Climate impact assessment Guidance: Mitigation

**Version 1.1**

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Eva Keller1, Francisco Koch2, Dr. Rainer Zah3

1Climate-KIC, Hochstrasse 60, 8044 Zurich, Switzerland

2South Pole Group, Technoparkstrasse 1, 8005 Zurich, Switzerland

3Quantis, Reitergasse 15, 8004 Zurich, Switzerland

**www.**[**climate-kic.org**](http://www.eit.europa.eu)

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# 1. Introduction

The following is a technical guidance for Climate-KIC project proponents to conduct the climate impact assessment for mitigation projects. It seeks to assist Climate-KIC project proponents to estimate the potential climate impact of their Climate-KIC project in terms of mitigating greenhouse gas (GHG) emissions. Both qualitative and quantitative aspects are considered. In addition, case studies are given to demonstrate how this guidance can be used to assess different types of innovation projects.

The climate impact assessment guidance draws upon methodologies from the Greenhouse Gas Protocol as well as other internationally accepted standards. While the qualitative assessment considers a narrative description of the potential climate impact, the quantitative term is conducted by the following approach:

*Climate Impact = Climate Relevance x Scalability*

*Climate relevance* refers to a single product or service and is referred to as the climate impact of a given *functional unit.* *Scalability* considers the market that project proponent address when implementing its project, in other words, the number of functional units achieved given the temporal and spatial boundaries of the Climate-KIC project. The potential *climate impact* is the total GHG emission reductions you can potentially achieve by scaling up the climate relevance (GHG emission reductions per functional unit) with the scalability (addressable market).

The project’s potential climate impact will be judged not only on climate relevance and scalability but also on the validity of the approach, the quality of the assumptions and therefore the likelihood of the climate impact assessment.

When can these guidelines be omitted?

If a Climate-KIC project is

1. already approved for generating certified emission reduction credits by an internationally recognized third party, or
2. if estimates for GHG emissions reductions are provided compared to a baseline scenario in accordance with ISO 14044 (Life Cycle Assessment) or ISO 14067 (Carbon Foot printing), or
3. if a climate impact assessment has been done following one of the official methodologies listed in ANNEX II or a comparable methodology with same relevance.

In such cases, the Climate-KIC project proponent does not need to carry out the climate impact assessment indicated in the present guidance. Instead, the alternative assessment following one of the above three points has to be submitted.

# 2. Key concepts and definitions

The following concepts are key for understanding the steps that need to be followed to perform the climate impact assessment.

## 2.1 Mitigation

Mitigation implies GHG reductions, brought about either by a reduction in GHG emission into the atmosphere or absorption of GHG emission from the atmosphere. GHG emission reductions can include a reduction on currently emitted emissions, or a reduction in emissions brought about by the project compared with a credible business-as-usual alternative, or the sequestration of emissions currently in the atmosphere.

## 2.2 Life Cycle Thinking

This guidance follows the principles of Life Cycle Thinking considering the entire lifecycle of a product or service, from raw material extraction and acquisition, through material production and manufacturing, to use and end of life treatment and final disposal. By taking such a life cycle perspective, the full climate impact of a product or service can be captured (reg. Fig.1). Life Cycle Thinking therefore helps identifying not only the GHG emissions resulting from the use of your product, but also those GHG emissions associated with resources extracted, materials processed, manufacturing of the product, its distribution, and final disposal once it has reached the end of its useful life, as shown in Figure 1. Life Cycle Thinking can however also be applied on services and enabling projects. In this case you need to think, which materials, products and processes are needed to deliver your service. In general, enabling projects lead to highest GHG emission reductions in the use phase.



Figure - The full life-cycle, Source: www.hydroquebec.com

## 2.3 Project types

All Climate-KIC projects seek to develop and implement products, processes, technologies, services and tools that can be taken up by the market by significantly reducing GHG emissions. When applying this guidance, make certain you first identify which type of project for project fits into.

“Technological Solution” project (Solution)

These types of projects develop concrete innovative GHG mitigation solutions such as: technologies, products, materials, businesses/services that lead to direct GHG emissions reductions when implemented.

Examples of solution projects and their outcomes:

|  |  |
| --- | --- |
| **Project** | **Outcomes** |
| Low-cost small-scale gas conversion device to be installed on farms<http://www.climate-kic.org/projects/biogas-energising-the-countryside/> | GHG emission reductions through decreased energy consumption from non-renewable sources by increasing decentralized access to sustainable energy |
| Building construction material made out of timber <http://bta.climate-kic.org/innovation_projects/woodenfacade/> | GHG emission reduction by replacing carbon intensive building material (concrete) with low-carbon building material (timber) |
| Additional examples of these types of projects can be found on the Climate-KIC webpage <http://www.climate-kic.org/projects/> |

“Enabling the Transition” project (Enabling)

These projects don’t reduce GHG emissions directly when implemented, but enable decisions, which result in the implementation of GHG emission reduction measures, such as the purchase and installation of a more efficient technology, use of less carbon intensive materials, etc. Therefore, when assessing the GHG mitigation of these type of Climate-KIC projects, the focus of the assessment is on the actual mitigation measures that they enable. Typical GHG emission reductions of enabling projects result from reduced energy consumption, reduced travel distances or reduced or eliminated materials used.

Examples of enabling projects and their outcomes:

|  |  |
| --- | --- |
| **Project** | **Outcomes** |
| Business models that generate demand for renewable energy technologies by end users<http://www.climate-kic.org/projects/employer-led-co%E2%82%82and-energy-reductions-by-employees/> | GHG emission reductions through higher demand/cost reduction of renewable technologies |
| Smart sensors that help manage energy at home | GHG emission reductions through less energy consumption due to improved energy control settings |
| Intelligent simulation system for cities to model GHG emissions and energy consumption of buildings and to design the energy transition <http://www.accentproject.com/> | GHG emission reductions through less energy consumption due to improved energy control settings, policy implementation, behavior changes |
| Additional examples of these types of projects can be found on the Climate-KIC webpage <http://www.climate-kic.org/projects/> |

## 2.4 Project scope

The project scope defines the area in which the Climate-KIC project is planned to be implemented, the purpose of the Climate-KIC project, as well as the potential climate impact resulting from the implementation of the Climate-KIC project.

Geographic area

It describes the geographical area or region in which the Climate-KIC project is planned to be implemented. This is of importance since potential climate impact is not only dependent on the type of Climate-KIC project but also on the area, geographic region within which the Climate-KIC project should be implemented.

A typical example is the potential climate impact of e-scooters. The potential climate impact of e-scooter is higher in geographic areas, where electricity is produced out of low carbon energy sources (e.g. water) instead of carbon intensive energy sources (e.g. coal).

Functional unit

The Functional unit (FU) defines the function/performance your Climate-KIC project is delivering to its user. It is a measure of the function of the studied project and it provides a reference to which the GHG emission producing inputs and outputs can be related. It is a key element of the climate impact assessment since it enables comparison of two different scenarios with the same function and estimation of the potential climate impact.

Examples for Functional Units are:

|  |  |
| --- | --- |
| **Product/Service** | **Functional Unit** |
| Energy efficient coffee machine | The coffee demand (in litres of coffee) of an average single coffee drinker during one year |
| Web-based smart logistics software/Eco-driving software solution | Fuel consumption of an average vehicle fleet with an average freight volume over a specific course in a defined geographic of an average transport company during one year |
| Highly efficient wind turbine | Quantity of electricity delivered to the grid by one wind turbine over one year |
| Climate friendly building material | Volume or area of building material required for an average single house with a certain living space in a specific geographic area |
| Home energy monitoring kit | Energy consumption demand of an average six-bedroom home in a certain geographic area over one year |
| Telecommuting system implementation | An average working environment of a typical office employee given the required working hours |

Temporal boundary

The temporal boundary describes the timeframe over which the potential climate impact of the Climate-KIC project is assessed.

For the Climate-KIC climate impact assessment, the temporal boundary is fixed to:

**“one average year of project implementation”**

Baseline scenario

In order to assess the potential climate impact, the Climate-KIC project being studied needs to be compared to a certain baseline. The baseline scenario describes what you think would happen if the outcomes of your project were not implemented and for which the GHG emissions have to be assessed.

