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Call for proposals

Annex C: Methodology for calculation of GHG emission avoidance

Innovation Fund Large-scale Projects
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Version	Publication date	Change
1.0	03.07.2020	Initial version.

Annex C: Methodology for calculation of GHG emission avoidance

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1 Introduction

The Innovation Fund (IF) supports projects in energy intensive industries, carbon capture and utilisation (CCU), carbon capture and storage (CCS), energy storage and renewable energy.
The methodologies for the calculation of the GHG emission avoidance are described in the following sections:

1) Energy intensive industries, including carbon capture and use, and substitute products
2) Carbon capture and storage
3) Renewable energy, including manufacturing plants for components
4) Energy storage, including manufacturing plants for components

Each section details the methodology to be used when:

1) applying for an Innovation Fund grant at first and second stage;
2) reporting performance for the purposes of disbursement of 60% of the grant that is linked to GHG emission avoidance; and
3) reporting performance for the purposes of knowledge-sharing[1].

1.1 Calculation of GHG emission avoidance compared to reference scenario

The calculations of GHG emission avoidance as well as relevant costs should comprehensively cover the impacts from the changes in inputs, processes, and outputs between the project and the reference scenario.

The reference scenarios should reflect the current state-of-the-art in the different sectors, as shown in Table 1.1and Table 1.2.

Table 1.1 Reference Scenarios

Sector	GHG emissions are based in the reference scenario (among others) on:
Energy intensive industry	EU ETS benchmark(s)
CCS	CO_2 releases that would occur in the absence of the project
Renewable electricity	Projected 2030 electricity mix
Renewable heat	Natural gas (NG) boiler
Energy storage	Single-cycle NG turbine (peaking power)

Table 1.2 Emission factors for projects involving production, use and/or storage of grid electricity

Sector	Grid electricity substituted by net electricity export from the project (discharging, for energy storage)	Net grid electricity consumed (charging, for energy storage)
Energy intensive industry	Expected 2050 electricity grid mix	Expected 2050 electricity grid mix
CCS	[Not applicable]	2050 electricity grid mix
Renewable electricity	2030 electricity grid mix	2050 electricity grid mix
Renewable heat	[Not applicable]	Expected 2050 electricity grid mix

[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.

Energy storage	Single-cycle NG turbine (used for peaking power)	Expected 2050 electricity grid mix

1.1.2 GHG emission avoidance

The methodology is able to assess projects concerned with the avoidance of GHG emissions in the use and end-of-life phase of products, as well as to account for process inputs such as biomass, biofuels, intermediate products and by-products of other processes, wastes, and the use of some feedstocks or process chemicals that are outside the scope of the EU Emissions Trading System (EU ETS).

For instance, for projects involving the production of low-carbon products, GHG emission avoidance will also take into account emissions from inputs also from outside EU ETS boundaries, and end-of-life emissions. However, emissions for fossil fuel refining, extraction and transport have been disregarded from the methodology, for consistency with EU ETS.

1.1.3 Relationship to calculation of relevant costs

Applicants should be aware that the reference product or process used as the basis for relevant costs calculations will differ in some cases to that used for the reference GHG emission avoidance calculations. This is because the methodologies used as a reference for estimating GHG emission avoidance derive from widely recognised methodologies for each case, which do not necessarily define the boundaries in the same way as one would define the financial model for the purposes of calculating relevant costs.

1.2 Specification of a sector for the purpose of the GHG emission avoidance calculations

The applicant needs to choose a sector (see Appendix C1) when submitting the application. This choice will influence the points to be awarded for the first criterion on the potential of GHG emission avoidance:

- The calculated value of absolute GHG emission avoidance will be compared to the largest absolute GHG emission avoidance among submitted projects in the chosen sector.
- To calculate the relative GHG emission avoidance, the project's absolute value of GHG emission avoidance will be compared to the GHG emissions in the reference scenario from the chosen sector.

The application may only be submitted for one sector:

In case that a project will earn revenues from the sale of a single product (e.g. steel, solar electricity), it will be straightforward to choose the according sector. Where a product will substitute another one of different composition (for example, ethanol to substitute gasoline in transport, rather than ethanol as a fine chemical), the relevant sector of the substituted product may be chosen (the refinery sector in this case).

In the case that a project will earn revenues from the sale of several products, the applicant should define the 'principal product(s)'. The principal product(s) should reflect the main aim of the project: is the project e.g. designed to principally save emissions in the steel industry, or to make alternative transport fuel (as a by-product of steelmaking)?

If multiple products are in the same sector (e.g. a CCU process may produce gasoline, diesel, kerosene and fuel oil), the applicant can consider all or some of them as the 'principal products'. The applicant can also only choose only one 'principal product'. This choice of principal products will influence the estimate of the project's *relative* GHG emission avoidance (see section 2.3).

If multiple products are in different sectors (e.g. a steel producer that proposes a project to produce recycled carbon fuel ethanol for transport alongside steel), the applicant will need to choose the sector to which the 'principal product(s)' belong and claim the absolute

GHG emission avoidance from the project in this sector. The relative GHG emission avoidance will also need to be calculated based on the chosen 'principal product(s)'.

Projects may aim also to sell the products in a market where they would displace a different product than the conventional use of the product, for example hydrogen that is used for heating rather than in a refinery. The reference emission factor will then be determined by the intended use, i.e. by the emission factor for the product that is being replaced. The sector of choice would however still be the sector where the main innovation takes place. In such cases, applicants will have to prove the intention with draft contracts or letters of intent from the buyers. Copies of contracts will have to be submitted once the project has entered into operation to ensure the intended emissions saved during the use phase are indeed taking place.

The concept of "functions" is added, because some new products may not be identical to existing ones, but provide the same functions. Thus, for example, if a new process produces a stronger plastic that enables bottles to be made twice as thin, the throughput of the reference plastic-producing process must be double that in the project scenario.

1.3 GHG emission avoidance calculation

The GHG emission avoidance is equal to the difference between the emissions from the project activity and a reference scenario over a defined period. Applicants shall carry out two calculations: a simpler one at the first stage and a more detailed one at the second stage. Wherever there is uncertainty in reference emissions or foreseen project emissions, the applicant should use data and assumptions that will conservatively estimate the emissions avoidance by the project.

1.3.1 *Absolute* GHG emission avoidance

The ***absolute* GHG emission avoidance** is calculated based on the expected emissions avoided in each year from the start of the operation over a 10 years period, using the equation below.

$$\Delta \mathrm{GHG_{abs}} = \sum_{y=1}^{10} (\mathrm{Ref}_y - \mathrm{Proj}_y)$$

Where:

$\Delta \mathrm{GHG_{abs}}$ = Net absolute GHG emissions avoided due to operation of the project during the first 10 years of operation, in tCO2e.

Ref_y = GHG emissions that would occur in the absence of the project in year y, in tCO2e.

Proj_y = Additional GHG emissions associated with the project activity and site in year y, in tCO2e.

1.3.2 *Relative* GHG emission avoidance

The ***relative* GHG emission avoidance** potential will be calculated by comparing Proj_y the GHG emissions associated with the project activity and site and Ref_y the GHG emissions that would occur in the absence of the project over a 10 years period.

$$\Delta \mathrm{GHG_{rel}} = \frac{\Delta \mathrm{GHG_{abs}}}{\sum_{y=1}^{10} (\mathrm{Ref}_y)}$$

Where:

$\Delta \mathrm{GHG_{abs}}$ = Net absolute GHG emissions avoided due to operation of the project during the first 10 years of operation, in tCO_2e.

$\Delta \mathrm{GHG_{rel}}$ = Relative GHG emissions avoided due to operation of the project during the first 10 years of operation, in percent.

Ref_y For energy storage, carbon capture and storage, renewable energy and industrial projects where there are no products other than the "principal products" = GHG emissions in the reference case in year *y* ($t\ CO_2$/yr)

For industrial projects with multiple products = the part of the GHG emissions in the reference case in year *y* (t CO_2/yr) that are attributed to the chosen "principal products". This is explained further in section 2.3.

In **case that the project operates for less than 10 years**, ΔGHG_{rel} will be set to zero for those years *y* in which the project does not operate. Applicants may also consider an expected ramping up period, i.e. reduced performance over the first years due to necessary stops and starts of the production for technical adjustments. Therefore, the calculations in the second stage do not necessarily need to lead to the same result as in the first stage. All the above considerations should be duly explained and justified in the description of the calculations.

There are also specific simplifications in the different categories, which will result in more accurate calculation of emission avoidance in the second stage.

Applicants may combine activities related to two or more eligibility categories (energy-intensive industry, CCS, RES, energy storage), to be referred to as **hybrid projects**. Applicants would still need to choose a main sector for which they apply for, see Section 1.2. Hybrid projects shall calculate the absolute GHG emission avoidance and the project emissions according to the individual methodologies and add 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 emission avoidance and the cumulated project emissions. Any project including intermittent use and/or generation of electricity at times when there is an excess of renewables in the grid-mix (e.g. smart grid applications) will need to resolve the demand profile into a continuous component plus a virtual storage activity as explained in the section on energy-intensive industries (see Section 2.2.3.4), in order to make sure the proper emission factors are applied to its electricity demand, generation and storage.

1.3.3 Greenhouse gases considered

The greenhouses gases that must be taken into account in emissions calculations shall be at least those listed in the EU ETS Directive, Annex II: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulphur hexafluoride (SF6). The Global Warming Potentials (GWP) to be used are those in the Annex to Commission Delegated Regulation supplementing Regulation (EU) 2018/1999 of the European Parliament and of the Council with regard to values for global warming potentials and the inventory guidelines and with regard to the Union inventory system and repealing Commission Delegated Regulation (EU) No 666/2014[2].

1.3.4 Emissions generally excluded

Generally, the following emissions are excluded for all projects unless specified otherwise:

- Emissions from capital goods (i.e. manufacture of machinery and equipment).
- Emissions due to the extraction, processing, transportation and storage of fossil fuel are also excluded inasmuch as they contribute to the emissions attributed to material inputs to IF projects.[3]
- Fugitive CO_2 and CH_4 emissions due to well testing and well bleeding in geothermal power plants.
- Combustion emissions for biomass, biogas, biomethane, biofuels and bioliquids.
- Biogenic CO_2 combustion emissions for biomass fuels. But emissions of non-CO_2 greenhouse gases (CH_4 and N_2O) from the fuel in use shall be included.
- Indirect land use change emissions from supply of crops, and consideration of carbon debt in forestry.

[2] to be adopted after European Parliament and Council scrutiny and applicable as of 1/1/2021

[3] This allows aligning with the methodology for calculating the EU ETS benchmarks, which considers only combustion emissions.

- Decommissioning of the power plant and machinery at the End-of-Life (EoL).
- 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.

Should there be substantial GHG emissions savings from emission sources that are excluded from the project boundaries, actions may provide a separate calculation of these potential emission savings, which will be considered under degree of innovation.

1.4 Simplifications for calculations in first stage

Various simplifications of the methodology are done for first stage of the application, which are explained in detail in the different sections. For example, for energy intensive industry, in the first stage, the applicant may select a bigger share of inputs that are considered minor or *de minimis* and therefore can respectively derived from literature or disregarded. For renewable electricity and heat projects (except for bio-electricity and bio-heat), project emissions are disregarded in first stage. Similarly, for energy storage projects, on-site project emissions are excluded in the first stage.

