

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

### 1. Typical Project

- Activities of shifting from high carbon intense fuel (such as heavy oil) to low carbon intense 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 intense fuel to a low carbon intense fuel.
- (2) In the case of new facilities, shifting from the most common high carbon intense fuel to a low carbon intense 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 intense fuel) and project scenario (application of low carbon intense fuel).

$$ER_y = BE_y - PE_y$$

$ER_y$  : Emission reduction through the project in a year y (t-CO<sub>2</sub>e/y)

$BE_y$  : GHG emission from the baseline scenario in a year y (t-CO<sub>2</sub>e/y)

$PE_y$  : GHG emission from the project scenario in a year y (t-CO<sub>2</sub>e/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 before the project.

$$BE_y = \sum_j (FC_{PJ,j,y} \times NCV_j \times \eta_{PJ} / \eta_{BL}) \times EF_{fuel,i}$$

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

$EF_{fuel,i}$  : CO<sub>2</sub> emission factor of the fuel i used in the baseline (t-CO<sub>2</sub>/TJ)

$NCV_j$  : Net caloric value of the fuel j used in the project (TJ/t)

$\eta_{BL}$  : Heat/steam generation efficiency of the system in the baseline (%)

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

(ii) When the capacity of the heat/steam generation facility increases compared to before the project

Calculate the CO<sub>2</sub> emissions per energy output (baseline emission factor) before the project implementation using the following formula.

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

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

$Q_{PJ,y}$  : Energy output in a 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 in year y before the project implementation (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<sub>2</sub> emission factor of the corresponding fuel.

$$PE_y = \sum_j (FC_{PJ,j,y} \times NCV_j \times EF_{fuel,j})$$

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

$NCV_j$  : Net caloric value of the fuel j used in the project (TJ/t)

$EF_{fuel,j}$  : CO<sub>2</sub> emission factor of the fuel j used in the project (t-CO<sub>2</sub>/TJ)

## 4. Data and Parameters Estimated and Need Monitoring

Data	Description	Data Sources			
		For baseline emission calculation		For project emission calculation	
		Ex-ante	Ex-post	Ex-ante	Ex-post
$Q_{PJ,y}$	Energy output in year y after project implementation (TJ/y)	A planned value	A monitored value (Purchase receipt)	N/A	
$Q_{BL}$	Energy output in year y before the project implementation (TJ/y)	A planned value			
$\eta_{BL}$	Heat/steam generation efficiency of the system in the baseline (%)	An IPCC default value (Table 6, 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 (%)	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	

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

$\eta_{PJ}$	Heat/steam generation efficiency of the system in the project (%)	An IPCC default value (Table 6, Appendix) If there is no default value applied or if there is another appropriate value, that value may be used.		N/A	
$FC_{PJ,j,y}$	Consumption of the fuel j used in the project (t/y)	A planned value	A monitored value (From fuel purchase bills or invoices)	A planned value	A monitored value (From fuel purchase bills or invoices)
$NCV_j$	Net caloric value of the fuel j used in the project (TJ/t)	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.			
$EF_{fuel,i}$	CO <sub>2</sub> emission factor of the fuel i used in the baseline (t-CO <sub>2</sub> /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	
$EF_{fuel,j}$	CO <sub>2</sub> emission factor of the fuel j used in the project (t-CO <sub>2</sub> /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<sub>4</sub> 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.

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

### (4) CH<sub>4</sub> and N<sub>2</sub>O

Since methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) do not have a significant impact on emission reductions by the project, they were not considered for simplification.