Guidance Document on typical approaches for estimating emission reductions from IKI project activities

Energy Sector (Energy Supply incl. Renewable Energies)

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List of Abbreviations

AC	Air conditioning
AFOLU	Agriculture/Forestry/Other Land Use
AR5	Fifth Assessment Report
BAU	Business-as-Usual
BE	Baseline emissions
BESS	Battery Energy Storage System
CDM	Clean Development Mechanism
CO_2e	Carbon dioxide equivalents
EC	Energy consumption
EF	Emission factor
ER	Emission reductions
GEF	Grid emission factor
GHG	Greenhouse gas emissions
GHGP	GHG Protocol
GS	Gold Standard
ICE	Internal combustion engine
IKI	International Climate Initiative
LPG	Liquefied petroleum gas
PE	Project emissions
SI 1	Standard Indicator 1
VCS	Verified Carbon Standard

1 Introduction and purpose

The International Climate Initiative (IKI) has been using Standard Indicators since 2015 to assess the effects and results of its portfolio. In 2021, these indicators were revised to provide more precise information on IKI results and improve the data quality. Since 2022, all new IKI projects are required to use this revised set of Standard Indicators[1].

An important change relates to Standard Indicator 1 - Mitigation (SI 1 - Mitigation) with stricter requirements for IKI projects. SI 1 - Mitigation measures the degree to which IKI project activities contribute to reducing greenhouse gas emissions (GHG) during project implementation, i.e. projects must transparently present assumptions and parameters for target and actual values in metric tonnes of CO_2 equivalents (CO_2e).

IKI projects have the potential to lead to GHG reduction or the enhancement of carbon stocks in various sectors. To support IKI projects to identify typical approaches for estimating emission reductions, the IKI Standard Indicator Helpdesk provides several guidance documents for the most relevant sectors / mitigation areas: Energy, Agriculture/Forestry/Other Land Use (AFOLU), Buildings and Transport.

This Guidance Document on **Energy** presents typical approaches for estimating emission reductions from IKI project activities in the energy sector. Through the fictitious project "Solar energy-based water treatment for hospitals", the methodological approach is explained in detail and further guidance for IKI implementing organisations is provided. This Guidance covers the following points:

(1) Common understanding of direct and indirect mitigation,
(2) typical emission sources for emission reduction activities / measures in the target sector,
(3) typical baseline and project scenario (and leakage emissions, if applicable),
(4) calculation of emission reductions, illustrated with sample calculations using the IKI Standard Indicator Report (Excel Tool), and
(5) relevant default values and reference sources are provided, incl. tips for helpful resources and other tools in the respective sector.

This Guidance Document complements the Guidelines on Project Planning and Monitoring in the International Climate Initiative - Version 2. In the Guidelines the guidance sheet on Standard Indicator 1 - Mitigation (Section 6.2.1) includes helpful methodological guidance on estimating projects' direct or indirect GHG emission reductions. Additional guidelines and online seminars regarding the estimation of GHG reductions / carbon stock enhancements are available on the IKI website. Further helpful information on mitigation estimation can be found in the Mitigation Action Facility Mitigation Guideline (2023)[2], which has also been used for this document.

[1] IKI Monitoring and Evaluation (M&E) Unit (2023): Guidelines on Project Planning and Monitoring in the International Climate Initiative. Version 2; Chapter 6.1. Retrieved from here.

[2] Mitigation Action Facility (2023): Mitigation Action Facility Mitigation Guideline (Outline & Proposal Phase). Retrieved from here, and Mitigation Action Facility (2023): Mitigation Guideline for the Project Concept Phase. Retrieved from here.

2 IKI understanding of direct and indirect mitigation

Within SI 1 - Mitigation, the IKI differentiates between direct and indirect GHG mitigation, which need to be reported quantitatively in tonnes of CO_2e. In addition, the Standard Indicator also captures qualitative information related to potential long-term mitigation impacts of enhanced policy frameworks.

Box 1: Differentiation between direct and indirect GHG mitigation

Direct mitigation: GHG emission reduction / carbon stock enhancement through financing of mitigation measures

Direct GHG emission reduction / carbon stock enhancement refers to the amount of CO_2e reduced, avoided, or sequestered immediately through mitigation measures that are (partly) financed by the IKI project or measures.

Indirect mitigation: GHG emission reduction / carbon stock enhancement through technical support of mitigation measures

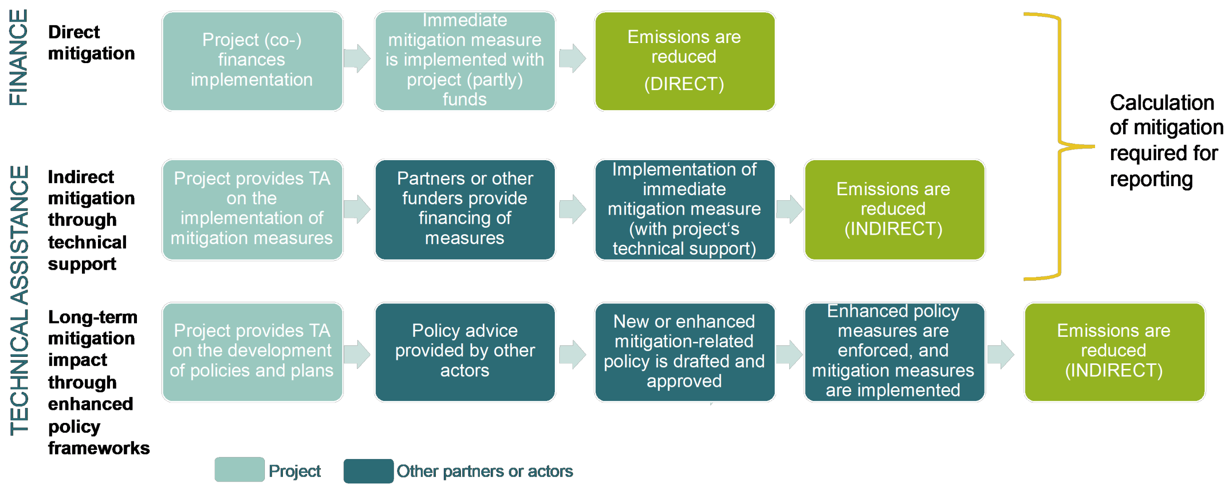
Indirect GHG emission reduction / carbon stock enhancement refers to an amount of CO_2e reduced, avoided, or sequestered with the help of IKI-funded technical assistance or capacity development measures. This includes cases where a physical mitigation measure was financed by an actor other than the IKI (e.g. a city government in a partner country) but where the IKI delivers crucial technical implementation support.

Enhanced policy frameworks: Long-term mitigation impact through enhanced policy frameworks

This category captures substantial contributions of IKI projects to new or improved policies, strategies or plans that are expected to lead to substantial long-term mitigation impacts in the future if they are fully implemented. In order to report on this category, projects need to plausibly contribute to an improvement in policy frameworks that increases the potential long-term mitigation impact of the policy. This can be achieved through more ambitious but realistic targets or through increasing the feasibility of implementing the policy framework.

