		$Q_{proj,m,BC}$	tonnes	Quantity of emissions of black carbon from maritime vessels in the project scenario	
	$Proj_{infra}$	$Q_{proj,infra,x}$	TJ	Quantity of energy type x used at infrastructure facilities in the innovative project	
	Other	TD_{goods}	tonne-kilometre	Total transport of goods	
	Other	$TD_{passengers}$	person-kilometre	Total transport of passengers	
Manufacturing of innovative aircraft, vessels, road vehicles or their components	n/a	N_t	units	Number of innovative aircrafts, maritime vessels, road vehicles of type t, or their components, supplied to the market by the proposed manufacturing plant	Based on relevant supporting documents, such as invoices
	n/a	UP	years	Applicable use period of the manufactured component	The use period is equal to a maximum of 5 years, or to the lifetime of the component if lower than five years
	n/a	CS_t	%	Cost share of the innovative manufactured component(s) of type t, as a fraction of the cost of the entire aircraft, vessel or vehicle	
	n/a	D_{proj}	km	Annual average distance travelled by the innovative aircraft(s), vessel(s) or vehicle(s) of type t	Applicants shall adopt the same values proposed for $D_{ref,t}$
	$Ref_{t,fug,unit}$	$SE_{ref,t,fug,z}$	tonnes of gas / km	Specific fugitive emissions due to intentional (venting) or non-intentional (leakage) releases of greenhouse gas type “z” for the operation of one conventional vessel or vehicle that will be replaced by the project activity	
	$Ref_{t,AddnonCO2,unit}$	$SC_{ref,a,FF}$	TJ / km	Specific consumption of conventional aviation fuel consumed for the operation of one conventional aircraft	

Type of project	Emission source	Data / Parameter	Data unit	Description	Comment
				replaced with other energy sources or modes of transportation in the project activity	
		$SE_{ref,m,BC}$	tonnes of gas / km	Specific emissions of black carbon from vessels or other maritime transportation type m for the operation of one conventional vessel replaced with other energy sources or modes of transportation in the project activity	
	$Proj_{t,ene,unit}$	$SC_{proj,t,x}$	TJ / km	Specific consumption of energy source type x used in mode of transportation type t consumed for the operation of one innovative aircraft, maritime vessel, or road vehicle produced in the project activity, or one equipped with an innovative component manufactured by the project	Estimated based on forecasted energy use that the innovative technology(ies) or component(s) will require when implemented
	$Proj_{t,fug,unit}$	$SE_{proj,t,fug,z}$	tonnes of gas / km	Specific fugitive emissions due to intentional (venting) or non-intentional (leakage) releases of greenhouse gas type z for the operation of one innovative vessel or vehicle of mode of transportation type manufactured by the project, or one equipped with an innovative component manufactured by the project	
	$Proj_{t,AddnonCO2,unit}$	Parameters used for the calculation $Proj_{a,nonCO2,unit}$	To be defined by the applicant	Parameters used for the calculation of additional non-CO_2 climate impacts from aviation activities in the project scenario	Applicants who opt to adopt actual data monitored according to the Monitoring, Reporting, and Verification (MRV) framework for aviation non-CO2 effects under the EU ETS shall include the corresponding parameters in their MRV plan

Type of project	Emission source	Data / Parameter	Data unit	Description	Comment
		$SE_{proj,m,BC}$	tonnes of black carbon / km	Specific emissions of black carbon from maritime vessels in the project scenario	

Source: European Commission internal elaboration.

In addition to the parameters listed above, further parameters will be monitored for knowledge-sharing purposes: check the Knowledge sharing report template available on the Funding and Tenders Portal.

5. *Credit for Carbon Capture and Storage or Utilisation*

In addition to the monitoring and reporting requirements under their specific category, projects that include a credit for carbon capture and storage or utilisation should monitor the additional parameters listed in this sub-section. Parameters that may not need to be monitored are listed in section 6.6, while Table A4.5 presents the parameters that, at minimum, shall be monitored throughout the project and be part of the project's monitoring and reporting plan.

Note that, for projects that include a CCU component, even if the CO_2 utilisation phase is not part of the application and is carried out by a third party, the CO_2 utilisation processes, inputs, and the combustion and/or end-of-life emissions from the CCU product(s) must be included as part of the GHG calculations (see section 2.2.5.3.1, 2.2.5.3.3, and other relevant provisions), and must be monitored in line with the provisions for EII projects.

For the parameters for monitoring corresponding to $CC_{capture}$, $CC_{pipeline}$ and $CC_{injection}$, refer to the Commission Implementing Regulation (EU) 2024/2493 of 23 September 2024 (amending Implementing Regulation (EU) 2018/2066) on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council, especially Articles 40 to 46 and Article 49 and Annex IV, Sections 21, 22 and 23. For estimating such emissions, the applicant may also consider the adoption of standard ratios in GHG emissions per tonne of CO_2 stored based on industry benchmarks, should these be available.