Examples for Baseline scenarios are:

|  |  |  |
| --- | --- | --- |
| **Product/Service** | **Functional Unit** | **Baseline scenario** |
| Energy efficient coffee machine | Energy consumption from fulfilling the coffee demand (in litres of coffee) of an average single coffee drinker during one year | GHG emissions due to energy consumption from fulfilling the coffee demand (in litres of coffee) of an average single coffee drinker during one year |
| Web-based smart logistics software/Eco-driving software solution | Fuel consumption of an average vehicle fleet with an average freight volume over a specific course in a defined geographic area of an average transport company during one year | GHG emissions due to the fuel consumption of an average vehicle fleet with an average freight volume over a specific course of in a defined geographic area of an average transport company during one year |
| Highly efficient wind turbine | Quantity of electricity delivered to the grid by one wind turbine over one year | GHG emission due to the quantity of electricity delivered to the grid by an average wind turbine |
| Climate friendly building material | Volume or area of building material required of for an average single house with a certain living space in a specific geographic area | GHG emission due to the volume or area of commonly applied building material (e.g. cement) required to build an average single house. |
| Home energy monitoring kit | Energy demand of an average six-bedroom home in a certain geographic area over one year | GHG emissions due to energy demand of an average six-bedroom home in a certain geographic area over one year. |
| Telecommuting system implementation | An average working environment of a typical office employee given the required working hours with an average energy consumption during one year. | GHG emissions from a business as usual working place of an average office employee during one year. |

Project scenario

The project scenario describes the situation when your proposed Climate-KIC project has been implemented. The GHG emissions that would occur if your Climate-KIC project is implemented to deliver the functional unit are assessed.

Examples of Project scenarios:

|  |  |  |  |
| --- | --- | --- | --- |
| **Product/Service** | **Functional Unit** | **Baseline scenario** | **Project scenario** |
| Energy efficient coffee machine | Energy consumption from fulfilling the coffee demand (in litres of coffee) of an average single coffee drinker during one year | GHG emissions due to energy consumption from fulfilling the coffee demand (in litres of coffee) of an average single coffee drinker during one year | GHG emissions due to energy consumption from fulfilling the coffee demand (in litres of coffee) of an average single coffee drinker during one year |
| Web-based smart logistics software/Eco-driving software solution | Fuel consumption of an average vehicle fleet with an average freight volume over a specific course in a defined geographic area of an average transport company during one year | GHG emissions due to the fuel consumption of an average vehicle fleet with an average freight volume over a specific course of in a defined geographic area of an average transport company during one year | GHG emissions due to the fuel consumption of an average vehicle fleet with an average freight volume over a specific course of in a defined geographic area of an average transport company during one year |
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| Home energy monitoring kit | Energy demand of an average six-bedroom home in a certain geographic area over one year | GHG emissions due to energy demand of an average six-bedroom home in a certain geographic area over one year. | GHG emissions due to energy demand of an average six-bedroom home in a certain geographic area over one year. |
| Telecommuting system implementation | An average working environment of a typical office employee given the required working hours with an average energy consumption during one year. | GHG emissions from a business as usual working place of an average office employee during one year. | GHG emissions from a business as usual working place of an average office employee during one year. |

System boundary

The system boundary of a Climate-KIC project determines what is included in the system and what is left out, respectively which project related processes that lead to direct GHG emissions or enable GHG emission reductions are considered for the climate impact assessment and which not. In other words, it considers life cycle processes of relevant components of the Climate-KIC projects that lead to major GHG emissions.

## 2.5 Climate relevance

In the Climate-KIC climate impact assessment guidance: mitigation, climate relevance is defined as the GHG emission reduction potential per functional unit. This should result in a negative number, the savings of GHG emissions related to the Functional Unit.

**Baseline scenario GHG emissions**

kg

CO2e

/y.

Time

**Project scenario GHG emissions**

**GHG Emissions**

**Reductions**

Climate-KIC mitigation

project start

Figure 2: GHG Emissions reductions determination for any given functional unit

## 2.6 Scalability

Where a single instance of an innovation is considered for the unit impact, scalability refers to the total number of instances where the innovation could be implemented. To provide a common baseline for all projects and to minimise the number of assumptions, scalability is defined as the addressable market in the context of the climate impact assessment: mitigation. The addressable market is a widely-used commercial concept to indicate the potential of an innovation and attempts to identify all prospective customers or users for a given product, service or idea.

## 2.7 Potential climate impact

Potential climate impact is the total GHG emission reduction you can potentially achieve by adding the climate relevance (GHG emission reductions per functional unit) with the scalability (addressable market).

# Climate impact assessment

The climate impact assessment guidance of Climate-KIC is a five step approach to develop a robust estimation of the GHG emission reduction potential of the Climate-KIC project:

* Climate impact story (Narrative)
* Scope definition (Narrative)
* Baseline scenario GHG emissions estimation (Quantitative)
* Project scenario GHG emissions estimation (Quantitative)
* Potential climate impact estimation (Quantitative)

The following figure describes the stepwise approach to be followed, which will in turn be explained in further detail.

Figure 3: Step approach of the climate impact assessment

## 3.1 Step 1 – Describe your project’s climate impact story

The climate impact story for Climate-KIC mitigation projects describes in simple terms how the proposed Climate-KIC project is expected to result in GHG emissions reductions and therefore limit the rate of long-term climate change. The suggested approach is to discuss how the project contributes to the reduction of GHG emissions or alternatively increases the capacity of carbon sinks.

**The climate impact story should include the following information:**

* Description of the specific climate change challenge the project tackles (e.g. global GHG emission hotspot, lack of technologies/solutions to tackle climate change, barriers that hinder reducing the GHG emissions)
* Description of the baseline scenario: What do you consider would happen in the absence of the proposed project (e.g. what is the business-as-usual solution/situation or common practice) and how would it lead to increased GHG emissions in the specific area the project focus
* Description in clear and concise terms of what the project sets out to achieve and how it reduces GHG emissions in the specific area (e.g. does it enable something to be produced in a less carbon intensive manner? Or does it enable services to be provided in a less carbon intensive manner or does it result in the development of tools that allow decisions to be taken that favour the implementation of the lower carbon solutions?)

In order to demonstrate relevance and evidence of the climate impact story, third party documentation shall be used which may include:

* Independent reports (e.g. IPCC report, MACs)
* Market research (e.g. to determine what is business-as-usual solution/situation or common practice in the area which the KIC project targets
* Peer reviewed literature
* Government data
* Other information that the project proponents feel helps substantiate the choice of the most likely baseline scenario

## 3.2 Step 2 - Define Scope

This is a crucial step that is often over-looked, leading to wrong results in the calculation. The scope definition is key for getting the climate impact assessment achieved.

Define implementation area

Define the geographical area or region in which the Climate-KIC project is planned to be implemented. Think about the realistic target market, e.g. new heating system limited to cooler geographic regions. The geographic area or region defined has to be considered when estimating the scalability of the project (Step 5). There is a strong correlation between the scale of adoption, which directly influences the effects.

**Recommendations:**

* Think about what is the intended audience of the Climate-KIC project
* Consider the realistic target market (geographically) for the Climate-KIC project

Define the functional unit (FU)

The FU that describes best the function of your product or service to the user. Three general parameters need to be considered when defining the FU:

(1) the magnitude of the function or service

(2) the duration or service life of that function or service and

(3) the expected level of quality.

Try to deliver the FU in the following format:

FU = (system function) per (unit of calculation)

**Requirements:**

* The FU of your project has to reflect the service/function of your project during ***one year***

**Recommendations:**

For defining your FU of your project, ask yourself the following questions:

* What is the function delivered by your project?
* Why is the product created?
* What purpose does the product serve?
* What defining characteristics or expected level of quality does the product have?

**Example:**

* For the function of drying hands both a paper towel and an air-dryer system are studied. The selected functional unit may be defined for both systems as a pair of hands dried. For each system, it is then possible to determine the reference flow, e.g. the average mass of paper or the average volume of hot air required to dry one pair of hands.
* A home insurance company may define their functional unit as the provision of premium home insurance coverage for one year. The quality of the insurance is specific to the definition of “premium”.