Figure 1 illustrates simplified causal chains for each of the categories. Further details and examples for each category of mitigation action can be found in the SI 1-Indicator Guidance Sheet in Guidelines on Project Planning and Monitoring in the International Climate Initiative - Version 2.

Figure 1: Simplified causal chain for reporting categories in SI 1



IKI projects can only report on the Standard Indicator, if the contributions to mitigation fall within any of the three reporting categories defined above: direct / indirect mitigation / potential future GHG emission reductions/carbon stock enhancement through enhanced policy frameworks. Projects should indicate whether and how they contribute to direct and/or indirect mitigation and shall provide separate estimates for these in the respective sheets for Standard Indicator 1 in the **IKI Standard Indicator Report (Excel Tool)** available here on the IKI website. Regarding the long-term mitigation impact through enhanced policy frameworks, projects are not asked to calculate projected future emissions reductions / carbon stock enhancements resulting from policy implementation. Projects are expected to name the policy frameworks they address and explain how they contribute to strengthening the mitigation potential of these policies.

The following chapters focus on the estimation of emission reductions which can be used for direct and indirect mitigation.

3 Typical emission sources and emission reduction activities in the energy sector

Fossil fuel combustion is the largest contributor to energy-related emissions. To achieve energy and climate goals, it is crucial to understand the characteristics of the fuels used, the sectors of production and macroeconomic factors driving emission trends. An economy's CO_2 emissions from fuel combustion depend on its population size, per capita wealth, energy intensity of the economy and carbon intensity of the energy mix. Especially the carbon intensity of the energy mix is the focus of most economies' decarbonisation efforts.

Despite efforts to decarbonise the energy sector, electricity and heat generation account for over 40% of global CO_2 emissions from fuel combustion, with coal-fired power plants causing over 70% of the associated emissions. CO_2 emissions from electricity generation are determined by the following factors: Types / technologies of electricity generation, efficiency of electricity generation, share of fossil fuels in total electricity generation and carbon intensity of electricity generated from fossil fuel sources.

The energy sector primarily consists of projects focused on reducing GHG emissions in electricity generation, heat production, and the implementation of energy storage solutions for renewable sources. Additionally, projects in the energy sector encompass energy efficiency improvements which reduce the amount of energy use required. These activities can involve both public and private / commercial sectors.[3]

Options to avoid and reduce GHG emissions in the energy sector comprise:

- Use of **renewable energies for power generation**, e.g.
  - Solar energy for centralised grids
  - Solar energy for isolated grids and autonomous systems
  - Wind energy
  - Ocean energy
  - Geothermal energy
  - Biofuel fired power plants
  - Hydroelectric power plants
- Use of **renewable energies for heating and cooling**, e.g.
  - Solar energy - thermal applications
  - Biomass
  - Biogas
  - Heat pumps
  - Geothermal energy
- Increasing **energy efficiency in electricity generation**, such as
  - Combined heat and power plants
  - District heating and cooling systems
- Improving **energy distribution**, through the use of e.g.
  - Modern electricity transmission and distribution (centralised grids)
  - Modern electricity transmission and distribution (isolated mini-grids)
  - Modern urban infrastructure for the supply of natural gas and the production, distribution and refilling of liquefied petroleum gas (LPG) cylinders.
  - Infrastructures for electric mobility
- **Energy efficiency measures** to reduce the consumption of consumed electricity and energy.
  - Use of energy-efficient equipment
  - Energy efficiency in the manufacturing / industry sector

[3] Mitigation Action Facility (2023): Mitigation Action Facility Mitigation Guideline for the Project Concept Phase (p.15), Retrieved from here.

4 How to assess the results from mitigation actions

4.1 Basic formula to estimate emission reductions

In order to assess the impact of mitigation efforts, it is essential to compare the GHG emissions resulting from a proposed action against a baseline. This involves analysing the energy use and fuel consumption both before and after the implementation of the project.

The calculation of emission reductions achieved by the project may vary according to the project type and underlying mitigation measures to be implemented. In general, the assessment of the mitigation impact, measured in terms of reduction of tCO_2e, is based on comparing the level of GHG emissions before **(baseline scenario)** and after implementing the project's mitigation activity **(mitigation or project scenario),** considering any **leakage emissions**. The calculation procedure for determining GHG emission reductions generally follows a standardised approach: The achieved **emissions reductions** from a project and/or mitigation activity are typically calculated as the **difference between baseline emissions and emissions after project implementation**, considering any potential leakage.[4]

$$ER_y = BE_y - PE_y - LE_y \quad \text{Equation (1)}$$

Where:

ER_y	=	Emission reductions in year y (tCO_2)
BE_y	=	Baseline emissions in year y (tCO_2)
PE_y	=	Project emissions in year y (tCO_2)
LE_y	=	Leakage emissions in year y (tCO_2)

To accurately determine the required parameters and data for the calculation in Equation (1), it is necessary to identify the emission sources and GHGs associated with each technology. Established carbon market methodologies and standards can be used as a reference to identify technology-specific emission sources and GHGs associated with the baseline and project scenario (see below).

4.2 Suitable methodological approaches

To calculate the associated emission reductions (ER), a suitable methodological approach should be determined. It is advisable to make use of approved and recognised methodologies, e.g. sourced from the Clean Development Mechanism (CDM), the Global Environment Facility (GEF), the Gold Standard (GS), GHG Protocol (GHGP), or Verified Carbon Standard (VCS).

4 Mitigation Action Facility (2023): Mitigation Action Facility Mitigation Guideline for the Project Concept Phase (pp. 14-15). Retrieved from here.

Any necessary simplifications of these methods should be considered and applied as required and feasible. This guidance is in line with the general principles of these recognised methodologies.

Box 2: Sources for identifying applicable methodological approaches for the energy sector

To identify suitable methodological approaches and useful default / reference values,

- check other projects that estimated emission reduction from same / similar activities and potentially provided excel calculation sheets as reference, e.g.
  - CDM Project Search, VERRA / VCS Project Registry, Gold Standard Project Registry etc.
  - consult existing methodologies: CDM, VCS etc., e.g. in the CDM Methodology Booklet
- consult and use simplified tools for the estimation, if existing. For example:
  - SEforAll Minigrid Emission Tool
  - The Global Environment Facility Manual for Calculating GHG Benefits of GEF Projects: Energy Efficiency and Renewable Energy Projects
  - GHG Protocol Calculation Tool and Guidance, with related energy calculation tools
  - IGES CDM Emission Reductions Calculation Sheet Series for typical project types (waste energy recovery, treatment of wastewater, electrification of rural communities using RE, efficient lightning, composting, landfill, manure management)
- make use of default values and reasonable assumption source from references, e.g.
  - CDM TOOL33 Methodological tool: Default values for common parameters
  - Harmonized IFI Default Grid Factors 2021 v3.2

For energy projects on renewable energies and energy efficiency measures, small-scale CDM methodologies provide a good orientation on the calculation approaches for a majority of projects related to power and thermal energy generation. For a complete list of CDM methodologies, please consult CDM: Approved SSC methodologies (unfccc.int).