1.5 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 that were made during the application for funding. Further requirements are introduced for the purpose of knowledge-sharing (KS), which will allow reporting on the actual emissions avoided during operation.

The general conditions on monitoring, reporting and verification (MRV) of performance, disbursement of the grant and knowledge-sharing are described in the call text. The respective sub-sections on MRV and KS therefore provides detail on the specific requirements for reporting for the purposes of disbursement and for knowledge sharing for the different categories.

2 Energy intensive industry (EII), including CCU and biofuels

2.1 Scope

This section will deal with the approach to estimate GHG emission avoidance in projects, including CCU projects falling in the energy-intensive industry activities covered by Annex I of the EU ETS Directive. Also included are processes (such as ones based on biomass) whose principle products substitute products otherwise produced in these sectors.

> The objective of this methodology is very different from the emission-saving methodology the Commission will propose for Renewable Fuels of Non-Biological Origin and Recycled Carbon fuels in RED2. The IF seeks to assess future emissions savings from innovations that are needed to reach climate goals in 2050, whereas the REDII estimates the "well-to-tank" emissions for fuels produced under current conditions, including current emissions attached to electricity consumption.

Thus eligible projects based on biomass must concern the processing that leads to the production of those products. In practice that means almost exclusively innovative processing of various types of biomass to biofuel, or innovative production of other bio-based products in bio-refineries.

At each application stage, each project will submit a block diagram based on Figure 2.1, with the boxes filled with the main items of relevance: inputs, processes, products, use differences (if necessary, the individual boxes may be expanded onto separate pages).

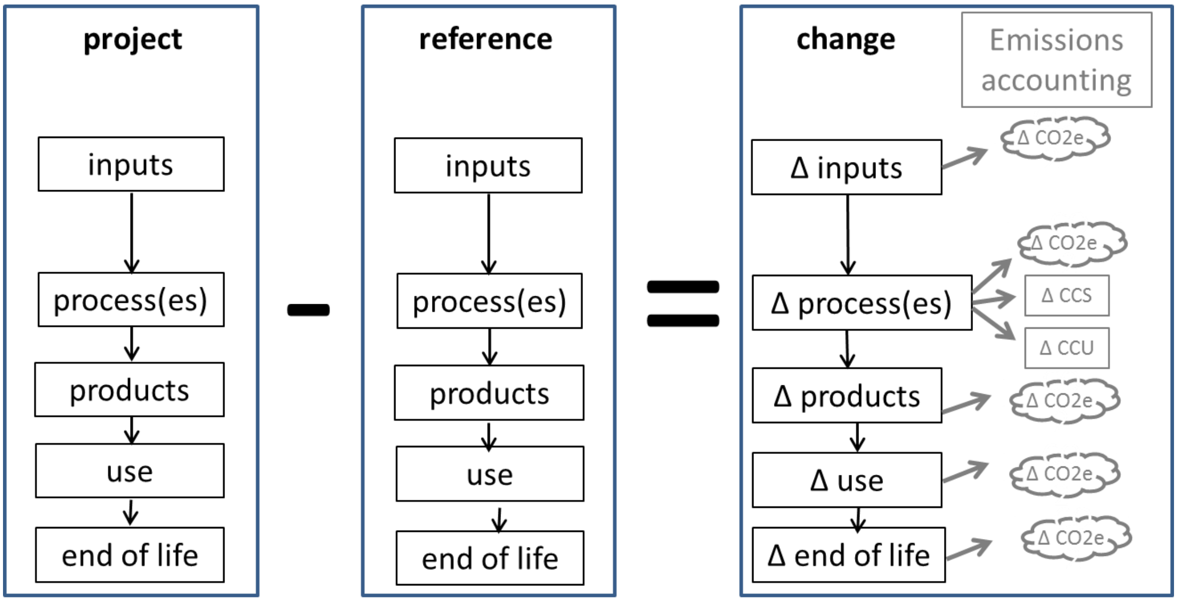
Due to the great variety of projects, no simplification of the diagram is foreseen for first stage. However, there are substantial simplifications in the calculation of emissions in the first stage as explained in the inputs section.

2.2 Absolute GHG emission avoidance

The life-cycle emissions from a project applying for the IF are evaluated by comparing a scenario including the proposed project, with a reference scenario without the project, as illustrated in Figure 2.1. The reference scenario provides the same products or functions as the project scenario.

The emissions avoided by the project, are those of the project scenario minus those of the reference scenario. Thus, if some processes, inputs, or outputs remain identical in the scenarios, there is no need to calculate their emissions. However, the scenarios include all components which are changed by the project.

Figure 2.1 Schematic of GHG emission avoidance related to IF projects



It follows that if a project involves construction of a new plant, the reference scenario includes the alternative process(es) that provide the same or equivalent function(s) in the absence of the project. An "equivalent function" is usually the same quantity of an identical product made in the conventional way. However, if the new product does not have an identical equivalent, it would be the conventional product(s) that would fulfil the same function.

The change in emissions attributed to the project, $\Delta E_{project}$ is the sum of the change in its component parts, each of which may be positive or negative:

$$\Delta E_{project} = \Delta E_{inputs} + \Delta E_{processes} + \Delta E_{products} + \Delta E_{use} + \Delta E_{EoL} \quad [1]$$

In most cases, several of these components will be identical for the project and reference scenarios, and so their change in emissions can be simply set to zero.

It is only for convenience of the description that the calculation is broken down into inputs, processes and products. As long as the products balance between the project and reference scenarios, the result would be the same whether, for example, emissions are represented as a major "input" or as additional "process" to make that input.

2.2.2 $\Delta E_{process(es)}$

2.2.2.1 *Definition of the processes in the project and reference scenarios*

First, the applicant identifies all the processes associated with production of the chosen principal product(s) or functions, which are under the control of the applicant. The processes in the reference scenario must balance those principal products or functions.

Then, just those processes that are changed in the project scenario compared to the reference scenario need to be considered (a "change" in the process includes changes in the output ("activity level") or in the emissions per unit output). Other inputs from processes that are outside the control of the applicant are to be dealt with in the "inputs" section. Differences between the other ("non-principal") products between the project and reference scenarios are dealt with in section 2.2.4.

In the case of a project to modify an existing plant, the reference scenario may contain the unmodified process(es) (rather than the EU ETS benchmarks) provided that the total of emissions for the modified processes in the project scenario (calculated using the EU ETS methodology for assigning free allocations that is current at the time of submission of the application for the first or second stage) is less than the corresponding sum of EU ETS benchmark emissions for the years of operation of the project. The objective is to allow improvements to current plants without "locking in" high-emissions plants that emit more than the EU ETS benchmark.

If a new plant is substituting an existing plant, the sum of GHG emissions associated with all installations and sub-installations within the new plant should be better than the respective EU ETS benchmarks.

For plants producing novel transport fuels falling under the definition of biofuels, renewable fuels of non-biological origin (RFNBOs) or renewable carbon fuels (RCFs) under REDII, the emissions for the equivalent quantity[4] of substituted conventional fuel shall be the "IF fossil

[4] 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.

fuel comparator"[5] of the substituted fuel in the following table minus the stoichiometric combustion emissions of the novel fuel (both expressed in gCO2e/MJ)[6].

Table 2.1 "IF fossil fuel comparators" and the Lower Heating Values for fossil fuels displaced by IF projects producing RFNBOs or RCFs and biofuels.[7]

Substituted fossil transport fuel	IF fossil fuel comparator (gCO2e/MJ)	LHV = NCV (MJ/kg)
Diesel	80.4	43.0
Gasoline	78.9	44.3
LPG	65.4	47.3

For new or modified plants producing other products, the reference scenario shall be built as far as possible from sub-installations with product benchmarks defined in the applicable Benchmarking Decision at the time of the submission of the application for the first or second stage. When the boundaries of the processes in the project do not coincide with EU ETS product benchmark sub-installations, other ETS sub-installations are added to the process or reference scenarios to balance the products and account for all energy and material flows between sub-installations.

Each process and sub-process in the project scenario will be calculated by the applicant according to the current EU ETS methodology, and those from the reference scenario subtracted.

For projects whose processes are not entirely covered by (combinations of) EU ETS product benchmarks and sub-installation emissions, the choice of another reference process needs to be convincingly justified. This entails listing all the alternative reference processes that could reasonably be proposed, and then justifying (e.g. by examining the present market) why the chosen one is indeed the one most likely to provide the same products or functions in the absence of the project. The evaluators will check the comprehensiveness of the list and the validity of the arguments for the selection, as some LCA studies sponsored by applicants of a project select the reference scenario with the worst conceivable emissions, neglecting to mention lower-emission alternatives that may be more realistic.

2.2.2.2 *Calculating the change in process emissions*

Except for the case of RFNBOs and RCFs, listed in the table above, the applicant must calculate the direct GHG emissions for the combination of processes in the project and reference scenarios using calculation methods specified in the Monitoring and Reporting Regulation[8].

The emissions of biogenic CO_2 from combustion of biofuels is not counted, which is consistent with the EU ETS and REDII Directives.

In addition, the applicant must specify the inputs that enter the boundary of the "processes" box of the product and reference scenarios in electricity inputs and material inputs which are not covered by EU ETS direct emissions calculations. This includes feedstocks that are residues or intermediate products of processes outside the control of the applicant, process chemicals not otherwise accounted for, biomass, bioliquids and biofuels. The emissions attributed to these changes is dealt with in the "inputs" section 2.2.3.

[5] The IF fossil fuel comparator differs from that in REDII because the IF 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.

[6] This procedure corrects for any differences in combustion emissions expressed in gCO2/MJ fuel. As biomass-derived CO_2 is not counted as an emission, no combustion emissions are subtracted in the case of biofuels..

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

[8] 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.)

2.2.2.3 *Changes in emissions from waste processing*

Besides accounting for changes in emissions due to the use of wastes as an input, it is also necessary to account for any changes in emissions because of the change in the nature of wastes produced by a process. For example, an innovative process may eliminate a waste stream that requires energy-intensive treatment. These emissions are considered part of the process emissions step. Obviously, if there is no change, no calculation is needed.

2.2.2.4 *Emission avoidance from carbon capture and geological storage (CCS)*

If an IF project in the energy-intensive industry category includes permanent storage of some of its carbon dioxide emissions in accordance with Directive 2009/31/EC on the geological storage of carbon dioxide, the stored CO2 may be subtracted from the process emissions although any emissions associated with the capture, transport and storage operation are taken into account in the project emissions. See section 3 for details. In case that a third party carries out the transport or geological storage, the relevant contractual arrangements must be submitted.

2.2.2.5 *Emission avoidance from CO2 capture and use (CCU)*

Both CO2 capture and use inside the project

It is expected that most CCU projects will be of this sort. It is implicit in the "project – reference" methodology that if additional CO2, that was either in the atmosphere or about to enter the atmosphere, is both captured and incorporated in a product in an IF project, the captured CO2 is accounted as a reduction in emissions of the project. Similarly, any CO2 capture and use in the reference scenario must also be taken into account in deciding what CO2 capture in the project is additional. The emissions attributed to the capturing process, plus any emissions from transporting the CO2, are accounted as part of the overall process emissions.

Imported CO2

Other CCU projects may use CO2 imported from a plant that is not under the control of the applicant. If the captured CO2 is an input from a known source outside the project and its carbon content incorporated into the product(s) of the project, the carbon incorporated into the product(s) shall reduce the CO2 emissions attributed to the product, but the emissions from the capture and transport of the CO2 must be also included in the project emissions.

