European Commission

Innovation Fund (INNOVFUND)

Methodology for GHG Emission Avoidance Calculation

Version 3.1
01 March 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.

Table of contents

1 Introduction

The Innovation Fund (InnovFund) methodology for the calculation of the GHG emission avoidance is described in the following sections:

Section 2: Energy intensive industries (EII), including substitute products, and carbon capture and use (CCU)

Section 3: Calculating a credit for projects involving carbon capture and storage (CCS) or carbon capture and utilisation (CCU)

Section 4: Renewable energy (RES), including manufacturing plants for components

Section 5: Energy storage (ES), including manufacturing plants for components.

Section 6: Maritime (MAR), including innovative ships or their components.

Section 7: Aviation (AVI), including innovative aircraft or their components.

Each methodology section provides the details to be used when:

- applying for an Innovation Fund grant;
- 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]

The core principles are the same across the methodology. Each section can encompass several sectors for classification of the Innovation Fund project proposals (see Table 1.1). The methodology indicates the choices to make in the calculation of GHG emissions in as many situations as can be foreseen, but each project will come up with a different combination of these choices in different parts of the calculation.

It is a central principle of the GHG emission avoidance calculation that specific GHG emissions and each GHG saving shall only be counted once ('no double counting'). It is possible that in some cases the detailed methodology described in this document may seem to call for a given emission or saving to be counted twice. In any such case, the 'no double counting' principle supersedes the other text of the methodology. If the applicants believes that they have identified such a case, the applicant should consider seeking clarification via the InnovFund helpdesk.

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, and relative GHG emission avoidance.

At the application stage, the GHG emission avoidance of a project is calculated over a period of 10 years after entry into operation. This is the value that will be taken into account during the evaluation of a proposal. **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.

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. Please note that the duration of the monitoring and reporting period may be shorter with respect to the period

[1] 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, call text and knowledge-sharing reporting template.

of 10 years over which the GHG emission avoidance of a project is calculated at the application stage.

The InnovFund grant disbursement depends on verified emission reductions. Therefore, it is important that the emissions reductions described in the application can be delivered. When forecasting operational data, applicants should consider any expected **ramping up period**, e.g., if reduced performance can be expected over the first years 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 (which will result in higher emission avoidance) this should be credibly demonstrated, for example by providing draft contracts or other relevant supporting documents.

> *Example: hydrogen to be supplied for fuel cell vehicles*
>
> *If a project producing hydrogen states that this hydrogen will be supplied for use in vehicles (allowing the reference to be set based on fossil fuel consumption by a conventional vehicle instead of using the hydrogen benchmark) the application should credibly support this claim, for example by providing a draft contractual arrangement with a hydrogen refuelling facility for mobility applications.*

The GHG emission avoidance calculations shall consider, both in the reference and project scenarios, the potential diversified **offtake strategy**, i.e., different share of final products or possible uses, and the emissions savings shall be calculated in accordance with their final use. In the case of a change in the share of products or their use, the project may not be able to reach the GHG emission avoidance[2] claimed at the time of the application, with potential implications on grant disbursement.

1.1.1 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 years' period, using the equation below.

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

Where:

$\Delta \mathrm{GHG}_{\mathrm{abs}}$ = 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.

2 A project that enters into operation should demonstrate a total amount of GHG emissions planned avoidance of at least 75% for a full grant disbursement.

For projects with multiple principal products and for hybrid projects, Ref_y and Proj_y represent the sum of the reference and project emissions respectively across all principal products and categories. In some cases, this will require adding together reference and project scenario emissions calculated using different sections of this methodology.

1.1.2 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 years' period.

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

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.

Note that for projects that consist of direct air capture of CO2 for the purpose of permanent storage, Ref_y is set as zero and therefore this equation cannot be used. For these projects, the relative emission avoidance shall always be set as 200%.

1.1.2.1 Net carbon removals

To be considered a net carbon removals project, a project must have negative project emissions. For EII projects, the calculation of adjusted project emissions for this purpose must exclude credits for non-principal products (section 2.2.10) and for timed operation (section 2.2.6.3.6), i.e. $\sum_{y=1}^{10}(Proj_y - NPP_y - TO_y) < 0$, where NPP_y is the emission credit associated with production of non-principal products in year y and TO_y is the emission credit associated with timed operation 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 can 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 $\widehat{\Delta GHG}_{rel}$ is therefore calculated as:

$$\widehat{\Delta GHG}_{rel} = \frac{\Delta GHG_{abs} + \sum_{y=1}^{10}(TO_y)}{\sum_{y=1}^{10}(Ref_y)} \qquad [1.3]$$

Direct air capture projects shall be given an adjusted relative emissions avoidance score of 200%, even if they claim credit for timed operations.

1.1.3 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 CO2 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.[3]

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 1.1.4).

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 (in particular methane[4] and nitrous oxide) due to fuel combustion (including from combustion of renewable fuels),

- End-of-life (i.e., decomposition or degradation) emissions of non-CO_2 greenhouse gases,

- Emissions of non-CO_2 greenhouse gases resulting from chemical processes such as refrigerant manufacture.

1.1.4 GHG emission sources that are generally excluded

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 fossil fuel extraction, processing, refining, distribution and storage are excluded from the calculation. This allows aligning to the methodology for calculating the EU ETS benchmarks, which considers only combustion emissions of fossil fuels. See section 2.2.6.3.1 and section 2.2.6.3.3 for further guidance.
- Fugitive CO_2 and CH_4 emissions due to well testing and well bleeding in geothermal power plants.

- Biogenic CO_2 emissions from:

    - combustion of biomass (including solid biomass, biogas, biomethane, biofuels and bioliquids),

    - decomposition or degradation at end of life from biomass, biogas, biomethane, biofuels and bioliquids,

    - other chemical or biological processes (e.g. fermentation).

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

[4] In particular, the methodology makes reference several times to the "stoichiometric combustion" of a carbon-based product or part of it. Given that in a certain amount of cases, some carbon atoms in a product could generate CH_4 rather than CO_2 emissions, the reference to "stoichiometric combustion" must be understood as "stoichiometric combustion of all carbon atoms that are not released to the atmosphere as CH_4". When CH_4 emissions occur in a stage of the lifecycle, they must be added to the CO_2 emissions calculated according to the "stoichiometric combustion" of the residual carbon atoms.

However, emissions of non-CO_2 greenhouse gases (CH_4 and N_2O) associated with biomass combustion, decomposition or degradation of biogenic materials and other chemical or biological processes must be included based on the relevant GWPs.

- 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 1.3.4.

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

1.1.5 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-CO2 greenhouse gases identified in section 1.1.3. 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.

Whilst these impacts have so far not been addressed by EU policy in the same manner as emissions of CO2 and the other GHG listed in section 1.1.3, their significance has been confirmed. Therefore, these additional non-CO_2 climate impacts shall be characterised in terms of global warming potentials on a 100-year basis and counted towards absolute GHG emission avoidance for maritime and aviation projects following the provisions in Section 6 and Section 7 respectively.

1.1.6 Buildings and road transport

This section applies to projects focusing on innovative solutions that reduce the GHG emission avoidance in the sectors Road Transport and Buildings. 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 4), or ES (Section 5).

For example, a road transport project that intends to produce batteries for electric vehicles should use Section 5 of the methodology, while a project that intends to produce vehicle fuel cells should use Section 2 of the Methodology. Furthermore, a road transport project that intends to replace the use of conventional fossil fuel with an alternative fuel, should use Section 2 of the methodology. More specifically, a project that aims exclusively at producing road transport fuels shall apply under the "Refineries" sector, while a project that includes the use of road transport fuels may apply under the "Road Transport" sector.

In both cases, the calculations should be performed according to Section 2 of the Methodology.

Similarly, a project that intends to produce electricity and/or heat for use in buildings should use Section 4 of the Methodology if the heat or electricity produced or used is of renewable origin, including bio-origin. This includes bio-heat, bio-electricity, and projects where bio-waste is used as feedstock for energy purposes. 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 Specification of a sector for the purpose of the GHG emission avoidance calculations, and principal products

When submitting the application, the applicant needs to choose the sector under which the project falls (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 may not be explicitly listed (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[5]	SECTOR[6]	PRODUCTS/SERVICES[7]	SECTION
Energy Intensive Industries (EII)	Refineries	fuels (incl. 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

5 Categories are derived from the legal basis – Article 10(a) of the EU ETS Directive

6 Sectors are derived from the activities listed in Annex I of the EU ETS Directive, the type of renewable energy source or energy storage.

7 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) both in Application Form B and C.

CATEGORY[5]	SECTOR[6]	PRODUCTS/SERVICES[7]	SECTION
	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[8]	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 sanitary and tissue paper other paper products or substitute products, please specify	Section 2
	Chemicals	organic basic chemicals inorganic basic chemicals nitrogen compounds plastics in primary forms synthetic rubber other chemical products or substitute products, incl. bio-based products, please specify	Section 2
	Hydrogen	hydrogen	Section 2
	Manufacturing of components for energy intensive industries (in case of production of electrolysers and vehicle fuel cells)	electrolysers and their components vehicle fuel cells and their components recycling of materials for production of electrolysers and their components recycling of materials for production of vehicle fuel-cells and their components other, please specify	Section 2
	Other[9]	Dispatchable electricity, incl. bio-electricity	Section 2, including for timed-operation

[8] The sector 'Glass, ceramics & construction material' is a combination of the EU ETS activities 'Glass and ceramics', 'Mineral wool' and 'Gypsum'.

[9] 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.

CATEGORY[5]	SECTOR[6]	PRODUCTS/SERVICES[7]	SECTION
		heat, incl. bio-heat other, please specify	projects and for electricity saving projects; or Section 4 for bio-electricity and bio-heat, including projects where bio-waste is used as (partial) feedstock for energy purposes.
Energy Intensive Industries (EII) where CCS is the main aim of the project[10]	choose an EII sector	choose an EII product	Section 2 and Section 3
	choose EII / Other	CO_2 Transport	Section 2 and Section 3
	choose EII / Other	CO_2 Storage	Section 2 and Section 3
Renewable energy (RES)	Wind energy	non-dispatchable electricity heating cooling	Section 4
	Solar energy	non-dispatchable electricity heating cooling	Section 4
	Hydro/Ocean energy	non-dispatchable electricity dispatchable electricity heating cooling	Section 4
	Geothermal energy (including ambient energy through heat pumps)	dispatchable electricity heating cooling	Section 4
	Use of renewable energy outside Annex I[11]	use of renewable energy in water desalination use of renewable energy in wastewater treatment other	Section 4
	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	Section 4

10 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'.

11 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.

CATEGORY[5]	SECTOR[6]	PRODUCTS/SERVICES[7]	SECTION
		other, please specify	
Energy storage (ES)	Intra-day electricity storage	electricity[12]	Section 5
	Other energy storage	electricity heating cooling	Section 5
		hydrogen-based energy storage e-fuel-based energy storage	Section 5 (projects producing hydrogen or e-fuels shall only be considered under the Energy Storage category when storage of excess renewable energy is a 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 5
Mobility (MOB)	Maritime	Transportation of goods/passengers Manufacturing of components for vessels other, please specify	Section 6
	Aviation	Transportation of goods/passengers Manufacturing of components for aircrafts other, please specify	Section 7
	Road Transport	Various, please specify	Various. Please refer to Section 1.1.6
Buildings (BIL)	Buildings	Various, please specify	Various. Please refer to Section 1.1.6.

In some cases, the principal product of a project may **replace the function** of a physically different conventional product, or a product with a different composition. There may also be cases in which the innovative product produced by a project is not listed in

[12] 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.

Table 1.1, but the conventional product that the project aims to replace is listed. In these cases, the relevant sector associated to **the substituted product** shall be chosen for the application. 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.

During 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.

> *Example: Project focusing on the introduction of low-carbon hydrogen in heating: the main purpose of the project is to produce heat in an innovative way. Therefore, the project falls under sector EII/other rather than EII/hydrogen.*

> *Example: The sole product of a project is ethanol that will substitute gasoline in transport (rather than ethanol being sold as a fine chemical). The relevant sector of the substituted product is EII/refineries.*

The application may only be submitted for one sector. Some applications may produce products associated to more than one sector, and potentially associated to multiple categories. For such projects, the applicant must 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. Note that projects that include principal products associated to more than one category are referred to as **hybrid projects** (see section 1.2.1).

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.

> *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)' those reflecting the main aim and innovation of the project. The set of products that generate the bulk of the revenues from a project should be identified as principal products. Other products may be identified as principal or non-principal at the discretion of the applicant.[13]

The conventional products substituted by 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. In the case that a project produces principal products associated to more than one sector, the applicant must choose the sector for the application, and justify its choice, based on the principal product that reflects the main aim and innovation of the project, and that generates most revenues. 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.

[13] For the attention of applicants in previous calls, these requirements have been revised – previously additional products in different sectors but the same category were required to always be assessed as non-principal products.

Note that the choice of principal product(s) and non-principal products may influence the project relative GHG emission avoidance of the project.

> <u>Example:</u> *A steel producer proposes a project to modify its existing plant in order to produce ethanol 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, and the applicant must decide whether to apply in the 'EII/Iron and steel' or the 'EII/Refineries' sector, giving consideration to what the primary aim and innovation of the project is, and which one is the main source of revenues.*
>
> *Is the project designed to primarily save emissions in the steel industry? Or is the project designed to primarily produce an alternative transport fuel? Which of the two principal products corresponds to the main source of revenues for the project?*
>
> *A small quantity of toluene will also be produced by the project. Since toluene would represent only a small part of the revenues, the applicant may choose to treat it as a third principal product or as a non-principal product. The applicant could not, however, treat toluene as the only principal product and steel and ethanol as non-principal products as this would not reflect the main aim of the project.*

Some projects involve the **manufacturing of components** to be used in renewable energy generation, energy storage systems, electrolysers, fuel cells, or mobility systems. Such projects will generally be classified in the dedicated sector under the relevant category based on the intended use of the component. See Section 1.2.2 for dedicated guidance. As an alternative, an applicant may choose to submit such a project as an energy intensive industry project in a sector other than "manufacturing of components" (e.g., in the sectors EII/chemicals or EII/non-ferrous metals) especially if the component produced is further upstream in the value chain, e.g., production of lithium. In such cases, Section 1.2.2 does not apply. Instead, the emissions savings shall be assessed by comparing the emissions from the innovative production system to the emissions of an appropriate reference production system following the principles given in Section 2. For projects submitted under an EII sector other than "manufacturing of components", emissions savings from the use of the component are outside of the system boundary and therefore may not be included in the calculation, while the manufacturing facility is within the system boundary.

In case of CCS projects, if capturing CO_2 from an existing plant is the main aim of the project, the principal product of that project should be set as the main output of the plant. See section 2.2.5.2.1and Section 3.1 for additional guidance.

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

Projects consisting only of CCS based on direct air capture, 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" (See also Section 2.2.4.7, Section 2.2.5.2.2 and Section 3.1).

Projects focusing only on CO_2 transport and/or geological storage–shall apply under category "EII" and sector "other" with the principal product identified as "CO_2 transport" and/or "CO_2 storage" (See also Section 2.2.4.8, Section 2.2.5.2.3 and Section 3.1).

For projects including a CCU component, refer to Section 2.2.5.3 and Section 3.2 for additional guidance.

1.2.1 Hybrid projects

When a project combines activities related to more than one category, 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 and innovation of the project. The main aim should be identified primarily by considering the revenues from the products or services that the project will produce or deliver. Note that the part of the project which defines the main sector must be innovative.

> *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. The applicant should choose wind energy as the main sector.*
>
> *If, however, the innovation is related only to the electrolyser rather than the wind farm, 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.

Hybrid projects shall calculate the absolute GHG emission avoidance by calculating the reference GHG emissions and the project emissions for each principal product according to the relevant sections of the methodology (For example, EII, RES, ES, MAR, AVI, etc., and then adding these up while removing double counting of avoidance and/or emissions, if any. The relative GHG emission avoidance shall be calculated based on the cumulated absolute GHG emission avoidance, divided by the cumulated reference GHG emissions, see Section 1.1.2.

1.2.1.1 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 to get credit if there is renewable energy exported. A typical case could be a project that proposes to export renewable electricity and/or renewable heat from an industrial plant belonging to one of the EII sectors.

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 in Table 1.3 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. 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).*

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.

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.

1.2.1.2 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 5. 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 5 for the ES part (principal product intra-day or other electricity storage).

1.2.1.3 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.

Example: Projects that generate renewable electricity and include a physical or virtual 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 5. The emission avoidance of the uncontrolled feed-in shall follow the calculation of section 4.

For a hybrid RES+ES project, the applicant should 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 exporting renewable power to the grid.

Example: Consider a hybrid project with a wind farm located at the same site of 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 4 and 5 should be combined, and any double counted emissions removed.

1.2.1.4 Energy intensive industries (EII), renewable energy (RES) and energy storage (ES) projects

For a project that includes EII, ES and RES parts, the applicant should consider submitting a hybrid application to get credit for the renewable energy exported and for the energy stored in addition to the GHG emissions avoided in the EII part. Such hybrid projects application should combine the three components and clarify the system boundaries for the three parts. The three GHG emission terms need to be then summed up while removing double counting.

1.2.1.5 Fuel production under energy intensive industries (EII) combined with fuel switching under maritime or aviation

Projects aiming exclusively at producing maritime or aviation fuels shall apply under the EII category. However, projects that include both the production of a maritime or aviation fuel and the use of that fuel in a vessel or aircraft may apply as hybrid projects combining the EII category (for production of the fuel) with the maritime or aviation category (to receive recognition for any 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. Therefore, those terms shall be excluded from the maritime/aviation part of the calculation to avoid double counting (i.e. Ref_energy,y/Ref_jet-A1,y shall be taken as zero in the maritime/aviation part of the calculation).

1.2.2 Manufacturing of components

Manufacturing projects focusing on the production of innovative components which will be used in specific energy or mobility systems are covered by this section. This includes the production of innovative components which will be used in:

- Electrolysers;
- fuel cells;
- renewable energy generation, including heat pumps,
- energy storage systems,
- vessels and aircrafts.

<u>Examples</u>: for renewable energy generation: manufacturing polysilicon for solar PV panels, wind turbines, transformers for utility-scale PV, inverters and subsidiary components, production of steel and concrete wind turbine towers.

<u>Examples</u>: for energy storage: batteries, smart grid technologies.

1.3.2Components 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.

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

<u>Example</u>: batteries may be used for intra-day electricity storage (facilities) or in electric vehicles (consumer products). Batteries can also be considered a standalone consumer product.

Such projects shall be submitted in the relevant category and sector based on the way that the components will be used:

- Projects manufacturing renewable energy components (e.g. wind turbine blades, photovoltaic modules, components for stationary fuel cells) shall apply in the renewable energy category under sector "Manufacturing of components for renewable energy".
- Projects manufacturing energy storage components (e.g. batteries) shall apply in the energy storage category under sector "Manufacturing of components for energy storage".
- Projects manufacturing electrolysers or vehicle fuel cells components shall apply in the energy intensive industries category under sector "Manufacturing of components for energy intensive industries".
- Projects manufacturing vessel components shall apply in the mobility category, under sector "Maritime".
- Projects manufacturing aircraft components shall apply in the mobility category, under sector "Aviation".

In these projects, for the purpose of the GHG calculation, applicants shall bring the operation of the facilities or consumer product that will be built with those components into the system boundary (subject to the requirement below 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). Applicants must provide clear justification for assumptions regarding the use of the produced components (e.g., operating hours, cost share, facility or consumer product in which the component will be used). Note that the number of energy systems included in the system boundary will increase over time.

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 considered under "Other GHG savings".

Projects covered under this section must produce specialised components, and projects producing bulk materials shall not apply as component manufacturing projects. "Components" for specific strategic energy systems shall have all the following characteristics distinguishing them from bulk materials:

- They shall be either a part of the energy or mobility system or a specialized material used in the energy or mobility system (e.g. the cooling fluid in a heat pump) and could be replaced with a spare part or spare material;
- When leaving the manufacturing facility, they already have the intended specialized function relevant to the final purpose of the energy or mobility system;
- They are innovative;
- They are in a ready to use form, i.e., they (can be directly assembled into the energy or mobility system.

Applicants must allocate emissions avoidance from the use of the individual components proportionally based on the innovative components' cost as a share of the total capital cost of the relevant facility or the total retail price of the relevant consumer product. The total capital cost for a facility is the sum of the cost of an innovative component plus the cost(s) of the remaining components constituting a typical operational facility. For components used in consumer products, the retail price shall be based on a typical use case for the component and may exclude sales taxes. Applicants must provide appropriate references to justify this cost assessment.

> *Example: If an innovative component represents 25% of the total capital cost of an operational facility, then the emissions in the project and reference scenarios (and therefore the absolute emission avoidance achieved) shall be multiplied by 0.25.*

An innovative component shall be understood and treated as the full unitary item that leaves the manufacturing plant, thus including but not limited to the sub-component with specific innovation.

> *Example: a manufacturing plant produces a whole battery as a saleable object. The cost of the whole battery is considered regardless of which part of the battery is innovative.*

> *Example: a manufacturing plant produces lithium ion cells for full batteries being assembled elsewhere. Only the cost of the lithium ion cell shall be relevant.*

Applicants with projects manufacturing electrolyser components may assume that the electrolysers will operate for 5,000 hours a year[14] and may choose to use the following electrolyser capital cost assumptions[15], 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 manufacturing fuel cell components for commercial vehicles should assume that the vehicles will be driven for 140,000 km per year. Applicants with projects to manufacture fuel cell components for passenger vehicles should assume that the vehicles will be driven for 12,500 km per year. Applicants may refer to the JEC-WTW v.5 for other typical vehicle data, or may provide their own project specific values. Applicants with projects to manufacture components for fuel cells for commercial vehicles may assume that the full fuel cell unit will cost 450 €/kW, or may provide their own project specific assumptions. Applicants with projects to manufacture fuel cell components for stationary applications 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

If the components produced by a project covered under this section will use hydrogen when in operation, for example in the case of components for fuel cells, applicants are

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

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

permitted to assume that the hydrogen that will be consumed has an emission factor of zero.

For projects covered under this section, the GHG emission avoidance is calculated based on the intended use of the components during 10 years counted **from the day on which the first produced component leaves the project's manufacturing facility**, even if the manufacturing facility will operate for less than 10 years.

The applicant may assume for the purpose of the GHG calculations that components enter in use immediately after being produced and sold. This means that every year more components are assumed to enter into operation. The cumulative emission avoidance shall be reflected in the calculation.

> Example: *A manufacturing plant produces wind turbines blades. The ten-year period for the project starts when the first wind turbine blade is produced. In reality, there will be a delay before the blades are installed on wind turbines and a further delay before those wind turbines enter operation. For the InnovFund GHG emission avoidance calculation, however, the applicant may assume that blades become operational immediately that they leave the manufacturing facility.*
>
> *The emissions calculation will consider the sum of the electricity generated by wind turbines using the manufactured blades through the ten-year monitoring period. For example, blades produced at the end of the fifth year of the project will be assumed to produce wind energy for the following five years. As the number of produced blades accumulates, in each year the project is associated with higher renewable energy generation than the year before, and therefore with a higher GHG emissions avoidance. A blade produced at the end of the ninth year of the monitoring period will contribute only one year worth of emission savings to the calculation.*
>
> *A component manufacture project may not claim the full emissions savings from the operational facility, but only a share consistent with the share of the capital cost for that facility spent on the component. If the applicant presented evidence that the rotor blades represented 15% of the capital cost of turbine installation, then the project should include only 15% of the associated reference and project scenario emissions (and therefore 15% of the reportable GHG emissions avoidance) in the GHG calculation.*

For a project that produces an innovative component to use in an energy or transport system, the operating conditions of the facility or consumer product in which the component will be installed shall be estimated based on credible assumptions, and well justified, for example by providing letters of intent 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 at the power plant, but which are not necessarily manufactured at the same facility.

1.3 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 in Section 2, Section 3, Section 4, Section 5, Section 6, and Section 7.

1.3.1 The reference scenario

The reference scenarios should reflect the current state-of-the-art in the different sectors, as shown in Table 1.2 and Table 1.3. The default values are also given in the GHG calculators.

Table 1.2. Reference Scenarios

Category / Sectors / products	**GHG emissions are based in the reference scenario (among others) on:**
EII	EU ETS benchmark(s), fossil fuel comparators (FFCs, see Table 2.2), or proposed by applicants if the reference cannot be constructed by combination of benchmarks and FFCs
EII / Refineries / Biofuels	Adapted fossil fuel comparators from REDII (1)
EII / CCS	CO_2 is released (i.e., not captured) /available in atmosphere
RES / Renewable electricity	2030 electricity mix
RES / Renewable heat EII / other (bio-heat)	Natural gas boiler
RES / Renewable cooling	2030 electricity mix
ES / Energy storage RES / Dispatchable renewable electricity EII / other (bio-electricity)	Single-cycle natural gas turbine (used for peaking power)
ES / Electricity grid auxiliary services	Combined-cycle natural gas turbine (partial load)
ES / Heat / Hydrogen storage	EU ETS benchmark for heat / hydrogen production
ES / Energy storage in vehicles	Diesel-fuelled internal combustion engine
MAR	A conventional vessel running on heavy fuel oil
AVI	A conventional aircraft running on jet A1 Kerosene

(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 it for industrial and residential use. The reference scenario for renewable heating is pre-set as natural gas boiler (see Table 1.2) with a pre-set efficiency.

Example: A project produces hydrogen to be used in vehicles. The reference scenario is the fossil fuel comparator (the emission factor) needed to drive such vehicles in the absence of the project.

