KfW Development Bank

Materials on Development Finance
Greenhouse Gas Accounting Methodology

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Introduction and Executive Summary

This document outlines and describes the underlying methodology for the greenhouse gas assessment of projects financed by KfW on behalf of the German federal government and other donors including the European Union under Financial Cooperation (FC). The focus of these guidelines lies on establishing calculation principles, metrics, physical boundaries, baselines, timeframes, and input and output data of projects. They provide a framework for estimating ex-ante GHG emissions of FC projects which can be valued and accounted for. The document is directed not only towards KfW staff but also towards auditors, external stakeholders, and other interested parties.

KfW Development Bank introduced systematic GHG assessments in 2009. Project-specific data is reported in project appraisal documents according to the requirements of the funding entity The methodology defines and explains the main GHG assessment concepts used by KfW in Financial Cooperation: **Absolute Emissions** of the financed project**, Emission Reductions, Avoided Emissions**, and **Carbon Removal.** In addition, the respective metrics and calculation process are explained, including the assessment of realistic baseline scenarios.

Given the complexity of FC projects, the document addresses the issue of project boundaries and provides guidance to different boundary scenarios. The methodology clarifies the application of different "scopes" (1, 2 and 3) to define direct and indirect emissions, based on definitions from the GHG Protocol, as well as the timeframe and relevant project phases. The methodology applies for all projects with relevant emissions. With this approach KfW Development Bank aims to capture approximately 95% of all project-related emissions.

The methodology outlined in this document is based on IFI-TWG Common Guidelines. The document's structure and parts of its chapters are based on the European Investment Bank's "EIB Project Carbon Footprint Methodologies" (July 2020). EIB's groundwork is gratefully acknowledged.

Various terms are defined in the Glossary of this document in order to be used consistently throughout the document. Such defined terms are written in capital letters.

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List of abbreviations

AbE	Absolute Emissions
AvE	Avoided Emissions
BaE	Baseline Emissions
BaR	Baseline Removal
BAU	Business as usual
CH4	Methane
CO2	Carbon dioxide
CR	Carbon Removal
DFI	Development Finance Institution
EIB	European Investment Bank
ER	Emission Reductions
FC	Financial Cooperation
FI	Financial Institution
GHG	Greenhouse Gas
GWP	Global warming potential
HFCs	Hydrofluorocarbons
IDFC	International Development Finance Club
IFI	International Financial Institution
IPCC	Intergovernmental Panel on Climate Change
Pop. Eq.	Population equivalent
REDD	Reducing Emissions from Deforestation and forest Degradation
RE	Renewable energy
N2O	Nitrous oxide
NF3	Nitrogen trifluoride
PFCs	Perfluorocarbons
SF6	Sulphur hexafluoride
WpR	“With” Project Removal
WRI	World Resource Institute
WBCSD	World Business Council for Sustainable Development

1 Introduction

This document outlines and describes the underlying methodology for the greenhouse gas assessment of projects implemented by KfW under Financial Cooperation (FC). It provides guidance to staff on how to calculate the project related emissions as well as the reduced, avoided or removed emissions of the projects financed under FC. Intermediated lending and policy financing are included only partially due to the limited information available to carry out a useful calculation for numerous sub-projects or – in the case of policy financing – for unknown end-use of FC funds. There will be separate guidelines for these types of FC operations.

The document also presents how FC calculates the project related emissions and Emission Reductions of its projects for its auditors, external stakeholders and other interested parties. The relevant data is registered on the project’s internal digital Data Sheet and in other project documents.

The GHG assessment can also be an additional criterion for assessing the (de-) merits of a project and choosing between alternatives. GHG assessment has its advantages and limitations, among them:

First, as yet greenhouse gas emissions result from virtually all human and natural activities. For example, even when the best available technologies are used when making cement, paper or steel, inevitably a significant quantity of CO_2 or equivalents are emitted. However, evaluating the merit of a project requires comparing economic costs (including of climate costs) with development benefits, including the costs and benefits in terms of incremental GHG emissions. In short, the assessment of GHG emissions, while an important metric in its own right, should be seen in the context of the overall economic assessment of a project.

Second, the recommended methodologies are assumed to be restricted in scope. The GHG assessment does not purport to be a comprehensive life-cycle analysis of a project, which would go beyond the scope of a pragmatic and reasonably accurate assessment. The GHG assessment takes place ex-ante with limited information and resources. For instance, downstream emissions from the use of the products and services resulting from projects financed by Financial Cooperation are generally not considered.

In summary, in considering the scope and nature of the GHG assessment methodology, readers should be mindful that the GHG emissions of a project per se cannot and should not be construed as an expression of the merit or value of that project, either broadly or more narrowly in terms of climate change alone.

The focus of these guidelines lies on establishing physical boundaries, baselines, timeframes, and input and output data of projects. Other dimensions of GHG Accounting such as economic considerations and financial principles of accounting are not considered in these guidelines. The objective is to provide a framework for estimating ex-ante GHG emissions of FC projects which can be valued and accounted for.

Whilst GHG assessment is being mainstreamed into FC operations, it remains under regular review. This methodology for assessing project-related emissions and the respective reduced, avoided or removed emissions is considered a “work in progress” that is subject to periodic review and revision in light of experience gained and as knowledge of climate change issues evolves. KfW Development Bank works closely with other financial institutions, IDFC members and stakeholders in its GHG assessment work and welcomes further feedback on the methodology. The methodology is guided by the International Financial Institution Framework for a Harmonised Approach to Greenhouse Gas Accounting, published in November 2015.

2 Quickstart Guide for GHG Assessment

KfW Development Bank introduced systematic GHG assessments in 2009. Initially, it focused on Emission Reductions, especially in energy projects. Over the years, the scope of emission reduction assessments was widened to sectors like sewerage and wastewater, waste management, transport, and ecosystems. In 2018, it became also mandatory to assess Absolute Emissions of a project (also known as the carbon footprint).

This document describes the methods to be used. This quick start guide serves as an introduction to the main concepts and gives an overview of the importance of GHG assessment in different projects and FC sectors. All information provided here will be illustrated in more detail in the following chapters.

2.1 GHG assessment concepts

Most of the projects financed by FC emit greenhouse gases into the atmosphere, either directly (e.g. fuel combustion or production process emissions) or indirectly, e.g. through purchased electricity or heat. However, many of these projects also reduce or avoid the emission of CO2 compared to business as usual scenario or help to remove carbon from the atmosphere. GHG Accounting at KfW Development Bank therefore addresses four main concepts for emissions:

- **Absolute Emissions** (previously referred to as the 'carbon footprint' within FC) are emissions that a project creates. For example, FC finances a pumping system for an irrigation project. The installed water pumps are run with electricity. This electricity is provided by the country's power plants, which - depending on the type of generation - produces a certain level of emissions. Hence, the irrigation project financed by FC generates Absolute Emissions.

- **Emission Reductions** (sometimes also called "Relative Emissions") describe the difference in Absolute Emissions between a "with" and a "without" project scenario. For example, FC-financed water pumps will be replacing an existing system of water pumps consumed more electricity than the newly installed pumps. By installing more efficient pumps, the difference between the Absolute Emissions of the new system (i.e. "with-project" scenario) and the Absolute Emissions of the previous system ("without-project" scenario) constitutes the Emission Reductions.

- **Avoided Emissions** are Emission Reductions against an expected future increase in emissions that would have taken place without the project. For example, FC invests in the conservation of a natural ecosystem. It thereby avoids deforestation and thus avoids emissions in the future. Avoided Emissions correspond to the concept of "Emission Reductions" above, however are much more hypothetical due to leakage and permanence risks.

- **Carbon Removal** (i.e. "sequestration" or "negative Absolute Emissions") takes place when a project in fact removes existing greenhouse gases from the atmosphere. For example, as part of the irrigation project, FC also finances also natural regeneration of an adjacent area. Through this afforestation, a certain amount of GHG that have been emitted elsewhere are removed.

All concepts are based on calculation and measurement of emissions in "tonnes of CO_2" (or CO_2 equivalents = CO_2e). However, they differ in character:

- **Absolute Emissions** are "real" emissions caused by a project. Similarly, **Carbon Removal** means that "real" existing greenhouse gases will be removed from the atmosphere in absolute terms.

- In contrast to "real" emissions, the concepts of **Avoided Emissions** and **Emission Reductions** are based on arithmetical differences between emissions when comparing "without-" and "with-" project scenarios. For example, in the above-mentioned irrigation project, efficiency gains of new vs. old pumps may lead to an arithmetical reduction in emissions of x tonnes CO_2e / year. This amount of x t CO_2e reduction will be reported as a positive impact in terms of an Emission Reduction. However, the new irrigation pumps will still emit y tons of CO_2e per year in terms of Absolute Emissions. Similarly, a project for protecting forest areas that store carbon but would be destroyed if present developments continue unchecked (e.g. by encroachment and deforestation), will have positive impacts in terms of Avoided Emissions, but may not remove additional greenhouse gases from the atmosphere.

Therefore, Absolute Emissions "real emissions" (Absolute Emissions and Carbon Removal) and "arithmetical emissions" (Reduced or Avoided Emissions) cannot off-set each other. This means, that, in addition to Reduced or Avoided Emissions, the Absolute Emissions caused by a project also need to be reported individually if they are significant. Also, it is only by reducing the Absolute Emissions to zero (e.g. through renewable energy generation) or by Carbon Removal (sequestration) that carbon neutrality can be achieved. Also see Figure 1 for a visualisation of the relationship between the four emission concepts.
Most of the projects financed by FC emit greenhouse gases into the atmosphere, either directly (e.g. fuel combustion or production process emissions) or indirectly, e.g. through purchased electricity or heat. However, many of these projects also reduce or avoid the emission of CO_2 compared to a business-as-usual scenario or help to remove carbon from the atmosphere. GHG Accounting at KfW Development Bank therefore addresses four main concepts of emissions:

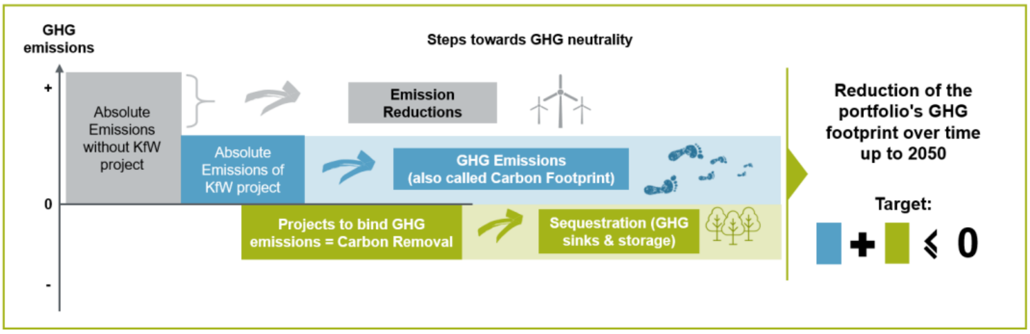

Figure 1: Emission concepts and carbon neutrality

2.2 Sectoral Guideline

The GHG assessment is compulsory - where feasible - for all projects with significant emissions (see chapter 4). Hence, projects do not only differ in accordance to the four GHG assessment concepts described in the previous chapter, but they may also differ in terms of GHG relevance (projects within sectors or subsectors with generally very small GHG-impact are not being considered) and data availability (projects involving technical assistance or projects that consist of many small independent sub-projects may be very hard to assess). Basically, projects can be divided into the following categories:

<u>Projects without GHG impact assessment</u>

a) **Projects with minor GHG impacts**:
Projects with only insignificant Greenhouse Gases do not need to be considered for GHG Assessment. Based on a portfolio analysis, the indication for consideration was set at 5,000 tonnes CO_2e per year (see chapter 4). The following list provides examples of types of projects that probably have GHG impacts below this threshold (this list, as all the following lists in this subchapter, is intended for illustrative purposes only, for a full list see Annex 1):

Projects for which GHG assessment is generally not required	a) Health, education and research b) Small drinking water supply networks c) Meteorological and hydrological measuring and information or early warning systems d) Small scale smallholder agricultural production e) Integrated Water Resources Management

Please note that, for all consulting services that are part of a project (e.g. those financed from a technical expert fund or as accompanying measure) and that consist mainly of technical advice, no significant direct impact on GHG emissions independent from the underlying project is expected. Therefore, no detailed separate assessment is needed for these measures.

b) Projects with indeterminable direct GHG impacts:
The assessment of the GHG impacts of multi-investment intermediated projects (e.g. Multi-beneficiary intermediated loans, Framework Loans, Global Loans, Equity and Debt Funds) poses challenges since information on the individual projects is unavailable ex ante, can remain limited even during implementation and may not allow a reliable assessment. This is especially the case when portfolios consist of many small projects or target multiple SMEs. Right now, these impacts are only calculated if sufficient information is available ex ante (e.g. in the case of energy efficiency credit lines). Otherwise, no GHG assessment takes place. The same principle also applies to open programmes for which there is insufficient information on the individual sub-projects ex ante. A methodology for assessing these types of projects is underway.