Baseline scenario definition

The project proponent shall describe in qualitative terms the scenario that is believed would exist in the absence of the proposed Climate-KIC project being taken up. Third party documentation should be provided by the project proponent to support assumptions made when defining what is believed to be the most likely baseline scenario. This evidence may include market research, peer reviewed literature, government data, independent reports or other information that the project proponents feels helps substantiate the choice of the most likely baseline scenario.

The baseline scenario often consi*s*ts of either alternative that existed prior to the project being implemented, or, describes a scenario that is believed is likely to occur, anticipating likely changes in the market and/or policy environment (e.g. the introduction of new or more stringent energy performance standards that will already lead to a decrease in the GHG emission intensity during the lifetime of the project). The most feasible baseline scenario has to be considered based on factors like techno-economic feasibility to the specific context, conservative GHG emissions estimate, policy considerations and so on.

**Recommendations:**

It helps, when defining what you consider the most likely baseline scenario to be, to ask yourself the following question:

* “How would the output or service that the Climate-KIC project provides have been otherwise produced or provided?”
* “How would the functional unit defined above been otherwise delivered?”

Define project temporal boundaries

For the Climate-KIC climate impact assessment, the temporal boundary is fixed to:

**one average year of project implementation**

You are advised to consider one year of implementation when defining the FU. This is why you don’t have to set temporal boundaries separately.

Define System boundaries

The system boundaries of the baseline scenario and project scenario should be described. A screening assessment of the relevant effects is conducted to obtain a rough estimate of the changes in emission for each life cycle process. Determine which processes/ components leading to GHG emissions or reducing GHG emissions are relevant for the climate impact assessment and which can be left out. This allows the exclusion of life cycle processes across both the project scenario and the baseline scenario that are insignificant and do not materially affect the study’s conclusions. Identify the processes where the most important material and energy consumption takes place. This requires knowledge about the flows in and out of the product system, including raw resources or materials, energy by type, water, and emissions to air, water and land by specific substance that are involved in producing and disposing of the equipment, products and materials that would have otherwise been produced, used and disposed of in the absence of your innovation. The goal is to compile a list that considers the relevant energy and material flows associated with the functional unit.

**Requirements:**

* Consider the full life cycle stages that are associated with your project: from material extraction, production, logistics, and use, and end-of-life disposal (see Figure 2). Climate-KIC project proponents may elaborate or classify the stages differently to better reflect a specific product’s or service's life cycle.
* List all the process/components and their inputs necessary for the baseline scenario and Climate-KIC project along the life-cycle.
* Consider only the processes/components in your assessment where the GHG emissions from your project and the baseline scenario (see step 3) are different.
* Neglect all processes/subsystems which are the same in both scenarios
* Only consider processes that seem relevant for the climate impact assessment and where you can clearly declare why the neglected processes are irrelevant

**Recommendations:**

In order to facilitate this exercise, it is recommended that you follow the corresponding process diagram in the template for your baseline and project scenario, highlighting the process where the most significant sources of emissions are expected. This will help you understand the process life cycle and single out the GHG sources of emissions that you need to account for in your assessment.

1. Identify the defined life cycle stages that are assumed to be relevant to your project
2. Identify the inputs and steps necessary to create and transport the finished product or service, aligning the processes with the appropriate life cycle stage
3. Identify the energy and material associated with the processes



Figure 4 - Schematic illustration of the process of system boundary definition for baseline and project scenario.

***Material acquisition & pre-processing***

The material acquisition and pre-processing stage starts when resources are extracted from nature and ends when the product components enter the gate of production facility. Think about the materials that is required to produce the proposed product or deliver the service.

Example:

* Type and amount of raw materials needed for producing a new type of insulation material

***Production***

The production stage starts when the product components enter the production site of the studied product or service and ends when the finished product/service leaves the production gate.

Examples:

* Manufacturing of the insulation material
* Preparation for distribution
* Treatment of waste created during the production of the insulation material

***Distribution and storage***

The product distribution and storage stage starts when the finished product leaves the gate of the production facility and ends when the consumer takes possession of the product.

Examples:

* Distribution centre or retail location operations
* Shipping transportation of the insulation material

***Use stage***

The use stage begins when the consumer takes possession of the product or the service is implemented and ends when the product is discarded for transport to a waste treatment location after the lifespan. The type and duration of attributable processes in the use stage depends heavily on the function and service life of the product. For products that consume energy to fulfil their function or that enable a service, attributable processes in the use stage and their corresponding emissions may account for the largest fraction of impacts over the complete life cycle.

Examples:

* Living in the newly insulated house: power and heat consumption, maintenance activities
* Having installed the Smart Meter: energy consumption of the Smart Meter and energy consumption of the household in general

***End-of-life***

The end-of-life stage begins when the used product is discharged by the consumer and ends when the product is returned to nature (e.g. incinerated) or allocated to another products life cycle (e.g. recycling).

Examples:

* Waste management
* Dismantling of components
* Shredding and sorting
* Incineration and sorting of bottom ash
* Land filling and landfill maintenance

For an enabling project, the production and use stage may be combined into the service delivery stage. This stage encompasses all operations required to complete a service. For example, for home appliance repair, attributable processes may include driving to the home, assessing the appliance, ordering or picking up parts, and returning to complete the final repair. All material flows (e.g. parts needed of the repair), energy flows (e.g. fuel to deliver the service person and/or parts), and end-of-life considerations of material and wastes make up the attributable processes along the service life cycle.

## 3.3 Step 3 - Baseline scenario GHG emissions estimation

Once the baseline scenario has been described and the relevant processes/components leading to GHG emissions have been defined, the next step is to estimate the baseline GHG emissions to deliver the functional unit.



Figure 5 - Schematic illustration of the process of baseline scenario GHG emission estimation

To do so, the materials and energy consumption for each phase of the baseline scenario’s life cycle will be quantified. For example, in the prior step the proponent identified that manufacturing a product may burn a known volume of natural gas. Now, the GHG emissions from the combustion of this gas would be calculated.

**Recommendations:**

1. Look for a CO2-emission factor (EF) that fit to your processes (see ANNEX II for more information)
2. Multiply the EF by the amount of material or fuel that would be needed to deliver the process
3. Relate the GHG emissions to your functional unit
4. Summarize all the GHG emissions of each process to the total climate impact of the baseline scenario

In cases where you can’t find a relevant EF in the provided database, the assessment includes interdependent, economy-wide impacts or where data availability is scarce, assumptions based on literature might be necessary. Otherwise please contact climate-accounting@climate-kic.org.

## 3.4 Step 4 – Project scenario GHG emissions estimation

Once the project scenario has been described and the relevant processes/components leading to GHG emissions have been defined, the next step is to estimate the project GHG emissions to deliver the functional unit.



Figure 6 - Schematic illustration of the process of project scenario GHG emission estimation

To do so, the materials and energy consumption for each phase of the baseline scenario’s life cycle will be quantified. For example, in the prior step the proponent identified that manufacturing a product may burn a known volume of natural gas. Now, the GHG emissions from the combustion of this gas would be calculated.

**Recommendations:**

1. Look for a CO2-emission factor (EF) that fit to your processes (see ANNEX II for more information)
2. Multiply the EF by the amount of material or fuel that would be needed to deliver the process
3. Relate the GHG emissions to your functional unit
4. Summarize all the GHG emissions of each process to the total climate impact of the baseline scenario

In cases where you can’t find a relevant EF in the provided database, the assessment includes interdependent, economy-wide impacts or where data availability is scarce, assumptions based on literature might be necessary. Otherwise please contact climate-accounting@climate-kic.org.