1.3.1.1 Relationship to calculation of relevant cost

The choice of Reference scenario should be in principle aligned with the choice of reference product or reference investment in the Relevant Costs methodology. This will be for example the case when choosing the EU ETS benchmark plant as reference for both Relevant Costs and GHG avoidance methodology.

Applicants should be aware that the reference product or process used as the basis for relevant costs calculations will, however, differ in some cases. This is because of the different scope of the two methodologies.

> 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 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 investment in the* manufacturing *plant.*

1.3.2 GHG emission factors for 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 as having zero associated GHG emissions, which corresponds to the projected average emissions of the 2050 grid electricity mix**[16]. 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**. Therefore, 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 tonnes CO_2e/MWh][17]), 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 t CO_2e/MWh][18]).

Credit is also given to projects in the energy intensive industries sector that manage their electricity consumption to use:

- less electricity (this type of projects cannot be combined with other type of projects as explained in more detail in section 2.2.6.3.5), or
- predominantly electricity with low emission factor, thereby increasing absorption of variable renewable electricity and reducing the need for dispatchable fossil power, by treating such projects as offering a ‘virtual’ energy storage service (this is explained in more detail in section 2.2.6.3.6).

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

[16] 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.

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

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

from it. These emissions factors apply to both the project and reference scenarios. The treatment of electricity under each project category and sector 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

Category / sector / products	**Net electricity exported**	**EF**	**Electricity consumed**	**EF**
Energy intensive industry, except bio-electricity	Net amount of electricity exported from the project to the grid	0.00 gCO_2e/MJ	Amount of electricity fed from the grid to the project	0.00 gCO_2e/MJ
Electricity-saving projects in energy intensive industry	An electricity-saving projects would not deliver net electricity export	n/a	Amount of electricity saved (i.e. no longer fed from the grid to the system)	48.8 gCO_2e/MJ [0.176 tCO_2e/MWh]
Timed electricity demand (see section 2.2.6.3.6):	A virtual-stored-energy-release component	140 gCO_2e/MJ [0.505 tCO_2e/MWh]	A constant average consumption component	0.00 gCO_2e/MJ
CCS	A CCS-only project would not deliver net electricity export	n/a	Electricity consumed for injection and/or capture:	0.00 gCO_2e/MJ
Renewable non-dispatchable electricity	Net amount of electricity produced in the reference scenario and replaced by non-dispatchable electricity in the project scenario	48.8 gCO_2e/MJ [0.176 tCO_2e/MWh] $EF_{electricity,ref}$	Amount of electricity imported from the grid and consumed at the project site:	0.00 gCO_2e/MJ $EF_{electricity,proj}$
Renewable dispatchable electricity, including bio-electricity in EII	Net amount of electricity produced in the reference scenario and replaced by dispatchable electricity in the project scenario	140 gCO_2e/MJ [0.505 tCO_2e/MWh] $EF_{electricity,ref}$	Amount of electricity imported from the grid and consumed at the project site:	0.00 gCO_2e/MJ $EF_{electricity,proj}$
Energy storage	Net amount of dispatchable electricity supplied by the project	140 gCO_2e/MJ [0.505 tCO_2e/MWh] EF_{out}	Amount of electricity consumed by the project (both storage and self-consumption)	0.00 gCO_2e/MJ EF_{in}
Maritime	n/a	n/a	Amount of electricity consumed by the project	0.00 gCO_2e/MJ

Category / sector / products	Net electricity exported	EF	Electricity consumed	EF
Aviation	n/a	n/a	Amount of electricity consumed by the project	0.00 gCO_2e/MJ

Source: European Commission internal elaboration.

> *<u>Example</u>: A project aims at generating renewable electricity by torrefaction and combustion of biomass feedstock in a combined heat and power (CHP) plant.*
>
> *The reference scenario: A term for the net amount of dispatchable electricity generated by the renewable technology and fed into the grid multiplied by $EF_{electricity,ref}$ = 140 gCO_2e/MJ, plus a term for the amount of heat supplied by the project multiplied by $EF_{NG,ref}$ / 0.90 (see section 4).*

1.3.3 GHG emissions from inputs

The applicant must specify the **energy and material inputs** that enter the system boundary, according to the specific guidance given in sections 2 to 5.

The following guidance on inputs apply to projects following Section 2 and 3. Inputs are divided into three categories: 'rigid', 'semi-elastic' and 'elastic'. Elastic inputs are in turn divided into three levels of materiality: 'major', 'minor' (not applicable to projects submitted to the small-scale topic) and 'de minimis'. The category and level of materiality for an input affect the way that its associated emissions are to be assessed.

Rigid inputs 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. *Elastic inputs* are inputs for which overall production is variable (flexible), i.e., inputs for which production would be expected to increase as demand increases. *Semi-elastic inputs* are inputs that fall between these cases.

The levels of materiality are relevant only to elastic inputs, since rigid 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.

1.3.3.1 Level of materiality of elastic inputs

The level of materiality of elastic inputs can be major, minor or *de minimis*. Inputs that do not fall under the definition of minor, or *de minimis* are major.

Minor elastic inputs (Not applicable to Small-Scale topic)

The applicant should make a list of all elastic inputs for the project and reference scenarios.

The applicant may select from this list minor elastic inputs whose emissions jointly amount to less than 15% of the total emissions ascribed to the inputs.

For monitoring and reporting for disbursements, the selection of minor elastic inputs must be restricted so that their emissions jointly amount to less than 15% of the total emissions ascribed to the inputs; for monitoring and reporting for knowledge-sharing to less than 10% of the total emissions ascribed to the inputs.

The emissions associated with the selected minor elastic inputs may be derived from reference literature, according to the method and hierarchy in Appendix .

De minimis inputs

De minimis inputs are elastic inputs that make such a small contribution to the overall emissions of a project or reference scenario that they should reasonably 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 assessed 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 select from the list of inputs de minimis inputs whose emissions jointly amount to less than 5 % of the total emissions ascribed to the inputs for the whole project.

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. De minimis inputs do not count as minor elastic inputs in calculating the joint emissions of the minor elastic inputs.

For projects submitted in a Small-Scale topic:

The remaining listed elastic inputs should have emissions factors assigned to them from the data hierarchy given in Appendix . The assessment of emissions associated with each elastic input shall be undertaken by multiplying the quantity of each elastic input to be used in the relevant scenario by the emissions factor.

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

All other inputs are considered major and must be included in the emissions calculation.

Simplification for projects submitted in a PILOTS topic

For PILOTS topic projects *de minimis* status can be granted based on use of an illustrative emission factor rather than requiring estimated emission factors for all inputs. Applicants could show that inputs would result in only modest emissions even if given a high emission factor, which would imply that if calculated with correct (and probably lower) emission factors the input emissions would be low to insignificant.

For example, fossil fuels have associated CO_2 emission factors of up to about 3 tonnes CO_2 per tonne of fuel, while the document "Definition of input data to assess GHG default emissions from biofuels in EU legislation" identifies chemical inputs with emission factors of up to 12 tonnes CO_2 per tonne of input (but most chemicals considered have lower footprints).

Alternatively, if it can be demonstrated that some group of process inputs would account for less than 10% of the reference emissions even if assessed with a high emission factor, these inputs could be taken as *de minimis*.

1.3.4 GHG emissions associated with transport

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.

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.

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

- Use actual expected values in the calculation submitted when data can be tracked from the transporters, or;
- Use data from Table 1.4 or other similar values that the applicant could duly justify.

Table 1.4. GHG emissions (g $CO_2e/(t*km)$) from the transportation of biomass.

Pathway/Tractor			
Rail transport	**Road**	**Inland/coastal waterway**	**Sea**
Freight electric train Electricity: InnovFund assumptions for electricity consumption	40 t diesel truck (includes return trip) 60.03 g/(t*km)	1.2 kt diesel tanker 37.38 g/(t*km)	12.6 kt HFO tanker 9.29 g/(t*km)

Freight diesel train 18.68 g/(t*km)		8.8 kt diesel bulk carrier 24.10 g/(t*km)	26 kt HFO bulk carrier Handysize 15.48 g/(t*km)

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

1.3.5 Combustion emissions

Emissions of greenhouse gases 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 biomass combustion may be treated as having an emission factor of zero, but other greenhouse gases emitted in biomass combustion shall be considered.

Where materials containing carbon atoms are used in or produced by projects it is sometimes required by this methodology to 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.

1.3.6 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.

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

During operation, beneficiaries will have to demonstrate GHG emission avoidance following the same assumptions made at the application stage. 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. The details on the length of the monitoring and reporting period are in the section 1.1. Beneficiaries shall ensure that the operational data determination is neither systematically nor knowingly inaccurate[19] and avoid bias in the selection of assumptions. In selecting a monitoring methodology, the improvements from greater accuracy shall be balanced against additional costs.

The general conditions on monitoring, reporting and verification (MRV) of performance, disbursement of the grant and knowledge-sharing are described in the call text. Appendix provides details on the specific requirements for reporting for the purposes of disbursement and for knowledge-sharing for the different project categories and sectors.

[19] 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 use (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 sectors. The principal product(s) from the project (section 1.2) should reflect the main aim and innovation of the project. To fall in one of the energy intensive industry sectors, the principal product(s) **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.

Projects concerned with innovative processing of biomass feedstock to produce bio-based products and biofuels in bio-refineries also have to follow the principles described in this section.

Some guidance on cases where a sector choice might be difficult 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 depending on the intended use of the product, that must be credibly justified.
Direct air capture (DAC) with CCS Waste-to-energy with CCS	EII / Other
DAC with CCU CCU	Such projects must result in substitute products for the products of Annex I of the ETS Directive. The sector to choose is the sector of the substitute product.
Wastewater treatment	If using renewable energy, then the sector is “Use of renewable energy outside Annex I”. If biofuels are produced, then refineries can be chosen.
Water desalination	If using renewable energy, then the sector is “Use of renewable energy outside Annex I”. Otherwise, then the sector can be EII / Other.
Production of hydrogen or other synthetic fuels from electricity	Such projects fall under the EII category / refineries sector. The production of hydrogen that will not be used as a fuel falls under the EII category / hydrogen sector. If the electricity consumed is essentially limited to period of high renewable energy production, which result in a particularly low load factor, projects fall under the energy storage category / other energy storage sector.

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, please look at sections 1.1.1 and 1.1.2. 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.

In some cases, an innovative process element may be introduced that reduces the emissions of only a fraction of the overall throughput of an existing facility. In such cases, if the innovation could in principle be extended (i.e., be scaled up) to cover the entire throughput of such a facility, then it is permitted to consider only the fraction of production when defining the project and reference scenarios. However, if the innovation cannot be scaled up to the full plant, then, in the calculation of relative emission avoidance, the applicant should use the GHG emission avoidance of the whole existing plant as reference scenario, while for the project scenario, the applicant can take only up to the maximum fraction convertible to the new technology.

Applicants should justify the maximum fraction used in the calculation.

> *Example: an ammonia production plant that currently consumes 100 thousand tonnes of hydrogen per year may apply 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.*
>
> *The absolute GHG reduction will be the same whether the entire facility or only the fraction processing green hydrogen is included within the project boundary.*
>
> *The relative emission reduction, however, will be greater if only the part of the facility processing green hydrogen is considered.*
>
> *In principle it would be possible to add additional electrolysis units to move the entire facility to green hydrogen, and therefore it is permitted to consider only that part of the existing process as reference scenario that will be modified to green hydrogen input. This is allowed even though it may not be possible to physically separate the green hydrogen from conventional hydrogen sources in the process. In such a case then the relative emission avoidance can be calculated as 100%.*
>
> *However, if there are technical limitations to substitute all the hydrogen with green hydrogen and, for example, only up to 60% of the hydrogen could be substituted, then the relative emission avoidance would be limited to 60%.*

2.2.2 Life-cycle stages

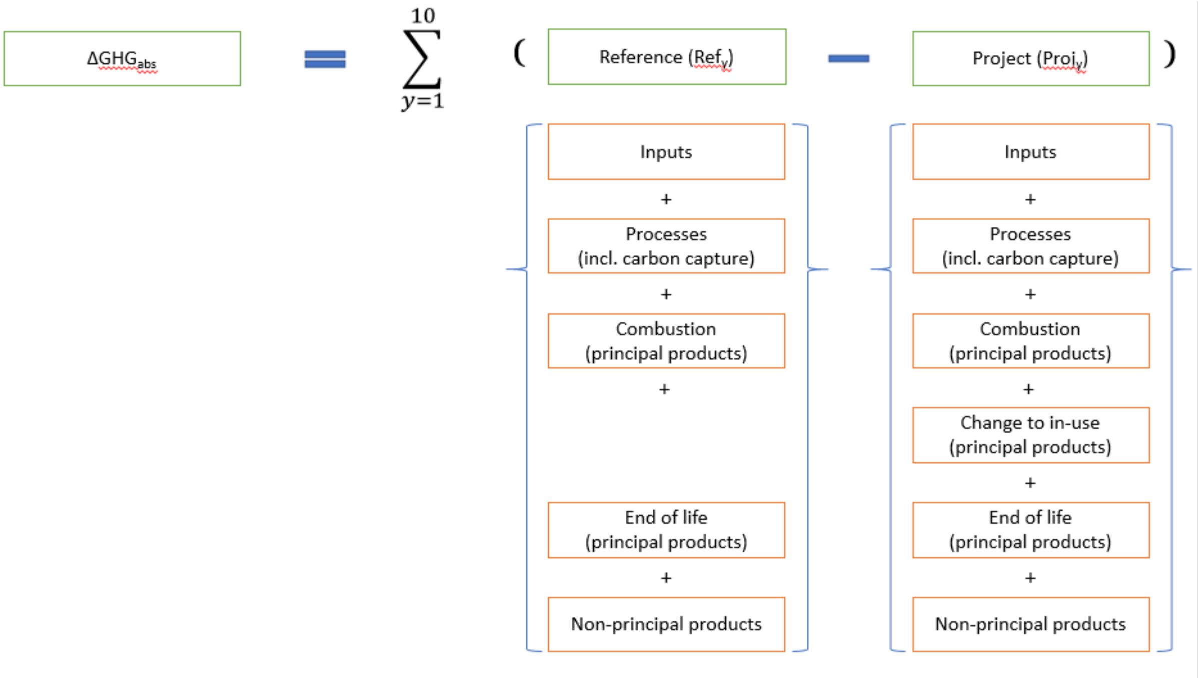
The GHG emissions for each life-cycle stage shall be included in the calculations for the reference scenario and the project scenario, as illustrated in Figure 2.1.

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, and indicating all the sub-processes, inputs, and products for both scenarios.

Where possible, the diagram should include quantities of the material and energy flows. The applicants may use Figure 2.1 for guidance, or provide a project-specific diagram.

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



Source: *European Commission internal elaboration.*

Both scenarios shall include any relevant emissions in the boxes: corresponding to "inputs", "processes (incl. carbon capture)", "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 sub-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 should 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). For processes **upstream of the innovative processes**, applicants may choose to either:

- treat the outputs of those upstream processes as inputs to the project and include them in the "inputs" box (see section 2.2.6),

- or, to expand the system boundary to include them within the "processes" box, providing that applicants have data available to do so (see section 2.2.5).

In general, when applicants control a process involved in the production of the principal products, that process should be placed within the system boundary and assessed in the "processes" box. Even when applicants do not control an **upstream** process, they are encouraged to expand the system boundary to include that process in the "processes" box, provided that they are able to arrange with the process operator to have access to the relevant GHG emissions data. There is no limit on how far upstream the system boundary may be extended. If data is available then applicants may include primary **material extraction** in the "processes" box (for the emissions covered and excluded: see sections 1.1.3, 1.1.4).

> *<u>Example</u>: hydrogen used to produce a synthetic fuel.*
>
> *If hydrogen production is under the control of the applicant (e.g., the applicant owns and operates an electrolyser), then hydrogen production should be brought into the system boundary and treated as part of the process along with synthetic fuel production.*
>
> *If, however, hydrogen is produced by a third-party operated facility, and the applicant is not able to arrange access to data in order to bring this facility inside the system boundary, then the hydrogen will be treated as an input.*

The reference scenario is defined by the principal product(s) being produced by the project. The system boundary for the reference scenario may vary depending 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.

2.2.4 Choice and construction of a "processes" box in the reference scenario to match the function of the project's principal product(s)

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 an identical conventional product(s). If the principal product is to be utilised to fulfil a function conventionally delivered in another way (i.e., by some combination of other products), then the reference scenario would be the production of the conventional product, or combination of conventional products that would fulfil the equivalent function.

In cases where there is more than one possible reference scenario, the reference scenario should be based on the conventional products most likely to fulfil the function in the absence of the project. 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.

Sum of individual reference scenarios: the **full reference scenario** will consist of the sum of the individual reference scenarios for each of the principal products identified for the project.

> *<u>Example</u>: A project with two principal products: hydrogen and synthetic diesel fuel. A reference scenario consists of the sum of both the EU ETS product benchmark for hydrogen production and 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 providing 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 basic cases for setting the reference scenario for a principal product:

The following nine cases are discussed in additional detail below.

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 should 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 below.
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) for production of that principal product with natural gas as the primary feedstock[20], then the applicant shall base the reference scenario on that emission value, reduced by 15% where appropriate, as detailed in section 2.2.6.3.3.
7. If the project is for CCS from direct air capture, the reference scenario is zero emissions.
8. If the project is to transport 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 production of all the principal products from a project in the ways identified above, then the applicant must propose an appropriate reference scenario with clear justification and provide a robust characterisation of the emissions associated with that system.

[20] 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.

Note that for projects with multiple principal products it is possible that reference scenarios for the individual principal products may fall under different sub-sections below. In that case, the reference emissions for the project as a whole shall be the sum of the reference emissions for all principal products.

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

Simplification for PILOTS topic **projects:** PILOTS projects must base their reference scenario on the relevant benchmark(s), when available. In addition, they are allowed to use information from LCA studies from the literature in cases where additional information on inputs and non-principal products would be required.

For projects producing principal products for which an EU ETS product benchmark is defined in Annex I of the applicable Benchmarking Decision[21] 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 in the "processes" box of the reference scenario. 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.

> *<u>Example</u>: hydrogen production 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.*

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

> *<u>Example</u>: 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**[22]:

> **"Inputs".** The EU ETS benchmarks do not include embedded emissions associated with inputs used. 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.
>
> *<u>Example</u>: 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*

---

[21] 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).

[22] 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

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 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.

"Non-principal products" associated with the reference scenario. In some cases, non-principal products should 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 should 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)" in 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.

"End of life (principal products)".

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

Simplification for PILOTS topic **projects**: PILOTS projects must base their reference scenario on the relevant benchmark(s), when available. In addition, they are allowed to use information from an LCA study from the literature in cases where it is not clear which sub-installations need to be added.

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 sub-installation, it may be possible to construct an appropriate reference scenario by combining the existing product benchmark sub-installation with other 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 sub-installations can be added to the "processes" box in the reference scenario to balance the scenarios.

There are three types of other EU ETS sub-installations[23]:

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

In these cases, the relevant EU ETS product benchmark plus additional 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).

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

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

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

> *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.*

> *Example: 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 (for example in determining whether to assume that additional energy is supplied as heat, fuel or **electricity**) should be clearly stated and justified, and should provide a reasonable characterisation of normal practice in the conventional production process. Where a decision must be made between two alternatives that are both equally common, the reference scenario should always reflect the lower GHG emissions option. 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.

> *Example: 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.*

[23] 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).

The reference scenario shall include emissions in additional boxes that the EU ETS product benchmarks and other benchmarks sub-installation do not cover. See related guidance in section 2.2.4.1.

2.2.4.3 Case 3: Modifications to existing production systems

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 if the principal product that is used to determine the sector of the application is also produced by the unmodified system. If, however, the CAPEX associated with the 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. 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**.

A project in which only inputs are changed does not qualify as a modification to an existing production system. Note, however, that the applicant may choose to bring the production of any input into the "processes" box (see 2.2.3 and 2.2.6) and assess the emissions directly. This requires that the applicant should be able to identify the source of that input and to cooperate with the producer of that input in order to obtain the necessary data for the calculation. In some cases, identifying a project as a modification will depend on the choice of principal product.

> *Example: 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.*

Applicants must provide justification of 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, this may affect the assessment of the quality of the GHG calculations.

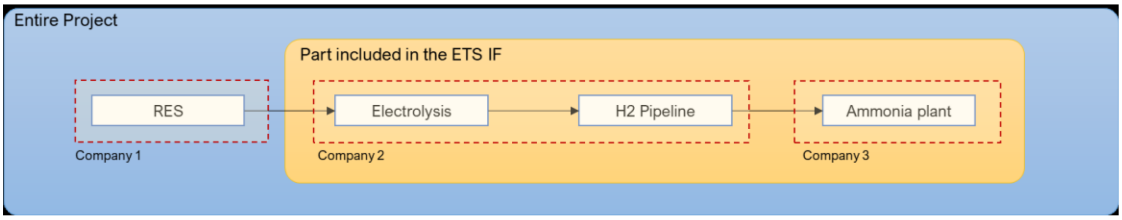
Rules for modified production systems: When a project is identified as a modification to an existing production system, the applicant **may be permitted** to take the unmodified processes as the reference scenario, rather than the relevant EU ETS benchmark(s), under the following conditions:

- 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.[24]
- 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

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

corresponding EU ETS product benchmark for at least one principal product of the project.

Example: 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. The project can be defined as a modification to the ammonia plant, as the hydrogen production unit is only 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).

However, if company 2 applied alone, then the principal product is hydrogen. In this case it would no longer be possible to treat the project as a modification, so the reference scenario would be the EU ETS benchmark for hydrogen (see case 1 in section 2.2.4.1 above).

- 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 2.2.6.1), 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 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"[25] (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 and projects supplying electricity or hydrogen for use in road transport.

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[26]. 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[27]. 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)" and the lower heating values (net calorific values) for fossil fuels displaced by InnovFund projects. [28]

Substituted fossil transport fuel	InnovFund fossil fuel comparator (gCO_2e/MJ)	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

[25] 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.

[26] 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.

[27] This procedure corrects for any differences in combustion emissions expressed in gCO2/MJ fuel. As biomass derived CO2 is not counted as an emission, no combustion emissions are reported in the case of biofuels.

[28] These are not combustion emissions: they are not to be used as emissions factors for these fuels as inputs.

Substituted fossil transport fuel	InnovFund fossil fuel comparator (gCO_2e/MJ)	LHV = NCV (MJ/kg)
Marine fuel (including gas oil and 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 literature hierarchy, Appendix 1. If the fuels will be used in vessels or airplanes and the applicant wants to include other non-CO2 climate impacts (e.g., black carbon), then the applicant may submit a hybrid application as detailed in section 1.2.1.5.

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 1.3.4.

Proposals producing products that can either be used as transport fuel substitutes or in other applications must credibly justify the intended use of the product, for example by providing draft contracts with distributors, letters of intent, or other relevant supporting documents..

> *Example: A project produces hydrogen for fuel cell vehicles.*
>
> *Hydrogen is supplied to fuel cell vehicles. It substitutes fossil fuel by providing the same transport function of conventional cars. Therefore, the appropriate sector is EII/Refineries. The reference scenario is the consumption of the fossil fuel (fossil fuel comparators Table 2.2) required for a comparable conventional car to transport **the same load over an equal distance**. This shall be calculated by considering the difference in efficiency and fuel consumption between a conventional car and a fuel cell car. In addition, the project scenario shall include emissions associated to hydrogen distribution to cars, since hydrogen is physically different with respect to conventional fossil fuels (Section 1.3.4).*
>
> *Applicants must convincingly establish that the hydrogen will be used for the claimed application in fuel cell cars. For example, by providing draft contracts withdistributors, letters of intent, or other relevant supporting documents.*
>
> *Otherwise, if the project produces hydrogen without targeting a specific application in transport, the correct reference scenario would be 'generic' hydrogen production based on the EU ETS hydrogen product benchmark. In this case, the appropriate sector is EII/hydrogen.*

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, hydrogen for supply via the natural gas grid), where the intended use of the substitute gas is unknown or may fall outside the energy intensive industry activities covered by Annex I of the EU ETS Directive, 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 intended use of the natural gas substitute is known (e.g., transport or industrial use), then the reference scenario shall reflect emissions associated with providing that equivalent function, which may be **different from a natural gas combustion reference**.

> *Example: Production of renewable gas fed into the natural gas grid.*
>
> *If there is no arrangement in place to supply to a specific market, then 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: Production of renewable gas for heavy duty transport.*
>
> *If the intended use of the natural gas substitute is known (e.g., power generation, transport or industrial use) then the reference scenario should reflect emissions associated with providing that equivalent function.*
>
> *For example, in the case that arrangements are made to have the produced gas supplied for heavy duty transport, then the diesel fossil fuel comparator would be the appropriate reference (80.4 gCO_2e/MJ, Table 2.2), and the applicant shall follow the guidance provided in Section 2.2.4.4. The relative efficiency of natural gas and diesel heavy duty engines should be included in calculating the amount of diesel displaced. Applicants must convincingly establish that the renewable gas would be used for heavy duty transport, and the project scenario shall include emissions associated to the produced gas distribution to the vehicles.*

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 [29] it is allowed to take as a reference scenario a life-cycle[30] emission factor drawn from the hierarchy of inputs data sources in Appendix , 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, 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 on a stoichiometric basis. The resulting value can be

[29] 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.

[30] 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.

used as an emission factor for production of the relevant principal product in the "processes" box of the reference scenario.

If the emission factor drawn from the data hierarchy includes upstream emissions associated to fossil fuel supply, these emissions shall be excluded from the emission factor. To this purpose, it is allowed to reduce the part of the emission factor not associated with the carbon content of the substance by 15% as an approximate approach (see section 2.2.6.3.3). This adjustment shall be made for the supply part of emissions intensity values taken from the REDII inputs data. For the particular case of **methanol**, the value to use in the reference scenario is 92.9 gCO_2e/MJ [31] (see example below).