In the case of policy-based financing, the focus is on supporting the development of policies, standards, regulations, budgeting and planning approaches. The impacts on emissions will be indirect and cannot be quantified with a reasonable level of confidence. Therefore, in such cases, no GHG assessment will take place. However, the expected implications in terms of GHG emissions shall be assessed and described qualitatively.

Projects for which GHG assessment may not be feasible	- Intermediated lending, e.g. to SMEs - Open programmes - Policy-based financing - Insurance

<u>Projects with GHG assessment</u>

a) **Projects that may significantly increase Absolute Emissions**:
Some projects financed by FC may emit significant amounts of GHG into the atmosphere. The following table provides examples of projects which will be considered for GHG assessment.

Projects for which GHG assessment will be required	a) Urban development b) Solid waste collection, transfer, treatment and/or disposal c) Waste-water treatment d) Mobility (rolling stock, road and rail infrastructure) e) Heat and power generating plants based on fossil fuels, water power, biomass and geothermic energy, waste-to-energy f) Demand-side energy efficiency (e.g. electrical appliances, industry, buildings) g) Supply-side energy efficiency (e.g. transmission and distribution lines) h) Power transmission lines and substations i) District heating networks j) Dams and reservoirs k) Desalinisation plants l) Large-scale agricultural intensification projects

Project teams should use the sectoral GHG-significance classification attached in Annex 1 to determine if a project is assigned to a subsector classified as “significant”. For these projects a GHG assessment is mandatory.

b) **Projects intended to create Emission Reductions**:
Many of our projects aim to either contribute to socioeconomic development while operating at lower emission levels than would be expected to prevail or materialize under “without-project” project conditions, or to maintain the same level of output while reducing related GHG emissions. The following table lists projects that can be expected to fall into this category.

Projects that usually intend to	- Demand-side energy efficiency (e.g. electrical appliances, industry, buildings) - Supply-side energy efficiency (e.g. transmission and distribution lines)

create Emission Reductions require a GHG assessment	- Replacement of inefficient light bulbs, electrical motors, and pumps, e.g. in urban or agricultural water management - Renewable energy in general - Waste biomass treatment instead of disposal - Transport projects increasing efficiency of energy use

c) **Projects that intend to avoid releasing GHG from existing sinks (Avoided Emissions)**: In certain project types, e.g. nature conservation or improved, more sustainable forest management, the release of emission from natural sinks will be avoided or reduced, respectively. Typical projects in this category are:

Projects that avoid releasing GHG require a GHG assessment	- Improved forest management - Improved management of grasslands and soils for agricultural production - Nature conservation, e.g. of wetlands, mangroves, tropical forests - Avoided deforestation

d) **Projects with Carbon Removal**: In certain project types, e.g. nature-based solutions or more specifically, in afforestation, GHG will be removed (sequestered). Artificial-sink approaches will not be considered until they are further developed. Potential project types are, amongst others:

Projects that aim for Carbon Removal require a GHG assessment	- Reforestation and afforestation - Enhancement / restoration of peat bogs and wetlands - Increase of organic content of soils

The methodologies set out in more detail below are based upon the internationally recognised IPCC Guidelines, the WRI GHG Protocol and the IFI's Harmonized Approach to GHG Accounting. If project specific factors are not available, the methodologies adopt an IPCC factor applicable at the global or trans-national level (termed tier level 1 in IPCC).

3 Guiding Principles

Certain principles underpin the estimation of project-based GHG emissions and Emission Reductions. These principles should form the basis for all GHG tools used in KfW as well as guide users in the assessment of GHG in cases / project types which are not covered by the tools or in situations which require the application of case-specific factors. The application of these principles will help to ensure the credibility and consistency of efforts to quantify and report emissions. These principles are:

Completeness
All relevant information should be included in the quantification of a project's GHG emissions and in the aggregation of the total FC-induced GHG footprint. This is to ensure that there are no material omissions from the data and information that would substantively influence the assessments and decisions of the users of the emissions data and information.

Consistency
The credible quantification of GHG emissions requires that methods and procedures are always applied to a project and its components in the same manner, that the same criteria and assumptions are used to evaluate significance and relevance, and that any data collected and reported allow meaningful comparisons over time.

Transparency
GHG emissions of a project are assessed at appraisal stage for all individual projects with Significant Emissions (see chapter 4). The calculated GHG data is reported in the project's appraisal report and recorded in INPRO, an internal data sheet. All published GHG data is based on the INPRO data-base.

Clear and sufficient information should be available to allow for an assessment of the credibility and reliability of reported GHG emissions. Specific exclusions or inclusions should be clearly identified, and assumptions should be explained. Appropriate references should be provided for data, calculation method and assumptions. Information relating to the project boundary, the explanation of baseline choice, and the estimation of Baseline Emissions should be sufficient to replicate results and understand the conclusions drawn. For the calculation method, using the standard FC tools is the default solution. Utilising an alternative method or tool should be documented. Such information/ data must generally be part of the project appraisal report or of project studies, either specific climate studies or the general feasibility study.

Conservativeness
KfW Development Bank should use conservative assumptions, values-, and procedures. Conservative values and assumptions are those that are more likely to overestimate Absolute Emissions and underestimate Emission Reductions or GHG sequestration.

Accuracy
GHG assessment involves many forms of uncertainty, including uncertainty about the identification of secondary effects, the identification of baseline scenarios and Baseline Emission estimates. Therefore, GHG estimates are, in principle, approximations. Uncertainties with respect to GHG estimates or calculations should be reduced as far as is practical, and estimation methods should avoid bias. Where accuracy is reduced, the data and assumptions used to quantify GHG emissions should be conservative.

Relevance
Select the GHG sources, GHG sinks, GHG reservoirs, data and methodologies appropriate to the needs of the intended user.

4 Significant Emissions

All investment projects in sectors and subsectors with significant emissions are to be assessed. Based on the results of an internal GHG portfolio screening, the indication for significance of a project was identified at 5,000 tonnes CO_2e per year. This indication is used for Absolute Emissions, Emission Reductions, Carbon Removal and Avoided Emissions.

One problem that arises in practice is that the project team cannot make a clear statement as to whether the project will exceed the threshold of 5,000 tons of CO_2e per year until the project emissions have been calculated. For this reason and in order to facilitate the GHG assessment process internally, an analysis of the different FC project types has been carried out to determine which projects are likely to exceed the threshold and which are not. Those project types (subsectors) that are likely to exceed the threshold were classified as “GHG significant”. For these projects, a GHG assessment is mandatory, regardless of whether the calculated Emissions (Absolute Emissions, Emission Reductions, Emission Removals, Avoided Emissions) of the project are above or below the threshold value. For all other project types (classified “GHG insignificant”) a GHG assessment is not required. Annex 1 provides an overview of the analysed project types and their classification.

However, if, in the expert opinion of the responsible portfolio manager or technical expert, a project may still lead to significant GHG emissions due to its specific design or size, a GHG assessment shall be conducted in individual cases. Another indication for the need of a GHG assessment could be if Emissions Reductions / Carbon Removals are an important (co-)benefit of a project. In this case the GHG emissions should be assessed, as well.

With this approach KfW Development Bank aims to capture approximately 95% of all project-related Absolute Emissions. Regular assessments will determine whether this goal is being achieved.

5 Greenhouse Gases and Emission Factors

5.1 Greenhouse gases included in the assessment

The greenhouse gases included in the assessment of KfW Development Bank include the seven gases listed in the Kyoto Protocol, namely: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF_6); and nitrogen trifluoride (NF_3). The GHG emissions quantification process converts all GHG emissions into tonnes of carbon dioxide called CO_2e (equivalent) using Global Warming Potentials (GWP), which can be found in table A2.8 in the Annex.

The following processes/activities usually generate GHGs that may be accounted for using the methodologies:

- CO_2 – stationary combustion of fossil fuels, indirect use of electricity, oil/gas production & processing, flue gas desulphurisation (limestone based), aluminium production, iron and steel production, nitric acid production, ammonia production, adipic acid production, cement production, lime production, glass manufacture, municipal solid waste incineration, transport (mobile combustion)
- CH_4 – biomass decomposition, oil/gas production & processing, coal mining, municipal solid waste landfill, municipal wastewater treatment
- N_2O – stationary combustion of fossil fuels/biomass, nitric acid production, adipic acid production, municipal solid waste incineration, municipal wastewater treatment, transport (mobile combustion)
- HFCs – refrigeration / air conditioning / insulation industry
- PFCs – aluminium production
- SF_6 – electricity transmission systems, specific electronics industries (e.g. LCD display manufacture)
- NF_3 – plasma and thermal cleaning of CVD reactors

ACTIVITY	GHG Type	POTENTIAL SOURCES OF EMISSION
Combustion for energy	CO_2 N_2O CH_4	Energy-related GHG emissions from combustion: boilers / burners / turbines / heaters / furnaces / incinerators / kilns / ovens / dryers / engines / flares / any other equipment or machinery that uses fuel, including vehicles.
Rice cultivation	CH_4	The extent of CH_4 release from rice cultivation depends on numerous factors, in particular the length of the rice growing season, the irrigation regime and fertilisation. The CH_4 release is only relevant for wet rice cultivation, where the fields are covered with water for different periods of time.
Cattle rearing	CH_4 N_2O	CH_4 emissions from cattle rearing in particular can be relevant in the FC context. These emissions originate mainly from rumen fermentation, but also partly from the management of organic fertilisers (e.g., storage and application technology). N_2O losses also occur in the management of organic fertilisers, but these are usually insignificant compared to methane losses and are therefore not taken into account here.
Nitric acid production	CO_2 N_2O	CO_2 from combustion sources and process-related.
Ammonia production	CO_2	CO_2 from combustion sources and process-related.
Wastewater treatment	CH_4 CO_2 N_2O	CH_4 from degradation of organic material in the wastewater under anaerobic conditions. CO_2 emissions from the consumption of electricity in the treatment process. N_2O as an intermediate product from the degradation of nitrogen components in wastewater.
Municipal solid waste incineration	CO_2 N_2O	GHGs from MSW combustion.
Municipal solid waste landfills	CH_4	CH_4 from anaerobic digestion of biodegradable waste
Refrigeration / air conditioning / insulation industry	HFCs	Fugitive emissions of HFCs

ACTIVITY	GHG Type	POTENTIAL SOURCES OF EMISSION
Power transmission	SF_6	Transmission losses are derived from the power production combustion sources and have an associated emission of CO_2 Fugitive emissions of SF_6

Table 1: Selected examples of direct GHG emission sources by activity type

5.2 Emission Factors

The greenhouse gas assessment methodology uses a series of emission factors from which greenhouse gas emissions can be calculated. These have been derived from internationally recognised sources, e.g. WRI/WBCSD's GHG Protocol and IPCC Guidelines for National GHG Inventories and can be found in table A2.2 – A2.8 in the Annex. These default factors can be used where no other, more relevant, factor is available or where factors that have been provided, by the promoter for example, appear to be unsubstantiated. Where possible, it is preferable to use project-specific factors in place of the defaults given here provided the source of the factors used is consistent with the guiding principles described in section 3 of the methodologies.

6 Project Boundaries

6.1 Emission scopes

The project boundary defines what is to be included in the calculation of the Absolute Emissions, Carbon Removals, Avoided Emissions, and Emission Reductions. The FC methodologies use the concept of "scopes", based on definitions from the WRI GHG Protocol "Corporate Accounting and Reporting Standard", when defining the boundary for emissions to be included in the emissions calculation.