## 3.5 Step 5 – Potential climate impact estimation

Climate relevance assessment

This forms the last step and is the step that should lead to a final estimation of GHG emissions that can be saved by the proponent’s project - the so-called climate relevance. This step is a simple subtraction of the estimated GHG emissions of baseline and project scenario, to calculate the total amount of GHG emissions that can be saved per functional unit (FU). The total GHG emissions reductions are determined by the difference between the lifecycle baseline emissions and the project’s life cycle emissions, that are associated with delivering a given Functional Unit (e.g. driving 1 Km in Switzerland, generating 1 MW of electricity, producing one ton of tomatoes), as visualized in Fig. 7.



Figure 7 - Schematic illustration of the process of climate relevance estimation

Scalability assessment

Scalability indicates the total climate and economic impact that an innovation may potentially deliver and therefore the significance of the innovation. To provide a common baseline for all projects and to minimise the number of assumptions, scalability should only be identified in terms of the addressable market. The addressable market is a widely-used commercial concept to indicate the potential of an innovation and attempts to identify all prospective customers or users for a given product, service or idea. At this stage, applications do not need to consider the reachable market, serviceable market or market-share. For non-commercial outcomes the equivalent of addressable market should be used with clear justifications for the conditions and assumptions utilised. For example, if a city mobility innovation only becomes effective with certain transport topography, only those cities with that topography can be considered as the addressable market.

**Requirements:**

* For evidence, use third party studies to explain and justify the defined addressable market

**Recommendations:**

* Consider the project region, baseline scenario and lifetime of your project when considering the addressable market

## Final Remarks

Please ensure that you are using the template (see ANNEX I) for completing the climate impact assessment.

## Further Information and Support

For further support or any further questions, please contact the Climate Accounting team of Climate-KIC via [climate.accounting@climate-kic.org](http:///h).

# ANNEX

# Annex I: Template

Climate impact assessment template: Mitigation

**Version 1.1**

Project Name:

Submitted by:

Date:

Step 1 - Describe your project’s climate impact story

*Please convey the climate impact story of your project using a short summary (max. 2,000 characters, with spaces).*

|  |
| --- |
| - |

Step 2 - Define Scope

**Geographic area**

*Please define the geographical area or region, in which the Climate-KIC project is planned to be implemented.*

|  |
| --- |
| … |

**Functional unit (FU)**

|  |
| --- |
| … |

*Please define the functional unit that best reflects what the Climate-KIC project is aimed to do.*

**Baseline scenario definition**

*Describe in qualitative terms the scenario related to the defined FU that is believed to exist in the absence of the proposed Climate-KIC project.*

|  |
| --- |
| …Notes/sources:… |

**Project scenario definition**

*Describe in qualitative terms the scenario related to the defined FU that is believed to exist when the proposed Climate-KIC project is implemented.*

|  |
| --- |
| …Notes/Sources:… |

*Describe in quantitative terms the lifetime of your proposed Climate-KIC project.*

|  |
| --- |
| … |

**Define System boundaries**

*Describe the system boundary of the baseline scenario and project scenario. Determine which processes/components leading to GHG emissions or reducing GHG emissions are included in the system of the project/service and what is left out.*

|  |  |
| --- | --- |
| **Baseline scenario** | **Project scenario** |
| Material acquisition & pre-processing | Material acquisition & pre-processing |
| - | - |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:*- |
| **Production** | **Production** |
| *-* | - |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:*- |
| **Distribution & storage** | **Distribution & storage** |
| *-* | - |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:* |
| **Use** | **Use** |
| - | - |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:*- |
| **End-of-Life** | **End-of-Life** |
| - | - |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:**-* |

Step 3 - Baseline scenario GHG emissions estimation

*Calculate the expected GHG emissions for each life-cycle step of the baseline scenario.*

|  |
| --- |
| **Material acquisition & pre-processing** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - |  |
| Total GHG emissions per functional unit/y: |  |
| *Sources/Notes:* |
| **Production** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - |  |
| Total GHG emissions per functional unit/y: |  |
| *Sources/Notes:* |
| **Distribution & storage** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - |  |
| Total GHG emissions per functional unit/y: |  |
| *Sources/Notes:* |
| **Use** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - |  |
| Total GHG emissions per functional unit/y: |  |
| *Sources/Notes:* |
| **End-of-life** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - |  |
| Total GHG emissions per functional unit/y: |  |
| *Sources/Notes:* |

|  |  |
| --- | --- |
| **Total GHG emissions baseline scenario** | **GHG emissions in kgCO2-eq** |
| Total GHG emissions baseline scenario per functional unit/y: |  |

Step 4 - Project scenario GHG emissions estimation

*Calculate the expected GHG emissions for each life-cycle step of the project scenario.*

|  |
| --- |
| **Material acquisition & pre-processing** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| … | *-* |
| Total GHG emissions per functional unit/y: | *-* |
| *Sources/Notes:* |
| **Production** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| … | - |
| Total GHG emissions per functional unit/y: | - |
| *Sources/Notes:* |
| **Distribution & storage** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| … | - |
| Total GHG emissions per functional unit/y: | - |
| *Sources/Notes:* |
| **Use** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| … | - |
| Total GHG emissions per functional unit/y: | - |
| *Sources/Notes:* |
| **End-of-life** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| … | - |
| Total GHG emissions per functional unit/y: | - |
| *Sources/Notes:* |

|  |  |
| --- | --- |
| **Total GHG emissions project scenario** | **GHG emissions in kgCO2-eq** |
| Total GHG emissions project scenario per functional unit/y: | - |

Step 5 - Potential climate impact estimation

**Climate relevance**

*Estimate the potential GHG emission reduction of the Climate-KIC project.*

|  |  |
| --- | --- |
| **Total GHG emissions baseline scenario** | **GHG emissions in kgCO2-eq** |
| Total GHG emissions baseline scenario per functional unit/y: | - |

|  |  |
| --- | --- |
| **Total GHG emissions project scenario** | **GHG emissions in kgCO2-eq** |
| Total GHG emissions project scenario per functional unit/y: | - |

|  |  |
| --- | --- |
| **Total GHG emission reductions per functional unit/y** | **GHG emissions in kgCO2-eq** |
| … | - |

**Scalability**

*Estimate the addressable market of the Climate-KIC project considering the geographical area defined in Step 2.*

|  |  |
| --- | --- |
| **Addressable market** | **# of sales units/functional units** |
| … |  |
| *Sources/Notes:* |

# Annex II: Case studies

Climate impact assessment: Mitigation

**Version 1.1**

Project Name: SMART Meter

Submitted by:

Date:

Step 1 - Describe your project’s climate impact story

Please convey the climate impact story of your project using a short summary (max. 2’000 characters, with spaces).

|  |
| --- |
| The buildings sector accounts for about 20% of energy-related direct and indirect GHG emissions globally (IPCC 2014). Most energy-efficiency programs have focused on realizing the potential of technical approaches, and although some initiatives have been launched targeting individual energy usage behavior, the opportunity remains mostly untapped. A breakthrough on the behavioral front, helped by smart controls and social media, could increase penetration of existing energy-efficiency products and practices to the majority of households. Information and communication technologies (ICT) systems offers a major opportunity to reduce emissions from this sector, by 15% in 2020. The Global e-sustainability initiative estimates an overall GHG mitigation potential of 0.28 Gt CO2e for user information in smart grids alone (GeSI 2008).In UK, GHG emissions from buildings accounted for about 37% of total UK GHG emissions in 2012. Total residential GHG emissions increased by 12% to 134 MtCO2 with a rising trend. Overall, there is a need for policy strengthening and consistency across all buildings sectors and policies (Committee on Climate Change 2015). In 2010, the UK Government published the 2050 Pathways Analysis, defining the pathway to reduce the GHG emissions by at least 80% by 2050. One of the key priorities in the buildings sector is increasing the energy efficiency of UKs housing stock. With the SMART Meter Programme, the government aims to install an energy meter in each household giving people far better information about, and control over, their energy consumption than today. This should lead to GHG emissions through reduced energy consumption. Energy suppliers have an obligation to deliver full roll-out by 2020 (HM Government 2013).By observing their consumption patterns, homeowners are able to modify their behaviours to optimize energy use. The SMART Meter includes a meter reader that clips to the home’s electric meter, a wireless hub that compiles usage data to be viewed online and smart plugs that allow remote control of individual appliances. The smart plugs measure how much electricity and energy is consumed by used appliances and allow for remote and automated turn-off. Although the additional information about energy consumption can lead to increased non-peak energy consumption, the kits would enable home owners to reduce their overall energy consumption and GHG emissions by a significant amount.Resources:IPCC, 2014: Summary for Policymakers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USAGESI (2008): SMART 2020: Enabling the low carbon economy in the information age, The Climate Group. <http://www.smart2020.org/_assets/files/02_smart2020Report.pdf>Hm Government (2013): The Carbon Plan - reducing greenhouse gas emissions, Department of Energy & Climate Change, UK, <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/47621/1358-the-carbon-plan.pdf>Committee on Climate Change (2015): Reducing emissions and preparing for climate change: 2015 Progress Report to Parliament. https://www.theccc.org.uk/wp-content/uploads/2013/06/CCC-Prog-Rep\_Chap3\_singles\_web\_1.pdf |