> *Example: A project will produce methanol as a principal product.*
>
> *If the methanol will be used as a gasoline additive, then the reference scenario can be based on the gasoline fossil fuel comparator. However, this project will supply the methanol to the chemicals market rather than the fuel market.*
>
> *The document "Definition of input data to assess GHG default emissions from biofuels in EU legislation" is at the second level of the data hierarchy and provides a lifecycle GHG emissions intensity value of 97.1 gCO_2e/MJ for methanol, divided into 28.2 gCO_2e/MJ of supply emissions and 68.9 gCO_2e/MJ of combustion emissions. This value is referenced to "Larsen, H. H., 1998, Haldor Topsoe A/S, Lyngby, 'Denmark: The 2,400 MTPD Methanol Plant at Tjeldbergodden". This report is based on a process for synthesis of methanol from associated natural gas produced at Heidrun oil field – as it is a natural-gas-based lifecycle value, can be used under this case. The scope for the lifecycle values in the document "Definition of input data to assess GHG default emissions from biofuels in EU legislation" includes upstream emissions from fossil fuel supply, and therefore the supply element of the value should be reduced by 15% from 28.2 gCO_2e/MJ to 24.0 gCO_2e/MJ before being used to set a reference scenario. The resulting emissions intensity value is 92.9 gCO_2e/MJ.*

Several chemicals that can be produced by steam cracking of natural gas liquids fall on the 'high value chemicals' (HVC) list in the ETS[32]. However, they may be produced in ratios that do not meet the HVC definition for use of the EU ETS HVC benchmark. In that case, the applicants shall propose a reference scenario based on a lifecycle emission value for the relevant chemical from the input data hierarchy (Appendix 1). 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 hydro-carbons 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 (reducing the part of the emissions not associated with the carbon content of the substance by 15% if appropriate) as their reference scenario.*

[31] Calculation based on the report "Definition of input data to assess GHG default emissions from biofuels in EU legislation."

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

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.

> *Example: If methanol will be supplied for use as a transport fuel in heavy duty vehicles, the reference scenario shall be based on the fossil fuel comparator for diesel (Section 2.2.4.4), and not on methanol production. Applicants must convincingly establish that the methanol willl be used for transport, and the project shall include emissions associated to the methanol distribution to the vehicles.*

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.

2.2.4.7 Case 7: Direct air capture for CCS, and BECCS

Where a project consists solely of the installation of a direct air capture facility or of a carbon capture unit at a biomass power 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 calculate relative emissions reductions using equation 1.2 and therefore **the relative emission reduction shall be set to 200%**.

See section 2.2.5.2.2 and Section 3.1 for additional guidance on DAC projects.

2.2.4.8 Case 8: Storage or transport of captured CO_2

For projects that involve only the storage 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. No distinction shall be made between CO_2 of fossil and biogenic origin in this case. If an applicant wishes to gain recognition within the GHG calculation for the transport or storage of biogenic CO_2, then the capture of that CO_2 must be brought within the system boundary and this reference case would not be applicable.

See section 2.2.5.2.3 and Section 3.1 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

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 justify the choice of an appropriate reference scenario which delivers the **same quantity or function** as the principal product in the project scenario.

The applicant may consider sources in the inputs data hierarchy (Appendix 1) but is not limited to those sources. 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, which are also more consistent with the principles of EU ETS benchmarking and more realistic.

The applicant must calculate **the direct GHG emissions for the combination of processes in the project scenario** using calculation methods specified in the Monitoring and Reporting Regulation (MRR)[33]. 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.

In addition, when defining the reference scenario, the applicant shall identify relevant inputs in the "inputs" box and use the other boxes as required.

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.

2.2.5 Emissions from processes (incl. carbon capture)

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).

This includes all emissions of CO_2 or other greenhouse gases occurring due to fossil fuel combustion or chemical or biological processes within the project boundary (remembering that any emissions of biogenic CO_2 should be recorded but shall be treated as zero for the emissions calculation). **This includes any expected methane leakage within the project boundary.** Methane leakage should be predicted based on standard rates for the type of facility/equipment proposed. See also section 1.1.4 and section 1.3.5

The processes box shall also include any emissions credit associated with carbon capture and storage or utilisation. See also Section 3.

Emissions associated with transport are to be considered and included in the "processes" box in the cases specified in Section 1.3.4.

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).

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). This means that the principal products in the project and reference scenarios do not need to match exactly, provided that the functions delivered do match.

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

2.2.5.1 Changes in emissions from waste processing

If a process produces waste, emissions from the processing of waste – waste handling emissions (e.g., wastewater treatments) belong to the "processes" box.

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

[33] Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 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 (Text with EEA relevance.)

2.2.5.2 Emission avoidance from CO_2 capture and geological storage

2.2.5.2.1 CCS from a point source within the system boundary of the project

An energy intensive industry project that has a CCS element capturing and storing **some or all** of its own process emissions (in accordance with Directive 2009/31/EC on the geological storage of carbon dioxide) can claim the emissions savings from the CCS component. The reference and project emissions shall be calculated as for any EII project using the methodology as detailed in this Section 2, and then a carbon capture credit shall be calculated using the methodology in Section 3 and included in the "processes" box. In such cases**, the "processes" box of the project scenario shall include the full amount of CO_2 generated even though some of this CO_2 is to be captured**. For fossil CO_2, this CO_2 will appear as a positive emission term. For biogenic CO_2, this CO_2 shall be recorded with an emission factor of zero. The credit calculated according to the methodology in section 3 shall then be included in the "processes" box as a negative emission term, thereby reducing the overall emissions in the project scenario.

In case that a third party carries out the transport or geological storage, the applicant should demonstrate the provision of the remaining services in the CCS supply chain by, for example, providing draft contractual arrangements or other relevant supporting documents. It is not enough to simply state an intention to geologically store the captured CO_2 .

In case the reference scenario includes an element of carbon capture and storage,(e.g. in the unusual case of a modification of an existing facility that already captures CO2) then a negative emissions term shall similarly be included in the "processes" box of the reference scenario.

2.2.5.2.2 CCS from direct air capture (DAC)

Projects consisting only of CCS based on direct air capture , 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". Such projects shall include a CCS credit in the "processes" box of the project scenario calculated **according to section 3**. The reference scenario emissions for a DAC project shall be zero (Case 7, Section 2.2.4.7).

However, if the CO_2 will be used rather than geologically stored, the applicant has to choose the respective sector of the principal product in which the CO_2 will be incorporated and apply the provisions for **CCU** (section 2.2.5.3).

2.2.5.2.3 Projects focusing on CO_2 transport and/or storage

Projects focusing on CO_2 transport and/or geological storage shall apply under category "EII" and sector "other" with the principal product identified as "CO_2 transport" and/or "CO_2 storage".

For such projects, the "processes" box of the project scenario shall include the full amount of CO_2 being brought into the system boundary as an emission term. This applies even though this CO_2 will not be emitted (excepting fugitive emissions). This emission term will then be offset by the inclusion of a carbon capture credit that shall be calculated using the methodology in Section 3 and included in the "processes" box. 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).

The "processes" box of the project scenario shall include the full amount of CO_2 entering the project boundaries. In addition, the credit calculated according to the methodology in section 3 shall be included in the "processes" box as a negative emission term, thereby reducing the overall emissions in the project scenario.

2.2.5.2.4 CO_2 capture from biogenic sources

There is **no difference** in calculation of the CC credit, using the methodology in section 3, 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, and is not affected by the origin of the CO_2.

For projects capturing **biogenic CO_2** the amount of CO_2 produced shall be recorded in the "processes" box with an **emission factor of zero**. Any fossil CO_2 produced shall be recorded in the "processes" box, with an emission factor different than zero. This applies to both the reference and the project scenarios. 3

If carbon capture is added to an existing biomass or waste to energy plant without increase in power generation capacity, the project shall follow the rules for Case 7 and set the reference scenario emissions as zero (see section 2.2.4.7). No additional emissions savings shall be included in the calculation based on continuing to operate the existing facility at its pre-existing capacity.

The following examples illustrate adding CCS to existing biomass plants:

> <u>Example:</u> *A carbon capture unit is added to an existing biomass-fired power plant without increasing power output or improving efficiency. The captured CO_2 will be geologically stored. The absolute emission savings shall be calculated as the amount of carbon stored, minus any additional emissions associated with the capture, transport and storage of the CO_2. No credit is given for the continued supply of renewable power from the facility, since this was occurring already in the reference scenario. If a modification is also introduced in the plant increasing the power output, the absolute emission savings shall be calculated as the sum of the CCS part and the emissions resulting from the modification of the plant taking as a reference the existing plant.*
>
> <u>Example</u>*: a project aims to install a carbon capture unit in 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. If the carbon capture unit is added without any other change in the CHP plant, the emission savings for the project are calculated following only section 3 and claiming credit on the total amount of CO_2 captured and stored, regardless its origin (biogenic or fossil).*
>
> *Assume, however, that the carbon capture unit is added alongside changes to increase the efficiency of the CHP plant. The emissions must then be calculated combining the methodology sections 2 and 3 taking the existing plant as a reference. As usual, the reference and project scenarios must be balanced so that the same quantity of the principal product (heat) is produced in both scenarios.*
>
> *In the* **reference scenario** *60% of the CO_2 produced by waste combustion is biogenic and is recorded in the "processes" box with an emission factor of zero. The other 40% of the CO_2 is fossil and is recorded in the "processes" box with an emission factor of 1 tonne of CO_2/tonne.*
>
> *In the* ***project scenario*** *the emissions from combustion of the fossil part of the waste must be recorded as a positive terms, even though most of those will be captured by the carbon capture unit unit. An additional carbon capture credit shall then be included as a negative emission term in the "processes" box of the project scenario following the methodology section 3. This credit is based on the total amount of CO_2 captured and stored (accounting for any emissions associated with*

leakage in transit or energy use for the capture and storage) and is independent of the fraction of the captured CO_2 that is of biogenic origin.

2.2.5.3 Emission avoidance from CO_2 capture and use (CCU)

Projects that will use captured carbon by incorporating it in a product may include in the processes box an emission credit for carbon capture and use calculated in accordance with Section 3. The CO_2 may be captured within the system boundary of the project or brought in from outside the boundaries of the project.

An emission reduction by CCU can only be claimed by **projects that will demonstrate that the captured carbon will be used.** A project that does not include any additional use for captured CO_2 may not report an emission reduction because of CCU.

If the incorporation of CO_2 into a product takes place at a facility operated by a third party, then the applicant must provide evidence that the intended use represents an **additional** utilisation of CO_2. No CCU 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.

In the case that CO_2 capture and use occur in the reference scenario, this must also be taken into account by the inclusion of an appropriate negative emission term in the "processes" box of the reference scenario.

CO_2 captured within the project boundaries

If the process from which the CO_2 is captured is included within the system boundary of the project, and one of the products of that process is set as the principal product of the project, then it is up to the applicant to choose whether to also bring the products of the CCU process within the system boundary. This includes cases where the CCU process is operated by a third party. If the CCU products are brought within the system boundary, even when operated by a third party, then the applicant must provide a full characterisation of the processes used to produce them in the calculation of the emissions for the project scenario. In this case, the CCU products may be set either as principal or as non-principal products.

If CO_2 is captured from processes within the system boundary of the project, the full amount of CO_2 produced within the project boundary shall be recorded as an emission term in the "processes" box, **even though some of this CO_2 is to be captured and used**, since the credit for CO_2 use is recorded as a separate negative term. Biogenic CO_2 produced within the system boundary shall be recorded with an emission factor of zero (see section 2.2.5.3.3).

CO2 brought in from outside the project boundaries

If the CO_2 is brought in from outside the project boundaries, then all the products from the CCU process and their associated production emissions must be included within the system boundary of the project scenario and at least one of the products of the CCU process must be set as a principal product of the project. In this case, for the purposes of the GHG calculations, the applicant must bring the CO_2 use (i.e., incorporation into a product) within the system boundary of the project even if it occurs at a separate location and/or is operated by a third party. The emissions from supplying the CO_2 to the point of use and any emission associated with the process needed to incorporate the CO_2 into a product shall be included in the "processes" box.

If CO_2 is brought in from outside the project boundaries, there is no need to include a positive emission term for CO_2 production. This means that **for CO_2 produced outside**

the system boundary it makes no difference to the calculation whether the source of the CO_2 is biogenic. Applicants may always expand the system boundary to include the upstream facilities where CO_2 is captured if they have access to the necessary data.

2.2.5.3.1 Use of geological CO_2

If CO_2 is being released naturally to the atmosphere (e.g., in a geyser), but a project captures it and then incorporates it in a CCU product, this may be treated as incorporation of CO_2 that was not generated by processes within the project boundary (see Section 2.2.5.3).

If, however, the project provokes the release of geological CO_2 which would otherwise have stayed underground (e.g., by drilling for geothermal steam from a reservoir where it is mixed with CO_2), and then captures it, then this project must be treated as incorporation of CO_2 captured from processes that are within the project boundary, with the provoked CO_2 emission included as a positive emission term in the "processes" box (see Section 2.2.5.3). See Section 4 Renewable electricity, heat and cooling for additional guidance on this aspect.

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

If CCU products that have been brought within the system boundary of the project as principal products are to be combusted for energy (e.g. in the case of RFNBOs 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. This provision applies also in the cases in which a third-party production process has been brought within the system boundaries of the project (please see section 2.2.5.3). Credit for CO_2 use is given **once and only once by the inclusion of the CCU credit in the "processes" box**.

Similarly, if carbon in a CCU product will be released by combustion or decomposition at end of life, this shall be counted as a CO_2 emission in the combustion or "end of life (principal products)" box just as it would be for a non-CCU product (see section 2.2.9). Where the CCU product replaces a similar conventional product this end-of-life term will be included in both the project and reference scenarios and be equivalent in the two scenarios. If the principal product replaces a different product with equivalent function, then the emission term in the reference scenario combustion or "end of life (principal products)" box shall be determined based on the reference product.

2.2.5.3.3 CCU with CO_2 from biogenic sources

Just as in the CCS case (Section 2.2.5.2.4) there is no difference in the calculation of the negative emission term for CCU between CO_2 captured from fossil sources and from biogenic sources. This credit is always based on the physical quantity of CO_2 incorporated in products, irrespective of origin. In the case that biogenic CO_2 generated within the project boundary is captured, when that CO_2 is included in the "processes" box it shall be recorded with an emission factor of 0 tonnes CO_2/t. Similarly, any CO_2 generated from biogenic sources in the reference scenario shall be reported with an emission factor of 0 tonnes CO_2/t.

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. However, combustion and end of life emissions associated with carbon that enters the project boundaries in biogenic inputs other than captured CO_2 (e.g., biomass, biogas, biomethane, biofuels or bioliquids), are counted as zero as indicated in Section 1.1.4.

<u>Example</u>: a project aims to produce methanol using CO_2 captured from waste gasification, with a waste composition of 70% biogenic and 30% fossil. If the waste gasification facility is within the system boundaries, the CO_2 generated shall be included as a term in the "processes" box. For the share of CO_2 generated from biogenic waste (70%) this term shall be given an emission factor of zero, while for the share of CO_2 generated from fossil waste (30%) this term shall be identical to the quantity of CO_2 produced (emission factor of 1 tonne CO_2/t). If the biological waste gasification facility is outside the project boundary, then the biogenic nature of a portion of the CO_2 has no impact on the calculations, and the treatment is identical irrespective of the CO_2 origin.

2.2.6 Emissions from inputs

The applicant must specify the inputs that enter the system boundary (see 2.2.3) associated with the "processes" box of the project and the reference scenarios. This shall include both **energy and material inputs**, with the exception of fuels combusted within the system boundary as emissions from combusted fuels are included in the **"processes" box** (see 2.2.6.3.1).

Emissions factors for inputs used should be drawn from the data hierarchy in Appendix 1 (this is explained in more detail below). 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. Where heat is used as a project input the emissions should be assessed based on a natural gas boiler with 90% LHV efficiency i.e. an emission factor of 62.4 g CO_2e/MJ..

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 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 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.

For the project scenario, and for reference scenarios under 'Case 3: modifications to existing production systems' (see 2.2.4.3), the applicant may choose to bring the production of any input into the "processes" box and assess the emissions directly. This requires that the applicant should be able to identify the source of that input and to cooperate with the producer of that input in order to obtain the necessary data for the calculation (see 2.2.3).

For the purposes of the GHG emission avoidance calculation, where electricity is consumed from the grid by an energy intensive industries project, or where additional electricity is exported from the project to the grid, **the emission factor for the grid electricity consumed as an input is zero** and there is no credit under section 2 (EII) for exporting **net** electricity (see Table 1.3) to the grid. If electricity exported from the project is renewable, the applicant may consider submitting a hybrid application including an EII and a 'Renewable electricity and heat' element to receive credit for the electricity export (see section 1.2.1.1).

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.

The **emissions for water provision** as an input should be neglected provided that water provision does not involve (prior to provision to the project) desalination, wastewater treatment or additional pumping.

2.2.6.1 RIGID inputs

The emission avoidance calculations take account of processes which **divert** materials from other uses. Therefore, it is necessary to consider whether an input is "rigid".

If the input has a fixed supply, then it is considered "rigid": it can only be supplied to a new InnovFund project by **diverting** it from another use or **disposition**. Its emissions intensity considers the impact of diverting it from its existing use (rather than any emissions associated with the generation of the rigid input), and the emissions associated with any additional treatment and transport. The emissions intensity may be negative (i.e., avoidance of GHG emission) 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 avoiding 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. This is discussed further in Appendix .

> *Examples of rigid inputs include: 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. The current use or disposition of such waste can be, for example, landfilling, incineration with or without energy recovery, and/or recycling. Applicants shall duly document the use or disposition from which the waste used by the project is diverted from.*
>
> *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.*
>
> *Process heat or waste heat[34] 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.*
>
> *Economically minor by-products of existing processes, where the ratio of the outputs cannot be changed significantly (to determine what are minor by-products see Appendix). If such inputs have an **economic value** of 10% to 50% of the total value of all co-products from the relevant process, then they are considered 'semi-elastic'.). For example, Hydrogen recovered from an existing chlor-alkali (Solvay) process is produced in a fixed ratio to the other products because of the stoichiometry of the reaction. It is considered a rigid source of hydrogen.*

2.2.6.1.1 Assessment: diversion emissions

When considering a rigid input, its emissions intensity 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.

[34] 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.

<u>*Examples:*</u>

The project is diverting waste steel (scrap) from other recycling operators rather than identifying additional sources of scrap for recycling. Then the displacement impact of the use of steel scrap as a rigid input is the production of more steel from ore.

A project uses heat recovered from an existing process, and as a result extra fuel needs to be burned 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 of the additional fuel burned.

A project is using municipal waste as an input, which is diverted from being burnt to provide district heating. The emissions avoided by the burning of the waste for district heating are offset by additional emissions incurred to replace that district heat, for example by using a natural gas boiler.

A project includes a process that requires heat input. The emissions attributed to the heat input shall be the increase in the emissions of any other processes associated with the heat export (for example due to increased rates of fossil fuel combustion).

*A project includes a process that requires heat input. The heat is recovered from "**waste heat**" as defined by Article 2 (9) of the REDII. This would be considered free of emissions.*

A project takes as an input industrial off-gas that would otherwise be combusted to produce process heat. Then the applicant should estimate the emissions from the source of heat that replaces the heat lost by diverting the off-gas from its use to the project, and add these emissions to the project scenario. As emissions for electricity are set to zero there is no emissions penalty in the Innovation Fund for diverting off-gases from electricity production.

A project takes as an input hydrogen piped from an existing chlor-alkali plant, which previously sold it in cylinders on the general industrial gas market. The hydrogen is being diverted, and is unlikely to be replaced by more hydrogen production from chlor-alkali plants, because it is a rigid source. The elastic source that is likely to supply extra hydrogen to replace the hydrogen diverted from the industrial gas market is steam reforming of natural gas. An emission factor for hydrogen use as an input must be taken from the input data hierarchy. Hydrogen formerly was being burnt to provide process heat. The process heat is then provided by natural gas instead. The emissions attributed to the hydrogen are the emissions from the supply and combustion of this natural gas for heat.

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.

   <u>*Example:*</u>

   The project used sugar beet molasses as an input. The applicant determines that molasses should be considered a semi-elastic input (see section 2.2.6.2) 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*[35] *(see Appendix). 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).*

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:

    If the existing fate of municipal waste was incineration without energy recovery, the emissions from the incineration are avoided. This means the emissions attributed to using the waste are ***negative****, i.e., avoiding the original fate saves emissions, so there is a* CO_2 *credit for its novel use.*

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

If carbon-containing waste is diverted from landfill (condition that the applicants must duly demonstrate 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 generally 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. Note that the combustion emissions of any biogenic CO_2 must be counted with an emission factor of zero, so carbon-containing waste with only biogenic carbon content would be given an emission factor of zero when used as an input. Any additional avoided greenhouse gas emissions from avoided methane production due to diversion of material from landfill are considered **out of scope of the main GHG calculation**, but may be included in the calculation of other GHG savings.

Where carbon-containing waste is diverted from either landfill or from incineration without energy recovery and used as an input for novel fuel production, this will result in a project scenario with a negative emission term for the carbon-containing waste as a rigid input in the “inputs” box and a positive emission in the “combustion (principal products)” box. If the number of carbon atoms in the waste input is identical to the number of carbon atoms in the produced fuel, these terms would exactly cancel each other out. In such cases, the applicants should still include both terms in the calculations for transparency and to aid the evaluators in understanding the project.

Example:

If a stream of industrial off-gas containing carbon monoxide (CO) is diverted from flaring with release of the CO_2 *to the atmosphere, the emission attributed to that input is* ***negative****, equal in magnitude to the* CO_2 *release that is avoided.*

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

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.

The implications of diverting a rigid input from its existing use should be assessed as far as possible with reference to the specific source of the input that is to be used by the project/is used by the reference. The results of the diversion analysis should be specific to the nature of the source of the input and the location of the project.

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.

2.2.6.1.2 Application of the Waste Framework Directive

Projects that involve the use of "waste" materials must respect the waste hierarchy in the Waste Framework Directive[36], 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 classed as "recovery", on a lower level of the waste hierarchy, along with burning it 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.

2.2.6.2 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 .

2.2.6.3 ELASTIC inputs

If the supply of the input can be varied in order to meet the change in the demand, then the input is considered "elastic", and its emission factor is found from the emissions involved in **supplying the extra quantity** of that input. The definition of an elastic input is given in the Appendix 2.

As explained in section 2.2.6.1.1, the emissions intensity of a rigid input is based on the elastic input that replaces the rigid input in its existing use. The provisions in this section also apply to elastic inputs identified as substitutes for diverted rigid inputs: they are considered on the same basis as the other elastic inputs for project and reference scenarios.

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

2.2.6.3.1 Fossil fuels inputs

The carbon content for inputs of fossil fuels appears either in the "processes" box emissions (for the part that is combusted as part of the production process) or in the "combustion (principal products)", "change to in-use (principal products)" or "end of life (principal products)" box emissions.

Consistent with the EU ETS-based accounting of changes in process emissions, emissions due to fossil fuel extraction, processing, refining, distribution and storage are excluded from the calculations and shall be included in the "input" box of neither the reference nor project scenario.

2.2.6.3.2 Biomass, biogas, biomethane, bioliquid and biofuels inputs

Any such fuels derived from biomass used in InnovFund projects must conform to the relevant minimum requirements specified in the Call Text. Where available, the emissions for biomass, biogas, biomethane, bioliquid or biofuels are derived by summing the disaggregated default emissions tabulated in Annex V and VI of REDII, except the 'Transport' emissions and the 'Non-CO_2 emissions from the fuel in use'. Transport emissions for inputs should instead be considered directly based on the actual distance travelled and mode of travel if biomass feedstocks are transported more than 500 km to reach the first point of processing/treatment (see section 1.3.4), and non-CO_2 greenhouse gas emissions associated to the combustion of any fuel that is combusted as part of the project should be included in the processes box or combustion (principal products) box as appropriate. If values are not available in the REDII then the data hierarchy (Appendix 1) should be followed.

Note that while the CO_2 emissions from the combustion of bio-based carbon are treated as zero in the "processes" box, the N_2O emissions from biomass combustion must be included as a non-zero term.

2.2.6.3.3 Other relevant inputs

Other inputs, such as high value chemicals, may have much higher processing emissions than simple fuels. The required GHG emission intensity data must be taken from the reference literature according to the method and hierarchy in Appendix . Applicants shall not use ETS benchmark values for inputs because they do not have an appropriate scope.

The applicant must reference 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 product, and must explain the choice.

For inputs including organic molecules (i.e., 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 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). 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 quoted emission factor includes the stoichiometric carbon content, the appropriate emission factors to use for the inputs can therefore be found by subtracting from the carbon intensity the stoichiometric carbon content of the input converted to mass of CO_2 using the molar weight ratio 44/12.