Scope 1: direct GHG emissions. Direct GHG emissions physically occur from sources that are operated by the project. For example, emissions generated by the combustion of fossil fuels, by industrial processes and by fugitive emissions, such as refrigerants or methane leakage.

Scope 2: indirect GHG emissions. Scope 2 accounts for indirect GHG emissions associated with energy consumption (electricity, heating, cooling and steam) consumed but not produced by the project. These are included because the project has direct control over energy consumption, for example by improving it with energy efficiency measures or switching to consume electricity from renewable sources.

Scope 3: other indirect GHG emissions. Scope 3 emissions are all other indirect emissions that can be considered a consequence of the activities of the project (e.g. emissions from the production or extraction of raw material or feedstock and vehicle emissions from the use of road infrastructure, including emissions from the electricity consumption of trains and electric vehicles).

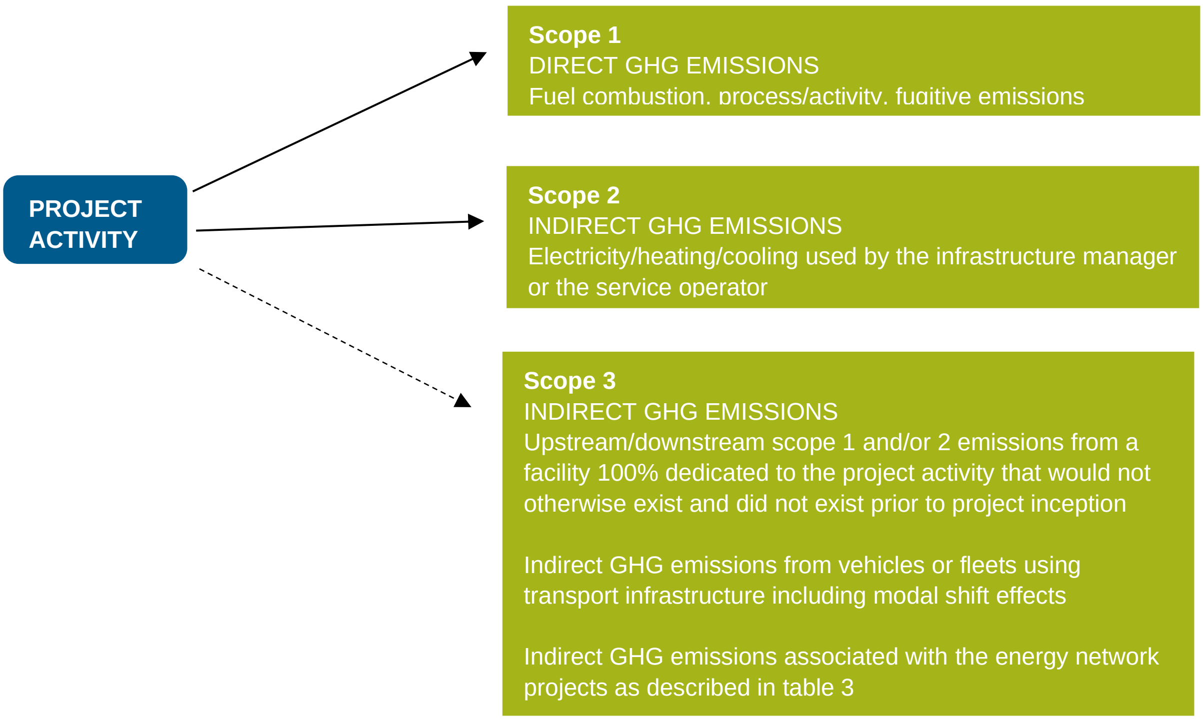

Figure 2: Project scope – all projects

In general, scope 1 and 2 emissions of the financed projects should always be included in the Absolute Emissions (previously referred to as the 'carbon footprint' within FC). For the majority of projects financed by FC these are the most important emissions associated with the projects. However, for certain sectors in which the scope 3 emissions associated with the projects are significant and can be estimated, e.g. in some transportation projects, scope 3 emissions must also be included. Table 2 provides an overview of the most important differences in the definition of scopes across sectors.

PROJECT TYPE	CLARIFICATION OF SCOPES
ALL PROJECTS, (OTHER THAN FOR THOSE EXCEPTIONS SPECIFIED BELOW)	INCLUSION: scope 1 and 2 emissions for a typical year of operation. EXCLUSION: scope 1 and 2 emissions associated with the commissioning and construction of the project if building the project will generate insignificant emissions. EXCLUSION: scope 1 and 2 emissions associated with the decommissioning of the project. EXCLUSION: scope 3 emissions. INCLUSION: scope 3 emissions from 100% dedicated sources upstream or downstream that would not otherwise exist and a number of specific cases below. An example of the first case would be a power plant that exists solely to supply the project (upstream) or a waste disposal site that is for the exclusive use of the project (downstream) that would not otherwise exist.
TRANSPORT MOBILE ASSETS AND INFRASTRUCTURE	INCLUSION: scope 3 emissions from vehicles travelling on the financed physical infrastructure links, or fleets departing from, or arriving at a transport node, are included in the Absolute Emission and the Emission Reductions calculations. GHG Emission Reductions are calculated based on the displacement of passengers from one type of transport to another (modal shift effects), shifts in travel patterns (one road to another or from one time of day to another) and the induced increase in passengers and freight traffic. If the project includes the replacement of rolling stock, the savings in emissions from this intervention should also be taken into account. INCLUSION: emissions associated with the commissioning and construction of the project if significant (e.g. construction of an underground railway).
ENERGY NETWORK PROJECTS	INCLUSION: scope 3 emissions from outside the boundary defined by the physical limits of the project are included in the Emission Reductions calculation where they are considered significant. For example, a district heating network project typically has a boundary that includes the losses of the heat network and any sources of heat generation under the control of the operator. If the project results in fuel switching (individual heating to district heating) or results in a change of the operational regime of a heat plant outside the control of the project operator, significant emissions from these sources are included.
ALL REHABILITATION / REFURBISHMENT PROJECTS	CLARIFICATION: The boundary for Absolute Emissions calculations for projects that rehabilitate or refurbish existing facilities corresponds to the boundary of the rehabilitation or refurbishment project and not the GHG emissions for the whole facility. If, however, the GHG emissions of the facility are significantly modified because of the project, the Emission Reductions calculation shall use a boundary that includes the entire facility. Example 1: The Bank invests in a project to rehabilitate a boiler house in a manufacturing facility. The bank reports the scope 1 and 2 emissions of the boiler house for the Absolute Emissions and Emission Reductions. If GHG emissions of the rest of the refinery are not affected by the project, the bank does not report the GHG emissions for the whole refinery. Example 2: The bank invests in a project to replace 5% of an electricity network. The bank calculates the emissions associated with the project, i.e. losses for 5% of the network. The bank does not report all network losses.

Table 2: Clarification of applicable scopes

6.2 Timeframe

The calculation of GHG emissions resulting from a project starts with the project's construction phase, if applicable, and always includes the operating phase (standard project's lifetime), which the FC portfolio manager and/or technical expert determines. Decommissioning is usually not included.

- **Construction phase:** If building the project will generate insignificant emissions, its construction phase is not included in the accounting. If the project's construction proves emissive, the emissions should be calculated (e.g. construction of an underground railway). The emissions of the construction phase are classified as significant if the total emissions due to construction divided by the **standard project's lifetime** (see next point) exceed a value of 5,000t CO2e per year.

- **Operating phase:** For ease of comparison, the **standard lifetime of a project** is assumed to be 20 operating years. Exceptions can be made for particularly long-lived assets and are suggested as follows:
  - 50 years for dams
  - 30 years for transportation infrastructure

- **Decommissioning phase**: Though potentially emissive, the decommissioning is usually insignificant compared to the operating phase of a project, and assumptions about decommissioning are too unreliable to justify its inclusion. This phase is therefore usually not included in the GHG assessment.

Annual GHG emissions are determined by dividing the project's total lifetime emissions (operating phase emissions) by the lifetime of the project. In the case of significant emissions during the construction phase the annual Absolute Emissions are calculated from the total emissions during the construction and operating phase divided by the project's lifetime.

In exceptional cases, the lifetime of an individual project can deviate from the periods set here. This can be determined on a case-by-case basis and has to be justified for each individual case. This may be especially required for projects in the area of natural sinks (e.g. afforestation) or solid waste management.

6.3 Different boundary scenarios

For some projects, as specified in table 3, the Absolute Emissions and Emission Reductions calculations may have different boundaries.

- **Absolute Emissions** are based on a project boundary that includes all significant scope 1, scope 2 and scope 3 emissions (as applicable) that occur within the project, as defined by the finance contract. For example, the boundary for a stretch of motorway would be the length of motorway defined as the project by the finance contract, and the calculation of Absolute Emissions would cover the GHG emissions of vehicles using that particular stretch of motorway in a typical year.
- **Emission Reductions** are based on a project boundary that adequately covers the "with-" and "without-" project scenarios. It includes all significant scope 1, scope 2 and scope 3 emissions (as applicable) within the project, but it may also require including a boundary outside the physical limits of the project to adequately represent the baseline. For example, without the motorway, traffic would increase on secondary roads outside the physical limits of the project. The Emission Reductions calculation will use a boundary that covers the entire region affected by the project (Figure 3)

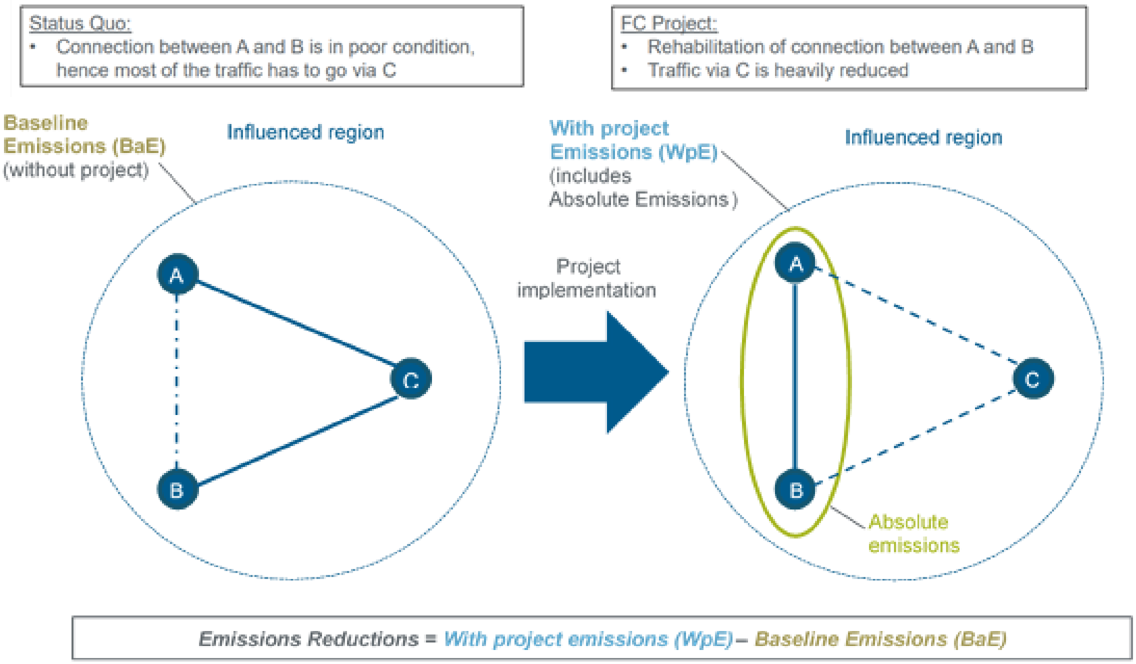

Figure 3: Example for baseline scenario with boundary outside physical limit of project (more details section 7.2)

6.4 Carbon leakage

Carbon leakage is not considered in the emissions calculation. Leakage normally occurs as a result of climate policies leading to a regional shift in emissions sources but may also occur as the result of an FC financed project, for example when an old technology is replaced and sold to be used elsewhere. The leakage risk should be considered during project design and be part of the impact assessment of the project. In case of a substantial leakage risk, the project may not be financed or would be required to mediate the risk.