This results in essentially the same calculation as in section 3 on carbon capture and storage (without the emission involved in the storage of course). However, in industrial projects the CO2 could be imported either in gaseous or liquid form, whereas only liquid CO2 transport is considered in section 3.

If the CO2 is bought off the industrial gas market (and therefore in liquid form) from a producer who does not provide data, the emissions for the transport are included.

Projects proposing only CO2 capture but without any additional use of CO2

Under present and medium-term market conditions, far more CO2 is emitted, also in concentrated form, than is needed by industry. Therefore, an increase in the demand for industrial CO2 leads to more CO2 capture, but increasing CO2 capture without increasing its usage merely displaces capture of CO2 by another installation, with no overall avoidance of CO2 emissions.

Therefore, projects proposing capture of CO2 cannot subtract the amount of captured CO2 from the calculated project emissions, unless the additional use of that CO2 is also part of the project[9].

Use of geological CO2

If CO2 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, then the avoided natural CO2

[9] It is essential that the CO2-use is integrated in the project boundary because almost always very considerable additional emissions are spent in transforming the CO2 into a useful product, and these emissions will disappear if the use of the CO2 is split off.

emissions can be used to reduce the net emissions of the production process, which may end up negative as a result.

However, if the project provoked the release of the geological CO2 which would otherwise have stayed underground (e.g. by drilling for geothermal steam from a reservoir where it is mixed with CO2), then there are no avoided emissions, so it does not reduce the emissions of the production process.

Combustion/end of life emissions of CCU fuels/products
To avoid double counting, as the incorporation of captured CO2 in a fuel (or other product) is already counted as reducing the emissions attributed to its production (and could make them negative), this does not influence the combustion emissions attributed to the CCU fuel, (or, for another CCU product, its emissions in its use or end-of-life).

2.2.3 ΔE_{inputs}

Inputs are any energy or material flow into the boundary of the process box in a scenario. ΔE_{inputs} is the change in emissions arising from changes in the inputs to processes, between the project and reference scenario, so any inputs that are quantitatively and qualitatively the same in the two scenarios can be ignored here.

In fact, ΔE_{inputs} results only from changes in the amount of the inputs or "activity level". That is because the production of these inputs is by definition outside the control of the project, so the emissions factor (e.g. tonnes CO2e/tonne input) attached to a given input must be the same for the project and reference scenarios.

As the objective of the Innovation Fund is to support future breakthrough technologies that will help EU reach climate neutrality in 2050, for the purposes of the GHG emission avoidance calculation, where electricity is fed from the grid to a project, it should be assumed that electricity sector is fully decarbonised, i.e. **the emission factor for the electricity consumed is zero**.

2.2.3.1 *RIGID inputs*

As the GHG emission calculations take account of processes which divert materials from other uses, 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 project by diverting it from another use. Its emissions intensity then considers the impact of diverting it from its existing use. The emissions intensity may be negative (i.e. avoidance of GHG emission) if the input was releasing emissions in its existing use, or positive (creating GHG emissions) if it was avoidance emissions in its existing use. The exact definition of a rigid input is given in the Appendix A1.2.

<u>Examples of rigid inputs</u> include:

- municipal waste, used plastics, used lubricating oil;
- intermediate streams from existing processes: e.g. blast furnace gas, black liquor;
- process heat or waste heat taken from an existing process; and
- 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 A1.2). An example of this type of rigid input is hydrogen recovered from an existing chlor-alkali process, which was already being sold as an industrial gas.

The emissions implications of the use of rigid inputs follow from considering the emissions in the project and reference scenarios, with all functions and products balanced:

> _Example: municipal waste as an input_
>
> *The emissions intensity takes into account the existing fate of the waste, as well as the emissions associated with any additional treatment and transport. For*

example, if its existing fate was incineration without energy recovery, the emissions from the incineration are avoided, and 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. If it is diverted from landfill, the carbon emissions attributed to it at the point of collection will also be negative. These shall be assumed equal to those for incineration without energy recovery, because although landfill sequesters part of the carbon, it is not desirable to encourage landfill for other environmental reasons.

But if for example, a "waste" input is diverted from being burnt to provide district heating, the emissions avoided by the burning of the waste for district heating are offset by the additional emissions incurred by replacing that district heat, for example by using a natural gas boiler.

<u>*Example: "waste heat" as an input*</u>

A process may take heat from another existing process outside the control of the applicant. In this case, the emissions attributed to the heat input shall be the increase in the emissions of the other process associated with the heat export. Thus, if the heat is truly "waste heat", it would be considered free of emissions. On the other hand, if extra fuel needs to be burnt to replace the heat in the existing process, its emissions intensity is the emissions from burning that extra fuel. Where heat is provided by an industrial heat network from multiple other plants, the emissions intensity of that heat can be taken as the same as that used in EU ETS declarations.

<u>*Example: industrial off-gas as an input*</u>

For example, if a stream of industrial off-gas 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.

If the industrial off-gas produces process heat in the reference scenario, the applicant should estimate the emissions from the source of heat that replaces the heat lost by diverting the gas its use in the project, and add these to the project scenario.

As emissions for electricity are set to zero there is no emissions penalty in the Innovation Fund for diverting gases from electricity production.

<u>*Application of the Waste Framework Directive*</u>

Projects that involve the use of "waste" materials must respect the current version of the Waste Framework Directive[10]. The waste hierarchy in the Waste Framework Directive 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. Furthermore, the alternative treatment of the feedstock assumed in the reference scenario must be at the highest level possible for that quality of waste in the waste hierarchy of the Waste Framework Directive.

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

2.2.3.2 *ELASTIC inputs*

If the supply of the input varies 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 input. The exact definition of an elastic input is given in the Appendix A1.2.

According to section 2.2.3.1, the emissions intensity of a rigid input may be based on the elastic input that replaces it in its existing use. The provisions in this section also apply to those elastic inputs: they are considered on the same basis as the other elastic inputs that change between project and reference scenarios.

Minor elastic input changes

At each stage of the project application, the applicant should make a list of all elastic inputs that change between project and reference scenarios.

- At the first stage of application, the applicant may select from this list, "**minor",** elastic inputs whose emissions jointly amount to less than 30% of the total emissions ascribed to the change in inputs. A preliminary calculation may need to be done with the reference emissions, in order to determine whether the thresholds are breached.
- At the second stage and 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 total of the total emissions ascribed to the change in inputs.
- For monitoring and reporting for knowledge-sharing, the selection of minor elastic inputs must be restricted so that their emissions jointly amount to less than 10% of total of the total emissions ascribed to the change in inputs.

The emissions associated with the selected minor elastic inputs may be derived from reference literature, according to the method and hierarchy in the Appendix A1.3.

De Minimis inputs

At the first stage of application, the applicant may select from the list of inputs ***de minimis*** **inputs,** whose emissions jointly amount to less than 10% of the total emissions ascribed to the change in inputs. A preliminary calculation has to be done with the reference emissions, in order to determine whether the thresholds are breached.

At the second stage and for monitoring and reporting for disbursement, the selection of *de minimis* inputs must be restricted so that they jointly amount to less than 5% of total of the total emissions ascribed to the change in inputs.

For monitoring and reporting for knowledge-sharing, the selection of *de minimis* inputs must be restricted so that they jointly amount to less than 2% of total of the total emissions ascribed to the change in inputs.

The emissions of *de minimis* inputs may be neglected. *De minimis* inputs do not count as minor elastic inputs in calculating the joint emissions of the minor elastic inputs.

Inputs that do not fall under the definition of "minor", or *De minimis* are "major".

Fossil Fuels Inputs (major and minor)

The carbon content for inputs of fossil fuels appears either in the process emissions (for the part that is combusted) or in the combustion emissions of the product. Consistent with the ETS-based accounting of changes in process emissions, as long as the ETS-based accounting of emissions is performed (by carbon mass-balance and/or direct measurement) no separate accounting of fossil fuel inputs is needed

Biomass, biogas, biomethane, bioliquid and biofuels inputs (major and minor)

Any such fuels, derived from biomass used in IF projects must conform to the sustainability requirements of the REDII.

If they come from a known supply source, which declares "actual emissions" under the REDII those declared emissions may be assumed for that input in the present calculation, but generally[11] diminished by 15% since the REDII takes into account a wider range of emissions, notably emissions from the production steps of the fossil fuel supplied to the biomass processing.

Otherwise, the emissions factor for biomass, biogas, biomethane, bioliquid or biofuels from an indeterminate supplier, are the default emissions tabulated in Annex V and VI of REDII, generally[11] diminished by 15%.

These rules apply for all stages of the application, but save administrative burden since suppliers will probably already be declaring emissions under REDII.

Remember that the CO2 emissions from the combustion of bio-based carbon are not counted in the process(es) step.

Major elastic inputs from known new or expanded sources

If an input comes from a new plant or source set up for the purpose, but which is not under control of the applicant, that plant must if possible be incorporated in the project scenario. The same applies if a particular plant is expressly expanded to fulfil the increased demand for the project, (in which case of course the unmodified plant will then go into the reference scenario).

If input data is not available for the new or expanding supply plant, the emissions factor of the input shall be calculated as for an input from indeterminate source.

Minor elastic inputs, and major elastic inputs from indeterminate sources

The main elastic inputs from indeterminate sources are expected to be fossil fuels. However, combustion emissions from fossil fuel inputs are already considered in the EU ETS-based accounting of the process step, and that accounts for most of the total emissions intensity of fossil fuels. To avoid complications, the other components of the complete emissions intensity shall be ignored, so that no emissions other than the combustion emissions shall be considered for inputs of fossil fuels. In this connection, "fossil fuels" comprise natural gas, coal, petroleum coke, bitumen, all grades of fuel oil, diesel, gasoline, kerosene, naphtha, LPG, and refinery gas. The combustion emissions factor for some of the more commonly-used fuels are tabulated in **Error! Reference source not found.**. Other inputs, such as high value chemicals, may have much higher processing emissions than simple fuels. However, life cycle and well-to-wheel databases show total carbon intensity, which is the sum of the stoichiometric carbon content and all emissions from processes in the supply chain. For inputs that do not contain carbon, there is no difference, but for carbon-containing inputs, the appropriate emission factors can be found by subtracting from the carbon intensity the stoichiometric carbon content of the input converted to mass of CO2 using the molar weight ratio 44/12. The required data is taken from the reference literature according to the method and hierarchy in Appendix A1.3.

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

If a major elastic input is one of multiple co-products, it is necessary to share process-stage emissions between the co-products. For a rigid input the calculation of emissions

[11] By exception, emissions for biogas and biomethane (which may be negative) are derived by summing the adjusted disaggregated default emissions in Annex VI, section C (p. 113) of the REDII: the adjustments are that (a) the 'cultivation' emissions are reduced by 15%, (b) emissions from 'compression at the filling station' are set to zero (as that uses electricity); (c) 4.5gCO2e/MJ are subtracted from the emissions for upgrading. The 'manure credit' (for avoided emissions from conventional use of manure) is unaltered.

intensity may be based on the elastic product 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 A1.1.

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. Any other choice needs to be clearly justified in terms of how the chosen allocation key describes the "cause of the limit" of production.