Upstream emissions in the fossil fuel supply chain (i.e., the emissions intensity of fossil fuel extraction and transport to market) are outside of the scope of the GHG calculations for the Innovation Fund, but these emissions may be included in the emissions factors provided by life cycle and well-to-wheel databases. Where possible, applicants should use emission factors that exclude these upstream fossil fuel emissions. If it is not possible to systematically exclude these upstream emissions, an approximate adjustment to the complete life-cycle emissions should be made by subtracting 15% from the emissions intensity result (noting that, as explained in the preceding paragraph, it may first be necessary to adjust the quoted emission factor to exclude any contribution from carbon atoms in the material). This adjustment should always be made in the case of lifecycle emissions values taken from the document *Definition of input data to assess GHG default emissions from biofuels in EU legislation.*

Examples:

1) A project uses hydrochloric acid (HCl) as an input. An emissions intensity value of 1061.1 gCO_2e/kg is provided for HCl in the document Definition of input data to assess GHG default emissions from biofuels in EU legislation*. As the lifecycle data in this document includes upstream emissions from the fossil fuel supply, this value should be adjusted downward by 15% to give a value of 901.9 gCO_2e/kg when used for an input in an Innovation Fund calculation.*

2) 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. These combustion emissions represent the emissions associated with release of the carbon physically contained within the methanol. . For methanol used as an input, only the supply emissions shall be considered. However, the value provided in the document includes upstream emissions from fossil fuel supply. The emission factor to use is therefore derived by subtracting 15% from the stated supply emissions value of 28.2 gCO_2e/MJ to give an emission factor of 24.0 gCO_2e/MJ.*

Where inputs are produced by electricity-consuming processes, life cycle and well-to-wheel databases and other similar sources in the data hierarchy (Appendix) should include a characterisation of CO_2e emissions associated with that electricity consumption. While electricity consumed within the system boundary is to be treated as having zero emissions, **this does not extend to electricity used to produce inputs**. Input emission factors from the data hierarchy must not be adjusted to remove emissions associated with electricity use. If, however, there is data available to do so applicants may expand the system boundary of their projects to include the production of materials used as inputs to the main processes. In this case, electricity consumed shall be treated as zero emissions as for any other process within the system boundary.

2.2.6.3.4 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 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 a rigid input the calculation of emissions intensity should be based on the elastic input that replaces it in its existing use, so the attribution may be needed there too.

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. Obviously, if an input to the process is itself a co-product of another process, the sharing out of emissions at the other 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 .

2.2.6.3.5 Electricity inputs supplied to industrial projects and EII electricity-saving projects

No emissions shall be ascribed to electricity either consumed or exported continuously or at times not correlated with grid emissions variations as explained in (section 1.3.2.). However, for knowledge-sharing purposes, the actual electricity consumption and export for the project and reference scenarios shall be reported. The project should also report whether the timing of the consumption or export is correlated with the time-varying emissions of the grid (section 2.2.6.3.6), and in this case hourly electricity consumptions shall be reported for the reporting period.

An **exception to the above rule** is made for projects in energy intensive industries 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 from electricity consumption shall be obtained by multiplying the project 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 explicitly forbidden to combine electricity-saving projects with other innovative projects under any category or hybrid projects in a single InnovFund application.

2.2.6.3.6 Lowering grid electricity emissions by timing operations

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 the same way as electricity storage.

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.

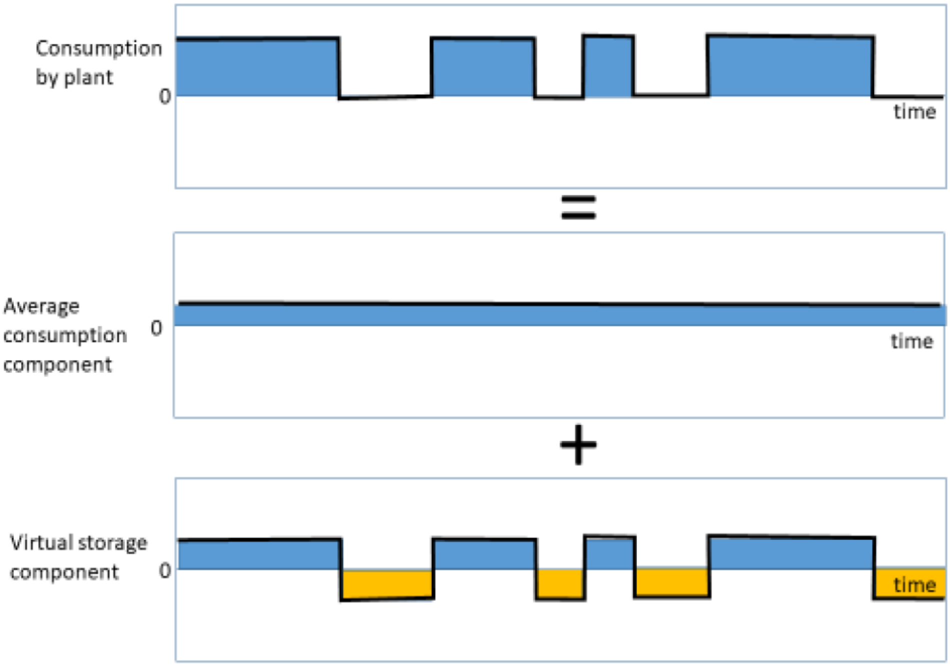
To estimate the electricity emissions in this mode of usage, the applicant resolves the time-dependent electricity demand into a **storage component** plus a constant average consumption, as indicated in the example diagram below (see Figure 2.2, please note that the "consumption by plant" therein could be above zero also during low power consumption periods, even though in the figure example they are set at zero for simplicity). The emission avoidance of the virtual storage component of the project shall be calculated as indicated in the section on energy storage (see section 5).

To claim such a 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, applicants must provide convincing evidence that using the 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 and the credit claimed is significant, this may affect the quality of the GHG calculations.

5Credit 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 for 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.

Counterintuitively, a project using timed operation **may show negative emissions for electricity consumed**. Such negative emissions arise because the Innovation Fund offers credit for timed operation (which can deliver real emissions savings in the short-term) while requiring applicants to use a long-term value (zero) for the emissions from electricity production. Such facilities should not be understood as truly delivering negative emissions / net carbon removals by consuming electricity (because the emissions from electricity production is currently not zero), but as being given extra credit for operating in the most climate friendly possible way already before 2050.

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 should be included in the "combustion (principal products)" box.

In the case of novel 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 (remembering that while CO_2 emissions from biomass combustion may be treated as zero, N_2O and CH4 emissions stemming from biomass combustion must be considered).

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 .

In the case of fuels produced using captured or recycled carbon the combustion emissions must still be included in the "combustion (principal products)" box. Any emissions savings associated with the carbon capture or recycling will be characterised in the "process" box (captured carbon) or "inputs" box (recycled carbon).

> *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.*

2.2.8 Emissions from change to 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 or by avoiding emissions of greenhouse gases other than CO_2. 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 (analogous to the fuel cell car case 2.2.4.4).

> *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 to manufacture hydrogen tanks in a process that has a lower carbon intensity than the conventional*

process for carbon fibre hydrogen tanks. The use of the steel in hydrogen tank manufacture is not enabled by any particular property of the produced steel, and therefore no additional credit may be given. The applicant could consider partnering with the hydrogen tank producer to bring tank production within the system boundary -in this case, the hydrogen tanks would become the principal product.

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 consistent with the fractional contribution of the cost of the innovative product to 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 are 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 avoided combustion emissions are dealt with via the "processes" and "combustion (principal products)" boxes, 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 the section on the "non-principal products" box for non-principal products that do not replace a conventional product but provide long-term carbon incorporation. Innovation Fund applications are not required to provide full end of life emissions estimates, but shall include end of life emissions 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 end of life CO_2e emissions 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 contains 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. 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:

- CH_4 releases by the principal product(s) at the end of life, if any; and
- stoichiometric combustion of all remaining carbon (i.e., complete oxidation to CO_2 of all carbon atoms contained in the principal products). If some fraction of the carbon in the principal products is derived from biomass, then the stoichiometric combustion emissions for that fraction of the product may be treated as having zero associated emissions (section 1.1.4).

> *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.*
>
> *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 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, 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 (< 90%) and some decomposition/landfilling/energy recovery, then an emission term should be included in the "end of life (principal products)" box based on CO_2 emissions from stoichiometric combustion of the fraction of carbon that is not recycled.

If an applicant claims that the product of the project scenario will be recycled but the conventional product 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 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.

> <u>Example</u>*: 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 95% 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 5% of the innovative bottles (the 5% that it is assumed are not sent for recycling).*

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[37], then the applicant shall **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. 2.2.5.2.

> <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 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.*

In the case that some amount of the carbon treated as remaining usefully incorporated in the product or as being recycled is of biogenic origin (i.e. derived from biogenic inputs to the project or from biogenic CO_2 captured within the system boundary) then the term in the end of life for stoichiometric emission of this carbon is set to zero, and therefore the emissions are unaffected by setting the end of life term to zero (recycled products) or reducing it by 50% (long-term carbon incorporation). 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

[37] I.e. it is not enough to claim that carbon will remain incorporated in the principal product after disposal to landfill.

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.*

Attention: Where carbon in a principal product is derived from **captured CO_2** this shall not be treated as biogenic carbon at end of life, even if the CO_2 was captured from a biogenic source. The credit for the biogenic characteristics of the captured carbon is given in the "processes" box where appropriate (2.2.5.2.4 and 2.2.5.3.3).

2.2.9.2 Applicant wishes to claim 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 decomposition-related** GHG emissions (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

The processes in both the project and reference scenarios shall produce the same **quantity** of the principal products ("processes" box) or 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 project's emission avoidance will generally be increased by the production of non-principal products in the **project 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 will reduce the overall reference emissions. This means that, for **both the reference and project scenarios**, the term in the "non-principal products" box shall be calculated as: (-1) * (quantity of non-principal product) * (emission factor of replaced conventionally produced product).

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

The emissions factors needed for this calculation are to be taken from the data hierarchy in Appendix 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 replacement product for which specific rules are stated below. **Allocation approaches should not be used** to deal with the emissions associated to non-principal products.

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 replacement product shall be chosen. There are two cases:

1. The non-principal product is physically the same as its conventional replacement 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 replacement product.** The carbon released through use/end of life of the non-principal product is the same as would be released through use/end of life of the conventional replacement product.

   Example: methanol is produced as a non-principal product using captured carbon, which is not biogenic. The conventional replacement 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 replacement product is calculated as the supply emissions minus 15% to remove upstream emissions from fossil fuel supply (see Section 2.2.6.3.3), which gives 24.0 gCO_2e/MJ.*

2. The non-principal product is physically different with respect to its conventional replacement and/or some of the carbon in the non-principal product is biogenic. In this case, the carbon released through use/end of life of the non-principal product **may not be the same** as would be released through use/end of life of the conventional replacement product, and therefore any difference must be calculated. The emission factor for the conventional replacement 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.

*Example 1: methanol is produced as a non-principal product using biogenic carbon. The conventional replacement 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 replacement product is calculated as the supply emissions minus 15% (to remove upstream emissions from fossil fuel supply, Section 2.2.6.3.3), plus the combustion emissions, which gives 92.9 gCO_2e/MJ.*

*Example 2: methanol is produced as a non-principal product using carbon from waste gasification that is 40% biogenic. The conventional replacement 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 replacement product is calculated as the supply emissions minus 15% (to remove upstream emissions from fossil fuel supply, Section 2.2.6.3.3), plus the combustion emissions for the conventional replacement product, minus the non-biogenic combustion emissions for the non-principal product methanol. This gives:*

$$(28.2 * (1 - 0.15) + 68.9 - 41.3) = 51.6\ gCO_2e/MJ$$

In some cases, it may not be obvious what the appropriate conventional replacement 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:

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[38] *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 storage calculated as 50% of the biogenic carbon content.

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, then the emissions factor should be determined based on the materials used more efficiently.

If the non-principal product will not be combusted and will enable other emissions reduction, the applicant may propose (with 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 be careful not to overstate the potential benefits. If the applicant does not convincingly justify the calculation of such a credit, then this 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).

[38] "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.

3 Credit for Carbon Capture and Storage or Use

This section of the methodology explains how a negative emission term (credit) may be calculated for inclusion in the emissions of the project scenario for an InnovFund project when the project relates to carbon capture with storage or use. That includes projects that involve capturing CO_2, projects that involve utilising captured CO_2, projects that involve transporting captured CO_2 for storage or use and projects that involve storing CO_2. A given project may include one or several of those steps. The calculation shall reflect the overall CCS/CCU efficiency by taking into account the leaked, vented, fugitive and incidental emissions occurring in the system as described in detail in section 3.

3.1 Carbon Capture and Storage (CCS)

Some projects within the Energy Intensive Industries or Renewable Energy categories may contain an element of carbon capture and storage (CCS). The CCS element of the project may be the only innovative element or may be operated alongside other innovative elements. CCS is characterised by the capture of CO_2 in exhaust gases from point sources in industrial processes or power generation, or directly from ambient air, followed by a separation and compression of the CO_2. This captured CO_2 will then be transported (e.g. by road tankers, ships, rail and/or pipelines) to be injected and permanently stored in a storage site permitted under Directive 2009/31/EC, such as depleted oil and gas reservoirs, un-mineable coal beds, saline aquifers, or basalts.

Where projects will capture CO_2 for storage from point sources the category, sector and product is determined by the nature of the facility from which the CO_2 is captured. In the case that this facility falls within the EII category and produces more than one product then the normal rules shall be followed for identifying the principal product (see also section 1.2, Section 1.3, and Section 2.2.5.2.1).

> *Example 1: CO_2 capture from a fossil power installation (gas, coal, etc.) shall apply under EII/other/electricity.*
>
> *Example 2: CO_2 capture from a geothermal power installation shall apply under Renewable energy/geothermal energy/electricity.*
>
> *Example 3: CO_2 capture from a biomass power installation shall apply under EII/other/bio-electricity.*
>
> *Example 4: CO_2 capture from a steel plant shall apply under EII/iron & steel/steel.*

Some projects with a CCS element will not include CO_2 capture from an industrial point source: either the CO_2 is captured from the atmosphere or is captured from outside the project boundary. In the case of direct air capture (DAC) plants that capture CO_2 directly from the atmosphere, the application shall be made under EII/other/CO_2 storage (See also Section 1.2, Section 2.2.4.7, and Section 2.2.5.2.2). If the project does not include any CO_2 capture within its system boundary but aims to store CO_2, it shall apply under EII/other/CO_2 storage (See also Section 1.2, Section 2.2.4.8, and Section 2.2.5.2.3). If the project aims to only transport CO_2 then it shall apply under EII/other/CO_2 transport (See also Section 1.2, Section 2.2.4.8, and Section 2.2.5.2.3).

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.

In the case that following the rules below for the assessment of the GHG emissions credit would result in double counting of any GHG source or sink already included in the assessment of project scenario emissions following the rules for EII or RES projects, this double counting shall be removed.

Project emissions from the CO_2 capture activity, the injection in the geological storage site and the transport network of CO_2 by pipelines shall be quantified according to Article 21, 22 and 23 of Annex IV of Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018.

3.2 Carbon Capture and Use (CCU)

Some projects in the Energy Intensive Industries category may include an element of carbon capture and use. CCU is characterised by the capture of CO_2 in exhaust gases from point sources in industrial processes or power generation, or directly from ambient air, followed by a separation of that CO_2 and incorporation of that CO_2 into a product by means of chemical reaction. The sector and product for such projects shall be identified following the provisions in section 1.2.

3.3 CO_2 capture from biogenic sources

There is **no difference** when calculating the **credit** for CCS/CCU between CO_2 captured from fossil sources and from biogenic sources. 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 by using a zero emission-factor for the point source CO_2 emission that is captured, with no difference in the CCS credit component.

3.4 Scope

This section applies to project activities 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.

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.

3.5 Calculation of credit

The equation to be applied for the calculation of the emission reduction credit for CCS and CCU projects is described in the following.

GHG emission credit	**=**	**Sinks**	**-**	**Sources**	
$CC_{credit,y}$	=	$\sum_{y=1}^{n}(CC_{storage,y} + CC_{use,y})$	-	$\sum_{y=1}^{n}(CC_{capture,y} + CC_{injection,y} + CC_{EHR,y} + CC_{pipeline,y} + CC_{transport,y})$	[3.1]

Where:

y = year of operation

n = 10th year following the start of operation

$CC_{credit,y}$ = Emission credit (negative emission term) that may be included in the project scenario[39] for year y.

$CC_{storage,y}$ = 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 excludes any CO_2 expected to be lost to fugitive emissions, leakage or venting between the point of capture 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 excludes any CO_2 lost to fugitive emissions or venting between the point of capture and the point of permanent storage.

$CC_{capture,y}$ = GHG emissions from CO_2 capture activities for the purposes of transport and geological storage in a storage site permitted under Directive 2009/31/EC or for incorporation in a product in year y, in tonnes CO_2e. This includes emissions from fuel and input material use for compression and liquefaction of the CO_2. 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 (and therefore in liquid form) 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 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 from injection; breakthrough CO_2 from enhanced hydrocarbon recovery operations; and leakages. 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, 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 for the purpose of geological storage in a storage site permitted under Directive 2009/31/EC or for incorporation in a product 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. It shall be calculated according to Regulation (EU) 2018/2066, Annex IV, Section 22.

$CC_{transport,y}$ = GHG emissions due to the transportation of CO_2 in tank trucks, rail or other road modals and in sea tankers or other maritime modals, for the purpose of geological storage in a storage site permitted under Directive 2009/31/EC or for incorporation in a product in year y, to be calculated based on distance travelled, type of modal and load according to Equation [3.2] and sub equations, in tonnes CO_2e. This methodology assumes the transportation of the CO_2 will be done through heavy goods vehicle (HGV) when via road, and by sea tankers for maritime journeys.

> 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 above Equations. Otherwise, an approximated estimate of the total distance

[39] Or in the reference scenario for the unusual case of a project modifying an existing plant where CCS is practiced.

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	
$CC_{transport,y}$	=	$CC_{transport,road,y} + CC_{transport,rail,y} + CC_{transport,maritime,y}$	[3.2]
$CC_{transport,road,y}$	=	$\sum_{L=1}^{T} (K_{road,L} * CO_{2road,L} * EF_{road} * 10^{-3})$	[3.3]
$CC_{transport,rail,y}$	=	$\sum_{L=1}^{T} (K_{rail,L} * CO_{2rail,L} * EF_{rail} * 10^{-3})$	[3.4]
$CC_{transport,maritime,y}$	=	$\sum_{L=1}^{T} (K_{maritime,L} * CO_{2maritime,L} * EF_{maritime} * 10^{-3})$	[3.5]

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 EF presented in Table 3.1. Parameters not to be monitored (fixed ex-ante) Parameters not to be monitored (fixed ex-ante) shall be applied.

$K_{rail,L}$ = 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 EF presented in Table 3.1. Parameters not to be monitored (fixed ex-ante) shall be applied.

$K_{maritime,L}$ = 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 EF presented in Table 3.1. Parameters not to be monitored (fixed ex-ante) shall be applied.

L = outbound trip by the modal.

T = total number of outbound trips by the modal in year y.

3.6 Data and parameters

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 $CC_{injection}$.

Table 3.1 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.

Table 3.1. 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.
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".

4 Renewable energy

This section describes the calculation of GHG emission avoidance from innovative renewable energy projects such as bioelectricity, bio-heat (i.e., bio-thermal), solar, geothermal, wind, and hydro/ocean energy. Emission avoidance from projects whose principal products are biofuel or biomaterials for use in bio-refineries, are more complex to calculate, necessitating the use of the rules in section 2, based on the procedures for industrial projects. The possible principal products for renewable electricity, heat and cooling projects are: dispatchable grid electricity; non-dispatchable grid electricity; heat; cooling. Electricity produced by a project and supplied directly to an end-user without an intermediary grid can also be identified as a product, in which case the GHG assessment should follow the rules for non-dispatchable electricity delivered via the grid.

The emissions of the project are defined by the difference between the main emissions from the project activity, and the emissions that would occur in the absence of the project for the generation or use of the same amount of energy using the conventional technology or fuel.

For the sake of simplification and to enable a fair competition between projects, the reference scenario has been pre-defined for all projects producing the same output (principal products), despite the regional differences that will invariably be observed in real life. For the purpose of the InnovFund, if one of the principal products is non-dispatchable grid electricity, the emissions attributed to grid electricity in the reference scenario corresponds to the typical EU grid emissions in 2030 according to the Commission's EU Reference Scenario 2020 , i.e., $EF_{electricity,ref}$ = 48.8 g CO_2e/MJ (0.176 tonnes CO_2e/MWh). Where one of the principal products is dispatchable grid electricity, 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 g CO_2e/MJ (0.505 tonnes CO_2e/MWh). For all projects generating renewable heating, a natural gas boiler with 90% LHV efficiency shall be adopted as the reference scenario, i.e. 62.4 g CO_2e/MJ.

For projects submitted to the InnovFund in a small-scale topic: GHG emissions due to fossil fuel consumption in stationary machinery and on-site vehicles at the project site(s) can be disregarded **for all project types**.

For projects delivering electricity or heat from geothermal energy and from biogenic sources, leakage during the operation of geothermal power plants and GHG emissions from the production and supply of biomass-based fuels used shall be accounted for in the calculations.

Applicants for projects generating more than one energy output, e.g., heat and electricity, biofuel and heat, etc., shall calculate the GHG emission avoidance separately using the appropriate equation for each energy output and add them up. See also section 1.3.1.

In terms of the project emissions, 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 minor. However, the same is not true for other renewables, such as geothermal, waste to energy, where emissions could include, for instance, fuel combustion in the plant and in on-site machinery, as well as fugitive losses.

Therefore, for the purpose of the InnovFund large scale topic (i.e., not applicable for the small scale topic since $Proj_{on\text{-}site}$ are disregarded for small scale topic projects), the applicant shall quantify at a minimum the emissions from all the on-site , emissions from the generation of purchased electricity and/or steam and other upstream emissions associated with inputs consumed .

For projects that include physical or virtual storage of renewable electricity at times when there is an excess of it in the grid, e.g., smart grid applications, should be considered as hybrid projects. They should split their feed-in of renewable electricity generated by the project into a storage component and the residual uncontrolled feed-in. In order to claim such a credit the applicant must provide details of their plan to manage power consumption to coincide with times when the emissions of the electricity supply are below average (i.e., consume electricity when its emissions are low”). The emission avoidance of the storage component shall be calculated as in section on emissions accounting for energy storage (see section 5).

Funding could be used for the retrofitting (or repowering), rehabilitation (or refurbishment), replacement or capacity addition of an existing renewable power plant, the construction of a power plant that will use renewable energy sources to generate energy; or the construction of a manufacturing plant for components of innovative technologies that will generate renewable energy, when implemented.

4.1 Scope

This section applies to innovative renewable energy projects for the purpose of generating electricity and heating/cooling, including electricity and/or heat produced from biomass, fuels derived from biomass, or heat pumps, and for the use of renewable energy outside the activities falling within Annex I of the ETS. Note that while **projects producing renewable energy from biomass should apply using the calculation rules in this Chapter**, they should be classified under the category/sector EII/other with the product dispatchable electricity and/or bio-heat.

Projects involving the installation of carbon capture units for permanent CO_2 storage at existing renewable power facilities without increasing the power output should apply under the category/sector/product EII/Other/CO_2 Storage and follow the EII methodology (Chapter 2), using Case 7 (BECCS) or Case 3 (any projects other than BECCS) for reference emissions.

Projects for the use of renewable energy outside Annex I must consume solely energy that is wholly renewable.

This section covers applications from activities that meet the conditions listed below.

4.1.1 Products

- Electricity from wind, solar, ocean, hydro, geothermal energy, biomass
- Combined heating and power from solar, geothermal energy or biomass
- Heating and cooling, including from solar and geothermal energy, biomass
- Components for renewable energy installations (e.g., production of innovative heat pumps, photovoltaic modules and wind turbines).
- Use of renewable energy outside Annex I.

4.1.2 Possible types of projects

- Retrofitting (or repowering), rehabilitation (or refurbishment), replacement or capacity addition of an existing renewable power plant
- Construction of a power plant that will use renewable energy sources to generate electrical and thermal energy (this includes stationary fuel cells using biofuels or RFNBOs)

- Construction of a manufacturing plant for components of innovative renewable technologies, including manufacturing of stationary fuel cells
- Installation of innovative drivetrains

4.1.2.1 Construction of a manufacturing plant of innovative technologies components

Where funding will be used to finance the construction of a manufacturing plant for components for innovative technologies, applicants shall demonstrate the existence of one or several buyers (i.e., companies that will use the innovative technology to generate renewable electrical or thermal energy) through provisional contract agreements to ensure accountability over the intended GHG emission avoidance,

For information on how GHG emission avoidance will be calculated for such projects, please refer to section 4.2.3.

4.1.3 System boundary

The emission sources that shall be included within the boundaries of the calculations for projects involving the production of electricity, heat or cooling using wind, ocean, solar, geothermal and bio-based fuels ([40]) are shown in Table 4.1.

Table 4.1. Emission sources included in or excluded from the boundaries of the GHG emission avoidance calculation

Source		**Included in LSC**	**Included in SSC**
Reference (Ref)	GHG emissions for the generation of electricity ($Ref_{electricity}$), heating (Ref_{heat}) or cooling (Ref_{cool}) in fossil fuel power plants, which will be replaced due to the project activity	Yes	Yes
Project (Proj)	GHG emissions due to consumed electricity and fossil fuel in stationary machinery and on-site vehicles at the project site(s) ($Proj_{on\text{-}site}$)	Yes	No
	GHG emissions due to leakage during the operation of geothermal power plants, ($Proj_{geo}$) and from the production and supply of biomass-based fuels ($Proj_{bio}$)	Yes	Yes

Source: European Commission internal elaboration.

4.2 Absolute GHG emission avoidance

The equations to be applied for the calculation of the absolute GHG emissions avoidance are described in the following sections. For a manufacturing plant that produces renewable energy systems or components, the absolute GHG emission avoidance shall be calculated according to Equation [4.3a].

[40] Bio-based fuels comprises biomass, biogas, biomethane, biofuels and bioliquids in their REDII definitions.

