7. Energy Saving / Energy Efficiency of Devices and Equipment

1. Typical Project

- Energy efficiency improvement such as introduction of high efficiency devices and equipment such as motors and pumps into factories, agricultural facilities, and water supply/sewerage facilities.

2. Applicability

(1) Introduction of high efficiency devices/equipment (e.g. motors, pumps) compared with those in common use.

(2) Replacement, improvement and renovation of existing devices/equipment, using the same energy sources as in the existing devices/equipment.

(3) Introduction of high efficiency devices/equipment leads to energy efficiency of the facility as a whole.

3. Methodology of Emission Reduction Calculation

The emission reduction from the project activity is determined as the differences between the GHG emission of baseline scenario (e.g. before the improvement of efficiency) and project scenario (after the improvement of efficiency)[1].

Details of sources of each data in the following formulae are provided in "4. Data and Parameters for the Estimation".

$$ER_y = BE_y - PE_y$$

ER_y : GHG emission reduction through the project in year y (t-CO_2e/y)

BE_y : GHG emission from the baseline scenario in year y (t-CO_2e/y)

PE_y : GHG emission from the project scenario in year y (t-CO_2e/y)

(1) Calculation of Baseline Emission

Baseline GHG emission is calculated based on annual electricity and fossil fuel consumption in the absence of the renovation and CO_2 emission factor of the electricity and fossil fuel respectively. For the case of capacity/output increase at the new device/equipment/facility, GHG emissions are calculated by dividing into two types; GHG emissions at the capacity/output increase before the project is implemented and GHG emissions corresponding to the increased capacity/output. The GHG emissions corresponding to the increased capacity/output is considered as emissions from the device/equipment/facility when using the most popular technology in the country where the project is implemented, and is calculated using the following formula.

If there is no data on the energy efficiency of the most popular facilities in the country, the GHG emission reduction of the capacity/output increase is regarded as zero from the viewpoint of conservative calculation of the GHG emission reduction.

(i) When the output or capacity does not increase compared to before the project.

$$BE_y = \left(BE_{elec} + BE_{fuel}\right) \times \frac{P_{PJ}}{P_{BL}}$$

$$= \left[\left(EC_{BL} \times EF_{elec}\right) + \sum_i \left(FC_{BL,i} \times NCV_i \times EF_{fuel,i} \div 10^6\right)\right] \times \frac{P_{PJ}}{P_{BL}}$$

(ii) When the output or capacity increases compared to before the project

[1] The target year shall be a representative year under average operation or an annual average of multiple years.

$$BE_y = (BE_{elec} + BE_{fuel}) + (BE_{elec,country} + BE_{fuel,country}) \times \frac{P_{PJ} - P_{BL}}{P_{BL}}$$
$$= (BE_{elec} + BE_{fuel}) + (BE_{elec} + BE_{fuel}) \times \frac{\eta_{BL}}{\eta_{BL,country}} \times \frac{P_{PJ} - P_{BL}}{P_{BL}}$$
$$= \left[(EC_{BL} \times EF_{elec}) + \sum_i (FC_{BL,i} \times NCV_i \times EF_{fuel,i} \div 10^6)\right] \times (1 + \frac{\eta_{BL}}{\eta_{BL,country}} \times \frac{P_{PJ} - P_{BL}}{P_{BL}})$$

BE_{elec} : Emission associated with electricity consumption before the project (t-CO_2e/y)

BE_{fuel} : Emission associated with fuel consumption before the project (t-CO_2e/y)

$BE_{elec,\ country}$: Baseline emission associated with electricity consumption before the project at the facilities using most popular technologies in the country where the project is implemented (t-CO_2e/y)

$BE_{fuel,\ country}$: Baseline emission associated with fuel consumption before the project at the facilities using most popular technologies in the country where the project is implemented (t-CO_2e/y)

P_{BL} : Production capacity (or other appropriate factors) before the project

P_{PJ} : Production capacity (or other appropriate factors) in the project

η_{BL} : Energy efficiency of device/equipment/facility before the project (%)

$\eta_{BL,country}$: Energy efficiency of device/equipment/facility using most popular technologies in the country where the project is implemented (%)

EC_{BL} : Electricity consumption before the project (MWh/y)

If there are multiple devices / equipment, the total value shall be used.

In case electricity consumption is not available, EC can be estimated using alternative data such as rated output, operation hours, load factor.

EF_{elec} : CO_2 emission factor of the grid electricity (t-CO_2/MWh)

$FC_{BL,i}$: Consumption of the fuel i before the project (t/y)

If there are multiple devices / equipment, the total value shall be used.

In case fuel consumption is not available, FC can be estimated using alternative data such as rated output, operation hours, load factor.

NCV_i : Net calorific value of fuel i (TJ/Gg=TJ/kt)

$EF_{fuel,i}$: CO_2 emission factor of fuel i (kg-CO_2/TJ)

(2) Calculation of Project Emission

Project GHG emission is calculated based on annual electricity and fossil fuel consumption in the project and CO_2 emission factor of the electricity and fossil fuel respectively.

$$PE_y = PE_{elec,y} + PE_{fuel,y}$$
$$= (EC_{PJ,y} \times EF_{elec}) + \sum_i (FC_{PJ,i,y} \times NCV_i \times EF_{fuel,i} \div 10^6)$$

$PE_{elec,y}$: Project emission associated with electricity consumption in year y(t-CO_2e/y)

$PE_{fuel,y}$: Project emission associated with fuel consumption in year y(t-CO_2e/y)

$EC_{PJ,y}$: Electricity consumption in the project in year y (MWh/y)

If there are multiple devices / equipment, the total value shall be used.

