9. Energy Saving / Fuel Switch in Industrial Facilities

1. Typical Project

- Switching from a high carbon content fuel (e.g. fuel oil) to a low carbon content fuel (e.g. natural gas) at new or existing industrial facilities.

2. Applicability

(1) Realization of fuel switch from a high carbon content fuel to a low carbon content fuel at new or existing industrial facilities.

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 (using a high carbon content fuel such as the situation before the project starts) and project scenario (using a low carbon content fuel)[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 the annual fuel consumption of the project, CO_2 emission factor of fuel and the baseline boiler efficiency etc.

For the case of boiler capacity increase at the new facility, GHG emissions are calculated by dividing into two types; GHG emissions at the capacity increase in the baseline scenario is implemented and GHG emissions corresponding to the increased capacity. The GHG emissions corresponding to the increased capacity is considered as emissions from the facility when using the most popular technology in the country where the project is implemented, and is calculated using the following formula.

(i) When the boiler capacity does not increase compared to the baseline scenario.

$$BE_y = \frac{\sum_i \left(FC_{PJ,i,y} \times NCV_i \times \eta_{PJ} \times EF_{fuel,BL} \div 10^6 \right)}{\eta_{BL}}$$

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

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

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

η_{BL} : Baseline boiler efficiency

η_{PJ} : Project boiler efficiency

(ii) When the boiler capacity increases compared to the baseline scenario

Calculate the CO_2 emissions per boiler output (baseline emission factor) before the project implementation using the following

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

formula.

$$EF_{BL} = \frac{\sum_i (FC_{PJ,i,y} \times NCV_i \times \eta_{PJ} \times EF_{fuel,BL} \div 10^6)}{\eta_{BL}} \times \frac{1}{Q_{PJ,y}}$$

$Q_{PJ,y}$: Boiler capacity in year y after project implementation (TJ/y)

Baseline emissions are calculated in the same way as (i) above until the boiler output before the project is implemented, and more than that, using the most popular boiler efficiency.

$$BE_y = (Q_{PJ,y} - Q_{BL}) \times EF_{BL} \times \frac{\eta_{BL}}{\eta_{BL,country}} + Q_{BL} \times EF_{BL}$$

Q_{BL} : Boiler capacity in the baseline scenario (TJ/y)

$\eta_{BL,country}$: Boiler efficiency of the most popular facilities in the country where the project is implemented (%)

(2) Calculation of Project Emission

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

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

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

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

4. Data and Parameters for the Estimation

Data	Description	Data Sources	
		For baseline emission calculation	For project emission calculation
$Q_{PJ,y}$	Boiler capacity in year y after project implementation (TJ/y)	A planned value	N/A
Q_{BL}	Boiler capacity in the baseline scenario (TJ/y)	A planned value	
$FC_{PJ,i,,y}$	Consumption of the project fuel i in year y (t/y)	A planned value	A planned value
NCV_i	Net calorific value of the project fuel i (TJ/Gg = TJ/kt)	A default value (Table 1, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	
$EF_{fuel,BL}$	CO_2 emission factor of the baseline fuel (kg-CO_2/TJ)	A default value (Table 2, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A
$EF_{fuel,i}$	CO_2 emission factor of the project fuel i (kg-CO_2/TJ)	N/A	A default value (Table 2, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.
η_{BL}	Baseline boiler efficiency	A default value (Table 5, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A
$\eta_{BL,country}$	Boiler efficiency of the most popular facilities in	A default value (Table 5, Appendix) If there is no default value applied or if	N/A

	the country where the project is implemented (%)	there is another appropriate value, that value may be used. If there is no energy efficiency data, set η_{BL} / $\eta_{BL, country}$ = 0. *	
η_{PJ}	Project boiler efficiency	A default value (Table 5, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.	N/A

（※）If there is no data on the energy efficiency of the most popular facilities in the country, the GHG emission reduction of the capacity 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 and construction processes. However, these emissions are temporary and negligible compare to the project scale. Therefore, tyey can be ignored.

(3) Comparison with existing methodologies

There are CDM methodologies such as ACM0009 (Consolidated baseline and monitoring methodology for fuel switching from coal or petroleum fuel to natural gas), AMS III.B. (Switching fossil fuels) and AMS III.AN (Fossil fuel switch in existing manufacturing industries) can be references for development of the methodology.

The small scale CDM methodology is only applicable to the projects that the emission reduction may not exceed the equivalent of 60 kt CO_2 per year. However, there is no limitation in this methodology. In AMS III.AN., the specific baseline emission factor, for the calculation of baseline emission calculation, shall be calculated as the minimum value among the ex ante and ex post values. However, this methodology does not apply the method. The CDM methodology includes project emissions associated with the electricity consumption at the project site; however, it is not included in this methodology.

(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	• Amended baseline emission calculation to use amount of fuel consumption in the project and baseline boiler efficiency
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

4.0	March 2023	• 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.