Project type	GHG emission avoidance	=	Reference scenario emissions	-	Project scenario emissions	
Delivered electricity from wind, hydro, ocean, solar, geothermal energy and from biogenic sources.	$\Delta GHG_{abs,RES\text{-}to\text{-}electricity\ y}$	=	$\sum_{y=1}^{n}$ $Ref_{electricity,y}$	-	$\sum_{y=1}^{n}$ ($Proj_{on\text{-}site,y}$ + $Proj_{geo,y}$ + $Proj_{bio,y}$ - $CC_{credit,y}$)	[4.1]
Delivered heat from solar, geothermal/ambient energy and from biogenic sources.	$\Delta GHG_{abs,\ RES\ to\ heat,y}$	=	$\sum_{y=1}^{n}$ $Ref_{heat,y}$	-	$\sum_{y=1}^{n}$ ($Proj_{on\text{-}site,y}$ + $Proj_{geo,y}$ + $Proj_{bio,y}$- $CC_{credit,y}$)	[4.2]
Delivered cooling from solar, and geothermal energy and from biogenic sources.	$\Delta GHG_{abs,\ RES\ to\ cool,y}$	=	$\sum_{y=1}^{n}$ $Ref_{cool,y}$	-	$\sum_{y=1}^{n}$ ($Proj_{on\text{-}site,y}$ + $Proj_{,geo,y}$ + $Proj_{bio,y}$- $CC_{credit,y}$)	[4.3]
Manufacturing plants	$\Delta GHG_{abs,\ RES\ manufacturing,y}$	=	$\sum_{y=1}^{n}$ (N_y × $CS_{component}$ ×$Ref_{energy,y}$)	–	$\sum_{y=1}^{n}$ (N_y × $CS_{component}$) × ($Proj_{on\text{-}site,y}$ + $Proj_{geo,y}$ + $Proj_{bio,y}$ - $CC_{credit,y}$)	[4.3a]
Renewable energy used outside annex I	$\Delta GHG_{abs,RES\text{-}outside\text{-}AnnexI,y}$	=	$\sum_{y=1}^{n}$ ($Ref_{energy\ used,y}$)	-	$\sum_{y=1}^{n}$ ($Proj_{energy\ used,y}$ - $CC_{credit,y}$)	[4.3b]

For projects submitted to the InnovFund in a small scale topic: The equations are identical with the difference that Project emissions do not include "$Proj_{on\text{-}site,y}$ ".

Where:

$Ref_{electricity,y}$ = GHG emissions for the generation of electricity in fossil fuel power plants, which will be displaced due to the wind, solar, ocean and geothermal activity or from liquid, gaseous or solid biofuels in year y, in tonnes CO_2e. Calculated according to Equation [4.4].

$Ref_{heat,y}$ = GHG emissions for the generation of heating in fossil fuel power plants, which will be displaced due to the wind, solar, ocean and geothermal activity or from liquid, gaseous or solid biofuels in year y, in tonnes CO_2e. Calculated according to Equation [4.6].

$Ref_{cool,y}$ = GHG emissions for the generation of cooling in fossil fuel power plants, which will be displaced due to the wind, solar, ocean and geothermal activity or from liquid, gaseous or solid biofuels in year y, in tonnes CO_2e. Calculated according to Equation [4.8].

$Ref_{energy,y}$ = $Ref_{electricity,y}$, $Ref_{heat,y}$ or $Ref_{cool,y}$.

$Ref_{energy\text{-}used,y}$ = GHG emissions associated with the energy source that is to be displaced by renewable energy use. This shall be calculated according to Equation [4.9a].

$Proj_{on\text{-}site,y}$ = GHG emissions due to fuel and electricity consumption at the project site in year y, in tonnes CO_2e. Calculated according to Equation [4.10].

$Proj_{geo,y}$ = GHG emissions from the operation of the geothermal power plant in year y, in tonnes CO_2e. Calculated according to Equation [4.14]. **This emissions term must still be included in full even if (some of) the emissions will be captured.**

$Proj_{bio,y}$= GHG emissions from the production and supply of biomass-based fuels for conversion into heat or electricity in year y, in tonnes CO_2e. Calculated according to Equation [4.17]. **This emissions term must still be included in full even if (some of) the emissions will be captured.**

$Proj_{energy\ used,y}$ = GHG emissions associated with the production of renewable energy to be used outside of Annex I. Calculated according to Equation [4.18].

$CC_{credit,y}$ = GHG emissions credit for projects including a CCS element, calculated in accordance with Chapter 3.

$CS_{component}$ = innovative components' cost as a share of the total capital cost of the relevant facility or retail price of the consumer product. The total capital cost for a facility is the sum of the cost of an innovative component plus standard costs of the remaining components constituting a typical operational renewable energy facility using the innovative component. For components used in consumer products, the retail price should be based on a typical use case for the component, and may exclude sales taxes. Applicants must provide appropriate references to justify this cost assessment.

N_y = number of renewable energy system units supplied to markets by the proposed manufacturing plant of renewable energy systems, cumulatively until year *y*. The applicant shall estimate this based on the expected output of the manufacturing plant and the current market potential.

y = year of the operation.

n = 10^{th} year following the start of operation.

4.2.1 Reference emissions sub-equations

Parameter	=	Equation	
$Ref_{electricity,y}$	=	$EG_{electricity,y}$ * $EF_{electricity,ref}$	[4.4]
$EG_{electricity,y}$	=	P_{elec} * PLF * T_y	[4.5]
$Ref_{heat,y}$	=	$EG_{heat,y}$ * $EF_{NG,ref}$ / 0.90	[4.6]
$EG_{heat,y}$	=	P_{heat} * PLF * T_y	[4.7]
$Ref_{cool,y}$	=	$EG_{cool,y}$ * $EF_{electricity,ref}$	[4.8]
$EG_{cool,y}$	=	P_{cool} * PLF * T_y	[4.9]
$Ref_{energy\text{-}used,y}$	=	$EC_{energy\text{-}used,y}$ * $EF_{energy\text{-}used,ref}$	[4.9a]

Where:

$EG_{electricity,y}$ = Net[41] amount of electricity to be generated by the renewable technology in year y, in MWh. Calculated according to Equation [4.5].

[41] Only the energy generated for external usage, i.e., fed into the grid or directly to another party or to a use not directly related to the renewable energy production shall be accounted for. Any on-site usage or losses occurring during the renewable energy production shall be deducted from the calculation of EG. For the

$EG_{heat,y}$ = Net amount of heat to be delivered by the renewable technology in year y, in MWh. Calculated according to Equation [4.7].

$EG_{cool,y}$ = Net amount of cooling to be delivered by the renewable technology in year y, in MWh. Calculated according to Equation [4.9].

$EC_{energy\text{-}used,y}$ = Net amount of energy that is to be displaced by renewable energy use in the project in year y, in a unit consistent with the units for the emission factor for that type of energy in Table 4.2 Parameters not to be monitored.

P_{elec} = Electric power plant installed capacity, i.e., net maximum power output also taking into account technology degradation, in Watts.

P_{heat} = Heating generation plant installed capacity, i.e., net maximum power output also taking into account technology degradation, in Watts.

P_{cool} = Cooling generation plant installed capacity, i.e., net maximum power output also taking into account technology degradation, in Watts.

PLF = Plant Load Factor, i.e., plant's capacity utilisation, in %

T_y = operating hours in year y, in hours.

$EF_{electricity,ref}$ = EU electricity emissions factor in the reference period, in tonnes CO_2e/MWh, for either dispatchable or non-dispatchable electricity: the appropriate EF presented in Table 4.2 Parameters not to be monitored should be applied. It is assumed that while non-dispatchable electricity replaces the EU average grid electricity (estimates for 2030), dispatchable electricity replaces the peak load plant that is most commonly used to stabilise the EU power grid, i.e. single cycle natural gas turbine[42].

$EF_{NG,ref}$ = Emission factor due to the combustion of the reference fuel, in tonnes CO_2e/MWh. Assumed to be natural gas for all projects generating heat. The EF presented in Table 4.2 Parameters not to be monitored should be applied.

$EF_{energy\text{-}used,ref}$ = Emission factor for the relevant reference energy source as presented in Table 4.2 Parameters not to be monitored. y = year of operation.

4.2.2 Project emissions sub-equations

Parameter	=	Equation	
$Proj_{on\text{-}site,y}$	=	$Proj_{FF,stat,y} + Proj_{FF,mob,y} + Proj_{elect,y}$	[4.10]
$Proj_{FF,stat,y}$		$Q_{FF\_stat,y} * EF_{FF}$	[4.11]
$Proj_{FF,mob,y}$		$Q_{FF\_mob,y} * EF_{FF}$	[4.12]
$Proj_{elect,y}$		$EC_y * EF_{electricity,proj}$	[4.13]

Where:

$Proj_{FF,stat,y}$ = GHG emissions from fossil fuel consumption in stationary machinery at the project site in year y, in tonnes CO_2e. This should include fuel consumed for generation of electric power and heat, and from auxiliary loads.

situations where the project involves retrofit/capacity added to an existing plant, only the surplus shall be accounted for.

42 See https://eippcb.jrc.ec.europa.eu/sites/default/files/2019-11/JRC_107769_LCPBref_2017.pdf, Section 2

$Proj_{FF,mob,y}$ = GHG emissions from fossil fuel 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.

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

$Q_{FF\_stat,y}$ = Quantity of fossil fuel type FF combusted in stationary sources at the project site in year y, in litres or m^3.

$Q_{FF\_mob,y}$ = Quantity of fossil fuel type FF combusted in mobile sources at the project site in year y, in litres.

EF_{FF} = Emission factor due to the combustion of the fossil fuel type FF, in tonnes CO_2e/litre or tonnes CO_2e/m^3. The applicable EF presented in Table 4.2 Parameters not to be monitored should be applied.

EC_y = Amount of electricity imported from the grid and consumed at the project site in year y, in MWh.

$EF_{electricity,proj}$ = Average EU electricity emissions factor in the project scenario, in tonnes CO_2e/MWh. The appropriate EF presented in Table 4.2 Parameters not to be monitored should be applied.

y = year of the operation

Parameter	**=**	**Equation**	
$Proj_{geo,y}$	=	$Proj_{dry\_flash,y} + Proj_{binary,y}$	[4.14]
$Proj_{dry\_flash,y}$	=	0.00544695[43] * $M_{steam,y}$	[4.15]
$Proj_{binary,y}$	=	$(M_{inflow,y} - M_{outflow,y}) * 0.00544695 + M_{working\ fluid,y} * GWP_{working\ fluid}$	[4.16]

Where:

$Proj_{dry\_flash}$ = 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.

y = year of the operation.

When estimating leakage emissions for geothermal plants, the applicant may also consider to use 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.

[43] 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.

Parameter	=	Equation	
$Proj_{bio,y}$	=	$\sum_{y=1}^{n}$ $EC_{bio.f,y}$ * $EF_{bio,f}$ * 0.85[44]	[4.17]
$Proj_{energy\ used,y}$	=	$\sum_{y=1}^{n}$ ($EC_{bio.f,y}$ * $EF_{bio,f}$ * 0.85 + $Proj_{geo,y}$)	[4.18]

Where:

$EC_{bio,f.y}$ = Amount of bio-based fuel '*f*' consumed by the project in year y, in MJ (LHV).

$EF_{bio,f}$ = GHG emissions from the transport and supply of bio-based fuel '*f*' used to make heat and/or electricity, produced, in tonnes CO_2e /MJ of the bio-based fuel. Calculated according to REDII, Annexes V and VI, by summing, where available, the disaggregated default emissions tabulated therein, except the 'Transport' emissions and the 'Non-CO_2 emissions from the fuel in use'. If values are not available in the REDII then the data hierarchy should be followed. As detailed in section 1.3.4, if biomass feedstocks are transported more than 500 km to reach the first point of processing/treatment then transport emissions should be included based on the actual distance travelled and mode of travel.

y = year of operation

4.2.3 Construction of a manufacturing plant of innovative technologies components

General applicable indication on manufacturing of component is given in section 1.2.2. For the situations where funding will be used to finance the construction of a manufacturing plant for innovative technologies components, the same equations presented above shall be used. The difference will rest on how the net amount of energy to be generated by the renewable technology shall be estimated.

For such projects, this will result from credible forecasts of:

- Number of components produced each year,
- Capacity for each component when implemented,
- Load factor,
- Operating hours

during the first ten years of operation of the manufacturing plant.

The rationale for the assumptions adopted to forecast the performance of the component produced as well as of other components that will be needed at the power plant but are not necessarily covered by the manufacturing plant shall be surrendered.

Project emissions (Proj) shall be estimated based on the fractional emission avoidance due to the use of the component, the industry benchmarks and assumptions for the projected leakage emissions and fuel usage at the power plant, which will use the innovative technology(ies) or component(s).

4.3 Relative GHG emission avoidance

Please refer to section 1.1.2 for Guidance on the calculation of ΔGHG_{rel}.

[44] To deduct emissions from the extraction and transport of crude oil, NG etc., as well as transport and distribution of the final fuel that are comprised in REDII but are not accounted for in EU ETS.

4.4 Data and parameters

The Table 4.2 Parameters not to be monitored presents the parameters that will be deemed as constant throughout the duration of the project, unless otherwise stated.

For inputs that are not listed here, please look them up in 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	Assumption / Comment
EF_{NG}	56.2	tCO_2e/TJ	Emission factor for combustion of natural gas	IPCC 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	Conversion assumption: density of 800 g / m^3
$EF_{heavy\ fuel\ oil}$	77.6	tCO_2e/TJ	Emission factor for combustion of heavy fuel oil	Based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories.	
$EF_{gasoline}$	69.5	tonnes CO_2e /TJ	Emission factor for the combustion of gasoline	Ibid	Conversion assumption: no biofuel blend. Motor gasoline. density of 742 g / litre gasoline LHV = 44,3 TJ/tonne or MJ/kg
EF_{diesel}	74.3	t CO_2e /TJ (=gCO_2e/MJ)	Emission factor for the combustion of diesel	Based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories	Conversion assumption: no biofuel blend. Diesel oil. Assumes density of 840 g / litre
$EF_{electricity,ref}$	For non-dispatchable electricity: 0.176	tonnes CO_2e / MWh	Emissions of electricity production in 2030	EU Reference Scenario 2020	Base year 2030. Combustion only.

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
	For dispatchable electricity: 0.505	tonnes CO_2e / MWh	Emissions of electricity production with single cycle natural gas turbine	Commission Delegated Regulation (EU) 2018/2066, Annex VI	The value should be applied in all years *y*. Based on $EF_{out,natural\ gas}$ and an electrical efficiency of 40%.
$EF_{electricity,proj}$	0.000	tonnes CO_2e / MWh	Emissions of electricity production in 2050	By assumption	Base year 2050. Combustion only.

Source: see the column "Source data".

5 Energy storage

GHG emission avoidance of an energy storage project is calculated as a difference of the project emissions and the emissions in a reference scenario (i.e., without the presence of an energy storage unit).

Specifically, emissions in the reference scenario will correspond to the emissions avoided due to the displaced energy by the output of the energy storage, whereas project emissions will be those associated with the input to the energy storage during operation. **For projects submitted to the InnovFund in a small scale topic**: on-site emissions of fugitive GHG and from energy use other than energy storage will not be considered but have to be reported for knowledge sharing purposes.

If the services delivered by the project are useful from a system perspective, additional emissions associated with the input to the storage unit may be disregarded under certain conditions. In this respect, the methodology distinguishes various services that contribute to the GHG emission avoidance delivered by energy storage units, among others short--term electricity storage, auxiliary services to electricity grids, the avoidance of renewable energy curtailment, and longer-term energy storage. Stacking of services and multiple outputs are considered.

For projects submitted to the InnovFund in a small scale topic: auxiliary services to electricity grids are not considered under the GHG emission avoidance criterion. If the project delivers also auxiliary services, this may be considered under 'other GHG savings'. Applicants should demonstrate this through additional calculation of the emissions avoided through these services and also argue their case in the specific part of the Application Form.

The energy stored may both be sourced from an energy grid or directly from a plant and be delivered to an energy grid or directly to a plant. The applicant should be able to supply evidence for the origin and the user of the energy stored. Otherwise, default factors depending on the source and user will be applied.

Successful 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 operating period, the applicant 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.

5.1 Scope

This section 5 applies to projects that include the construction and operation of a greenfield plant or the extension of an existing plant by a unit that stores any type of energy (in particular 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 permissible to claim credit for a storage system during any period during which it is simultaneously charged and discharged. The storing 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 Industries category. Such projects may only fall under this section if the utilisation of excess renewable energy is a primary aim of the project. For such projects, the electricity consumed must be limited to periods of high renewable energy production that result in a particularly low load factor.

This section is also to be used to calculate emissions savings from timed operation in EII projects as detailed in section 2.2.6.3.6.

If a project includes an element of energy storage alongside industrial production or renewable energy generation then the main sector should be determined following the principles in section 1.3.1. on hybrid projects.

This section is applicable to energy storage projects related to the following services, technologies, energy sources and energy sinks (though not limited to the list below):

5.1.1 Services and products

Short-term electricity storage (among others arbitrage, reserve power, ramping);

Auxiliary services to electricity grids (among others reactive power, synchronous inertia, or example from the list hereunder). **For projects submitted to the InnovFund in a small scale topic**: not applicable.

Avoidance of renewable energy curtailment;

Other energy storage, such as storage of hydrogen converted through stationary fuel cells;

Manufacture of components for energy storage, such as batteries.

5.1.2 Constructing a reference for auxiliary services

The reference scenario for auxiliary services is more complicated to identify than the reference scenario for e.g. intra-day electricity storage, because the reference scenario for auxiliary services may involve a change in the efficiency at which another service is delivered rather than in the quantity of that service delivered. Applicants must propose appropriate reference scenarios for their projects that take account of the details of the auxiliary service provided and the local context for providing it. This is explained in additional detail in relation to equation [5.4] 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).*

5.1.2.1 Construction of a manufacturing plant of innovative technologies' components

Specific guidance is given in section 1.2.2 and throughout section 5 how to calculate GHG emission avoidance for such projects.

5.1.3 Technologies

- Electricity storage technologies
- Heat and cold storage technologies
- Hydrogen storage technologies
- Gaseous fuel storage technologies

- Liquid fuel storage technologies
- Combinations of the above, including smart grid technologies.

5.1.4 Energy sources

- Electricity grid
- Heat grid
- Gas grid
- Pipelines and trailers
- Renewable energy plants
- Waste heat recovery.

5.1.5 Energy sinks

- Electricity grid
- Heat grid
- Gas grid
- Pipelines and trailers
- Fuelling stations
- Industrial plants.

5.2 System boundary

The spatial extent of the system boundary includes the project energy storage plant/unit and all facilities that the InnovFund project energy storage plant is connected to and are not metered separately. In well justified cases, such as for 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 5.1.

Table 5.1. Emission sources included in the system boundary

Source		**Included in LSC**	**Included in SSC**
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 and grid 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 and grid heat and from transmission losses associated with the grid transport.	Yes	No

Source		Included in LSC	Included in SSC
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 and grid 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 GHG and from energy use other than energy storage. 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.	Yes	No

Source: European Commission internal elaboration.

5.3 Absolute GHG emission avoidance

The equations to be applied for calculating absolute GHG emission avoidance by an energy storage plant are described below.

The absolute GHG emission avoidance by an energy storage plant shall be calculated according to Equation [5.1]. For a manufacturing plant that produces energy storage units, the absolute GHG emission avoidance shall be calculated according to Equation [5.2].

In the case of a manufacturing plant, the term 'energy storage plant' occurring in the sub-equations is meant to refer to one energy storage unit delivered to the market. See also section 1.2.2 for other calculation indications specific to the case of manufacturing plants.

GHG emission avoidance	=	Reference scenario emissions	−	Project scenario emissions	
ΔGHG_{abs}	=	$\sum_{y=1}^{10}(Ref_{energy,y} + Ref_{services,y})$	−	$\sum_{y=1}^{10}(Proj_{energy,y} + Proj_{on-site,y})$	[5.1]
ΔGHG_{abs}	=	$\sum_{y=1}^{10} N_y \times CS_{component} \times (Ref_{energy,y} + Ref_{services,y})$	−	$\sum_{y=1}^{10} N_y \times CS_{component} \times Proj_{energy,y}$	[5.2]

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 and grid 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 [5.3] 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 and grid heat as well as from transmission losses associated with the energy transport. It shall be calculated according to Equation [5.4] 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 [5.4a] 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 and grid 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 [5.5] 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 [5.6] below and its [5.6a], [5.6b], [5.6c] sub-equations.

$CS_{component}$ = innovative components' cost as a share of the total capital cost of the relevant facility or retail price of the relevant consumer product. The total capital cost is the sum of the cost of an innovative component plus standard costs of the remaining components constituting a typical operational renewable energy or energy storage facility using the innovative component. For components used in consumer products, the retail cost should be based on a typical use case for the component, and may exclude sales taxes. Applicants must provide appropriate references to justify this cost assessment.

N_y = number of energy storage units supplied to markets by the proposed manufacturing plant of energy storage units, cumulatively until year *y*. The applicant shall estimate this based on the expected output of the manufacturing plant and the current market potential.

y = year of operation.

Parameter	=	Equation	
$Ref_{energy,y}$	=	$EF_{transport,y} * E_{transport,y} * EER + \sum_{x=1}^{X} EF_{out,x,y} * E_{out,x,y} / (1 - \theta_x)$	[5.3]

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.

$E_{transport,y}$ = energy supplied for use in non-rail vehicles, 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 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 power, useful storage capacity, state-of-charge range, forecasted degradation and operating cycles that the innovative technology(ies) or component(s) will be able to generate when implemented.

$EF_{transport,y}$ = emission factor for the energy displaced by the output of the energy storage in non-rail vehicles, in year *y*, in tonnes CO_2e/TJ. For the emission factors, the values presented in Table 5.2. 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.

EER = Energy Efficiency Ratio, which accounts for change in vehicle energy efficiency. For the energy efficiency ratio, the value presented in Table 5.2. Parameters not to be monitored shall be applied as the default case.

$E_{out,x,y}$ = 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 5.2. 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 5.2. Parameters not to be monitored should be applied.

Parameter	**=**	**Equation**	
$Ref_{services,y}$	=	$\sum_{a=1}^{A} \Delta EF_{service,a} * T_{services,a,y} * R_{services,a,y}$	[5.4]
$Ref_{services,y}$	=	$\sum_{a=1}^{A} EF_{out,\ natural\ gas} * [0.1 / (0.55 * 0.45)] * CCGT_{services,a} * T_{services,a,y} * R_{services,a,y}$	[5.4a]

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.

$CCGT_{services,a}$ = MW of CCGTs required to run at 45% instead of 55% efficiency per unit of service *a*.

Parameter	=	Equation	
$Proj_{energy,y}$	=	$\sum_{x=1}^{X} EF_{in,x,y} * E_{in,x,y} / (1 - \Theta_x)$	[5.5]

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.

$EF_{in,y,x}$ = 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 5.2. 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 5.2. Parameters not to be monitored should be applied.

Parameter	=	Equation	
$Proj_{on\text{-}site,y}$	=	$Proj_{stat,y} + Proj_{mob,y} + Proj_{fug,y}$	[5.6]
$Proj_{stat,y}$	=	$\sum_{x=1}^{X} EF_{in,x} * E_{stat,x,y}$	[5.6a]
$Proj_{mob,y}$	=	$\sum_{x=1}^{X} EF_{in,x} * E_{mob,x,y}$	[5.6b]
$Proj_{fug,y}$	=	$\sum_{z=1}^{Z} M_{fug,z,y} * GWP_{fug,z}$	[5.6c]

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 1.1.3).

$Proj_{stat,y}$ = 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 [5.6a] 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 [5.6b] 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 [5.6c] 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.

$EF_{in,x}$ = Emission factor due to the use of the energy type *x*, in tonnes CO_2e/ TJ. The applicable EF presented in Table 5.2. 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 1.1.3).

Simplification for PILOT topic **projects:** For PILOT projects expected emissions from mobile machinery and fugitive emissions ($Proj_{mob}$ and $Proj_{fug}$) can be excluded from the calculation.

<u>For projects submitted to the InnovFund in a small scale topic:</u>

The equations to be applied for calculating absolute GHG emission avoidance by an energy storage plant are described below.

The absolute GHG emission avoidance by an energy storage plant shall be calculated according to Equation [5.7]. **For a manufacturing plant** that produces energy storage units, the absolute GHG emission avoidance shall be calculated according to Equation [5.8]. In the case of a manufacturing plant, the term 'energy storage plant' occurring in the sub-equations is meant to refer to one energy storage unit delivered to the market.

GHG emission avoidance	=	Reference scenario emissions (SSC)	–	Project scenario emissions (SSC)	
$\Delta GHG_{abs,storage}$	=	$\sum_{y=1}^{10} Ref_{energy,y}$	–	$\sum_{y=1}^{10} Proj_{energy,y}$	[5.7]
$\Delta GHG_{abs,storage}$	=	$\sum_{y=1}^{10} N_y \times CS_{component} \times Ref_{energy,y}$	–	$\sum_{y=1}^{10} N_y \times CS_{component} \times Proj_{energy,y}$	[5.8]

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 and grid 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 [5.3] above.

$Proj_{energy,y}$ = 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 and grid 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 [5.5] above.

N_y = number of energy storage units supplied to markets by the proposed manufacturing plant of energy storage units, cumulatively until year *y*. The applicant shall estimate this based on the expected output of the manufacturing plant and the current market potential.

$CS_{component}$ = innovative components' cost as a share of the total capital cost of the relevant facility or retail price of the relevant consumer product. The total capital cost is the sum of the cost of an innovative component plus standard costs of the remaining components constituting a typical operational renewable energy or energy storage facility using the innovative component. For components used in consumer products, the retail cost should be based on a typical use case for the component, and may exclude sales taxes. Applicants must provide appropriate references to justify this cost assessment.

y = year of operation.

5.4 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 by using Equation [5.9].