Table A4.5. Parameters for monitoring in CCS projects

Data / Parameter	Data unit	Description
$CC_{storage,y}$	tonnes CO_2	Amount of CO_2 transferred to the capture installation
$CC_{use,y}$	tonnes CO_2	Amount of CO_2 that is incorporated into products
$CC_{capture,y}$	tonnes CO_2	GHG emissions from CO_2 capture activities
$CC_{injection,y}$	tonnes CO_2	For CCS projects, GHG emissions from injection and geological storage of CO_2
$CC_{pipeline,y}$	tonnes CO_2	GHG emissions from transport of CO_2 by pipelines

HC_y	tonnes	Total mass of hydrocarbons in tonnes produced at the EHR location. For projects in which CO_2 injection and storage is associated with enhanced hydrocarbon recovery (EHR).
$K_{road,L}$	km	Distance of each one-way trip L travelled by road modals
$CO_{2road,L}$	tonnes CO_2	Amount of CO_2 transported in each one-way trip by road modals
$K_{rail,L}$	km	Distance of each one-way trip travelled by rail
$CO_{2rail,L}$	tonnes CO_2	Amount of CO_2 transported in each one-way trip by rail
$K_{maritime,L}$	km	Distance of each one-way trip travelled by maritime modals
$CO_{2maritime,L}$	tonnes CO_2	Amount of CO_2 transported in each one-way trip by maritime modals

Source: European Commission internal elaboration.

In addition to the parameters listed above, further parameters will be monitored for knowledge-sharing purposes: check the Knowledge sharing report template available on the Funding and Tenders Portal.

Appendix 5

Definitions[56]

For the purpose of this methodology, the following definitions apply:

(1) 'accuracy' means the closeness of the agreement between the result of a measurement and the true value of the particular quantity or a reference value determined empirically using internationally accepted and traceable calibration materials and standard methods, taking into account both random and systematic factors.

(2) 'activity data' means data on the amount of fuels or materials consumed or produced by a process relevant for the calculation-based monitoring methodology, expressed in terajoules, mass in tonnes or (for gases) volume in normal cubic metres, as appropriate.

(3) 'auxiliary services to electricity grids' mean services required for the operation of electricity grids such as the provision of reserve power, reactive power, inertia, frequency response and similar.

(4) 'binary geothermal power' plant is a geothermal technology that utilises an organic Rankine cycle (ORC) or a Kalina cycle and typically operates with temperatures varying from as low as 73°C to 180°C. In these plants, heat is recovered from the geothermal fluid using heat exchangers to vaporise an organic fluid with a low boiling point (e.g., butane or pentane in the ORC cycle and an ammonia-water mixture in the Kalina cycle) and drive a turbine. Binary geothermal plants are categorised as closed cycle technology.

(5) 'biomass fuels' means gaseous and solid fuels produced from biomass. Definition in line with RED.

(6) 'biofuels' means liquid fuel for transport use produced from biomass. Definition in line with RED.

(7) 'biogas' means gaseous fuels produced from biomass. Definition in line with RED.

(8) 'bio-heat' means heating or cooling from biomass-derived fuels. Definition in line with RED.

(9) 'bioliquids' means liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass. Definition in line with RED.

(10) 'biomass' means the biodegradable fraction of products, waste and residues from biological origin from agriculture, including vegetal and animal substances, from forestry and related industries, including fisheries and aquaculture, as well as the biodegradable fraction of waste, including industrial and municipal waste of biological origin. Definition in line with RED.

(11) 'biomass-derived fuels' include biomass, biomass fuels, biogas and biomethane, bioliquids, and biofuels, used for energy generation. CCU fuels produced using CO_2 of biogenic origin are not considered to be biomass-derived fuels.

(12) 'biomass-derived fuels and materials' include biomass-derived fuels and biomass-derived materials (i.e. materials of biogenic origin used for purposes other

[56] Definitions are taken from EU legislative acts and from UNFCCC CDM0002, where relevant.

than energy generation). CCU materials produced using CO_2 of biogenic origin are not considered to be biomass-derived material.

(13) 'biomethane' means biogas that is purified to a standard fit to inject into the natural gas grid.

(14) 'calculation factors' means net calorific value, emission factor, oxidation factor, conversion factor, carbon content or biomass fraction.

(15) 'calibration' means the set of operations, which establishes, under specified conditions, the relations between values indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material and the corresponding values of a quantity realised by a reference standard.

(16) 'capacity addition' is an increase the installed power generation capacity of existing power plants through: (i) the installation of new power plants/units besides the existing power plants/units; or (ii) the installation of new power plants/units, additional to the existing power plants/units; or (iii) construction of a new reservoir along with addition of new power plants/units in case of integrated hydro power projects. The existing power plants/units in the case of capacity addition continue to operate after the implementation of the project activity.

