# 7. Energy Saving / Energy Efficiency in Industrial Facilities

## 1. Typical Project

- Energy efficiency improvement such as introduction of high efficient motors in industrial facilities.

## 2. Applicability

(1) Construction of new facilities in which high efficient equipment compared with equipment in common use is applied.

(2) Improvement and renovation of existing facilities by installing new equipment, which uses the same energy sources as in the existing facility.

## 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 (before the improvement of efficiency) and project scenario (after the improvement of efficiency).

$$ER_y = BE_y - PE_y$$

$ER_y$ : GHG emission reduction through the project in a year y (t-$CO_2$e/y)

$BE_y$ : GHG emission from the baseline scenario in a year y (t-$CO_2$e/y)

$PE_y$ : GHG emission from the project scenario in a year y (t-$CO_2$e/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 CO2 emission factor of the electricity and fossil fuel respectively. For new facilities, the energy consumption will be estimated by using the data of similar facilities in common use. 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 does not increase compared to before the project.

$$\begin{aligned} BE_y &= (BE_{elec} + BE_{fuel}) \times \frac{P_{PJ}}{P_{BL}} \\ &= \left[ (EC_{BL} \times EF_{elec}) + \sum_i \left( FC_{BL,i} \times NCV_i \times EF_{fuel,i} \right) \right] \times \frac{P_{PJ}}{P_{BL}} \end{aligned}$$

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

$$\begin{aligned} BE_y &= \left( BE_{elec} + BE_{fuel} \right) + \left( BE_{elec,country} + BE_{fuel,country} \right) \times \frac{P_{PJ} - P_{BL}}{P_{BL}} \\ &= \left( BE_{elec} + BE_{fuel} \right) + \left( BE_{elec} + BE_{fuel} \right) \times \frac{\eta_{BL}}{\eta_{BL,country}} \times \frac{P_{PJ} - P_{BL}}{P_{BL}} \\ &= (EC_{BL} \times EF_{elec}) + \sum_i \left( FC_{BL,i} \times NCV_i + EF_{fuel,i} \right) \times \left( 1 + \frac{\eta_{BL}}{\eta_{BL,country}} \times \frac{P_{PJ} - P_{BL}}{P_{BL}} \right) \end{aligned}$$

$BE_{elec}$ : Baseline emission associated with electricity consumption in a year y (t-$CO_2$e/y)

$BE_{fuel}$ : Baseline emission associated with fuel consumption in a year y (t-$CO_2$e/y)

$BE_{elec,\ country}$: Baseline emission associated with electricity consumption in a year y at the most popular facilities in the country where the project is implemented (t-CO2e/y)

$BE_{fuel,\ country}$: Baseline emission associated with fuel consumption in a year y at the most popular facilities in the country where the project is implemented (t-CO2e/y)

$P_{BL}$ : Production capacity (or other appropriate factors) in the baseline

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

$\eta_{BL}$ : Baseline energy efficiency (%)

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

$EC_{BL}$ : Electricity consumption in the baseline in a year y (MWh/y)

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

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

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

$EF_{fuel,i}$ : $CO_2$ emission factor of fuel i (t-$CO_2$/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.

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

$PE_{elec,y}$ : Project emission associated with electricity consumption in a year y(t-$CO_2$e/y)

$PE_{fuel,y}$ : Project emission associated with fuel consumption in a year y(t-$CO_2$e/y)

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

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

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

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

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

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

**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 |
| $EC_{BL}$ | Electricity consumption in the | For a new facility: Estimated by a measured value at similar facility | | N/A | |

| | | | | | |
|---|---|---|---|---|---|
| | baseline in year a y (MWh/y) | For an existing facility: A measured value before the project starts (Fixed value) | | | |
| $FC_{BL,i}$ | Consumption of the fuel i in the baseline in a year y (t/y) | | | | |
| $P_{BL}$ | Production capacity (or other appropriate factors) in the baseline | 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 | A measured value or planned value | | |
| $\eta_{BL}$ | Baseline energy efficiency (%) | New facility: Estimated value based on results of similar facilities. Improvement and renovation of existing facility; A monitored value of existing facility. | | | |
| $\eta_{BL,country}$ | Energy 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 $\eta_{BL} / \eta_{BL,country} = 0$. * | | | |
| $EC_{PJ,y}$ | Electricity consumption in the project in a year y (MWh/y) | N/A | | A planned value | A monitored value (Electric meter or purchase receipt) |
| $FC_{PJ,i,y}$ | Consumption of the fuel i in the project in a year y (t/y) | | | A planned value | A monitored value (Purchase receipt) |
| $EF_{elec}$ | $CO_2$ emission factor of the grid electricity (t-$CO_2$/MWh) | A default value (Table 4, 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/t) | 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 (t-$CO_2$/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 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.