5.5 Data and parameters

The Table 5.2 presents the parameters that will be deemed as constant throughout the duration of the project, unless otherwise stated.

Table 5.2. Parameters not to be monitored

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
$EF_{in,H2,y}$ / $EF_{out,H2,y}$	57.0 (6.84)	gCO_2e/MJ (tCO_2e/tH_2)	Emission benchmark for generating hydrogen under the ETS in year *y*	Commission Implementing Regulation (EU) 2021/447 of 12 March 2021	Benchmark value for 2021- 2025 to be used for all the first 10 years of production
$EF_{in,heat,y}$ / $EF_{out,heat,y}$	47.3	gCO_2e/MJ (tCO_2e/TJ)	Emission benchmark for generating heat under the ETS in year *y*	Commission Implementing Regulation (EU) 2021/447 of 12 March 2021	Benchmark value for 2021- 2025 to be used for all the first 10 years of production

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
$EF_{in,natural\ gas}$ / $EF_{out,natural\ gas}$	56.2	gCO_2e/MJ (tCO_2e/TJ)	Combustion emissions of natural gas	IPPC 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	
$EF_{in,diesel}$/ $EF_{out,diesel}$	74.3	gCO_2e/MJ (tCO_2e/TJ)	Combustion emissions of diesel fuel or gasoil	IPPC 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	
$EF_{in,heavy\ fuel\ oil}$ / $EF_{out,heavy\ fuel\ oil}$	77.6	gCO_2e/MJ (tCO_2e/TJ)	Combustion emissions of heavy fuel oil (residual fuel oil)	IPPC 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	
$EF_{in,\ other\ fossil\ fuels}$ / $EF_{out,\ other\ fossil\ fuels}$	look up in TABLE 2.2 of the source of data	gCO_2e/MJ (tCO_2e/TJ)	Combustion emissions many fossil fuels	IPPC 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	If not in that table, use the literature hierarchy in Appendix 1
$EF_{in,electricity,y}$	0	gCO_2e/MJ (tCO_2e/TJ)	Emissions for electricity in 2050	By assumption	The 2050 value provided here should be applied in all years *y*.
$EF_{out,electricity,y}$	140	gCO_2e/MJ (tCO_2e/TJ)	Emissions for electricity production with single-cycle NG turbine (used for peaking power)	IPPC 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	The value should be applied in all years *y*. Based on $EF_{out,natural\ gas}$ and an electrical efficiency of 40%.
$EF_{transport,y}$	74.3	gCO_2e/MJ (tCO_2e/TJ)	Emissions for diesel-fuelled combustion engines (used in vehicles)	IPPC 2006 https://www.ipcc-nggip.iges.or.jp/public/2006gl/vol2.html	The value should be applied in all years *y*. Based on $EF_{out,diesel}$ For cars, an average travel distance of 14,300 km/year should be assumed. For other types of vehicles, individual data and data source should be provided.

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
$EER_{\_EV}$	3	-	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.
$\Theta_{electricity}$	6.58	%	Mean losses due to transport of electricity to consumers via the grid in the EU in 2018	EUROSTAT 2020	Use default only, if no country-specific prescription exists
Θ_{heat}	8.54	%	Mean losses due to transport of heat to consumers via heat networks in the EU in 2018	EUROSTAT 2020	Use default only, if no country-specific prescription exists
Θ_{gas}	0.43	%	Mean losses due to transport of gaseous fuel s to consumers via the grid in the EU in 2018	EUROSTAT 2020	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".

6 Maritime

Section 6 describes how to calculate the amount of GHG emissions that will be avoided from innovative projects in the maritime activities covered by the EU ETS. The absolute GHG emission avoidance is defined by the difference between the emissions that would occur in the absence of the project for the delivery of the same transport services, and the emissions that occur due to the project activity.

In general, GHG emissions due to the use and combustion of fuels in the maritime sector are considered in this Section, i.e., Tank-to-Wake (TtW) emissions. However, there are important exceptions. In particular, the GHG emissions associated to the production of hydrogen and ammonia from fossil fuels are taken into account, while biogenic CO_2 emissions from fuels complying with the sustainability criteria set in the RED II and associated Delegated Acts are considered with an emission factor of zero.

For maritime projects, the fuel used in the reference scenario (i.e., in the absence of the project) shall be the average fossil fuel mix in the EU maritime sector, which includes 0.5% sulphur fuel oil, marine diesel oil (MDO)/marine gas oil (MGO) and Liquefied Natural Gas (LNG). Emission reductions will, therefore, occur if projects reduce the consumption of this fuel mix per functional unit (e.g., per km, per voyage), through, for example, the replacement of this fuel mix by another less carbon intensive energy mix (e.g., use of electric or synthetic fuel from renewable hydrogen or biofuels).

For a project that aims to manufacture innovative ships or their components, the project emissions are defined by the emissions from the manufactured ship when in operation. These emissions shall be estimated based on credible assumptions, that should be credibly substantiated with, for example, letters of intent or other relevant supporting documents. Applicants shall justify the projected performance of the component produced, as well as the projected performance of other components that are needed to build the ship, but which are not necessarily manufactured by the project.

6.1 Scope

In addition to the GHG emissions identified in Section 1.1.3, this section covers also black carbon. Other non-CO2 climate impacts are not included in this Section. Emissions savings from other non-CO2 climate impacts beyond the boundaries established in this section can be claimed as other GHG emission savings.

6.1.1 Possible types of projects

Maritime projects shall follow the provisions in Section 6. A non-exhaustive list of examples of such projects is:

- Innovative vessels and their components (e.g., new hull designs, wind propulsion technologies, energy saving propulsors, power train hull appendage and other hull technologies);
- 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);
- Fuel switch (e.g., use of electricity, sustainable biofuels, recycled carbon fuels or renewable fuels of non-biological origin instead of fossil fuels);
- Projects combining the above; and,
- Port infrastructure projects contributing to the decarbonisation of maritime transport, e.g. onshore RES power supply to ships.

Projects aiming exclusively at producing maritime fuels shall apply under the EII category (See Section 2 for guidance). However, projects that envisage both the production and use of maritime fuels may apply as hybrid EII and MAR projects, where the GHG emissions avoided are calculated separately, and added up, whilst removing any double-counted emissions or reductions. See Section 1.2.1.5 for specific guidance.

6.2 System boundary

The greenhouse gases and additional climate impacts included in or excluded from the system boundary are shown in Table 6.1.

Table 6.1. Emission sources included in the system boundary

Source		Included in large and medium scale projects	Included in small scale projects
Reference scenario (Ref)	Ref_{energy} = Energy-related GHG emissions present in the reference scenario for the delivery of the same transport services provided by the innovative project. This includes direct emissions of climate pollutants from the use of fuels and additional climate impacts due to black carbon emissions, both by vessels, vehicles and at port facilities. This may also include indirect emissions from the use of methanol, ammonia and hydrogen, if sufficient evidence for their relevance is provided.	Yes	Yes
	Ref_{other} = Other GHG emissions present in the reference case for the delivery of the same transport services provided by the innovative project e. This includes fugitive and slipped emissions of all GHGs (in particular methane leakage).	Yes	Yes
Project (Proj)	$Proj_{energy}$ = Energy-related GHG emissions that will occur due to the delivery of the reference transport services by the project put in place. This includes direct emissions of climate pollutants from the use of fuels as well as indirect emissions from the use of methanol, ammonia and hydrogen, both by vessels, vehicles and at port facilities. This also includes additional climate impacts due to black carbon emissions.	Yes	Yes
	$Proj_{other}$ = Other GHG emissions not present in the reference scenario that will occur due to the delivery of the reference transport services by the project put in place. This includes fugitive and slipped emissions of all GHGs (in particular methane leakage).	Yes	Yes

Source: European Commission internal elaboration.

6.3 Absolute GHG emission avoidance

The equations to be applied for calculating absolute GHG emission avoidance by an innovative project in the maritime sector are described below.

The absolute GHG emission avoidance by an innovative project in the maritime sector shall be calculated according to Equation [6.1]. For a manufacturing plant that produces vessels, port infrastructure or their components, the absolute GHG emission avoidance shall be calculated according to Equation [6.2].

In the case of a manufacturing plant, the term 'project put in place' occurring in the sub-equations is meant to refer to one ship or port infrastructure facility delivered to the market. See also section 1.2.2 for additional guidance for the case of manufacturing plants.

GHG emission avoidance	=	Reference scenario emissions	–	Project scenario emissions	
$\Delta\mathrm{GHG}_{\mathrm{abs}}$	=	$\sum_{y=1}^{10}(\mathrm{Ref}_{\mathrm{energy,y}} + \mathrm{Ref}_{\mathrm{other},y})$	–	$\sum_{y=1}^{10}(\mathrm{Proj}_{\mathrm{energy,y}} + \mathrm{Proj}_{\mathrm{other,y}})$	[6.1]
$\Delta\mathrm{GHG}_{\mathrm{abs,manuf}}$	=	$\sum_{y=1}^{10} N_y \times \mathrm{CS}_{\mathrm{innovative}} \times (\mathrm{Ref}_{\mathrm{energy,y}} + \mathrm{Ref}_{\mathrm{other,y}})$	–	$\sum_{y=1}^{10} N_y \times \mathrm{CS}_{\mathrm{innovative}} \times (\mathrm{Proj}_{\mathrm{energy,y}} + \mathrm{Proj}_{\mathrm{other,y}})$	[6.2]

Where:

y = year of operation. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, this is the year of operation of the manufacturing plant.

$\mathrm{Ref}_{\mathrm{energy},y}$ = Energy-related GHG emissions present in the reference scenario for the delivery of the same transport services provided by the innovative project in year y, in tonnes CO_2e. This includes direct emissions of climate pollutants from the use of fuels and additional climate impacts due to black carbon emissions, both by vessels, vehicles and at port facilities. This may also include indirect emissions from the use of methanol, ammonia and hydrogen, if sufficient evidence for their relevance is provided. It shall be calculated according to Equation [6.3] below.

$\mathrm{Ref}_{\mathrm{other},y}$ = Other GHG emissions present in the reference case for the delivery of the same transport services provided by the innovative project in year y, in tonnes of CO_2e. This includes fugitive and slipped emissions of all GHGs (in particular methane leakage). It shall be calculated according to Equation [6.5] below.

$\mathrm{Proj}_{\mathrm{energy,y}}$ = Energy-related GHG emissions that will occur due to the delivery of the reference transport services by the project put in place in year y, in tonnes CO_2e. This includes direct emissions of climate pollutants from the use of fuels as well as indirect emissions from the use of methanol, ammonia and hydrogen, both by vessels, vehicles and at port facilities. It shall be calculated according to Equation [6.6] below.

$\mathrm{Proj}_{\mathrm{other},y}$ = Other GHG emissions that will occur due to the delivery of the reference transport services by the project put in place in year y, in tonnes of CO_2e. This includes fugitive and slipped emissions of all GHGs (in particular methane leakage). It shall be calculated according to Equation [6.8] below.

$\mathrm{CS}_{\mathrm{innovative}}$ = innovative technologies' cost as a share of the total capital cost of the relevant ship or port infrastructure facility. The total capital cost is the sum of the cost of an innovative component plus standard costs of the remaining components constituting a typical operational ship respectively port infrastructure facility using the innovative component. Applicants must provide appropriate references to justify this cost assessment.

N_y = number of manufactured innovative units supplied to markets by the innovative project, cumulatively until year *y*. The applicant shall estimate this based on the expected output of the manufacturing plant and the current market potential.

Parameter	=	Equation	
$\mathrm{Ref}_{\mathrm{energy,y}}$	=	$\sum_{x=1}^{X} \mathrm{EF}_x * (\sum_{t=1}^{T} E_{\mathrm{ref},t,x,y} + E_{\mathrm{ref\ port},x,y}) + \mathrm{BC}_{\mathrm{ref},y}$	[6.3]
$\mathrm{BC}_{\mathrm{ref},y}$	=	$\sum_{t=1}^{T} \sum_{x=1}^{X} Q_{\mathrm{ref,BC,t,x,y}} * \mathrm{GWP}_{\mathrm{BC}}$	[6.4]

Where:

T = number of transport modes considered. This includes all modes occurring in the reference scenario, independent of their occurrence in the project scenario.

X = number of energy types considered. This includes all energy types replaced, in particular all kinds of fuels, energy types with associated indirect GHG emissions such as electricity and hydrogen as well as energy types without GHG emissions such as wind energy. The reference fuel used shall be the fuel mix defined in the FuelEU Maritime Regulation. The inclusion of other energy types require clear explanations and sufficient evidence why this is necessary.

y = year of operation. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, this is the year of operation of the manufacturing plant.

Z = number of climate pollutants considered. In addition to the GHGs listed in section 1.1.3., the applicant shall include black carbon.

$E_{ref,t,x,y}$ = Quantity of energy type *x* used in vessel or vehicle of mode *t*, in year *y* in the reference scenario, in terajoules (TJ). For the application, 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 fleet in the reference scenario. As a default, the applicant should assume the use of the reference fuel mix in the EU maritime sector, with the emission factor provided in Table 6.2 below. Deviations from the default require clear explanations and sufficient evidence why this is necessary. 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 average transport distances D_{ref} as provided in Table 6.2 below and the forecasted operation that the innovative technology(ies) or component(s) will be able to achieve when implemented.

$E_{ref\ port,x,y}$ = Quantity of energy type *x* used at port infrastructure facilities that are replaced by the innovative project in year y, in TJ. This shall include fuels consumed for processing of materials, on-site vehicles and other transportation, and generation of electric power and fuels at the port. For the proposal, this shall be estimated by the applicant based on the foreseen total transport distances and volumes of goods and passengers and the planned operation of the corresponding vehicle fleet in the project scenario. 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_x = GHG emission factor of energy type *x* for the energy displaced by the innovative maritime project put in place, in tonnes CO_2e/TJ. For the emission factors, the values are presented in Table 6.2. Parameters not to be monitored shall be applied as the default case. If the energy is used in a pre-defined set of vehicles 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.

$Q_{ref,BC,t,x,y}$ = Quantity of emissions of black carbon from combustion of fuel type *x* in vessels or vehicles of mode *t* in the reference scenario for the delivery of the same transport services as provided by the innovative project in year y, in tonnes (for instance by end-of-pipe technologies). This shall be estimated by the applicant based on the foreseen total transport distances and volumes of goods and passengers and the planned operation of the corresponding vehicle fleet in the project, using the Fourth IMO GHG Study[45] as a reference. 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 average transport distances D_{ref} as provided in Table 6.2 and forecasted black carbon emissions that the reference technology(ies) or component(s) would emit, also in this case the applicants shall use the Fourth IMO GHG Study as a reference.

GWP_{BC} = Global Warming Potential of black carbon. For black carbon, the applicable GWP is presented in Table 6.2. The GWP provided in Table 6.2 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.

Parameter	=	Equation	
$Ref_{other,y}$	=	$\sum_{z=1}^{Z} Q_{ref\ fug,z,y} * GWP_{z\ y}$	[6.5]

[45] 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

Where:

y = year of operation. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, this is the year of operation of the manufacturing plant.

Z = number of climate pollutants considered.

$Q_{ref\ fug,y,z}$ = Quantity of the fugitive and slipped emissions of greenhouse gas *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 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. 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_z = Global Warming Potential of the fugitive greenhouse gas *z* in g CO_2e/g. For all GWPs covered by EU regulation, see section 1.1.3.

Parameter	=	Equation	
$Proj_{energy,y}$	=	$\sum_{x=1}^{X} EF_x * (\sum_{t=1}^{T} E_{proj,t,x,y} + E_{proj\ port,x,y}) + BC_{proj,y}$	[6.6]
$BC_{proj,y}$	=	$\sum_{t=1}^{T} \sum_{x=1}^{X} Q_{proj,BC,t,x,y} * GWP_{BC}$	[6.7]

Where:

T = number of transport modes considered. This includes all modes occurring in the project scenario, independent of their occurrence in the reference scenario.

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 hydrogen.

y = year of operation. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, this is the year of operation of the manufacturing plant.

EF_x = GHG emission factor of energy type *x* for the energy used by the innovative maritime project put in place, in year *y*, in terajoules (TJ). For the emission factors, the values are presented in Table 6.2. Parameters not to be monitored shall be applied as the default case. If the energy is used in a set of vehicles 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.

$E_{proj,t,x,y}$ = Quantity of energy type *x* used in vessels or vehicles of mode *t*, in year *y* in the project scenario, in terajoules (TJ). For the application, 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 project scenario. 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 average transport distances D_{proj} and the forecasted operation that the innovative technology(ies) or component(s) will be able to achieve when implemented. The default distance per year in tkm shall be the same as in the reference case $D_{proj} = D_{ref}$. If the projected distance is required to be different, for instance because the vessels produced achieve longer travel distances due to higher speeds, a different value for D_{proj} may be used, and require clear explanations and sufficient evidence why this is necessary.

$E_{proj\ port,x,y}$ = Quantity of energy type *x* used at port infrastructure facilities that are part of the project in year y, in TJ. This shall include fuels consumed for processing of materials, on-site vehicles and other transportation, and generation of electric power and fuels at the port. This shall be estimated by the applicant based on the foreseen total transport distances and volumes of goods and passengers and the planned operation of the corresponding vehicle fleet in the project scenario. 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.

$Q_{proj,BC,t,y,z}$ = Quantity of black carbon emitted from combustion of fuels in vessels or vehicles of mode *t* due to the delivery of the reference transport services by the project put in place in year y, in tonnes. For the proposal, this shall be estimated by the applicant based on the foreseen total transport distances and volumes of goods and passengers and the planned operation of the corresponding vehicle fleet in the project, using the Fourth IMO GHG Study[46] as a reference. The applicant needs to provide sufficient evidence for the level of black carbon emitted by the project. 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 average transport distances D_{proj} and the forecasted operation that the innovative technology(ies) or component(s) will be able to achieve when implemented, also in this case the applicant shall use the Fourth IMO GHG Study as a reference. The default distance per year in tkm shall be the same as in the reference case D_{proj} = D_{ref}. If the projected distance is required to be different, for instance because the vessels produced achieve longer travel distances due to higher speeds, a different value for D_{proj} may be used, and require clear explanations and sufficient evidence why this is necessary.

GWP_{BC} = Global Warming Potential of black carbon. For black carbon, the applicable GWP is presented in Table 6.2. The GWP provided in Table 6.2 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.

Parameter	=	Equation	
$Proj_{other,y}$	=	$\sum_{z=1}^{Z} Q_{proj\ fug,z,y} * GWP_z$	[6.8]

Where:

y = year of operation. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, this is the year of operation of the manufacturing plant.

Z = number of GHGs considered.

$Q_{proj\ fug,y,z}$ = Quantity of the fugitive and slipped emissions of greenhouse gas *z* due to the delivery of the reference transport services by the project put in place 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 foreseen total transport distances and volumes of goods and passengers and the planned operation of the corresponding vehicle fleet in the project. For fugitive emissions lower than in the reference case the applicant needs to provide sufficient evidence for their mitigation by the project. For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, the fugitive emissions that the innovative technology(ies) or component(s) will result in when implemented shall be estimated based on average transport distances D_{proj} and the forecasted operation. The default distance per year in tkm shall be the same as in the reference case D_{proj} = D_{ref}. If the projected distance is required to be different, for instance because the vessels produced achieve longer travel distances due to higher speeds, a different value for D_{proj} may be used, and require clear explanations and sufficient evidence why this is necessary.

GWP_z = Global Warming Potential of the fugitive greenhouse gas *z.* For all GWPs covered by EU regulation, see section 1.1.3.

6.4 Relative GHG emission avoidance

Please refer to section 1.1.2 for guidance on the calculation of the relative GHG emission avoidance ΔGHG_{rel}.

[46] 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

6.5 Data and parameters

Table 6.2 presents the parameters that will be deemed as constant throughout the duration of the project, unless otherwise stated.

Table 6.2. Parameters not to be monitored

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
$EF_{maritime\ reference\ fuel}$	77.5	gCO_2e/MJ (tCO_2e/TJ)	Average TtW emission factor for combustion of fossil fuels in the EU maritime sector	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	
$EF_{natural\ gas}$	56.2	gCO_2e/MJ (tCO_2e/TJ)	TtW emission factor for combustion of gaseous natural gas	Commission Delegated Regulation (EU) 2018/2066, annex VI	
EF_{diesel}	74.1	gCO_2e/MJ (tCO_2e/TJ)	TtW emission factor for combustion of diesel fuel or gasoil	Commission Delegated Regulation (EU) 2018/2066, annex VI	
$EF_{electricity}$	0	gCO_2e/MJ (tCO_2e/TJ)	Emission factor for electricity production in 2050	By assumption	The 2050 value provided here should be applied in all years *y*.
$EF_{biofuel}$	1.3	gCO_2e/MJ (tCO_2e/TJ)	TtW emission factor for combustion of biodiesel that counts as a sustainable biofuel according to the definition in the RED II and associated Delegated Acts	By assumption	Biofuels used by the project will be required to be certified according to the RED II and associated Delegated Acts
$EF_{RES\ H2}$	0	gCO_2e/MJ (tCO_2e/TJ)	TtW emission factor for combustion of hydrogen that counts as an renewable liquid and gaseous	By assumption	Renewable hydrogen used by the project will be required to be certified according to the RED II and

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
			fuels of non-biological origin (RFNBO) according to the definition in the RED II and associated Delegated Acts		associated Delegated Acts
EF_{RFNBO}	1.1	gCO_2e/MJ (tCO_2e/TJ)	TtW emission factor for combustion of fuels other than hydrogen that counts as a renewable liquid and gaseous fuels of non-biological origin (RFNBO) according to the definition in the RED II and associated Delegated Acts	By assumption	RFNBOs used by the project will be required to be certified according to the RED II and associated Delegated Acts
$EF_{low\text{-}carbon\ gas,y}$	28.2	gCO_2e/MJ (tCO_2e/TJ)	GHG emission factor for combustion of fuels that will count as a low-carbon gas under the EU Taxonomy	By assumption	The value assumes a reduction of GHG emissions by 70% compared to the fossil comparator of 94 g/MJ established for low-carbon gases under the EU Taxonomy. Low-carbon gases used by the project will be required to be certified in line with the methodology for RFNBOS established under the RED II and associated Delegated Acts
$EF_{other\ H2}$	57.0 (6.84)	gCO_2e/MJ (tCO_2e/tH_2)	GHG emission factor for combustion of hydrogen not qualifying as RFNBO or low-carbon gas based on the emission benchmark for producing hydrogen under the EU ETS	Commission Implementing Regulation (EU) 2021/447 of 12 March 2021	Benchmark value for 2021-2025 to be used for hydrogen not qualifying as RFNBO or low-carbon gas in all the first 10 years of operation
$EF_{other\ ammonia}$	104.8	gCO_2e/MJ	GHG emission factor for combustion of ammonia not qualifying as RFNBO	Commission implementing Regulation (EU)	Benchmark value for 2021-2025 to be used for ammonia not qualifying as RFNBO

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
			or low-carbon gas based on the emission benchmark for producing ammonia under the EU ETS	2021/447 of 12 March 2021	or low-carbon gas in all the first 10 years of operation
$EF_{other\ methanol}$	102.9	gCO_2e/MJ	GHG emission factor for combustion of methanol not qualifying as RFNBO	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-CO2 combustion emissions provided for e-methanol.
$EF_{other\ LNG}$	56.7	gCO_2e/MJ (tCO_2e/TJ)	TtW emission factor for combustion of liquefied natural gas not qualifying as low-carbon gas	Regulation (EU) on the use of renewable and low-carbon fuels in maritime transport	LNG slippage not included. The applicant needs to take the slippage into account under Ref_{other} and $Proj_{other}$.
EF_{MDO}	76.2	gCO_2e/MJ (tCO_2e/TJ)	TtW emission factor for combustion of marine diesel oil	Regulation (EU) on the use of renewable and low-carbon fuels in maritime transport	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
$EF_{other\ fossil\ fuels}$	look up tank-to-wheel emission factor in Table 1 of the Annex to the REGULATION (EU) on the use of renewable and low-carbon fuels in maritime transport	gCO_2e/MJ (tCO_2e/TJ)	Combustion emissions many fossil fuels	Ibid	To be 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. If not in that table, use the literature hierarchy in Appendix 1

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
GWP_{BC}	900	gCO_2e/g (tCO_2e/t)	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.50171,	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 ICCT) is used here.
D_{ref}	52’638	km/year	Average distance sailed by ships per year	IMO 4th GHG Study Reduction of GHG emissions from ships 2020 table 35 weighted average over all ship types and sizes	To be used in reference calculation and as default for project calculation

Source: see the column “Source data”.

7 Aviation

Section 7 covers projects that can contribute directly to the reduction of the warming effects caused by GHGs (see Section 1.1.3), and by additional non-CO_2 climate impacts (see Section 1.1.5). The latter includes, in particular, emissions of oxides of nitrogen (NO_x), soot particles, oxidised sulphur species, and water vapour.

Section 7 includes provisions on how to calculate the impact that will be avoided in operating flights 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 services using a conventional technology or fuel, and those that will occur following the project activity.

With respect to GHGs covered by section 1.1.3, the aviation methodology 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 fuels from biogenic origin[47]. As such, for projects involving the use of Sustainable Aviation Fuels (SAF), which may be composed by a blend of fossil, biogenic and other alternative fuels, the share of each shall be appropriately treated.

For aviation projects, the reference scenario (i.e., in the absence of the project) shall be the use of conventional jet A-1 kerosene. The overall climate impact in terms of absolute GHG emission avoidance can be reduced by projects envisaging the reduction in the consumption of energy use per functional unit (e.g., per km, per leg), or emissions per energy use.

For a project that aims to manufacture innovative aircraft, or an innovative component to be used in such aircraft, the project emissions shall be defined by the emissions that the final aircraft will emit, when operational, which shall be estimated based on credible assumptions and underpinned with robust evidence.