Table 1: Recommendations for appropriate CDM methodologies

Methodology / Tool	Description	Project activity example
AMS-I.A.: Electricity generation by the user	Renewable electricity generation units, such as solar photovoltaic, hydro, wind or biomass gasification are implemented by the users as new installations (Greenfield) or replacement of existing onsite fossil-fuel-fired generation.	Project supplies electricity to household users (included in the project boundary) located in off grid areas.
AMS-I.C.: Thermal energy production with or without electricity	This methodology comprises renewable energy technologies that supply users i.e. residential, industrial or commercial facilities with thermal energy that displaces fossil fuel use. These units include technologies such as solar thermal water heaters and dryers, solar cookers, energy derived from renewable biomass and other technologies that provide thermal energy that displaces fossil fuel.	Thermal energy production using renewable energy source including biomass-based cogeneration and/or trigeneration. Projects that seek to retrofit or modify existing facilities for renewable energy generation are also applicable.

Methodology / Tool	Description	Project activity example
AMS-I.D.: Grid connected renewable electricity generation	This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass: (a) Supplying electricity to a national or a regional grid; or (b) Supplying electricity to an identified consumer facility via national/regional grid through a contractual arrangement such as wheeling.	Project supplies electricity to a national/regional grid, or Project supplies electricity to an identified consumer facility via national/ regional grid (through a contractual arrangement such as wheeling).
AMS-I.F.: Renewable electricity generation for captive use and mini-grid	This methodology comprises renewable energy generation units, such as photovoltaic, hydro, tidal/wave, wind, geothermal and renewable biomass that supply electricity to user(s). The project activity will displace electricity from an electricity distribution system that is or would have been supplied by at least one fossil fuel fired generating unit, i.e. in the absence of the project activity, the users would have been supplied electricity from one or more sources listed below: (a) A national or a regional grid: (b) A fossil fuel fired captive power plant; (c) A carbon intensive mini-grid.	Project displaces grid electricity consumption (e.g. grid import) and/or captive fossil fuel electricity generation at the user end (excess electricity may be supplied to a grid), or Project supplies electricity to a mini grid system where in the baseline all generators use exclusively fuel oil and/or diesel fuel.
AMS-I.L.: Electrification of rural communities using renewable energy	This methodology is applicable to electrification of a community achieved through the installation of renewable electricity generation systems that displace fossil fuel use, such as in fuel-based lighting systems, stand-alone power generators, and fossil fuel based mini-grids. The two categories of applicable project activities are: (a) Implementation of individual, renewable energy systems such as roof top solar photovoltaic systems; (b) Installation or extension of an isolated mini-grid which distributes electricity generated only from renewable energy systems.	After the project implementation, rural communities are supplied with electricity from renewable-based systems (e.g. solar home systems, renewable mini-grid).

Source: Adopted from UNFCCC (2022): CDM Methodology Booklet and linked methodologies in the table

4.3 Project boundary

The project boundary encompasses all GHG emissions that are under the control of the project or significantly and reasonably linked to project activities. The specific project boundary will vary depending on the interventions and technologies used, and it can pertain to either operational control or geographical delineation, i.e. spatial extent. If defining the project boundary proves challenging, the project should refer to approved methodologies (e.g. CDM or GHG Protocol) that are applicable to the specific project case for a detailed determination of the project boundary.

4.4 Baseline scenario, project scenario and leakage emissions

To measure the impacts of GHG emissions, it is essential to define a baseline scenario and project scenario. For each mitigation action it is required to determine both the baseline and project scenarios.

The **baseline scenario** serves as the reference case for the project, representing a hypothetical description of what would likely have happened in the absence of the project to deliver a product or service similar to the project's outcome. It is used to estimate baseline emissions. Generally, the baseline approach, as defined in the applied methodology (refer to section 3), should be adhered to, considering the following guidance. There are three generic possibilities for the baseline scenario and related emissions that would occur without the proposed project, according to the Clean Development Mechanism (CDM) and GHG Protocol[5]:

1. **Business-as-Usual (BAU):** This refers to the continuation of existing activities, technologies, or practices that offer the same type, quality, and quantity of product or service as the project. BAU results in emissions based on current or historical data, as applicable.
2. **Benchmark Approach:** In this approach, the focus is on current activities, technologies, or practices that provide a product or service similar to the project. Only activities undertaken in the previous five years, under similar social, economic, environmental, and technological conditions, and demonstrating top 20 percent performance in low emissions, are considered. For example, for energy efficiency projects, the benchmark approach could involve introducing technologies or equipment with higher energy efficiency than existing market solutions. Adopting the benchmark approach facilitates the identification of technical parameters for establishing the baseline scenario and estimating baseline emissions.
3. **Economically Attractive Alternatives:** This approach considers emissions from an activity, technology, or practice that represents an economically attractive option when compared to the project. It takes into account investment barriers and assesses alternative activities, technologies, or practices within a specific geographical area and time frame that can provide a similar product or service as the project. An example could be activities in the transport sector, where certain vehicle types (e.g. private transport or internal combustion engine (ICE) mini-buses) are more economically appealing and expected to increase over the project period and beyond.

When establishing the baseline, pinpoint the scenario that most accurately reflects the potential situation in which the project would not be implemented. The baseline represents the hypothetical situation in the absence of the project, and thus the baseline emissions (BE) are the expected emissions during the assessment period without the project. When in doubt about the most realistic baseline scenario, projects should apply a conservative approach to avoid overestimating the effects of IKI projects. Under a project that utilises renewable electricity generation such as solar, wind or geothermal either new installations (greenfield) are implemented, or existing onsite fossil-fuel-fired generation is replaced. The renewable