2.2.3.3 Electricity inputs supplied to industrial projects

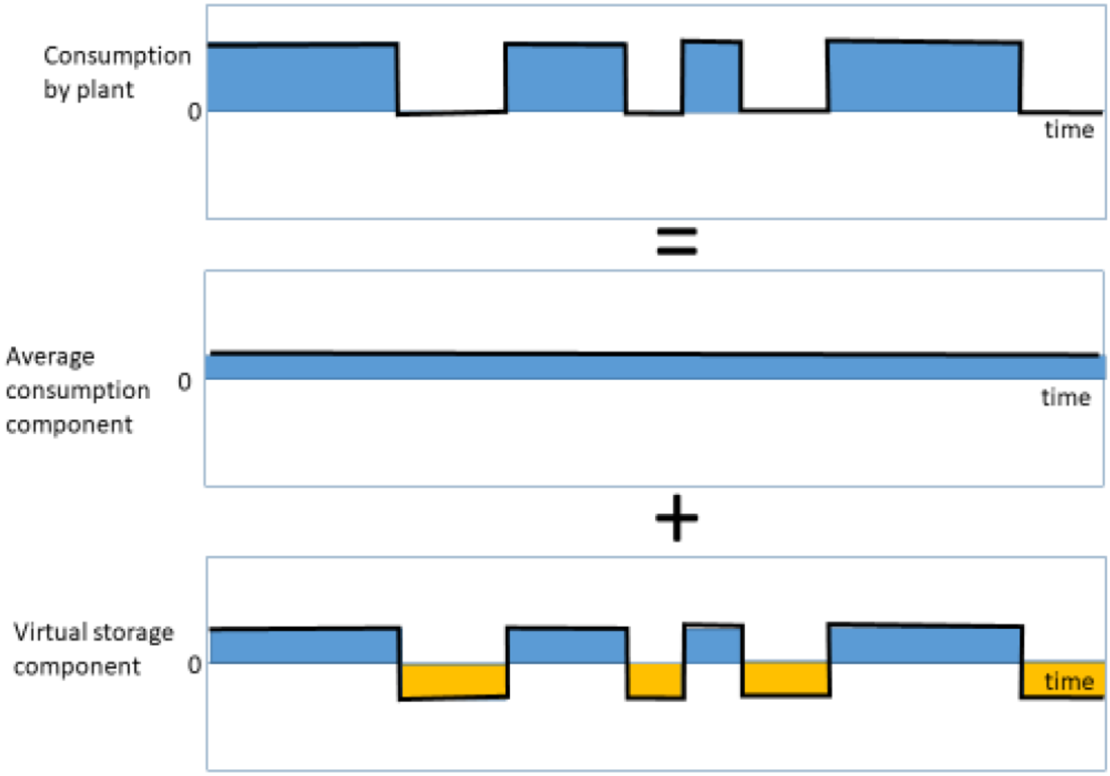
No emissions shall be ascribed to electricity either consumed or exported continuously or at times not correlated with grid emissions variations. However, for *knowledge-sharing purposes*, the actual change in electricity consumption or export between the project and reference scenarios shall be reported.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

2.2.3.4 Lowering grid electricity emissions by timing plant operation

Even without any certification or contracts to use additional renewable electricity, a plant using electricity (such as an electrolyser) can reduce the emissions of its electricity supply by operating only at times when the emissions of the electricity supply are below average. This demand management will become more important in the future as the grid accommodates increasing fractions of intermittent wind and solar electricity. It helps grid stability in the same way as electricity storage.

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 diagram below. The emission avoidance of the virtual storage component shall be calculated as in section on emissions accounting for energy storage (see Section 5).

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



2.2.4 $\Delta E_{products}$

If a project does not change the products (or functions) of the process, no calculation is required. If the products (or functions) are changed, applicants must calculate the emissions saved (or incurred).

The processes in the project and reference scenarios should balance the principal products; however, there may be inevitable changes in by-products. To balance the scenarios, the emissions attached to changes in by-products must be considered. By-products produced in the project scenario but not in the reference scenario increase the project's emission avoidance by the emissions attributed them; conversely by-products products produced in the reference scenario but not in the project scenario increase the project's emission avoidance by the emissions attributed them. The emissions factors needed for this calculation are calculated according to the method in the paragraph on *Minor elastic inputs, and major elastic inputs from indeterminate sources* in section 2.2.3.2.

2.2.5 ΔE_{use}

Innovative products may save emissions in the use phase of the principal product by increasing energy efficiency or reducing emissions during use. For example, new agrochemicals could reduce nitrous oxide emissions when used on the soil; innovative absorbents or catalysts could save emissions in the chemical industry.

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. During monitoring and reporting stage, applicants will be required to prove the amount of products sold in addition to monitoring and reporting of the parameters related to the production of the product.

2.2.6 $\Delta E_{end\ of\ life}$

Most projects will not change end-of-life emissions of the principal products. However, effects on the life-cycle emissions are possible. For example, innovative refrigerants could replace others with higher global warming potential, avoiding emissions when they leak or are not collected at end-of-life. Furthermore, some projects may propose more efficient recycling due to changes in products. Therefore in such cases, changes in end-of-life emissions may be estimated and added to the emissions changes from other project stages.

2.3 Relative emission avoidance for industrial projects

Applicants have to estimate a comparative indicator for the percentage reduction in emissions. For the general formula, please look at section 1.1.3. In case of multiple products, the relative emission avoidance for the product(s) for which the applicant is claiming funding (principal product(s)) is found by dividing the emission avoidance of the project, by an estimate of the emissions for the production of the chosen "principal product(s)" in the reference scenario.
If there are products in the reference scenario apart from the "principal products", the total emissions in the reference scenario must be shared between the "principal products" and the others, using the attribution procedure in Appendix A1.1.

2.4 Data and parameters

Each project will present the parameters that will be deemed as constant throughout the duration of the project and, consequently, shall not be monitored choosing the sources of data as explained above. These will include all emission factors, combustion emissions (carbon contents) and lower heating values (net calorific values) after approval at second stage.

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

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 at second stage of application. For each stage of the application, the documentation should include the following elements:

- Process diagrams for the "project", "reference" and "change" 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").
- A simplified process diagram for the three scenarios showing only the main sub-processes and flows important to the emissions-avoidance calculations.
- Explanation of the choices in the reference scenario, as described in section 2.2.2.1
- 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 for the "change" scenario, identification of "de minimis" and "minor inputs" following section 2.2.3.2.
- List of the emissions intensities taken from the literature according to section 2.2.3.2, 2.2.2.2 and 2.2.4 and the sources of the data.

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

At the reporting stage, all measurements should be conducted with calibrated measurement equipment according to relevant EU ETS MRR requirements.

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.

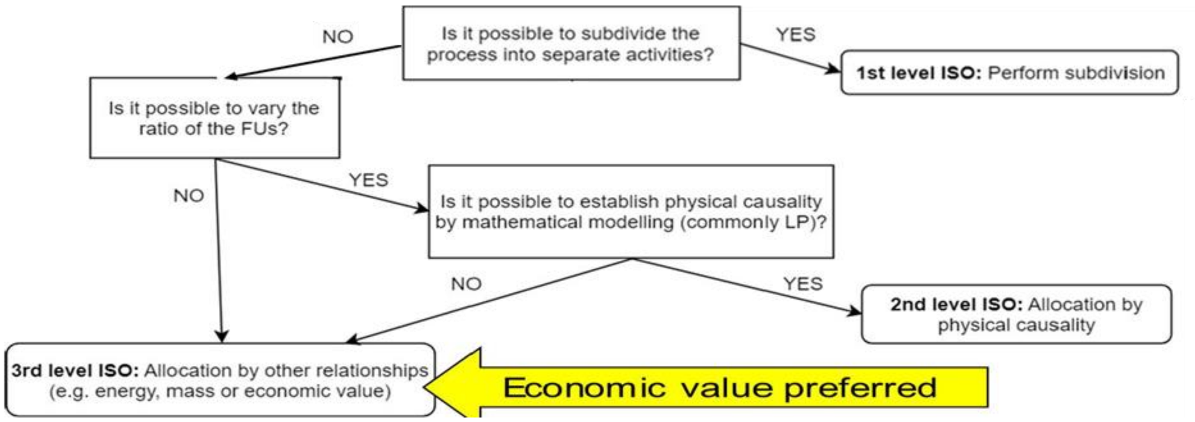
In addition to the parameters listed above, the following parameters will be monitored and reported for **knowledge sharing purposes** for projects using grid electricity where applicable:

- 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.

A1.1 Attribution of emissions to co-products in emissions calculations for IF projects

A simplified version of the ISO 14044 (2006) multifunctionality framework is used to attribute emissions to co-products.

Figure A1.1 Simplification of the ISO 14044 (2006) hierarchy for sharing emissions between co-products[12]



Following the diagram, the applicant first sees if any installation inside the project boundary treats only one of the project's co-products: then obviously the emissions from that installation can be ascribed entirely to that co-product.

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 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 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[13] 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.

[12] 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.

[13] 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.

A1.2 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 (products, by-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 products produced by the plant.

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 perfectly 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 perfectly 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 perfectly 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:

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

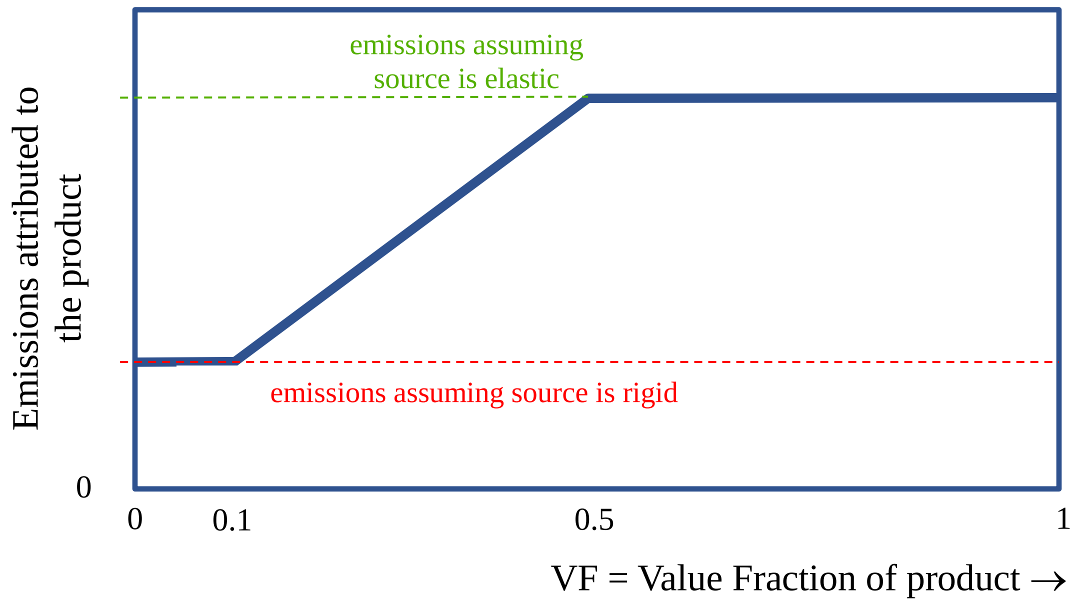
…where *VF* = Value Fraction of the product =

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

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 A1.2 Determining emissions for semi-elastic inputs



In practice, we it is expected that the great majority of inputs to fall into either the "elastic or "rigid category, so the simplification is considerable in most cases. The prices should be the average of the data for the last 3 years.