In case electricity consumption is not available, EC can be estimated using alternative data such as rated output, operation hours, load factor.

EF_{elec} : CO_2 emission factor of the grid electricity (t-CO_2/MWh)

$FC_{PJ, i,y}$: Consumption of the fuel i in the project in year y (t/y)

If there are multiple devices / equipment, the total value shall be used.

In case fuel consumption is not available, FC can be estimated using alternative data such as rated output, operation hours, load factor.

NCV_i : Net calorific value of fuel i (TJ/Gg = TJ/kt)

$EF_{fuel,i}$: CO_2 emission factor of fuel i (kg-CO_2/TJ)

If there is no energy efficiency data, set ηBL / ηBL, country = 0.

4. Data and Parameters for the Estimation

Data	Description	Data Sources	
		For baseline emission calculation	For project emission calculation
EC_{BL}	Electricity consumption before the project (MWh/y)	For a new facility: Estimated by a measured value at similar facility For an existing facility: A measured value before the project starts (Fixed value) If there are multiple devices / equipment, the total value shall be used. In case electricity or fuel consumption is not available, it can be estimated using alternative data such as rated output, operation hours, load factor.	N/A
$FC_{BL,i}$	Consumption of the fuel i before the project (t/y)		
P_{BL}	Production capacity (or other appropriate factors) before the project	A measured value or planned value before the project starts (Fixed value)	
P_{PJ}	Production capacity (or other appropriate factors) in the project	A planned value	
η_{BL}	Energy efficiency of device/equipment/facility before the project (%)	New facility: Estimated value based on results of similar facilities. Improvement and renovation of existing facility; A monitored value of existing facility.	N/A
$\eta_{BL,country}$	Energy efficiency of device/equipment/facility using most popular technologies in the country where the project is implemented (%)	Survey results in the country of the project implementation. If there is no energy efficiency data, set $\eta_{BL} / \eta_{BL, country} = 0$. *	N/A
$EC_{PJ,y}$	Electricity consumption in the project in year y (MWh/y)	N/A	A planned value
$FC_{PJ,i,y}$	Consumption of the fuel i in the project in year y		A planned value

	(t/y)		
EF_{elec}	CO_2 emission factor of the grid electricity (t-CO_2/MWh)	A default value (Table 4, "Energy Efficiency", Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	
NCV_i	Net calorific value of fuel i (TJ/Gg=TJ/kt)	A default value (Table 1 and 2, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	
$EF_{fuel,i}$	CO_2 emission factor of fuel i (kg-CO_2/TJ)		

（※）If there is no data on the energy efficiency of the most popular facilities in the country, the GHG emission reduction of the capacity/output increase is regarded as zero from the viewpoint of conservative calculation of the GHG emission reduction.

5. Others

(1) Project Boundary

The physical boundary for estimating GHG emissions includes the facility in the project site.

(2) Leakage

There are indirect emissions that potentially lead to leakage due to activities such as manufacturing and transport of materials/products and waste processes. However, these emissions are temporary and negligible compare to the project scale. Therefore, they can be ignored.

(3) Comparison with existing methodologies

There are CDM methodologies such as AMS II.C. (Demand-side energy efficiency activities for specific technologies), AMS II.D (Energy efficiency and fuel switching measures for industrial facilities) and JBIC J-MRV002 (The methodology for energy saving projects) can be references for development of the methodology.

AMS II.D defines that from the point of time of replacement, modification and retrofit of the exiting industrial facilities, the baseline scenario is assumed to correspond to the project scenario (then baseline energy consumption is assumed to equal project energy consumption) and no emission reductions are assumed to occur. However, this methodology does not take into account this condition.

The CDM methodology is only applicable to the projects of aggregated energy savings of a single project (inclusive of a single facility or several facilities) may not exceed the equivalent of 60 GWh per year.

(4) CH_4 and N_2O

Since methane (CH_4) and nitrous oxide (N_2O) do not have a significant impact on emission reductions by the project, they were not considered for simplification.

(5) Revision history

Version	Year/Month	Revisions
2.0	March 2014	• Added default values for combined margins and operating margins of CO2 emission factors of electricity
3.0	September 2019	• Added a calculation method for capacity/output increase • Prioritized the use of default values • Added instructions not to consider CH_4 and N_2O emissions

7. Energy Saving / Energy Efficiency of Devices and Equipment

4.0	March 2023	• Revised to apply to energy efficiency not only in industry, but also in agriculture, water and wastewater treatment plants, etc. • The title was revised to “7. Energy Saving / Energy Efficiency of Devices and Equipment”. • In the description of the calculation method and necessary data of baseline emissions, the words "before project implementation" was revised to use "the baseline scenario". The baseline scenario is the scenario that would have occurred in the absence of the project, such as continuation of the pre-project conditions. • Deleted the column "Ex-post" in "4. Data and Parameters Estimated and Need Monitoring": current version of Climate-FIT aims to quantify GHG emission reductions in the "planning phase").
5.0	March 2024	• No revision.