6.5 Rebound effects

Rebound effects in energy efficiency projects occur when additional energy is consumed because energy efficiency measures make the use of equipment cheaper. This can occur in households (e.g. no need to turn off energy-saving lights, because they consume almost no energy anyway) or in industry. Such effects are usually included during project design work and impact assessment. The potential effects are not included explicitly/ separately in the GHG methodology.

7 Metrics

7.1 Absolute Emissions (AbE)

Absolute Emissions refer to a project's emissions during a typical year of operation i.e. not including commissioning or unplanned shutdowns. If significant emissions are generated during the construction phase of a project, these are also calculated as Absolute Emissions. The appraisal team calculates and reports the Absolute Emissions of the pro-rated share of FC when FC is only contributing a part of the total financing plan.

The Absolute Emissions should be calculated based on project-specific data. Where project-specific data is not available, it is good practice to use default factors based on sector-specific activity data and through the application of documented emission factors. A compilation of default methodologies by sector is attached to this document for guidance (see Annex A2.1). Absolute Emissions will be estimated by multiplying activity data, such as the volume of fuel used or product produced, by a project-specific or an industry default emission factor.

A combination of methodologies can be used where appropriate. For example, a project which has:

- onsite energy generation through fuel combustion e.g. generators, boilers or kilns and;
- uses purchased electricity from the national grid and;
- has an associated process type emission e.g. cement production

may use a combination of Annex 2 methodologies to calculate Absolute Emissions for the project as follows:

1A Stationary fossil fuel combustion + 1E Purchased electricity + 6 Cement (clinker) production

7.2 Emission Reductions (ER)[1]

The concept of Emission Reductions usually refers to projects that reduce the emission-intensity[2] of the provision of goods and services. In order to calculate the volume of the GHG Emission Reductions of the respective project, you compare the emissions generated in the with-project scenario with a baseline scenario-, that describes the most credible scenario without the implementation of the project. Thus, net Emission Reductions are defined as:

Absolute Value of Emission Reductions = "With" Project Emissions (WpE) - Baseline Emissions (BaE)

$$| ER | = WpE - BaE$$

The with project emissions must have the same boundary as the without-project emissions in terms of scope, but can differ from the boundary used for Absolute Emissions, because the boundary is sometimes extended for the Emission Reductions calculation, e.g. in the case of networks (see boundary conditions in section 0 of the methodology above). In the majority of cases however, the with-project emissions have the same boundaries as the Absolute Emissions and consequently with-project emissions will be equal to the Absolute Emissions (AbE).

The Baseline Emissions are calculated based on a credible alternative scenario "without" the project, against which the with-project scenario can be compared – giving an indication of how,

[1] We are using the term "Emission Reductions" to reflect the ambition of FC to actually reduce emissions. In addition, and for reporting purposes, the net amount of Emission Reductions is always reported as a positive value to facilitate its aggregation (a negative value can be misunderstood as the project leading to net increased emissions compared to the baseline). However, the scientifically more appropriate term would be "Relative Emissions" to record the case in which a project actually increases emissions over a baseline, i.e. generates "negative emission reductions".

[2] Emission intensity is the emission rate of a given pollutant relative to the intensity of a specific activity or an industrial production process; for example grams of carbon dioxide released per megajoule of energy produced.

measured in GHG metrics, the proposed project performs. However, the baseline scenario is clearly theoretical and hence incorporates an additional level of uncertainty.
The project baseline scenario is defined as the expected alternative means to meet the output supplied by the proposed project[3].

The baseline scenario must therefore determine the likely alternative to the proposed project. Important arguments for a realistic alternative scenario can be, inter alia, that the alternative: (i) can meet required output in technical terms; and (ii) is credible in terms of socio-economic and regulatory requirements.[4]

The first step is to propose a baseline scenario that meets demand in technical terms. Two examples – expanded in detail below – are:

- Example 1: A new RE power plant is introduced into an electricity network with zero demand growth; without the new plant, the existing power plants connected to the grid (the operating margin) would have continued to meet demand. By contrast, if demand is growing sharply, supply would have been provided in part by existing capacity and in part by alternative new generation capacity (build margin) and/or in part through a regional grid interconnection.
- Example 2: Construction and operation of a biogas cogeneration facility in a wastewater treatment plant. The power produced in the cogeneration facility is used entirely to meet the demand of the wastewater treatment plant.

In a second step, it is necessary to check that the proposed scenario is credible. The baseline scenario should meet three conditions:

- The socio-economic test: The baseline has to make “social, technological and economic sense”. In the first place, this requires consideration of only proven (existing / standard, reliable and accepted) technologies, procedures and modes of operation. In the financial and economic analyses, the assumed development without the project should show acceptable returns. If the socio-technological pathway that would be followed without the project is, for some reason not financially and/or economically viable[5], it needs to be justified why this can still be considered to be the correct baseline. The underlying assumptions need to be transparently documented.
- The legal requirement test: the baseline alternative must not fail to comply with binding legal requirements (either technology, safety or performance standards, including portfolio standards e.g. 10% biofuels in fuel mix);
- The life-expired asset test: the baseline alternative could not assume to continue using existing assets beyond their economic life (based on regular operations and maintenance), at least not without appropriate deterioration in quality of service.

In some project types the alternative scenario that meets the demand of the proposed project may be difficult to define (e.g. in cases involving various technology levels or when consumer preferences will change after implementing a project). In such cases, the baseline should be clearly justified based on the specific project.

[3] In general, the baseline scenario is based on a combination of the principles of the best available technology and least cost. In some circumstances, one could also assess alternative scenarios in which prices or regulatory requirements are used to determine options or constrain demand to existing supply. This is relevant where current pricing is clearly inefficient or when regulatory requirements impose specific conditions on all installations.
[4] A baseline that is consistent with the best economic alternative is not necessarily identical to it. The best economic alternative is defined as the most competitive and viable alternative investment to which the project is compared; whereas the baseline for the carbon footprint is the most likely outcome in the absence of the project, e.g. meeting demand through a combination of existing and new infrastructure.
[5] E.g., if the financial viability depends on government subsidies which are not considered in the economic analysis.

Carbon Shadow Pricing
Several development finance institutions (DFIs) use carbon shadow pricing in their economic analyses. This applies, for example, for the European Investment Bank (EIB), which also promotes the – presently – highest carbon price level among DFIs (today EUR 80 per tonne is used, this will increase to EUR 250 per tonne in 2030 and EUR 800 per tonne in 2050). However, this value may still be too low. The British Government, for example, is already applying a shadow price of approximately EUR 300 per tonne for the analysis of its policies and projects. The effect of carbon shadow pricing is that investment alternatives leading to higher GHG emissions or less GHG reductions may perform worse than other alternatives more aligned with the objective of low-carbon development (if the carbon pricing effect is not counteracted by other factors). Shadow prices are often used in economic analysis for monetising negative or positive externalities of investments not reflected in market prices. Their definition is complex, and the concrete values derived can be disputed[6]. In FC, carbon shadow pricing is not obligatory. However, we recommend its use if different investment alternatives with different GHG implications are feasible, since the results can provide additional arguments for the ranking of these alternatives.

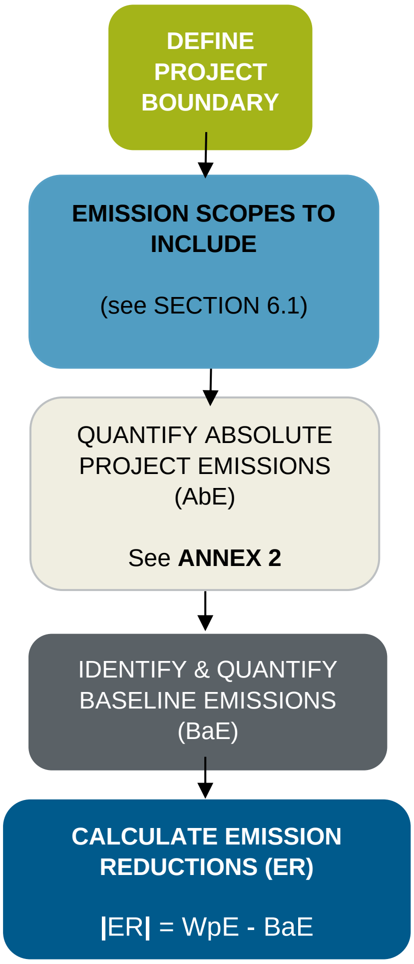

Figure 4: Emission Reductions calculation flow

The **examples** below present the approach FC typically takes for calculating the emissions in a specific energy and a wastewater project. All emissions are calculated for a typical year of operation during the economic lifespan of the project.

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[6] https://www.investopedia.com/terms/s/shadowpricing.asp

Example 1: Electric Transmission Expansion Project in "Utopia" with greenfield and brownfield component
Greenfield component:

New investments to an existing electric transmission system in the county of "Utopia" (with a GEF of 500kgCO_2/MWh) will be carried out. Due to its state-of-the-art nature, the transmission expansion will have only limited transmission losses of 2% p.a. About 1 million MWh will be transmitted over the transmission line over the period of one year. Since this is a new build, no emission reductions will be realised.

Baseline Emissions:	BaE = (1,000,000MWh X 2%) X 0.5 (GEF) = 10,000tCO_2/year
Absolute Emissions:	AbE = (1,000,000MWh X 2%) X 0.5 (GEF) = 10,000tCO_2/year

Brownfield component:
In addition, a brownfield component will be implemented by the project. This activity will lead to a reduction of line losses from 10% to 4% (e.g. reductions of 6%) p.a. due to the rehabilitation of existing transmission system components. About 200,000MWh will be transmitted over the transmission line over the period of one year.

Baseline Emissions:	BaE = (200,000MWh X 10%) X 0.5 (GEF) = 10,000tCO_2/year
With project Emissions:	WpE = (200,000MWh X 4.0%) X 0.5 (GEF) = 4,000tCO_2/year
Emission Reductions:	|ER| = (200,000MWh X 6%) X 0,5 (GEF) = 6,000tCO_2/year

If greenfield and brownfield components will be implemented within one FC project, the sum of the respective Absolute Emissions as well as the respective Emission Reductions will be reported, hence:

Combined results of greenfield and brownfield activities:

Baseline Emissions:	20,000tCO_2/year
With project Emissions:	14,000tCO_2/year
Emission Reductions:	6,000tCO2/year

Example 2: Cogeneration facility in the wastewater treatment plant in Macondo

The project consists of the design, construction, and operation of a biogas cogeneration facility and the acquisition and installation of new equipment to improve the sludge management system in the wastewater treatment plant in Macondo.

Baseline
The anaerobic treatment of the sewage sludge in the digesters produces biogas, which is currently flared in an environmentally friendly manner. The power consumed by the wastewater treatment plant comes from the normal grid.

With project situation
After comparing different alternatives, the decision was made to install a microturbine because it produces less electricity relative to other technologies but does not require extensive pre-treatment of the biogas. The microturbine produces an average of 25,000 kWh/d or 25 MWh/d. The generated power will be entirely consumed by the wastewater treatment plant.

Emission Reduction = 25 MWh/d*365d*0.6 (GEF Macondo) = 5,475 tCO2e/year

7.3 Avoided Emissions (AvE, Deforestation)

The concept of Avoided Emissions refers to projects that aim to protect ecosystems, mostly forests, grasslands, and peatlands, in order to prevent their degradation or conversion into other land uses and the resulting emission of GHG. To calculate the volume of Avoided Emissions of a respective project, the emissions that would have been generated due to the destruction of the ecosystem are compared with the emissions occurring without the destruction (or with only reduced destruction).

Absolute Value of Avoided Emissions (AvE)= With-Project Emissions (WpE) - Baseline Emissions (BaE)
= With-Project Emissions - Emissions after projected land use conversion/degradation

$$|AvE| = WpE - BaE$$

Although the concept also involves the comparison between a with-project scenario and a baseline scenario as in the case of Emission Reductions in the previous chapter, the concept of Avoided Emissions is much more hypothetical because of generally higher carbon leakage and permanence risks. Permanence concerns the risk of a sudden reduction of carbon stocks of an ecosystem due to natural factors, economic pressure or policy changes, which may reverse earlier carbon storage in an instant. For example, forest fires can quickly release the carbon stored in protected forest. Carbon leakage describes the shift of emissions outside the project region, which would otherwise have simply occurred within the project region. For example, better forest governance within the project region may reduce pressure on forests within the project region but may intensify deforestation and forest degradation activities outside of the project region. Such relocation effects are usually more likely within a country but also happen across borders.