An example of such a process is the chlor-alkali process, which 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 IF. By contrast, if the hydrogen is not sold, but is being burnt for process heat, then the emissions of the plant are obviously 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.

A1.3 Hierarchy of data sources for inputs and products in industrial projects

The GHG emissions intensity and combustion emissions of inputs or products, *that is not specified elsewhere in the section on industrial projects*, and need to be found from literature (which never includes heat or electricity), will be taken from the following sources, in order of preference (top to bottom). 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* is also known, for transport fuels, as *well-to-wheels* emissions: it comprises not only combustion emissions, but also all the emissions from the supply chain: extraction of raw materials, all steps in the processing, transport and distribution.

1. Stoichiometric combustion emissions for a wide range of fuels is provided in IPCC 2006 Guidelines for National Greenhouse Gas Inventories.
2. Emissions intensity for most widely-used process chemicals are provided in "Definition of input data to assess GHG default emissions from biofuels in EU legislation". (European Commission 2016)[14]. The same values are intended to be shown also in a revised version of the BIOGRACE tool[15]. 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 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% is subtracted from all the values to account for the upstream (etc.) emissions.
3. If the data are not available there, coherent data for a different range of inputs/products may be found in JEC-WTW v.4, WTT appendix 4, which shares the same input database as the calculations in Annex V of REDII.
4. Calculations using input data from ECOINVENT 3.5. Calculations in ECIOINVENT should use the "cut-off system model". An equivalent calculation may also be made in proprietary software packages (e.g. GABI, openLCA) 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 complete lifecycle emissions should be made by subtracting 15% from the emissions intensity result. If the calculation calls for allocation of emissions between multiple products, allocation by economic allocation should be selected (the database includes the cost of products).
5. "Official" sources, such as IPCC*, IEA* or governments (but note that most IPCC and IEA tables show combustion emissions, not emissions intensity).
6. Other reviewed sources of data, such as E3 database, GEMIS database.
7. Peer-reviewed publications.
8. Duly documented own-estimates.
9. "Grey literature": unreviewed sources, such as commercial literature and websites.

[14] https://ec.europa.eu/jrc/en/publication/definition-input-data-assess-ghg-default-emissions-biofuels-eu-legislation.

[15] www.biograce.net/

3 Carbon Capture and Storage

Carbon capture and storage (CCS) projects are characterised by the capture of exhaust gases in large industrial processes or power generation, followed by a separation and compression of the CO_2, which will then be transported by road tankers, ships, rail and/or pipelines to a suitable storage site where it will 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.

Applications for such projects can be submitted by any players in the CCS supply chain, i.e. by the legal entity hosting the capture installation, or by legal entities providing transport services or injection infrastructure. If the full CCS supply chain is not part of the application, the applicant should demonstrate the provision of the remaining services in the CCS supply chain by third parties. As 60% of the IF grant is dependent on verified emission reductions, if CO2 capture and or CO2 transport projects are submitted for funding, then when they report during operation, they will have to prove that amount of CO2 they claim is stored in a site permitted under Directive 2009/31/EC.

Building on the reporting requirements for EU ETS, the GHG emission avoidance for CCS projects will be calculated by deducting project emissions (i.e. emissions that are only occurring due to the project activity) from the reference emissions that would occur in the absence of the project, which is represented by the amount of CO_2 transferred to the capture installation.

Project emissions from the CO_2 capture activity using pre-, post-, oxyfuel or chemical looping combustion techniques, 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.

Project emissions due to transportation by road, rail and maritime modals shall be quantified based on distance travelled data, type of modal and load. This methodology assumes the transportation of the CO_2 will be done through heavy goods vehicle (HGV) when via road, and by sea tankers in the maritime journeys.

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.

3.1 Scope

This methodology applies to project activities that involve capturing and compressing of CO_2 from power and heat generation facilities or energy-intensive industries, including oil refineries, steel works and production of iron, aluminium, metals, cement, lime, glass, ceramics, pulp, paper, cardboard, acids and bulk organic chemicals, for injection in a storage sites permitted under Directive 2009/31/EC on the geological storage of carbon dioxide.

This methodology is applicable to CCS project activities such as but not exclusive to:

3.1.1 Plant of origin

- Energy intensive industries,
- Fossil fuel power generation facilities,
- Natural gas processing.

3.1.2 Technologies

- Pre-combustion,
- Post-combustion,

- Oxyfuel combustion,
- Chemical looping combustion.

3.1.3 Storage sites

- Depleted (or nearly depleted) oil and gas reservoirs,
- Unmineable coal beds,
- Saline aquifers,
- Basalts.

3.2 Project boundary

The greenhouse gases and emission sources included in or excluded from the project boundary are shown in Table 3.1.

Table 3.1 Emission sources included in or excluded from the reference and project boundaries

	Emission sources	Included First stage	Included Second stage
Reference (Ref)	CO_2 releases from power plants or industries that would be to atmosphere in the absence of the project activity ($Ref_{release}$)	Yes	Yes
Project (Proj)	CO_2 capture activities. Includes emissions from fuel and input material use for compression and liquefaction of the CO_2, as well as fugitive and venting pre-injection. ($Proj_{capture}$)	Yes	Yes
	Transport of CO_2 by pipeline. Includes emissions from combustion and other processes at installations functionally connected to the transport network such as booster stations; fugitive emissions from the transport network; vented emissions from the transport network; and emissions from leakage incidents in the transport network. ($Proj_{transport\ pipeline}$)	Yes	Yes
	Transport of CO_2 by road, rail and maritime modal. Includes emissions from combustion at tank trucks, sea tanker and other vehicles. ($Proj_{transport\ road}$; $Proj_{transport\ rail}$ and $Proj_{transport\ maritime}$)	Yes	Yes
	Injection at the geological storage site. Include 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. ($Proj_{injection}$)	Yes	Yes

3.3 Absolute GHG emission avoidance

The equation to be applied in both first and second stages for the calculation of absolute GHG emission avoidance is described in the following.

GHG emission avoidance	=	Reference scenario emissions	-	Project emissions	
$\Delta GHG_{abs,CCS}$	=	$\sum_{y=1}^{n}$ $Ref_{release,y}$	-	$\sum_{y=1}^{n}$ ($Proj_{capture,y}$ + $Proj_{transport\ pipeline,y}$ + $Proj_{transport\ road,y}$ + $Proj_{transport\ rail,y}$ + $Proj_{transport\ maritime,y}$ + $Proj_{injection,y}$)	[3.1]

Where:

$\Delta GHG_{abs,CCS}$ = Absolute GHG emissions avoided by the CCS project, in tonnes CO_2e.

$Ref_{release,y}$ = Amount of CO_2 transferred to the capture installation in year y, in tonnes CO_2e, 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.

$Proj_{capture,y}$ = 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 in year y, in tonnes CO_2e. This includes emissions from fuel and input material use for compression and liquefaction of the CO_2, as well as fugitive and venting pre-injection. It shall be calculated according to Regulation (EU) 2018/2066, Annex IV, Section 21.

$Proj_{transport\ pipeline,y}$ = GHG emissions from transport of CO_2 by pipelines for geological storage in a storage site permitted under Directive 2009/31/EC 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; fugitive emissions from the transport network; vented emissions from the transport network; and emissions from leakage incidents in the transport network. It shall be calculated according to Regulation (EU) 2018/2066, Annex IV, Section 22.

$Proj_{injection,y}$ = 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.

$Proj_{transport\ road,y}$ = GHG emissions due to the transportation of CO_2 in tank trucks or other road modals in year y, to be calculated according to Equation [3.2], in tonnes CO_2e.

$Proj_{transport\ rail,y}$ = GHG emissions due to the transportation of CO_2 by rail in year y, to be calculated according to Equation [3.2], in tonnes CO_2e.

$Proj_{transport\ maritime,y}$ = GHG emissions due to the transportation of CO_2 in sea tankers or other maritime modals in year y, to be calculated according to Equation [3.2], in tonnes CO_2e.

y = first year of the operation

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

Parameter	=	Equation	
$PE_{transport,v,y}$	=	$K_{v,y}$* $CO2_{transported,y}$ * EF_v * 10^{-3}	[3.2]

Where:

$K_{v,y}$ = distance travelled by vehicle type v in year y, in kilometres.

$CO2_{transported,y}$ = amount of CO_2 transported in year y, in tonnes.

Table 3.2 EF_v = emission factor for vehicle type v, in kg CO_{2-eq} / tonne.km. The EF presented in Table 3.2Parameters not to be monitored (fixed ex-ante)

be applied.

3.4 Data and parameters

The table below presents the parameters that will be deemed as constant throughout the duration of the project, unless otherwise stated. Should applicant wish to adopt emission and conversion factors different to those proposed, a justification shall be provided and the corresponding parameter(s) shall be included in the monitoring plan.

The emissions attributed to electricity use for injection and/or capture shall be zero (EUCO 2050 scenario).

Table 3.3 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 CO2 transport by heavy truck.	JRC own calculation agreeing with that of 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 20m3 pressurized cryotank. Includes empty return trip.
EF_{rail}	0.065	kg CO2e / tonne.km	Emission factors for freight by maritime 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
$EF_{maritime}$	0.030	kg CO2e / 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 CO2 an empty return trip.

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

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 at second stage of application. This document shall contain at least the elements laid down in Equations [3.1] and [3.2].

Parameters for monitoring

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 $Proj_{capture}$, $Proj_{transport\ pipeline}$ 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.

All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

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

Table 3.4 Parameters for monitoring

Data / Parameter	Data unit	Description	Source of data	Measurement methods and procedures	Monitoring frequency	QA/QC Procedures	Responsibility for collection and archiving	Comment
$CO_{2\ fossil\ transferred\ to\ the\ capture\ installation}$	tonnes CO_2	Amount of CO_2 transferred to the capture installation	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
K_{road}	km	Distance travelled by road modals	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
$CO2_{transported,road}$	tonnes CO_2	Amount of CO_2 transported to the storage site by road modals	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
K_{rail}	km	Distance travelled by rail modals	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
$CO2_{transported,rail}$	tonnes CO_2	Amount of CO_2 transported to the storage site by train modals	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
$K_{maritime}$	km	Distance travelled by maritime modals	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
$CO2_{transported,maritime}$	tonnes CO_2	Amount of CO_2 transport	[to be informed by	[to be informed by	[to be informed by	[to be informed by	[to be informed by	

Data / Parameter	Data unit	Description	Source of data	Measurement methods and procedures	Monitoring frequency	QA/QC Procedures	Responsibility for collection and archiving	Comment
		ed to the storage site by maritime modals	applicants]	applicants]	applicants]	applicants]	applicants]	

In addition to the parameters listed above, the following parameters shall be monitored on a yearly basis and reported for **knowledge sharing purposes**. Substantial monthly deviations if any should also be reported.

- Capture ratio, in tonnes CO2e emitted / tonne CO2 fossil transferred to the capture installation.
- Transport by pipeline ratio, in tonnes CO2e / tonne CO2 fossil transferred to the capture installation.
- Injection ratio, in tonnes CO2e emitted / tonne CO2 fossil transferred to the capture installation.
- Type(s) of modal(s) used in the transportation of the CO2 from the site of origin to the storage site
- Weight fraction of the truck, train wagon or ship occupied by the compressed CO2 and, separately, the empty tank (i.e. fully or partially loaded), per trip and modal.
- High-level mapping of environmental impacts and mitigation measures.
- High-level risk screening and mitigation measures.