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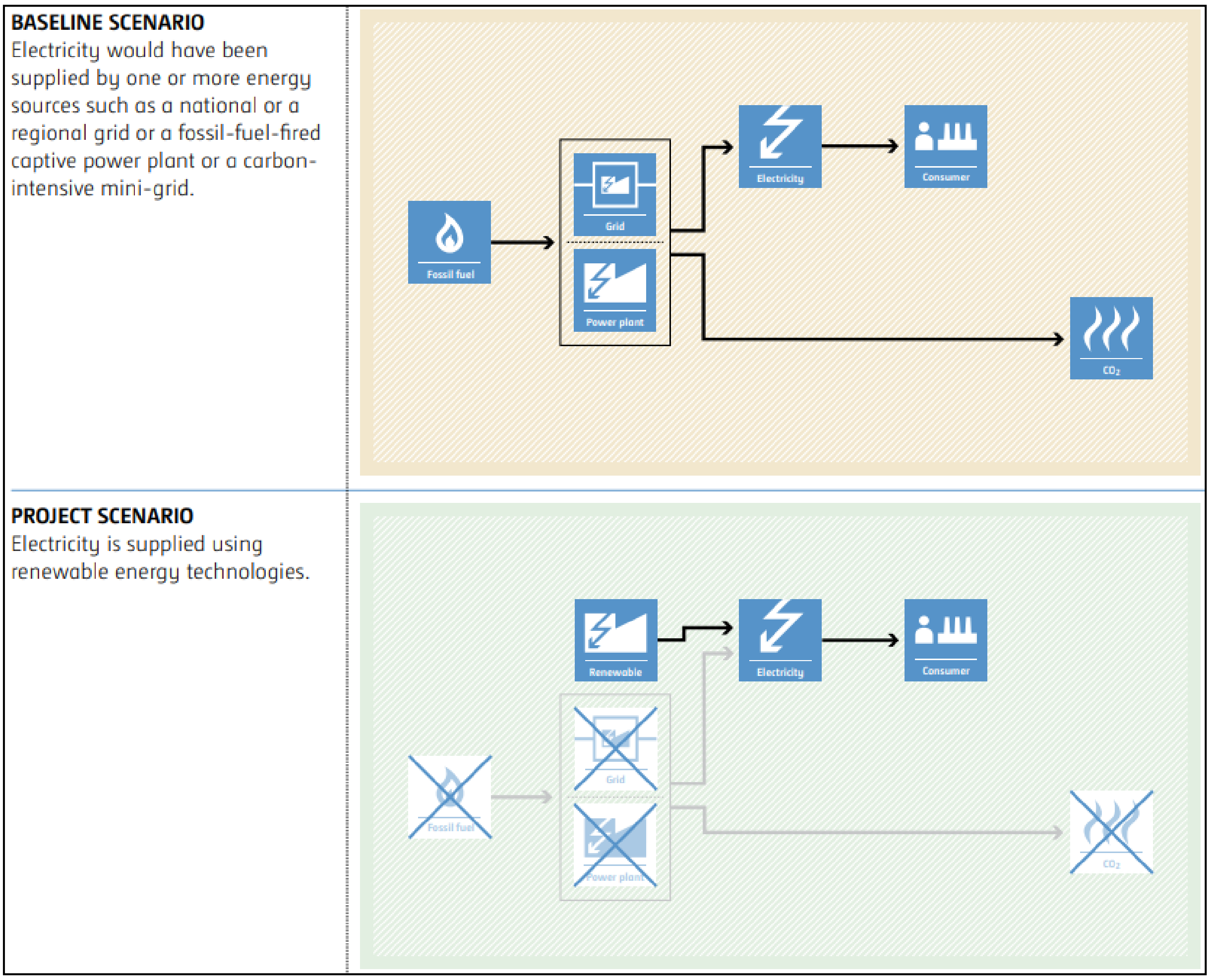
[5] Mitigation Action Facility (2023): Mitigation Action Facility Mitigation Guideline for the Project Concept Phase (p. 9). Retrieved from here.

electricity generation units displace electricity that would be provided to the user(s) by more GHG-intensive means, such as diesel gen-sets or the electricity from the national grid. Under the baseline scenario, the electricity is provided by those more GHG-intensive means.

The **project scenario** describes the expected outcome of the project. It includes all relevant mitigation activities implemented in the project and accounts for the emissions that are produced through these mitigation activities. Depending on the specific mitigation activities, project emissions for renewable energy power generation activities can be zero. It is important to consider the expected lifetime of a project measure or technology in order to correctly assess the project's mitigation impact throughout its lifetime. The technical lifetime is defined as the total time (in years or hours of operation) for which the equipment is technically designed to operate from its first commissioning (see, e.g., MAF Mitigation Guideline). While some technologies are rather short-lived (e.g. the battery of an electric vehicle usually must be replaced after a couple of years), others have a long lifespan (solar panels, e.g., can produce electricity for 25-30 years). A thorough assessment thus requires the calculation of a project's mitigation impact throughout its entire lifetime in addition to the mitigation impact during project duration.

Leakage emissions refer to the additional emissions that occur outside the boundaries of the mitigation action project as a result of implementing that project. This may happen when equipment replaced by the mitigation project continues to be used outside the project boundaries, leading to increased emissions. Common instances in the energy sector include diesel gen-sets, inefficient air conditioners or electric appliances that are replaced but then utilised elsewhere. If leakage emissions are a significant and relevant source of emissions, they should be addressed comprehensively and subtracted from the baseline emissions.

Figure 2: Typical baseline and project scenario for RE generation for captive use and mini-grids



Source: UNFCCC (2022): CDM Methodology Booklet, p. 176.

5 Sample calculation of emission reductions

5.1 Renewable energy generation

This chapter illustrates the calculation of emission reductions for typical renewable energy projects, making use of the IKI Standard Indicator Report (Excel Tool). To estimate the mitigation potential of renewable electricity generation, the general approach of the CDM methodology "Renewable electricity generation for captive use and mini-grid" (AMS-I.F.)[6] can be used. An introduction to the example can be found in the following box. The detailed calculations can be found in IKI SI1 Energy Example on the IKI Website.

Example: Solar energy-based water treatment for hospitals

The aim of the "Solar energy-based water treatment for hospitals" project is to displace electricity that would otherwise have been sourced from fossil fuel-fired generating units. More specifically, the project finances the replacement of fossil fuel powered water treatment systems by a total of 25 solar energy-based water treatment systems in selected urban and rural hospitals. The project can consequently report on direct mitigation.

In the **baseline scenario**[7]**,** the use of fossil fuel powered water treatment continues to prevail. Due to high upfront investment cost of solar PV the operators of water treatment systems are very likely to keep using diesel generation or an existing grid connection. The baseline emissions are calculated based on the fuel consumption of the technology in use in the baseline scenario (i.e. the technology that would have been used to generate the equivalent quantity of energy in the absence of the project).

Under the **project scenario** of the project example, a pilot project for solar-powered water treatment plants in hospitals is implemented at selected urban and rural sites. It is assumed that 40% of the hospitals (10 in total) participating in the pilot project are in rural communities and are using diesel-based generators to power their water treatment systems before the pilot is implemented. The other 60% of the participating hospitals (15 in total) are in urban areas where they can use electricity from the grid to power their water treatment systems. The solar energy-based water treatment systems will thus replace conventional systems run by diesel generators or with electricity from the power grid. The project covers the total investment costs for the construction of 25 solar energy-based water treatment systems. The technology lifetime of the solar-based water treatment systems is assumed to be 20 years. The project duration is from January 2020 until December 2025.

Leakage emissions in the project example stem from diesel gen-sets that are continued to be used after project implementation. It is assumed that 20% of the gen-sets in rural areas are still in use elsewhere after the introduction of the solar water treatment systems.

[6] UNFCCC (2022): Small-scale Methodology - Renewable electricity generation for captive use and mini-grid (Clean Development Mechanism, AMS-I.F.), Version 5.0 (p. 6.) Retrieved from here.

[7] In many cases the "business-as-usual scenario".