The specific calculation of Avoided Emissions differs depending on the ecosystem or the type of Avoided Emission. The most relevant distinction – due to large amounts of Avoided Emissions possible and large room for estimation error - has to be made between:
(1) prevented deforestation
(2) prevented forest degradation
(3) peatland rewetting and conservation

(1) Prevented deforestation
The main challenge in estimating Avoided Emissions through prevented deforestation is an accurate and realistic quantification of the deforestation rate in the project area as well as how much this deforestation rate is reduced due to project activities. Small errors in quantification lead to large differences in results. Thus, obtaining the best possible available estimate of deforestation rate is key. The findings of current REDD+ programmes are utilized for this, where possible.

Avoided Emissions in an official REDD+ project are calculated within the REDD+ project in accordance with methodologies provided by UNFCCC and not calculated separately by FC. Similarly, Avoided Emissions in projects protecting forest area located in a REDD+ partner country are calculated in accordance with methodologies provided by UNFCCC utilising the applicable jurisdictional REDD+-related data available at the lowest possible administrative level (national or sub-national). A more conservative estimate of Avoided Emissions based on expert judgement is permitted. In particular, this is the case where protected areas are remote or are otherwise little exposed to the jurisdiction-specific drivers of deforestation. Avoided Emissions in a non-REDD+ jurisdiction are estimated based on the best available data such as scientific and peer-reviewed literature and data sources such as https://globalforestwatch.org/.

(2) Prevented forest degradation
Estimating forest degradation for large areas is highly resource-intensive since remote-sensor-based technologies have generally underperformed and ground-based forest inventories are necessary to adequately judge degradation. Most FC projects do not have these types of resources. Therefore, Avoided Emissions through prevented forest degradation are estimated based on available data sources as found in REDD+ programme documentation or scientific literature applicable to the project region.

(3) Peatland rewetting and conservation
Peatland rewetting and conservation has tremendous potential for Avoided Emissions but measurements and overall GHG monitoring need to follow a standardised process to estimate Avoided Emissions correctly. Therefore, an accepted methodology of the voluntary carbon market must be used[7].

Deviations from these specific calculation approaches require justification. In general, however, all calculations apply the following approach:

[7] In temperate peatlands, the latest version of “VM0036 Methodology for Rewetting Drained Temperate Peatlands” is recommended. In the tropics, “VM0027 Methodology for Rewetting Drained Tropical Peatlands” is available.

The with-project scenario consists of the situation with the implementation of the conservation project. To determine the "with" project emissions, the standard assumption is that no ecosystem conversion/degradation will occur after the implementation of the project and hence, no emissions will be released. This is because projects mainly focus on mature ecosystems which have reached a carbon equilibrium, i.e. the natural growth absorbs as much carbon as is naturally released from dying biomass. It is also possible to assume that ecosystem conversion is only reduced by a certain percentage and consequently, emissions would also be released in the with-project scenario.

Emissions in the baseline scenario are calculated for a region, either national or sub-national, for which assumptions are made regarding the baseline ecosystem development without intervention. The baseline is often grounded in historical data but frequently corrected with assumptions about future policy or socio-economic changes within the boundaries of the project. Therefore, the baseline is usually much more uncertain than for conventional Emission Reductions calculations. The calculation of the baseline scenario generally follows a formula composed of a carbon stock (of the specific ecosystem), a degradation ratio and a time factor.

Example 3: Protected area project in "Wild World"

Investment in the establishment of 50,000ha of protected area in county "Wild World". The purpose of the protected area is to prevent poaching of local biodiversity and deforestation through illegal settlements. The deforestation rate in the jurisdiction is estimated at 0.42% p.a. and forest carbon stocks are 300tCO_2e/ha. Carbon stocks in illegal settlements are estimated at 100tCO_2e/ha due to agricultural use of former forest area. The project is estimated to reduce the deforestation rate to 0.2% p.a. with a leakage effect of 20%.

With Project Emissions:	WpE = 50,000ha X 0.2% p.a. X (300-100)tCO_2e/ha X (100+20)% = 24,000tCO_2e/year
Baseline Emissions:	BaE = 50,000ha X 0.42% p.a. X (300-100)tCO_2e/ha = 42,000tCO_2e/year
Avoided Emissions:	**|**AvE**|** = 24,000tCO_2e/year - 42,000 tCO_2e/year = -18,000tCO_2e/year

7.4 Carbon Removal (CR, sequestration)

The concept of Carbon Removal is the natural or technical capture of carbon dioxide from the air and its permanent storage or utilisation. The most prominent Carbon Removal is the natural process of biomass creation, the most prominent storage is in forest ecosystems or soil. Technical Carbon Removal either from fossil fuel exhaust or from the air (direct air capture) are alternative non-natural processes, as is the permanent underground storage of CO_2. For FC, only natural Carbon Removal is relevant at this stage. To calculate the volume of CO_2 removal, the removal with the project and the removal without the project is compared:

Carbon Removal (CR) = "With" Project Removal (WpR) - Baseline Removal (BaR)

$$CR = WpR - BaR$$

Natural Carbon Removal is distinguished from the Emission Reductions and Avoided Emissions because it is a "negative Absolute Emission", i.e. a real reduction of carbon dioxide in the atmosphere. It therefore is the only alternative to technical carbon capture and storage when it comes to eliminating unavoidable GHG emissions.

The calculation of the "With" Project Carbon Removal depends on the data availability and/or the extent of the project area. See Annex 4 for a detailed description of the methods.

FC assumes zero Baseline Carbon Removal for afforestation projects, while it does not assume a zero baseline for forest rehabilitation where, for example, the mean annual increment is improved through forestry management practices in comparison to the baseline. The reason is that, in case of forest rehabilitation, a forest generally already exists but is either unmanaged or poorly managed, meaning that carbon is also sequestered in the baseline scenario but at a lower level compared to sustainably managed forests. See Annex 4 for a detailed description of the methods.

Most relevant examples of Carbon Removal are forest projects (natural regeneration, afforestation, plantation), regeneration of moors or seagrass meadows and, to a lesser extent, also sustainable crop- and grassland management.

Example 4: Afforestation in “Bare Land”
Investment in the establishment of 1,000 ha of natural forest with subsequent community use rights in the county “Bare Land”. Considering the growth rates of the planted trees and the future forest management, the long-term average carbon stocks per area of land increase from 50 tCO_2e/ha to 200 tCO_2e/ha. The growth rate of carbon stocks due to the afforestation is estimated at 10 tCO_2e/ha/year. This growth rate can be used until the long-term average of 200 tCO_2e/ha is reached, so in this case, 15 years. There is no growth of carbon stocks in the baseline.

“With” Project Removal:	WpR = 1,000 ha X 10 tCO_2e/ha/year = 10,000 tCO_2e/year
Baseline Removal:	BaR = 0 tCO_2e/year
Carbon Removal:	CR = 10,000 tCO_2e/year - 0 tCO_2e/year = 10,000 tCO_2e/year

8 Special Cases

8.1 Intermediated Finance

All emissions and Emission Reductions are to be calculated ex ante. Unfortunately though, for Intermediated Finance projects[8], having sufficient detailed information about final sub-projects at hand ex-ante tends to be the exception. Hence, it is hardly possible to conduct a detailed analysis based on the methodology laid down in this document.

In most of the cases, the information is not sufficient in order to make a detailed analysis since the loans to the final borrowers are not granted until the beginning of the project's implementation. FC aims to address this challenge by applying second-best solutions wherever possible, i.e. by using all the information available ex ante in order to produce the best reliable estimate of GHG-emissions for intermediated finance projects. Among the intermediate finance projects with insufficient information, FC distinguishes two cases:

1. For all projects in which the utilisation of the loan is specified explicitly ex ante (e.g. in the case of credit lines promoting energy efficiency, renewable energy or building insulation investments), but the specific investment is unknown, emissions are calculated based on the specific purpose and according to the established methodology with simplified assumptions (e.g. setting the baseline equal to zero, estimated composition of project pipeline etc.). More information is found in Annex 2.

2. If specific information on the utilisation of the loan is not available or insufficient and no specific purpose has been defined ex ante, GHG emissions are currently not calculated. However, FC is reviewing other methods (e.g., the Joint Impact Model (JIM) and the PCAF method) in order to be able to calculate a second-best estimate. You can find detailed information in Annex 2.

In conclusion, ex-post emission calculation for Intermediated Finance projects has its shortfalls as well. Even though loans have been granted at the time of calculation in this case, a detailed analysis may nevertheless still be unfeasible in cases with high numbers of very small subprojects. JIM and PCAF might also provide a solution and we are therefore reviewing their applicability for this situation as well.

8.2 Open programmes

For open investment programmes, apply the same principles as for intermediated finance: Information on the individual sub-projects may be unavailable ex ante, so GHG emissions are currently not calculated. However, the available information should be used in the most plausible way to calculate a reliable estimate whenever possible. JIM and PCAF might also provide a solution for open programmes.

8.3 Policy-based Financing

In the case of Policy-based Financing, the focus is on supporting the development of policies, standards, regulations, budgeting or planning approaches and others. The impacts on emissions will be indirect and cannot be quantified with a reasonable level of confidence. Therefore, in such cases, no quantitative GHG assessment will take place. However, the expected implications in terms of GHG emissions shall be assessed and described qualitatively.

8.4 Technical assistance and consulting services

[8] Operations with FIs which 'intermediate' i.e. on-lend the FC funds to final beneficiaries (including framework loans intermediated through a financial institution), or lend funds to final beneficiaries in relation to FC funds to invest in a portfolio of investee companies.

All consulting services involved in a project (those financed from a technical expert fund, as an accompanying measure or consulting services financed directly by the project itself) are not included in the GHG assessment. Even if consulting services generate Absolute Emissions (e.g. those generated by travelling or using offices), the volume of these emission is too small compared to the GHG significance threshold.

9 Documenting and Reporting

KfW Development Bank plans to report aggregated Absolute Emissions and Emission Reductions as part of its sustainability reporting. Project-specific data is reported in project appraisal documents according to the requirements of the funding entity.

For the purposes of annual reporting, the project figures are prorated in proportion to the FC funding for the project, i.e. financed contract amounts signed in that year compared to its total investment costs. Thus, if KfW Development Bank signs a contract for 25% of a project in a particular year, 25% of the estimated project emissions will be reported in that year. If further contracts are signed for the same project in subsequent years, they will be accounted for separately in the respective year, again using a prorated approach based on the finance contract amount in that year, ensuring that there is no double counting of the impact of a project.

KfW Group’s policy regarding reporting of emissions data is under development and will be decided as part of the ongoing Sustainable Finance Strategy of the group. Evolving German and EU regulations as well as KfW’s strategic development will change requirements over time

ANNEX

ANNEX 1: GHG CLASSIFICATION OF SECTORS / SUBSECTORS FOR FC PROJECTS

The significance classificaton is based on a sectoral assessment of KfW Development Bank portfolio. Emissions are significant if a project has a value of 5.000 tonnes CO2 emissions per year.