7.1 Scope

Section 7 applies for the calculation of the GHG emission avoidance occurring due to innovative aviation projects that can demonstrate GHG emission avoidance and/or that contribute to the reduction of non-CO_2 climate impacts. Examples of such projects could include:

- Projects that reduce energy use per functional unit (e.g., new airframes, optimised weight, replacement of fleet with more efficient aircrafts);
- Manufacturing of electric or hydrogen-fuelled aircraft or their components;
- Fuel switch (e.g., use of SAFs, electricity, hydrogen or alternative kerosene with less aromatics and sulphur, instead of the conventional jet A-1 kerosene);
- Projects that envisage a modal shift (e.g., new mode of transportation, or a combination or various modes); and,
- Other projects that contribute to the reduction of GHG emissions and non-CO2 climate impacts of aviation.

Projects aiming exclusively at producing aviation fuels shall apply under the EII category (See Section 2 for guidance). However, projects that envisage both the production and use of aviation fuels may apply as hybrid EII and AVI projects, where the GHG emissions avoided are calculated separately, and added up, whilst removing any double-counted emissions or reductions. See Section 1.2.1.5 for specific guidance.

[47] It is assumed that the biogenic CO_2 emitted during combustion of the biomass is equivalent to the amount of CO_2 that have been sequestered by such biomass during plant growth, resulting in zero net emissions.

7.2 System boundary

The emission sources that shall be included within the boundaries of the calculations for projects involving the reduction of fuel use, or emissions intensity in flights within the scope, are shown in Table 7.1.

Table 7.1. Emission sources included in or excluded from the boundaries of the GHG emission avoidance calculation for aviation activities

Source		Included in large and medium scale projects	Included in small-scale projects
Reference (Ref)	GHG emissions due to the combustion of conventional aviation fuel that in the absence of the project activity would be consumed for the operation of the flights covered by the project, Ref_{jetA1}	Yes	Yes
	Additional non-CO2 climate impacts that would occur in the absence of the project activity in, Ref_{nonCO2}	Yes	Yes
Project (Proj)	GHG emissions due to the combustion of the fuels of fossil origin, including any residual quantities of jet A-1 kerosene and the fossil fuel share of SAFs, that will be consumed in air, water or land modes proposed in the project activity, $Proj_{FF}$	Yes	Yes
	GHG emissions due to the combustion of the biomass-based fuel, including the share of biogenic fuels in SAFs that will be consumed in air, water or land modes proposed in the project activity, $Proj_{bio}$	Yes	No
	GHG emissions due to the generation of renewable energy sources to be consumed in air, water or land modes proposed in the project activity, $Proj_{res}$	Yes	No
	GHG emissions due to the generation of electricity that will be either imported from the grid or produced on-site and that will be consumed in air, water or land modes proposed in the project activity, $Proj_{elec}$	Yes	No
	GHG emissions due to the use of H2, including derived synthetic fuels, and any share used in the composition of SAFs that will be consumed in air, water or land modes proposed in the project activity, $Proj_{H2}$	Yes	Yes
	Additional non-CO2 climate impacts that will occur in the project activity, $Proj_{nonCO2}$	Yes	Yes

Source: European Commission internal elaboration.

7.3 Absolute GHG emission avoidance

The equations to be applied for the calculation of the absolute GHG emissions avoidance from **projects that reduce energy use per functional unit**, **fuel switch** projects, and projects that envisage a **modal shift**, or their combination, are described in the equation 7.1 in Section 7.3.1.

Projects envisaging a combination of one or more modes of transportation shall calculate emissions that will be released by each modal using their corresponding fuel(s) and add them up.

Projects aiming to build a plant for the **manufacturing of electric or hydrogen-fuelled planes** or their components shall calculate their absolute GHG emission avoidance according to Equation 7.8 described in Section 7.3.2.

Projects that contribute to the reduction of **non-CO_2 climate impacts** from aviation, shall estimate their reductions using the guidance presented in Section 7.3.3

7.3.1 Projects that reduce energy use per functional unit, fuel switch projects and projects that envisage a modal shift, or their combination.

GHG emission avoidance	=	Reference scenario emissions	-	Project scenario emissions	
$\Delta GHG_{abs,flights}$	=	$\sum_{y=1}^{n} Ref_{jetA1,y} + Ref_{nonCO2,y}$	-	$\sum_{y=1}^{n} ((\sum_{t=1}^{T} (Proj_{FF,t,y} + Proj_{bio,t,y} + Proj_{res,t,y} + Proj_{elec,t,y} + Proj_{H2,t,y}) + Proj_{nonCO2,y})$	[7.1]

Where:

$Ref_{jetA1,y}$ = GHG emissions due to the combustion of the conventional aviation fuel that in the absence of the project activity would be consumed for the operation of the corresponding conventional flights, in year y, in tonnes CO_2e. Calculated according to Equation [7.2].

$Ref_{nonCO2,y}$ = other climate impacts due to the non-CO_2 effects that would occur in the absence of the project activity, in year y, in tonnes CO_2e. Calculated according to Section 7.3.3.

$Proj_{FF,t,y}$ = GHG emissions due to the combustion of the fuels of fossil origin, including any residual quantities of fossil jet A-1 and the fossil fuel share of SAFs that will be consumed in the project in mode of transportation type t, and that, alone or in combination of other modes, delivers an equivalent service that will be replaced by the project activity, in year y, in tonnes CO_2e. Calculated according to Equation [7.3].

$Proj_{bio,t,y}$ = GHG emissions due to the combustion of the biomass-based fuel, including the share of biogenic fuels in SAFs and other alternative climate-neutral fuels from biogenic origin that will be consumed in the project in mode of transportation type t, and that alone or in combination of other modes, delivers an equivalent service that will be replaced by the project activity, in year y, in tonnes CO_2e. Calculated according to Equation [7.4].

$Proj_{res,t,y}$ = GHG emissions due to the generation of renewable energy sources to be consumed in the project in mode of transportation type t and that, alone or in combination of other modes, will deliver an equivalent service that will be replaced by the project activity, in year y, in tonnes CO_2e. Calculated according to Equation [7.5].

$Proj_{elec,t,y}$ = GHG emissions due to the generation of electricity that will be either imported from the grid or produced on-site and that will be consumed in the project in mode of transportation type t and that, alone or in combination of other modes, delivers an equivalent service that will be replaced by the project activity, in year y, in tonnes CO_2e. Calculated according to Equation [7.6].

$Proj_{H2,t,y}$ = GHG emissions due to the use of H_2, including derived synthetic fuels, and any share used in the composition of SAFs that will be consumed in the project in mode of transportation type t and that that, alone or in combination of other modes, delivers an equivalent service that will be replaced by the project activity, in year y, in tonnes CO_2e. Calculated according to Equation [7.7].

$Proj_{nonCO2,y}$ = other climate impacts due to the non-CO_2 effects in the project activity, in year y, in tonnes CO_2e. Calculated according to Section 7.3.3.

t = mode of transportation type t used, including air transportation (e.g., airplanes, drones), land transportation (e.g., road vehicles, rails) and maritime transportation (e.g., vessels, boats, ships).

y = year of the operation.

n = 10^{th} year following the start of operation.

Simplification for small-scale projects: For projects submitted under the small-scale topic under of the InnovFund calls, the parameters $Proj_{bio}$, $Proj_{res}$ and $Proj_{elec}$ can be disregarded from the calculation and monitoring.

7.3.1.1 Reference emissions sub-equations

Parameter	=	Equation	
$Ref_{jetA1,y}$	=	$Q_{jetA1,y} * EF_{jetA1}$	[7.2]

Where:

$Q_{jetA1,y}$ = 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 GJ.

EF_{jetA1} = Emission factor due to the combustion of the jet A-1, in tonnes CO_2e/GJ. The applicable EF presented in Table 7.2 in Section 7.5 shall be applied.

Y = year of the operation

7.3.1.2 Project emissions sub-equations

Parameter	=	Equation	
$Proj_{FF,t,y}$	=	$Q_{FF,t,y} * EF_{FF}$	[7.3]
$Proj_{bio,t,y}$	=	$Q_{bio,t,y} * EF_{bio}$	[7.4]
$Proj_{res,t,y}$	=	$Q_{res,t,y} * 0$	[7.5]
$Proj_{elec,t,y}$	=	$Q_{elec,c,t,y} * EF_{elec,c,y}$	[7.6]
$Proj_{H2,t,y}$	=	$Q_{H2,t,y} * EF_{H2}$	[7.7]

Where:

$Q_{FF,t,y}$ = Quantity of fossil fuel type “FF”, including the fossil share of SAFs, consumed in the project activity in mode of transportation type “t”, in year y, in GJ.

EF_{FF} = Emission factor due to the combustion of the fossil fuel type “FF”, in tonnes CO_2e/GJ. The applicable EF presented in Table 7.2. Parameters not to be monitored shall be applied.

$Q_{bio,t,y}$ = Quantity of bio-based fuel type “bio”, including the biogenic share of SAFs, consumed in the project activity in mode of transportation type “t”, in year y, in GJ.

EF_{bio} = GHG emissions from the combustion of bio-based fuel “bio”, in tonnes CO_2e / GJ of the bio-based fuel. The applicable EF presented in in Table 7.2. Parameters not to be monitored in Section 7.5 shall be applied.

$Q_{res,t,y}$ = Quantity of energy generated by renewable energy sources type “res” and used directly for motion in the project activity in mode of transportation type t, in year y, in GJ.

$Q_{elec,c,t,y}$ = Quantity of electricity that will be either imported from the grid or produced on-site in country “c” where the modal type “t” will be charged in the project, in year y, in GJ.

$EF_{elec,c,y}$ = Emission factors for the generation of electricity that is injected in the national grid, whether in EU or third countries, in tonnes CO_2e/GJ. The appropriate EF presented in Table 7.2. Parameters not to be monitored shall be applied.

$Q_{H2,t,y}$ = Quantity of hydrogen consumed in the project activity in mode of transportation type "t", in year y, in GJ.

EF_{H2} = Emission factor due to the combustion of the renewable or non-renewable hydrogen, in tonnes CO_2e/ GJ. The applicable EF presented in Table 7.2. Parameters not to be monitored shall be applied.

t = mode of transportation type t used, including air transportation (e.g., airplanes, drones), land transportation (e.g., road vehicles, rails) and maritime transportation (e.g., vessels, boats, ships).

y = year of operation

7.3.2 Manufacturing of electric or hydrogen-fuelled aircraft or their components

Projects related to the construction of facilities for the manufacturing of electric or hydrogen-fuelled aircraft or of innovative component(s) to be used in such aircraft, will avoid GHG emissions when the innovative technology is operational and have replaced the conventional technology. As such, project emissions shall be defined by the emissions that the final aircraft would emit when in operation. These emissions shall be estimated based on credible assumptions and underpinned with robust justification on projected performance of the component produced as well as of other components that will be needed for the final assembly of the aircraft, but which may or may not be manufactured by the project. For example, letters of intent or other relevant supporting documents should be presented at application stage.

Equation 7.8 describes the parameters that shall be included in the calculation of the Absolute GHG emissions avoidance for such projects.

GHG emission avoidance	=	Reference scenario emissions	-	Project scenario emissions	
$\Delta GHG_{abs,flights}$	=	$\sum_{y=1}^{n}$ (A_y * $CS_{component}$ * D_{ref} * ($Ref_{jetA1,a,y}$ + $Ref_{nonCO2,a,y}$))	–	$\sum_{y=1}^{n}$ (A_y * $CS_{component}$ * D_{proj} * ($Proj_{FF,a,y}$ + $Proj_{bio,a,y}$ + $Proj_{elec,a,y}$ + $Proj_{H2,a,y}$ + $Proj_{nonCO2,a,y}$))	[7.8]

Where:

$Ref_{jetA1,a,y}$ = GHG emissions due to the combustion of conventional aviation fuel that in the absence of the project activity would be burned for the operation of a corresponding conventional aircraft that will be replaced by the project activity, in year y, in tonnes CO_2e / km. Calculated according to Equation [7.9].

$Ref_{nonCO2,a,y}$ = other climate impacts due to the non-CO_2 effects occurring during the operation of a corresponding conventional aircraft that will be replaced by the project activity, in year y, in tonnes CO_2e / km. Calculated according to Section 7.3.3.

$Proj_{FF,a,y}$ = GHG emissions due to the combustion of the fuels of fossil origin, including jet A-1 and the fossil share of SAFs that are expected to be burned by the innovative aircraft to be manufactured and that will replace an equivalent conventional aircraft, in year y, in tonnes CO_2e / km. Calculated according to Equation [7.10].

$Proj_{bio,a,y}$ = GHG emissions due to the combustion of the biomass-based fuel, including the biogenic share of SAFs that are expected to be burned by the innovative aircraft to be manufactured and that will replace an equivalent conventional aircraft, in year y, in tonnes CO_2e / km. Calculated according to Equation [7.11].

$Proj_{elec,a,y}$ = GHG emissions due to the generation of electricity that will be either imported from the grid or produced on-site and that are expected to be consumed by the innovative aircraft to be manufactured and that will replace an equivalent conventional aircraft, in year y, in tonnes CO_2e / km. Calculated according to Equation [7.12].

$Proj_{H2,a,y}$ = GHG emissions due to the combustion of H_2 and derived fuels, that are expected to be burned by the innovative aircraft to be manufactured and that will replace an equivalent conventional aircraft, in year y, in tonnes CO_2e / km. Calculated according to Equation [7.13].

$Proj_{nonCO2,a,y}$ = other climate impacts due to the non-CO_2 effects by the innovative aircraft to be manufactured in the project activity, in year, in tonnes CO_2e / km. Calculated according to Section 7.3.3.

$CS_{component}$ = cost of the innovative components as a share of the cost of the entire aircraft. The cost for the entire aircraft is the sum of the cost of an innovative component, plus standard costs of the remaining components constituting a typical operational aircraft that uses the innovative component, in %.

A_y = cumulative number of innovative aircraft to be supplied to the market by the proposed manufacturing plant, in year y, in units of aircraft.

D_{ref} = annual average distance travelled by a conventional aircraft, in km. The value presented in Table 7.2. Parameters not to be monitored shall be applied.

D_{proj} = annual average distance travelled by the innovative aircraft, in km. For D_{proj}, applicants shall adopt the same default values proposed for D_{ref}, unless the average distance of the innovative aircraft is expected to differ significantly from the reference scenario. In this case, applicants must provide appropriate references to justify all assumptions adopted in the calculation.

a= air transportation modal (e.g., aircraft, drones).

y = year of the operation.

n = 10^{th} year following the start of operation of the aircraft.

Robust justification shall be provided to underpin the calculation of the cost share ($CS_{component}$). Estimates of the number of aircraft (A) shall be based on the expected output of the manufacturing plant and the current market potential.

For setting the 10-year period for the calculation it is not necessary to forecast the moment when the component will be first used, or the moment when the manufacturing plant is being built: the only relevant moment for the calculation is the moment the entire aircraft is sold. The applicant may assume for the purpose of the calculation that components enter into use immediately after being produced and sold. This means that every year more aircrafts are assumed to enter into operation. The cumulative emission avoidance shall be reflected in the calculation.

General guidance on manufacturing of component projects is given in section 1.2.2.

7.3.2.1 Reference emissions sub-equations

Parameter	**=**	**Equation**	
$Ref_{jetA1,a,y}$	=	$SC_{jetA1,a,y} * EF_{jetA1}$	[7.9]

Where:

$SC_{jetA1,a,y}$ = Specific consumption of conventional aviation fuel burned for the operation of one conventional aircraft, in year y, in GJ / km.

EF_{jetA1} = Emission factor due to the combustion of the jet A-1, in tonnes CO_2e/GJ. The applicable EF presented in in Table 7.2 shall be applied.

y = year of the operation

7.3.2.2 Project emissions sub-equations

Parameter	=	Equation	
$Proj_{FF,a,y}$	=	$SC_{FF,a,y} * EF_{FF}$	[7.10]
$Proj_{bio,a,y}$	=	$SC_{bio,a,y} * EF_{bio}$	[7.11]
$Proj_{elec,a,y}$	=	$SC_{elec,c,a,y} * EF_{elec,c,y}$	[7.12]
$Proj_{H2,a,y}$	=	$SC_{H2,a,y} * EF_{H2}$	[7.13]

Where:

$SC_{FF,a,y}$ = Specific consumption of fossil fuel type “FF”, including the fossil share of SAFs, burned by one innovative aircraft, in year y, in GJ / km.

EF_{FF} = Emission factor due to the combustion of the fossil fuel type “FF”, in tonnes CO_2e/GJ. The applicable EF presented in Table 7.2. Parameters not to be monitored shall be applied.

$SC_{bio,a,y}$ = Specific consumption of bio-based fuel type “bio”, including biogenic share of SAFs, burned by one innovative aircraft, in year y, in GJ / km.

EF_{bio} = GHG emissions from the combustion of bio-based fuel “bio”, in tonnes CO_2e / GJ of the bio-based fuel. The applicable EF presented in in Table 7.2. Parameters not to be monitored in Section 7.5 shall be applied.

$SC_{elec,c,a,y}$ = Specific consumption of electricity either imported from the grid or produced on-site in country “c” that will be consumed by one innovative aircraft, in year y, in GJ / km.

$EF_{elec,c,y}$ = Emission factors for the generation of electricity that is injected in the national grid, whether in EU or third countries, in tonnes CO_2e/GJ. The appropriate EF presented in Table 7.2. Parameters not to be monitored shall be applied.

$SC_{H2,a,y}$ = Specific consumption of hydrogen used burned by one innovative aircraft, in year y, in GJ / km.

EF_{H2} = Emission factor due to the use of the renewable or non-renewable hydrogen, in tonnes CO_2e/ GJ. The applicable EF presented in Table 7.2. Parameters not to be monitored shall be applied.

y = year of operation

7.3.3 Additional non-CO_2 climate impacts for aviation projects

Additional non-CO_2 climate impacts for aviation projects derive mostly from the condensation trails (contrails) as a result of water vapour and emissions from nitrogen oxides (NOx), soot particles and oxidised sulphur species (see also section 1.1.5).

Applicants shall calculate non-CO2 climate impacts in the reference scenario as follows:

$Ref_{nonCO2} = 2 * Q_{jetA1} * EF_{CO2,jetA1}$ [Informs Equation 7.1]

$Ref_{nonCO2,a} = 2 * SC_{jetA1,a} * EF_{CO2,jetA1}$ [Informs Equation 7.8]

Applicants shall calculate non-CO_2 climate impacts in the project scenario ($Proj_{nonCO2}$ or $Proj_{nonCO2,a}$) using a well-justified approach based on scientific literature, or by modelling global near surface temperature change.

This approach ensures equal treatment of projects in the situation where no MRV framework for aviation non-CO_2 effects on climate is yet available under the EU ETS, and it is aligned to the range from 2 to 4 times the radiative forcing from CO_2 alone[48], recognised by the IPCC in its special report on Aviation and Global Atmosphere[49].

7.4 Relative GHG emission avoidance

Please refer to section 1.1.2 for Guidance on the calculation of ΔGHG_{rel}.

7.5 Data and parameters

Table 7.2 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.

Table 7.2. 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_{jetA1}	0.0720	tonne CO_2e/GJ	Emission factor for 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)	

[48] A minimum factor of 2 would mean that the total climate impacts is equivalent to the impact estimated for the CO_2e released from both fossil and biogenic fuels multiplied by 2, meaning that the non-CO_2 alone would be equal to the estimated CO_2e, whereas a factor of 4 would mean that the total impacts are 4 times CO_2e impacts, with the non-CO_2 being 3 times those estimated for CO_2e.

[49] https://archive.ipcc.ch/ipccreports/sres/aviation/index.php?idp=0

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
$EF_{CO2,jetA1}$	0.0715	tonne CO_2e/GJ	CO_2 emission factor for the combustion of jet A-1 kerosene	IPCC 2006.	For use in the calculation of non-CO_2 impacts only.
EF_{avgas}	0.0705	tonne CO_2e/GJ	Emission factor for the combustion of aviation gasoline	IPCC 2006, and IPCC, 2013.	
EF_{NG}	0.0595	tonnes CO_2e/GJ	Emission factor for combustion of natural gas in on-road mobile sources	IPCC 2006, and IPCC, 2013.	
EF_{LPG}	0.0649	tonnes CO_2e/GJ	Emission factor for combustion of liquefied petroleum gas in on-road mobile sources	IPCC 2006, and IPCC, 2013.	
$EF_{heavyoil}$	0.0781	tonnes CO_2e/GJ	Emission factor for combustion of heavy fuel oil in maritime transportation	IPCC 2006, and IPCC, 2013.	
$EF_{gasoline}$	0.0732	tonne CO_2e/GJ	Emission factor for the combustion of gasoline in on-road off-road mobile sources	IPCC 2006, and IPCC, 2013.	Most conservative EF for the fuel adopted, regardless of the type of vehicle.
EF_{diesel}	0.0818	tonnes CO_2e/GJ	Emission factor for combustion of diesel in rails or on-road and off-road mobile sources	IPCC 2006, and IPCC, 2013.	Ibid.
$EF_{H2,renewable}$	0.0000	tonnes CO_2e/GJ	Emission factor for combustion of renewable H_2	Assumption	

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
$EF_{H2,fossill}$	0.0570	tonnes CO_2e/GJ	Emission factor for combustion of H_2 not qualifying as RFNBO or low-carbon gas	Commission Implementing Regulation (EU) 2021/447 of 12 March 2021	ETS Benchmark value for 2021-2025 to be used for hydrogen not qualifying as RFNBO or low-carbon gas in all the first 10 years of operation
EF_{bio}	0.0005	tonne CO_2e/GJ	Emission factor for the combustion of fuels of biogenic origin	Based on IPCC 2006 and IPCC 2013.	Based on default values for combustion of all fuels in aircraft
$EF_{elect,EU}$	0.0000	tonne CO_2e/GJ	Emission factor for the EU grid	Assumption	
$EF_{elect,NON-EU}$	0.0000	tonne CO_2e/GJ	Emission factor for the grid for a non-EU country	Assumption.	
D_{ref}	2,790,000	km / year	Annual average distance travelled by a conventional aircraft, in km.	European Union Aviation Safety Agency Environmental Labelling for Aviation Product Environmental Footprint Category Rules v2	Average annual number of flights = 1,184.57 flight/year. Per aircraft sub-model taking into account assumed operations, forecasted maintenance, and expected downtime And average flight distance = 2,355.76 km. Per aircraft sub-model taking into

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
					account average historical scheduled flights distance per aircraft sub-model. Figures rounded.

List of figures

List of tables

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 section on energy intensive industry,** and need to be sourced from literature (which never includes heat or electricity), will be taken from the following sources in the order from the top to bottom of the hierarchy of data sources provided in this appendix. If using values from several sources at the same level of the hierarchy, the application should explain why this was necessary; cherry-picking favourable values is not allowed.

> *Example: a producer cannot claim that industrial hydrogen bought from an indeterminate source has the emission factor derived from a chlor-alkali plant, because that production is fixed by the demand for chlorine and soda; an increase in hydrogen demand would presently be supplied by steam reforming of natural gas.*

Note that the **emissions intensity** is not the same as **combustion emissions** (which are used for calculating the direct carbon emissions for processes in EU ETS). Emissions intensity, which is 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.

Where emissions values are taken from the hierarchy of data sources, applicants are not permitted to make alternative assumptions about the upstream emission fraction. The applicant does, however, have the option of expanding the system boundary to include the production of any given input and assessing the associated emissions directly (see section 2.2.3), in which case the grid electricity consumed by an energy intensive industries project to produce an input should be treated as zero emissions.

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.

> *Example: The applicant should use the following assumptions for coke: a factor of 3.169 tCO_2e taken from the IPCC 2006 Guidelines.*
>
> *It would be incorrect to use the EU ETS benchmark for coke (0.217 tCO_2e) which does not include e.g., the carbon content of coke combustion, upstream emissions for coal extraction.*

The hierarchy of data sources is provided below:

1. 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.[50]

2. 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).[51] The same values are intended to be shown also in a revised version of the BIOGRACE tool.[52] These data are already used for calculating emissions for biomass, bio-liquids and biofuels in Annex V of REDII. However, these data include a wider range of emissions than those in EU ETS, and the

[50] https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_2_Ch2_Stationary_Combustion.pdf.
[51] https://ec.europa.eu/jrc/en/publication/definition-input-data-assess-ghg-default-emissions-biofuels-eu-legislation.
[52] www.biograce.net.

rest of the present calculations. In particular they include both **upstream emissions** for the provision of fossil fuels, emissions for transport and distribution of products, and the **combustion emissions** of any fuel products. Therefore, to obtain values that are approximately coherent with the emissions calculated in EU ETS from combustion of fossil fuels, first 15% should be subtracted from the part of these values labelled as ’supply’ to account for the upstream (etc.) emissions, leaving (where relevant) the part of the emission value identified as ’combustion’ unchanged. See section 2.2.6.3.1 and section 2.2.6.3.32.2.6.3.1 for further guidance.

3. If the data are not available there, 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.

4. 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 emissions calculations cannot be made without considering upstream emissions for fossil fuel supply, an approximate adjustment to the life-cycle emissions should be made by subtracting 15% from the part of the emissions intensity result not associated with carbon contained in the product. 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 of the chosen source (the GHG methodology is not prescriptive about specific LCA decisions when peer reviewed sources are used). Note that it is not acceptable to simply take a value without developing the GHG emission avoidance calculations in full alignment with the methodology.

5. Duly documented and justified own-estimates.

6. “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.