(17) 'carbon intensity' is the sum of the stoichiometric carbon content and all emissions from processes in the supply chain.

(18) 'CO_2 capture' means the activity of capturing from gas streams CO_2 that would otherwise be emitted.

(19) 'CO_2 transport' means the transport of CO_2 for use or storage.

(20) 'CO_2e' means the 100 year global-warming potential of a quantity of greenhouse gas emissions, including CO_2 and any other greenhouse gases listed in Annex II to Directive 2003/87/EC (i.e.CH_4, N_2O, HFCs, PFCs, SF_6), expressed as the equivalent mass of CO_2 emissions.

(21) 'combustion emissions' means greenhouse gas emissions occurring during the exothermic reaction of a fuel with oxygen.

(22) 'direct emissions' means greenhouse gas emissions within the system boundary.

(23) 'dry steam geothermal power plant' is a geothermal technology that directly utilises dry steam that is piped from production wells to the plant and then to the turbine. Dry steam geothermal plants are categorised as open cycle technology.

(24) 'emission factor' means the average emission rate of a greenhouse gas relative to the activity data of a source stream assuming complete oxidation for combustion and complete conversion for all other chemical reactions.

(25) 'emission sink' means a separately identifiable part of an installation or a process within an installation, which removes a greenhouse gas, an aerosol or a precursor of a relevant greenhouse gas from the atmosphere..

(26) 'emission source' means a separately identifiable part of an installation or a process within an installation, from which relevant greenhouse gases are emitted.

(27) 'energy from renewable sources' or 'renewable energy' means energy from renewable non-fossil sources, namely wind, solar (solar thermal and solar photovoltaic) and geothermal energy, ambient energy, tide, wave and other ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas, and biogas.

(28) ‘energy storage plant/unit’ is a facility that stores a certain type of energy. Several energy storage units at one site comprise one energy storage plant, whereas an energy storage unit is characterised by the fact that it can operate independently from other energy storage units at the same site. Where several identical energy storage units (i.e. with the same power rating, age and efficiency) are installed at one site, they may be considered as one single energy storage unit.

(29) ‘enhanced hydrocarbon recovery’ means the recovery of hydrocarbons in addition to those extracted by water injection or other means.

(30) ‘EU ETS product benchmark’ is based on the average GHG emissions of the best performing 10% of the installations producing that product in the EU and EEA-EFTA states. They refer to the direct GHG emissions from the final process in a production chain that produces a unit quantity of a defined product, using a particular process whose boundary is defined. It is only part of the emissions intensity of the product, because it does not consider emissions from previous production stages (usually covered by other benchmarks) or from supplying inputs (or the combustion emissions of the product itself). The benchmark may comprise emissions from several sub-installations.[57] The relevant benchmarks are those applicable at the time of the deadline of submission of the application.

(31) ‘flash steam geothermal power plant’ is a geothermal technology that is used where water-dominated reservoirs have temperatures above 180°C. In these high-temperature reservoirs, the liquid water component boils, or “flashes”, as pressure drops. Separated steam is piped to a turbine to generate electricity and the remaining hot water may be flashed again twice (double flash plant) or three times (triple flash) at progressively lower pressures and temperatures, to obtain more steam. Flash steam geothermal plants are categorised as open cycle technology.

(32) ‘fossil carbon’ means inorganic and organic carbon that is not biomass.

(33) ‘fugitive emissions’ means irregular or unintended emissions from sources that are not localised, or too diverse or too small to be monitored individually.

(34) ‘generator rating’ of an energy storage unit is the maximum power, expressed in Watts or one of its multiples, for which the energy storage unit’s generator has been designed to operate. The generator rating of an energy storage plant is the sum of the generator ratings of its energy storage units.

(35) ‘geological storage of CO_2’ means geological storage of CO_2 as defined in Article 3(1) of Directive 2009/31/EC.

(36) ‘geothermal energy’ means energy stored in the form of heat beneath the surface of solid earth.

(37) ‘greenfield plant’ means a new plant that is constructed and operated at a site where no plant of the same type was operated prior to the implementation of the project activity.

(38) ‘indirect emissions’ means emissions associated with the generation of grid electricity and/or grid heat outside the system boundary.

(39) ‘inertia capability’ means the maximum inertia, expressed in Volt-Ampere seconds (VAs) or one of its multiples, which the energy storage unit has been designed to

[57] Commission Delegated Regulation (EU) 2019/331 of 19 December 2018 determining transitional Union-wide rules for harmonised free allocation of emission allowances pursuant to Article 10(a) of Directive 2003/87/EC of the European Parliament and of the Council.

provide at nominal conditions. The inertia capability of an energy storage plant is the sum of the inertia capabilities of its energy storage units.