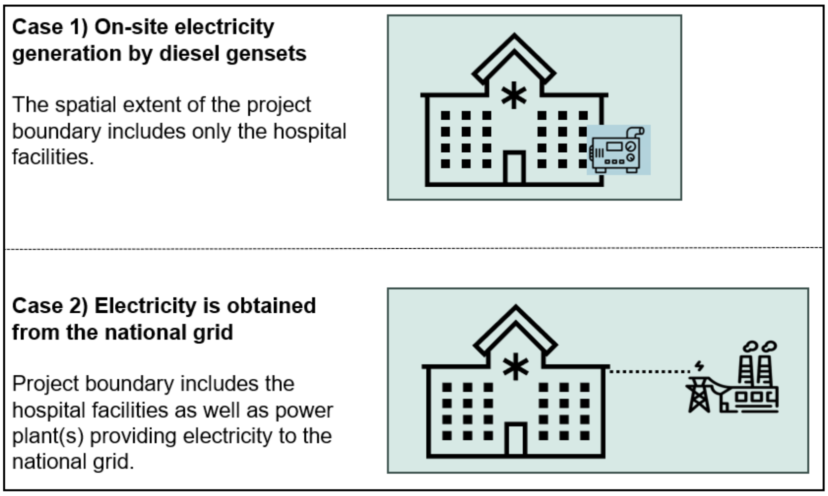
5.1.1 Project boundary

Typically for energy projects, the project boundary includes the physical, geographical site of the (renewable) electricity generating unit(s) and the equipment that uses the electricity produced. For grid connected renewable electricity projects, the project boundary includes the project power plant and all power plants connected physically to the electricity system to which the project power plant is connected.

Example: Solar energy-based water treatment for hospitals

In the project example, the spatial extent of the project boundary comprises all hospitals where the electricity for water treatment is generated on-site by diesel gensets. For the additional hospitals that obtain electricity from the national grid to power their water treatments systems, the boundary extends to the power plants connected physically to the national grid.[8]

Figure 3: Project boundary of the example case



Source: Own illustration

5.1.2 Baseline, project, and leakage emissions

In general, **baseline emissions** for energy projects can be estimated based on the fuel consumption of the technology in use or the technology that would have been used to generate the displaced energy under the baseline scenario. In case of grid connected renewable energy projects, baseline emissions include CO_2 emissions from electricity generation in fossil fuel-fired power plants that are displaced due to the projects:

[8] UNFCCC (2022): Small-scale Methodology - Renewable electricity generation for captive use and mini-grid (Clean Development Mechanism, AMS-I.F.), Version 5.0 (p. 6.) Retrieved from here.

$$ER = BE_y = E_{BL,y} \, x \, EF_k \qquad \text{Equation (2)}$$

Where

BE_y	=	Baseline emissions in year y (tCO_2e).
$E_{BL,k,y}$	=	Energy baseline in year y (kWh) - Quantity of net electricity / energy displaced or reduced of energy/(fossil) fuel type *k* as a result of the implementation of the project
EF_k	=	CO_2 emission factor of energy/(fossil) fuel type *k* (tCO_2e/energy unit)

For most renewable energy power generation project activities, **project emissions** are deemed zero, i.e. $PE_y = 0$. However, some project activities may involve project emissions that can be significant, e.g. hydropower and geothermal energy. These could relate to the following categories[9]:

- *Emissions from fossil fuel combustion:* For geothermal or solar thermal projects, which also use fossil fuels for electricity generation, CO_2 emissions from the combustion of fossil fuels need be accounted for as project emissions. For all renewable energy power generation project activities, emissions due to the use of fossil fuels for the backup generator (e.g. diesel gen-set in mini-grids) can be neglected, if not deemed significant.
- *Emissions from the operation of dry steam, flash steam and binary geothermal power plants* due to non-condensable gases and/or working fluid: For dry or flash steam geothermal project activities, projects should consider emissions of CO_2 and CH_4 due to release of non-condensable gases from produced steam.
- *Emissions from water reservoirs of hydropower plants*: For hydropower project activities that result in a new or in an increase of single or multiple reservoirs, projects should account for CH_4 and CO_2 emissions from the reservoirs.
- *Emissions from charging of a Battery Energy Storage System (BESS) using power from the grid or from fossil fuel electricity generators:* Under normal conditions, BESS should be charged with the electricity generated by the associated renewable power plant. However, in cases where BESS is charged using grid electricity, the corresponding project emissions should be considered and calculated.

Furthermore, typically **leakage emissions** are not applicable for renewable energy projects. However, leakage in renewable energy projects should be considered in case biomass and/or biomass residues are used and in cases where the baseline technology, such as diesel gen-sets, might continue to exist and being operated elsewhere after the project implementation.

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[9] UNFCCC (2022): Large-scale Consolidated Methodology - Grid-connected electricity generation from renewable sources (Clean Development Mechanism, ACM0002) Version 21.0. Retrieved from here.

Example: Solar energy-based water treatment for hospitals

The **baseline emissions** are calculated by multiplying the annual electricity generated by the renewable energy units with the emission factor of the baseline's energy technology. Since rural hospitals use diesel generators while urban ones are connected to the grid, two different emission factors are required for the calculations. For those hospitals in rural areas an emission factor of a modern diesel generating unit of the relevant capacity operating at optimal load is used. In this example, the size of typically replaced diesel gensets is assumed to be >15 kW with a load factor of about 50%. For hospitals located in urban areas the national grid emission factor (GEF) is applied as emission factor.

The **project emissions** for this project are deemed zero since the installed water-treatment systems are run through solar energy. No further calculations are necessary.

Leakage emissions are considered stemming from diesel gen-sets that could be continuously used after project implementation. It is estimated that 20% of the diesel gen-sets in rural areas are still in use elsewhere after the introduction of the solar water treatment systems.

For more details on the calculations, please consult the filled in IKI Standard Indicator Report for the project example available on the IKI website.

Key parameters required for the calculation

For calculating the emission reduction from renewable power projects such as the sample case the following parameters are required. Potential default values are listed in Table 3 (see Section 6 below).

Table 2: Parameters to estimate example case's emission reduction

Parameter	Unit	Value / source
Number of renewable energy facilities installed (e.g. solar energy-based water treatment systems)	No.	Project data
Average solar system size and total installed capacity all solar PV systems	kW_p	Project data
$E_{BL,y}$ - Energy baseline per project facility (generation or consumption)	kWh	Measured or historical figures (for ex-ante estimation default capacity factors can be used for estimating the energy generation)

$EF_{CO2,y}$ – Emission factor of baseline energy source (e.g. diesel generator or electricity grid)	tCO_2e/kWh	For grid connected projects: Harmonized IFI Default Grid Factors 2021 v3.2, combined margin for energy consumption. Off-grid: If no project-specific data is available, a default value as per Table 1 of CDM TOOL33 Methodological tool: Default values for common parameters Version 02.0 should be considered.

5.2 Energy efficiency measures

Energy efficiency projects aim to optimize energy use and many energy efficiency measures have environmental as well as economic benefits. An energy-efficient building for example uses less energy to heat, cool, and run appliances than a building that consumes energy inefficiently.

5.2.1 Project boundary

For energy projects, the project boundary includes the physical, geographical site of the energy generating unit(s) and the equipment that uses the energy produced.