[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:

$$\frac{(emissions\ assuming\ elastic\ source\ ) * (VF - 0.1) + (emissions\ assuming\ rigid\ source) * (0.5 - VF)}{(0.5 - 0.1)}$$

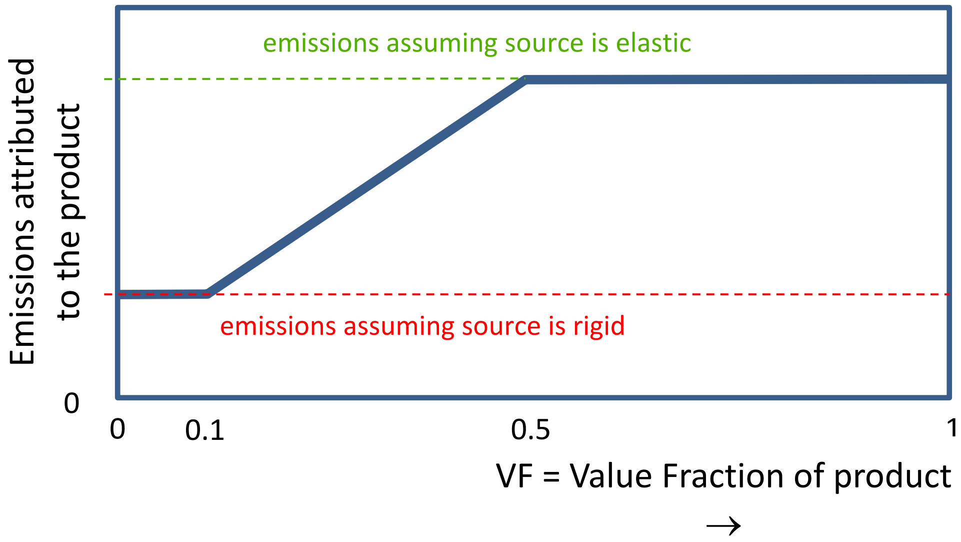
…where *VF* = Value Fraction of the product =

$$\frac{(value\ of\ the\ product)}{(total\ value\ of\ all\ the\ products\ produced\ by\ the\ process)}$$

This relation is represented in the following graph. 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 0.1. 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.

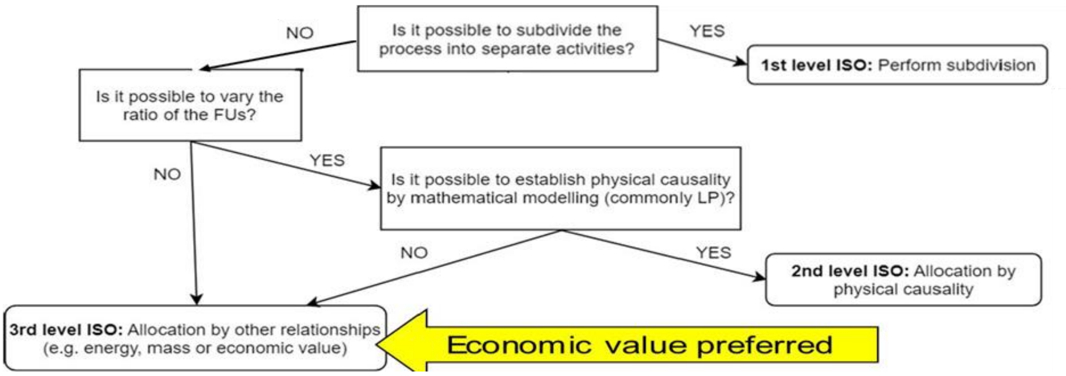
> *Example: The chlor-alkali process produces sodium hydroxide, chlorine and hydrogen in a ratio that is fixed by stoichiometry. Here, we consider the case where all three are sold as inputs to a process in InnovFund project.*
>
> *By contrast, if hydrogen is not sold, but is being burnt for process heat, then the emissions of the plant are only attributed to sodium hydroxide and chlorine.*
>
> *If it is then proposed to start selling the hydrogen, replacing the process heat with natural gas, the hydrogen is a rigid source, and its emissions are given by those of the natural gas that replaces it.*

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.

Figure 0.1. 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 InnovFund projects

Legislation Overview

A monitoring plan consisting of a detailed, complete and transparent documentation of the parameters used in calculations and data sources shall be submitted by the applicant. The monitoring plan should be in line with the Commission Implementing Regulation (EU) 2018/2066 of 19 December 2018 on the monitoring and reporting of greenhouse gas emissions pursuant to Directive 2003/87/EC of the European Parliament and of the Council as it has been amended by Regulation 2020/2085. The present Appendix constitutes an overview of the MRV legislation supplemented with specific requirements under the Innovation Fund. It should be noted that by no means does it intend to substitute the detailed provisions included in the relevant legal documents.

Available methodologies

Under the MRV Regulation (Articles 21 and 22) the following methodologies are available for monitoring the GHG emissions:

Calculation based approaches:

Standard methodology (distinguishing combustion and process emissions);

Mass balance;

Measurement based approaches;

Methodology not based on tiers ("fall-back approach");

Combinations of approaches.

It is highlighted that the calculation based approaches also require measurements. However, the measurement here is usually applied to parameters such as the fuel consumption, which can be related to the emissions by calculation, while the measurement based approach always includes measurement of the GHG itself.

Classification of installations

Under the MRV Regulation (Article 19(2)), installations included in Annex I of the EU ETS Directive are classified into three categories based on their average annual emissions:

Category A: ≤ 50 000 tonnes of CO_2e;

Category B: > 50 000 tonnes of CO_2e, and ≤ 500 000 tonnes of CO_2e;

Category C: > 500 000 tonnes of CO_2e.

The derogations in Article 27(a) of the EU ETS Directive and Article 47(2) of the MRV Regulation relating to installations with low emissions (less than 25000 tonnes of CO_2e) are not relevant in the context of the Innovation Fund. The classification of an installation in each category implies a different level of accuracy required with stricter monitoring rules applying to bigger emitters.

Classification of source streams

Within an installation the greatest attention is and should be given to the bigger source streams. For minor source streams, lower requirements are applicable. The operator has to classify all source streams for which the operator uses calculation based approaches according to Article 19(3). For this purpose, the operator must compare the emissions of the source stream with the "total of all monitored items". The following steps have to be performed:

3. Determine the "total of all monitored items", by adding up:

4. The emissions (CO_2e) of all source streams using the standard methodology:

The absolute values of all CO_2 streams in a mass balance (i.e., the out-going streams are also counted as positive)

All CO_2 and CO_2e which is determined using a measurement based methodology

Only CO_2 from fossil sources is taken into account for this calculation. Transferred CO_2 is not subtracted from the total.

5. Thereafter the operator should list all source streams (including those which form a part in a mass balance, given in absolute numbers) sorted in descending order.

6. The operator may then select source streams which the operator wants to classify "minor" or "de-minimis" source streams, in order to apply reduced requirements to them. For this purpose, the thresholds given below must be complied with.

The operator may select as **minor source streams**: source streams which *jointly* correspond to less than 5000 tonnes of fossil CO_2 per year or to less than 10% of the "total of all monitored items", up to a total maximum contribution of 100000 tonnes of fossil CO_2 per year, whichever is the highest in terms of absolute value.

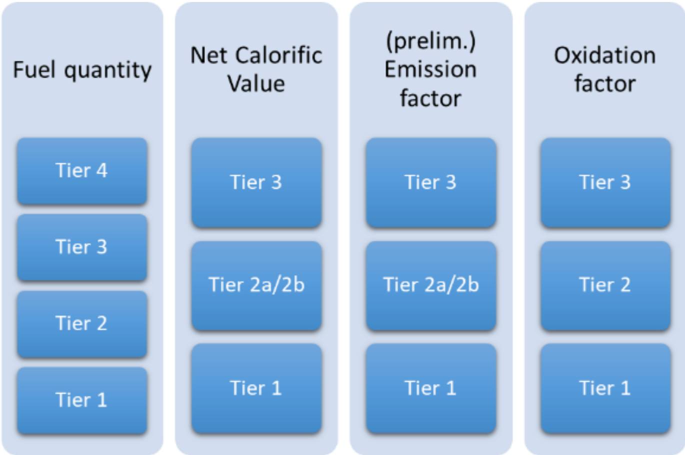
The operator may select as **de-minimis source streams**: source streams which *jointly* correspond to less than 1000 tonnes of fossil CO_2 per year or to less than 2% of the "total of all monitored items", up to a total maximum contribution of 20000 tonnes of fossil CO_2 per year, whichever is the highest in terms of absolute value. Note that the de-minimis source streams are no longer part of the minor source streams.

All other source streams are classified as **major source streams**.

The Tier System

The EU ETS system for monitoring and reporting provides for a building block system of monitoring methodologies. Each parameter needed for the determination of emissions can be determined by different "data quality levels". These "data quality levels" are called "tiers". For each Annex I activity and for each parameter (e.g., fuel quantity, emission factor), Annex II of the MRV Regulation lists all the available tiers. Annex IV of the MRV Regulation describes some Annex I activity specific derogations from those tiers. In general, it can be said that tiers with lower numbers represent methods with lower requirements and being less accurate than higher tiers. Tiers of the same number (e.g., tier 2a and 2b) are considered equivalent. Figure 0.1 summarizes the tiers which can be selected for determining the emissions of a fuel under the calculation based methodologies.

Figure 0.1. Illustration of the tier system for calculation based approaches (combustion emissions)



Source: *European Commission internal elaboration.*

The combination of the category of one installation with the classification of each source stream defines the level of accuracy required for the monitoring of each parameter. Detailed guidelines are provided in Article 26.

Table 6.1 summarizes the full system of tier selection requirements for calculation based approaches. Unreasonable costs which prevent the application of the preferred Tier according to the category of installation and the classification of source streams are defined in Article 18.

Table 0.1. Summary of tier requirements for calculation approaches. Note that this is only a brief overview.

Source stream level	**Category A**	**Category B**	**Category C**
Major	Annex V	Highest	Highest
Major, but technically not feasible or unreasonable costs	up to 2 tiers lower with a minimum of tier 1	up to 2 tiers lower with a minimum of tier 1	1 tier lower with a minimum of tier 1
Major, but still technically not feasible or unreasonable costs; improvement plan (max. 3 year transition)	Minimum tier 1	Minimum tier 1	Minimum tier 1
Minor		highest tier technically feasible and without unreasonable costs (minimum tier 1)	
De-minimis		Conservative estimation, unless a defined tier is achievable without additional effort	

Source: European Commission internal elaboration.

For measurement-based approaches, Article 41 of MRV Regulation describes the analogous tier requirements for emission sources.

MRV specific provisions for InnovFund projects

The general legislative framework concerning the MRV requirements has been outlined in the previous section of the present Appendix. However, it is understood that some elements of the ETS MRV requirements may not be applicable during the planning stage of the installation development and thus may be ignored. For applicants' convenience, indications on the minimum requirements a monitoring plan should contain are included in the GHG calculators. At the reporting stage, all measurements should be conducted with calibrated measurement equipment according to industry standards and in line with relevant EU ETS MRV requirements. Each parameter monitored shall be accompanied with the following information:

- Source of the data
- Measurement methods and procedures
- Monitoring frequency
- QA/QC Procedures
- Responsibility for collection and archiving

Specific MRV provisions for the different InnovFund sectors are given below.

1. Energy Intensive Industries

The documentation should include the following elements:

Process diagrams for the "project" and "reference" scenarios, filling out Figure 2.1 by indicating all the sub-processes, inputs, and products that will be changed by the project, either in terms of technology or output ("activity level").

Explanation of the choices in the reference scenario, as described in section 2.2.4.

A list or diagram quantifying all the material and energy flows between the sub-processes in the project and reference scenarios.

A list quantifying each of the products (or functions) delivered by the "processes" stage of in the three scenarios.

Identification of the selected "principal product(s)" (or functions) from the list of products for the project scenario.

Lists quantifying each material and energy input entering the "process(es)" stage of each scenario, organized in decreasing order of size. At the bottom of the list, descriptions may be generic (e.g., "other process chemicals", "lubricants").

From the list of inputs, identification of "de minimis" and "major inputs" following section 1.1.5.

List of the emissions intensities taken from the literature and the sources of the data.

A documented calculation of the absolute and relative emission avoidance from the project.

Due to the high heterogeneity of the sector a detailed list of the parameters required to be monitored is not provided here; the applicants are referred to Annex IV of the MRV Regulation. It is also noted that monitoring is not necessary for the inputs of biological origin, since either REDII default emissions factors are used, or the actual values which are checked under the monitoring provisions of REDII. It is enough to document the provenance of the batches of inputs of biological origin.

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. Carbon Capture and Storage

Table 0.2 presents the parameters that, at minimum, shall be monitored throughout the project and be part of the project's monitoring and reporting plan to be submitted

For the parameters for monitoring corresponding to the $Proj_{capture}$, $Proj_{pipeline}$ and $Proj_{injection}$, please refer to the Monitoring and Reporting Regulation, 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.

For carbon capture and storage projects, there will not be a difference in the MRV for disbursement and for knowledge-sharing.

Table 0.2. Parameters for monitoring in CCS projects

Data / Parameter	Data unit	Description
$CO_{2\ transferred\ to\ the\ capture\ installation}$	tonnes CO_2	Amount of CO_2 transferred to the capture installation
$K_{road,L}$	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.

3. Renewable electricity, heat and cooling

Table 0.3 presents the parameters that, at minimum, shall be monitored throughout the project and be part of the project's monitoring and reporting plan.

Table 0.3. Parameters for monitoring for a renewable electricity, heat and cooling project

Data / Parameter	Data unit	Description	Comment
EG_{grid}	MWh	Net amount of electricity to be generated by the renewable technology and fed into the grid	Alternatively, derived from: P_{elec}, PLF, Ty
EG_{heat}	MWh	Net amount of heat to be generated by the renewable technology	Alternatively, derived from: P_{heat}, PLF, Ty
EG_{cool}	MWh	Net amount of cooling to be generated by the renewable technology	Alternatively, derived from: P_{cool}, PLF, Ty
QFF_stat,	litres or m^3	Quantity of fossil fuel type FF combusted in stationary sources at the project site	
QFF_mob,	litres	Quantity of fossil fuel type FF combusted in mobile sources at the project site	
EC	MWh	Amount of electricity imported from the grid and consumed at the project site	
$M_{steam,}$	tonnes steam	Quantity of steam produced	
$M_{inflow,}$	tonnes steam	Quantity of steam entering the geothermal plant	
$M_{outflow,}$	tonnes steam	Quantity of steam leaving the geothermal plant	
$M_{working\ fluid}$	tonnes working fluid	Quantity of working fluid leaked/reinjected	
$GWP_{working\ fluid}$	tonnes CO_2e / tonnes working fluid	Global Warming Potential for the working fluid used in the binary geothermal power plant.	
$EC_{bio.f,y}$	MJ	Amount of bio-based fuel 'f' consumed by the project	
$EF_{bio.f}$	tonnes CO_2e /MJ	GHG emissions from the supply of bio-based fuel 'f'	

Source: European Commission internal elaboration.

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 generated, steam losses and working fluid per tonne of steam, based on industry benchmarks, should these be available.

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. Energy Storage

The verification 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.

Table 0.4 presents the parameters that, at minimum, shall be monitored throughout the project and be part of the project's monitoring and reporting plan.

In addition, 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 the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies' components, applicants shall demonstrate at the application the contractual arrangements with customers (i.e., companies that will use the innovative energy storage technology).

Table 0.4. Parameters for monitoring for an energy storage project

Data / Parameter	Data unit	Description	Comment
P_{in}	MW	Input power rating	
P_{out}	MW	Output power rating	
E_{stor}	TJ	Maximum storage capacity including degradation	
$R_{services,gen}$	MW	Generator rating	Only for intra-daily electricity storage
$R_{services,var}$	MVAr	Reactive power rating	Only for intra-daily electricity storage; set to 0 if not applicable
$R_{services,Inert}$	GVAs	Inertia capability rating	Only for intra-daily electricity storage; set to 0 if not applicable
η	%	Input-output efficiency including storage losses	To be derived from stock, input and output
$E_{in,x}$	TJ	Energy used by the project of type *x*	Hourly data required for knowledge sharing purposes
$E_{transport}$	TJ	Electricity supplied for the use in non-rail vehicles	For cars, an average travel distance of 14,300 km/year should be assumed. For other types of vehicles, individual data and data source should be provided.
$E_{out,x}$	TJ	Energy supplied by the project of type *x*	Hourly data required for knowledge sharing purposes
$E_{stat,x}$	TJ	Energy of type x used in stationary sources (except	

Data / Parameter	Data unit	Description	Comment
		in the energy storage units) at the project site	
Emob,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 1.1.3 to be included

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. Maritime

Table 6.5 presents the parameters that, at minimum, shall be monitored throughout the project and be part of the project's monitoring and reporting plan.

Table 6.5 Parameters for monitoring for a maritime project

Data / Parameter	Data unit	Description	Comment
$TD_{goods,y}$	Tonne- kilo-metres	Total transport of goods in year y	
$TD_{passengers,y}$	Tonne-kilo-metres	Total transport of passengers in year y	
D_{proj}	Kilo-metres	Average distance sailed by operated/produced ships per year	
$E_{ref,t,x,y}$	Terajoules	Quantity of energy used in vessel or vehicle of mode *t*, in year *y* in the reference scenario	
$E_{ref\ port,x,y}$	Terajoules	Quantity of energy type *x* used at port infrastructure facilities that are replaced by the innovative project in year y	
N_y	Number	number of manufactured units or components supplied to markets by the proposed manufacturing plant, cumulatively until year *y*	
$CS_{component}$	€	innovative components' cost as a fraction of the total capital cost of the relevant ship or port infrastructure facility	
$Q_{ref,BC,t,x,y}$	Tonnes	Quantity of emissions of black carbon from combustion of fuel type *x* in vessels or vehicles of mode *t*, for the delivery of the same transport service provided by the innovative project in year y	

$Q_{ref\ fug,y,z}$	Tonnes	Quantity of the fugitive emissions of greenhouse gas *z* in year y in the reference scenario for the delivery of the same transport service provided by the innovative project	All types of GHGs from Section 1.1.3 to be included
$E_{proj,t,x,y}$	Terajoules	Quantity of energy used in vessels or vehicles of mode *t*, in year *y* in the project scenario	
$E_{proj\ port,x,y}$	Terajoules	Quantity of energy type *x* used at port infrastructure facilities that are part of the project in year y	
$Q_{proj,BC,t,y,z}$	Tonnes	Quantity of black carbon emitted from combustion of fuels in vessels or vehicles of mode *t*, due to the delivery of the reference transport service by the project put in place in year y	
$Q_{proj\ fug,y,z}$	Tonnes	Quantity of the fugitive emissions of greenhouse gas *z* due to the delivery of the reference transport service by the project put in place in year y	All types of GHGs from Section 1.1.3 to be included

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.

6. Aviation

Table 6.6 presents the parameters that, at minimum, shall be monitored throughout the project and be part of the project's monitoring and reporting plan.

Table 0.6. Parameters for monitoring for an aviation project

Data / Parameter	Data unit	Description	Comment
Q_{jetA1}	GJ	Quantity of conventional aviation fuel (e.g. jet A1 kerosene, aviation gasoline) consumed for the operation of flights that will be reduced and/or replaced with other energy sources in the project activity	
$Q_{FF,t}$	GJ	Quantity of fossil fuel type "FF" consumed in the project activity in modal type "t"	
$Q_{bio,t}$	GJ	Quantity of bio-based fuel type "bio", including SAF and other alternative climate-neutral fuels from biogenic origin consumed in the project activity in modal type "t"	
$Q_{res,t}$	GJ	Quantity of energy generated by renewable energy sources type "res" and used directly for motion in the project activity in modal type t	
$Q_{elec,c}$	GJ	Quantity of electricity that will be either imported from the grid or produced on-site in country "c" where the modal type "t" will be charged in the project	

Data / Parameter	Data unit	Description	Comment
$Q_{H2,t}$	GJ	Quantity of hydrogen consumed in the project activity in modal type "t"	
TD_{goods}	ATK	Total transport of goods	
$TD_{passengers}$	ATK	Total transport of passengers	
C	%	Cost of the innovative components as a fraction of the entire aircraft, or all components put together in the case of production of the entire aircraft.	The cost for the entire aircraft is the sum of the cost of an innovative component, plus standard costs of the remaining components constituting a typical operational aircraft manufacturing facility using the innovative component
A_y	Units of aircraft	Number of innovative aircraft to be supplied to the market by the proposed manufacturing plant	
D_{proj}	km	Annual average distance travelled by the innovative aircraft.	For D_{proj}, applicants shall adopt the same default values proposed for D_{ref}, unless the average distance of the innovative aircraft is expected to differ significantly from the reference scenario. In this case, applicants must provide appropriate references to justify all assumptions adopted in the calculation.
$SC_{jetA1,a}$	GJ / km	Specific consumption of conventional aviation fuel (e.g., jet A-1 or aviation gasoline) burned for the operation of one conventional aircraft.	
$SC_{FF,a}$	GJ / km	Specific consumption of fossil fuel type "FF" burned by one innovative aircraft.	
$SC_{bio,a}$	GJ / km	Specific consumption of bio-based fuel type "bio", including SAF and other alternative climate-neutral fuels from biogenic origin burned by one innovative aircraft.	
$SC_{elec,c,a}$	GJ / km	Specific consumption of electricity either imported from the grid or produced on-site in country "c" that will be consumed by one innovative aircraft.	
$SC_{H2,a}$	GJ / km	Specific consumption of hydrogen used in one innovative aircraft	
Parameters used for the calculation of Ref_{nonCO2} and $Proj_{nonCO2}$	To be defined by the applicant	Parameters used for the calculation of cumulated indirect climate impacts due to the emissions of non-CO_2 gases from jet contrails that are expected to be emitted in both reference and project scenarios	

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) 'bio-electricity' means electricity generated from biomass-derived fuels

(6) 'biofuels' means liquid fuel, suitable for transport use, produced from biomass.

(7) 'biogas' means gaseous fuels produced from biomass.

(8) 'bio-heat' means heating or cooling from biomass-derived fuels.

(9) 'bioliquids' means liquid fuel for energy purposes other than for transport, including electricity and heating and cooling, produced from biomass.

(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.

(11) 'biomass-derived fuels' include biomass, solid biofuels, bioliquids, liquid biofuels, biogas and biomethane, in the meanings of REDII.

(12) 'biomethane' means biogas that is purified to a standard fit to inject into the natural gas grid.

(13) 'calculation factors' means net calorific value, emission factor, oxidation factor, conversion factor, carbon content or biomass fraction.

(14) 'calibration' means the set of operations, which establishes, under specified conditions, the relations between values indicated by a measuring instrument or

[56] Definitions are taken from EU legislative acts and from UNFCCC CDM0002.

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.

(15) ‘capacity addition’ is an investment to 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.

(16) ‘carbon intensity’ is the sum of the stoichiometric carbon content and all emissions from processes in the supply chain.

(17) ‘CO_2 capture’ means the activity of capturing from gas streams CO_2 that would otherwise be emitted.

(18) ‘CO_2 transport’ means the transport of CO_2 for use or storage.

(19) ‘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.

(20) ‘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*.*

(21) ‘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.

(22) ‘emissions direct’ from the use of fossil fuels and generation of heat.

(23) ‘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.

(24) emissions for transport and distribution of products

(25) ‘emissions indirect’ from the use of grid electricity and grid heat.

(26) ‘emissions intensity’ is also known, for transport fuels, as well-to-wheels emissions, or complete life-cycle emissions: it comprises combustion emissions, and also all the “upstream” GHG emissions from the supply chain that supplies the product: extraction of raw materials, all steps in the processing, transport and distribution.

(27) ‘emissions process-related’ from the production of hydrogen, and from transmission losses associated with the grid transport.

(28) ‘emission sink’

(29) emissions upstream for the provision (extraction, processing, refining, transport) of fossil fuels

(30) ‘emission source’ means a separately identifiable part of an installation or a process within an installation, from which relevant greenhouse gases are emitted.

(31) ‘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.

(32) '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.

(33) 'enhanced hydrocarbon recovery' means the recovery of hydrocarbons in addition to those extracted by water injection or other means.

(34) '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.

(35) '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.

(36) 'fossil carbon' means inorganic and organic carbon that is not biomass.

(37) 'fugitive emissions' means irregular or unintended emissions from sources that are not localised, or too diverse or too small to be monitored individually.

(38) '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.

(39) 'geological storage of CO_2' means geological storage of CO_2 as defined in Article 3(1) of Directive 2009/31/EC.

(40) 'geothermal energy' means energy stored in the form of heat beneath the surface of solid earth.

(41) '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.

(42) '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.

(43) '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.

(44) '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

(45) '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.

(46) '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.

(47) 'leakage' means leakage as defined in Article 3(5) of Directive 2009/31/EC.

(48) '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.

(49) 'modification' see 'retrofit'

(50) 'net calorific value' (NCV) 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.

(51) '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

(52) '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

(53) '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.

(54) '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.

(55) '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.

(56) '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.

(57) 'renewable liquid and gaseous transport fuels of non-biological origin' means liquid or gaseous fuels which are used in the transport sector other than biofuels or biogas, the energy content of which is derived from renewable sources other than biomass.

(58) '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.

(59) 'reporting period' means a calendar year during which emissions have to be monitored and reported.

(60) '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.

(61) '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.

(62) '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.

(63) 'storage site' means storage site as defined in Article 3(3) of Directive 2009/31/EC.

(64) 'substitution' see 'replacement'

(65) 'tonnes of CO_2e' means metric tonnes of CO_2 or CO_2e.

(66) 'transport network' means transport network as defined in Article 3(22) of Directive 2009/31/EC.

(67) 'vented emissions' means emissions deliberately released from an installation by provision of a defined point of emission.

(68) '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.