4 Renewable electricity and heat

This section describes the calculation of GHG emission avoidance from innovative renewable energy projects such as bioelectricity, bio-heat, 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 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, despite the regional differences that will invariably be observed in real life. Therefore, for the purpose of the IF, if the output is grid-connected electricity, the emissions attributed to grid electricity in the reference scenario corresponds to the typical EU grid emissions during in 2030 according to the Commission's PRIMES/EUCO3232.5 scenarios. For all projects generating renewable heating, a natural gas boiler with 90% LHV efficiency shall be adopted as the reference scenario.

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.
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 IF, the applicant shall quantify at a minimum the emissions from all the direct sources (Scope 1), indirect emissions from the generation of purchased electricity and/or steam (Scope 2) and other indirect emissions that occur across the value chain (Scope 3), as per definition of the GHG Protocol Corporate Standard.[16] Although this approach does not require the quantification of all cradle-to-grave emissions, it intends to capture the main emissions sources within the project boundaries and control.

For projects that include storage of renewable electricity at times when there is an excess of it in the grid-mix, e.g. smart grid applications, please refer Section 2.2.3.4, for guidance on the methodology and emission factors to apply.

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 of components of innovative technologies that will generate renewable energy, when implemented.

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.

[16] The GHG Protocol Corporate Standard classifies a company's GHG emissions into three 'scopes'. Scope 1 emissions are direct emissions from owned or controlled sources (e.g. fuel combustion on site such as in boilers, fleet vehicles and air-conditioning leaks). Scope 2 emissions are indirect emissions from the generation of energy purchased and used by the organisation. Scope 3 emissions are all other indirect emissions that occur across the value chain of the organisation, in sources that the organisation does not own or control, such as business travel, raw material production, waste degradation.

4.1 Scope

This methodology applies for innovative renewable energy projects for the purpose of generating grid-connected electricity and heating/cooling, including electricity and/or heat produced from biomass or fuels derived from biomass.

Any innovative renewable energy generation projects that can demonstrate GHG emission avoidance could be eligible for funding.

This methodology envisages applications from activities that meet the conditions listed below.

4.1.1 Products

- Grid-connected electricity from wind, solar, ocean, hydro, geothermal energy, biomass
- Combined heating and power from 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, PV modules and wind turbines)

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; or
- Construction of a manufacturing plant of components of innovative renewable technologies

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 (i.e. manufacturing plant) of components for innovative technologies, applicants shall demonstrate the existence of a buyer (i.e. a company that will run the innovative technology to generate renewable electrical or thermal energy or to store energy) through provisional contract agreements to ensure:

- accountability over the intended GHG emission avoidance, and
- that the use takes place in the territory of the EU/Norway/Iceland.

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

4.1.3 Project boundary

The emission sources that shall be included within the boundaries of the calculations for wind, ocean, solar, geothermal and bio-fuels[17] to grid or to heat projects are shown in Table 4.1.

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

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

	Source	Included First stage	Included Second stage
Reference (Ref)	GHG emissions for the generation of grid-connected electricity (Ref_{grid}) or heating (Ref_{heat}) in fossil fuel fired power plants, which will be displaced due to the project activity	Yes	Yes
Project (Proj)	GHG emissions due to purchased electricity and fossil fuel consumption in stationary machinery and on-site vehicles at the project site(s) ($Proj_{on-site}$)	No	Yes
	GHG emissions due to leakage during the operation of geothermal power plants ($Proj_{geo}$)	No	Yes
	GHG emissions from the supply of consumed materials other than fuels ($Proj_{bio}$)	Yes	Yes

4.2 Absolute GHG emission avoidance

The equations to be applied in both stages are described in the following sections.

4.2.1 First stage methodologies

Project type	GHG emission avoidance	=	Reference emissions	-	Project emissions	
Delivered grid-connected electricity from wind, hydro, ocean, solar, geothermal energy and from biogenic sources. Including manufacturing plants	$\Delta GHG_{abs,RES\text{-}to\text{-}grid,y}$	=	$\sum_{y=1}^{n} Ref_{grid,y}$	-	$\sum_{y=1}^{n} Proj_{bio,y}$	[4.1]
Delivered heat from solar, geothermal energy and from biogenic sources. Including manufacturing plants	$\Delta GHG_{abs,\ RES\ to\ heat,y}$	=	$\sum_{y=1}^{n} Ref_{heat,y}$	-	$\sum_{y=1}^{n} Proj_{bio,y}$	[4.2]

Where:

$Ref_{grid,y}$, GHG emissions for the generation of grid-connected electricity in fossil fuel fired 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 [4.3].

$Ref_{heat,y}$ = GHG emissions for the generation of heating/cooling in fossil fuel fired 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 [4.5].

$Proj_{bio,,y}$= 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 [4.7].

y = first year of the operation

n = 10th year following the start of operation

4.2.1.1 Reference emissions sub-equations

Parameter	=	Equation	
$Ref_{,grid,y}$	=	$EG_{grid,y} * EF_{grid,ref}$	[4.3]
$EG_{grid,y}$	=	$P_{elec} * PLF * T_y$	[4.4]
$Ref_{heat,y}$	=	$EG_{heat,y} * EF_{NG,ref} * 0.90$	[4.5]
$EG_{heat,y}$	=	$P_{heat} * PLF * T_y$	[4.6]

Where:

$EG_{grid,y}$ = Net[18] amount of electricity to be generated by the renewable technology and fed into the grid in year y, in MWh. Calculated according to Equation [4.4].
$EG_{heat,y}$ = Net amount of thermal energy to be delivered by the renewable technology in year y, in MWh. Calculated according to Equation [4.6].
P_{elec} = Electric power plant installed capacity, i.e. maximum electrical power output, in Watts.

P_{heat} = Heating/Cooling generation plant installed capacity, i.e. maximum thermal power output, in Watts.

PLF = Plant Load Factor, i.e. plant's capacity utilisation, in %
T_y = operating hours in year y, in hours.
$EF_{grid,ref}$ = EU grid emissions factor in the reference period, in tonnes CO_2e/MWh. The appropriate EF presented in Table 4.2 should be applied.
$EF_{NG,ref}$ = 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 should be applied.
y = year of operation

4.2.1.2 Project emissions sub-equations

Parameter	=	Equation	
$Proj_{bio,,y}$	=	$\sum_{y=1}^{n} EC_{bio.f,y} * EF_{bio.f} * 0.85$[19]	[4.7]

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 supply of bio-based fuel *'f'* used to make heat and/or electricity, produced, in tonnes CO_2e /MJ of bio-based fuel. Calculated according to Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources (Recast), Annexes V and VI
y = year of operation

[18] For grid-connected electricity projects, only the energy generated and fed into the grid should be accounted for, i.e. any on-site losses or electricity generated for internal use shall be deducted. For the situations where the project involves retrofit/capacity added to an existing plant, only the surplus should be accounted for.
[19] To deducted 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.

4.2.2 Second stage methodologies

Project type	GHG emission avoidance	=	Reference emissions	-	Project emissions	
Delivered grid-connected electricity from wind, hydro, ocean, solar, geothermal energy and from biogenic sources. Including manufacturing plants	$\Delta GHG_{abs,RES\text{-}to\text{-}grid,y}$	=	$\sum_{y=1}^{n}$ $Ref_{grid,y}$	-	$\sum_{y=1}^{n}$ $(Proj_{on\text{-}site} + Proj_{geo} + Proj_{bio,y})$	[4.8]
Delivered heat from solar, geothermal energy and from biogenic sources. Including manufacturing plants	$\Delta GHG_{abs,\ RES\ to\ heat,y}$	=	$\sum_{y=1}^{n}$ $Ref_{heat,y}$	-	$\sum_{y=1}^{n}$ $(Proj_{on\text{-}site} + Proj_{geo} + Proj_{bio,y})$	[4.9]

Where:
$Ref_{grid,y}$, GHG emissions for the generation of grid-connected electricity in fossil fuel fired 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 [4.3].
$Ref_{heat,y}$ = GHG emissions for the generation of heating/cooling in fossil fuel fired 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 [4.5].
$Proj_{on\text{-}site,y}$ = 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].
$Proj_{bio,,y}$= GHG emissions from the supply of biomass-based fuels for conversion into heat and electricity in year y, in tonnes CO_2e. Calculated according to Equation [4.7].

y = first year of the operation

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

4.2.2.1 Reference emissions sub-equations

For the calculation of the emissions $Ref_{grid,y}$, $Ref_{heat,y}$, and $Proj_{bio,,y}$ please refer to the equations and sub-equations described in Section 4.2.1.

4.2.2.2 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]
$Proj_{elect,y}$		$EC_y * EF_{grid,proj}$	[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.

$Proj_{FF,mob,y}$ = 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.

Table 4.2 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 4.2Parameters 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.

Table 4.3 $EF_{grid,proj}$ = Average EU grid emissions factor in the project scenario, in tonnes CO_2e/MWh. The appropriate EF presented in Table 4.3Parameters 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]
$PE_{dry\_flash,y}$	=	0.00544695[20] $* M_{steam,y}$	[4.15]
$PE_{binary,y}$	=	$(M_{inflow,y} - M_{outflow,y}) * 0.00544695 + M_{working\ fluid,y} * GWP_{working\ fluid}$	[4.16]

Where:
PE_{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.
PE_{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.

4.2.3 Construction of a manufacturing plant of innovative technologies components

For the situations where funding will be used to finance the construction of a manufacturing plant of innovative technologies components, the same equations presented in Sections 4.2.1 and 4.2.2 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, and

[20] Based on IPCC AR5 and CDM benchmarks. Assumes: Average mass fraction of methane in the produced steam = 0.00000413 tonnes CH4/ tonne steam; Average mass fraction of carbon dioxide in the produced steam = 0.00533144 tonnes CO2/tonne steam.

- Operating hours,

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), will consume when operating.

4.3 Data and parameters

The table below 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 A1.3.

Table 4.4 Parameters not to be monitored

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
$EF_{NG,ref}$	0.202	tonnes CO_2e / MWh NG	Emission factor for combustion of natural gas	Commission Delegated Regulation (EU) 2018/2066, Annex VI	56.1 tCO2/TJ times 0.0036 TJ/MWh.
EF_{NG}	56.1	tonnes CO_2/TJ	Emission factor for combustion of natural gas	Ibid	
$EF_{heavyoil}$	3.12	tonnes CO_2/ tonne	Emission factor for combustion of heavy fuel oil	Based on 2006 IPCC Guidelines for National Greenhouse Gas Inventories.	
EF_{NG}	0.00215	tonnes CO_2e / m^3	Emission factor for combustion of natural gas	Commission Delegated Regulation (EU) 2018/2066, Annex VI	Assumes density of 800 g / m^3
$EF_{gasoline}$	0.00228	tonnes CO_2e / litre	Emission factor for the combustion of gasoline	Ibid	No biofuel blend. Motor gasoline. Assumes density of 742 g / litre gasoline EF is 69.3 gCO2/MJ LHV is 44.3 MJ/kg
$EF_{gasoline}$	69.3	tonnes CO_2e /TJ	Emission factor for the combustion of gasoline	Ibid	LHV = 44,3 TJ/tonne or MJ/kg

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Assumption / Comment
EF_{diesel}	0.00268	tonnes CO_2e / litre	Emission factor for the combustion of diesel	Based on EF and NCV from 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 2. Energy	No biofuel blend. Diesel oil. Assumes density of 840 g / litre
EF_{diesel}	74.1	tonnes CO_2e /TJ (=gCO2e/MJ)	Emission factor for the combustion of diesel	Commission Delegated Regulation (EU) 2018/2066, Annex VI	
$EF_{grid,ref}$	0.150	tonnes CO_2e / MWh	Emissions of electricity production in 2030	Technical Note Results of the EUCO3232.5 scenario on Member States	Base year 2030. Combustion only.
$EF_{grid,proj}$	0.000	tonnes CO_2e / MWh	Emissions of electricity production in 2050	By assumption	Base year 2050. Combustion only.