5.2.2 Baseline, project, and leakage emissions

For calculating the emission reductions from energy efficiency projects, the energy use / fuel consumption of different fuel types, e.g. electricity and gas before (**baseline emissions**) and after the project implementation (**project emissions**) is determined. The energy consumption (EC)[10] is multiplied with the corresponding GHG emission factor (EF) to determine the corresponding emissions as per the following generic equation.

$$ER_y = \sum_k (EC_{BE,k,y} - EC_{PE,k,y}) \times EF_k \qquad \text{Equation (3)}$$

Where:

ER_y	=	Emission reductions in year y (tCO_2e).
$EC_{BE,k,y}$	=	Annual consumption of energy/fuel type *k* of baseline, i.e. before implementation, in year *y* (energy units/a)
$EC_{PE,k,y}$	=	Annual consumption of energy/fuel type *k* of project, i.e. after implementation, in year *y* (energy units/a)
EF_k	=	CO_2 emission factor of energy/(fossil) fuel type *k* (tCO_2/energy unit)

[10] In case of electricity transmission and distribution losses (TDL) are added to estimate the gross energy consumption

Leakage emissions are to be considered if, for example, the displaced technology (e.g. ACs) is further used elsewhere or if the applied energy efficiency technology is transferred from another project which thus operates with a less efficient technology after the project implementation than it did before. For conservativeness, potential rebound effects should be accounted for. Rebound effects occur e.g. when some of the energy savings achieved by energy efficiency gains are lost due to resulting changes in behaviour, such as increased consumption of goods or services.[11]

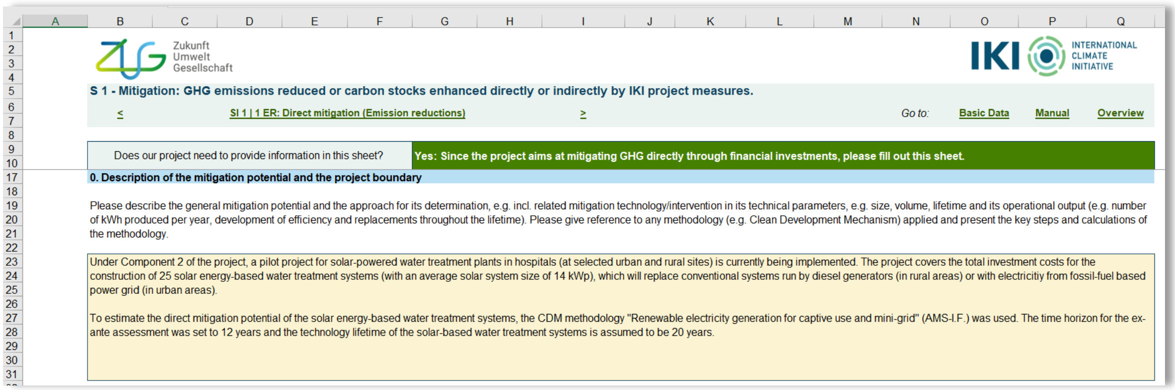
5.3 Mitigation estimation using the IKI Standard Indicator Report (Excel Tool)

IKI projects are required to use the IKI Standard Indicator Report (Excel Tool) to collect project-level data on those IKI Standard Indicators that are relevant to the project. In this subchapter, it is shown how to enter data on the project example in the IKI SI Report (Excel Tool). The filled-in Excel tool illustrating the project example can be accessed on the IKI website.

In the IKI Standard Indicator Report (Excel Tool) any cells where projects should enter data or information are yellow. Instructions on the information that should be provided in the yellow cell can be found in in the text above the cell. In some cases, additional explanatory text will appear in a pop-up window, if the cell is selected. The tool leads the user through the different steps required to calculate the project's mitigation effects, as outlined above. There are separate sheets for direct and indirect mitigation. While the calculations for direct and indirect mitigation follow the same structure, this guidance document describes the approach to assess a project's direct mitigation (i.e. sheet SI1 | 1 ER in the Excel Tool).

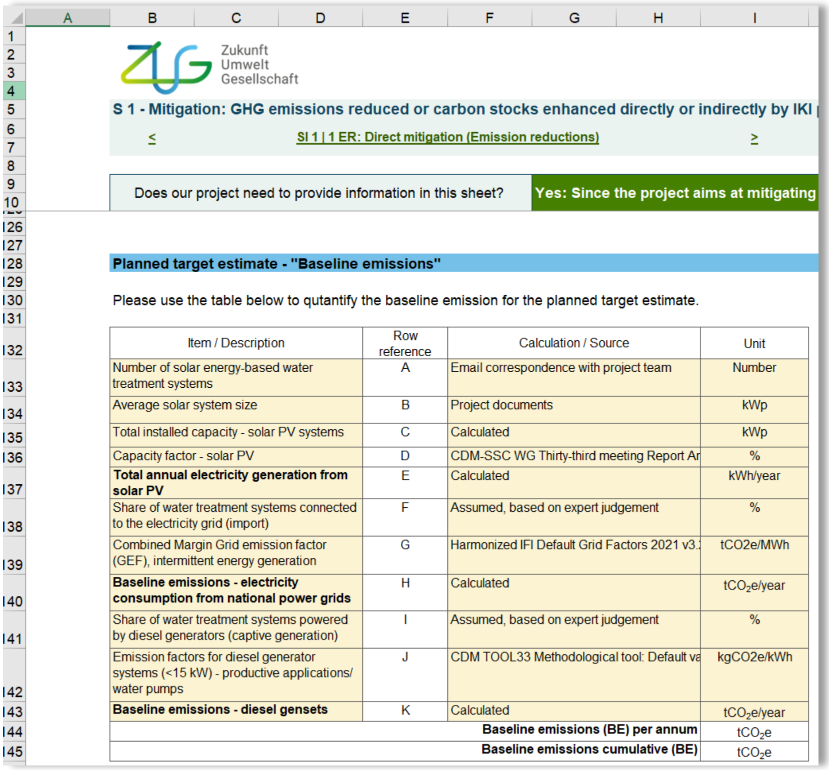
The following list provides a brief overview of the steps required to calculate the project's direct mitigation:

0) **Project description, scope and project boundary** (sheet SI1 | 1 ER): In the beginning, users need to narratively describe the project's background, scope and potential mitigation, incl. the approach for its determination and the project boundary.



[11] For further information and recommendation how to address leakage and rebound effect, Please see Mitigation Action Facility (2023): Mitigation Action Facility Mitigation Guideline (Outline & Proposal Phase) (p.14). Link here.

1) **Parameters and assumptions applied in the estimations / documentation of emissions effects** (sheet SI1 | 1 ER with reference to SI1 | Mitigation): Users need to transparently list all parameters needed to calculate target and achieved values for GHG mitigation. The sources and units of the respective parameters should be mentioned, making use of and direct referencing to the table for *Parameters and assumptions applied* in sheet SI1 | Mitigation. For the sample case, the total annual electricity generation from solar PV implemented by the project must be calculated to assess the baseline emissions associated with the power grid and diesel gensets usage. When filling all calculation tables, users should reference the parameter sheet in the general information sheet SI1 | Mitigation.



Zukunft Umwelt Gesellschaft

S 1 - Mitigation: GHG emissions reduced or carbon stocks enhanced directly or indirectly by IKI

< SI 1 | 1 ER: Direct mitigation (Emission reductions) >

Does our project need to provide information in this sheet? | Yes: Since the project aims at mitigating

Planned target estimate - "Baseline emissions"

Please use the table below to qutantify the baseline emission for the planned target estimate.

