

## 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

- 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) and project scenario (using a low carbon content fuel).

$$ER_y = BE_y - PE_y$$

$ER_y$  : GHG 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 annual fuel consumption of the project 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 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.

- When the boiler capacity does not increase compared to before the project.

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

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

$NCV_i$  : Net calorific value of the project fuel i (TJ/t)

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

$\eta_{BL}$  : Baseline boiler efficiency

$\eta_{PJ}$  : Project boiler efficiency

- When the boiler capacity increases compared to before the project

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

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

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

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

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

$NCV_i$  : Net calorific value of fuel i (TJ/t)

$EF_{fuel,i}$  : CO<sub>2</sub> emission factor of project fuel i (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
$Q_{PJ,y}$	Boiler capacity in a year y after project implementation (TJ/y)	A planned value	A monitored value (Purchase receipt)	N/A	
$Q_{BL}$	Boiler capacity in a year y before the project implementation (TJ/y)	A planned value			
$FC_{PJ,i,y}$	Consumption of the project fuel i in a year y (t/y)	A planned value	A monitored value (Purchase receipt)	A planned value	A monitored value (Purchase receipt)
$NCV_i$	Net calorific value of the project fuel i (TJ/t)	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.			
$EF_{fuel,j}$	CO <sub>2</sub> emission factor of the baseline fuel j (t-CO <sub>2</sub> /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 <sub>2</sub> emission factor of the project fuel i (t-CO <sub>2</sub> /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.	

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$\eta_{BL}$	Baseline boiler efficiency	A 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
$\eta_{BL, country}$	Boiler 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
$\eta_{PJ}$	Project boiler efficiency	A 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

(※) 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, they 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<sub>2</sub> 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<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.