Step 2 - Define Scope

**Geographic area**

*Please define the geographical area or region, in which the Climate-KIC project is planned to be implemented.*

|  |
| --- |
| Our target geographic area is United Kingdom |

**Functional unit (FU)**

*Please define the functional unit that best reflects what the Climate-KIC project is aimed to do.*

|  |
| --- |
| The SMART Meter should support covering the energy demand of a single household in UK within one year in an efficient way. The functional unit has been defined as:“Energy consumption of an average single household within UK within one year” |

**Baseline scenario definition**

*Describe in qualitative terms the scenario related to the defined FU that is believed to exist in the absence of the proposed Climate-KIC project.*

|  |
| --- |
| It is assumed that in absence of the SMART Meter, the average GHG emissions from the energy consumption of an average UK households would remain or slightly increase. A small-scale case study has been conducted in order to measure the energy consumption reduction compared to the business as usual scenario. The climate impact assessment will be done for two cases (see notes). Case A) As a baseline scenario, the business-as-usual situation has been taken:“Total GHG emissions from the energy consumption of the single home in UK (test object for the case study) within one year”Case B)As a baseline scenario, the business-as-usual situation has been taken:“Total GHG emissions from the energy consumption of an average household in UK without a SMART Meter within one year”*Notes/sources:*Case A): A small-scale pilot study to assess the impact of the kit on home energy use has been conducted in UK. It observed the electricity consumption for a single home in UK over the course of 15 months. Energy consumption has been measured before and after the SMART meter installation (see attached case study). |

**Project scenario definition**

*Describe in qualitative terms the scenario related to the defined FU that is believed to exist when the proposed Climate-KIC project is implemented.*

|  |
| --- |
| It is assumed that with the implementation of the SMART Meter, the GHG emissions due to reduced energy consumption will decrease.As a project scenario, following has been defined:Case A)“Total GHG emissions from the energy consumption of a single home (test object for the case study) in UK reduced by 65% due to the installation of the SMART Meter within one year.”Case B)“Total GHG emissions from the energy consumption of an average household in the UK reduced by 15% due to the installation of the SMART Meter within one year.”*Notes/Sources:*Case A): (see case study attached)Case B) SMART 2020 report predicts that through ICT global GHG emissions can be reduced by 7.8Gt CO2e by 2020 (from an assumed total of 51.9Gt CO2e if remain on the current situation). The ICT sector has a powerful role to play in tackling climate change by enabling others and one of the sector is buildings, to become more efficient. The GHG emission reductions, which can be achieved with ICTs is five times more than the GHG emissions emitted by the ICT.International case studies have shown energy consumption reductions between 6-30% after implementing SMART Meters. For the Climate-KIC climate impact assessment, a conservative energy consumption reduction potential of 15% has been taken. https://www.ethz.ch/content/dam/ethz/special-interest/mtec/sustainability-and-technology/PDFs/SER\_Final\_report.pdf<http://www.dena.de/fileadmin/user_upload/Publikationen/Energiesysteme/Dokumente/140709_dena-Smart-Meter-Studie_Endbericht_final.pdf><http://english.rvo.nl/sites/default/files/2014/06/Dutch%20Smart%20Meter%20Energy%20savings%20Monitor%20final%20version.pdf> |

*Describe in quantitative terms the lifetime of your proposed Climate-KIC project.*

|  |
| --- |
| Lifetime of the SMART Meter: 10 years |

**Define System boundaries**

*Describe the system boundary of the baseline scenario and project scenario. Determine which processes/components leading to GHG emissions or reducing GHG emissions are included in the system of the project/service and what is left out.*

|  |  |
| --- | --- |
| **Baseline scenario** | **Project scenario** |
| Material acquisition & pre-processing | Material acquisition & pre-processing |
| - | SMART MeterGHG emission from material acquisition required for production of the SMART Meter components |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:*- |
| **Production** | **Production** |
| *-* | SMART MeterGHG emissions from the production of the SMART Meter components |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:*- |
| **Distribution & storage** | **Distribution & storage** |
| *-* | - |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:*GHG emissions from transport of SMART Meter are assumed to be less than 5% of the total GHG emissions of the product which is why they are negligible. |
| **Use** | **Use** |
| HouseholdGHG emissions from the energy consumption of a single household in UK without a SMART Meter | SMART MeterGHG emissions from the energy consumption of the SMART MeterHouseholdGHG emissions from the energy consumption of a single household in UK due to using a SMART Meter |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:*- |
| **End-of-Life** | **End-of-Life** |
| None | SMART MeterGHG emissions from SMART Meter recycling |
| *Please list the processes/components that are not relevant for the climate impact assessment and describe the reason why here:* |

Step 3 - Baseline scenario GHG emissions estimation

*Calculate the expected GHG emissions for each life-cycle step of the baseline scenario.*

|  |
| --- |
| **Material acquisition & pre-processing** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - |  |
| Total GHG emissions per functional unit/y: |  |
| *Sources/Notes:* |
| **Production** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - |  |
| Total GHG emissions per functional unit/y: |  |
| *Sources/Notes:*  |
| **Distribution & storage** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - |  |
| Total GHG emissions per functional unit/y: |  |
| *Sources/Notes:* |
| **Use** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| Case A)Energy consumption six-bedroom house:Electricity: 3’911.9 kWh/yEmission factor UK-electricity mix: 0.69 kg CO2-eq/kWhGas consumption: 11’735.7 kWh/yEmission Factor: Natural gas UK: 0.07 kg CO2-eq/MJTotal energy consumption: 15’647.55 kWh/yCase B)Average energy consumption average household in UK 2014: (includes electricity and gas consumption): Electricity: 4’115 kWh/yEmission factor UK-electricity mix: 0.69 kg CO2-eq/kWhGas consumption: 12’404 kWh/yEmission Factor: Natural gas UK: 0.07 kg CO2-eq/MJTotal Energy consumption: 16’519 kWh/y | 2’6993’0715'7702'839.43’2466'085.4 |
| Total GHG emissions per functional unit/y:Case A)Case B) | 5'7706'085.4 |
| *Sources/Notes:*Case A)To quantify the GHG emissions of the SMART Meter, a small-scale pilot study to assess the impact of the kit on home energy use has been conducted in UK. It observed the electricity consumption for a single home over the course of 15 months. The household studied was a six-bedroom home with an average energy consumption of 42.87 kWh/day, 15’647.55 kWh/year without having the SMART meter installed.Source Emission Factors: Ecoinvent databaseCase B)The GHG emissions from an average energy consumption of an average household in UK in 2014 has been taken as a baseline scenario.<https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/449134/ECUK_Chapter_3_-_Domestic_factsheet.pdf>Source Emission Factor: Ecoinvent database |
| **End-of-life** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - |  |
| Total GHG emissions per functional unit/y: |  |
| *Sources/Notes:* |

|  |  |
| --- | --- |
| **Total GHG emissions baseline scenario** | **GHG emissions in kgCO2-eq** |
| Total GHG emissions baseline scenario per functional unit/y:Case A)Case B) | 5'7706'085.4 |