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

A monitoring plan consisting of a detailed, complete and transparent documentation of the parameters used in calculations and data sources shall be submitted at second stage of application. The table below presents the parameters that, at minimum, shall be monitored throughout the project and be part of the project's monitoring and reporting plan.

All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

Table 4.5 Parameters for monitoring

Data / Parameter	Data unit	Description	Source of data	Measurement methods and procedures	Monitoring frequency	QA/QC Procedures	Responsibility for collection and archiving	Comment
EG_{grid}	MWh	Net amount of electricity to be generated by the renewable technology	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	Alternatively, derived from: P_{elec}, PLF, Ty

Data / Parameter	Data unit	Description	Source of data	Measurement methods and procedures	Monitoring frequency	QA/QC Procedures	Responsibility for collection and archiving	Comment
		and fed into the grid						
EG_{heat}	MWh	Net amount of thermal energy to be generated by the renewable technology	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	Alternatively, derived from: P_{heat}, PLF, Ty
Q_{FF_stat},	Litres or m^3	Quantity of fossil fuel type FF combusted in stationary sources at the project site	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
Q_{FF_mob},	litres	Quantity of fossil fuel type FF combusted in mobile sources at the project site	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
EC	MWh	Amount of electricity imported from the grid and consumed at the project site	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
M_{steam},	tonnes steam	Quantity of steam produced	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
M_{inflow},	tonnes steam	Quantity of steam entering the geothermal plant	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	

Data / Parameter	Data unit	Description	Source of data	Measurement methods and procedures	Monitoring frequency	QA/QC Procedures	Responsibility for collection and archiving	Comment
$M_{outflow,}$	tonnes steam	Quantity of steam leaving the geothermal plant	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
$M_{working\ fluid}$	tonnes working fluid	Quantity of working fluid leaked/reinjected	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
$GWP_{working\ fluid}$	tonnes CO2 / tonnes working fluid	Global Warming Potential for the working fluid used in the binary geothermal power plant.	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
$EC_{bio.f,y}$	MJ	Amount of bio-based fuel 'f' consumed by the project	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	
$EF_{bio.f}$	tonnes CO2e /MJ	GHG emissions from the supply of bio-based fuel 'f'	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	[to be informed by applicants]	

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, it is suggested that the following parameters are monitored and reported for **knowledge sharing purposes**:

- [All RES] Energy generated by hour, based on the actual load factor, and technology efficiency per operating hour.
- [All RES] Key raw materials and feedstock used at the power plant, and their origin.
- [Geothermal] Composition of steam by month, in % of each element.

- [Geothermal] Average loss, by month, i.e. Quantity of steam leaving the geothermal plant / Quantity of steam entering the geothermal plant, in %.
- [Geothermal] Average amount working fluid leaked/reinjected by month, in t working fluid/t steam entering the geothermal plant.
- [Geothermal] Heat production by month, in kWh / t steam entering the geothermal plant.
- [Geothermal] Electricity production by month, in kWh / t steam entering the geothermal plant.
- [Waste to energy] Original use/treatment of the feedstock.
- [Bioelectricity and heat] Type of bio-based fuel used (refer to annexes V and VI of the REDII). Any pre-treatment(s) of biomass before processing.
- [Bioelectricity and heat] Type(s) of modal(s) used in the transportation of solid biomass fuels from the site of origin to the bio-refinery or power plant.
- High-level mapping of environmental impacts and mitigation measures.
- High-level risk screening and mitigation measures.

5 Energy storage

GHG emission avoidance of an energy storage project is calculated as an annual comparison of the project emissions and the emissions in a reference scenario 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.

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. 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 will 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. At first stage, on-site emissions of fugitive GHGs and from energy use other than energy storage can be omitted.

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 annual 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 methodology 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) that was supplied to the moment of use. The storing of energy may include the conversion of one energy type into another.

A project is classified as an energy storage project, if energy storage (in any of the forms defined above) is the major purpose or one of its major purposes.

A project that includes energy storage but has as industrial production as a major purpose should follow the guidance for energy intensive industry projects (see Section 2). For a project focusing on the production of hydrogen or renewable fuels of non-biological origin, the applicant should select to use this methodology if the majority of the revenue for the project comes from the energy stored (e.g. due to avoided curtailment). Otherwise, the applicant should follow the methodology for energy intensive industry projects. If such a project or any other industrial project makes use of fluctuations in electricity markets, it should calculate the associated GHG emission avoidance based on the guidance for energy storage projects.

This methodology 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),

- Avoidance of renewable energy curtailment,
- Other energy storage,
- Manufacture of components for energy storage, such as batteries.

5.1.2 Technologies

- Electricity storage technologies,
- Heat and cold storage technologies,
- Hydrogen storage technologies,
- Gaseous fuel storage technologies,
- Liquid fuel storage technologies, or
- Combinations of the above, including smart grid technologies.

5.1.3 Energy sources

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

5.1.4 Energy sinks

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

5.2 Project boundary

The spatial extent of the project boundary includes the project energy storage plant/unit and all facilities that the IF 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 project boundary are shown in Table 5.1**Error! Reference source not found.**.

Table 5.1 Emission sources included in the project boundary

	Source	Included first stage	Included second stage
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 as well as from transmission losses associated with the network transport.	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 as well as from transmission losses associated with the grid transport.	Yes	Yes
Project (Proj)	$Proj_{energy}$: Emissions related to the provision of energy caused by the project activity. This includes direct emissions from the use of fossil fuels and generation of heat, indirect emissions from the use of grid electricity and grid heat, process-related emissions from the production of hydrogen as well as from transmission losses associated with the grid transport.	Yes	Yes
	$Proj_{on\text{-}site}$: On-site emissions of fugitive GHGs 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.	No	Yes

5.3 Absolute GHG emission avoidance

The equations to be applied in both the first and second stage are described in the following sections.

5.3.1 First stage methodologies

During the first stage of application, 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 markets.

GHG emission avoidance	=	Reference scenario emissions	–	Project emissions	
$\Delta GHG_{abs,storage}$	=	$\sum_{y=1}^{10}(Ref_{energy,y} + Ref_{services,y})$	–	$\sum_{y=1}^{10} Proj_{energy,y}$	[5.1]
$\Delta GHG_{abs,storage}$	=	$\sum_{y=1}^{10} N_y \times (Ref_{energy,y} + Ref_{services,y})$	–	$\sum_{y=1}^{10} N_y \times Proj_{energy,y}$	[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 grid 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 grid transport. It shall be calculated according to Equation [5.4] below.

$Proj_{energy,y}$ = 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 grid transport. It shall be calculated according to Equation [5.5] below.

N_y = number of energy storage units supplied to markets by the proposed manufacturing plant of energy storage units, in 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	
$Ref_{energy,y}$	=	$EF_{transport,y} * E_{transport,y} + \sum_{x=1}^{X} EF_{out,x,y} * E_{out,x,y} \;/\; (1 - \theta_x)$	[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.

$E_{transport,y}$ = electricity supplied for the use in non-rail vehicles, in year *y*, in terra Joules (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. 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 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 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.

$E_{out,x,y}$ = secondary energy supplied to energy grids or final energy delivered to end-user of energy type *x*, in year *y*, in terra Joules (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. 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.

$EF_{out,x,y}$ = 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 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.

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 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]

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.

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.

$E_{in,y,x}$ = energy used by the energy storage plant of energy type *x*, in year *y*, in terra Joules (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.

$EF_{in,y,x}$ = emission factor of energy type x for the energy used by the energy storage plant, in year y, in terra Joules (TJ). For the emission factors, the values presented in Table 5.2 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.

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 should be applied.

5.3.2 Second stage methodologies

During the second stage of application, the absolute GHG emission avoidance by an energy storage plant shall be calculated according to Equation [5.6]. For a manufacturing plant that produces energy storage units, the absolute GHG emission avoidance plant shall be calculated according to Equation [5.7].

GHG emission avoidance	=	Reference scenario emissions	–	Project emissions	
ΔGHG_{abs}	=	$\sum_{y=1}^{10}(Ref_{energy,y} + Ref_{services,y})$	–	$\sum_{y=1}^{10}(Proj_{energy,y} + Proj_{on-site,y})$	[5.6]
ΔGHG_{abs}	=	$\sum_{y=1}^{10} N_y \times (Ref_{energy,y} + Ref_{services,y})$	–	$\sum_{y=1}^{10} N_y \times Proj_{energy,y}$	[5.7]

For the second stage, the same calculations rules for $Ref_{energy,y}$, $Ref_{services,y}$, $Proj_{energy,y}$ apply (see Equations [5.3] to [5.5] above). The calculations from the first stage of application shall be updated, if any of the required input data has changed between the first and second stage of application.

$Proj_{on\text{-}site,y}$ = 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 [5.8] below.

Parameter	=	Equation	
$Proj_{on\text{-}site,y}$	=	$Proj_{stat,y} + Proj_{mob,y} + Proj_{fug,y}$	[5.8]
$Proj_{stat,y}$	=	$\sum_{x=1}^{X} EF_{in,x} * E_{stat,x,y}$	[5.8a]
$Proj_{mob,y}$	=	$\sum_{x=1}^{X} EF_{in,x} * E_{mob,x,y}$	[5.8b]
$Proj_{fug,y}$	=	$\sum_{z=1}^{Z} M_{fug,z,y} * GWP_{fug,z}$	[5.8c]

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 1.3.3).

$Proj_{stat,y}$ = 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 [5.8a] 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 [5.8b] 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 [5.8c] 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 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 1.3.3).