Item / Description	Row reference	Calculation / Source	Unit
Number of solar energy-based water treatment systems	A	Email correspondence with project team	Number
Average solar system size	B	Project documents	kWp
Total installed capacity - solar PV systems	C	Calculated	kWp
Capacity factor - solar PV	D	CDM-SSC WG Thirty-third meeting Report Ar	%
Total annual electricity generation from solar PV	E	Calculated	kWh/year
Share of water treatment systems connected to the electricity grid (import)	F	Assumed, based on expert judgement	%
Combined Margin Grid emission factor (GEF), intermittent energy generation	G	Harmonized IFI Default Grid Factors 2021 v3.:	tCO2e/MWh
Baseline emissions - electricity consumption from national power grids	H	Calculated	tCO_2e/year
Share of water treatment systems powered by diesel generators (captive generation)	I	Assumed, based on expert judgement	%
Emission factors for diesel generator systems (<15 kW) - productive applications/ water pumps	J	CDM TOOL33 Methodological tool: Default va	kgCO2e/kWh
Baseline emissions - diesel gensets	K	Calculated	tCO_2e/year
		Baseline emissions (BE) per annum	tCO_2e
		Baseline emissions cumulative (BE)	tCO_2e

2) **Calculation tables for "Baseline emissions", “Project emission” and “Leakages emissions”** (sheet SI1 | 1 ER): Users can either directly enter figures related to the used parameters or– where needed – calculate them. Please note: the grey cells are filled automatically based on the information provided in the yellow cells. For example, “Baseline emissions cumulative” are filled in automatically once the equation for calculating the baseline emissions per annum is filled.

Zukunft Umwelt Gesellschaft

IKI

S 1 - Mitigation: GHG emissions reduced or carbon stocks enhanced directly or indirectly by IKI project measures.

< SI 1 | 1 ER: Direct mitigation (Emission reductions) > Go to: Basic Data Manual

Does our project need to provide information in this sheet?	Yes: Since the project aims at mitigating GHG directly through financial investments, please fill out this sheet.

Planned target estimate - "Baseline emissions"

Please use the table below to qutantify the baseline emission for the planned target estimate.

Item / Description	Row reference	Calculation / Source	Unit	2020 Year 1	2021 Year 2	2022 Year 3	2023 Year 4	2024 Year 5	2025 Year 6
Number of solar energy-based water treatment systems	A	Email correspondence with project team	Number	2	5	10	15	20	25
Average solar system size	B	Project documents	kWp	14	14	14	14	14	14
Total installed capacity - solar PV systems	C	Calculated	kWp	28	70	140	210	280	350
Capacity factor - solar PV	D	CDM-SSC WG Thirty-third meeting Report Ar	%	16	16	16	16	16	16
Total annual electricity generation from solar PV	E	Calculated	kWh/year	39.245	98.112	196.224	294.336	392.448	490.560
Share of water treatment systems connected to the electricity grid (import)	F	Assumed, based on expert judgement	%	60	60	60	60	60	60
Combined Margin Grid emission factor (GEF), intermittent energy generation	G	Harmonized IFI Default Grid Factors 2021 v3.1	tCO2e/MWh	0,46	0,46	0,46	0,46	0,46	0,46
Baseline emissions - electricity consumption from national power grids	H	Calculated	tCO_2e/year	11	27	54	82	109	136
Share of water treatment systems powered by diesel generators (captive generation)	I	Assumed, based on expert judgement	%	40	40	40	40	40	40
Emission factors for diesel generator systems (<15 kW) - productive applications/ water pumps	J	CDM TOOL33 Methodological tool: Default va	kgCO2e/kWh	0,90	0,90	0,90	0,90	0,90	0,90
Baseline emissions - diesel gensets	K	Calculated	tCO_2e/year	14	35	71	106	141	177
		Baseline emissions (BE) per annum	tCO_2e	25	63	125	188	250	313
		Baseline emissions cumulative (BE)	tCO_2e	25	88	213	400	651	963

3) **Calculation of baseline, project, and leakage emissions:** Users need to enter or calculate all project figures or assumption for the "Baseline emissions", "Project emissions", and – if applicable – "Leakage emissions". For each of these three emission categories, there are two sections: i) **Planned target estimate** and ii) **Reporting**. Depending on the status of the project, e.g. the project's planning or implementation phase, the corresponding tables needs to be filled or updated. See Guidelines on Project Planning and Monitoring in the International Climate Initiative for more information and the definition of **Planned target estimate** and **Reporting** figures.

Planned target estimate - "Baseline emissions"

Please use the table below to qutantify the baseline emission for the planned target estimate.

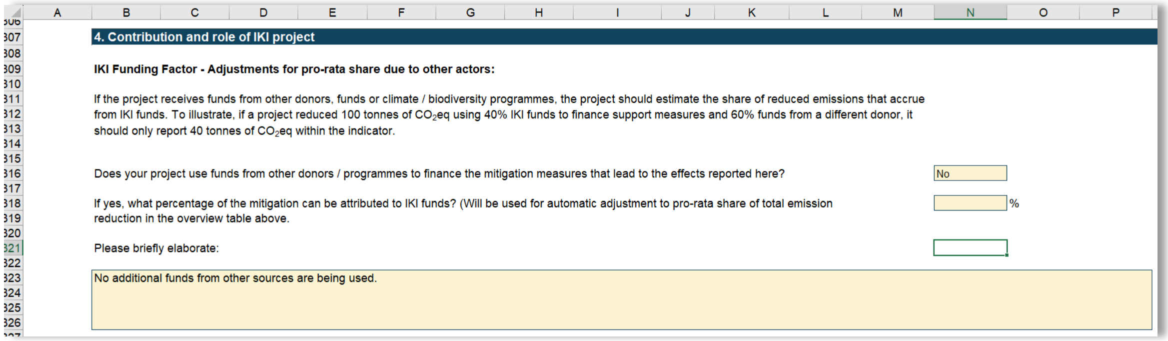
Item / Description	Row reference	Calculation / Source	Unit	2020 Year 1	2021 Year 2	2022 Year 3	2023 Year 4	
Number of solar energy-based water treatment systems	A	Email correspondence with project team	Number	2	5	10	15	20
Average solar system size	B	Project documents	kWp	14	14	14	14	14

Reporting - "Baseline emissions"

Please use the table below to quantify the baseline emission for the annual reporting estimate.

Item / Description	Row reference	Calculation / Source	Unit	2020 Year 1	2021 Year 2	2022 Year 3	2023 Year 4
Number of solar energy-based water treatment systems	A	Email correspondence with project team	Number	1	4	10	0,00
Average solar system size	B	Project documents	kWp	14	14	14	0,00
Total installed capacity - solar PV systems	C	Calculated	kWp	14	56	140	0,00
Capacity factor - solar PV	D	CDM-SSC WG Thirty-third meeting Report Ar	%	16	16	16	0,00
Total annual electricity generation from solar PV	E	Calculated	kWh/year	19.622	78.490	196.224	0,00
Share of water treatment systems connected to the electricity grid (import)	F	Assumed, based on expert judgement	%	60	60	60	0,00
Combined Margin Grid emission factor (GEF), intermittent energy generation	G	Harmonized IFI Default Grid Factors 2021 v3.1	tCO2e/MWh	0,46	0,46	0,46	0,00

4) **Contribution and role of IKI project** (sheet SI1 | 1 ER): If the project receives funding from other donors, the project should estimate the share of reduced emissions that accrue from IKI funds. For instance, if a project reduced 100 tCO_2e using 40% IKI funds and 60% funds from a different donor, it should only report 40 tCO_2e within the indicator. The contribution estimation only applies for direct emission reductions and is not applicable for indirect mitigation.