Step 4 - Project scenario GHG emissions estimation

*Calculate the expected GHG emissions for each life-cycle step of the project scenario.*

|  |
| --- |
| **Material acquisition & pre-processing** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| SMART Meter:200g electronics (plugs, etc.)Emission factor: Electronics for control units: 26kg CO2-eq/kg400g plastics (plugs, etc.)Emission factor: plastic mix, at plant: 4.5kg CO2-eq/kgLifetime: 10 years | 5.21.8 |
| Total GHG emissions per functional unit/y: | 0.7 |
| *Notes/Sources:*Emission Factor: Ecoinvent database |
| **Production** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - | - |
| Total GHG emissions per functional unit/y: | - |
| *Notes/Sources:*SMART Meter: GHG emissions from production are already included in materials acquisition calculation (Emission Factor) |
| **Distribution & storage** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| - | - |
| Total GHG emissions per functional unit/y: |  |
| *Notes/Sources:* |
| **Use** |
| ***Processes/component*** | ***GHG emissions in kgCO2-eq*** |
| SMART MeterElectricity consumption: 60kWh/yEmission factor UK-electricity mix: 0.69 kg CO2-eq/kWhHousehold:Case A)Average energy consumption six-bedroom house using SMART Meter: Electricity: 1’363.3 kWh/yEmission factor UK-electricity mix: 0.69 kg CO2-eq/kWhGas consumption: 4’089.8 kWh/yEmission Factor: Natural gas UK: 0.07 kg CO2-eq/MJTotal Energy consumption: 5453.1 kWh/yCase B)Estimated reduction of energy consumption of an average household UK using SMART Meter: 15%Electricity consumption: 3’510 kWh/yEmission factor UK-electricity mix: 0.69 kg CO2-eq/kWhGas consumption: 10’530 kWh/yEmission factor natural gas: 0.07 kg CO2-eq/MJTotal Energy consumption: 14’041.2 kWh/y | 41.4940.71’1252’065.72’421.92’5004’921.9 |
| Total GHG emissions per functional unit/y:Case A)Case B) | 2’107.14’963.3 |
| *Notes/Sources*Emission factors: Ecoinvent database |
| **End-of-life** |
| *Processes/component* | *GHG emissions in kgCO2-eq* |
| SMART MeterRecycling, 600g electronics scrap, 400g plastics scrapEmission factor: Electronics scrap from control units/Europe: 1.06kgCO2-eq/kgLifetime: 10 years | 0.6 |
| Total GHG emissions per functional unit/y: | 0.106 |
| *Notes/Sources:*Emission Factor: Ecoinvent database |

|  |  |
| --- | --- |
| **Total GHG emissions project scenario** | **GHG emissions in kgCO2-eq** |
| Total GHG emissions project scenario per functional unit/y:Case A) Case B) | 2'1084'964.1 |

Step 5 - Potential climate impact estimation

**Climate relevance**

*Estimate the potential GHG emission reduction of the Climate-KIC project.*

|  |  |
| --- | --- |
| **Total GHG emissions baseline scenario** | **GHG emissions in kgCO2-eq** |
| Total GHG emissions baseline scenario per functional unit/y:Case A)Case B) | 5'7706'085.4 |

|  |  |
| --- | --- |
| **Total GHG emissions project scenario** | **GHG emissions in kgCO2-eq** |
| Total GHG emissions project scenario per functional unit/y:Case A) Case B) | 2'1084'964.1 |

|  |  |
| --- | --- |
| **Total GHG emission reductions per functional unit/y** | **GHG emissions in kgCO2-eq** |
| Case A) Case B) | 3’6621'121.3 |

**Scalability**

*Estimate the addressable market of the Climate-KIC project considering the geographical area defined in Step 2.*

|  |  |
| --- | --- |
| **Addressable market** | **# of sales units/functional units** |
| # of households in 2016 in UK: 27’735’0001Estimated # of households in 2033 in UK: 31’887’000 (linear increase)1Addressable market size by 2033: 70% of UK households2 | 22’320’900 |
| *Notes/Sources:*1https://www.gov.uk/government/statistical-data-sets/live-tables-on-household-projections2https://www.atkearney.com/sustainability/featured-article/-/asset\_publisher/BqWAk3NLsZIU/content/the-smart-meter-mandate/10192 |