Sector *(Information on portfolio relevance relates to the financing volume)*	Sector/ Project type	Calculation Absolute Emissions (AbE) required	Calculation Mitigation (Emission Reduction, ER) required	Comments / Exceptions
Education (110) ***(6% of the portfolio 2014-20)***	Education in general, includes: - Primary and secondary education - Vocational training - Higher education	No	No	**Exception:** Project includes building component (new construction) for over EUR 5 million, then AbE and, if applicable, ER calculation is required[9]
Health (120) ***(5% of the portfolio 2014-20)***	Health in general, includes: - Health infrastructure - Disease-related programs - Reproductive health - Basic nutrition	No	No	**Exception:** Project contains health infrastructure component (new construction) for over EUR 5 million, then AbE and, if applicable, ER calculation is required
Water Supply & Sanitation (140) ***(13% of the portfolio 2014-20)***	Rural water supply and sewage disposal	Yes	No	-
	Desalination plants	Yes	Yes	**Exception:** Calculate ER only if desalination plant would replace large pumping plants for water transport.
	Urban water supply	Yes	No	-
	Urban sewage disposal (for example, Wastewater Treatment Plants (WWTP))	Yes	No	**Exceptions**: **ER <u>shall</u>** be calculated for: • WWTPs where the wastewater is emitted to a water body which has to a great extent anaerobic conditions • Large WWTP's (> 250 000 population equivalents)

Sector ***(Information on portfolio relevance relates to the financing volume)***	**Sector/ Project type**	**Calculation Absolute Emissions (AbE) required**	**Calculation Mitigation (Emission Reduction, ER) required**	**Comments / Exceptions**
	Energy efficiency measures	Yes	Yes	-
	Urban drainage	Yes	No	-
	Integrated water resources management (IWRM) - With/ without afforestation	Assumption AbE = 0	Yes	**Exception:** No AbE and ER required if afforestation measure is not part of the measure.
	Waste disposal/ solid waste management	Yes	Yes	-
Government & Civil Society (150) ***(9% of the portfolio 2014-20)***	State and civil society	No	No	No significant emissions directly attributable to the project (macro-economically oriented, personnel support)
Transport & Storage (210) ***(5% of the portfolio 2014-20)***	Urban mobility / transportation: - Public transport, - Not-motorized transport, - Traffic management, - New technologies and fuels etc.	Yes	Yes	-
	Mobility / transport regional, national, international (road, rail, shipping)	Yes	Yes	-
Energy (230) ***(25% of the portfolio 2014-20)***	Generation based on fossil fuels and the following renewable energies: large hydropower (according to WCD criteria), geothermal energy, biomass, biogas	Yes	Yes	-
	Renewable energy generation (new construction or rehabilitation incl. small to medium hydropower)	Assumption AbE = 0	Yes	**Note:** AbE by definition = 0
	Demand-side energy efficiency	Yes	Yes	-
	Energy access: (rural) electrification/off-grid, mini-grids	Yes	Yes	-
	Transmission and distribution networks	Yes	Yes	-

Sector *(Information on portfolio relevance relates to the financing volume)*	Sector/ Project type	Calculation Absolute Emissions (AbE) required	Calculation Mitigation (Emission Reduction, ER) required	Comments / Exceptions
Banking & Financial Service (240) *(14% of the portfolio 2014-20)*	Credit lines for renewable energy plants	Assumption AbE = 0	Yes	**Note:** Use of energy tools, AbE by definition = 0
	Credit lines with financing mainly of current costs	No	No	**Exception:** Financing of fossil fuels
	SME credit lines energy efficiency	Yes	Yes	**Note:** Use of energy tools
	SME credit lines housing finance	Yes	Yes	**Note:** Calculation based on consulting report
	Deposit protection fund	No	No	-
	Insurances	No	No	-
General Environment Protection (410) *(5% of the portfolio 2014-20)*	Marine biodiversity / sustainable use: protected areas	No	No	A calculation of AbE is not yet possible due to highly variable marine habitats, interactions, and lack of publications.
	Marine biodiversity / sustainable use: Mangroves	Assumption AbE = 0	Yes	-
	Marine biodiversity / sustainable use: aquaculture	No	No	**Exception:** • Absolute emissions must be calculated for intensive aquaculture (due to energy consumption, especially diesel) Emission Reductions shall be calculated for intensive aquaculture if GHG-reduction measures are conducted (e.g. energy efficiency or use of renewable energy)
	Marine biodiversity / sustainable use: fishing	No	No	**Exception:** AbE and ER calculation is required.for measures to increase efficiency of cold chain/ ice production or fishing fleet.
	Terrestrial biodiversity / sustainable use: wetlands/marshes, savannas, temperate zones, etc.	Assumption AbE = 0	Yes	-
	Environmental protection in general, environmental education/research, industrial environmental protection	No	No	**Exception:** ER is required for commercial/ industrial energy efficiency measures

Sector *(Information on portfolio relevance relates to the financing volume)*	Sector/ Project type	Calculation Absolute Emissions (AbE) required	Calculation Mitigation (Emission Reduction, ER) required	Comments / Exceptions
Agriculture (311) ***(2% of the portfolio 2014-20)***	Irrigation	Yes	No	**Exception:** Only if pumps are part of the project, AbE is to be calculated.
	Ecological agriculture	No	No	**Exception:** AbE calculation is required for wet rice cultivation > 1,400 ha.
	Integrated plant protection	No	No	-
	Livestock farming and production	Yes	No	**Exception:** AbE calculation required for rangeland restoration and improved grazing management > 12,500 ha.
	Agroforestry systems	Assumption AbE = 0	Yes	-
	Improved nutrient management	Assumption AbE = 0	Yes	**Exception:** If nitrogen fertilization is increased to > 4,000 ha, AbE calculation is required (AbE > 0).
	Low-emission food production	Yes	Yes	-
	Reduction of food loss and waste	Yes	Yes	-
Forestry (312) ***(1% of the portfolio 2014-20)***	Reforestation/ restoration of forests	Assumption AbE = 0	Yes	-
	Forest conservation incl. REDD+ sustainable forest management	Yes	Yes	As emissions from (reduced) deforestation continue to take place in REDD+ projects, these must be reported.
	Sustainable forest management	Assumption AbE = 0	Yes	-
	Forest conversion/ afforestation in temperate latitudes	Assumption AbE = 0	Yes	-
Other Multisector (430) ***(6% of the portfolio 2014-20)***	(Sustainable) urban development	Depending on the sectoral focus	Depending on the sectoral focus	The need for AbE/ER calculations based on the focus of the funded measures.
	Rural development	Depending on the sectoral focus	Depending on the sectoral focus	The need for AbE/ER calculations based on the focus of the funded measures.
	Research and scientific institutions	No	No	**Exception:** Project contains construction/building component (new construction) for more than EUR 5 million MZ
Other Social Infrastructure & Services (160) ***(3% of the portfolio 2014-20)***	Multisectoral aid for basic social services Social security Low-cost housing Employment opportunities	No	No	**Exception:** Project contains construction/building component (new construction) for more than EUR 5 million MZ

Sector ***(Information on portfolio relevance relates to the financing volume)***	**Sector/ Project type**	**Calculation Absolute Emissions (AbE) required**	**Calculation Mitigation (Emission Reduction, ER) required**	**Comments / Exceptions**
Disaster Prevention & Preparedness (740) ***(0% of the portfolio 2014-20)***	Disaster prevention and preparedness, incl. flood protection	No	No	-
Business & Other Services (250) ***(0% of the portfolio 2014-20)***	Private sector and other services	No	No	-
Industry (321) ***(1% of the portfolio 2014-20)***	Small and medium enterprise development, industrial development	Depending on the sectoral focus	Depending on the sectoral focus	The need for AbE/ER calculations based on the sectoral focus of the project. The AbE/ER calculation check should be based on the focus of the funded measure.
Other approaches not subject to GHG calculation given their insignificant portfolio relevance and subordinate GHG relevance: General budget support **(1% of the portfolio 2014-20)** Development-oriented food aid/food security assistance **(0% of the portfolio 2014-20)** Trading policies and rules/trade-related adjustment measures and tourism **(0% of the portfolio 2014-20)** Non-attributable measures **(1% of the portfolio 2014-20)** Emergency relief and related services **(1% of the portfolio 2014-20)**				

ANNEX 2: DEFAULT EMISSIONS CALCULATION METHODOLOGIES

Method #	Sector & GHG	Calculation Input Data Requirements	Calculation Method
1A	**Stationary fossil fuel or biomass combustion** **CO_2e (incl. CH_4 and N_2O if applicable)**	(i) Annual fuel use in energy units (e.g. TJ, kWh), volume or mass units (ii) Default emission factor (expressed as CO_2e)	Internal GHG Tool for Energy Sector: CO_2e (t) = Fuel energy use * Emissions Factor (see A.2.2)
1B	**Cogeneration Combined Heat and Power (CHP)** **CO_2e**	Direct emissions from fuel combustion to follow methodology 1A, as applicable, above.	Currently not fully covered in FC GHG Tool for Energy Sector
1C	**Purchased electricity** **CO_2e**	(i) Energy Purchased for use in project activities (ii) Country specific emissions factor for electricity consumption or in special cases	CO_2 (t) = Energy use * Country Specific Emissions Factor for Electricity Consumption (see A.2.3)
1D	**Renewable energy** **CO_2e**	(i) Zero or minor Absolute Emissions except for geothermal and hydropower with large reservoir storage capacity (to be calculated based on project specific studies). (ii) Renewable energy is assumed to displace (at least in part) fossil fuels (see electricity generation baseline assumptions).	CO_2 (t) = Energy generated * Country Specific Emissions Factor for Electricity Combined Margin (see A.2.3)
2	**Electricity Transmission & Distribution** **CO_2e**	(i) Annual electricity transmitted/distributed (MWh/a) (ii) Technical losses of transmission / distribution line before and after project implementation (iii) Country specific grid emission factor	CO_2e (t) = ((Technical loss rate before project implementation – Technical loss rate after implementation) X amount of annual electricity delivered through T/D line x country-specific GEF
3	**Industrial processes** **All GHGs**	The main emission sources from industrial processes are those which chemically or physically transform materials. Industrial processes include: • Metal Industry processes, such as aluminium, iron, steel, lead, copper and zinc production. • Chemical industry processes, such as the production of nitric acid, ammonia, adipic acid production • Mineral industry processes, such as cement, lime, glass, soda ash production • Other industry processes such as pulp and paper production	If plant-level information is not available, use 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 3 for default factors. (see here)

		The footprint calculation will include: (i) Emissions from 1A Stationary Combustion of Fossil Fuels (ii) Emissions from 1C purchased electricity (iii) Plant specific process emissions Plant-specific process emissions are those produced for industrial activities not related to energy.	
4	**Waste Water & Sludge Treatment** **CO_2 , CH_4, N_2O**	The main process emission sources from wastewater and sludge treatment and discharge are Methane emissions from Domestic wastewater (Refer to IPCC 2019, Section 6.2) • Methane emissions from Containment • Methane emissions from wastewater treatment process • Methane emissions from discharge from treated or untreated system Nitrous Oxide Emissions from Domestic Wastewater (Refer to IPCC 2019, Section 6.3) • Nitrous Oxide emissions from wastewater treatment process • Nitrous Oxide emissions from discharge from treated or untreated system FC is using three available tools to estimated GHG emissions from wastewater treatment and discharge; (1) French Agency for Development (AFD) GHG calculation tool, especially for calculating emissions in the construction phase (2) ECAM-tool by WaCCliM (3) FC internal tool with a special focus on different design options in water supply projects	Please refer to the IPCC 2019 Refinement to the 2006 Guidelines for National Greenhouse Inventories; Volume 5, Chapter 6: Wastewater treatment and discharge for equations and default EFs. (see here) AFD tool ECAM tool Internal GHG-tool for water projects
5	**Water Supply**	The main emission source for water supply is CO_2 emissions from electricity use. Three available internal tools can be used to estimate GHG emissions from using electricity.	Please refer to the IPCC 2019 Refinement to the 2006 Guidelines for National Greenhouse Inventories; Volume 2, Chapter 2 (see here) AFD tool ECAM tool KfW Internal GHG-tool for water projects
6	**Road transport** **CO_2**	*The internal GHG calculation tool for all projects related to road transport is currently being designed. Following this, the specific sectoral information will be added here*	Please refer to the IPCC 2006 Guidelines for National Greenhouse Inventories, Volume 2, Chapter 3, see here Internal GHG Tool for transport sector (in development)