4. Contribution and role of IKI project

IKI Funding Factor - Adjustments for pro-rata share due to other actors:

If the project receives funds from other donors, funds or climate / biodiversity programmes, the project should estimate the share of reduced emissions that accrue from IKI funds. To illustrate, if a project reduced 100 tonnes of CO_2eq using 40% IKI funds to finance support measures and 60% funds from a different donor, it should only report 40 tonnes of CO_2eq within the indicator.

Does your project use funds from other donors / programmes to finance the mitigation measures that lead to the effects reported here? No

If yes, what percentage of the mitigation can be attributed to IKI funds? (Will be used for automatic adjustment to pro-rata share of total emission reduction in the overview table above. %

Please briefly elaborate:

No additional funds from other sources are being used.

5) **Overall accuracy and rebound effects** (sheet SI1 | 1 ER): Lastly, users should describe any uncertainties regarding estimations and assumptions. Moreover, users should describe any rebound effects expected through the project and, if possible, provide an estimate of their scale.

6 Relevant default values and reference sources

The following table provides an overview of typical and useful default values for estimating the baseline and project emissions from energy efficiency and renewable energy projects.

Table 3: Default values and references for mitigation estimation

Parameter	Value and Unit	Source
Energy efficiency activities		
Emission factor for diesel generators and mini grid (baseline emissions)	0.8-1.0 tCO_2/MWh	CDM TOOL33 Methodological tool: Default values for common parameters Version 02.0
Emission factor electricity grid for the specific country (*Combined Margin for energy efficiency / electricity consumption*)	various, tCO_2/MWh	Harmonized IFI Default Grid Factors 2021 v3.2, combined margin for energy consumption

<table>
<tr><td>Transmission and distribution losses[12] (for conservativeness distinguished between project and baseline energy consumption)</td><td>20% for project (or leakage) electricity consumption sources;
3% for baseline electricity consumption sources</td><td>CDM TOOL05 Methodological tool Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation Version 03.0</td></tr>
<tr><td colspan="3">Renewable energy electricity generation activities, e.g. solar, wind, geothermal</td></tr>
<tr><td>Emission factor for diesel generators and mini grid (baseline emissions)</td><td>0.8-1.0 tCO_2/MWh</td><td>CDM TOOL33 Methodological tool: Default values for common parameters Version 02.0</td></tr>
<tr><td>Emission factor electricity grid for the specific country (Combined Margin for renewable electricity)</td><td>various, tCO_2/MWh</td><td>Harmonized IFI Default Grid Factors 2021 v3.2, combined margin for intermittent energy generation</td></tr>
<tr><td>Transmission and distribution losses (for conservativeness distinguished between project and baseline energy consumption)</td><td>20% for project (or leakage) electricity consumption sources;
3% for baseline electricity consumption sources</td><td>CDM TOOL05 Methodological tool Baseline, project and/or leakage emissions from electricity consumption and monitoring of electricity generation Version 03.0</td></tr>
<tr><td>Capacity factors for estimating the energy yield, i.e. energy generation</td><td>Default values:
<table>
<tr><td>Wind</td><td>0.29</td></tr>
<tr><td>PV</td><td>0.16</td></tr>
<tr><td>Hydro</td><td>0.45</td></tr>
<tr><td>Biomass</td><td>0.68</td></tr>
<tr><td>Ocean, Wave/ Tidal</td><td>0.25</td></tr>
<tr><td>Geothermal</td><td>0.75</td></tr>
</table></td><td>CDM-SSC WG Thirty-third meeting Report Annex 6 “Information Note on Guidelines for the demonstration of additionality of microscale project activities”, p. 13
Databases for energy yields:
• Global Solar Atlas
• Global Wind Atlas</td></tr>
<tr><td colspan="3">Global Warming Potential (GWP) of refrigerants</td></tr>
<tr><td>GWP of refrigerants, if applicable, e.g. for exchange of air conditioning (AC) or chillers</td><td>Selected default values:
<table>
<tr><td>HFC-23</td><td>12,400</td></tr>
<tr><td>HFC-41</td><td>116</td></tr>
<tr><td>HFC-125</td><td>3,170</td></tr>
<tr><td>HFC-134</td><td>1,120</td></tr>
<tr><td>HFC-134a</td><td>1,300</td></tr>
</table></td><td>GHG Protocol Global Warming Potential Values based on IPCC values, IPCC Fifth Assessment Report, 2014 (AR5)</td></tr>
</table>

[12] As of CDM Tool05: In the generic approach, project, baseline and/or leakage emissions from consumption of electricity from the grid are calculated based on the quantity of electricity consumed, an emission factor for electricity generation and a factor to account for transmission losses. Transmissions and distribution losses occur during the transmission of electricity from the powerplant to the end consumer.

For energy-related projects, the CDM Tool 33 offers additional default values applicable for different project contexts. The tool currently provides default values for the following parameters:

- CO_2 emission factor for diesel generating system used for off-grid power generation purposes;
- CO_2 emission factor for kerosene used for lighting applications;
- Wood-to-charcoal conversion factor;
- Average annual consumption of woody biomass per person for cooking;
- Fraction of non-renewable biomass;
- Efficiency of pre-project cooking device.

Please check the most recent version available for the corresponding values.

Finally, as indicated in Box 2 above, other projects that have estimated emission reductions from similar activities and potentially published Excel calculation sheets, provide good references and entry points for the estimation of emission reduction. Projects can, inter alia, consult the CDM Project Search, VERRA / VCS Project Registry, or Gold Standard Project Registry for reference sources.

References

IKI Monitoring and Evaluation (M&E) Unit (2023): Guidelines on Project Planning and Monitoring in the International Climate Initiative. Version 2, accessed 6 February 2024. Retrieved from here.

Mitigation Action Facility (2023): Mitigation Action Facility Mitigation Guideline (Outline & Proposal Phase), accessed 6 February 2024. Retrieved from here.

Mitigation Action Facility (2023): Mitigation Action Facility Mitigation Guideline for the Project Concept Phase, accessed 6 February 2024. Retrieved from here

UNFCCC (2022): CDM Methodologies Booklet, accessed 6 February 2024. Retrieved from here.

UNFCCC (2022): Small-scale Methodology – Renewable electricity generation for captive use and mini-grid (Clean Development Mechanism, AMS-I.F.), Version 5.0, accessed 6 February 2024. Retrieved from here.

UNFCCC (2022): Large-scale Consolidated Methodology - Grid-connected electricity generation from renewable sources (Clean Development Mechanism, ACM0002) Version 21.0, accessed 6 February 2024. Retrieved from here.