# Annex III: Sources for Emission Factors

Extraction from Ecoinvent database

|  |  |  |
| --- | --- | --- |
| **Materials/components/activity** | **Emission Factor** | **Unit** |
| Concrete, normal, at plant/CH | 261.8386 | kg CO2-eq/m3 |
| Brick, at plant/Europe | 0.23865349 | kg CO2-eq/kg |
| Sawn timber, hardwood, planed, air / kiln dried, u=10%, at plant/Europe | 93.525599 | kg CO2-eq/m3 |
| Sawn timber, softwood, planed, air dried, at plant/Europe | 85.628732 | kg CO2-eq/m3 |
| Three layered laminated board, at plant/Europe | 276.36362 | kg CO2-eq/m3 |
| Alkyd paint, white, 60% in H2O, at plant/Europe | 2.7423375 | kg CO2-eq/kg |
| Alkyd paint, white, 60% in solvent, at plant/Europe | 2.8625118 | kg CO2-eq/kg |
| Steel, converter, chromium steel 18/8, at plant/Europe | 4.4694775 | kg CO2-eq/kg |
| Steel, converter, low-alloyed, at plant/Europe | 2.0600241 | kg CO2-eq/kg |
| Steel, converter, unalloyed, at plant/Europe | 1.6240525 | kg CO2-eq/kg |
| Cast iron, at plant/Europe | 1.4926257 | kg CO2-eq/kg |
| Aluminium, primary, at plant/Europe | 12.049556 | kg CO2-eq/kg |
| Brass, at plant/CH | 2.4564898 | kg CO2-eq/kg |
| Bronze, at plant/CH | 2.7701241 | kg CO2-eq/kg |
| Copper, at regional storage/Europe | 1.8836127 | kg CO2-eq/kg |
| Lead, primary, at plant/Global | 2.125466 | kg CO2-eq/kg |
| Sanitary ceramics, at regional storage/CH | 2.3533165 | kg CO2-eq/kg |
| Foam glass, at plant/Europe | 1.5779056 | kg CO2-eq/kg |
| Glass wool mat, at plant/CH | 1.5046083 | kg CO2-eq/kg |
| Polystyrene foam slab, at plant/Europe | 4.3059923 | kg CO2-eq/kg |
| Rock wool, at plant/CH | 1.0910631 | kg CO2-eq/kg |
| Tube insulation, elastomere, at plant/DE | 4.5114202 | kg CO2-eq/kg |
| Electronics for control units/Europe | 26.058194 | kg CO2-eq/kg |
| Battery, LiIo, rechargeable, prismatic, at plant/Global | 5.8517015 | kg CO2-eq/kg |
| Electronic component, active, unspecified, at plant/Global | 737.29749 | kg CO2-eq/kg |
| Electronic component, passive, unspecified, at plant/Global | 49.340513 | kg CO2-eq/kg |
| Integrated circuit, IC, logic type, at plant/Global | 1014.5338 | kg CO2-eq/kg |
| Integrated circuit, IC, memory type, at plant/Global | 507.84581 | kg CO2-eq/kg |
| Printed wiring board, mixed mounted, unspec., solder mix, at plant/Global | 154.82704 | kg CO2-eq/kg |
| Cable, network cable, category 5, without plugs, at plant/Global | 0.43104562 | kg CO2-eq/m |
| Cable, three-conductor cable, at plant/Global | 2.474186 | kg CO2-eq/m |
| Photovoltaic panel, multi-Si, at plant/Europe | 160.89604 | kg CO2-eq/m2 |
| Photovoltaic panel, ribbon-Si, at plant/Europe | 130.90015 | kg CO2-eq/m2 |
| Photovoltaic panel, single-Si, at plant/Europe | 200.28505 | kg CO2-eq/m2 |
| Photovoltaic panel, a-Si, at plant/US | 74.287004 | kg CO2-eq/m2 |
| Photovoltaic panel, CIS, at plant/DE | 123.73728 | kg CO2-eq/m2 |
| Electricity, low voltage, at grid/CH | 0.14891531 | kg CO2-eq/kWh |
| Electricity, low voltage, at grid/Belgium | 0.36698828 | kg CO2-eq/kWh |
| Electricity, low voltage, at grid/DE | 0.72292705 | kg CO2-eq/kWh |
| Electricity, low voltage, at grid/Denmark | 0.62631499 | kg CO2-eq/kWh |
| Electricity, low voltage, at grid/Spain | 0.59646922 | kg CO2-eq/kWh |
| Electricity, low voltage, at grid/Great Britain | 0.68752186 | kg CO2-eq/kWh |
| Electricity, low voltage, at grid/the Netherlands | 0.72713052 | kg CO2-eq/kWh |
| Electricity, low voltage, at grid/Sweden | 0.10195833 | kg CO2-eq/kWh |
| Electricity, low voltage, production UCTE, at grid/Europe | 0.59665705 | kg CO2-eq/kWh |
| Heat, natural gas, at boiler condensing modulating <100kW/Europe | 0.261701424 | kg CO2-eq/kWh |
| Diesel, burned in building machine/Global | 0.329863392 | kg CO2-eq/kWh |
| Excavation, hydraulic digger/Europe | 0.53156375 | kg CO2-eq/m3 |
| glazing, double (2-IV), U<1.1 W/m2K, at plant/Europe | 31.166 | kg CO2-eq/m2 |
| glazing, triple (3-IV), U<0.5 W/m2K, at plant/Europe | 56.907 | kg CO2-eq/m2 |
| window frame, wood, U=1.5 W/m2K, at plant/Europe | 131.85 | kg CO2-eq/m2 |
| window frame, aluminium, U=1.6 W/m2K, at plant/Europe | 490.81 | kg CO2-eq/m2 |
| window frame, plastic (PVC), U=1.6 W/m2K, at plant/Europe | 246.44 | kg CO2-eq/m2 |
| manufacturing of a gas boiler 10kW/Europe | 380.62 | kg CO2-eq/unit |
| manufacturing of a heat pump 30kW/Europe | 5059.7 | kg CO2-eq/unit |
| electronic component, active, unspecified/Global | 640.75344 | kg CO2-eq/kg |
| electronic component, active, unspecified/Global | 640.7572 | kg CO2-eq/kg |
| electronic component, passive, unspecified/Global | 62.933402 | kg CO2-eq/kg |
| electronic component, passive, unspecified/Global | 62.937157 | kg CO2-eq/kg |
| electronics scrap from control units/Global | 1.0984749 | kg CO2-eq/kg |
| electronics scrap from control units/Europe | 1.0629268 | kg CO2-eq/kg |
| electronics, for control units/Global | 27.61229 | kg CO2-eq/kg |
| electronics, for control units/Europe | 27.608535 | kg CO2-eq/kg |
| transport, passenger car with internal combustion engine/Europe | 0.32235695 | kg CO2-eq/km |
| transport, passenger car, electric/Global | 0.23756228 | kg CO2-eq/km |
| transport, passenger car, EURO 3/Europe | 0.31590479 | kg CO2-eq/km |
| transport, passenger car, EURO 3/Rest of World | 0.36581434 | kg CO2-eq/km |
| transport, passenger car, EURO 4/Europe | 0.3304361 | kg CO2-eq/km |
| transport, passenger car, EURO 4/Rest of World | 0.33042547 | kg CO2-eq/km |
| transport, passenger car, EURO 5/Europe | 0.32274567 | kg CO2-eq/km |
| transport, passenger car, EURO 5/Rest of World | 0.3227264 | kg CO2-eq/km |
| transport, passenger coach/CH | 0.052664945 | kg CO2-eq/person\*km |
| transport, passenger coach/Global | 0.055053546 | kg CO2-eq/person\*km |
| transport, passenger coach/Rest of World | 0.055073821 | kg CO2-eq/person\*km |
| transport, passenger train/Austria | 0.072164805 | kg CO2-eq/person\*km |
| transport, passenger train/Belgium | 0.055989068 | kg CO2-eq/person\*km |
| transport, passenger train/CH | 0.010828959 | kg CO2-eq/person\*km |
| transport, passenger train/CH, regional | 0.016297461 | kg CO2-eq/person\*km |
| transport, passenger train/CH, urban | 0.014099523 | kg CO2-eq/person\*km |
| transport, passenger train/DE | 0.08267112 | kg CO2-eq/person\*km |
| transport, passenger train//DE, high-speed | 0.068924578 | kg CO2-eq/person\*km |
| transport, passenger train//France | 0.02531204 | kg CO2-eq/person\*km |
| transport, passenger train/France, high-speed | 0.022060345 | kg CO2-eq/person\*km |
| transport, passenger train/Global | 0.07620066 | kg CO2-eq/person\*km |
| transport, passenger train/Italy | 0.063269831 | kg CO2-eq/person\*km |
| transport, passenger train/Italy, high-speed | 0.065125566 | kg CO2-eq/person\*km |
| transport, passenger, aircraft/Global | 0.13096796 | kg CO2-eq/person\*km |
| transport, passenger, aircraft/Europe, intercontinental | 0.11142308 | kg CO2-eq/person\*km |
| transport, passenger, aircraft/Europe, intracontinental | 0.17072067 | kg CO2-eq/person\*km |
| transport, passenger, bicycle/Global | 0.012490346 | kg CO2-eq/person\*km |
| transport, passenger, electric bicycle/Global | 0.019655045 | kg CO2-eq/person\*km |
| transport, passenger, electric scooter/Global | 0.055102024 | kg CO2-eq/person\*km |
| transport, passenger, motor scooter/Global | 0.12464932 | kg CO2-eq/person\*km |
| transport, passenger car, EURO 5/Europe | 0.32274567 | kg CO2-eq/km |
| transport, passenger car, EURO 5/Rest of World | 0.3227264 | kg CO2-eq/km |
| transport, passenger coach/CH | 0.052664945 | kg CO2-eq/person\*km |
| transport, passenger coach/Global | 0.055053546 | kg CO2-eq/person\*km |
| transport, passenger coach/Rest of World | 0.055073821 | kg CO2-eq/person\*km |
| transport, passenger train/Austria | 0.072164805 | kg CO2-eq/person\*km |
| transport, passenger train/Belgium | 0.055989068 | kg CO2-eq/person\*km |
| transport, passenger train/CH | 0.010828959 | kg CO2-eq/person\*km |
| transport, passenger train/CH, regional | 0.016297461 | kg CO2-eq/person\*km |
| transport, passenger train/CH, urban | 0.014099523 | kg CO2-eq/person\*km |
| transport, passenger train/DE | 0.08267112 | kg CO2-eq/person\*km |
| transport, passenger train//DE, high-speed | 0.068924578 | kg CO2-eq/person\*km |
| transport, passenger train//France | 0.02531204 | kg CO2-eq/person\*km |
| transport, passenger train/France, high-speed | 0.022060345 | kg CO2-eq/person\*km |
| transport, passenger train/Global | 0.07620066 | kg CO2-eq/person\*km |
| transport, passenger train/Italy | 0.063269831 | kg CO2-eq/person\*km |
| transport, passenger train/Italy, high-speed | 0.065125566 | kg CO2-eq/person\*km |
| transport, passenger, aircraft/Global | 0.13096796 | kg CO2-eq/person\*km |
| transport, passenger, aircraft/Europe, intercontinental | 0.11142308 | kg CO2-eq/person\*km |
| transport, passenger, aircraft/Europe, intracontinental | 0.17072067 | kg CO2-eq/person\*km |
| transport, passenger, bicycle/Global | 0.012490346 | kg CO2-eq/person\*km |
| transport, passenger, electric bicycle/Global | 0.019655045 | kg CO2-eq/person\*km |
| transport, passenger, electric scooter/Global | 0.055102024 | kg CO2-eq/person\*km |
| transport, passenger, motor scooter/Global | 0.12464932 | kg CO2-eq/person\*km |
| transport, passenger, aircraft/Global | 0.13096796 | kg CO2-eq/person\*km |
| transport, passenger, aircraft/Europe, intercontinental | 0.11142308 | kg CO2-eq/person\*km |
| transport, passenger, aircraft/Europe, intracontinental | 0.17072067 | kg CO2-eq/person\*km |

Emission factor databases

|  |  |
| --- | --- |
| Idemat dataset | http://www.ecocostsvalue.com/EVR/model/theory/subject/5-data.html |
| IPCC | http://www.ghgprotocol.org/Third-Party-Databases/IPCC-Emissions-Factor-Database |

# Annex IV: Source Book

Information and Tools to undertake the GHG impact assessment steps.

