11. Thermal Power Generation/Fuel Efficiency Improvement

1. Typical Project Outline

- Construction of high efficient thermal power generation plants.
- Improvement of existing thermal power plants (replacement of existing facilities, introduction of combine cycle facilities).

2. Applicability

(1) Construction of a high efficient thermal power plant comparing to the most common thermal power plants in the host countries.

(2) Replacement of existing facilities with high efficient facilities in existing thermal power plants.

(3) Not applicable for introduction of co-generation.

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 (facilities with low efficiency) and project scenario (facilities with high efficiency).

$$ER_y = BE_y - PE_y$$

$\mathrm{ER_y}$: Emission reduction through the projet in a year y (t-CO_2e/y)

$\mathrm{BE_y}$: GHG emission from the baseline scenario in a year y (t-CO_2e/y)

$\mathrm{PE_y}$: GHG emission from the project scenario in a year y (t-CO_2e/y)

(1) Calculation of Baseline Emission

Baseline GHG emission is calculated based on the amount of power generated by the project and specific fuel consumption of baseline facilities.

For the case of capacity increase at the new power plant, 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 plant 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 power plant does not increase compared to before the project.

$$BE_y = EG_{PJ,y} \times GE_{BL} \times NCV_i \times EF_{fuel,i}$$

$\mathrm{EG_{PJ,y}}$: Amount of electricity generated by the project in a year y (MWh/y)

$\mathrm{GE_{BL}}$: Specific fuel consumption of baseline facilities (t/MWh)

$\mathrm{NCV_i}$: Net caloric value of the fuel i used for power generation (TJ/t)

$\mathrm{EF_{fuel,i}}$: CO_2 emission factor of the fuel i used for power generation (t-CO_2/TJ)

(ii) When the capacity of the power plant increases compared to before the project

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

$$BE_y = \left\{ \left(EG_{PJ,y} - EG_{BL} \right) \times \frac{\eta_{BL}}{\eta_{BL,country}} + EG_{BL} \right\} \times GE_{BL} \times NCV_i \times EF_{fuel,i}$$

EG_{BL} : Amount of electricity generated in a year y before the project implementation (MWh/y)

η_{BL} : Power generation efficiency before the project is implemented (%)

$\eta_{BL,country}$: Power 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 consumption of fuel for power generation in the project and CO_2 emission factor of the fuel used for power generation.

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

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

NCV_i : Net caloric value of the fuel i used for power generation (TJ/t)

$EF_{fuel,i}$: CO_2 emission factor of the fuel i used for power generation (t-CO_2/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
$EG_{PJ,y}$	Amount of electricity generated by the project in a year y (MWh/y)	A planned value	A monitored value	N/A	
EG_{BL}	Amount of electricity generated in a year y before the project implementation (MWh/y)	A planned value		N/A	
GB_{BL}	Specific fuel consumption of baseline facilities (t/MWh)	From the following sources in the order of priority i) A value from the actual performance of existing typical old power plants or the target power plant ii) A value from the specification of the target power plant facilities		N/A	
$FC_{PJ,i,y}$	Consumption of the fuel i used for power generation in the project (t/y)	N/A		A planned value	A monitored value (From fuel purchase bills or invoices))
$EF_{fuel,i}$	CO_2 emission factor of the fuel i used for power generation (t-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.			
NCV_i	CO_2 emission factor of the fuel i used for power generation (t-CO_2/TJ)	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.			
η_{BL}	Power generation efficiency before the project is implemented	A monitored value		N/A	

	(%)		
$\eta_{BL,country}$	Power 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 η_{BL} / $\eta_{BL,\ country}$ = 0. *	N/A

（※）If there is no data on the power generation efficiency of the most popular plants 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 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.

(3) Comparison with existing CDM methodologies

There are CDM methodologies such as AM0061 (Methodology for rehabilitation and/or energy efficiency improvement in existing power plants, Version 2.1), AM0062 (Energy efficiency improvements of a power plant through retrofitting turbines, Version 2.0), ACM0013 (Construction and operation of new grid connected fossil fuel fired power plants using a less GHG intensive technology, Version 05) and AMS-II.B. (Supply side energy efficiency improvements-generation, Version 09) 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 ACM001. However, this methodology tries to apply straightforward parameters and default values as more as possible such as specific 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.