10. Energy / Heat and Electricity Generation Facility/Fuel Switch

1. Typical Project

- Activities of shifting from high carbon content fuel (such as heavy oil) to low carbon content fuel (such as natural gas) in the facilities of heat and electricity generation.
- Target both of new and existing facilities.

2. Applicability

(1) In the case of existing facilities, shifting from existing high carbon content fuel to a low carbon content fuel.

(2) In the case of new facilities, shifting from the most common high carbon content fuel to a low carbon content fuel.

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 (application of high carbon content fuel) and project scenario (application of 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 : Emission reduction through the projet 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 project fuel consumption and efficiencies of baseline and project heat/steam generation facility.

For the case of capacity increase at the new facility, GHG emissions are calculated by dividing into two types; GHG emissions at the capacity increase before the project 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 capacity of the heat/steam generation facility does not increase compared to the baseline scenario.

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

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

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

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

η_{BL} : Heat/steam generation efficiency of the system in the baseline scenario (%)

η_{PJ} : Heat/steam generation efficiency of the system in the project (%)

(ii) When the capacity of the heat/steam generation facility increases compared to the baseline scenario

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

Calculate the CO_2 emissions per energy output (baseline emission factor) in the baseline scenario using the following formula.

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

$Q_{PJ,y}$: Energy output of the facility in year y after project implementation (TJ/y)

Baseline emissions are calculated in the same way as (i) above until the energy output before the project is implemented, and more than that, using the most popular energy 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} : Energy output of the facility in year y in the baseline scenario (TJ/y)

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

(2) Calculation of Project Emission

Project emission is calculated based on the fuel consumption in the project and CO_2 emission factor of the corresponding 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 fuel i used in the project (t/y)

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

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

4. Data and Parameters for the Estimation

Data	Description	Data Sources	
		For baseline emission calculation	For project emission calculation
$Q_{PJ,y}$	Energy output in year y after project implementation (TJ/y)	A planned value	N/A
Q_{BL}	Energy output in year y in the baseline scenario (TJ/y)	A planned value	
η_{BL}	Heat/steam generation efficiency of the system in the baseline scenario (%)	An IPCC 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
$\eta_{BL,country}$	Heat/steam generation efficiency of the most popular facilities in the country where the project is implemented (%)	An IPCC default value (Table 5, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used. If there is no energy efficiency data, set η_{BL} / $\eta_{BL,country}$ = 0. *	N/A

η_{PJ}	Heat/steam generation efficiency of the system in the project (%)	An IPCC 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
$FC_{PJ,i,y}$	Consumption of the fuel i used in the project (t/y)	A planned value	A planned value
NCV_i	Net caloric value of the fuel i used in the project (TJ/Gg = TJ/kt)	An IPCC 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 fuel used in the baseline scenario (kg-CO_2/TJ)	An IPCC 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 fuel i used in the project (kg-CO_2/TJ)	N/A	An IPCC default value (Table 2, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.

（※）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 measuring GHG emissions includes power and heat generation facilities where project activity is implemented.

(2) Leakage

There are probably indirect emissions that potentially lead to leakage due to activities such as product manufacturing or transport of materials. However, the kind of emission is temporary and negligible compare to the project scale. Therefore, it can be ignored. On the other hand, regarding fugitive CH_4 emissions associated with fuel production in the case of application of natural gas, 10% of the project emission can be taken as leakage for simplicity.

(3) Comparison with existing CDM methodologies

There are CDM methodologies such as AMS-III.B. (Switching fossil fuels, Version 16.0)、AMS-III.AM. (Fossil fuel switch in a cogeneration/tri-generation system, Version 2) and ACM0011 (Consolidated baseline methodology for fuel switching from coal and/or petroleum fuels to natural gas in existing power plants for electricity generation, Version 2.2) can be references for development of the methodology.

The logic of emission reduction calculation in the methodology is almost the same as that of the CDM methodologies. However, this methodology tries to apply straightforward parameters and default values as more as possible such as project fuel consumption for simplicity and transparency. Moreover, there is no limitation for the emission reduction in the methodology like the CDM methodologies did.

(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	• Combined two methodologies (10. Energy plant construction with fuel switching (Ver1.0) and 12.Thermal power with fuel switching (Ver1.0)) as the methodological logic was identical • Amended baseline emission calculation to use default values and simplified the formula • Amended baseline emission calculation to use project fuel consumption 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.