7	**Rail transport** **CO_2**	*The internal GHG calculation tool for all projects related to rail transport is currently being designed. Following this, the specific sectoral information will be added here.*	Please refer to the IPCC 2006 Guidelines for National Greenhouse Inventories, Volume 2, Chapter 3, see here, and Chapter 2 (see here) Internal GHG Tool for transport sector (in development)
8	**Urban transport** **CO_2**	*The internal GHG calculation tool for all projects related to urban transport is currently being designed. Following this, the specific sectoral information will be added here.*	Please refer to the IPCC 2006 Guidelines for National Greenhouse Inventories, Volume 2, Chapter 3, see here Internal GHG Tool for transport sector (in development)
9	**Reservoirs** **CO_2, CH_4**	(i) Flooded total surface area (ii) CO_2 diffusive emissions factor (table A.2.8) (iii) CH_4 diffusive emissions factor (table A2.8) (iv) CH_4 bubbles emissions factor (table A2.8) The large uncertainties associated with IPCC emissions factors should be noted.	CO_2 = 365 * ii * i CH_4 = (365 * iii * I) + (365 * iv*i)) Conversion factors to convert to CO_2e, see table at A2.8
10	**Waste Treatment Facilities / Solid Waste Landfill**	*The internal GHG calculation tool for all projects related to solid waste facilities and solid waste landfills projects is currently being updated. Following this, the specific sectoral information will be added here* The tool will be used for • Solid waste collection, transfer, treatment and/or disposal • Waste biomass treatment instead of disposal Timeframe: The calculation of GHG emissions covers the phase of filling the landfill (mostly 3 to 7 years) and the phase of aftercare. For GHG calculation the first 20 years of aftercare are taken into account.	Please refer to the IPCC 2019 Refinement to the 2006 Guidelines for National Greenhouse; Volume 5 (see here) (New Tool in development)
11	**Refrigeration / Air conditioning / Insulation Industry HFCs**	A variety of industrial processes involve refrigeration and air conditioning and thus indirectly employ HFCs. It is recommended that only where the manufacture and use of such equipment is a major aspect of a project should an assessment be undertaken. In such cases the user is referred to IPCC 1996 Reference Manual for recommended sector -specific calculation methods. See link at A.2.8 for GWP of HFCs.	See table of GWP for HFCs (table: A.2.8)
12	**Building Refurbishment** **CO_2e**	(i) Electric Energy Purchased for use in the buildings (ii) Thermal Energy/ fuel purchased for use in the buildings (iii) Project specific heat emissions factor (District Heating, fossil fuel boilers (building or apartment level)	CO_2e (t) = electric energy use * country specific emissions factor for electricity consumption + heat energy use * project specific heat emission factor

		(iv) Country specific emission factors (see link at A.2.3)	
13	**Forestry** **CO_2, N_2O**	Emissions and Carbon Removal levels in Improved Forest Management projects are calculated on an average annual basis over the full rotation cycle (economic lifetime) of the forest. Depending on data availability and significance this can be estimated via a global default factor of 1tCO_2e per ha per year or through a detailed assessment of forest management and growth rate. Further information can be found in ANNEX4: FORESTRY EMISSIONS CALCULATION METHODOLOGY. For prevented tropical deforestation (=forest conservation) the user is referred to the UNFCCC REDD+ calculations or https://globalforestwatch.org/ to adequately estimate baseline deforestation rates. Afforestation/reforestation projects follow the approach described in section of this document 7.4 Carbon Removal (CR, Sequestration). For prevented tropical deforestation the user is referred to the calculations.	UNFCCC REDD+ calculations
14	**Peatlands** **CO_2, CH_4**	A detailed methodology for the calculation of emissions of a peatland project can be found in the latest version of the Verra VCS methodology catalogue. A non-updated list is below: • VM0004 - Avoided land use conversion; • VM0027 - Rewetting tropical wetlands • VM0036 - Rewetting temperate wetlands	Verra VCS methodology catalogue. VM0004 - Avoided land use conversion; VM0027 - Rewetting tropical wetlands VM0036 - Rewetting temperate wetlands
15	**Agriculture**	Sustainable agricultural land management (SALM) or Climate-smart agriculture (CSA) can reduce emissions from various sources such as from mineral fertilizers or burning and increase carbon removals through biomass and soil organic carbon. Different activities require different ways of calculation and the user is referred to the 2006 IPCC Guidelines for National Greenhouse Gas inventories and the applicable 2019 Refinement. The use of tools which apply these guidelines, such as the FAO EX-ACT are permissible.	FAO EX-ACT See links to agriculture and forestry emission factors at A.2.7
16	**Financial Sector**	*KfW is analysing right now using the Joint Impact Model (JIM) and the PCAF method) to calculate emissions in Financial sector projects. Following this, the specific sectoral information will be added here*	*n/A*

Table A2.1: Specific methodologies and tools used for Sectors/subsectors

A2.2: Links to general Default Emission Factors

The Default Emission Factors for Fuels applied by KfW (and incorporated in its relevant GHG tools) are based on the
2006 IPCC Guidelines for National Greenhouse Gas Inventories which can be retrieved here.

A2.3 Links to Country Specific Electricity Emission Factors

The Country Specific Electricity Emission Factors applied by KfW (and incorporated in its relevant energy sector GHG tool) are based on the IFI Dataset of Default Grid Factors v.3.1 (updated in January 2022), which was created by the IFI Technical Working Group on GHG Accounting. The IFI dataset can be found here. The calculation methodology for the dataset (published in July 2019) can be found here.

A2.4 Links to Water Supply and Wastewater Emissions Factors

Emission factors and methodologies applicable to the water supply (energy consumption in supply facilities) and wastewater sectors can be found here and here

A2.5 Links to Transport Emissions Factors

Emissions from transport can be found here

A2.6 Links to Waste Treatment Facilities / Solid Waste Landfill Emissions Factors

An overview of the emission factors and methodologies applied can be found here

A2.7 Links to Agriculture and Forestry Emissions Factors

The IPCC 2019 Refinement to the 2006 IPCC can be found here

Table A2.8 IPCC Global Warming Potential (GWP) Factors

Source: IPCC Sixth Assessment Report, 2021 (AR6). The full table can be found here.

Gas	Chemical formula	Global warming potential (100-year time horizon)
Carbon dioxide	CO_2	1
Methane	CH_4	27.9
Nitrous oxide	$N_{2}0$	273
Hydrofluorocarbons (HFCs)		
HFC-23	CHF_3	14,600
HFC-32	CH_2F_2	771
HFC-41	CH_3F_2	135
HFC-43-10mee	$C_5H_2F_{10}$	1,600
HFC-125	C_2HF_5	3,740
HFC-134	$C_2H_2F_4$ (CHF_2CHF_2)	1260
HFC-134a	$C_2H_2F_4$ (CH_2FCF_3)	1526
HFC-143	$C_2H_3F_3$ (CHF_2CH_2F)	364
HFC-143a	$C_2H_3F_3$ (CF_3CH_3)	5810
HFC-152a	$C_2H_4F_2$ (CH_3CHF_2)	164
HFC-227ea	C_3HF_7	3600
HFC-236fa	$C_3H_2F_6$	8690
HFC-245ca	$C_3H_3F_5$	787
Hydrofluoroethers (HFEs)		
HFE-449sl (HFE-7100)	$C_4F_9OCH_3$	460
HFE-569sf2 (HFE-7200)	$C_4F_9OC_2H_5$	60.7
Perfluorocarbons (PFCs)		
Perfluoromethane (tetrafluoromethane) PFC-14	CF_4	7,380
Perfluoroethane (hexafluoroethane) PFC-116	C_2F_6	12,400
Perfluoropropane PFC-218	C_3F_8	9,290
Perfluorobutane PFC-31-10	C_4F_{10}	10,000
Perfluorocyclobutane PFC-318	c-C_4F_8	10,200
Perfluoropentane PFC-41-12	C_5F_{12}	9,220
Perfluorohexane PFC-51-14	C_6F_{14}	8,620
	SF_6	

**Note: IPCC AR6 also differentiates the global warming potential of methane depending on fossil (GWP-100: 27.2) and non-fossil (GWP-100: 29.8) sources.*

ANNEX 3: APPLICATION OF ELECTICITY GRID EMISSION FACTORS FOR PROJECT BASELINES

1. ELECTRICITY GENERATION PROJECTS

With respect to energy generation projects, it is recommended that for grid-connected electricity generating projects a combined margin, which is a weighted average of operating margin and build margin should be used to define the Baseline Emissions of the project. For this purpose, KfW Development Bank will use the figures from the IFI Dataset of Default Grid Factors v.2.0 from July 2019, which was created by the IFI Technical Working Group on GHG Accounting.

2. PURCHASED ELECTRICITY

Projects that purchase electricity from the grid must take into account the losses from the transmission and distribution (T&D) of the electricity. The size of the losses will depend on the project's capacity, i.e. whether it is connected to the high, medium or low voltage grid. The grid emission factors, including T&D losses, are located in the link under A.2.3. For simplicity T&D losses are assumed to be as follows:

- High voltage grid: 2% T&D losses. Projects with >10MW consumption generally will be connected to the high voltage grid, e.g. high-speed rail, large heavy industry projects
- Medium voltage grid: 4% T&D losses. This includes most industry projects
- Low voltage grid: 7% T&D losses. This includes all residential and commercial projects.

3. NETWORK INVESTMENTS – GAS AND ELECTRICITY

Networks are transporters of energy and are usually mandated to meet supply requirements/demand growth. The baseline will usually supply the same amount of energy as the project, either less efficiently (without the project) or using similar new infrastructure (no economic alternative). For the purposes of the carbon footprint methodology, the investments in gas and electricity transmission and distribution networks are divided into 3 categories. Each category is characterised by its objectives and its contribution to GHG emissions:

i) Some investments are primarily intended to improve commercial operations, service quality and/or security of supply. These investments may facilitate customer billing or reduce O&M costs, or they may be required by the regulator or mandated to meet new environmental/safety standards. The investments are characterised as having little or no impact on GHG emissions and their effects are excluded from the carbon footprint calculation.

ii) Other investments are required to maintain the condition of the existing network. These investments are characterised by the **rehabilitation/replacement** of existing assets and are intended to ensure the long term supply of electricity or gas. Energy losses (for electricity transmission and distribution networks), energy consumption (for gas transmission and distribution networks) and fugitive emissions (for gas distribution networks) are the main sources of GHG emissions. The carbon footprint for these investments is based on a percentage share of the total emissions for the network that is in proportion with the percentage share of the network assets replaced or rehabilitated.

Calculation: CO_2 emissions are estimated for the entire network and an emissions factor per unit of supply is calculated. The volume of supply used is that of the last year of operation, prior to start of project construction. Assumptions are made about the emissions factor with and without the project. In most cases, emissions for the current level of supply would go up without the investment. The percentage share of the network assets replaced/rehabilitated is estimated. Carbon footprints (absolute and baseline) are calculated using this percentage share of the total emissions of the network (with and without the project) for the pre-project levels of demand.

iii) Still other investments are required to meet growing demand. These investments are characterised by **network extensions**, upgrades of capacity and new connections. In reality, these investments are difficult to separate physically from the rehabilitation and replacement of assets or even from those required for commercial or regulatory reasons, but their GHG emissions impact is related to increasing the supply of electricity or gas through the entire network.

Calculation: CO_2 emissions factors (with and without the project) per unit of supply are estimated as above. These factors are applied to the incremental demand that is accommodated as a result of the project (typically 3-4 years of demand growth). All emissions associated with the incremental demand are attributed to the project.

ANNEX 4: FORESTRY CARBON REMOVAL CALCULATION METHODOLOGY

Generally, forest management data and plans are sparse in developing countries. Without such forest management data, a detailed assessment of the carbon footprint is not possible. Additional data collection is resource-intensive and at the same time unjustifiable with regards to relatively little Carbon Removal potential (when e.g. compared to afforestation or forest protection).
In light of this background, there are two options at FC to calculate the Carbon Removal of forestry projects. The choice is up to the operational team and depends on the significance of Carbon Removal and data availability.

Option 1

Option 1 is mostly applicable to projects with low data availability and/or little extent of project area (<1,000 ha) and/or little emphasis in the overall project targets.

Assume a global default Carbon Removal rate of **1 tCO_2e per hectare per year, over a period of 20 years**.

This default figure is informed by the average of all improved forest management (IFM) projects in the database of the Verified Carbon Standard (March 2018, N =11). The average equals a Sequestration rate of 3 tCO_2e per hectare per year globally. This figure has been reduced by two-thirds to conservatively account for differences in different forest types, growth rates, and baseline conditions.

Option 2

Option 2 is a detailed assessment of Absolute Emissions in forestry projects. It is mostly applicable to projects with existing forest management plans and/or large extent of project area (>1,000 ha). Also, if a detailed assessment is required, e.g. due to a high emphasis in the overall project targets or political reasons, option 2 shall be chosen.