5.4 Data and parameters

The table below 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
$EF_{in,H2,y}$ / $EF_{out,H2,y}$	62.4 (8.85)	t CO_2e / TJ (t CO_2e / tonne H_2)	Emission benchmark for generating hydrogen under the ETS in year *y*	COMMISSION DELEGATED REGULATION (EU) 2019/331	Starting point for determination of annual reduction rate for benchmark value update not yet defined

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
$EF_{in,heat,y}$ / $EF_{out,heat,y}$	62.3	t CO_2-eq / TJ	Emission benchmark for generating heat under the ETS in year *y*	COMMISSION DELEGATED REGULATION (EU) 2018/2066, annex VI	Starting point for determination of annual reduction rate for benchmark value update not yet defined
$EF_{in,natural\ gas}$ / $EF_{out,natural\ gas}$	56.1.	t CO_2-eq / TJ	Combustion emissions of natural gas	Ibid	
$EF_{in,diesel}$/ $EF_{out,diesel}$	74.1	t CO_2-eq / TJ	Combustion emissions of diesel fuel or gasoil	Ibid	
$EF_{heavy\ fuel\ oil}$ / $EF_{out,heavy\ fuel\ oil}$	77.4	t CO_2-eq / TJ	Combustion emissions of heavy fuel oil (residual fuel oil	Ibid	
$EF_{in,\ other\ fossil\ fuels}$ / $EF_{out,\ other\ fossil\ fuels}$	look up in table 1 of COMMISSION DELEGATED REGULATION (EU) 2018/2066, annex VI	t CO_2-eq / TJ	Combustion emissions many fossil fuels	Ibid	If not in that table, use the literature hierarchy in Appendix A1.3
$EF_{in,electricity,y}$	0	t CO_2-eq / TJ	Emissions for electricity and steam production in 2050	By assumption	The 2050 value provided here should be applied in all years *y*.
$EF_{out,electricity,y}$	140	t CO_2-eq / TJ	Emissions for with single-cycle NG turbine (used for peaking power)	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%. Note this corresponds to 504 tCO2/GWh.

Data / Parameter	Value to be applied	Data unit	Description	Source of data	Comment
$EF_{transport,y}$	222.3	t CO_2-eq / TJ	Emissions for diesel-fuelled combustion engines (used in vehicles)	Ibid	The value should be applied in all years *y*. Based on $EF_{out,diesel}$ and a three times higher efficiency of electric motors compared to combustion engines. Note this corresponds to 800 tCO2/GWh.
$\theta_{electricity}$	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 fuels 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_2-eq 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	The reference case shall consider the provision of the service by a CCGT plant running at an electrical efficiency of 45% instead of 55%

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

A monitoring plan consisting of a detailed, complete and transparent documentation of the parameters used in calculations and data sources shall be submitted at second stage of the application. This document shall contain at least the elements laid down in Equations [5.3] to [5.8].

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

All measurements should be conducted with calibrated measurement equipment according to relevant industry standards.

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 run the innovative energy storage technology).

Table 5.3 Parameters for monitoring

Data / Para-meter	Data unit	Description	Source of data	Measur e-ment method s and proce-dures	Moni-toring fre-quency	QA/QC proce-dures	Respo n-sibility for col-lection and archi-ving	Comme nt
P_{in},	MW	Input power rating	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	
P_{out}	MW	Output power rating	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	
E_{stor}	TJ	Maximum storage capacity including degradation	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	
$R_{services,gen}$	MW	Generator rating	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	Only for intra-daily electricity storage
$R_{services,var}$	Mvar	Reactive power rating	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	Only for intra-daily electricity

Data / Para-meter	Data unit	Description	Source of data	Measur e-ment method s and proce-dures	Moni-toring fre-quency	QA/QC proce-dures	Respo n-sibility for col-lection and archi-ving	Comme nt
								storage; set to 0 if not applicable
$R_{services,Inert}$	GVAs	Inertia capability rating	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	Only for intra-daily electricity storage; set to 0 if not applicable
η	%	Input-output efficiency including storage losses	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	To be derived from stock, input and output
$E_{in,x}$	TJ	Energy used by the project of type *x*	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	Hourly data required for knowledge sharing purposes
$E_{transport}$	TJ	Electricity supplied for the use in non-rail vehicles	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	[to be informed by appli-cants]	For cars, an average travel distance of 14,300 km/year should be assumed. For other types of vehicles, individual data

Data / Para-meter	Data unit	Description	Source of data	Measur e-ment method s and proce-dures	Moni-toring fre-quency	QA/QC proce-dures	Respo n-sibility for col-lection and archi-ving	Comme nt
								and data source should be provided .
$E_{out,x}$	TJ	Energy supplied by the project of type *x*	[to be informe d by appli-cants]	[to be informed by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	Hourly data required for knowled ge sharing purposes
$T_{services,a}$	h	Duration of delivery of service a by the project	[to be informe d by appli-cants]	[to be informed by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	
$E_{stat,x}$	TJ	Energy of type *x* used in stationary sources (except in the energy storage units) at the project site	[to be informe d by appli-cants]	[to be informed by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	
$E_{mob,x}$	TJ	Energy of type *x* used in mobile sources at the project site	[to be informe d by appli-cants]	[to be informed by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	
$M_{fug,z}$	tonn es	Amount of the fugitive emissions of greenhouse gas z at the project site	[to be informe d by appli-cants]	[to be informed by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	[to be informe d by appli-cants]	All six types of GHGs from the Kyoto basket to be included

In addition to the parameters listed above, the following parameters will be monitored and reported for **knowledge sharing purposes** where applicable:

- Energy consumed and supplied by each energy storage unit individually metered (per annum).

- Hourly profiles for use and feed-in of grid electricity aggregated on the level of grid zones.
- Hourly profiles for generation of electricity delivered to the project from PPAs by grid zone.
- Hourly profiles for avoided curtailment based on final physical notifications of co-located RES plants or grid operator instructions.
- Hourly profiles for provided system services by grid zone.
- Reliability expressed according to reliability indicators such as Energy Not Supplied by grid zone.
- Improvement in voltage variation in the grid and length of voltage variation attributable to the Project versus reference system by grid zone.
- Total Loss of Power, Restoration Time, Equivalent Time of Interruption by grid zone.
- High-level mapping of environmental impacts and mitigation measures.
- High-level risk screening and mitigation measures.

Appendix C1 Classification of projects into sectors

CATEGORY	SECTOR	PRODUCTS
Energy storage incl. manufacturing plants for components	Intra-day electricity storage	electricity
	Other energy storage	electricity
		heating/cooling
		e-fuels
		hydrogen
Renewable energy incl. manufacturing plants for components	Wind energy	electricity
	Solar energy	electricity
	Hydro/Ocean energy	electricity
	Geothermal energy	electricity, CHP
	Bio-electricity	electricity, CHP
	Renewable Heating/Cooling	heating/cooling
Energy Intensive Industries incl. CCU incl. substitute products incl. CCS (CO2 capture and full chain)	Refineries	fuels (incl. e-fuels)
	Biofuels and bio-refineries	biofuel, bio-based products
	Iron & steel	coke
		iron ore
		iron
		steel
		cast ferrous metals products
		other ferrous metal products or substitute products
	Non-ferrous metals	aluminium
		precious metals
		copper
		other non-ferrous metal
		cast non-ferrous metal products
		other ferrous metal products or substitute products
	Cement & lime	cement
		lime, dolime, sintered dolime
		other cement or lime products or substitute products
	Glass, ceramics & construction material	flat glass
		container glass
		glass fibres
		other glass products
		tiles, plates, refractory products
		bricks
		houseware, sanitary ware

CATEGORY	SECTOR	PRODUCTS
		other ceramic products
		mineral wool
		gypsum and gypsum products
		other construction materials or substitute products
	Pulp & paper	chemical pulp
		mechanical pulp
		paper and paperboard
		sanitary and tissue paper
		other paper products or substitute products
	Chemicals	organic basic chemicals
		inorganic basic chemicals
		nitrogen compounds
		plastics in primary forms
		synthetic rubber
		other chemical products or substitute products
	Hydrogen	hydrogen
	Other	electricity
		heat
		other
CCS (CO2 Transport and Storage)	CO2 Transport and Storage	CO2 Transport and Storage

Notes:
Categories: those are derived from the legal basis – Article 10(a) of the EU ETS Directive. They also help applicants choose the right methodology section for calculations of the GHG emission avoidance. All CCS projects follow the methodology in the section Carbon capture and storage irrespective if they fall in the Energy Intensive Industry category or not.
Sectors: are derived from the sectors listed in Annex I of the EU ETS Directive, the type of renewable energy source or energy storage. For Carbon capture and storage and Energy intensive industries, a sector is defined by its products, i.e. there is a unique relationship between a product and the corresponding sector. This list helps the applicant to choose the sector for the purpose of the GHG emission avoidance calculations.
Products: The list of products given for each sector are non-exclusive and most give 'other products [specified to sector]' as an option. There are a few exceptions to this rule:

- The only product of the sector 'hydrogen' is hydrogen
- 'Biofuels and bio-refineries' are defined separately from 'Refineries'. The former covers biologically based products, while the latter accounts for all other activities that lead to the production of fuels, except hydrogen. The generic product 'fuels (incl. e-fuels)' shows that diverse products (and related technologies) are covered here.
- The sector 'Glass, ceramics & construction material' is a combination of the EU ETS sectors 'Glass and ceramics', 'Mineral wool' and 'Gypsum'.
- 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. The sector also covers all other combustion for industrial purposes, which falls under the EU ETS if the thermal heat input exceeds 20MW. 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.

- The list of products in renewable energy is exclusive, which means that projects generating heat outside of 'Geothermal energy' and 'Bio-electricity' are combined in the separate sector 'Renewable Heating/Cooling'. 'Wind energy', 'Solar energy' and 'Hydro/Ocean energy' are associated with electricity as exclusive product.
- 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.

Appendix C2 Definitions[21]

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

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

(12) '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.

(13) 'calculation factors' means net calorific value, emission factor, preliminary 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 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 a 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

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

power projects. The existing power plants/units in the case of capacity addition continue to operate after the implementation of the project activity.

(16) 'CO2 capture' means the activity of capturing from gas streams CO2 that would otherwise be emitted.

(17) 'CO2 transport' means the transport of CO2 for use or storage.

(18) 'CO2e' means any greenhouse gas, other than CO2, listed in Annex II to Directive 2003/87/EC with an equivalent global-warming potential as CO2.

(19) 'combustion emissions' means greenhouse gas emissions occurring during the exothermic reaction of a fuel with oxygen.

(20) '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.

(21) '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.

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

(23) 'emissions intensity' is also known, for transport fuels, as *well-to-wheels* emissions: it comprises not only combustion emissions, but also all the GHG emissions from the supply chain that supplies the product: extraction of raw materials, all steps in the processing, transport and distribution.

(24) '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.

(25) '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 characterized 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.

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

(27) '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.[22] The relevant benchmarks are those applicable at the time of submission of the application whether at first or second stage.

(28) '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)

[22] 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 10a of Directive 2003/87/EC of the European Parliament and of the Council

at progressively lower pressures and temperatures, to obtain more steam. Flash steam geothermal plants are categorised as open cycle technology.

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

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

(31) 'generator rating' means the 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.

(32) 'geological storage of CO2' means geological storage of CO2 as defined in Article 3(1) of Directive 2009/31/EC.

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

(34) '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.

(35) '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 provide at nominal conditions. The inertia capability of an energy storage plant is the sum of the inertia capabilities of its energy storage units.

(36) '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.

(37) '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.

(38) '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.

(39) '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

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

(41) '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.

(42) 'modification' see 'retrofit'

(43) '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.

(44) '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

(45) '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

(46) "plant" in the case of energy intensive industries is any of the installations in the "processing" box. Those are defined as all installations under the control of the applicant that will be changed by the project, compared to the reference scenario.

(47) '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.

(48) '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.

(49) '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.

(50) '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 lants/units.

(51) '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.

(52) '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.

(53) '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. A retrofit restores the installed production capacity to or above its original level. Retrofits include measures that involve capital investments and not regular maintenance or housekeeping measures.

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

(55) '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.

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

(57) 'tonnes of CO2e' means metric tonnes of CO2 or CO2e.

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

(59) 'substitution' see 'replacement'

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

(61) '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.