(40) 'input power rating (or installed input capacity)' means the (active) power, expressed in Watts or one of its multiples, for which the energy storage unit has been designed to operate at nominal conditions. The input power rating of an energy storage plant is the sum of the input power ratings of its energy storage units.

(41) 'intra-daily electricity storage' means all electricity storage units providing auxiliary services to the electricity grid and/or taking part in intra-daily electricity markets

(42) 'installation' is a stationary technical unit where one or more activities under the scope of the European Union Emissions Trading Scheme (EU ETS) and any other directly associated activities which have a technical connection with the activities carried out on that site and which could have an effect on emissions and pollution.

(43) 'installed power generation capacity' or 'installed capacity or nameplate capacity' means the capacity, expressed in Watts or one of its multiples, for which the power unit has been designed to operate at nominal conditions. The installed power generation capacity of a power plant is the sum of the installed power generation capacities of its power units.

(44) 'measurement system' means a complete set of measuring instruments and other equipment, such as sampling and data-processing equipment, used to determine variables such as the activity data, the carbon content, the calorific value or the emission factor of the greenhouse gas emissions.

(45) 'net calorific value' (NCV) (also referred to as lower heating value, LHV) means the specific amount of energy released as heat when a fuel or material undergoes complete combustion with oxygen under standard conditions, less the heat of vaporisation of any water formed.

(46) 'other energy storage' means all energy storage other than intra-daily electricity storage, in particular including heat / cold storage, gaseous and liquid fuel storage as well as long-term electricity storage

(47) 'output power rating (or installed output capacity)' means the (active) power, expressed in Watts or one of its multiples, for which the energy storage unit has been designed to operate at nominal conditions. The output power rating of an energy storage plant is the sum of the output power ratings of its energy storage units

(48) 'power plant/unit' is a facility that generates electric power. Several power units at one site comprise one power plant, whereas a power unit is characterised by the fact that it can operate independently from other power units at the same site. Where several identical power units (i.e. with the same capacity, age and efficiency) are installed at one site, they may be considered as one single power unit.

(49) 'proxy data' means annual values which are empirically substantiated or derived from accepted sources and which an operator uses to substitute the activity data or the calculation factors for the purpose of ensuring complete reporting when it is not possible to generate all the required activity data or calculation factors in the applicable monitoring methodology.

(50) 'reactive power rating' means the maximum reactive power, expressed in volt-ampere reactive (var) or one of its multiples, which the energy storage unit has been designed to provide at nominal conditions. The reactive power rating of an energy storage plant is the sum of the reactive power ratings of its energy storage units.

(51) 'rehabilitation' or 'refurbishment' means an investment to restore the existing plants/units that was severely damaged or destroyed due to foundation failure, excessive seepage, earthquake, liquefaction, or flood. The primary objective of rehabilitation or refurbishment is to restore the performances of the facilities. Rehabilitation may also lead to increase in efficiency, performance or production capacity of the plants/units with/without adding new plants/units.

(52) 'renewable fuels of non-biological origin' means liquid or gaseous fuels the energy content of which is derived from renewable sources other than biomass. Definition in line with RED.

(53) 'replacement' or 'substitution' is an investment in new plants/units that replaces one or several existing units at the existing plant. It shall be treated as a new/greenfield plant.

(54) 'repowering' means renewing power plants that produce renewable energy, including the full or partial replacement of installations or operation systems and equipment for the purposes of replacing capacity or increasing the efficiency or capacity of the installation.

(55) 'retrofit' or 'modification' means an investment to repair or modify existing operating plants/units, with the purpose to increase the efficiency or performance of the plants/units, without adding new plants/units. Retrofits include measures that involve capital investments and not regular maintenance or housekeeping measures.

(56) 'Smart grids' for the purpose of the Innovation Fund include a number of applications which generally involve a self-sufficient electricity network system based on digital automation technology for monitoring, control, and analysis within the supply chain. However, in most use cases they refer to a specific component such as a smart sub-station, an appliance or a communications solution. The reference scenario of proposals should therefore refer to the specific use case.

(57) 'storage site' means storage site as defined in Article 3(3) of Directive 2009/31/EC.

(58) 'tonnes of CO_2e' means metric tonnes of CO_2 or CO_2e.

(59) 'transport network' means transport network as defined in Article 3(22) of Directive 2009/31/EC.

(60) 'upstream emissions' means emissions associated with the provision (extraction, processing, refining, transport) of fossil fuels and other inputs, which occur prior to the fuel or input entering the system boundary.

(61) 'vented emissions' means emissions deliberately released from an installation by provision of a defined point of emission.

(62) 'waste' means waste as defined in point (1) of Article 3 of Directive 2008/98/EC, excluding substances that have been intentionally modified or contaminated in order to meet this definition.