The operational boundary of forestry projects, which defines the emission sources to be included for forestry projects, includes:

- **Scope 1 emissions**
  - Fuel consumption associated with site preparation, management, etc.
  - Emissions from fertilizer use
- **Scope 2 emissions**
  - Electricity consumption
- **Scope 3 emissions**
  - Not included
- **Carbon Removal**
  - Carbon sequestration due to biomass growth
  - Loss of carbon sequestration due to biomass removals (e.g. thinning and harvesting)

The Absolute Emissions are measured as the average annual emissions over the project lifetime:

$$\begin{aligned} \mathit{Absolute\ emissions}\left(\frac{t\ CO_2e}{year}\right) &= \mathit{average\ annual\ fuel\ consumption\ emissions}\left(\frac{t\ CO_2e}{year}\right) \\ &+ \mathit{average\ annual\ fertilizer\ consumption\ emissions}\left(\frac{t\ CO_2e}{year}\right) \\ &+ \mathit{average\ annual\ scope\ 2\ emissions}\left(\frac{t\ CO_2e}{year}\right) - \mathit{average\ annual\ carbon\ removal}\left(\frac{t\ CO_2e}{year}\right) \end{aligned}$$

Emissions and Carbon Removal levels are calculated on an average annual basis over the full rotation cycle (economic lifetime) of the forest and not only the project lifetime. Taking an average over this time-period is important as biomass growth and carbon Sequestration is not linear for forest growth due to changing growth rates depending on the forest management regime applied, impact of thinning and harvesting, other management interventions, and natural conditions. GHG emissions and removals related to the management of forest resources are accounted as per the LULUCF Regulation EU 2018/841 EU. Wood removals as part of sustainable forest management practices (such as tending, thinning, and final cuts followed by forest regeneration) increase carbon Sequestration at a general forest inventory level in comparison to unmanaged or poorly managed forests.

Unmanaged or poorly managed forests have much lower growth rates as compared to sustainably managed forests. In addition, sustainable forest management activities also apply the concept of preserving high biodiversity and high carbon stock areas such

as peatlands. The economic lifetime is generally aligned with the time of harvesting, meaning that GHG removals from harvesting is accounted for when calculating the average annual carbon Sequestration.

The *average annual fuel consumption emissions* related to forest management are calculated by multiplying the fuel average annual fuel consumption over the forest's economic lifetime (e.g. diesel, gasoline, etc.) with the standard fuel-specific emission factor (e.g. kg CO_2e/litre).

The *average annual fertilizer consumption emissions* (on the field) are calculated by multiplying the input consumption (e.g. tons of fertilizer) with an input-specific emission factor (t CO_2e/t of input) from acknowledged databases such as Ecoinvent or emission factor information from the input producer.

When calculating the *average annual carbon Removal* in forest biomass, KfW accounts for annual forest biomass growth (annual increment), as well as for forest biomass reductions due to forest tending, thinning and harvesting activities within the full economic lifetime (rotation cycle) of the forest (i.e. which is typically longer than then the project lifetime). Such biomass reductions are directly subtracted from the carbon sequestered.

Carbon Removal is accounted for both belowground and aboveground biomass. Based on IPCC Guidelines[10], the following formula is used to calculate the average annual carbon Removal of KfW's forestry projects measured in t CO_2e/year:

$$Average\ annual\ carbon\ sequestration\ \left(\frac{t\ CO_2e}{year}\right) = \left[MAI\left(\frac{\frac{m^3}{ha}}{year}\right)\right] x\ [BCEF]\ x\ [1 + R]\ x\ \left[CF\ \left(\frac{t\ C}{t\ dry\ matter}\right)\right] x\ \left[CCF\ \left(\frac{t\ CO_2e}{t\ C}\right)\right] x\ [Forest\ area\ (ha)]$$

Where:

- *MAI - Mean annual increment* (or mean annual growth) refers to the average growth per year of a forest stand, which is a variable depending on the specific local site and climate conditions, tree species, rotation period, forest management practices applied (e.g. intensity of tending/thinning operations), etc. The MAI used by KfW is calculated for the local specific conditions and forest management practices applied in each project. The information on MAI is provided by project promotors at project appraisal and then scrutinized against KfW's own expert knowledge and default MAI values from sources such as FAO's data on forests growth[11] or IPCC Guidelines.
- *BCEF (biomass conversion and expansion factor)* refers to the expansion factor of merchantable growing stock volume to above-ground biomass. BCEF transforms merchantable volume of growing stock directly into its aboveground biomass. BCEF values are more convenient because they can be applied directly to volume-based forest inventory data and operational records, without the need of having to resort to basic wood densities (D). They provide best results, when they have been derived locally and based directly on merchantable volume. However, if BCEF values are not available and if the biomass expansion factor (BEF) for wood removals, which is dimensionless, and wood density (D) values are separately estimated, the following conversion can be used:
  $$BCEF = BEF\ x\ D\ (\frac{t}{m^3})$$
  If country-specific data on roundwood removals are not available, expert knowledge or FAO statistics on wood harvests will be used. Given that FAO statistical data on wood harvests exclude bark, the FAO statistical wood harvest data without bark will be multiplied by a default expansion factor of 1.15 to convert it into merchantable wood removals including bark.
- *D (wood density)* – the basic wood density (expressed in tons/m^3) varies by species and climate conditions (0.2 to 0.9 in tropical forests and 03 to 0.6 in temperate forests). Wood density is conservatively estimated based on expert knowledge and available reference documents[12], and the default used value is 0.5 tons/m^3.
- *R* refers to *ratio of belowground biomass to aboveground biomass* or root to shoot ratio for a specific vegetation type, in tonne dry matter belowground biomass (tonne dry matter aboveground biomass)$^{-1}$. R is conservatively estimated based on expert knowledge and available reference documents and must be set to zero when assuming no changes of belowground biomass allocation patterns.

[10] 2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 4: Agriculture, Forestry and Other Land Use
[11] FAO's Global Planted Forests Assessment: Global planted forests thematic study (2006)
[12] Overview of wood densities for several different tree species: from Estimating Biomass and Biomass Change of Tropical Forests: a Primer. (FAO Forestry Paper - 134); 2006 IPCC Guidelines for National Greenhouse Gas Inventories – Volume 4: Agriculture, Forestry and Other Land Use

- *CF* is a conversion factor that refers to *carbon fraction of dry matter*, expressed in tons of C per ton of dry matter. Using a conservative approach of default values for wood carbon content[13], the default CF *value* assumed in calculations is 0.5 (t C/t dry matter).

- *CCF* – is *carbon conversion factor from C to CO_2e* calculated as follows:

$$conversion\ factor\ from\ C\ to\ t\ CO_2e = \frac{12 + (16\ x\ 2)}{12} = 3.67$$

- *Forest area (ha)* is the project's forest area provided by the Promotor and verified by the KfW.

After having calculated the Absolute Emissions from the project and the Absolute Emissions of the baseline (calculated based on the same methodology as *with project* scenario), the Emission Reductions can be estimated. The Emission Reductions are calculated by subtracting the Baseline absolute emissions from the project Absolute Emissions:

$$Emission\ Reductions\ \left(\frac{t\ CO_2e}{year}\right) = Project\ Carbon\ Removal\ \left(\frac{t\ CO_2e}{year}\right) - \ Baseline\ Carbon\ Removal\ \left(\frac{t\ CO_2e}{year}\right)$$

For the baseline definition, FC assumes zero Baseline Carbon Removal for afforestation projects, while it does not assume a zero baseline for forest rehabilitation where, for example, the MAI is improved through forestry management practices in comparison to the baseline. The reason is that in case of forest rehabilitation, a forest is generally already existing, but either unmanaged or poorly managed, meaning that carbon is also sequestered in the baseline scenario, however at a lower level compared to sustainably managed forests.

[13] At present, 50% carbon content (w/w or "weight by weight", the proportion of carbon compared to wood mass, as measured by weight) is widely promulgated as a generic value for wood. Carbon in kiln-dried hardwood species, for example, ranged from 46.27% to 49.97% (w/w), in conifers from 47.21% to 55.2% (see Lamlom & Savidge (2003): A reassessment of carbon content in wood: variation within and between 41 North American species).

GLOSSARY

Absolute Emissions (AbE). A project annual GHG emissions estimated for an average year of operation.

Avoided Emissions (AvE) Avoided Emissions refer to Deforestation and Forest Degradation projects and capture the expected Emission Reductions against the baseline case.

Baseline Emissions (BaE). The project Baseline Emissions arise from the expected alternative scenario that reasonably represents the anthropogenic emissions by sources of GHGs that would have occurred in the absence of the project, estimated for an average year of operation.

Baseline Removal (BaR). Calculated Carbon Removal without the project.

Carbon Footprint. A Carbon Footprint is the climate impact (GHG emissions) of a project.

Carbon Removal (CR). Emission Removal is the natural or technical capture of carbon dioxide from the air and its permanent storage or utilisation.

GHG Emissions. Greenhouse Gas emissions are fugitive, combustion or chemical processes related emissions from sources that are owned or controlled by the reporting company inside the project boundary. See Scope 1 emissions.

GHG Protocol. GHG Protocol establishes comprehensive global standardized frameworks to measure and manage greenhouse gas (GHG) emissions from private and public sector operations, value chains and mitigation actions.

Emissions. The release of GHG into the atmosphere.

Emission Factor. A factor allowing GHG emissions to be estimated from a unit of available activity data (e.g. tonnes of fuel consumed, tonnes of product produced) and gross GHG emissions.

Emission Reductions (ER). Emission Reductions result from a comparison of “with project” and “without project” scenario emissions for a typical year of operation.

Fugitive Emissions. Emissions that are not physically controlled but result from the intentional or unintentional releases of GHGs. They commonly arise from the production, processing transmission storage and use of fuels and other chemicals, often through joints, seals, packing, gaskets, etc.

Framework Loan. Loan to finance a certain investment programme, not having defined the specific measures ex ante, i.e. programmes channelled via financial intermediaries.

GHG. Greenhouse gases. GHGs are the seven gases listed in the Kyoto Protocol: carbon dioxide (CO_2); methane (CH_4); nitrous oxide (N_2O); hydrofluorocarbons (HFCs); perfluorocarbons (PFCs); sulphur hexafluoride (SF_6); and nitrogen trifluoride (NF_3).

GHG Accounting. Systematic recording, monetary and non-monetary evaluation and the monitoring of direct and indirect GHG emissions.

GHG Assessment. Calculation of project related emissions in order to answer the question: “What impact is the project / a project portfolio having on the build-up of greenhouse gases in the atmosphere.

Global Warming Potential (GWP). A factor describing the radiative forcing impact (degree of harm to the atmosphere) of one unit of a given GHG relative to one unit of CO_2 over a given period of time.

Indirect GHG Emissions. Emissions that are a consequence of the operations of the project but occur at sources owned or controlled by another company e.g. purchased electricity. See Scope 2 and Scope 3 emissions.

Pop. Eq. Population Equivalent in waste water treatment is the number expressing the ratio of the sum of the pollution load produced during 24 hours by industrial facilities and services to the individual pollution load in household sewage produced by one person in the same time.

Process Emissions. Emissions generated from manufacturing processes, such as the CO_2 that arises from the breakdown of calcium carbonate ($CaCO_3$) during cement manufacture

Project boundaries. The boundaries that determine the direct and indirect emissions associated with operations owned or controlled by the project. This assessment allows a project developer (investor) to establish which operations and sources cause direct and indirect emissions, and to decide which indirect emissions to include that are a consequence of the project operations

Relative Emissions. The difference (delta) between the absolute project emissions and the baseline scenario emissions. The term captures the case that a project actually increases emissions over a baseline, i.e. generates “negative emission reductions”. Even though this term might be scientifically more appropriate, the term “Emission Reductions” reflects the ambition of FC to actually reduce emissions.

Sequestration. See Carbon/Emissions Removal.

Significant Emissions. project with Absolute Emissions exceeding 5.000 tonnes CO2e per year.

Typical year of operation. In calculating the Absolute or Relative Emissions of a project, a typical year of operation is used in which the project operates at normal capacity. This means excluding emissions from construction or decommissioning and unexpected outages and maintenance activities. In many cases, it is the average year over the lifetime of the project.

“With” Project Removal (WpR). Calculated Carbon Removal for “with project scenario”.

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