GHG Emission Reduction Protocols (Mitigation)

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| --- | --- | --- |
| **Scheme/ Program** | **Description / Sector coverage** | **Links** |
| Clean Development Mechanism (CDM)  | Project and Program levelEnergy industries (renewable - / non-renewable sources), Energy distribution, Energy demand, Manufacturing industries, Chemical industry, Construction, Transport, Mining/Mineral production, Metal production, Fugitive emissions from fuels (solid, oil and gas), Fugitive emissions from production and consumption of halocarbons and sulphur hexafluoride, Solvents use, Waste handling and disposal, Afforestation and reforestation, Agriculture  | [http://cdm.unfccc.int/methodologies/index.html](http:///h)  |
| Joint Implementation (JI)  | Same as CDM  | <http://ji.unfccc.int/CritBasMon/index.html>  |
| Verified Carbon Standard (VCS)  | Same as CDM  | <http://v-c-s.org/methodologies/find>  |
| Climate Action Reserve  | Project level; Coal Mine Methane, Forest and Landfill  | [http://www.climateactionreserve.org/how/protocols/](http:///h)  |
| Regional Greenhouse Gas Initiative (RGGI)  | Project level; Landfill methane capture and destruction; Reduction in emissions of sulphur hexafluoride (SF6); Sequestration of carbon due to afforestation; Reduction or avoidance of CO2 emissions from natural gas, oil, or propane end-use combustion due to end-use energy efficiency; avoided methane emissions from agricultural manure management operations  | [http://www.rggi.org/market/offsets](http:///h)  |
| American Carbon Registry (ACR)  | Project level; 6 Kyoto gases, IPCC AR4 gases, WG1 Ch.2 Table 2.14, and ODS listed in Montreal Protocol  | [http://americancarbonregistry.org/carbon-accounting/american-carbon-registry-standard-v2.0/ACR%20Standard%20v2.1%20Oct%202010.pdf](http:///h)  |
| Carbon Farming Initiative  | Project level; Agriculture (livestock, soil carbon, fertilisers, feral animals), vegetation (re-growth, reforestation, avoided clearing and avoided harvest) and landfill and alternative waste treatment (AWT)  | [http://www.climatechange.gov.au/reducing-carbon/carbon-farming-initiative/methodologies](http:///h)  |
| Carbon Fix  | Project level; Forestation  | <http://www.carbonfix.info/CarbonFix-Standard/CarbonFix-Standard-v32.html> <http://www.carbonfix.info/>  |

Life Cycle Assessment (LCA)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Document** | **Purpose** | **Aggregation levels** | **Description / Sector coverage** | **Links** |
| OpenLCA  | GHG emission levels | Prosduct | openLCA is a free, professional Life Cycle Assessment (LCA) and Footprint software with a broad range of features and many available databases.  | [http://www.openlca.org/home](http:///h)  |
| GaBi Software  | GHG emission levels  | Product | Analyses and comparisons of product, process and services according to the ISO standard covering the whole life cycle from the production of raw materials to end of life.  | [http://www.gabi-software.com/uk-ireland/solutions/life-cycle-assessment/](http:///h) |
| European reference Life Cycle Database  | GHG emission levels  | Product | The ELCD (European reference Life Cycle Database) comprises Life Cycle Inventory (LCI) data from front-running EU-level business associations and other sources for key materials, energy carriers, transport, and waste management. | [http://elcd.jrc.ec.europa.eu/ELCD3/](http:///h) |

Intergovernmental Panel on Climate Change

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| **Document** | **Purpose** | **Aggregation levels** | **Description / Sector coverage** | **Links** |
| IPCC Guidelines for National GHG Inventories | GHG emission levels (Inventory)  | National GHG inventories  | Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use, Waste | [http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html](http:///h)  |
| IPCC Good Practice Guidance and Uncertainty Manage-ment in National Greenhouse Gas Inventories  | Inventory Uncertainty Manage-ment  | National GHG inventories  | Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use, Waste | [http://www.ipcc-nggip.iges.or.jp/public/gp/english/](http:///h)  |

WRI/WBCSD GHG Protocol

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Document** | **Purpose** | **Aggregation levels** | **Description / Sector coverage** | **Links** |
| Corporate Accounting and Reporting Standards (Corporate Standard):  | Inventory  | Organizations  | Accounting and reporting of scope 1 (direct) and scope 2 (Indirect: purchased heat, steam, electricity) emissions of the six greenhouse gases covered by the Kyoto Protocol  | [http://www.ghgprotocol.org/standards/corporate-standard](http:///h)  |
| Corporate Value Chain (Scope 3) Accounting and Reporting Standard  | Inventory  | Organizations (including other indirect emissions)  | Allows companies to assess their entire value chain emissions impact and identify the most effective ways to reduce emissions.  | [http://www.ghgprotocol.org/standards/scope-3-standard](http:///h)  |
| Product Life Cycle Accounting and Reporting Standard  | Inventory  | Product | Allows companies to measure the greenhouse gases associated with the full life cycle of products including raw materials, manufacturing, transportation, storage, use and disposal.  | [http://www.ghgprotocol.org/standards/product-standard](http:///h)  |
| Project Accounting Protocol and Guidelines  | GHG emission reductions (Mitigation)  | Project | Policy-neutral accounting tool for quantifying the greenhouse gas benefits of climate change mitigation projects  | [http://www.ghgprotocol.org/standards/project-protocol](http:///h)  |
| Policy and Action Accounting and Reporting Standard  | Mitigation  | Policies  | Policies and actions in any sector (e.g., in the energy supply, residential and commercial buildings, industry, transportation, waste, and AFOLU (agriculture, forestry, and other land use) sectors) as well as cross-sector policy instruments (e.g., emissions trading programs, carbon taxes)  | [http://www.ghgprotocol.org/files/ghgp/GHG%20Protocol%20Policy%20and%20Action%20Standard%20-%20Second%20Draft%20for%20Pilot%20Testing.pdf](http:///h)  |
| Mitigation Goals Accounting and Reporting Standard  | Mitigation  | National and sub-national  | Economy-wide mitigation goals or sectoral goals (in any sector)  | [http://www.ghgprotocol.org/files/ghgp/GHG%20Protocol%20Mitigation%20Goals%20Standard%20-%20Second%20Draft%20for%20Pilot%20Testing.pdf](http:///h)  |

Publicly Available Specification (PAS)

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| **Document** | **Purpose** | **Aggregation levels** | **Description / Sector coverage** | **Links** |
| PAS 2050:2011 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services  | GHG emission levels  | Organization  | Provides specification for quantifying the life cycle greenhouse gas (GHG) emissions of goods and services  | [http://www.ghgprotocol.org/files/ghgp/public/GHG%20Protocol%20PAS%202050%20Factsheet.pdf](http:///h)  |
| PAS 2060:2010 Specification for the demonstration of carbon neutrality  | GHG emission levels and reductions  | Organization  | Specifies requirements to be met by any entity seeking to demonstrate carbon neutrality through the quantification, reduction and offsetting of greenhouse gas (GHG) emissions from a uniquely identified subject  | [http://www.bsigroup.com/en-GB/PAS-2060-Carbon-Neutrality/](http:///h)  |
| Evaluating the carbon reducing impacts of ICT | Assessment methodology for enabling products | Services/products | Methodology proposes a three-step process to evaluate the carbon impact of ICT solutions. It emphasizes streamlining the evaluation process by identifying and assessing the ICT-related impacts | http://gesi.org/files/Reports/Evaluating%20the%20carbon-reducing%20impacts%20of%20ICT\_September2010.pdf |